

Sri Sivasubramaniya Nadar College of Engineering

(An Autonomous Institution, Affiliated to Anna University, Chennai)



Regulations 2024

Curriculum and Syllabi

for

B. E in Computer Science and Engineering

Sri Sivasubramaniya Nadar College of Engineering
(An Autonomous institution, Affiliated to Anna University Chennai)

Department of Computer Science and Engineering

B. E in Computer Science and Engineering

VISION

- To emerge as a world class technology department through education, innovation and collaborative research.

MISSION

- To impart quality education to students.
- To create and disseminate knowledge for the betterment of mankind.
- To establish a center of excellence in collaboration with industries, research laboratories and other agencies to meet the changing needs of society.
- To provide individual attention and enable character building.
- To encourage entrepreneurship skills among students.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1:

Professional Success: Our graduates will excel in their career in industries associated with Computer Science and Engineering, or in research, or as entrepreneurs by applying their expertise in diverse domains.

PEO2:

Adaptability: Our graduates will adapt to emerging technologies and develop new skills to remain competitive.

PEO3:

Professionalism: Our graduates will maintain ethical and professional standards in their technical work keeping sustainable development of the society in view.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to

PO	Graduate Attribute	Programme Outcome
1	Engineering Knowledge	Apply the knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex Computer Science and Engineering problems (WK 1 to 4).

2	Problem Analysis	Identify, formulate, review research literature, and analyze complex Computer Science and Engineering problems reaching substantiated conclusions with consideration for sustained development (WK 1 to 4).
3	Design/Development of solutions	Design creative solutions for complex Computer Science and Engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).
4	Conduct Investigations of Complex Problems	Conduct investigations of complex Computer Science and Engineering problems using research-based knowledge including design of experiments, modelling, analysis and interpretation of data to provide valid conclusions (WK8).
5	Engineering Tool Usage:	Create, select, and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex Computer Science and Engineering problems (WK2 and WK6).
6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex Computer Science and Engineering problems for their impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5 and WK7).
7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws (WK9).
8	Individual and Collaborative Teamwork.	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9	Communication	Communicate effectively and inclusively within the engineering community and the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multi-disciplinary environments.
11	Life-long learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK8).

PROGRAM SPECIFIC OUTCOMES (PSOs)

On successful completion of the program, our graduates will be able to

PSO 1: Apply foundational knowledge in discrete structures, algorithms, computer networks, databases, operating systems, Internet programming and Artificial Intelligence, to solve complex computing problems.

PSO 2: Design and implement software and hardware systems using contemporary information processing technologies by applying software engineering principles and practices.

PEOs mapping with POs and PSOs

PEOs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
PEO – I	3	3	3	3	2	1	1	1	2	3	2	3	3	3
PEO – II	1	2	3	2	3	3	3	1	2	1	2	3	2	3
PEO – III	2	2	2	2	1	2	2	3	2	1	3	2	2	3

Mapping Programme Outcomes with Graduate Attributes

Programme Outcomes	NBA's GAs
PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex Computer Science and engineering problems.	GA1
PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex Computer Science and engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	GA2

PO3: Design/Development of Solutions: Design creative solutions for complex Computer Science and engineering problems and design/develop systems/components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society, and environment as required. (WK5).	GA3
PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex Computer Science and engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).	GA4
PO5: Engineering Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex Computer Science and engineering problems. (WK2 and WK6).	GA5
PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex Computer Science and engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture, and environment. (WK1, WK5, and WK7).	GA10
PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; adhere to national & international laws. (WK9).	GA10
PO8: Individual and Collaborative Teamwork: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams	GA6
PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.	GA8
PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.	GA7
PO11: Life-Long Learning: Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and	GA9, G11

emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).	
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CO-PO-PSO MAPPING

Semester	Course Name	POs												PSOs	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
I	Communicative English (TCP)						1			1	3		1		
	Algebra and Calculus for Engineers	3	2			1							1		
	Engineering Physics (TCP)	3	2		1						2				
	Engineering Chemistry (TCP)	3			1		1	1		1			1		
	Problem Solving and Python Programming (TCP)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Engineering Graphics	3				1					3		1	1	1
II	Calculus of Vectors, Complex Functions and Laplace Transforms	3	2										1		
	Basic Electrical and Electronics Engineering	3	3	1	1		1	1	1	1	1	1	1		
	Program Development Using C (TCP)	3	3	3	3		2		3	3	3		3	2	2
	Environmental Science						2	3		1	1		1		
	Digital Principles and Design	3	2	3										2	2
	Design Thinking and Engineering Practices Laboratory						2		2	2	2		2		
	Digital Principles and Design Lab	3	2	3	3					3	3			2	2
	Fundamentals and Practice on Software Development (EFP)	3	3	3	3	3	3	3	3	3	3	3	3	3	3

TCP - Theory-cum Practical

Curriculum – R-2024 (Choice Based Credit System)

SEMESTER I				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UEN3186	Communicative English (TCP)	HS	4	30	0	15	45	90	3
2	UMA3176	Algebra and Calculus for Engineers	BS	4	45	15	0	60	120	4
3	UPH3186	Engineering Physics (TCP)	BS	5	45	0	15	60	120	4
4	UCY3186	Engineering Chemistry (TCP)	BS	5	45	0	15	60	120	4
5	UGE3188	Problem Solving and Python Programming (TCP)	ES	5	15	0	30	45	90	3
6	UGE3176	Engineering Graphics	ES	5	15	0	30	45	90	3
7	UGA3176	Heritage of Tamils	HS	1	15	0	0	15	30	1
PRACTICALS										
-	-	-	-	-	-	-	-	-	-	-
TOTAL				29	210	15	210	225	660	22
SKILL DEVELOPMENT										
8	UGEV301	SDG Experiential Laboratory I ^s	EEC	2	0	0	30	0	30	1

SEMESTER II				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UMA3276	Calculus of Vectors, Complex Functions and Laplace Transforms	BS	4	45	15	0	60	120	4
2	UEE3276	Basic Electrical and Electronics Engineering	ES	3	45	0	0	45	90	3
3	UCS3281	Program Development Using C (TCP)	ES	5	15	0	60	15	90	3
4	UCY3276	Environmental Science*	MC	1	15	0	0	15	30	1
5		Humanities I-Elective	HS	4	30	0	30	30	90	3
6	UCS3262	Digital Principles and Design	ES	3	45	0	0	45	90	3
7	UGA3276	Tamils and Technology	HS	1	15	0	0	15	30	1
PRACTICALS										

8	UGE3297	Design Thinking and Engineering Practices Laboratory	ES	3	0	0	45	0	45	1.5
9	UCS3211	Digital Principles and Design Laboratory	ES	3	0	0	45	0	45	1.5
10	UCS3212	Fundamentals and Practice on Software Development	EEC	4	0	0	60	0	60	2
TOTAL				31	210	15	240	225	690	23
SKILL DEVELOPMENT										
11	UGEV302	SDG Experiential Laboratory II ^{\$}	EEC	2	0	0	30	0	30	1

SEMESTER III				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW&SL	TH	C
THEORY										
1	UMA3352	Foundations of Discrete Mathematics	BS	4	45	15	0	60	120	4
2	UHS3386	Universal Human Values 2: Understanding Harmony	HS	4	30	0	30	30	90	3
3	UCS3301	Data structures	PC	3	45	0	0	45	90	3
4	UCS3302	Computer Organization and Architecture	PC	3	45	0	0	45	90	3
5	UCS3361	Object Oriented Programming	PC	6	30	0	60	30	120	4
6	UCS3303	Operating Systems	PC	3	45	0	0	45	90	3
7	UGE3386	Design Thinking, Innovation and Entrepreneurship	EEC	5	15	0	60	15	90	3
PRACTICALS										
8	UCS3311	Data structures Laboratory	PC	3	0	0	45	0	45	1.5
9	UCS3312	Operating Systems Laboratory	PC	3	0	0	45	0	45	1.5
TOTAL				34	255	15	240	270	780	26
SKILL DEVELOPMENT										
10	UCSV303	Skill Development Laboratory – I ^{\$}	EEC	1	0	0	30	0	30	1

SEMESTER IV				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UMA3476	Probability Theory and Statistics	BS	4	45	15	0	60	120	4
2	UGA3476	Indian Constitution	MC	1	15	0	0	15	30	1
3	UCS3401	Design and Analysis of Algorithms	PC	3	45	0	0	45	90	3
4	UCS3402	Database Management Systems	PC	3	45	0	0	45	90	3
5	UCS3461	Foundations of Artificial Intelligence (TCP)	PC	5	45	0	30	45	120	4
6	UCS3462	Internet Programming	PC	6	30	0	60	30	120	4
7	UCSV304	Industry Oriented Course	EEC	1	15	0	0	15	30	1
PRACTICALS										
8	UCS3411	Database Laboratory	PC	3	0	0	45	0	45	1.5
9	UCS3412	Competitive Programming Laboratory	PC	3	0	0	45	0	45	1.5
TOTAL				29	240	15	180	255	690	23
SKILL DEVELOPMENT										
10	UCSV305	Skill Development Lab – II ^s	EEC	0	0	0	30	0	30	1

SEMESTER V				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UCS3501	Computer Networks	PC	3	45	0	0	45	90	3
2	UCS3502	Principles of Machine Learning	PC	3	45	0	0	45	90	3
3	UCS3503	Theory of Computation	PC	3	45	0	0	45	90	3
4	UCS3504	Software Engineering	PC	3	45	0	0	45	90	3
5		Professional Elective I	PE	3	45	0	0	45	90	3
6		Open Elective -I	OE	3	45	0	0	45	90	3
PRACTICALS										
7	UCS3511	Networks Laboratory	PC	3	0	0	45	0	45	1.5
8	UCS3512	Principles of Machine Learning Laboratory	PC	4	0	0	60	0	60	2
9	UCS3513	System Design Laboratory	PC	3	0	0	45	0	45	1.5
TOTAL				28	270	0	150	270	690	23

SEMESTER VI				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UCS3661	Compiler Design (TCP)	PC	4	30	0	30	30	90	3
2	UCS3362	Microcontrollers and Interfacing (TCP)	PC	4	30	0	30	30	90	3
3	UCS3663	Computer Graphics (TCP)	PC	4	30	0	30	30	90	3
4	UCS3664	Embedded Programming (TCP)	PC	3	15	0	30	15	60	2
5		Professional Elective II	PE	3	45	0	0	45	90	3
6		Professional Elective III	PE	3	45	0	0	45	90	3
PRACTICALS										
7	UCS3617	Mini Project	EEC	6	0	0	45	45	90	3
TOTAL				27	195	0	165	150	600	20

SEMESTER VII				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1	UCS3701	Network and Computer Security	PC	3	45	0	0	45	90	3
2		Professional Elective IV	PE	3	45	0	0	45	90	3
3		Professional Elective V	PE	3	45	0	0	45	90	3
PRACTICALS										
4	UCS3711	Network Security Laboratory	PC	4	0	0	60	0	60	2
5	UCS3718	Project Work Phase I	EEC	6	0	0	45	45	90	3
6	UCS3716	Industrial Training / Internship	EEC	4	0	0	0	60	60	2
TOTAL				23	135	0	105	150	480	16

SEMESTER VIII				Teaching and Learning Scheme (per semester)						
S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	TW& SL	TH	C
THEORY										
1		Open elective - II	OE	3	45	0	0	45	90	3

2		Professional Elective VI	PE	3	45	0	0	45	90	3
PRACTICALS										
3	UCS3818	Project Work Phase II	EEC	16	0	0	120	120	240	8
TOTAL				22	90	0	120	210	420	14

[§] Value added course – Credits will not be counted for GPA and CGPA Calculation.

* Mandatory Course

L - Lecture , **T** - Tutorial , **P** - Practical , **C** – Credits , **TCP** - Theory-cum Practical Course and **TW & SL** – Term Work & Self Learning

GRAND PROJECT PATHWAY

Semester	Course	Credit
III	Design thinking, Innovation and Entrepreneurship	3
IV	Independent Research/Project Work I	1
V	Independent Research/Project Work II	2
V	Management Elective- Project Management and Planning	3
VI	Mini Project	3
VII	Project Phase I	3
VIII	Project Phase II	8
Total Credit for GPP		23

SEMESTER WISE GRADE DISTRIBUTION

SEMESTER	HS	BS	ES	PC	PE	OE	EEC	MC	TOTAL
I	4	12	6				1*		22
II	4	4	12				2+1*	1	23
III	3	4		16			3+1*		26
IV		4		18			1+1*	1	23
V				17	3	3			23
VI				11	6		3		20
VII				5	6		5		16
VIII					3	3	8		14
TOTAL	11	24	18	66	18	6	22	2	167

PROFESSIONAL ELECTIVES

Professional Elective I [Semester 5]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW & SL	TH	C
1	UCS3561	Foundations of Data Science	PE	30	0	30	30	90	3
2	UCS3562	User Experience Design	PE	30	0	30	30	90	3
3	UCS3563	Exploratory Data Analysis	PE	30	0	30	30	90	3
4	UCS3521	Statistical Methods in Data Analysis	PE	45	0	0	45	90	3
5	UCS3522	Mathematics for Machine Learning	PE	45	0	0	45	90	3
6	UCS3564	Natural Language Processing Techniques	PE	30	0	30	30	90	3
7	UCS3565	UNIX and Shell programming	PE	30	0	30	30	90	3
8	UCS3566	Image Processing and Analysis	PE	30	0	30	30	90	3
9	UCS3567	Graphics and Multimedia Techniques	PE	30	0	30	30	90	3
10	UCS3568	Ethical Hacking	PE	30	0	30	30	90	3
11	UCS3523	Advanced Graph Theory	PE	45	0	0	45	90	3
12	UCS3524	Advanced Data Structures and Algorithms	PE	45	0	0	45	90	3
13	UCS3525	Advanced Java Programming	PE	45	0	0	45	90	3
14	UCS3526	Principles of Blockchain Technology	PE	45	0	0	45	90	3
15	UCS3527	Introduction to Number Theory for Cryptography	PE	45	0	0	45	90	3

HUMANITIES I-ELECTIVE (II-SEMESTER)

COURSE CODE	COURSE TITLE	Teaching and Learning Scheme (per semester)					
		L	T	P	TW&SL	TH	C
UEN3286	Psychology and Communication	30	0	30	30	90	3
UEN3287	Human Relations and Communication Skills	30	0	30	30	90	3
UEN3288	Communication Through Media	30	0	30	30	90	3
UEN3289	Technical Writing	30	0	30	30	90	3

Professional Elective II [Semester 6]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW&SL	TH	C
1	UCS3665	Big Data Management	PE	30	0	30	30	90	3
2	UCS3621	Information Retrieval Techniques	PE	45	0	0	45	90	3
3	UCS3622	Computer Vision	PE	45	0	0	45	90	3
4	UCS3623	Principles of Reinforcement Learning	PE	45	0	0	45	90	3
5	UCS3624	IoT Technologies	PE	45	0	0	45	90	3
6	UCS3625	Object Oriented Analysis and Design	PE	45	0	0	45	90	3
7	UCS3626	Principles of Programming Languages	PE	45	0	0	45	90	3
8	UCS3627	Embedded system for Industrial Applications	PE	45	0	0	45	90	3
9	UCS3628	Wireless Sensor Networks & Protocols	PE	45	0	0	45	90	3
10	UCS3662	Augmented Reality & Virtual Reality	PE	30	0	30	30	90	3

11	UCS3629	Speech Processing and Synthesis	PE	45	0	0	45	90	3,
12	UCS3630	Game Theory	PE	45	0	0	45	90	3
13	UCS3631	Information Security	PE	45	0	0	45	90	3
14	UCS3632	Cloud Security and Privacy Data Privacy	PE	45	0	0	45	90	3
15	UCS3633	Software Testing	PE	45	0	0	45	90	3
16	UCS3634	Cyber Crime and Loss	PE	45	0	0	45	90	3
17	UCS3667	LLM & Generative AI	PE	30	0	30	30	90	3
18	UCS3635	Data warehouse techniques	PE	45	0	0	45	90	3

Professional Elective III [Semester 6]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW & SL	TH	C
1	UCS3636	Health care Data Analytics	PE	45	0	0	45	90	3
2	UCS3637	Bayesian Data Analysis	PE	45	0	0	45	90	3
3	UCS3638	Data Engineering	PE	45	0	0	45	90	3
4	UCS3668	Principles of deep learning	PE	30	0	30	30	90	3
5	UCS3639	Principles of Pattern Recognition	PE	45	0	0	45	90	3
6	UCS3640	Biometrics	PE	45	0	0	45	90	3
7	UCS3691	GPU Computing	PE	45	0	0	45	90	3
8	UCS3692	Software Configuration Management	PE	45	0	0	45	90	3
9	UCS3693	Agile Methodologies	PE	45	0	0	45	90	3
10	UCS3694	Smart Sensors	PE	45	0	0	45	90	3
11	UCS3669	3D Modeling and Animation	PE	30	0	30	30	90	3
12	UCS3666	Game Programming	PE	30	0	30	30	90	3
13	UCS3695	Mobile and Wireless Security	PE	45	0	0	45	90	3
14	UCS3682	Cloud Computing and Microservices	PE	30	0	30	30	90	3

15	UCS3620	Cyber Security	PE	45	0	0	45	90	3
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Professional Elective IV [Semester 7]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW&SL	TH	C
1	UCS3761	Mobile Application Development	PE	30	0	30	30	90	3
2	UCS3721	Bioinformatics	PE	45	0	0	45	90	3
3	UCS3762	Soft Computing	PE	30	0	30	30	90	3
4	UCS3722	Agentic Process Automation	PE	45	0	0	45	90	3
5	UCS3723	Artificial Intelligence based Search Methods for Problem Solving	PE	45	0	0	45	90	3
6	UCS3763	Wearable Computing	PE	30	0	30	30	90	3
7	UCS3764	Software Project Management	PE	30	0	30	30	90	3
8	UCS3765	Application Development using AR, VR and MR	PE	30	0	30	30	90	3
9	UCS3724	Cryptography and Data Security	PE	45	0	0	45	90	3
10	UCS3766	Malware Analysis	PE	30	0	30	30	90	3
11	UCS3725	Cyber Forensics	PE	45	0	0	45	90	3
12	UCS3726	Distributed Systems	PE	45	0	0	45	90	3

Professional Elective V [Semester 7]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW & SL	TH	C
1	UCS3767	Big Data Technologies (TCP)	PE	30	0	30	30	90	3
2	UCS3727	Multivariate Statistical Analysis	PE	45	0	0	45	90	3

3	UCS3768	Financial Data Analytics (TCP)	PE	30	0	30	30	90	3
4	UCS3728	Fundamentals of Edge Computing	PE	45	0	0	45	90	3
5	UCS3769	Social Networks Analysis(TCP)	PE	30	0	30	30	90	3
6	UCS3729	Applied optimization techniques	PE	45	0	0	45	90	3
7	UCS3731	Principles of Brain Computer Interface	PE	45	0	0	45	90	3
8	UCS3732	Robotic Process Automation	PE	45	0	0	45	90	3
9	UCS3733	Robotics	PE	45	0	0	45	90	3
10	UCS3734	Realtime Systems	PE	45	0	0	45	90	3
11	UCS3781	Software Verification & Validation (TCP)	PE	30	0	30	30	90	3
12	UCS3735	Video Processing & Analytics	PE	45	0	0	45	90	3
13	UCS3736	Network & Server Security	PE	45	0	0	45	90	3
14	UCS3737	Privacy and Security in Social Networks	PE	45	0	0	45	90	3
15	UCS3738	Drone Technology	PE	45	0	0	45	90	3

Professional Elective VI [Semester 8]

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW & SL	TH	C
1	UCS3861	Penetration Testing and Vulnerability Analysis (TCP)	PE	30	0	30	30	90	3
2	UCS3821	Quantum Computing	PE	45	0	0	45	90	3
3	UCS3822	Edge Analytics	PE	45	0	0	45	90	3
4	UCS3823	Logic Programming	PE	45	0	0	45	90	3
5	UCS3824	Formal System Verification	PE	45	0	0	45	90	3

6	UCS3825	Database Tuning	PE	45	0	0	45	90	3
7	UCS3862	Software Defined Networks	PE	30	0	30	30	90	3
8	UCS3826	Multicore Architectures and Programming	PE	45	0	0	45	90	3
9	UCS3827	Information Visualization	PE	45	0	0	45	90	3
10	UCS3828	Cognitive Computing	PE	45	0	0	45	90	3
11	UCS3829	Privacy and Security in IoT	PE	45	0	0	45	90	3
12	UCS3831	Time series analysis	PE	45	0	0	45	90	3
13	UCS3832	AI Data Governance	PE	45	0	0	45	90	3
14	UCS3833	Design Thinking in AI	PE	45	0	0	45	90	3
15	UCS3834	Ethics in AI	PE	45	0	0	45	90	3

HONOURS SPECIALIZATION

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Teaching and Learning Scheme (per semester)					
				L	T	P	TW & SL	TH	C
1	UCS3522	Mathematics for Machine Learning	PE	45	0	0	45	90	3
2	UCS3564	Natural Language Processing Techniques	PE	30	0	30	30	90	3
3	UCS3622	Computer Vision	PE	45	0	0	45	90	3
4	UCS3623	Principles of Reinforcement Learning	PE	45	0	0	45	90	3
5	UCS3H61	Large Language Models & Generative AI	PE	30	0	30	30	90	3
6	UEC3733	Deep Learning Techniques	PE	30	0	30	30	90	3
7	UCS3639	Principles of Pattern Recognition	PE	45	0	0	45	90	3
8	UCS3762	Soft Computing	PE	30	0	30	30	90	3

9	UCS3723	Artificial Intelligence based Search Methods for Problem Solving	PE	45	0	0	45	90	3
10	UCS3769	Social Networks Analysis	PE	30	0	30	30	90	3
11	UCS3729	Applied optimization Techniques	PE	45	0	0	45	90	3
12	UCS3823	Logic Programming	PE	45	0	0	45	90	
13	UCS3828	Cognitive Computing	PE	45	0	0	45	90	3

INDEPENDENT STUDY*

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TW&SL	TH	C
1	GCS3417	Independent research / Project work – 1	EEC	0	0	30	15	45	1
2	GCS3517	Independent research / Project work -2	EEC	0	0	45	15	60	2

*Can waive one PE of 3 credits

*In Place of 1 PE by waiver

GROUPING OF ELECTIVES

PE	Data Science	AI & ML	System Design	Multimedia Processing	Security & Privacy
PE1 (Vsem)	Foundations of Data Science , Exploratory Data Analysis , Statistical Methods in Data Analysis	Mathematics for Machine Learning, Natural Language Processing	UNIX and Shell programming , User Experience Design , Advanced Graph Theory, Advanced data structures and algorithms, Advanced Java Programming	Image Processing and Analysis , Graphics and Multimedia Techniques	Ethical Hacking, Principles of Blockchain Technology, Introduction to Number Theory for Cryptography
PE2 (VIsem)	Information Retrieval Techniques, Big Data Management,	Computer Vision, Principles of Reinforcement Learning,	Wireless Sensor Networks & Protocols, IoT Technologies,	Augmented Reality & Virtual Reality,	Information Security, Cloud Security and Privacy,

	Data warehouse techniques	Large Language Models & Generative AI	Object Oriented Analysis and Design, Principles of programming languages, Embedded system for Industrial Applications	Speech Processing and Synthesis, Game theory	Software Testing, Cyber Crime and Loss
PE3 (VIsem)	Health care Data Analytics, Bayesian Data Analysis, Data Engineering	Deep Learning Techniques, Principles of Pattern Recognition, Biometrics	Multicore Architectures and Programming, Software Configuration Management, Agile Methodologies, Smart Sensors	3D Modeling and Animation , Game Programming	Mobile and Wireless Security, Cloud computing and micro services, Cyber Security
PE4 (VIIsem)	Bioinformatics	Artificial Intelligence based Search Methods for Problem Solving, Soft Computing , Agentic Process Automation	Wearable Computing , Software Project Management , Mobile Application Development	Application Development using AR, VR & MR	Cryptography and Data Security, Malware Analysis , Cyber Forensics
PE5 (VIIsem)	Multivariate Statistical Analysis, Financial Data Analytics, Fundamentals of Edge Computing, Big Data Technologies	Social Networks Analysis , Applied optimization techniques, Principles of Brain Computer Interface,	Robotics, Realtime Systems, Software Verification & Validation	Video Processing & Analytics, Drone Technology	Network & Server Security, Privacy and Security in Social Networks

		Robotic Process Automation			
PE6 (VIIIsem)	Quantum Computing, Edge Analytics	Logic Programming, Cognitive Computing, Introduction to Data and AI Governance, Design Thinking in AI, Ethics in AI	Database Tuning, Software Defined Networks , GPU Computing, Formal System Verification	Information Visualization, Time series analysis	Privacy and Security in IoT, Penetration Testing and Vulnerability Analysis

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING - MINOR SPECIALIZATION

S. No.	COURSE CODE	COURSE TITLE	Teaching and Learning Scheme (per semester)					
			L	T	P	TW & SL	TH	C
1	UCS3M61	Principles of Data Science	30	0	30	30	90	3
2	UCS3M62	Machine Learning	30	0	30	30	90	3
3	UCS3M21	Fundamentals of Artificial Intelligence	45	0	0	45	90	3
4	UCS3M22	Deep Learning	45	0	0	45	90	3
5	UCS3M63	Image processing	30	0	30	30	90	3
6	UCS3M23	Introduction to Natural Language Processing	45	0	0	45	90	3
7	UCS3M24	Speech processing Techniques	45	0	0	45	90	3
8	UCS3M25	Big Data analytics	45	0	0	45	90	3
9	UCS3M26	Foundations and Applications of Machine Learning	45	0	0	45	90	3
10	UCS3M64	Introduction to Exploratory Data Analysis	30	0	30	30	90	3
11	UCS3M27	Fundamentals of Information Retrieval Techniques	45	0	0	45	90	3

12	UCS3M28	Fundamentals of Edge Analytics	45	0	0	45	90	3
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OPEN ELECTIVE - I (SEMESTER-V) – COMMON TO ALL DEPARTMENTS
(Offered by MBA Department)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	Teaching and Learning Scheme (per semester)					
					L	T	P	TW & SL	TH	C
1	UBA3941	Project Management and Planning	OE	3	45	0	0	45	90	3
2	UBA3942	Total Quality Management	OE	3	45	0	0	45	90	3
3	UBA3943	Work Ethics, Corporate Social Responsibility, and Governance	OE	3	45	0	0	45	90	3

OPEN ELECTIVE - I (SEMESTER-V) – COMMON TO ALL DEPARTMENTS
(Offered by English Department)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	Teaching and Learning Scheme (per semester)					
					L	T	P	TW & SL	TH	C
1	UEN3941	Advanced Professional Communication	OE	3	30	0	30	30	90	3

OPEN ELECTIVE - I (SEMESTER-V) – COMMON TO ALL DEPARTMENTS
(Offered by Mathematics Department)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	Teaching and Learning Scheme (per semester)					
					L	T	P	TW & SL	TH	C
1	UMA3942	Introduction To Linear Algebra	OE	3	45	0	0	45	90	3
2	UMA3944	Number Theory and Cryptography	OE	3	45	0	0	45	90	3

OPEN ELECTIVE - I (SEMESTER-V)
(Offered by Mathematics Department to CHEM,EEE,ECE,BME,CSE & IT Departments)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	Teaching and Learning Scheme (per semester)					
					L	T	P	TW & SL	TH	C
1	UMA3941	Graph Theory and Applications	OE	3	45	0	0	45	90	3

Open Electives offered by CSE department to Other Departments)

OPEN ELECTIVE – I (Semester – V)

S. No.	COURSE CODE	COURSE TITLE	L	T	P	TW&SL	TH	C
1	UCS3941	Introduction to Data structures	45	0	0	45	90	3
2	UCS3942	Object Oriented Programming Techniques	45	0	0	45	90	3
3	UCS3943	Problem solving and programming in C	45	0	0	45	90	3

OPEN ELECTIVE – II (Semester – VIII)

S. No.	COURSE CODE	COURSE TITLE	L	T	P	TW&SL	TH	C
1	UCS3041	Introduction to Big Data Analytics	45	0	0	45	90	3
2	UCS3042	Machine Learning Applications	45	0	0	45	90	3
3	UCS3043	Web Technology	45	0	0	45	90	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3186	COMMUNICATIVE ENGLISH (Common to all B.E./B.Tech. programs)	30	0	15	45	90	3

OBJECTIVES

The learners will be able to:

- Enhance conversation fluency and assertive communication in English
- Contribute efficiently to meetings and improve networking skills
- Participate and communicate meaningfully during group discussions
- Cultivate the ability to deliver structured and persuasive presentations
- Equip students with necessary skills to excel in job interviews

UNIT I	CONVERSATION AND ASSERTIVENESS	9
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Introducing yourself, peers and others. Conversation skills: starting a conversation; keeping the conversation going; closing the conversation; giving directions and instructions; learning functional language needed for everyday interactions. Imparting the basic language skills and techniques for telephonic conversations. Communication styles: passive, aggressive and assertive. Role-plays as a technique for practising conversation.

UNIT II	MEETING SKILLS AND NETWORKING SKILLS	9
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Setting up and holding meetings; organising and conducting effective meetings; learning the language used to lead a meeting; practising how to agree and disagree with ideas and people politely. Mock meetings. Making notes, summarising and reporting in meetings. Writing professional emails.

UNIT III	GROUP DISCUSSION SKILLS AND TEAM SKILLS	9
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Group discussion skills: Basic skills required for a GD; strategies for improving discussion skills; learning the language used for a GD; voicing an opinion and arguing a point effectively, leading a discussion; chairing a discussion; discussing to arrive at a consensus. Mock GDs for practice.

UNIT IV	PRESENTATION SKILLS AND PERSUASIVE SKILLS	9
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Making effective presentations: structure of a presentation; referring to visual data; describing visuals; non-verbal communication skills; examples of model presentations; and learning the language used to deliver effective and persuasive presentations. Developing cross-cultural communication skills. Mock presentations for practice.

UNIT V	INTERVIEW SKILLS AND INTERPERSONAL SKILLS	9
Applying for jobs; writing resumes; and cover letters. Participating in job interviews and other interviews. Strategies for effective interviewing: preparing for the interview, during-the-interview and after-the-interview etiquette. Common interview questions and learning interviewing language skills. Mock interviews for practice.		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Develop conversation skills and assertiveness in English
CO2 Cultivate proficiency in conducting meetings and networking
CO3 Articulate clearly and successfully during group discussions
CO4 Deliver engaging and professional presentations confidently
CO5 Communicate effectively during the interview process

TEXT BOOKS
1. Bovee, C. L.& Thill, J. V. (2016). <i>Business Communication Today, 15/e</i> . Pearson Education India.
2. Beebe, S. A., & Mottet, T. P. (2021). <i>Business and Professional Communication (3rd ed)</i> . Pearson Higher Education AU.
3. Herbert Hirsch. (2007). <i>Essential Communication Strategies: For Scientists, Engineers, and Technology Professionals</i> , 2nd edition. Wiley-IEEE Press.

REFERENCE BOOKS
1. Dodd, C. H. (2012). <i>Managing business and professional communication (3rd ed)</i> . Allyn & Bacon/Pearson.
2. Dwyer, J. (2012). <i>Communication for Business and the Professions: Strategies and Skills (7th ed)</i> . Pearson Higher Education AU.
3. Gill Hasson. (2012). <i>Brilliant Communication Skills: What the Best Communicators Know, Do and Say</i> . Ft Pr
4. Jones, L., & Alexander, R. (2011). <i>New international business English updated edition student's book: Communication skills in English for business purposes (Vol. 3)</i> . Cambridge university press.
5. Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler. (2013). <i>Crucial Conversations: Tools for Talking When Stakes Are High</i> . Brilliance Audio.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	3		1		
CO2								1	3		1		
CO3								1	3		1		
CO4								0	3		1		
CO5								0	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3176	ALGEBRA AND CALCULUS FOR ENGINEERS (Common to all B.E./B.Tech. programs)	45	15	0	60	120	4

OBJECTIVES

- To reduce quadratic to canonical form of a matrix and find the eigenvalues of a matrix numerically
- To study the concept of curvature, evolute and envelope
- Learn to find the extreme values for a function of two variables
- To compute area of closed surface and volume of solids using multiple integrals
- Learn to evaluate definite integrals numerically

UNIT I	MATRICES	12
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Characteristic equation - Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors, Cayley-Hamilton Theorem (simple problems only), Diagonalization of matrices – Similarity transformation - Quadratic form - Reduction of a quadratic form to canonical form by orthogonal transformation – Eigen values of matrices by Power method.

UNIT II	DIFFERENTIAL CALCULUS AND ITS APPLICATIONS	12
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Curvature, radius of curvature - Cartesian and parametric co-ordinates – Centre of curvature – Circle of curvature in Cartesian form, Evolutes, Envelopes (including two parameter family), Evolute as envelope of normal.

UNIT III	FUNCTIONS OF SEVERAL VARIABLE	12
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Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and its properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV	MULTIPLE INTEGRALS	12
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Double integrals in Cartesian and polar coordinates – Change of order of integration, Area enclosed by plane curves – Change of variables in double integrals, Triple integrals.

UNIT V	NUMERICAL INTEGRATION	12
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Single integral - Trapezoidal, Simpson's 1/3 rule, Gaussian quadrature 2 point and 3-point formula - Double integral – Trapezoidal rule, Simpson's rule 1/3 rule.

TOTAL PERIODS	60
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 compute the eigenvalues and eigenvectors and reduce quadratic form to canonical form

CO2 compute evolute of a given curve and envelope of family of curves

CO3 analyse the extrema of function of two variables

CO4 calculate the area and volume using double and triple integrals

CO5 evaluate single and double definite integrals numerically

CO6 apply differential and integral calculus in real life problems and compute the extrema of functions

TEXT BOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publishers, 45th Edition, 2020.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 10th Edition, 2020.

REFERENCE BOOKS

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Ninth Edition, Laxmi Publications Pvt Ltd., 2016.
2. James Stewart, Calculus: Early Transcendental, Cengage Learning, New Delhi, 7th Edition, 2013.
3. Dass, H.K., and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
4. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 2015.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	2											
CO5	3	2											
CO6	3	2									2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UPH3186	ENGINEERING PHYSICS (Common to all B.E./B.Tech. programs)	45	0	15	60	120	4

OBJECTIVES

1. Comprehend and identify different crystal structures and their imperfections.
2. Understand the elastic and thermal properties of materials and understand their significance in engineering materials.
3. Provide an overview of the characteristics of sound, architectural acoustics and the production and applications of ultrasound.
4. Develop an understanding of quantum mechanical phenomena and their applications.
5. Understand the origin of laser action, production of laser, fibre optics and their applications.

UNIT I	CRYSTAL PHYSICS	15
Single crystalline, polycrystalline and amorphous materials– single crystals - Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative treatment) - Crystal Imperfections with Examples – Point, line (Edge and Screw dislocations –Burger vectors) Surface (stacking faults) and Volume defects.		
LABORATORY EXPERIMENT		
1. Determination of the band gap of a semiconductor crystal.		

UNIT II	PROPERTIES OF MATTER AND THERMAL PHYSICS	15
Properties of matter: Elasticity- Hooke's law - different elastic moduli (conceptual)- Relationship between the three moduli of elasticity– stress -strain diagram– Poisson's ratio –Factors affecting elasticity. cantilever: theory and experiment–Extension to non-uniform bending- uniform bending theory and experiment, -Applications- I-shaped girders.		
Thermal Physics: Transfer of heat energy - thermal expansion of solids and liquids - expansion joints-bimetallic strips, Modes of heat transfer – thermal conduction, convection and radiation – Newton's law of cooling - thermal conductivity- Lee's disc method for bad conductor – Heat transfer through compound media (series and parallel)-Applications -Heat Exchangers.		
LABORATORY EXPERIMENTS		
1. Determination of the Young's modulus of the material of the given beam by non-uniform bending method.		
2. Determination of the rigidity modulus of the material of the given wire using torsion pendulum.		
3. Determination of the coefficient of thermal conductivity of the given bad conductor using		

Lee's disc.

UNIT III	ACOUSTICS AND ULTRASONICS	15
Acoustics: Classification and characteristics of Sound - decibel - Weber–Fechner law– Sabine's formula (conceptual) —factors affecting the acoustics of buildings and their remedies. Ultrasonics: Production of ultrasonics by Magnetostriction and Piezoelectric methods – acoustic grating -Non-Destructive Testing – pulse echo system through transmission and reflection modes - A, B and C – scan displays- Phased Array Ultrasound and Time of Flight Diffraction techniques. LABORATORY EXPERIMENTS 1. Determination of the velocity of sound in the given liquid and compressibility of the liquid using an Ultrasonic interferometer.		

UNIT IV	QUANTUM PHYSICS	15
Black body radiation – Planck's three-dimensional) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton Effect (Conceptual)– Photoelectric effect (conceptual)- Properties of Matter waves – wave particle duality - Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box and extension to three dimensional box – Degeneracy of electron energy states - Quantum tunneling (Qualitative)- Scanning tunneling microscopy. LABORATORY EXPERIMENT 1. Determination of the Planck's constant and the work function using photoelectric effect.		

UNIT V	PHOTONICS AND FIBRE OPTICS	15
Photonics: Spontaneous and stimulated emission- Population inversion -Einstein's A and B coefficients –Conditions for Laser action - Types of lasers (Qualitative) – Nd: YAG, Basics of diode lasers-Industrial and Medical Applications. Fibre optics: Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – Fibre Optical Communication system (Block diagram) - Active and passive fiber sensors - pressure and temperature- Applications. LABORATORY EXPERIMENTS 1. Determination of the grating element/wavelength, and the particle size using a laser. 2. Determination of the Numerical Aperture and the acceptance angle of an optical fiber.		

TOTAL PERIODS	45L+30P
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OTHER EXPERIMENTS 1. Determination of the wavelength of the characteristic lines of mercury spectrum using Spectrometer and grating. (Wave optics) 2. Determination of dispersive power of prism using Spectrometer. (Light/Optics) 3. Determination of thickness of a thin wire using interference fringes. (Light/Optics)
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4. Determination of the coefficient of viscosity of the given liquid using Poiseuille's method. (Properties of Matter).

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze crystal structures and the influence of imperfections on their properties.

CO2 Demonstrate and explain the general concepts of elastic and thermal properties of materials used in various mechanical and civil structures.

CO3 Analyze the applications of acoustics and ultrasonics to engineering and medical disciplines.

CO4 Comprehend the quantum mechanical principles to correlate with experimental results and their applications.

CO5 Elucidate the principle and working of lasers and optical fibers, and their applications in the field of industry, medicine and telecommunication.

TEXT BOOKS

1. Gaur, R.K., and Gupta, S.L., Engineering Physics, Dhanpat Rai Publishers, 2012.
2. S. Singaravadelu and A. Chandrasekaran, Engineering Physics, Vedha Publications, Chennai, 2022
3. Serway, R.A., & Jewett, J.W., Physics for Scientists and Engineers, Cengage Learning, 2010.
4. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson, 2006

REFERENCE BOOKS

1. Halliday, D., Resnick, R. & Walker, J. Principles of Physics, Wiley, 2015.
2. Tipler, P.A. & Mosca, G. Physics for Scientists and Engineers with Modern Physics, WH Freeman, 2007.
3. Avadhanulu, M. N., Kshirsagar, P. G, A textbook of Engineering Physics, S. Chand & Co. Ltd., Ninth Revised Edition, 2012.
4. K. Malik and A. K. Singh, Engineering Physics, 2nd Edition, McGraw Hill, 2016
5. Pandey B.K., Chaturvedi.S. "Engineering Physics", Cengage Learning India Pvt. Ltd, 2012

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2		1									
CO2	3	2		1						2			
CO3	3	2		1						2			
CO4	3	2		1									
CO5	3	2		1									
Average	3	2		1						2			

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCY3186	ENGINEERING CHEMISTRY (Common to all B.E./B.Tech. programs)	45	0	15	60	120	4

OBJECTIVES

- To impart knowledge on various aspects of chemistry
- To improve the ability of students to think logically and solve the problems in industries and day-to-day life efficiently

UNIT I	WATER AND ITS TREATMENT	15
Theory: Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical, Water quality parameters - WHO guidelines and BIS guidelines. Industry water treatment - External treatment – Ion exchange process, zeolite process. Domestic water treatment - Reverse Osmosis-Working of RO system – Advantages/limitations. Practical: Exp.1: Estimation of hardness of water Exp.2: Hardness of different sources of water Laboratory Demonstration: Ion Exchange process		

UNIT II	ELECTROCHEMISTRY	15
Theory: Conductance- Conductometric titration and its applications -estimation of strong acid, estimation of mixture of strong and weak acids (numerical based on conductance). Electrochemistry-redox reaction- types of Electrode-Ion selective electrodes –Glass electrodes-measurement of pH-potentiometry. Energy systems for electric vehicles – Principle & Electrochemistry of a H₂–O₂ fuel cell, Li-ion battery, Na-ion battery, Green Hydrogen. Practical: Exp.3: Conductometric titrations- strength of mixture of acids Exp.4: Estimation of strong acid-pH Exp.5: Estimation of ferrous ion by potentiometry		

UNIT III	CORROSION	15
Theory: Corrosion - Types of corrosion - wet corrosion – mechanism –galvanic corrosion - differential aeration- Rate of corrosion, Corrosion control –Cathodic protection-electroless		

plating (Printed Circuit Board), Corrosion in different industries –concrete (reinforcing steel in concrete), boilers, electronic components

Practical:

Exp.6: Rate of corrosion

Industrial visit:

Plating industry- Electroless plating

UNIT IV	POLYMERS IN EVERYDAY LIFE	15
Theory: Polymers and Polymerization: types of polymerization: addition and condensation – Properties: Crystallinity, Glass Transition temperature (T_g), Average Molecular weight-viscosity method &PDI, tacticity, polymer recycling-biodegradable polymers. Practical: Exp.7 : Molecular weight of water soluble polymer by viscosity method Exp.8: Finding the T_g point of different polymer. Laboratory Demonstration: Chemical recycling of post consumed polymer		

UNIT V	ANALYTICAL TECHNIQUES	15
Theory: Spectroscopy: Beer-Lambert's law. Colorimetric estimation of Fe³⁺, Principle, working and applications of IR, UV-Visible spectroscopy and Chromatography (TLC and column) Practical: Experiment 9: Colorimetric estimation of Fe³⁺ ions Laboratory Demonstration: Thin Layer Chromatography		

TOTAL PERIODS	45L+30P
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Analyze the water samples, categorize based on the nature of impurities and suggest suitable method of treatment for domestic and industrial usage
CO2 Apply electrochemical knowledge to identify challenges and propose innovative solutions for improving fuel cell and battery technologies for zero-emission mobility.
CO3 Identify the type of corrosion and analyze different preventive methods of corrosion in various industries.
CO4 Examine the fundamental concepts of polymer chemistry, including structure, classification, and synthesis techniques and identify and evaluate renewable, biodegradable, and recyclable polymeric materials for sustainable future.
CO5 Apply analytical skills of techniques such as chromatography, spectroscopy to characterize materials to solve real life problems.

CO6 Investigate water quality and industrial effluents for chemical impurities using suitable analytical techniques and examine the conversion of post-consumed plastic waste into value-added products for a circular economy.

TEXT BOOKS

1. Jain P.C. and Monika Jain, 'Engineering Chemistry' 17th edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2023.
2. S.S.Dara, 'The Text Book of Engineering Chemistry, S.Chand & Co.Ltd, New Delhi, 2011.

REFERENCE BOOKS

1. N.F. Gray, 'Water Technology-An Introduction for Environmental Scientists and Engineers' Third Edition, Taylor & Francis, USA, 2010.
2. S. Glasstone, 'An Introduction to Electrochemistry' East-West Press Pvt. Ltd., New Delhi, 2007.
3. Bengt Sundén, 'Hydrogen, Batteries and Fuel Cells' Academic Press Inc, USA, 2019
4. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, 'Polymer Science' New Age International (P) Ltd, New Delhi, reprint, 2005.
5. R. Gopalan, K. Rangarajan, P.S. Subramanian, "Elements of Analytical Chemistry" Sultan Chand & Sons, 2003.
6. B.Viswanath, B, P.S. Raghavan, 'Practical Physical Chemistry', ViVa Books Pvt. Ltd, New Delhi, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					3							
CO2	3					3							
CO3	3					2							
CO4	3					2							
CO5	3					2							
CO6	2		2		2	3		2	2		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGE3188	PROBLEM SOLVING AND PROGRAMMING USING PYTHON (Common to all B.E./B.Tech. programs)	15	0	30	45	90	3

OBJECTIVES

- To learn problem-solving strategies.
- To learn different types of statements in Python.
- To learn modularity in problem solving.
- To solve complex problems using sequenced data types and advanced constructs like dictionaries and files of Python.
- To develop simple software projects using Python.

UNIT I	ALGORITHMIC PROBLEM SOLVING	3
Logical Thinking – Algorithmic Thinking; Problem Solving and Decomposition: Defining a Problem – Devising a Solution – Decomposition; Effective building blocks: Basic Algorithmic Constructs (pseudo code, flow chart) – Program State.		

UNIT II	CONDITIONAL AND ITERATION	3
Introduction to Python – Functional abstraction – Defining simple functions – Data abstractions and objects, built-in objects, Expressions and operators (methods), Variables and Assignment, conditional (if), alternative (if-else), case analysis (if-elif-else), pattern matching – Iteration: while, for, break, continue, pass.		

UNIT III	FUNCTION AND STRINGS	3
Functions: Local and global scope, Methods of passing arguments, Recursion, Lambda functions; Strings: string slices, immutability, string functions and pattern matching.		

UNIT IV	LISTS AND TUPLES	3
Lists: Operations, Slices, Methods, Iteration, Mutability, Aliasing, Cloning, Parameters, Nested lists, List comprehension; Tuples: Operations, Assignments, Return value.		

UNIT V	DICTIONARIES AND FILES	3
Dictionaries: operations and methods, looping and dictionaries, reverse lookup, dictionaries and lists; Files: Text files, reading and writing files, format operator, file names and paths, CSV files.		

THEORY PERIODS	15
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LABORATORY COMPONENT: (10 x 4 = 40 hours)
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1. Practice session on using Linux shell commands, Python in interactive mode, and using an IDE (integrated development environment)
2. (a) Case study: Area of the geometric shapes and Simple calculator.
(b) Develop programs using sequential statements (e.g. Temperature conversion, Currency conversion)
3. (a) Case study: Electricity bill generation.
(b) Develop programs using alternate statements (e.g. Counting people eligible to vote)
4. (a) Case study: Armstrong number, Prime number generation within a range and Pascal's triangle.
(b) Develop programs using iterative statements (e.g. n-way password verification problem)
5. (a) Case study: Finding square root.
(b) Develop programs using functions (e.g. GPA calculation by considering internal and external marks)
6. (a) Case study: Fibonacci series and Palindrome.
(b) Develop programs using recursion (e.g. Computation of sine series)
7. (a) Case study: Group anagrams.
(b) Develop programs using strings without built-in functions (e.g. Finding longest common prefix among n strings)
8. (a) Case study: Sorting and Searching.
(b) Develop programs using lists and tuples (e.g. Finding similarity between two documents by constructing one hot vectors)
9. (a) Case study: Top 'k' frequent words.
(b) Develop simple programs using dictionaries (e.g. Constructing histogram)
10. (a) Case study: Exceptions and Assertions.
(b) Develop programs using Files and exception handling (e.g. Finding top k most frequent words in a text file)

PROJECT COMPONENT

(5 x 4 = 20 hours)

Software applications to be developed in teams using Python Graphical User Interface like Tkinter, QT for Python, PySimpleGUI, PyGame.

Sample Case Study: PACMAN GAME

Input: Maze, PacMan, Pellets, Ghosts

Output: Score display and lives display

Constraints:

- Pacman navigates through a maze, gobbling up pellets while avoiding the ghosts.
- The user plays in such a way that the Pacman consumes all the pellets scattered throughout the maze without being captured by ghosts.
- Automatic maze generation of different levels.
- Intelligence for enemies like Ghosts to move around the maze.
- Level progression.

PRACTICAL PERIODS	60
TOTAL PERIODS	15L+60P

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Solve programming problems and express design solutions in pseudo code. (K3)

CO2 Apply sequential, alternate, and iterative approaches for solving problems. (K3)

CO3 Solve complex problems by using functions, strings, lists, tuples and dictionaries.(K3)

CO4 Apply files and exception handling concepts for handling large data. (K3)

CO5 Create simple software development projects in teams using best coding practices and communicate effectively through reflections, reports, and presentations. (K6)

TEXT BOOKS

1. Allen B. Downey, "Think Python", 3rd edition, O'Reilly Media, 2024, Online Version: <https://alldowney.github.io/ThinkPython/>
2. Sridhar, Indumathi, Hariharan, "Python Programming", Pearson, 2023.

REFERENCE BOOKS

1. Karl Beecher, "Computational Thinking – A beginner's Guide to Problem Solving and Programming", British Computer Society (BCS), 2017.
2. John V Guttag, "Introduction to Computation and Programming Using Python", 3rd edition, MIT Press, 2021.
3. Ashok Namdev Kamthane, Amit Ashok Kamthane, "Programming and Problem Solving with Python", McGraw Hill Education (India) Private Limited, 2018.
4. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
5. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
6. Kenneth A. Lambert, "Fundamentals of Python: First Programs", 2nd Edition, CENGAGE Learning, 2018.
7. Alan D. Moore, "Python GUI programming with Tkinter", Second Edition, Packt Publishing Ltd., 2021.
8. Joshua M. Willman, "Beginning PyQt: A hands-on approach to GUI programming with PyQt6", Second Edition, APress, 2022.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3												
CO3	3	2			2								
CO4	3	2			2								
CO5	3	3	3		2			2	2				
Average	3	3	3	3	2	2		2	2				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGE3176	ENGINEERING GRAPHICS (Common to all B.E./B.Tech. programs)	15	0	60	15	90	3

OBJECTIVES

- To develop graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.
- To visualize the job in three dimensions
- To draw 2D / 3D objects using computer drafting software

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATIONS)

1

Importance of Engineering Graphics in engineering applications - Drawing instruments and their uses, Types of lines, Lettering, General rules for dimensioning, Geometrical constructions using instruments.

UNIT I

PROJECTION OF POINTS, LINES AND PLANES

14

Orthographic projection principle – Reference planes - Layout of views. Projections of points when they are situated in different quadrants. Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes. Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating plane method.

UNIT II

PROJECTION OF SOLIDS

15

Projections of solids like prisms, pyramids, cylinder and cone, whose axis is parallel to one of the reference planes and inclined to the other by rotating object method.

UNIT III

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

15

Sectional planes – when the cutting plane is inclined to one of the principal planes and perpendicular to the other, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section. Development of lateral surfaces of simple and truncated solids in vertical position– prisms, cylinders, pyramids, cones.

UNIT IV

FREEHAND SKETCHING AND FUNDAMENTALS OF COMPUTER AIDED DRAFTING

15

Visualization concepts and Free Hand sketching: Visualization principles–Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects. Introduction to CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION and practicing two-dimensional modelling of simple objects by any free computer drafting software. (Assessment only through Assignments - Not for examination)

UNIT V	ISOMETRIC AND PERSPECTIVE PROJECTION	15
Principles of isometric projection – isometric scale – Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and practicing three-dimensional modelling of simple objects by any free CAD software (Assessment only through Assignment - Not for examination). Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Construct the Orthographic projections of points, lines and plane surfaces.
CO2 Construct the Projection of solids.
CO3 Construct the details of an object through sectional views and development of surfaces.
CO4 Construct orthographic views of an object by free hand sketching.
CO5 Construct the three dimensional isometric view and perspective projection.

TEXT BOOKS
1. Venugopal, K. and Prabhu Raja, V., Engineering Drawing + AutoCAD, New Age International (P) Limited, 2022 [ISBN: 788122472752].
2. Natarajan, K.V., A Textbook of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 33rd Edition, 2020. [ISBN: 9788190414089].
3. Ramesh babu. V, A Textbook on Engineering Graphics, VRB Publishers, Chennai, 2021. [ISBN: 9789389027211].

REFERENCE BOOKS
1. Bhatt, N.D., Engineering Drawing, Charotar Publishing House, 54 th edition, 2023. [ISBN: 9789385039706].
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, 23 rd edition, Dreamtech Press, 2016 [ISBN: 9789351199465].
3. Agarwal, B., Agarwal C.M., Engineering Drawing, 3 rd edition, McGraw Hill Education, 2019 [ISBN: 9789353167448].
4. Parthasarathy, N. S. and Vela Murali, Engineering Drawing, Oxford University Press, 2015 [ISBN: 9780199455393].

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				1				3		1	1	1
CO2	3				1				3		1	1	1
CO3	3				1				3		1	1	1
CO4	3				1				3		1	1	1
CO5	3				1				3		1	1	1

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGA3176	HERITAGE OF TAMILS (Common to all B.E./B.Tech. programs)	15	0	0	15	30	1

UNIT I	LANGUAGE AND LITERATURE	3
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.		

UNIT II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART SCULPTURE	3
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.		

UNIT III	FOLK AND MARTIAL ARTS	3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.		

UNIT IV	THINAI CONCEPT OF TAMILS	3
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.		

UNIT V	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	3
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 PERIODS	15
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TEXT CUM REFERENCE BOOKS
1. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL -(in print)
2. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.

3. Historical Heritage of the Tamils (Dr. S.V. Subaramanian, Dr. K.D. Thirunavukkarasu)(Published by: International Institute of Tamil Studies).
4. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
5. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
6. 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)
7. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay)(Published by: The Author)
8. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGEV301	SDG EXPERIENTIAL LABORATORY I (Common to all B.E./B.Tech. programs)	0	0	30	0	30	1

PREAMBLE

Sustainable Development Goals (SDGs), an essential guide to understanding and engaging with the global framework designed to achieve a better and more sustainable future for all. In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development, which includes 17 SDGs, recognizing that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests

OBJECTIVES

- To understand the basics of 17 SDGs.
- To acquire knowledge of the target and indicators of all SDGs

METHODOLOGY

Students shall study any external course on Introduction to SDG, on a Self-Learning mode. Will be assessed at the end by a Seminar presentation on a possible project proposal in SDG.

TOTAL PERIODS

30

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Understand the history, scope, and challenges of the SDGs.

CO2 Analyze the interlinkages and synergies between different goals.

CO3 Evaluate the progress made towards achieving the SDGs globally and locally.

CO4 Develop strategies to implement and monitor the SDGs in various contexts.

REFERENCE BOOKS

1. Hazra, Somnath., Bhukta, Anindya (2020) Sustainable Development Goals An Indian Perspective, Springer International Publishing, Switzerland
2. Ziai, Aram (2016) Development Discourse and Global History from colonialism to the sustainable development goals. Routledge, London & New York
3. OECD (2019), Sustainable Results in Development: Using the SDGs for Shared Results and Impact, OECD Publishing, Paris, <https://doi.org/10.1787/368cf8b4-en>
4. Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., Woelm, F. 2020. The Sustainable Development Goals and COVID-19. Sustainable Development Report 2020. Cambridge: Cambridge University Press.
5. <https://www.un.org/sustainabledevelopment>

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3276	CALCULUS OF VECTORS, COMPLEX FUNCTIONS AND LAPLACE TRANSFORMS (Common to all B.E./B.Tech. programs)	45	15	0	60	120	4

OBJECTIVES

- Solve second order ordinary differential equations
- Evaluate line, surface and volume integrals.
- Understand the concept of analytic functions and its construction and apply the same in evaluating contour integrals.
- Find the Laplace Transforms of standard functions.
- Find the Inverse Laplace Transform of standard functions and solve second order linear ordinary differential equations with constant coefficients.

UNIT I	ORDINARY DIFFERENTIAL EQUATIONS	12
Solution of second and higher order linear differential equations with constant coefficients (RHS functions - e^{mx} , $\sin mx$, $\cos mx$, x^n , $x^n f(x)$, $e^{mx} f(x)$), Application to harmonic oscillation of an undamped Mass-Spring system- Method of variation of parameters- Simultaneous linear differential equations with constant coefficients of first order.		

UNIT II	VECTOR CALCULUS	12
Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields, Line integrals, Path independence of line integrals, Surface integral - Area of a curved surface, Volume integral. Green's theorem in the plane, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.		

UNIT III	CALCULUS OF COMPLEX FUNCTIONS	12
Complex functions – Limit and Continuity, Derivative, Analytic functions – necessary and sufficient conditions – Cauchy-Riemann equations in Cartesian form (with proof) – Properties - Harmonic functions, Construction of analytic function, Bilinear transformation. Cauchy's integral theorem – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour (except the poles on the real axis).		

UNIT IV	LAPLACE TRANSFORMS	12
Definition, properties, existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Shifting theorems – Transforms of derivatives and integrals – Initial and final value theorems, Evaluation of integrals by Laplace transforms, Periodic functions.		

UNIT V	INVERSE LAPLACE TRANSFORMS	12
Inverse transforms – Definition, Properties, Method of Partial Fractions, Inverse Laplace transforms of derivatives and integrals - Convolution theorem - Applications of Convolution theorem. Applications to solving linear second order ordinary differential equations with constant coefficients using Laplace Transform.		

TOTAL PERIODS	60
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 solve ordinary differential equations with boundary conditions
CO2 apply the concepts of vector calculus to evaluate line, surface and volume integrals
CO3 construct analytic functions and apply the concepts of analytic functions in contour integrals
CO4 obtain the Laplace Transforms of standard functions.
CO5 apply the concepts of Laplace Transforms in solving differential equations
CO6 construct ordinary differential equations to real life problems and solve using Laplace transform techniques

TEXT BOOKS
1. Grewal B.S, Higher Engineering Mathematics, Khanna Publishers, 45th Edition, 2020.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 10 th Edition, 2020.

REFERENCE BOOKS
1. Bali, N.P., Goyal, M., Watkins, C., Advanced Engineering Mathematics, Laxmi Publications Pvt. Limited, 2007.
2. Boyce, W.E., and DiPrima, R.C., Elementary Differential Equations and Boundary Value Problems, Wiley India, 2012.
3. George B. Thomas Jr., Maurice D. Weir, Joel R. Hass, Thomas' Calculus: Early Transcendental, 13th Edition, Pearson Education, 2013.
4. O'Neil. P. V., Advanced Engineering Mathematics, 7th Edition, Cengage Learning India Pvt., Ltd, New Delhi, 2011.
5. Howard Anton, Irl C. Bivens, Stephen Davis, Calculus Early Transcendentals, 11th Edition, John Wiley & Sons, Inc., 2016.
6. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 2015.
7. Srivastava, A.C., and Srivastava, P.K., Engineering Mathematics Volume I and II, PHI learning Pvt. Ltd, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	2											
CO5	3	2											
CO6	3	2									2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEE3276	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	45	0	0	45	90	3

OBJECTIVES

- To learn the basic concepts of electric circuits.
- To know the operation of various electrical machines.
- To study the concepts of utilization of electrical power.
- To comprehend the working principle of electronic devices and its applications.
- To grasp the working principle of various sensors and transducers.

UNIT I	ELECTRICAL CIRCUITS	9
DC Circuits: Ohm's Law- Kirchhoff's laws - Series parallel connections, Voltage divider and Current divider Rule. Mesh current and Node voltage methods (Analysis with only independent source), AC circuit: Waveforms and RMS value, Phasor diagram, Inductance, Capacitance, concept of reactance and impedance, Power, Power factor in series RLC circuits. Three phase supply – Star connection, Delta connection (Balanced Loads).		

UNIT II	ELECTRICAL MACHINES	9
Construction and Working Principle – DC Generators, EMF Equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Transformers - Construction, Working, Types and Applications- Three Phase Induction Motor and Alternator.		

UNIT III	FUNDAMENTALS OF POWER SYSTEMS	9
General structure of electrical power systems using single line diagram approach, Power rating of household appliances. Energy measurement, Electricity tariff, Equipment Safety measures: Working principle of Fuse and Miniature circuit breaker (MCB), Personal safety measures: Electric Shock, Earthing.		

UNIT IV	ELECTRONIC DEVICES AND APPLICATIONS	9
Operation of PN junction diodes, VI characteristics, Half wave and full wave rectifier, capacitive filters, Zener diode, Zener voltage regulator, BJT, Transistor configurations, CE input and output characteristics, Applications of BJT as a switch and amplifier. Introduction to FET.		

UNIT V	SENSORS AND TRANSDUCERS	9
Sensors: Capacitive and resistive sensors, Hall effect sensors, Ultrasonic sensors, IR sensors and Accelerometer sensors. Transducers: Classification of transducers, strain gauges, Thermocouples, RTD, Thermistors, Piezo-electric and LVDT.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply the DC and AC circuits analysis concepts on real world complex engineering problems.

CO2 Analyze operations and characteristics of the AC and DC machines and select a suitable machine for engineering Applications

CO3 Analyze the electrical power generation, distribution system and safety devices used in the electrical systems.

CO4 Analyze the operations and characteristics of the electronics devices used in the various engineering electronic devices.

CO5 Analyze the working and characteristics of the various sensors and transducers and select suitable sensors and transducers for engineering applications.

CO6 Design and develop an engineering product from the concepts of electrical and electronics engineering.

TEXT BOOKS

1. S. Salivahanan, R. Rengaraj and G. R. Venkatakrishnan, Basic Electrical, Electronics and Measurement Engineering, McGrawHill, 2017.

2. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.

3. Edward Hughes, John Hiley, Keith Brown and Ian McKenzie Smith "Electrical And Electronic Technology" Pearson Education Ltd, 10 th Edition, 2008.

REFERENCE BOOKS

1. S.B. Lal Seksena and Kaustuv Dasgupta, Fundaments of Electrical Engineering, Cambridge, 2016.

2. M.S. Sukhija and T.K. Nagsarkar, Basic Electrical and Electronic Engineering, Oxford, 2016.

3. S.K.Sahdev, Basic of Electrical Engineering, Pearson, 2015.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		2								
CO2	3	2											
CO3	3		2										
CO4	3		2		2								
CO5	3		2										
CO6	3	3	3	3	2			2	2		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3281	PROGRAM DEVELOPMENT USING C	15	0	60	15	90	3

OBJECTIVES

- Build a foundation for C Programming.
- Develop programs using C constructs.
- Practice writing clean and maintainable code.

UNIT I	BASICS OF PROGRAM DEVELOPMENT	3
Basic data types -- Operators and expressions -- Data input and output statements -- Control statements.		

UNIT II	FUNCTIONS	3
Function prototype -- Function definition and call -- Passing arguments to a function -- Recursion -- Standard library functions -- Storage classes.		

UNIT III	ARRAYS AND STRINGS	3
Arrays: Declaration, Initialization, Multi-dimensional arrays, Passing arrays to functions, Bubble sort, Insertion sort, Linear and Binary search -- Arrays and Strings, String library functions.		

UNIT IV	POINTERS	3
Pointer declarations -- Passing pointers to functions -- Pointers and one-dimensional arrays -- Dynamic memory allocation -- Operations on pointers -- Array of pointers -- Pointer to pointer.		

UNIT V	STRUCTURES AND FILES	3
Structures: User-defined data types (typedef) -- Array of structures - Structures and pointers -- Passing structures to functions - Linked list - Files - Choosing suitable data types and programming constructs.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Solve problems using suitable programming constructs and employ modular programming. (K3)
- CO2 Apply the concept of arrays, strings, and pointers to solve complex problems efficiently. (K3)
- CO3 Develop applications using structures and file handling techniques. (K3)
- CO4 Design and implement an application by applying structured coding techniques, demonstrating problem-solving skills, teamwork, and the ability to document and present technical work effectively. (K5)

TEXT BOOKS

1. Bryon Gottfried, Programming with C (Schaum's Outline Series), McGraw-Hill Education, 4th Edition, 2018.

2. Brian W Kernighan and Dennis M Ritchie, The C Programming Language, Pearson Education India, 2nd Edition, 2015.
3. Maureen Sprankle, Jim Hubbard, “Problem Solving & Programming Concepts”, Pearson Education, 9th edition, 2011.

REFERENCE BOOKS
1. Reema Thareja, Programming in C, Oxford University Press, 2nd Edition, 2016.
2. Yashwant Kanetkar, Let Us C, BPB Publications, 14th Edition, 2016.
3. King, K.N., C Programming A Modern Approach, W. W. Norton & Company, II Ed. 2008.
4. Yashwant Kanetkar, Understanding Pointers in C and C++, 2019.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	2
CO2	3		2									2	2
CO3	3		2									2	2
CO4	3	2	3		2		2	2	2		3	2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3262	DIGITAL PRINCIPLES AND DESIGN	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamental principles of Boolean algebra and demonstrate the relationships between Boolean expressions.
- To introduce the methods for simplifying Boolean function.
- To analyze and design combinational circuits.
- To analyze and design sequential circuits.
- To understand the design of memory.

UNIT I	BOOLEAN ALGEBRA AND LOGIC GATES	9
Binary Numbers – Number-Base Conversions – Octal and Hexadecimal Numbers – Complements of Numbers – Signed Binary Numbers – Binary Code – Binary Storage and Registers – Binary Logic; Basic Theorems and Properties of Boolean Algebra – Boolean Functions – Canonical and Standard Forms – Digital Logic Gates.		

UNIT II	SIMPLIFICATION OF BOOLEAN FUNCTIONS	9
Minterm – Maxterm – Sum of Products (SOP) – Product of Sums (POS) – Simplification of Boolean Functions using Karnaugh Map – Four Variable K-Map – Five Variable K -Map Logic Don't-Care Conditions, NAND–NOR implementations.		

UNIT III	COMBINATIONAL LOGIC	9
Combinational Circuits – Analysis and Design Procedures – Binary Adder–Subtractor – Decimal Adder – Binary Multiplier – Decoders – Encoders – Multiplexers.		

UNIT IV	SEQUENTIAL LOGIC	9
Sequential Circuits – Storage Elements: Latches, Flip-Flops; Analysis of Clocked Sequential Circuits – State Reduction and Assignment – Design Procedure – Counters; Introduction to Asynchronous circuits.		

UNIT V	MEMORY	9
Registers - Shift Registers - Serial adder - Universal Shift Register; RAM – Memory Decoding – ROM – PROM – Programmable Logic Array – Programmable Array Logic.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental principles of Boolean algebra and relationships between logic gates (K2)

CO2 Utilize K-Map to simplifying Boolean function (K3)
CO3 Analyze and construct Combinational Circuits (K4)
CO4 Analyze and construct Sequential Circuits (K4)
CO5 Build various memories and Boolean functions using Programmable Logic Devices (K3)

TEXT BOOKS

1. Morris R Mano, Michael D Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog", 6th Edition, Pearson Education, 2018.

REFERENCE BOOKS

1. S Salivahanan, S Arivazhagan, "Digital Circuits and Design", 5th edition, Oxford University Press, 2018.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th Edition, Tata McGraw Hill, 2012.
3. G K Kharate, "Digital Electronics", Oxford University Press, 2010.
4. John F Wakerly, "Digital Design Principles and Practices", 5th Edition, Pearson Education, 2017.
5. Charles H Roth Jr, Larry L Kinney, "Fundamentals of Logic Design", 6th Edition, Cengage Learning, 2013.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2										2	2
CO3	3	2										2	2
CO4	3	3										2	2
CO5	3	2										2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCY3276	ENVIRONMENTAL SCIENCE (Common to all B.E./B.Tech. programs)	15	0	0	15	30	1

OBJECTIVES

- To develop a better understanding of human relationship with environment
- To explain the importance of conservation of resources
- To create awareness on pollution and environmental degradation
- To acquire knowledge on sustainable development
- To apply technical skills for solving environmental problems

UNIT I	FUNDAMENTALS OF ENVIRONMENTAL SCIENCE	9
Definition, scope and importance of environment and function of an ecosystem- Terrestrial(Forest)-Aquatic(lake)-ecological succession – ecological pyramids – Biodiversity in the environment- Types and Values of biodiversity- hot-spots of biodiversity – threats to biodiversity-In-situ and ex-situ conservation of biodiversity. Field Trip: Zoo/Botanical Garden		

UNIT II	NATURAL RESOURCES	9
Forest resources: deforestation– Water resources: over- utilization of surface water and, conflicts over water, dams-benefits and problems – Mineral resources: environmental effects of mining– Food resources: fertilizer-pesticide problems– Energy resources: Need for renewable energy sources, use of alternate energy sources (Wind, Solar, Geothermal)– Land resources: soil erosion and desertification.		

UNIT III	CURRENT ENVIRONMENTAL ISSUES	9
Planetary boundaries-Environmental issues– causes, effects and control measures of Pollution of (a) Air (Smog, acid rain, climate change, ozone layer depletion) (b) Water (waste water treatment) (c) Soil Solid waste management -wasteland reclamation, Electronic waste management Population explosion- Population growth among nations– Disaster management Case study-Air Pollution in Delhi, Cooum river pollution, Chennai municipal waste management Field Trip: Wastewater Treatment Plant		

UNIT IV	SUSTAINABLE DEVELOPMENT	9
Origin, purpose, and importance of the SD- Key issues and challenges of Environmental sustainability- 2030 Agenda for Sustainable Development- Indicators and metrics for tracking progress of sustainable development- Circular economy Rainwater Harvesting-- Principles - Green Buildings-Advantages of green buildings over conventional buildings-smart city-Electric and Hybrid Electric Vehicles (HEV)		

UNIT V	ENGINEERING INTERVENTIONS TO REDUCE ENVIRONMENTAL STRESSES	9
Role of technology in environment studies and human health- Use of Artificial Intelligence and Internet of Things- Environment database management system. Real-time data collection and analysis-Environmental Modelling and Simulation- Geographical Information Systems (GIS)-Remote Sensing- satellites and sensors-Use of Drones of Aerial mapping and Surveying.		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Analyse the functioning of ecosystem and apply conservation strategies to protect biodiversity and ecosystem stability.
CO2 Acquire knowledge on natural resources and explore suitable conservational practices to achieve sustainability.
CO3 Analyse the impact of environmental pollution on ecosystem and implement possible strategies to maintain environmental sustainability.
CO4 Examine the challenges of achieving environment sustainability and integrate circular economy strategies, green technologies, and smart solutions for sustainable development.
CO5 Evaluate the role of technology in environmental studies and human health, and analyse the use of advanced tools like AI, IoT, GIS, and remote sensing for data-driven environmental monitoring and management.
CO6 Explore interdisciplinary approaches for mitigating environmental issues and provide comprehensive review of technology-based solutions for addressing current challenges.

TEXT BOOKS
1. Anubha Kaushik and Kaushik, C. P. "Environmental Science and Engineering", New Age International Publishers, 14th Edition, 2014.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006

REFERENCE BOOKS
1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
2. Tyler Miller G. , and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.
3. M.H. Fulekar, Bhawana Pathak and R.K.Kale, 'Environment and Sustainable Development' Springer Nature, 2013.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1					3							
CO2	1					3	2						
CO3	1					3	2				1		
CO4	1					3	2				1		
CO5	1					3					1		
CO6	2					3		2	2		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGA3276	TAMILS AND TECHNOLOGY (Common to all B.E./B.Tech. programs)	15	0	0	15	30	1

UNIT I	WEAVING AND CERAMIC TECHNOLOGY	3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		

UNIT II	DESIGN AND CONSTRUCTION TECHNOLOGY	3
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.		

UNIT III	MANUFACTURING TECHNOLOGY	3
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 stonetypes described in Silappathikaram.		

UNIT IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3
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.		

UNIT V	SCIENTIFIC TAMIL & TAMIL COMPUTING	3
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 PERIODS	15
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TEXT – CUM – REFERENCE BOOKS
1. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL (in print)
2. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr. S.V. Subaramanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
5. 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)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu

Text Book and Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R. Balakrishnan)(Published by: RMRL)– Reference Book.

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGE3297	DESIGN THINKING AND ENGINEERING PRACTICES LABORATORY (Common to all B.E./B.Tech. programs)	0	0	45	0	45	1.5

OBJECTIVES

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
- To train the students to dismantle, understand the functional / aesthetic aspects of the product, prepare the part functional model, and to assemble the different engineering components.

LIST OF EXPERIMENTS

<u>GROUP A: (CIVIL & MECHANICAL ENGINEERING PRACTICE)</u>
I CIVIL ENGINEERING PRACTICE - Buildings: Study of plumbing and carpentry components of residential and industrial buildings - Safety aspects. Plumbing Works: - Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings. - Preparation of plumbing line sketches for water supply and sewage works. - Hands-on-exercise: - Basic pipe connections - Mixed pipe material connection - Pipe connections with different joining components. - Plumbing with basic connections for washing basin and sink - Carpentry using Power Tools only: - Study of the joints in roofs, doors, windows and furniture. - Hands-on-exercise: Woodwork, joints by sawing, planning and cutting. - Fabrication of different models of pencil box and pen stand. - Fabrication of wooden wall shelf - Demonstration of wood working machinery
II MECHANICAL ENGINEERING PRACTICE - Basic Machining: - Drilling Practice (holes of various diameters - steel sheet metal, wood, hylam/plywood sheet) Sheet Metal Work: - Forming & Bending - Different type of joints. - Fabrication of mobile phone metal stand - Fabrication of electrical control panel box

- Design thinking practices: To dismantle, understand the functional / aesthetic aspects of the product, prepare the part functional model, and to assemble the following components.
- Pedestal Fan head swing mechanism - Reserve mechanism (Two-wheeler) - Tyre removal and mounting for four wheeler.
- Flush tank container mechanism - Hand pump - washer Mechanism

GROUP B (ELECTRICAL & ELECTRONICS ENGINEERING PRACTICE)

1. Residential house wiring, staircase wiring and tube light wiring with single phase AC two wire system.
2. Energy measurement with RLC Load.
3. Earth resistance measurement.
4. Measurement of AC parameters using CRO and half wave and Full wave rectifier.
5. Study of logic gates AND, OR, EX-OR & NOT.
6. Soldering practice – Components Devices and Circuits – Using PCB.
 - **Design thinking practices:**
 1. Assemble a single phase 3 wire circuit for connecting household appliances and explain through schematic diagram.
 2. Measure the energy consumed by the household appliances and verify it theoretically.
 3. Analyze the fault occurring in electrical appliances.
 4. Design, assemble and test a cell phone charger.
 5. Design, assemble and test relay logic to control electrical appliances.
 6. Design, assemble and test a dc power supply using PCB.

TOTAL PERIODS

60

COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Draw pipeline plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household woodwork.
- CO2 Practice machining to make holes on different materials; fabricate sheet metal components.
- CO3 Dismantle, understand the functional/aesthetic aspects of the product, prepare the part functional model of various components.
- CO4 Construct domestic electrical circuits and verify their output parameters.
- CO5 Construct electronics circuits and verify their output.

REFERENCE BOOKS

1. S Gowri, T Jeyapoovan, Engineering Practices Laboratory Manual, 5th Edition, Vikas Publishing, 2016 [ISBN: 9788125949657].
2. V Ramesh Babu, Engineering Practices Laboratory, VRB Publications, 2006 [ISBN: 978819359938].

3. Willis H Wagner, Howard Bud Smith, Mark W Huth, Modern Carpentry, 12th Edition, Goodheart-Willcox Pub, 2015 [ISBN: 9781631260834].
4. . P C Sharma, A Textbook of Production Technology (Manufacturing Processes), S Chand publisher, 2006 [ISBN: 9788121911146].
5. Robert W Messler, Jr., Reverse Engineering: Mechanisms, Structures, Systems and Materials, Illustrated Edition, McGraw-Hill Professional Pub, 2013 [ISBN: 9780071825160].
6. David W Rongey, A Complete Guide to Home Electrical Wiring, 2013 [ISBN: 9780989042703].

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						2	2	2	2		2		
CO2						2	2	2	2		2		
CO3						2	2	2	2		2		
CO4						2	2	2	2		2		
CO5						2	2	2	2		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3211	DIGITAL PRINCIPLES AND DESIGN LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- To understand the various basic logic gates
- To design and implement the various combinational circuits
- To design and implement combinational circuits using MSI devices.
- To design and implement sequential circuits
- To understand and code with HDL programming

SUGGESTED EXPERIMENTS

1. Verification of Boolean Theorems using basic gates
2. Design and implementation of combinational circuits using basic gates for arbitrary functions
3. Design and implement code converters
4. Design and implement 4-bit binary adder/subtractor
5. Design and implement parity generator/checker
6. Design and implement encoder, decoder and priority encoder
7. Design and implement 2*2 multiplier
8. Design and implement Boolean function using multiplexers
9. Design and implement shift-registers
10. Design and implement synchronous counter
11. Design and implement ripple counter
12. Coding combinational circuits using HDL
13. Coding sequential circuits using HDL

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Use Boolean simplification techniques to design a combinational circuit using logic gates and MSI devices (K3)

CO2 Construct different registers and counters using flip-flops (K3)

CO3 Construct combinational circuits and sequential circuits using Verilog HDL (K3)

LABORATORY REQUIREMENT FOR BATCH OF 25 STUDENTS

Hardware : Digital trainer kits – 25; Digital ICs required for the experiments in sufficient numbers

Software: HDL simulator

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2		3					2			2	2
CO2	3	2	2	3					2			2	2
CO3	3	2	2	3					2			2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3212	FUNDAMENTALS AND PRACTICE ON SOFTWARE DEVELOPMENT	0	0	60	0	60	2

OBJECTIVES

- Learn the stages of software development, from requirements gathering to maintenance.
- To link system building to computing fundamentals.
- Understand the ethical considerations in software development.

SAMPLE PROJECT

Students will be divided into teams. Each team will be given problem specifications to develop a system. Teams will be mentored to follow the best software engineering practices to develop simple software projects. A sample problem specification is as follows:

Title: Software System for University Course Registration

Problem Statement: To develop a software system for course registration and course allotment in a university. The system should have the following features:

Each student should log into the system to register for the chosen courses in each semester.

- Once the student logs in, a list of courses that are offered in that semester should be displayed along with the information about faculty members who are teaching each section of the course.
- Assume that each core course will have 3 sections and each elective course will have two sections.
- Students can choose the courses in which they would like to register.
- Each student should register for a minimum of 4 and a maximum of 6 courses per semester
- At the end of the registration process, the list of successfully allotted courses along with the name of the teacher for each course should be displayed for each student. In addition, the list of waitlisted courses along with the waitlist number should also be displayed.

Constraints

- A student should be able to register in a particular course only if he/she has already completed all prerequisites for that course.
- Each course can be offered by multiple faculty members.
- Every section will have a fixed strength. If the section fills up, further registration should not be allowed.
- A waitlist (10% of the class strength) will be maintained in case the allotment is not possible in the first round.
- If a student wants to add or drop any course after initial registration, it should be allowed only within the first two weeks after the semester starts.

- Students from the waitlist can be allotted their choice after the processing of drop requests.

Input

- Student-id
- Number of courses the student wishes to register for
- For each course
- Course Code
- Course Name
- Name of the Faculty Member

Output

A list for each student where each entry comprises the following:

- Course Code
- Course Name
- Name of the Faculty Member
- Allotment Status (Yes/No)
- Waitlist Number if Allotment Status is “No”

TOTAL PERIODS	60
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Formulate the problem elaborating the requirements, identifying the scope and boundaries. (K6)

CO2 Design and develop solutions adapting technologies, tools, and techniques. (K6)

CO3 Work effectively in teams to develop and integrate modules, communicate through reports and presentations, and consider the impact on health, safety, society, environment, and any legal and ethical issues.

Rubrics for evaluating the project:

Assessment tool	Project Execution	Viva-Voce	Presentation	Project Report	Weightage
Review 1	--	10%	60% Problem formulation, scope, related work, limitations	30% A report on design of various modules, detailed plan, and tools	20%
Review 2	90% for Implementation & Demo	10%	--	--	30%
Review 3	50% (Exploration, solution, quality of implementation)	10%	20%	20% Design, implementation, testing and results	50%

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	3
CO2	3		3		3							3	3
CO3						3	3	3	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGEV302	SDG EXPERIENTIAL LABORATORY II (Common to all B.E./B.Tech. programs)	0	0	30	0	30	1

PREAMBLE

This course explores the principles and practices of sustainability within the context of a college campus. Through hands-on projects and collaboration with campus facilities, students will identify, design, and implement sustainability initiatives aimed at improving the environmental, social, and economic health of the campus community. The "Live in Lab" approach provides students with the opportunity to apply theoretical knowledge in real-world settings, working directly with campus stakeholders to achieve measurable sustainability outcomes.

OBJECTIVES

- Understand the principles of sustainability and their application to campus environments.
- Analyze the current sustainability practices of the campus.
- Develop and implement projects aimed at enhancing campus sustainability.
- Collaborate with campus stakeholders to achieve project goals.
- Evaluate the impact of sustainability initiatives on the campus community.

METHODOLOGY

Students shall work in teams of not more than four, on a project related to the SDG theme. Teams will be guided by faculty. assessment at the end of the semester will be on a project evaluation mode

COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Apply sustainability principles to analyze and evaluate societal and environmental aspects that are relevant to economy, health, safety , culture and environment (WK1)
- CO2 Conduct sustainability assessments of the campus facilities and operations by implementing multi-disciplinary team projects in collaboration with campus stakeholders using the available resources in relevance to the societal and environmental aspects (WK1, WK7, WK8, WK9)
- CO3 Monitor and report the project results of the sustainability initiatives to diverse audiences.

LIST OF EXPERIMENTS/ACTIVITIES/PROJECTS

1. **Sustainability Tours** – Visit to Solar Farms, Substation and Power plant Lakes, and wells in and around the campus

2. Sustainability Project ideas

Priority Areas: Projects support - priority framework areas ensuring a climate-ready, liveable planet, in terms of health and wellbeing of people, for global prosperity, and supporting our academic mission and purpose.

Choose a sustainability project/ propose a sustainability project/ adopt a sustainability project'

Sample list of Projects

- Social Media campaign for student climate action
- Campus Metabolism – (Energy)
- Social media Campaign for student Purchase Behaviour
- SSN Waste Stationeries/ Data Management
- Energy Management and control system Portal for SSN
- Sustainable Design of Future SSN Campus – Carbon neutrality
- Creating a Campus Sustainability Map
- Tree survey on the Campus
- Alternative Transportation ideas for students, Faculty
- Study the Department wise waste generation pattern in the Campus
- Ideas to Recycle the waste generated on the campus
- Ideas to upcycle the waste generated on the campus
- Design new Recycling signage suitable for the campus
- Creating awareness of Recycling and waste reduction on the campus beyond or the no-waste campaign
- Create a sustainable low-impact event plan
- Green Skilling – working with sustainable agriculture collaborate
- Choose a sustainability project/ propose a sustainability project/ adopt a sustainability project'

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2					2							
CO2	1					2		2	2		1		
CO3	1							1	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3286	PSYCHOLOGY AND COMMUNICATION (Common to all B.E./B.Tech. programs)	30	0	30	30	90	3

OBJECTIVES

- Recall, recognize, and regulate their emotions effectively, and understand the various factors that motivate human behaviour
- Articulate and understand the underlying principles of social psychology, group work and leadership skills
- Demonstrate and apply the principles of personality, learning, memory and thinking
- Discuss and analyse the concepts of developmental psychology and stress management
- Describe and differentiate between various psychological disorders - personality disorders and clinical disorders

UNIT I	EMOTION AND MOTIVATION	9
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Recognizing emotions - Emotions, feelings, and behaviour - Regulating Emotions - Emotional intelligence - Motivation - Basic definitions - different types of motivation - Intrinsic and Extrinsic motivation - Defence Mechanisms - Self-actualization and Maslow's hierarchy of needs

UNIT II	SOCIAL PSYCHOLOGY	9
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Psychology and social behaviour - Forming and maintaining relationships - Liking and attachment - Social Life - Communicating one to one - Communicating in a group - Stages of group formation - Team building - Factors that affect group performance: Social loafing, Polarisation and Groupthink - Attitudes, Prejudice, and stereotypes - Boosting group performances - Leadership skills and traits - transformational and transactional leadership

UNIT III	PERSONALITY AND LEARNING	9
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Personality -- Freud's psychoanalytic theory - Personality traits – The Big Five - Self-esteem, self-confidence, and self-efficacy - -- Conditioning and learning – Classical and operant conditioning - Building memory - Types of memory - Types of thinking – Problem solving, making good and bad decisions - Creative thinking

UNIT IV	DEVELOPMENTAL PSYCHOLOGY	9
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The lifespan - Infancy and Childhood - Attachment - insecure-avoidant, anxious-ambivalent and secure - Adolescent - Types of Love: intimacy, passion, and commitment - Adulthood - Cognitive development, moral development, and social development - Sex, gender and sexuality - Stress - Coping with stress - Managing stress - Happiness

UNIT V	PSYCHOLOGICAL DISORDERS	9
Personality disorders: antisocial; avoidant; borderline; dependent; histrionic; narcissistic; obsessive compulsive; paranoid; schizoid; schizotypal - Clinical disorders: Anxiety disorders, Disorders of mood, Schizophrenia, Dissociative Identity Disorder (DID) - Self-help - Therapeutic help		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Communicate and apply the psychological theories of emotion and motivation to their everyday lives effectively
CO2 Summarise and practice the principles of social psychology to improve interpersonal relationships, group dynamics and leadership roles with confidence and ease
CO3 Articulate and demonstrate a comprehensive understanding of personality, learning, memory and thinking
CO4 Discuss and interpret developmental psychology principles and effective stress management technique to handle life's challenges
CO5 Debate and realise the impact of psychological disorders in an individual's life, and the effectiveness of available treatment options

TEXT BOOKS
1. Myers, D. G. & DeWall, C. N. (2020). <i>Psychology in everyday life</i> . (5 eds). Macmillan.
2. Strongman, K. T. (2006). <i>Applying psychology to everyday life: A beginner's guide</i> . John Wiley & Sons.

REFERENCE BOOKS
1. Morgan, C., King, R., Weisz, J., Schopler, J. <i>Introduction to Psychology</i> . McGraw Hill Education, 7th edition
2. Ralls, E., & Riggs, C. (2021). <i>The Little Book of Psychology: An Introduction to the Key Psychologists and Theories You Need to Know</i> . Simon and Schuster.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	3		2		
CO2								2	3		2		
CO3								1	3		1		
CO4								1	3		1		
CO5								1	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3287	HUMAN RELATIONS AND COMMUNICATION SKILLS (Common to all B.E./B.Tech. programs)	30	0	30	30	90	3

OBJECTIVES

- Describe and understand the impact of personality, attitudes, self-esteem, perception, emotional intelligence and stress on human relations
- Explain and recognize the importance of motivation, teamwork and communication strategies in career development
- Demonstrate and gain insights into decision-making processes and ethical considerations at the workplace
- Communicate and learn conflict management styles and negotiation strategies for effective workplace interactions
- Discuss and analyse leadership management styles to manage career growth opportunities

UNIT I	MANAGING YOURSELF	9
The importance of human relations - Personality and Attitude - Perception skills - Self-Esteem and Self-confidence - Emotional intelligence - Goal setting - Continuous learning - Managing stress - Types of stress - Symptoms of stress - Sources of stress - Reducing stress		

UNIT II	MANAGING TEAMS	9
Communication strategies - Verbal and non-verbal communication strategies - Human motivation at work - Strategies used to increase motivation - Work effectively in groups - Types of groups - Group development process - Group member roles - Positive and negative roles - Team building skills		

UNIT III	MANAGING DECISION MAKING	9
Making good decisions - Understanding decision - Making faulty decision - Decision making in groups - Ethics at work - An Ethics framework - Making ethical decisions - Social responsibility		

UNIT IV	MANAGING CONFLICT AND NEGOTIATION	9
Handling conflict and negotiation - Understanding conflict - Causes and outcomes of conflict - Conflict management - Negotiations - Ethical and cross-cultural negotiations - Managing diversity at work - Diversity and Multiculturalism		

UNIT V	MANAGING CAREER	9
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Leadership and management skills - Leadership styles - Career growth - Power positioning and power sources - Behaviour and change - Impression management - Personality and strategies

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain and recognise how personality, attitudes, self-esteem, perception, emotional intelligence, and stress influence human relations

CO2 Discuss and apply motivation, teamwork, and communication strategies to enhance career development

CO3 Express and evaluate decision-making processes and ethical standards in professional settings

CO4 Defend and practice conflict management styles and negotiation tactics in academic settings

CO5 Debate and develop leadership abilities and career management skills

TEXT BOOKS

1. Laura Portolese Dias (2012). *Human Relations*. Saylor Foundation.
<https://open.umn.edu/opentextbooks/textbooks/132>

REFERENCE BOOKS

1. DuBrin, A. J. (2011). *Human relations for career and personal success: Concepts, applications, and skills*. Prentice Hall/Pearson.
2. McCann, V. (2016). *Human relations: The art and science of building effective relationships*. Pearson.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							0	1	3		1		
CO2							0	3	3		1		
CO3							1	1	3		1		
CO4							1	1	3		1		
CO5							0	1	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3288	COMMUNICATION THROUGH MEDIA (Common to all B.E./B.Tech. programs)	30	0	30	30	90	3

OBJECTIVES

- Describe the developments in the history of films over the centuries
- Comprehend the basic film terminologies and theories to understand the structure and components of films
- Examine the role of regional and global films in reflecting the various aspects of society
- Acquire the necessary writing skills to analyze and critically appreciate films as a creative art form
- Learn the art of storytelling through films, from crafting short and long narratives to producing and presenting a compelling short film

UNIT I	HISTORY OF FILMS	9
• Origins, contribution of Lumiere brothers, Cinema Verite • Early cinema: Silent Films • Evolution from Motion Pictures to Feature Films • Social and political context of films • The Indian Film Industry and the Hollywood		

UNIT II	STRUCTURE AND COMPONENTS OF FILMS	9
• Basic film vocabulary: story, plot, character, tagline, logline, dramatic question • Three Act Structure • Film Theory: Auteur's Theory, Realist Theory • Components of cinematography: Camera angle, Shots, Movements, Equipment, Film Technology • Process and People in Film Making: Cast, Production, Distributor, Director, Editor		

UNIT III	FILM AND SOCIETY	9
• Films and their influence on the language of people • Aspects of gender in films • Regional cinema and global cinema • Cultural impact of films in society: Case studies from Indian cinema • Film as tool of social criticism		

UNIT IV	FILM APPRECIATION	9
• Film Genres, Types, Documentaries • Creating character profiles • Mise-en-scene • Web Series, OTT: sample case studies • Writing film Reviews		

UNIT V	FILM AS CREATIVE EXPRESSION	9
• Creating short stories 250 words • Creating long stories 700 words • Designing storyboard / screenplay		

- Types of scripts, creating film script
- Producing and presenting a short film (5 to 10 minutes)

TOTAL PERIODS
45
COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Read and comprehend resources that trace the history and evolution of films in the global context over the centuries

CO2 Listen to lectures and study materials to understand and apply basic film vocabulary and film theory

CO3 Speak effectively on the larger impact of the role of films in the society

CO4 Write film reviews, stories and film scripts by learning to appreciate the various nuances and aspects involved in the filmmaking process

CO5 Present their artistic abilities by creating their own short films based on the takeaways from the course

TEXT BOOKS

1. *Film Studies: An Introduction* - Ed Sikov

2. *Understanding the Film: An Introduction to Film Appreciation* - Jan Bone and Ron

REFERENCE BOOKS

1. *Bollywood: A Guidebook to Popular Hindi Cinema* - Tejaswini Ganti

2. *Introduction to Film Studies* - Jill Neldes

3. *The 5 C's of Cinematography: Motion Picture Filming Techniques* - Joseph V. Mascelli

4. *The Film Book: A Complete Guide to the World of Film* - Ronald Bergan

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							1	0	3		1		
CO2							0	0	3		1		
CO3							1	0	3		1		
CO4							0	1	3		1		
CO5							0	1	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3289	TECHNICAL WRITING (Common to all B.E./B.Tech. programs)	30	0	30	30	90	3

OBJECTIVES

- Prepare effective instructions, checklists and emails
- Write different kinds of paragraphs and argumentative essays
- Develop and revise effective resumes, cover letters and SOPs
- Document and organise various kinds of reports, case studies and white papers
- Create well-structured proposals and press releases

UNIT I	WRITING INSTRUCTIONS, CHECKLISTS AND EMAILS	9
Writing instructions and checklists; using bulleted lists and numbered lists. Writing professional emails: appropriate greetings, subject line, writing three-body paragraphs – introduction, body, and closing paragraph; discussion of samples. Language skills: Tenses – present and past		

UNIT II	WRITING ARGUMENTATIVE PARAGRAPHS AND ESSAYS	9
Writing paragraphs. Structure of a paragraph: basic, compare and contrast. Product descriptions and process descriptions. Interpreting charts and graphs. Writing argumentative essays; handling three types of arguments: Classical, Rogerian, Toulmin; structure of an argumentative essay: introduction, building the thesis, body paragraphs with three arguments or claims and supporting evidence, conclusion. Sample essays. Language skills: Connectors and definitions		

UNIT III	WRITING JOB APPLICATIONS AND SUMMARIES	9
Writing job applications; resumes and cover letters. Writing the statement of purpose (SOP): Outline – professional narrative, previous experience, research interests, and career goals. Writing summaries: reading the text; identifying the main ideas and supporting details. Writing paraphrases: step by step paraphrasing; text comparison; sentence analysis. Language skills: subject-verb agreements		

UNIT IV	WRITING REPORTS, CASE STUDIES AND WHITE PAPERS	9
Writing datasheets: outline – descriptions, graphics, benefits, features and specifications, requirements, and contact information. Writing abstracts. Writing technical reports; practising IMRAD structure; Engineering reports & Feasibility reports. Writing case studies and white papers: main components of an issue case study – problems, search for solutions, implementation of the solution and results. Language skills: Active voice, passive voice		

UNIT V	WRITING PROPOSALS AND PRESS RELEASES	9
Writing business proposals: format -- title page, table of contents, executive summary, project details, deliverables and milestones, budget, conclusion. Writing for Websites: Inverted pyramid style; headings and subheading; bulleted lists; short paragraphs with one idea. Writing press releases: outline – headline, date of publication, contact information, summary, intro paragraph, detail paragraphs, and about section. Language skills: Correction of errors, proofreading and editing		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Write instructions, checklists and emails with clarity and readability
CO2 Compose paragraphs, and structure an argumentative essay effectively
CO3 Create and edit resumes, cover letters and SOPs concisely
CO4 Document well-structured reports, case studies and white papers
CO5 Develop effective proposals and press releases

TEXT BOOKS
1. Laplante, P. A. (2018). <i>Technical writing: A practical guide for engineers, scientists, and nontechnical professionals</i> . CRC Press.
2. David Bonamy. (2013) <i>Technical English Level 2 Course Book</i> . Pearson

REFERENCE BOOKS
1. Kmiec, D., & Longo, B. (2017). <i>The IEEE guide to writing in the engineering and technical fields</i> . John Wiley & Sons.
2. Lewis Lansford; Peter Astley. (2013). <i>Oxford English for Careers: Engineering 1: Student's Book</i> . Oxford University Press.
3. Mark Ibbotson. (2008). <i>Cambridge English for Engineering, 2008</i> , Cambridge University Press.
4. Rubens, P. (2002). <i>Science and technical writing: A manual of style</i> . Routledge.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								0	3		1		
CO2								0	3		1		
CO3								0	3		1		
CO4								1	3		2		
CO5								1	3		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UHS3286	GERMAN BEGINNER LEVEL (Common to all) B.E./B.Tech. programs)	30	0	15	45	90	3

OBJECTIVES

- Introduce students to the fundamentals of German language.
- Develop basic language skills: listening, speaking, reading, and writing.
- Equip students to achieve A1 level language proficiency certification.
- Cultivate intercultural understanding and appreciation for diverse linguistic and cultural perspectives.
- Understand the Grammatical structure of the German language.

UNIT I	LANGUAGE AND CULTURE	9
Greetings – Self Introduction – Numbers and Alphabets – Names Of Countries And Continents		

UNIT II	BASIC GRAMMAR	9
Definite And Indefinite Articles – Simple Verbs and Conjugation – Pronouns – Possessive Pronoun – W Questions		

UNIT III	READING SKILLS	9
Reading Simple Passages – Context-Based Learning – Professions – Language and Country – Freetime Activities – Daily Routine		

UNIT IV	LISTENING SKILLS	9
Comprehending Real-Time Situation-Based Dialogues – Travel Announcements – Supermarket – Plans For Vacations – Dialogues At Work		

UNIT V	WRITING AND SPEAKING SKILLS	9
Introducing Self – Describing Daily Routine – At the Café, Restaurant – Ordering Food – Weather and Clothing - Family		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Understand the Relationship Between Language and Culture

CO2 Apply Basic Grammar Rules

CO3 Develop Effective Reading Skills

CO4 Enhance Listening Skills

CO5 Communicate Effectively in Writing and Speaking

TEXT BOOKS

1. Netzwerk a1 deutsch als fremdsprache by stephanie dengler (2012)
2. Studio d a1 deutsch als fremdsprache by hermann funk (2011)

REFERENCE BOOKS

1. Password Deutsch 1 By Ulrike Albrecht

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						1			1	3	1		
CO2						1			1	3	1		
CO3						1			1	3	1		
CO4						1			1	3	1		
CO5						1			1	3	1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3352	FOUNDATIONS OF DISCRETE MATHEMATICS	45	15	0	60	120	4

OBJECTIVES

- To equip the students with the concepts of classical logic, normal forms and its applications.
- To solve problems using counting techniques and graph theory
- To study the algebraic structures and Boolean algebra and their applications.

UNIT I	MATHEMATICAL LOGIC	12
Introduction to logic: Multivalued logic – three-valued logic, connectives – Two valued logic: Propositions – Propositional equivalences – Normal forms - Predicates and quantifiers – Nested quantifiers – Rules of inference – Introduction to proofs – Proof methods and strategy.		

UNIT II	COMBINATORICS	12
Mathematical induction – The pigeonhole principle – Recurrence relations – Solving linear recurrence relations using generating functions – Principle of Inclusion and Exclusion – Divisibility – Primes – The Chinese remainder theorem.		

UNIT III	GRAPHS	12
Graphs: basic definitions – special types of graphs – Subgraphs – Matrix representation of graphs – Connectivity – Eulerian and Hamilton graphs – Trees: Properties – Distance and Centres – Spanning Tree.		

UNIT IV	ALGEBRAIC STRUCTURES	12
Algebraic systems – Semi groups and monoids – Groups–Subgroups – Homomorphisms – Normal subgroup and cosets – Lagrange’s theorem – Rings and Fields: Definitions and examples.		

UNIT V	LATTICES AND BOOLEAN ALGEBRA	12
Relations – Equivalence relation – Partial ordering – Posets – Lattices as Posets – Properties of lattices – Lattices as algebraic systems – Sublattices – Boolean algebra – Stone’s representation Theorem.		

TOTAL PERIODS	120
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Apply logical inferences in deriving decisions in engineering problems (K3)
CO2 Formulate and solve problems using recurrence relation and various counting techniques.(K5)
CO3 Apply graph theoretical techniques in network analysis. (K3)
CO4 Identify various algebraic structures and solve problems using their properties.(K3)
CO5 Identify and solve problems using Boolean algebra. (K3)

TEXT BOOKS

1. Kenneth H Rosen, “Discrete Mathematics and its Applications”, 8th Edition, Special Indian edition, Tata McGraw Hill, New Delhi, 2021.
2. Tremblay J P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, 35th Reprint, Tata McGraw Hill, New Delhi, 2008.

REFERENCE BOOKS

1. Ralph P Grimaldi, “Discrete and Combinatorial Mathematics: An Applied Introduction”, 4th Edition, Pearson Education Asia, 2007.
2. Eric Lehman, F Tom Leighton, Albert R Meyer, Mathematics for Computer Science, Samurai Media Limited, 2017.
3. Thomas Koshy, “Discrete Mathematics with Applications”, Elsevier Publications, 2004.
4. C.L. Liu, DP Mohapatra, “Elements of Discrete Mathematics: A Computer Oriented Approach”, 4th Edition, McGraw Higher Education, 2017.
5. John M Harris, Jeffry L Hirst, Michael J Mossinghoff, “Combinatorics and Graph Theory”, Springer Verlag New York, 2008.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	2											
CO5	3	2											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UHS3386	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY (Common to all B.E./B.Tech. programs)	30	0	30	30	90	3

OBJECTIVES

- To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education
- To help students initiate a process of dialog within themselves to know what they 'really want to be' in their life and profession
- To help students understand the meaning of happiness and prosperity for a human being
- To facilitate the students to understand harmony at all the levels of human living and live accordingly.
- To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life course

UNIT I	INTRODUCTION TO VALUE EDUCATION	9
Value Education - Need, Basic Guidelines, Content and Process, Self-Exploration - meaning, importance and process, Continuous Happiness and Prosperity - A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities - the basic requirements, Understanding Happiness and Prosperity - A critical appraisal of the current scenario, Method to fulfill the above human aspirations - understanding and living in harmony at various levels.		

UNIT II	HARMONY IN THE HUMAN BEING	9
Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.		

UNIT III	HARMONY IN THE FAMILY AND SOCIETY	9
Understanding harmony in the Family- the basic unit of human interaction , Understanding values in human to human relationship; Understanding Trust the foundational value in relationship, Difference between intention and competence, Understanding Respect - as the right evaluation, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society - comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order - from family to world family!		

UNIT IV	HARMONY IN THE NATURE AND EXISTENCE	9
Understanding the harmony in the Nature, Interconnectedness, self-regulation and mutual fulfilment among the four orders of nature- recyclability, Understanding Existence as Co-existence of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.		

UNIT V	IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS	9
Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics - augmenting universal human order, the scope and characteristics of people-friendly and eco-friendly, Holistic Technologies, production systems and management models - Case studies, Strategy for transition from the present state to Universal Human Order - At the level of individual: as socially and ecologically responsible engineers, technologists and managers, At the level of society: as mutually enriching institutions and organizations.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.
CO2 Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co- existence of Self and Body.
CO3 Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society.
CO4 Understand the harmony in nature and existence and work out their mutually fulfilling participation in the nature.
CO5 Distinguish between ethical and unethical practices and start working out the strategy to actualize a harmonious environment wherever they work.

TEXT BOOKS
1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi, 2nd Revised Edition, 2019

REFERENCE BOOKS
1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. xSmall is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							3	2	3		1		
CO2							3	2	3		1		
CO3							3	3	3		1		
CO4							3	2	3		1		
CO5							3	2	3		1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3301	DATA STRUCTURES	45	0	0	45	90	3

OBJECTIVES

- To comprehend the notion of linear and non-linear data structures.
- To apply the linear and non-linear data structures to various problems.
- To learn hashing techniques and disjoint set operations.
- To choose suitable data structure to solve the given problem.

UNIT I	LINEAR DATA STRUCTURES – LIST	9
Abstract Data Type (ADT); List ADT: Array based and Linked List based Implementations; Doubly Linked List; Circular Linked List; Applications of List: Polynomial Manipulation; Asymptotic Notations: big-Oh; Efficiency of algorithms: Notion of time and space complexity; Analysis of non-recursive and recursive algorithms.		

UNIT II	LINEAR DATA STRUCTURES – STACKS AND QUEUES	9
Stack ADT: Stack model – Implementation of stacks – Applications: Balancing symbols – Infix to postfix conversion – Evaluating postfix expressions; Queue ADT: Queue model – Implementation of queues – Applications of queues.		

UNIT III	NON LINEAR DATA STRUCTURES – TREES	9
Tree Preliminaries; Binary Tree: Traversal on Trees, Expression Tree; Threaded Binary Tree; Binary Search Tree ADT; AVL Tree operations and implementation; Priority queues using Binary Heap, Binomial heap, and Fibonacci heap; Tries.		

UNIT IV	NON LINEAR DATA STRUCTURES – GRAPHS	10
Graphs: Basic definition and Representation of Graphs; Graph Traversals: Breadth First Search and Depth First Search; Topological Sort; Shortest Path: Dijkstra's Algorithm, Floyd Warshall Algorithm; Traversal Applications.		

UNIT V	HASHING AND DISJOINT SET	8
Hash ADT: Hash function, Separate chaining, Open addressing, Rehashing, Extendible hashing, Cuckoo Hashing; Applications of Hashing technique; Algorithms for Disjoint Set operations.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Use linear data structures namely arrays and linked lists for developing applications by analysing their time complexity. (K4)

CO2 Use Stack and Queue data structures to develop solutions for various problems. (K3)
CO3 Solve problems using different types of tree data structures (K3)
CO4 Choose appropriate graph algorithms to solve the given problems. (K5)
CO5 Solve problems applying hashing and using disjoint sets (K3)
CO6 Choose appropriate data structures and algorithms demonstrating the ability for independent and life-long learning, critical thinking, and contributing to quality education in the context of evolving technologies. (K6)

TEXT BOOKS

1. M A Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2002. (All Units)
2. Richard F Gilberg, Behrouz A Forouzan, "Data Structures: A Pseudocode Approach with C", 2nd Edition, Cengage India, 2007.

REFERENCE BOOKS

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI Learning Private Limited, April 2022.
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekar, "Fundamentals of Computer Algorithms", 2nd Edition, University Press, 2017.
3. S Sridhar, "Design and Analysis of Algorithms", 1st Edition, Oxford University Press, 2015.
4. Byron Gottfried, "Schaum's Outline of Programming with C", 4th edition, 2019, McGraw Hill Education (India)
5. A V Aho, J E Hopcroft, J D Ullman, "Data Structures and Algorithms", Pearson Education, 1st Edition Reprint, 2003.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3											3	
CO3	3											3	
CO4	3	3	3									3	2
CO5	3											3	
CO6	3	3	3		2						3	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3302	COMPUTER ORGANIZATION AND ARCHITECTURE	45	0	0	45	90	3

OBJECTIVES

- To learn the fundamental building blocks and arithmetic operations in computer systems.
- To understand MIPS instruction set architecture and the language of computers.
- To explore the design and implementation of processors including non-pipelining and pipelining.
- To understand memory hierarchy and input/output mechanisms including IO modes and DMA.
- To provide insights into parallel architectures and their challenges in modern computing.

UNIT I	BASIC STRUCTURES OF COMPUTERS & ARITHMETIC DESIGN	9
Functional Units, Basic Operational Concepts, Adder and subtraction, Multiplication (Booths and modified Booths), Division (restoring and non-restoring), Floating Point Representation, Floating Point Operations.		

UNIT II	PERFORMANCE & MIPS INSTRUCTION SET ARCHITECTURE	9
Performance, Language of the Computers, Operations and Operands of the Computer Hardware, Representing Instructions in the Computer, Logical Operations Instructions for Making Decisions, Addressing Modes.		

UNIT III	PROCESSOR DESIGN	10
Logic Design Conventions, building a Data path, A Simple Implementation Scheme, An Overview of Pipelining, Pipelined Data path and Control, Data Hazards: Forwarding versus Stalling, Control Hazards, Exceptions, Parallelism via Instructions.		

UNIT IV	MEMORY UNIT AND I/O MODES	9
Memory Hierarchy, Memory Technologies (SRAM & DRAM), The Basics of Caches, Measuring and Improving Cache Performance, Cache Replacement Techniques, Cache Coherence, IO Modules, Programmed IO, Interrupt Driven IO, Direct Memory Access.		

UNIT V	PARALLEL PROCESSOR ARCHITECTURES	8
Parallel processing challenges, Flynn's classification, Vector Architectures, Hardware Multithreading, Multi-core processors and other shared memory, Multiprocessors, Introduction to Graphics Processing Units.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Illustrate the structure and function of basic components in a computer system, and develop arithmetic operations, and floating-point operations. (K3)
CO2 Analyze and apply the MIPS instruction set to represent and implement low-level programs. (K4)
CO3 Construct a datapath design with non-pipelining and pipelining architecture. (K3)
CO4 Develop memory organization and apply techniques to improve memory and I/O performance using appropriate modes. (K3)
CO5 Explain parallel processing architectures (K2)
CO6 Choose engineering tools (e.g., MIPS Simulator, Logisim, VHDL/Verilog) to model, simulate, and validate arithmetic and memory designs, while collaboratively developing solutions and presenting the outcomes in a structured report. (K5)

TEXT BOOKS

1. David A Patterson, John L Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5th Edition, Morgan Kaufmann / Elsevier, 2014. (Unit - 1, 2, 3, 4: Memory Part)
2. William Stallings, "Computer Organization and Architecture: Designing for Performance", 10th edition, Pearson Series, 2016. (Unit-4: IO Modules, Programmed IO, Interrupt Driven IO, Direct Memory Access.)
3. John L Hennessey, David A Patterson, "Architecture – A Quantitative Approach", 5th edition, Morgan Kaufmann, Elsevier, 2012 (Unit-5)

REFERENCE BOOKS

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th Edition, Tata McGraw Hill, 2022.
2. Morris Mano M, "Computer System Architecture", Revised 3rd Edition, Pearson Publication, 2017
3. Chakraborty P, "Computer Architecture and Organization", JAICO Publishing House, 2010.
4. John P Hayes, "Computer Architecture and Organization", 3rd Edition, Tata McGraw Hill, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										2	
CO3	3		3	3								3	
CO4	3	3	3	3								3	
CO5		3				3					2	2	
CO6			3					3	3				3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3361	OBJECT ORIENTED PROGRAMMING	30	0	60	30	120	4

OBJECTIVES

- To learn the basics of Object-Oriented Programming.
- To know the principles of inheritance and polymorphism.
- To learn the concepts of exception handling and packages.
- To learn the concepts of generic methods and generic collections.
- To demonstrate multitasking through multithreading and Unit testing.

UNIT I	INTRODUCTION	6
Object oriented programming: features, Basics of Java programming: Data types, Variables, Operators, Control structures, Java methods, Overloading, Math class, Arrays in Java, Objects and Classes: Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, this reference, static members		

UNIT II	INHERITANCE AND POLYMORPHISM	6
Inheritance, Super and sub class, Types of inheritance: Single - Multilevel - Multiple - Hierarchical; Subclass constructors; Overriding, Polymorphism, Dynamic binding, Abstract class, Interface in java.		

UNIT III	EXCEPTION HANDLING AND PACKAGES	6
Exception Handling: Benefits of exception handling - Exception hierarchy - Checked exceptions and unchecked exceptions - Usage of try, catch, throw, throws and finally, rethrowing exceptions - Built in exceptions - Creating own exception sub classes; Packages: Built in packages, creating and accessing a user-defined package – Files – Operations - File streams.		

UNIT IV	GENERIC CLASS AND COLLECTIONS	6
Generic classes and generic methods - Generic types - Restrictions and limitations, Introduction to collections: Collection Classes and Interfaces: List, Set, Queue, Array list, Linked list, Trees; Iterators for collections - Map class.		

UNIT V	MULTITHREADING AND JUNIT	6
Thread life cycle and methods, Runnable interface, Thread synchronization, Lambda expressions, filter, functional interface, var-args, Benefits of Unit Testing, JUnit Introduction, JUnit Life Cycle API, Developing an Application with JUnit 5, Dependency Injection, Mocking, Testing Traits, and Grouping Tests.		

SUGGESTED EXPERIMENTS

1. Micro project on real time applications. (Eg.: Library Management System, Ticket Booking System, Finance Management System)
2. Programs using class, methods, and objects with method overloading. (Eg.: Electricity bill generation)
3. Program using inheritance and method overriding. (Eg.: Payroll application)
4. Programs using interfaces and abstract class. (Eg.: Stack, Queue)

5. Program to demonstrate Packages. (Eg.: Currency converter)
6. Program to demonstrate Exception Handling. (Eg.: Bank Account manipulation)
7. Programs using Collections. (Eg.: ArrayList, LinkedList)
8. Program to demonstrate Multithreading. (Eg.: Chat application)
9. Test the programs in JUnit 5. (Validate the Java applications)

TOTAL PERIODS	120
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental concepts of object-oriented programming and the basic features of Java (K2)

CO2 Use the concepts of inheritance and polymorphism in an application to demonstrate substitutability and extensibility. (K3)
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CO3 Develop user-defined packages with exception handling mechanisms to use modular approach (K3)

CO4 Choose suitable collection frameworks for efficient data manipulation and type-safe operations. (K4)
--

CO5 Apply unit testing methods to validate the correctness and performance of Java applications (K3)
--

CO6 Design object-oriented solutions for real-world problems through collaborative teamwork and demonstrate the application. (K5)

TEXT BOOKS

1. Herbert Schildt, "Java: The Complete Reference", 12th Edition, McGraw Hill Education, 2022. (Unit I-V)

2. Shekhar Gulati Rahul Sharma, "Java Unit Testing with JUnit 5", APress, 2017 (Unit V)

REFERENCE BOOKS

1. Cay S Horstmann, Gary Cornell, "Core Java Volume – I Fundamentals", 10th Edition, Prentice Hall, 2016.

2. Edward Lavieri, "Mastering Java 11" - Second Edition, Packt Publishing, 2018.
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3. Steven Holzner, "Java 2 Black book", Dream tech press, 2018.

4. Danny Poo, Derek Kiong, Swarnalatha Ashok, "Object-Oriented Programming and Java", 2nd Edition, Springer Publication, 2008.
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5. C Thomas Wu, "An introduction to Object-oriented programming with Java", 5th Edition, Tata McGraw-Hill Publishing company Ltd., 2009.
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CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	3										2	2
CO3	3	2										3	2
CO4	3	2	3									3	2
CO5	3	2			2							3	
CO6			3					3	3	2		3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3303	OPERATING SYSTEMS	45	0	0	45	90	3

OBJECTIVES

- To understand the structure and functions of OS
- To learn about Processes and Scheduling algorithms
- To understand the principles of synchronization and inter process communication
- To learn various memory management schemes
- To study and work with real time operating systems

UNIT I	INTRODUCTION	9
Introduction: System software, operating system operations, operating systems generations, Types of operating systems, operating system structures, Process concepts: process control block, process state, operations on process, System calls for process management		

UNIT II	PROCESS MANAGEMENT AND IPC	9
Process Management: scheduling queues, schedulers, dispatcher, CPU Scheduling: Scheduling Criteria, Scheduling Algorithms, Real-Time CPU Scheduling, Inter Process Communication: Cooperating process, independent process, Communications using Shared memory, Pipe and Message passing, System calls for IPC		

UNIT III	SYNCHRONIZATION AND DEADLOCK	9
Concurrency And Synchronization: Process synchronization, critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of synchronization: producer and consumer problem, reader and writers problem. System calls for process synchronization, Deadlock: Characteristics, Prevention, Avoidance, Detection and Recovery		

UNIT IV	MEMORY MANAGEMENT	9
Main Memory Management: Swapping, contiguous memory allocation, fragmentation, compaction, paging, segmentation, Virtual Memory: demand paging, page-replacement algorithms, Files and Directories, file system implementation, Systems calls for file operations		

UNIT V	REAL TIME OPERATING SYSTEMS	9
Real time systems, Types of RTOS, Working with RTOS IDEs, Debugging tools for real time systems, Application: FreeRTOS scheduler, Synchronizing tasks, Intertask communications.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Demonstrate a comprehensive understanding of fundamental concepts of operating system structure and system calls. (K2)
CO2 Apply appropriate process scheduling and inter process communication techniques for an application. (K3)
CO3 Analyse concurrency issues in process synchronization and resource allocation and

develop solutions (K4)
CO4 Identify suitable memory management techniques for main memory management and secondary memory management. (K3)
CO5 Experiment with various features of real-time operating systems such as task scheduling, synchronization, and inter-task communication. (K3)
CO6 Evaluate existing research on system-level challenges in operating systems and recommend potential solutions based on contemporary methods. (K5)

TEXT BOOKS

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", 10th Edition, John Wiley and Sons Inc, 2021
2. W. Richard Stevens Stephen A. Rago, "Advanced Programming in the UNIX ® Environment", Third Edition, Pearson Education, Inc., 2013
3. Brian Amos , "Hands-On RTOS with Microcontrollers", Packt Publishing Ltd, 2020

REFERENCE BOOKS

1. William Stallings, "Operating Systems, Internals and Design Principles", 9th edition, Pearson Education, India, 2018.
2. Harvey M. Deitel, David R. Choffnes and Paul J. Deitel, "Operating systems", 3rd edition, Pearson Education, India, 2008.
3. Sunil K Joseph, Surabhi Kurian, "Mastering Linux: A Comprehensive Guide to the Operating System", Notion Press, 2023
4. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", 5th edition, Pearson Education, India, 2023.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										3	
CO3	3	2										3	2
CO4	3	2										3	
CO5	3				2							3	
CO6				3					3		2	3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGE3386	DESIGN THINKING, INNOVATION AND ENTREPRENEURSHIP (Common to all B.E./B.Tech. programs)	15	0	60	15	90	3

OBJECTIVES

- Learn to identify problems, frame challenges, and apply human-centered design methodologies for creative problem-solving.
- Utilize brainstorming techniques, rapid prototyping, and user feedback to refine and test ideas effectively.
- Understand business model frameworks, customer segmentation, and strategies to create scalable and sustainable startups.
- Learn startup funding options, financial planning, pricing strategies, and revenue models to support business expansion.
- Explore different types of innovation, emerging technologies, and industry trends to drive competitive advantage. Offer hands-on experience in prototyping

UNIT I	FUNDAMENTALS OF DESIGN THINKING	9
A primer on design thinking – Design thinking vs Traditional Approach - Human centered design approach - Five Stage of Design thinking process – Identifying and defining clear and actionable problem statement. SL: Case Study on application of design thinking on product development by leading companies. Use "How Might We" (HMW) questions to explore solutions by redefining problems Activity hands-on: Conduct user interviews and create empathy maps, Product design challenge in short sprint covering all phases of Design thinking principles.		

UNIT II	DESIGN THINKING PROCESS AND PROTOTYPING	9
Principles of Divergent and Convergent thinking - Ideation Techniques – Rapid prototyping and Wireframing - Low fidelity – Mid fidelity and High-Fidelity Prototypes - Google design Sprint Method - User Testing and Feedback SL & Activity hands-on: Develop a low fidelity prototype with respect to your domain, develop of physical prototype for a product, Work in teams in a 3-day design sprint, Submit Video Diary summarizing Sprint learnings, Conduct User testing, document feedback and propose three design changes		

UNIT III	FOUNDATIONS OF ENTERPRENURSHIP	9
Characteristics of Entrepreneur - Types of Entrepreneurships - Entrepreneurial Mindset – Business Model – Business Model Canvas - Types of Startup Business Models - Unique Selling Proposition SL: Elements of Pitch Deck – Registering a business – Risk Assessment and Decision Making - Art of Leadership, Minimum Viable Product Activity hands-on: Develop and Submit a 1-minute elevator pitch, develop a business canvas model for a product, Submit a case study on assessing the characteristics of an entrepreneur.		

UNIT IV	ENTREPRENEURIAL FINANCE	9
Source of Funding for Startups, bootstrapping vs. Debt Financing, Profit & Loss Statement, Balance sheet, Managing Burn rate and Runway - Business Expansion Models – Scaling SL: Break even analysis - Pricing Strategy & Revenue Models – Revenue Projections Activity hands-on: Prepare a Basic Finance plan for an imaginary product, Prepare a presentation compare and analyzing pricing model of a product , Simulate a Mock Investment Pitch		

UNIT V	INNOVATION MANAGEMENT AND FUTURE TRENDS IN INNOVATION	9
Difference between Innovation, Invention and Improvement - Types of Innovation – Disruptive Vs Incremental Innovation - Emerging Technologies & Their Impact on Entrepreneurship SL: Technology Driven Business Models, Emerging start up Trends – Green Innovation Activity Session: Analyze a disruptive innovation case study, develop an innovation roadmap for a chosen industry, Record a One Minute Story on a product in the promising emerging markets, Identify a company that failed due to lack of innovation and analyze the reasons.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Understand and implement design thinking methodologies to identify user needs, frame challenges, and develop innovative solutions.
CO2 Utilize brainstorming, rapid prototyping, and user testing to refine ideas and create viable product concepts.
CO3 Develop a business model canvas, identify revenue streams, and validate the feasibility of an idea using lean startup principles.
CO4 Develop a financial plan, analyze different pricing models, and participate in a mock investment pitch to refine startup strategy and fundraising skills
CO5 Identify the difference between invention, innovation, and improvement, analyze types of innovation, and explore how emerging technologies impact startups and business growth

TEXT BOOKS
1. Tim Brown, How design thinking transforms organizations and inspires innovation change by design, Harper Business, 2013.
2. Ries, Eric. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business, New York, 2011. ISBN: 978-0-307-88789-
3. Christensen, Clayton M. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Harvard Business Review Press, Boston, 1997. ISBN: 978-1-63369-178-0.

REFERENCE BOOKS
1. IDEO, Human Centered Design Tool Kit, 2nd edition (July 1, 2011) Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
2. J. Berengueres, The brown book of design thinking, UAE university College, Al Ain, First edition, November 16, 2013, ISBN 978-1-63041-059-9

3. Tom Kelly, The art of innovation - Lessons in Creativity from IDEO, America's Leading Design Firm, Profile Books; Main edition, 2016
4. Reddy, N. Krishniah. Innovation Management: Strategies, Concepts, and Tools for Growth and Profit. Tata McGraw-Hill, New Delhi, 2009. ISBN: 978-0-070-15084-3.
5. Thiel, Peter, and Masters, Blake. Zero to One: Notes on Startups, or How to Build the Future. Crown Business, New York, 2014. ISBN: 978-0-8041-3929-8.
6. Osterwalder, Alexander, Pigneur, Yves. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley, New Jersey, 2010. ISBN: 978-0-470-87641-1.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1		2	3										
CO2		2	3										
CO3			2							3			
CO4										3			
CO5		1	2							3	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3311	DATA STRUCTURES LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- Implement the operations on linear and non-linear data structures
- Use suitable linear and nonlinear data structures for a given problem statement.

SUGGESTED EXPERIMENTS

1. Applications of Array (e.g. Finding pairs in an array with the given constraints)
2. Applications of Linked List (e.g. Polynomial manipulations)
3. Applications of Doubly Linked List (e.g. Simulation of a music player)
4. Applications of Stack (e.g. Simulation of Undo & Redo operations in a text editor)
5. Applications of Queue (e.g. Simulating printer jobs)
6. Implementation of Expression Tree (e.g. Elimination of common subexpression)
7. Applications of Binary Search Tree (e.g. Finding kth-largest and kth smallest element)
8. Applications of Graph Traversal Techniques (e.g. Simulation of network routing protocols)
9. Implementation of Shortest path algorithms (e.g. Finding the shortest route to connect one city to another)
10. Implementation of Hash Table (e.g. Symbol tables in Compilers)
11. Applications of Disjoint Set (e.g. Finding connected components and cycles)
12. Micro Project - Solving classical data structures problems referring to competitive programming websites

Laboratory Requirement for Batch of 30 Students

- Hardware
- PC - 30 Nos
- Software
- GCC compiler

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Solve the applications using array, list, stack and queue data structures. (K3)

CO2 Use trees, graphs, hash tables and disjoint set data structures to solve real-world applications. (K3)

CO3 Select suitable data structure for real-world problems and work in teams applying best practices for problem solving and demonstrating its working with a good documentation (K5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3		3									3	2
CO2	3		3									3	2
CO3	3	3	3		2		2		2		3	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3312	OPERATING SYSTEMS LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- To learn and implement basic Unix commands using system calls
- To implement various CPU Scheduling Algorithms, Inter Process Communication and Synchronization algorithms
- To implement Page Replacement Algorithms
- To explore RTOS and its operations

SUGGESTED EXPERIMENTS

1. Install virtual machine or windows subsystem and develop programs for process management using system calls. (Eg.: fork, wait, waitpid, exec, system, read, write, sleep, getpid, getppid, abort, kill)
2. Implement UNIX commands using system calls and include it as a part of the system commands in Linux operating system. (Eg.: ls, grep, cp using system calls like open, creat, read, write, close, lseek, dup, fcntl, ioctl, stat, umask, chmod, link, unlink, mkdir, chdir, opendir, closedir, readdir, getcwd, etc.)
3. Simulate the CPU scheduling algorithm (FIFO, Preemptive Priority). (Eg.: Printer job scheduling, scheduling jobs in automated boiler plant)
4. Develop inter-process communication mechanisms using shared memory and pipes for parent-child communication and client-server communication. (Eg.: Chat application, File transfer using system calls like pipe, popen, pclose, mkfifo, shmget, shmat, shmdt, shmctl, etc.)
5. Implement synchronization between processes using semaphores. (Eg.: Log File Synchronization using system calls like semget, semctl, semop, sem_wait, sem_open, sem_close, sem_post, sem_init, sem_destroy, sem_getval etc.)
6. Apply a deadlock avoidance algorithm to ensure safe resource allocation and prevent deadlocks. (Eg.: Cloud resource allocation for multiple users, Computer resource allocation)
7. Simulate the memory allocation using page replacement algorithms (LRU, Optimal). (Eg.: Multiprogramming in RAM)
8. Implement file allocation techniques for secondary memory management (Linked, Indexed). (Eg.: FAT storage structure)
9. Install RTOS and execute scheduler to run the jobs.
10. Apply synchronization techniques for inter task communication in RTOS.

TOTAL PERIODS

45

LABORATORY REQUIREMENT FOR BATCH

Hardware: 1. Standalone Desktops with Linux OS - 38 Nos

Software: 1. C Compiler

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Examine the use of system calls, IPC mechanisms, and synchronization methods in operating systems. (K4)

CO2 Use relevant algorithms to build solutions for managing processes, allocating resources, and handling memory efficiently. (K3)

CO3 Assess the core features of real-time operating systems focusing on meeting time constraints in scheduling and synchronization. (K5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3									3	2
CO2	3	2					2					3	2
CO3	3				3				2	2	2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCSV303	SKILL DEVELOPMENT LABORATORY – I	0	0	30	0	30	1

OBJECTIVES

- Introduce fundamentals of prompt engineering for interacting with Large Language Models (LLMs).
- Develop skills in crafting effective prompts for text, coding, and specialized tasks.
- Explore advanced techniques like prompt chaining and API integration.
- Understand LLMs' capabilities, limitations, and ethical implications.
- Apply prompt engineering in a practical project combining basic and advanced methods.

Pre-requisites

Basic programming skills (e.g., Python, C++). No prior LLM knowledge needed.

UNIT I	Foundations of Prompt Engineering and LLMs	3
Objective: Understand LLMs and the basics of prompt engineering.		
Theory (1 Hour): • Overview of Large Language Models: Transformers, tokens, and context. • Role of prompt engineering in AI applications (e.g., chatbots, code assistants). • Real-world use cases: Content generation, code completion, and automation. • Introduction to model limitations: Context window, hallucinations.		
Real-world examples: Pizza My Heart's "Jimmy the Surfer" Chatbot: A California pizza chain employs an AI persona named Jimmy the Surfer to handle orders via text, illustrating how role-based prompting ("You are Jimmy, a laid-back surf expert") guides tone and improves engagement in a real retail setting <u>WIRED</u> .		
Hands-on (2 Hours): • Accessing free LLMs (e.g., ChatGPT, Gemini, Grok, or Hugging Face models). • Write simple prompts for text generation (e.g., "Describe a futuristic city"). • Experiment with prompt variations (e.g., tone, specificity) and compare outputs.		
Learning Outcomes: • Understand how LLMs process prompts. • Gain initial experience with LLM interactions.		

UNIT II	Crafting Effective Prompts for Text and Coding	3
Objective: Design precise prompts for text generation and basic coding tasks. Theory (1 Hour): • Anatomy of a good prompt: Clarity, specificity, context. • Techniques: Zero-shot, few-shot, and chain-of-thought prompting. • Prompts for coding: Specifying language, functionality, and constraints. • Common pitfalls: Ambiguity, bias, incorrect code logic. Real-world examples: Med-PaLM2 Chain-of-Thought in Clinical QA: Google’s Med-PaLM2 uses multi-step “chain-of-thought” prompts to decompose medical questions into reasoning steps, achieving over 85 % accuracy on USMLE-style exams—demonstrating few-shot plus CoT prompting in high-stakes domains OpenReview. Hands-on (2 Hours): • Create prompts for text tasks (e.g., summarize a CS article, write a README). • Write prompts for Python code (e.g., generate a sorting algorithm). • Debug a code snippet using LLM prompts (e.g., “Fix errors in this loop”). Learning Outcomes: • Craft effective prompts for text and coding. • Evaluate LLM outputs for accuracy and relevance.		

UNIT III	Intermediate Prompt Engineering Techniques	3
Objective: Apply iterative and domain-specific prompt engineering. Theory (1 Hour): • Iterative prompting: Refining outputs through follow-up prompts. • Domain-specific prompts: Tailoring for tasks like technical writing or data analysis. • Introduction to prompt chaining: Structuring multiple prompts for complex tasks. • Collaborative workflows: Using LLMs as a “co-pilot” (e.g., iterative editing). • Real-world examples: • Frost Bank Call-Summary AI: Frost Bank’s customer-service AI automatically summarizes banking conversations using tailored summarization prompts, reducing agent after-call work by 30 % and ensuring consistent record-keeping San Antonio Express-News. Hands-on (2 Hours): • Iteratively refine a technical document (e.g., algorithm explanation). • Design a domain-specific prompt (e.g., “Explain a binary tree for a beginner”). • Use prompt chaining to solve a multi-step task (e.g., “Generate, test, and document a function”). Learning Outcomes: • Refine prompts iteratively for better results. • Apply prompt chaining for structured tasks.		

UNIT IV	Advanced Prompt Engineering and API Integration	3
Objective: Explore advanced techniques and basic LLM API interactions. Theory (1 Hour):		

- Advanced prompt chaining: Automating workflows with sequential prompts.
- Contextual prompt design: Optimizing for specialized tasks (e.g., generating SQL queries, UI mockups).
- Introduction to LLM APIs: Basic structure of API calls (e.g., Hugging Face, xAI API).
- Limitations of advanced techniques: Computational cost, API quotas.

Real-world examples:

CI/CD-Integrated OpenAI Evals: Teams at leading AI startups integrate OpenAI Evals into their CI/CD pipelines, running nightly automated pass/fail tests on production prompts to detect performance regressions before release [OpenAI Cookbook](#).

Hands-on (2 Hours):

- Create a chained prompt workflow (e.g., “Generate a dataset, analyze it, and visualize results”).
- Design a contextual prompt for a specialized task (e.g., “Write a REST API endpoint in Flask”).
- Make a simple API call to an LLM (e.g., Hugging Face’s text generation API using Python).

Learning Outcomes:

- Implement advanced prompt chaining for complex tasks.
- Interact with LLMs via APIs at a basic level.

UNIT V	Advanced Prompt Engineering and API Integration	3
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Objective: Address ethical issues and apply skills in a project combining basic and advanced techniques.

Theory (1 Hour):

- Ethical considerations: Bias, misinformation, responsible AI use.
- Advanced LLM limitations: Hallucinations, scalability, and ethical risks in automation.
- Future trends: Agentic AI, prompt engineering in production systems.

Real-world examples:

1. **Consistent Diagnostic Prompts for Medical AI:** A study found that GPT-4-Web with a “ROT” (Requirement-Outcome-Test) declarative prompt achieved the most consistent, reproducible answers on professional medical exam questions, highlighting reproducibility practices [PMC](#).
2. **PromptLayer in Fintech Compliance:** Fintech firms use PromptLayer to log, evaluate, and version prompts powering KYC and transaction-monitoring workflows—enabling audit trails and automatic rollback when prompt performance drifts [blog.promptlayer.com](#).
3. **AWS Bedrock Content Moderation:** Banks deploying AWS Bedrock leverage its built-in moderation checks and prompt-sanitization filters to prevent inadvertent exposure of PII in customer-facing AI assistants [incubity.ambilio.com](#).

Hands-on (2 Hours):

- Identify and mitigate bias in LLM outputs (e.g., rewrite a biased prompt).
- Develop a solution using prompt engineering (e.g., a chatbot script, an automated code generator, or a data analysis pipeline). Use basic and advanced techniques (e.g., prompt chaining, API calls). Present a short demo.

Learning Outcomes:

- Critically assess LLM outputs for ethical concerns.
- Synthesize prompt engineering skills in a practical project.

REQUIREMENTS

Tools: Free access to ChatGPT, Grok, or Hugging Face models. Optional: xAI API for educational use (see <https://x.ai/api>).

Hardware: Lab computers with internet access; Python installed for API exercises.

TOTAL PERIODS**45****COURSE OUTCOMES**

On successful completion of this course, students will be able to

CO1 Apply prompt engineering techniques to interact effectively with Large Language Models for diverse tasks such as content generation, summarization, and basic code writing. (K3)

CO2 Implement prompt refinement methods including few-shot learning, chain-of-thought prompting, and iterative feedback to improve output quality in domain-specific scenarios (K3)

CO3 Develop and demonstrate a functional solution using prompt chaining and API integration, showcasing ethical and practical applications of LLMs in real-world projects (K3)

REFERENCE BOOKS

1. [OpenAI Prompt Engineering Guide](#) (online).
2. [Hugging Face tutorials on text generation APIs](#).
3. Blog posts on advanced prompt engineering (e.g., Zapier, DataCamp).

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		2	3	3	3	2		3	3	2
CO2	3	2	3		2	3	3	3	3		3	3	2
CO3	3	3	3		3	3	3	3	3		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3476	PROBABILITY THEORY AND STATISTICS (Common to CSE and IT)	45	15	0	60	120	4

OBJECTIVES

- To equip students with the knowledge on concepts of probability, random variables, hypothesis testing, and statistical modeling using appropriate data.
- To impart knowledge on quality control tools to evaluate and improve processes, products, and engineering designs.

UNIT I	RANDOM VARIABLES	12
Random variables – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions – Functions of random variable.		

UNIT II	TWO-DIMENSIONAL RANDOM VARIABLES	12
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Convergence concepts of Central limit theorem - Central limit theorem.		

UNIT III	TESTS OF SIGNIFICANCE	12
Sampling distributions - large sample test - Test based on Normal: single and difference of mean and proportion – small sample test - t distribution: single and difference of means, Paired t test - χ^2 test - Test for goodness of fit, Independence of attributes - F test for variance.		

UNIT IV	DESIGN OF EXPERIMENTS	12
Design and analysis of experiments - Basic concepts and applications - ANOVA - Completely randomized design - Randomized block design - Latin square design.		

UNIT V	STATISTICAL QUALITY CONTROL	12
Quality Improvement – Basic concepts - Control charts for measurements: $\bar{X}$ and R charts - Control charts for attributes: p, c and np charts - Tolerance limits - Acceptance sampling.		

TOTAL PERIODS	120
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Formulate real life problems based on probability distributions. (K5)

CO2 Analyze two-dimensional random variables to determine joint distributions, expectations, and correlation measures.(K4)

CO3 Select suitable testing tools like t-test, F-test, chi-square test on data to derive appropriate inference about populations. (K4)
CO4 Analyze the different mathematical models with the help of statistical designs and make proper evaluation.(K4)
CO5 Assess the quality of a process and product in engineering and technology using various quality control tools.(K5)
CO6 Design experiments and apply statistical quality control tools to evaluate models, improve quality, and ensure system performance.(K6)

TEXT BOOKS

1. Milton, J. S. and Arnold, J.C., Introduction to Probability and Statistics, Tata McGraw Hill, New Delhi, 4th Edition, 2014.
2. Johnson, R.A., Miller and Freund's Probability and Statistics for Engineers, Pearson Education, Asia, 9th Edition, 2018.

REFERENCE BOOKS

1. Devore, J.L., Probability and Statistics for Engineering and the Sciences, Thomson Brooks/Cole, International Student Edition, New Delhi, 8th Edition, 2012.
2. Ross, S.M., Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J. and Srinivasan, R.A., Schaum's Outline of Probability and Statistics, Tata McGraw Hill, New Delhi, 4rd Edition, 2017.
4. Gupta, S.C and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan and Chand Company, New Delhi, 12th Edition, 2020.
5. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, Pearson Education, Asia, 9th Edition, 2016.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2			2								
CO4	3	2			2								
CO5	3	2			2								
CO6	3	2			2						2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UGA3476	INDIAN CONSTITUTION (Common to all B.E./B.Tech. programs)	15	0	0	15	30	1

OBJECTIVES

- To teach the history and philosophy of the Indian constitution.
- To summarize the powers and functions of the Indian government.
- To explain the structure and functions of local administration.
- To demonstrate the organization and working of the Judiciary.
- To discuss financial power and emergency provisions.

UNIT I	INTRODUCTION	9
Historical background Government of India act Indian councils act Making of the constitution - Philosophy of the Indian constitution Preamble.		

UNIT II	GOVERNMENT OF THE UNION	9
Powers and Functions of President and Prime Minister - Council of Ministers President in relation to his council - Legislature structure and functions of Lok Sabha and Rajya Sabha Speaker.		

UNIT III	GOVERNMENTS OF THE STATES AND LOCAL GOVERNMENT	9
The state executive: General structure Governor Council of ministers State legislature. Local government - Panchayat Municipality Power authority and responsibilities municipalities.		

UNIT IV	THE JUDICATURE	9
Organization and Composition of Judiciary Constitution Appointment Qualifications Powers and functions of the supreme court High courts Control over subordinate courts.		

UNIT V	THE FEDERAL SYSTEM	9
Distribution of financial powers: Need, principles-Underlying distribution of tax revenues- Distribution of legislative power Interstate relation - Emergency provisions.		

TOTAL PERIODS	75
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Understand the history and philosophy of the Indian constitution

CO2 Realize the powers and functions of the Indian government.

CO3 Acquire awareness of the structure and functions of local administration.

CO4 Enhance knowledge about the organization and composition of the judiciary.

CO5 Explore the distribution of financial powers and emergency provisions.

TEXT BOOKS

1. Basu D.D, "Introduction to Indian Constitution", Prevtice Hall of India, New Delhi, 2015.
2. Gupta D.C, "Indian Government and Politics", Vikas Publishing House, New Delhi, 2010.

REFERENCE BOOKS

1. Pylee M.V, "Introduction to the Constitution of India", Vikas Publishing House, New Delhi, 2011.
2. Kashyap S, "Our Constitution", National Book Trust, New Delhi, 2010.
3. "The Constitution of India, 1950 (Bare Act)", Government Publication.
4. Jain M.P, "Indian Constitution Law", 7th Edition, Lexis Nexis, 2014.
5. Busi S.N, Ambedkar B.R, "Framing of Indian Constitution", 1st Edition, 2015.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						2		2	2	2			
CO2						2		2	2	2			
CO3						2		2	2	2			
CO4						2		2	2	2			
CO5						2		2	2	2			

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3401	DESIGN AND ANALYSIS OF ALGORITHMS	45	0	0	45	90	3

OBJECTIVES

- To learn algorithm analysis techniques.
- To analyze asymptotic performance of algorithms.
- To apply different algorithm design strategies.
- To prove the limitations of algorithmic power.

UNIT I	INTRODUCTION AND ANALYSIS	9
Introduction: Fundamentals of algorithmic problem solving – Important problem types; Fundamentals of the Analysis of Algorithm Efficiency: Analysis framework – Asymptotic notations and basic efficiency classes – Mathematical analysis for recursive and non-recursive algorithms - Time complexity using recurrence relations and decision trees - Master theorem.		

UNIT II	BACKTRACKING, BRANCH-AND-BOUND	9
Optimization problems vs Decision Problems, Backtracking: N-queens problem - Subset Sum problem - Hamiltonian Circuit Problem; Branch-and-bound: 0-1 Knapsack problem - Traveling Salesman Problem - Binary Integer Linear Programming; Linear Programming vs Integer Linear Programming.		

UNIT III	DIVIDE & CONQUER, ITERATIVE IMPROVEMENT	9
Divide and Conquer: Analysis of Mergesort – Quicksort – Multiplication of large integers – Strassen's matrix multiplication – Closest pair of points; Iterative Improvement: Maximum Network Flow – Maximum matching in bipartite graphs - Stable matching.		

UNIT IV	DYNAMIC PROGRAMMING, GREEDY	9
Dynamic Programming: Computing a binomial coefficient – Knapsack problem – Ordering of matrix multiplications – Longest increasing subsequence – Analysis of Floyd-Warshall algorithm; Greedy Algorithms: Analysis of Dijkstra's algorithm - Prim's algorithm – Kruskal's algorithm – Huffman Coding.		

UNIT V	LIMITATIONS OF ALGORITHMIC POWER	9
Limitations of algorithm power: Lower-bound arguments – P, NP and NP-complete problems; Reductions: 3-SAT to CLIQUE; Coping with the limitations: Introduction to Approximation Algorithms using Travelling Salesman Problem (Nearest-Neighbour and Twice-around-the-MST).		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Solve the time and space complexity of algorithms using asymptotic notation and compare algorithmic approaches. (K3)
CO2 Apply algorithmic paradigms such as backtracking, branch-and-bound and linear programming to develop solutions. (K3)
CO3 Apply algorithmic paradigms such as divide and conquer and iterative improvement to develop solutions. (K3)
CO4 Apply algorithmic techniques such as greedy strategy and dynamic programming to effectively solve optimization problems, and analyze the conditions under which each technique applies (K4)
CO5 Analyze scenarios where exact efficient solutions are impractical and apply approximation algorithms accordingly. (K3)
CO6 Design creative solutions for complex engineering problems by applying a combination of one or more algorithm design techniques, analyze their time and space complexity and effectively communicate the findings to the audience. (K5)

TEXT BOOKS

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012. (All units)
2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI Learning Private Limited, April 2022 (All units)

REFERENCE BOOKS

1. S Dasgupta, C H Papadimitriou, U V Vazirani, "Algorithms", 1st Edition, McGraw Hill Education, 2017.
2. Steven S Skiena, "The Algorithm Design Manual", 2nd Edition, Springer, 2008.
3. Jeff Erickson, "Algorithms", 1st Edition, 2019

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	2	2									3	
CO3	3	2	2									3	
CO4	3	2	2		2							3	
CO5		2										3	
CO6		3	3	3	2	2	2	2	2			3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3402	DATABASE MANAGEMENT SYSTEMS	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamentals of database systems and conceptual modeling
- To learn SQL and relational model
- To learn database programming and relational database design
- To explore the fundamental concepts of transaction processing, concurrency control and recovery techniques
- To explain Distributed and NOSQL databases.

UNIT I	DATABASE SYSTEM CONCEPTS AND CONCEPTUAL MODELING	9
Characteristics of database – Database users – Data models, Schemas – Three-schema architecture – Database system environment – Centralized and client/server DBMS architectures – Data modeling using ER model – Enhanced - ER model.		

UNIT II	RELATIONAL MODEL AND SQL	9
Relational Model: Concepts – Constraints – Update operations – Constraint violations; Relational Algebra; Basic SQL: Data Definition – SQL constraints – Basic retrieval queries – Insert, delete and update commands – Schema modification; More SQL: dealing NULL – Tuples, Set/Multiset comparisons – Correlated nested – EXISTS function – SQL Renaming – JOIN and Outer JOINS – Aggregate functions – Grouping.		

UNIT III	DATABASE PROGRAMMING AND DESIGN	9
Triggers – Views; Database Programming Techniques: Overview and Issues – Embedded SQL – JDBC – Database Stored Procedures and SQL/PSM ; Design guidelines – Functional dependencies – First, second and third Normal Forms – Boyce-Codd Normal Forms; FD: Inference rules – Minimal cover; ER-to-relational mapping.		

UNIT IV	TRANSACTION, CONCURRENCY AND RECOVERY	9
Transaction Processing: Concepts – ACID properties – schedules – serializability; Concurrency control: Two-phase locking technique – Timestamp Ordering; Recovery: Concepts – Deferred update – Immediate update.		

UNIT V	DISTRIBUTED AND NOSQL DATABASES	9
Distributed Database Concepts – Data fragmentation and Replication – Allocation techniques; Introduction to NOSQL Systems – The CAP Theorem – Document-Based NOSQL Systems and MongoDB – Column-based NOSQL systems - Graph based NoSQL Systems– Introduction to vector database.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Demonstrate fundamental database concepts, models, and architectures, including SQL and NoSQL systems, and develop proficiency in relational database management and SQL. (K2)
CO2 Analyze requirements, develop conceptual model and design relational database schemas using normalization techniques, ensuring minimal redundancy and improved data integrity. (K5)
CO3 Formulate DDL and complex DML queries on relational databases and apply transaction management techniques and concurrency control techniques to ensure data consistency and integrity in multi-user environments. (K3)
CO4 Formulate queries on NoSQL databases such as MongoDB and graph databases, and apply distributed database techniques like fragmentation and replication to support big data applications in distributed environments. (K3)
CO5 Design optimal database solutions using relational model and NoSQL technologies for scalable real-world applications with comprehensive documentation. (K5)

TEXT BOOKS

1. Ramez Elmasri, Shamkant B Navathe, “Fundamentals of Database Systems”, 7th Edition, Pearson, 2016.
2. Raghu Ramakrishnan, “Database Management Systems”, 4th Edition, Tata McGraw Hill, 2010.

REFERENCE BOOKS

1. Jeffrey D Ullman, Jennifer Widom, “A First Course in Database Systems”, 3rd Edition, Pearson Education, 2014.
2. S Sumathi, S Esakkirajan, “Fundamentals of Relational Database Management Systems”, (Studies in Computational Intelligence), Springer-Verlag, 2007.
3. Abraham Silberschatz, Henry F Korth, S Sudharshan, “Database System Concepts”, 6th Edition, Tata McGraw Hill, 2011.
4. Thomas M Connolly, Carolyn E Begg, “Database Systems – A Practical Approach to Design, Implementation and Management”, 6th edition, 2015, Global Edition, Pearson.
5. Hector Garcia-Molina, Jeffrey D Ullman, Jennifer Widom, “Database Systems: The Complete Book”, 2e, Pearson.
6. Nitin Borwankar, “Vector Databases”, O'Reilly Media, Inc, 2025.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2		2	3		3							2	
CO3		3										2	
CO4			2									2	
CO5			2	3	3				3	3			2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3461	FOUNDATIONS OF ARTIFICIAL INTELLIGENCE	45	0	30	45	120	4

OBJECTIVES

- To study the fundamental concepts of AI agents and environments.
- To explore various problem-solving techniques and search algorithms, including uninformed and informed search strategies, and their application to optimization and constraint satisfaction problems.
- To learn knowledge representation and reasoning using logical formalisms and probabilistic models, enabling AI systems to make decisions under uncertainty.
- To apply AI methods to real-world challenges, including decision-making in dynamic environments, game theory, and autonomous systems, using appropriate algorithms and models.

UNIT I	INTELLIGENT AGENTS AND PROBLEM SOLVING	8
Introduction: What is AI; Intelligent Agents: Agents and environments – Good behavior – The nature of environments – Structure of agents; Problem solving agents – Example problems.		

UNIT II	SEARCH TECHNIQUES	10
Solving Problems by Searching: Searching for solutions – Uninformed search strategies – Informed search strategies – Heuristic functions; Beyond Classical Search: Local search algorithms – Hill climbing – Simulated annealing – Adversarial Search: Games – Optimal decisions in games – Alpha-beta pruning; Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems – Constraint propagation – Inference in CSPs – Backtracking search for CSPs – Local search for CSPs.		

UNIT III	KNOWLEDGE REPRESENTATION AND REASONING	9
Knowledge-based Agents: Knowledge representation – Propositional logic – Propositional theorem proving; First-order Logic: Syntax and semantics for first-order logic – Using first-order logic; Inference in first-order logic: Propositional versus first-order logic – Unification and lifting – Forward chaining – Backward chaining – Resolution.		

UNIT IV	UNCERTAINTY AND PROBABILISTIC REASON	9
Quantifying Uncertainty: Acting under uncertainty – Basic probability notation – Inference using full joint distributions – Bayes' rule & its use; Probabilistic Reasoning: The semantics of Bayesian networks – Exact inference in Bayesian networks.		

UNIT V	PLANNING AND DECISION MAKING	9
Automated Planning: Definition of Classical Planning - Example domains - Algorithms for Classical Planning - Hierarchical Planning.		

Making Simple Decisions: Combining beliefs and desires under uncertainty – The basis of utility theory – Utility functions – multi-attribute utility functions – Decision networks.

SUGGESTED EXPERIMENTS

(Python 3.0 and above, scikit-learn, Matplotlib, Scikit-Robot (Intel or AMD 4 cores, 2.4GHz, 64-bit (x64), 8GB RAM)

- Informed Search Techniques
- Adversarial Search techniques
- Inference from knowledge base using FOL.
- Inference using full joint probability distribution/Bayesian networks.
- Planning & Decision making
- One Application using AI algorithms as micro project.

TOTAL PERIODS	120
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze the characteristics of intelligent agents and their interaction with environments

to determine optimal agent behavior and design effective agent architectures (K4)

CO2 Evaluate and design appropriate search strategies—including uninformed, informed, local, and adversarial methods—as well as constraint satisfaction approaches for solving complex AI problems (K5)

CO3 Construct logical representations of knowledge using propositional and first-order logic, and implement reasoning techniques such as unification, forward/backward chaining, and resolution (K3)

CO4 Apply probabilistic reasoning models and evaluate the use of Bayesian networks and Bayes' rule to make informed decisions under uncertainty (K3)

CO5 Analyze classical and hierarchical planning strategies along with decision-making models using utility theory and decision networks to handle uncertainty in intelligent systems (K4)

CO6 Design and implement intelligent systems using advanced search algorithms and planning techniques, incorporating decision-making under uncertainty to solve real-world complex AI problems (K6)

TEXT BOOKS

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 4th Edition, Pearson Education / Prentice Hall of India, 2015 (Units 2, 3, 4 and 5)
2. David Poole, Alan Mackworth, "Artificial Intelligence: Foundation of Computational Agents", 2nd Edition, Cambridge University Press, 2017 (Unit 1).

REFERENCE BOOKS

1. Elaine Rich, Kevin Knight, “Artificial Intelligence”, 2nd Edition, Tata McGraw-Hill, 2003.
2. Dawn W Patterson, “Introduction to Artificial Intelligence and Expert Systems”, 1st Edition, Pearson Education India, 2015.
3. Andreas Muller, Sarah Guido, “Introduction to Machine Learning with Python: A Guide for Data Scientists”, Shroff/O’Reilly, 1st edition, 2016.
4. Prateek Joshi, “Artificial Intelligence with Python”, 1st edition, Packt Publishing Limited, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2	2									3	2
CO3	3	2	2									3	
CO4	3	2	2									3	
CO5	3	2	2									3	2
CO6		2	3	3	1						2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3462	INTERNET PROGRAMMING	30	0	60	30	120	4

OBJECTIVES

- To learn client-end and server-end technologies
- To develop web application using traditional technologies
- To develop web applications using ReactJS and Spring Boot

UNIT I	HTML & CSS	6
HTTP protocol: Request and Response Messages; HTML5: Table, List, Image, Form; Tailwind CSS: Basics, Typography, Box, Page Layout, Customization, Animation, Responsive Design		

UNIT II	TYPESCRIPT	6
Type Annotations, Interfaces and Type Aliases, Classes, Generics, Union and Intersection types, Enums.		

UNIT III	SERVLET PROGRAMMING	6
Servlets: Architecture, Life Cycle, Parameter data; Web based storage: Session objects, Cookies and URL rewriting.		

UNIT IV	MICROSERVICES USING SPRING BOOT	6
Spring Boot: Foundational features, Rest Controllers, Database access for Spring Boot App, CRUD Repository, Configuration and inspection of Spring Boot App, Testing for Spring Boot Application.		

UNIT V	FRONTEND FRAMEWORK USING REACTJS	6
ReactDOM, React Components, Hooks: useState, useEffect, useContext; React router: Incorporation, Nesting, Parameters; Redux, Integration of ReactJS with Spring Boot: High level authentication and JWT.		

SUGGESTED EXPERIMENTS

1. Build a web page using HTML, and CSS (Eg.: Registration form)
2. Practicing CSS using reverse engineering of Tailwind CSS (Eg.: Flexbox Froggy Game)
3. Practicing JavaScript using reverse engineering of Typescript to JavaScript equivalent concepts. (Eg.: Creation of FAQ page)
4. Develop a web application using Servlet and MySQL. (Eg.: CRUD operations on Payroll database)
5. Develop a web application to *keep track of user sessions* using session tracking mechanisms.
6. Practice on ReactJS components and React Hooks (Eg.: Window width tracker)
7. Develop Spring Boot micro services (Eg.: CRUD operations on Student database)

8. Develop a web application using React JS, Spring Boot and Mongo (Eg.: CRUD operations on Student database)
9. Develop a Full stack web application for managing *Todo list* using React JS, Spring Boot and Mongo.
10. Develop a Full stack web application for *Shopping cart* using React JS, Spring Boot and Mongo using Redux state management technique.
11. Micro Project - Develop a web application for a real-world problem.
12. *RailConnect* is a full-stack web-based Railway Reservation System designed to offer a seamless and intuitive platform for both passengers and administrators to manage train travel effectively. Built with a modern technology stack comprising React for the frontend, Spring Boot for the backend, and MongoDB as the database.

Implement role-based access, namely, Normal and Admin roles.

Users with normal role authentication should have the following:

- Search Trains by source, destination, and date
- Book Tickets with real-time seat availability check
- View Booking History
- Cancel Reservation
- User Registration/Login (JWT-based authentication)

Users with admin role should have the following:

- Add/Edit/Delete Train Information
- Manage Routes and Schedules
- Track Booking Analytics
- View All Bookings

The React Router allows smooth navigation across different views such as login, registration, train search, booking, and user dashboards. Axios is used for asynchronous HTTP requests to interact with the backend REST API. The UI is designed with responsiveness in mind, ensuring usability across desktop and mobile devices. The frontend also includes authentication guards, form validations, and user-friendly alerts for successful or failed operations.

The backend exposes RESTful endpoints to handle business logic and data processing, ensuring clear separation between client and server responsibilities. It manages user authentication and authorization using JWT (JSON Web Tokens), providing secure access to both user and admin features. The system distinguishes between normal users and administrators through role-based access control. Users can perform actions such as viewing train schedules, booking, or cancelling tickets, and checking booking history. Administrators, on the other hand, can add or edit train schedules, manage routes, and monitor all bookings across the platform.

The authentication system is secured using JWT and integrated with Spring Security. Upon successful login, a JWT is issued and stored on the client-side (typically in local storage). This token is then sent with each request to protect endpoints. Passwords are hashed using crypt before being stored in the database to ensure secure credential management.

For deployment, the frontend can be hosted using platforms like *Netlify* or *Vercel*, while the backend can be deployed on *Render*, *Railway*, or a custom server.

TOTAL PERIODS	120
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Make use of HTML5 and Tailwind CSS to design modern web site (K3)
CO2 Utilize TypeScript to implement dynamic web page (K3)
CO3 Develop web applications using Servlets (K3)
CO4 Develop micro services using Spring Boot (K3)
CO5 Develop full stack web applications using ReactJS and Spring Boot (K3)
CO6 Create a secure, scalable, and responsive full-stack web application by integrating front-end, back-end, and microservices, deploying it using a web-based platform. (K6)

TEXT BOOKS
1. Mark Heckler, Spring Boot: Up and Running, O'Reilly Media, Inc, February 2021 (Unit 4)
2. Alex Banks, Eve Porcello, "Learning React: Modern Patterns for Developing React Apps", June 2020, O'Reilly Media Inc., (Unit 5)

REFERENCE BOOKS
1. Noel Rappin, Modern CSS with Tailwind: Flexible Styling Without the Fuss, Pragmatic express, 2021 (Unit 1)
2. Stefan Baumgartner, TypeScript Cookbook, O'Reilly Media, Inc. August 2023. (Unit 2)
3. David McFarland, "CSS3: The missing manual", O'Reilly Media, December 2012. (Unit 1)
4. Matthew MacDonald, "HTML5: The missing manual", O'Reilly Media, August 2011
5. Jeffrey C, Jackson, "Web Technologies A Computer Science Perspective", Pearson Education, 2011. (Units 1,2,3)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3							2	
CO2	3		3		3							2	
CO3	3		3		3							2	
CO4	3		3		3							2	
CO5	3		3		3							2	2
CO6	3		3		3	2					2	2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCSV304	INDUSTRY ORIENTED COURSE	15	0	0	15	30	1

OBJECTIVES

- To introduce the principles and practices of Domain-Driven Design (DDD)
- To enable students to tackle complexity in software design by focusing on the core domain
- To provide practical experience in applying DDD concepts to real-world problems

UNIT I	INTRODUCTION TO DOMAIN-DRIVEN DESIGN	6
Overview of Domain-Driven Design - Importance of focusing on the core domain - Key concepts: Domain, Subdomain, Bounded Context		

UNIT II	BUILDING BLOCKS OF DDD	6
Entities and Value Objects - Aggregates and Aggregate Roots - Repositories and Factories		

UNIT III	STRATEGIC DESIGN	3
Context Mapping - Distilling the Core Domain - Relationships between Bounded Contexts		

Self-Learning Topics

- Case studies on successful implementation of DDD
- Online tutorials and videos on DDD patterns and practices

TOTAL PERIODS	30
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply fundamental concepts of Domain-Driven Design to analyze and structure software development around domain logic (K3)

CO2 Identify and model core domains and subdomains using appropriate DDD building blocks such as entities, value objects, and aggregates (K3)

CO3 Implement software solutions using DDD patterns and practices to manage complexity and improve maintainability(K3)

REFERENCE BOOKS

1. Evans, Eric (2003): Domain-Driven Design: Tackling Complexity in the Heart of Software. Addison-Wesley.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					2	3				3	2	2
CO2					3	2	3				3	2	2
CO3					3	2	3				3	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3411	DATABASE LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- To understand data definitions and data manipulation commands
- To learn about the use of nested and join queries.
- To understand procedural extensions of databases
- To design a database schema for an application using ER model, Normalization
- To implement a database application using Front-end tools

SUGGESTED EXPERIMENTS

1. Data Modelling
2. Data Definition Commands Creating tables with constraints, constraint violations Schema modifications
3. Data Manipulation Commands
 - a. Update operations
 - b. Simple SQL queries
 - c. Transaction Control statements - Savepoint and Rollback
4. Complex SQL Queries:
 - a. Nested Queries
 - b. Correlated Subqueries
 - c. Joins and Outer Joins
 - d. Aggregate functions
 - e. Grouping and Ordering commands.
5. Views
6. Database Programming:
 - a. PL/SQL - Procedures and Functions
7. Triggers
8. Queries of MongoDB
9. Queries of Graph database
10. Database applications using JDBC connectivity
11. Implement a database application by applying database design and database programming using library class.
 - a. Develop GUI using front end tool.
 - b. Develop a connection between front end and database.
 - c. Query the database using DML, joins and subqueries.
 - d. Implement database programming.

TOTAL PERIODS	45
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Software Requirements:

- Oracle
- NoSQL

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Construct queries using SQL in database creation and manipulation and develop PL/SQL blocks using database programming constructs. (K3)

CO2 Construct queries using MongoDB database. (K3)

CO3 Design a database schema and develop an application using IDE that interacts with a DBMS server via API. (K6)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3		2									2
CO2	3	3											2
CO3	3	3	3	3	2				2	2	2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	C
UCS3412	COMPETITIVE PROGRAMMING LABORATORY	0	0	45	0	45

OBJECTIVES

- To formulate solutions based on the requirements and constraints specified in the problem statement
- To identify suitable data structures based on the requirements of the problem
- To identify and apply appropriate algorithm design strategies to solve computational problems efficiently
- To solve challenges in competitive programming contests

SUGGESTED EXPERIMENTS

1. Iterative and recursive algorithms (Sample problems: Iterative and recursive variants of Sum of digits of a number - Computing the factorial - Computing x^n - Binary search - Generate permutations - Insertion sort)
2. Algorithms using Backtracking (Sample problems: Generate all subsets of a set – n -Queens for small n , Word Search in a 2D grid)
3. Algorithms using Branch-and-bound (Sample problems: 0-1 Knapsack, TSP for small graphs, Job sequencing with deadlines)
4. Algorithms using Divide and Conquer (Sample problems: Finding the max in a list - Computing $x^n = x^{n/2} * x^{n/2}$ - Mergesort - Counting inversions using Mergesort - Quick Sort - Closest pair of points)
5. Algorithms using Iterative improvement (Sample problems: Maximum Network Flow, Maximum matching in bipartite graphs, Stable matching)
6. Algorithms using Dynamic Programming (Sample problems: Fibonacci, longest (increasing, decreasing, palindromic) subsequence, counting the number of ways to climb the stairs, navigating grids, questions from leetcode)
7. Algorithms using Greedy technique (Sample problems: Prim's, Dijkstra's, Kruskal's, Huffman Coding, questions from leetcode)
8. Complex engineering problems where the student must figure out the algorithm design technique(s) that apply.
9. Complex engineering problems where the student must figure out the appropriate data structures that lead to efficient code
10. Complex engineering problems where the student must determine appropriate data structures as well as algorithm design technique(s) that lead to efficient and optimal solutions

TOTAL PERIODS

45

Software:

- Python Compiler
- Coding sites

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply suitable problem-solving strategies and algorithmic techniques to develop optimal solutions for computational problems (K3)

CO2 Identify and implement appropriate data structures to develop both time and space efficient solutions (K3)

CO3 Formulate and implement efficient solutions to complex engineering problems within competitive environments through participation in timed contests (K6)

TEXT BOOKS

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012.

2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI Learning Private Limited, April 2022

3. Steven Halim and Felix Halim, "Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s", July 2020

4. Antti Laaksonen, "Guide to Competitive Programming - Learning and Improving Algorithms Through Contests", Edition 2, May 2020

REFERENCE BOOKS

1. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles", July 2023

REFERENCE LINKS:

1. Competitive Programming | NPTEL-NOC IITM:
<https://www.youtube.com/watch?v=MY3jR-a29JI&list=PLyqSpQzTE6M9p9pKxFGpskf4voY45T2DZ&index=1>

2. Dynamic Programming Bootcamp | IIT Gandhinagar:
https://www.youtube.com/playlist?list=PLAj_13N2fk-RA6wvOUmWOyUeL9zmWFJoI

3. <https://leetcode.com/problem-list/dynamic-programming/>,
<https://leetcode.com/problem-list/greedy/>

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2									3	
CO2	3	2	2									3	
CO3		3	3	3	2		2		2			3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCSV305	SKILL DEVELOPMENT LABORATORY - II	0	0	30	0	30	1

OBJECTIVES

- Understand the CI/CD lifecycle using GitHub Actions for microservice-based applications.
- Gain hands-on experience in automating build, test, and deployment pipelines.
- Integrate containerization and deployment practices using GitHub with Docker and Kubernetes.

SUGGESTED EXPERIMENTS

Experiment 1: Version Control using Git in GitHub for Microservices.

Steps:

1. Initialize a microservice-based project with separate services.
2. Push each microservice to a different GitHub repository.
3. Demonstrate branching and merging strategies (feature, dev, main branches).
4. Use .gitignore and .gitattributes for environment-specific settings.
5. Use .gitignore for hiding application secrets like AWS credentials or third-party keys like Google Map key.

Experiment 2: Dockerizing Microservices

Steps:

1. Write Dockerfiles for each microservice.
2. Build and test Docker images locally.
3. Push Docker images to Docker Hub.
4. Verify images using docker pull and docker run.

Experiment 3: Introduction to GitHub Actions - Automating Builds

Steps:

1. Create a .github/workflows directory.
2. Define a workflow YAML file for build automation.
3. Trigger workflow on every push to the main branch.
4. Monitor and debug the pipeline via GitHub Actions UI.

Experiment 4: CI Pipeline with Unit Testing

Steps:

1. Integrate a test runner (e.g., JUnit, PyTest) in your microservices.
2. Modify the GitHub Actions workflow to include test steps.
3. Configure test coverage reports.
4. Validate build fails on test failure.

Experiment 5: Multi-Service CI with Matrix Strategy

Steps:

1. Use GitHub matrix strategy to run jobs for multiple microservices in parallel.
2. Separate build and test stages for each service.
3. Collect outputs and logs from each service job.

Experiment 6: CD Pipeline – Deploying Dockerized Services

Steps:

1. Setup deployment environment (e.g., local VM or GitHub-hosted runner).
2. Modify GitHub Action to deploy Docker containers.

3. Use Docker Compose or Kubernetes manifests.
4. Monitor container logs post-deployment.

Experiment 7: CI/CD with Branch Protection and Environment Approval

Steps:

1. Enable GitHub branch protection rules.
2. Add manual approval for production deployment.
3. Simulate PR merge and approved deployment.
4. Audit workflow run history and approvals.

Experiment 8 (Optional): Deploying to Heroku / Kubernetes via GitHub Actions

Steps:

1. Write Kubernetes manifests (YAML files).
2. Configure kubectl in GitHub runner.
3. Deploy to a cluster using GitHub Actions.
4. Rollback on failure simulation.

REQUIRED SOFTWARE		
Tool / Software	Purpose	Recommended Version / Notes
Git	Version control system	Latest stable version; CLI and GUI (e.g., GitKraken optional)
GitHub	Remote repository + CI/CD platform via GitHub Actions	Free GitHub accounts for students; enable GitHub Education
Docker	Containerization of microservices	Docker Desktop or Docker Engine (latest stable)
Docker Compose	Managing multi-container applications	Optional but useful for Experiment 6
Node.js / Python / Java	Programming languages for building microservices	Any one depending on microservice language (e.g., Node.js v18+)
Visual Studio Code	Code editor with extensions for Docker, GitHub, etc.	Latest version with relevant extensions
GitHub CLI (gh)	Command-line interaction with GitHub	Useful for automation and scripting
Postman	API testing and debugging	Useful for validating microservices
YAML Validator	For validating workflow and Kubernetes YAML files	Online tools or VS Code extensions
Kubernetes (Minikube)	Local Kubernetes cluster to deploy services	For optional Kubernetes deployment experiment
Heroku	Heroku.com	Deployment Environment
kubectl	Kubernetes command-line interface	Must match Minikube version
JUnit / PyTest / Mocha	Unit testing frameworks depending on language used	Should match microservice stack
Chrome / Postman	For REST API testing	Used to verify deployments

LAB ENVIRONMENT REQUIREMENTS	
Resource	Specification / Requirement
Operating System	Ubuntu 22.04 LTS / Windows 10+ / macOS optional

RAM	Minimum 8 GB (preferably 16 GB for Docker + K8s)
Processor	Intel i5/i7 or AMD Ryzen equivalent
Internet Access	Required for GitHub and Docker Hub access
Admin Access	Needed to install Docker, Minikube, etc.
Virtualization Enabled	Required for Docker and Minikube

TOTAL PERIODS	45
COURSE OUTCOMES	
On successful completion of this course, students will be able to	
CO1 Implement version control and automate build pipelines for microservices (K3)	
CO2 Develop and configure CI/CD pipelines using GitHub Actions for containerized apps (K4)	
CO3 Deploy microservices using Docker/Kubernetes and evaluate pipeline effectiveness (K5)	

TEXT BOOKS
1. Jez Humble, David Farley, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", Addison-Wesley, 2010
2. Mikael Krief, "Learning DevOps: Continuously Deliver Better Software", Packt, 2020.
3. Gene Kim, Patrick Debois, et al., "The DevOps Handbook", IT Revolution, 2016.
4. Kelsey Hightower, Brendan Burns, "Kubernetes Up and Running", 3 rd Edition, O'Reilly, 2022
5. Nigel Poulton, "Docker Deep Dive", (Independently published)

WEBSITES AND ONLINE TUTORIALS
1. GitHub Docs: GitHub Actions Docs , Official documentation on GitHub Actions
2. Docker Docs: Docker Docs , Introductory and advanced Docker usage
3. KubernetesDocs: Kubernetes Tutorials , Guides and tutorials for Minikube and kubectl
4. Heroku: https://cs.gmu.edu/~offutt/classes/432/instructions/GithubHeroku-servlets.html , https://devcenter.heroku.com/start , https://www.heroku.com/training-and-education/
5. Git Docs: Git SCM , Git command-line documentation
6. GitHub Learning Lab: Learning Lab , Interactive CI/CD workflows and GitHub Actions tutorials
7. FreeCodeCamp: CI/CD with GitHub Actions , Beginner-friendly CI/CD workflows
8. DigitalOcean Tutorials: CI/CD Tutorials , Comprehensive, project-based tutorials for Docker, K8s, CI/CD
9. YouTube: TechWorld with Nana, Academind, FreeCodeCamp.org channels, Video tutorials on GitHub Actions, CI/CD, Docker, Kubernetes

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2		3	3	2		3	3	2
CO2	3	2	3	3	2		3	3	3		3	3	2
CO3	3	3	3	3	3		3	3	3		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3501	COMPUTER NETWORKS	45	0	0	45	90	3

OBJECTIVES

- To provide a broad overview of computer networking and the services of the application layer.
- To understand the functions and protocols of the transport layer.
- To learn the functionalities of network layer and its routing algorithms.
- To understand the services provided by the link layer and Wireless LAN technologies.
- To familiarize the students with Wireless networks and advanced topics such as SDN.

UNIT I	COMPUTER NETWORK AND INTERNET	9
Introduction - Internet- Network Edge - Network Core - Performance - Protocol Layers. Application Layer: Principles of Network Applications - The Web and HTTP - Electronic Mail in the Internet - DNS -The Internet's Directory Service - Peer-to-Peer Applications - Video Streaming and Content Distribution Networks - Socket Programming: Creating Network Applications		

UNIT II	TRANSPORT LAYER	9
Introduction and Transport-Layer Services - Multiplexing and Demultiplexing – Connectionless Transport: UDP - Principles of Reliable Data Transfer - Connection-Oriented Transport: TCP - Principles of Congestion Control - TCP Congestion Control		

UNIT III	NETWORK LAYER	9
Overview of Network Layer - Switching - The Internet Protocol (IP): IPv4, Addressing – Network Address Translation (NAT) - IPv6. Routing Algorithms - The Link-State (LS) Routing Algorithm - The Distance-Vector (DV) Routing Algorithm - Intra-AS Routing in the Internet: OSPF - Routing Among the ISPs: BGP.		

UNIT IV	LINK LAYER AND LANS	9
Introduction to the Link Layer - The Services Provided - Error-Detection and -Correction Techniques - Parity Checks - Check summing Methods - Cyclic Redundancy Check (CRC) - Multiple Access Links and Protocols - Channel Partitioning Protocols - Random Access Protocols. Switched Local Area Networks - Link-Layer Addressing and ARP - Ethernet - Link-Layer Switches - Virtual Local Area Networks (VLANs) - Link Virtualization - Data Center Networking.		

UNIT V	WIRELESS, MOBILE AND EMERGING NETWORK TECHNOLOGIES	9
Wireless and Mobile Networks - Introduction - Wireless Links and Network Characteristics – CDMA - WiFi: 802.11 Wireless LANs - Cellular Internet Access - Mobility Management:		

Principles – Mobile IP - Managing Mobility in Cellular Networks. Software-Defined Networking (SDN): Fundamental Characteristics - SDN Operation - SDN Devices.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply the principles of Internet architecture and communication protocols to develop basic network applications using socket programming. (K3)

CO2 Analyze and evaluate flow control and congestion control techniques in data communication networks. (K4)

CO3 Implement routing algorithms and assess their efficiency in different network scenarios. (K3)

CO4: Implement error detection and correction mechanisms at the data link layer in wired and wireless LANs. (K3)

CO5: Describe wireless and mobile communication protocols, including SDN solutions, considering ethical and societal issues. (K2)

CO6 Solve complex networking problems using research-based methods, including simulation, analysis, and interpretation of data, to provide valid conclusions. (K6)

TEXT BOOKS

1. James Kurose and Keith Ross, “Computer Networking: A Top-Down Approach”, 7th edition, Pearson, 2017. (All Units)

REFERENCE BOOKS

1. Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach Morgan Kaufmann, 6th Edition, 2019.

2. Behrouz A Forouzan, Data Communications and Networking, 5th Edition TMH, 2017.

3. Paul Göransson Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, 2014.

4. William Stallings, “Data and Computer Communications”, 10th Edition, Pearson Education, 2013.

5. W. Richard Stevens, “Unix Network Programming: Networking APIs: Sockets and XTI (Volume 1), Addison-Wesley, 2004.

6. Nader F Mir, “Computer and Communication Networks”, 2nd Edition, Prentice Hall, 2014.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1							3	2
CO2	3	3									2	3	
CO3	3	3	2									3	
CO4	3	2										3	2
CO5	3					2	3					3	
CO6				3	2		3	3	3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3502	PRINCIPLES OF MACHINE LEARNING	45	0	0	45	90	3

OBJECTIVES

- To understand machine learning problems.
- To study the various supervised, unsupervised and reinforcement learning algorithms in machine learning.
- To study the dimensionality reduction techniques to represent the data and their dependencies.
- To understand the need of optimization techniques.
- To analyze the ethical implications of machine learning models and suggest improvements

UNIT I	INTRODUCTION	9
Introduction: Machine learning; Examples of Machine Learning Applications: Learning associations – Classification – Regression – Unsupervised learning – Reinforcement learning; Preliminaries: Weight space – Curse of dimensionality – Testing machine learning algorithms– Evaluation metrics for supervised learning-training testing and validation - Turning data into probabilities – Basic statistics – Bias-variance trade off. Ethical Considerations in ML: Algorithmic bias – Transparency and Inclusiveness – Data privacy – Ethical use of ML. Interpretability and Explainability of ML algorithms		

UNIT II	SUPERVISED & UNSUPERVISED LEARNING	9
Neural Networks and Linear Discriminants: Brain and the neuron – Neural networks – Perceptron – Linear separability – Linear regression; Multi-layer Perceptron: Forward and Backward propagation-loss functions-activation functions-regularization methods; Support Vector Machines- linear and non-linear kernels, K-means algorithm		

UNIT III	PROBABILISTIC LEARNING, LEARNING WITH TREES	9
Probabilistic Learning: Naive Bayes Classifier, Gaussian mixture models – Nearest neighbour methods; Learning with Trees: Constructing decision trees –Entropy, Information Gain, Gini Index-Classification and Regression trees – overfitting and pruning in decision trees. Classification example; Ensemble Learning: Boosting – Bagging – Random forests.		

UNIT IV	REINFORCEMENT LEARNING	9
Reinforcement learning: State and action space – Reward function – Discounting – Action selection – Policy – Value- Value iteration and Policy iteration- Markov decision process – Monte Carlo-Temporal Difference Learning- SARSA and Q-learning.		

UNIT V	DIMENSIONALITY REDUCTION, OPTIMISATION TECHNIQUES	9
Dimensionality Reduction Techniques: Linear Discriminant analysis, Principal Component Analysis; Optimisation and Search: Least-squares optimisation-Stochastic Gradient Descent and Adam, Conjugate gradients – Search approaches – Exploitation and exploration.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the basic concepts of machine learning (K2)
CO2 Apply supervised algorithms for different classification problems (K5)
CO3 Apply the concepts of ensemble learning methods (K3)
CO4 Apply unsupervised and reinforcement learning techniques to various problems (K5)
CO5 Apply dimensionality reduction and optimization techniques (K3)
CO6 Analyze the ethical implications of machine learning models and suggest improvements (K4)

TEXT BOOKS
1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015. (Units 1-4)
2. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, The MIT Press, 2014. (Unit 5)

REFERENCE BOOKS
1. Jason Bell, “Machine learning – Hands on for Developers and Technical Professionals”, 1st Edition, Wiley, 2014.
2. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, 1st Edition, Cambridge University Press, 2012.
3. Richert, Willi, “Building machine learning systems with Python”, Packt Publishing, 2013.
4. Tom M Mitchell, “Machine Learning”, McGraw-Hill Education (India), 2013.
5. Y S Abu-Mostafa, M Magdon-Ismael, H T Lin, “Learning from Data”, AML Book Publishers, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										2	
CO2	3	3	3		3							2	2
CO3		2	3		2								2
CO4		3	3	3								2	3
CO5	3	2			3							2	
CO6						3	3	3	2				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3503	THEORY OF COMPUTATION	45	0	0	45	90	3

OBJECTIVES

- To learn the mathematical notations and construct finite automata of the given language.
- To understand and infer the relationship of finite automata and regular expressions.
- To understand the language hierarchy, relationship between context free grammar and its language and to construct a PDA of CFG.
- To understand Turing machines and their programming capability.
- To infer the knowledge of undecidable problems.

UNIT I	FINITE AUTOMATA AND REGULAR LANGUAGES	9
Finite Automata (FA): Deterministic Finite Automata (DFA) - Non- deterministic Finite Automata (NFA) - Finite automata with epsilon transitions - Equivalence of FAs; Regular Expressions and Languages; Regular expressions - Finite automata and regular expressions; Properties of Regular Languages: Proving languages not to be regular - Closure properties of regular languages - Equivalence and Minimization of Automata		

UNIT II	CONTEXT FREE LANGUAGES	9
Chomsky's Hierarchy of Languages: Context-Free Grammar and Languages: Context-Free Grammar (CFG) - Parse trees - Ambiguity in grammars and languages; Normal Forms for Context Free Grammars: Elimination of Useless Symbols, epsilon and unit productions - Chomsky Normal Form (CNF) - Greibach Normal Form (GNF).		

UNIT III	PUSHDOWN AUTOMATA	9
Pushdown Automata (PDA): Definition of the Pushdown automaton - The languages of a PDA - Equivalence of PDAs and CFGs: From Grammars to Pushdown Automata - From Pushdown Automata to Grammars; Deterministic and Non-Deterministic Pushdown Automata; Pumping Lemma for Context Free Languages.		

UNIT IV	TURING MACHINES	9
The Turing Machine (TM): Language to TM construction; Programming Techniques for Turing Machines: Storage in the State - Multiple Tracks - Subroutines; Extensions to the Basic Turing Machines - Applications.		

UNIT V	UNDECIDABILITY	9
Recursive (R) and Recursively Enumerable (RE) languages: Definition - Properties; Universal Turing Machines; Undecidability: Language that is Recursively Enumerable (L _u) - Language that is not Recursively Enumerable (L _d) - Undecidable problem that is RE - Undecidable problems about Turing machines - Post's Correspondence Problem (PCP).		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Construct finite automata and regular expressions and demonstrate their equivalence in recognizing regular languages (K3)

CO2 Analyse context-free grammars for ambiguity, simplify them by eliminating useless symbols, epsilon, and unit productions, and transform them into Chomsky and Greibach Normal Forms (K4)

CO3 Construct and analyse pushdown automata for context-free languages, demonstrate their correspondence with context-free grammars, and use the pumping lemma to test non-context-free properties. (K3)

CO4 Develop and apply Turing Machine models to simulate and extend computational processes using programming methods. (K3)

CO5 Explain the concepts of undecidability and analyse problems that are not solvable by Turing Machines (K2)

CO6 Design and implement finite state machines or equivalent computational models to represent and simulate real-life systems or problem scenarios. (K5)

TEXT BOOKS

1. Hopcroft J E, Motwani R, Ullman J D, "Introduction to Automata Theory, Languages and Computations", Pearson Education, 3rd Edition, 2008. (Units I – V)

REFERENCE BOOKS

1. Harry R Lewis, Christos H Papadimitriou, "Elements of the Theory of Computation", Prentice Hall of India, 2nd Edition, 2003.
2. Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishers, 3rd Edition, 2002.
3. Mishra K L P, Chandrasekaran N, "Theory of Computer Science – Automata, Languages and Computation", Prentice Hall of India, 3rd Edition, 2004.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	1
CO2	3	3										3	1
CO3	3	3										3	
CO4	3	3										3	
CO5	3	3										3	
CO6	3	3		1					3			3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3504	SOFTWARE ENGINEERING	45	0	0	45	90	3

OBJECTIVES

- To understand the phases in a software project, estimate cost and effort.
- To understand fundamental concepts of requirements engineering and Analysis Modeling.
- To understand the various software design methodologies
- To learn various testing techniques and maintenance measures.
- To understand agile development and ML Devops

UNIT I	SOFTWARE PROCESS AND PLANNING	9
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Introduction to Software Engineering; Objectives, Principles and Practices; The Software Development Life Cycle : Pre-development phases of the SDLC — Development specific phases of the SDLC — Post-development phases of the SDLC; Methodologies Paradigm and Practices : Process methodologies — Development paradigms — Development practices; Project Planning Process; Software Project Estimation: Decomposition techniques — Empirical estimation models — Project scheduling; Risk Management; Project delivery management.

UNIT II	REQUIREMENTS ANALYSIS AND SPECIFICATION	9
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Software Requirements: Functional and non-functional — Security requirements — User requirements — System requirements — Software requirements document; Requirement Engineering Process: Feasibility studies — Requirements elicitation and analysis — Requirements validation — Requirements Management; Classical Analysis: Structured system analysis; Requirement modelling tools.

UNIT III	SOFTWARE DESIGN	9
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Design Concepts: Design process — Design concepts — Modularity, Coupling and cohesion — Design model — Modeling principles; Structured Design; Architectural Design: Architectural styles; Architecture for Network based Applications — Decentralized Architectures.

UNIT IV	SOFTWARE TESTING	9
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Software Testing Fundamentals; Internal and External Views of Testing: White box testing — Basis path testing — Control structure testing— Black box testing — Unit testing — Integration testing — Regression testing — Validation testing — System testing — Security testing; Testing Tool; Debugging; Software Implementation: Coding Practices and Principles; Maintenance: Types

UNIT V	AGILE DEVELOPMENT AND DEVOPS	9
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Agile Development: Agile Teams — Team and Scrum — Branches — Pull Requests — Reviews — Integration — Agile Iterations — Reporting and fixing bugs; ML Dev/Ops: From development to deployment — Three-Tier — Responsiveness, Service level objectives, and Apdex — Releases and feature flags — Monitoring and finding bottlenecks — Improving rendering and database performance with caching; Security: Defending customer data in application.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Choose an appropriate process model and estimate project cost and effort required by applying software engineering principles (K5)

CO2 Identify and analyze the requirements and construct their models (K5)

CO3 Apply systematic procedure for software design (K3)

CO4 Compare and contrast the various testing and maintenance activities (K2)

CO5 Make use of agile development and DeVops (K3)

CO6 Identify unethical issues and apply ethical practices for a given case study (K3)

TEXT BOOKS

1. Roger S. Pressman, Bruce R. Maxim, *Software Engineering: A Practitioner's Approach*, McGraw-Hill International Edition, 9th Edition, 2019. (All units)
2. Armando Fox and David Patterson, *Engineering Software as a Service: An Agile Approach Using Cloud Computing*, Strawberry Canyon LLC, Second Beta Edition, 2021. (Unit 5)

REFERENCE BOOKS

1. Ian Sommerville, "Software Engineering", Pearson Education Asia, Tenth Edition, 2015.
2. Stephen R Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited, 2007.
3. Brian Albee, *Hands-On Software Engineering with Python*, Packt Publishing, 2018.
4. Kelkar S A, "Software Engineering", Prentice Hall of India, 2007.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2										3
CO2	2	3		2									2
CO3		2	3		3								3
CO4			3	3									2
CO5					3				3				3
CO6						2	3	3					2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3511	NETWORKS LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- To find the network statistics and understand the speed and traffic on the network.
- To guide students in simulating the operations of the data link layer, IP layer, and transport layer.
- To simulate routing, congestion control algorithms and wireless topologies.

SUGGESTED EXPERIMENTS

1. Apply the following networking tools to analyse the status, performance and record the observations. a. netstat, ifconfig, iwconfig, ping, route, nmap, tcpdump, ping, dig, traceroute, mtr.
2. Develop client server applications using TCP and UDP sockets. Modify server to handle multiple clients concurrently.
3. Simulate frame transmission at the datalink layer using SimPy, incorporating error detection mechanisms like checksum or CRC.
4. Simulate the Automatic Repeat Request (ARQ) protocol in SimPy with the receiver acknowledging the receipt of a correct frame and request retransmission for corrupted or lost frames.
5. Simulate the behavior of TCP congestion control algorithms such as Reno, Cubic, and BBR in a network using SimPy.
6. Simulate a UDP packet transmission system in a network using SimPy. Model packet generation, transmission, packet loss, and random delays.
7. Simulate a network with multiple nodes and define routing paths based on IP addresses using SimPy.
8. Simulate the ARP (Address Resolution Protocol) in a network using SimPy, where nodes map IP addresses to MAC addresses.
9. Simulate a wireless network using SimPy with multiple nodes communicating with each other. Assign Wi-Fi, Bluetooth, and Zigbee technologies to different nodes.
10. Simulate the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol used in wireless networks using SimPy.
11. Simulate TCP flow control in a network using SimPy, where the sender adjusts its transmission rate based on the receiver's advertised window size
12. Simulate common topologies, generate traffic, in Mininet and trace packet-level behaviour using Wireshark
13. Develop a simulation in Mininet to implement a simple SDN controller.
14. Mini projects like,
 - Develop a custom ARQ-based reliable data transfer mechanism in SimPy with enhancements like timeout optimization or adaptive window sizing.
 - Simulate ARP resolution and create a mechanism to detect conflicting MAC address mappings (ARP spoofing detection) using SimPy.
 - Demonstrate adaptive routing and redundancy techniques in fault-tolerant network design.
 - Develop a simple packet sniffer using tcpdump or scapy, and build a dashboard that analyzes captured traffic by protocol, source/destination, and packet type.

- Build a tool using ping, traceroute, and mtr to measure latency and jitter between nodes. Use matplotlib or Dash to visualize performance trends over time.
- Simulate a DHCP server-client interaction in SimPy where clients request and lease IP addresses from a pool, including lease expiration and renewal.
- Simulate multiple IoT nodes using lightweight MQTT protocol over UDP and evaluate packet loss, delay, and delivery guarantees.

TOTAL PERIODS

45

Software: C / Python / Equivalent Compiler.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze network performance using tools and develop multi-client client-server applications using TCP and UDP socket programming. (K4)

CO2 Simulate core networking protocols and communication mechanisms (wired and wireless) using SimPy to model data link, transport, and routing behaviour and analyse the performance. (K4)

CO3 Design and execute a mini project to investigate complex networking scenarios using SimPy, incorporating protocol modeling, performance evaluation, and creative problem-solving. (K6)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	1							3	2
CO2	3	3	2	3	1							3	2
CO3	3	3	2	3	1	2		3	2		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3512	PRINCIPLES OF MACHINE LEARNING LABORATORY	0	0	60	0	60	2

OBJECTIVES

- To apply and analyze the appropriate machine learning strategy for any given problem.
- To have a thorough understanding of the supervised and unsupervised learning techniques.
- To interpret the various non-linear learning techniques and feature selection methods.

SUGGESTED EXPERIMENTS

- Working with Python packages - Numpy, Scipy, Scikit-learn, Matplotlib
- Loan amount prediction using linear regression and visualize the interpretation
- Handwritten character recognition using neural networks
- Classification of Email spam and MNIST data using Support Vector Machines.
- Predicting Diabetes using decision tree
- Applications of Random Forest and AdaBoost ensemble techniques
- K-means clustering for Euclidean distance metric
- k-Nearest Neighbor algorithm
- Software agent to learn optimal paths in a grid environment using the Q-learning algorithm.
- Applications of dimensionality reduction techniques on any dataset
- Miniproject: Analyze any two supervised / unsupervised machine learning algorithms for any of the following real-time applications:
(a) Text processing (b) Image processing (c) IoT systems

TOTAL PERIODS

60

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply supervised, unsupervised and reinforcement learning techniques for various problems (K3)

CO2 Apply ensemble learning and demonstrate the implementation of dimensionality reduction methods to improve the performance of ML models (K3)

CO3 Design and implement an end-to-end machine learning solution for a real-world problem, integrating data privacy measures and ethical considerations (K6).

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			2			2	2			2	
CO2	3	2	3		3								2
CO3	3	3	3	3	3	3	2					2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3513	SYSTEM DESIGN LABORATORY	0	0	45	0	45	1.5

OBJECTIVES

- Build proficiency in evaluating tradeoffs between different system design approaches
- Gain practical experience designing scalable, reliable, and maintainable systems
- Apply theoretical concepts to realistic system design scenarios
- Prepare students for system design interviews and real-world engineering challenges

SUGGESTED EXPERIMENTS

1. Design a system that supports zero to millions of users.
2. Design and develop a rate limiter which is used to control the rate of traffic sent by a client or a service.
3. Design and develop a Consistent hashing to distribute requests/data efficiently and evenly across servers.
4. Design and develop a Key-Value Store to identify the value uniquely by a key.
5. Design and develop a unique ID generator with auto-increment feature for primary key in Distributed Systems.
6. Design and develop a URL shortener service for shortening the given URL.
7. Design and develop a web crawler which uses search engines to discover new or updated content on the web.
8. Design and develop a search autocomplete system which would provide suggestions as you type in the search box.

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze system requirements for large-scale distributed applications by analyzing real-world problem scenarios. (K4)

CO2 Assess scalable, fault-tolerant, and efficient architectures for distributed systems. (K5)

CO3 Design and develop end-to-end prototypes of distributed systems by considering alternate system design requirements. (K6)

HARDWARE REQUIREMENTS:

- Minimum 8 GB RAM,
- Intel i5 or Ryzen 5 and above

- 256 GB SSD (or HDD if budgeted)

SOFTWARE REQUIREMENTS:

Apache VS Code IDE

Java, JMeter, Postman

MongoDB, Kafka, GitHub, Redis

TEXT BOOKS

1. Alex Xu, Sahn Lam, System Design Interview: An Insider's Guide Volume 2, Open Source: ByteByteGo, 2022
2. Martin Kleppmann, Designing Data-Intensive Applications, O'Reilly Media, Inc, March 2017, (Chapters 5 & 6)

REFERENCE

Github repository:

[GitHub - donnemartin/system-design-primer: Learn how to design large-scale systems.](#)

[Prep for the system design interview. Includes Anki flashcards.](#)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2								3		
CO2	3	3	3	3							3	3	
CO3	3	3	3	3	3			3	3		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3661	COMPILER DESIGN	30	0	30	30	90	3

OBJECTIVES

- To learn various phases of a compiler
- To learn various parsing techniques
- To understand intermediate code generation
- To learn to implement code generator
- To learn to implement code Optimization

UNIT I	INTRODUCTION TO COMPILERS	6
Language processors – Phases of compiler – Role of lexical analyzer – Input buffering – Specification of tokens – Recognition of tokens – Conversion of Regular expression to DFA; Lexical analyzer generator: Structure of lex program – Lookahead operator and conflict resolution.		

UNIT II	SYNTAX ANALYSIS	9
Role of Parser – Writing grammars for language constructs – Types of grammars: Ambiguity – Deterministic and recursive; Top down parsers: Recursive descent parser – Predictive parser; Bottom up parsers: Shift-Reduce Parsing - Conflicts during Shift-Reduce Parsing - SLR Parser – CLR Parser – LALR Parser; Error handling and recovery in syntax analyzer; Syntax analyzer generator: Structure of yacc program – Creating yacc lexical analyzers with lex.		

UNIT III	INTERMEDIATE CODE GENERATION	5
Syntax directed definitions: Synthesized attribute – Inherited attribute – Dependency graph –Evaluation order of syntax directed definitions; Intermediate languages: Syntax tree – Three address code; SDD for type checking – Declarations – Evaluation of expressions and flow of control statements – Bottom-up evaluation of S-attribute definitions.		

UNIT IV	RUNTIME ENVIRONMENTS AND CODE GENERATION	5
Source language issues – Storage organization – Storage allocation strategies: Static, Stack and Heap – Implementation of symbol table – Issues in code generation – Design of a simple code generator.		

UNIT V	CODE OPTIMIZATION	5
Principal sources of optimization – DAG – Optimization of basic blocks – Peephole Optimization - Global data flow analysis – Introduction to Low Level Virtual Machine (LLVM)		

SUGGESTED EXPERIMENTS

1. Implementation of Lexical Analyzer using C

2. Implementation of Lexical Analyzer using Lex Tool
3. Implementation of Calculator using Lex and YACC
4. Implementation of Syntax Analyser using LEX and YACC
5. Generation of TAC for a simple program using LEX and YACC
6. Implementation of Code optimization from TAC statements
7. Generation of assembly code from optimized TAC
8. Use modern tools and technologies to design a new optimized compiler that takes a novel language and generate the machine language as a team.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Construct a lexical analyzer for a sample language (K3)
- CO2 Apply different parsing algorithms to develop the parsers for the given grammar (K3)
- CO3 Build syntax directed translation for programming language constructs (K3)
- CO4 Outline and develop a simple code generator (K3)
- CO5 Make use of code optimization techniques (K3)
- CO6 Construct a compiler for a simple language using modern tools (K6)

TEXT BOOKS

1. Alfred V Aho, Monica S Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", 2nd Edition, Pearson Education, 2013. (Unit 1 to 5)
2. Rafael Auler, Bruno Cardoso Lopes, "Getting Started with LLVM Core Libraries", Packt Publishing, 2014. (Unit 5)

REFERENCE BOOKS

1. Randy Allen, Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence Based Approach", Morgan Kaufmann Publishers, 2001.
2. Steven S. Muchnick, "Advanced Compiler Design and Implementation", Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint 1997.
3. Keith D Cooper, Linda Torczon, "Engineering a Compiler", Morgan Kaufmann Publishers Elsevier Science, 2011.
4. Andrew W. Appel, "Modern Compiler Implementation in C", Cambridge University Press, 1st edition, 2004.
5. Watson, Des, "A Practical Approach to Compiler Construction", 1st edition, Springer-Verlog, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2		3								2	3
CO2	3	2		3	3							2	3
CO3	3	2		3								2	3
CO4	3	2		3								2	3
CO5	3	2		3						2		2	3
CO6		3	3	3	3			1	2	2	2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3662	ARM MICROCONTROLLERS AND INTERFACING (TCP)	30	0	30	30	90	3

OBJECTIVES

- To understand the fundamental architecture and operational features of ARM Cortex-M processors.
- To develop proficiency in ARM assembly language and Embedded C programming.
- To familiarize students with on-chip peripherals of ARM-based microcontrollers.
- To provide an in-depth understanding of serial communication interfaces.
- To build practical skills in interfacing sensors, displays, and actuators, and to design simple real-time embedded applications.

UNIT I	INTRODUCTION TO ARM ARCHITECTURE	6
ARM families - Cortex-M series overview: programmer's model and registers, APSR/IPSr/EPSR - ARM vs Thumb/Thumb-2 instruction sets - memory organization and bus architecture - pipeline concepts - exception model and vector table - processor modes and privilege levels.		

UNIT II	ARM ASSEMBLY AND EMBEDDED C PROGRAMMING	6
Instruction Sets: Data processing instructions, load/store instructions, branching and conditional instructions - stack operations - subroutines and parameter passing - Assembly programs - CMSIS introduction: startup code - reset sequence - linker script basics - bare-metal programming in assembly and C.		

UNIT III	ON-CHIP MICROCONTROLLER PERIPHERALS	6
GPIO configuration and operations - timers and counters - watchdog timer - PWM modes, NVIC architecture - interrupt handling and prioritization - SysTick timer - system control block - fault exceptions - sleep and deep-sleep power modes.		

UNIT IV	COMMUNICATION INTERFACES	6
UART/USART operation and configuration - SPI protocol and data transfer - I2C/TWI addressing and communication, CAN bus basics, interrupt-driven communication, DMA-based data transfer techniques.		

UNIT V	INTERFACING AND APPLICATION DEVELOPMENT	6
LED, switch, buzzer interfacing, seven-segment display, LCD and keypad interfacing, ADC and DAC usage, sensor interfacing (temperature, light, IR, ultrasonic), DC motor, stepper motor and servo motor control, simple real-time applications		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS:

1. Fundamental ARM assembly programming
 - a. Arithmetic, logical and data transfer operations.
 - b. Sorting of a 32-bit array in ascending and descending order.
 - c. Floating point arithmetic operations

2. Timer-Based Delay Generation: Use SysTick or general-purpose timers to generate precise delays.
3. PWM Signal Generation: Configure timers for PWM mode, adjust duty cycle and control LED brightness or motor speed.
4. Generate analog output waveform using PWM filtering or using built-in DAC.
5. Seven-Segment Display Interface: Display numbers with GPIO and multiplex multiple digits.
6. External Interrupt handling by configuring EXTI lines.
7. Sending and receiving data through serial communication Interface.
8. Controlling the direction and speed of stepper motor using GPIO.
9. Send command/data to LCD interface to display a text message.
10. Mini project – Sample applications
 - a. Touchless Hand Sanitizer Dispenser - The system should use an ultrasonic or IR proximity sensor to detect the presence of a hand near the dispenser without requiring any physical touch.
 - b. Mini Weather Station - Basic environmental parameters such as temperature, humidity, and light intensity should be read using sensors connected to an ARM microcontroller and displayed in a dashboard.

HARDWARE AND SOFTWARE REQUIREMENTS

- Standalone systems
- ARM Development Board or ARM Emulators (QEMU/CPULator).

COURSE OUTCOMES

On successful completion of this course, students will be able to

- | |
|--|
| CO1 Explain the ARM Cortex-M architecture, programmer's model, instruction sets, memory organization, exception handling, and privilege levels. (K2) |
| CO2 Develop assembly and embedded C programs using ARM instruction sets (K3) |
| CO3 Utilize on-chip peripherals such as GPIO, timers, watchdog, PWM, NVIC, SysTick, and system control features for embedded applications. (K3) |
| CO4 Develop programming interfaces for serial communication including UART, SPI, I2C/TWI, CAN, and apply interrupt-driven and DMA-based data transfer techniques. (K3) |
| CO5 Design real-time embedded application prototypes that interface sensors, actuators, displays, and motors with ARM microcontrollers. (K6) |

TEXT BOOKS

1. Joseph Yiu, the Definitive Guide to the ARM Cortex-M3, Second Edition, Newnes, (Elsevier), 2010.
2. Jonathan W. Valvano – Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers, 2012, Createspace Independent Pub, 2nd edition.

REFERENCE BOOKS

1. Practical Microcontroller Engineering with ARM Technology, Ying Bai, John Wiley & Sons, 2016
2. Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C, Third Edition, Yifeng-Zhu, E-Man Press LLC, 2017
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, 2004, Elsevier.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2	2		3				2		2	2	2
CO3	3	2	3		3			2	2		2	2	2
CO4	3	2	3		3				2		2	2	2
CO5	3	2	3	2	3	2		2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3663	COMPUTER GRAPHICS	30	0	30	30	90	3

OBJECTIVES

- To understand basics of computer graphics output primitives and transformations
- To learn about curved surfaces and solid modeling
- To learn about various color models and illumination techniques
- To learn about the basic principles of animation
- To learn advanced modelling techniques

UNIT I	GEOMETRIC TRANSFORMATIONS AND PROJECTIONS	6
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Rasterization principles; Output primitives: Points and lines; Two dimensional geometric transformations: Basic transformations – Matrix representations and homogeneous coordinates –Composite transformations; 3D basic transformations; Liang-Barsky clipping algorithm; Projection: Orthographic versus perspective projection.

UNIT II	CURVES, SURFACES AND SOLID MODELING	6
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Parametric Curves & Interpolation: Continuity conditions; Spline representations, cubic spline interpolation, Bézier curves, Hermite/Catmull-Rom splines; Parametric Surfaces: Bézier patches, B-spline surfaces; Solid Modeling: Boolean operations, Binary space partitioning tree and constructive solid geometry.

UNIT III	COLOR MODELS, ILLUMINATION AND VISIBLE SURFACE DETECTION	6
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Color Models: Properties of light – Standard primaries and chromaticity diagram – RGB, CMY, HSV and HLS color models; Phong illumination model, Ambient occlusion, Visible Surface Detection: Z-buffer (depth testing), Painter's algorithm.

UNIT IV	ANIMATION	6
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Computer Animation: Design of animation sequences – Keyframe systems – Motion specifications: Direct motion specification, Goal directed systems, Kinematics and Dynamics; Morphing; Rigging and Skinning; Interpolation methods: LERP, SLERP, splines; Procedural animation.

UNIT V	FRACTALS & PROCEDURAL GENERATION TECHNIQUES	6
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Fractal Fundamentals: Self-similarity and recursion - exact self-similar (Sierpinski, Koch), Statistical self-similar (terrain, clouds), Iterated function Systems; Grammar based modeling -Lindenmayer Systems; Procedural Texturing: Noise-based (Perlin, Worley), Pattern generation (Voronoi, reaction-diffusion)

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Depict a scene with basic output primitives, simple 2D and 3D objects using a graphical tool like Paint 3D, OpenGL, Blender
2. Apply 2D and 3D transformations on the objects created to create basic animations.
3. Implement Interactive 2D Bézier curve with movable control points
4. Render Boolean operations (union/subtraction) on simple shapes (cubes/spheres) using stencil buffers.
5. Implement per-pixel lighting in GLSL. Use teapot model and compare with Gouraud shading.
6. Construct a 2D scene and visualize depth conflicts by rendering intersecting triangles with z-buffer and painter's algorithm
7. Animate a bouncing ball using different interpolation methods
8. Rig a robotic arm using kinematics
9. Generate 3D terrain using fractals
10. Apply procedural textures on objects.

HARDWARE REQUIREMENTS

Desktops with GPU capabilities

SOFTWARE REQUIREMENTS

OpenGL/Manim/Blender/Unity or any open source graphics library

COURSE OUTCOMES

On successful completion of this course, students will be able to

- | |
|--|
| CO1 : Demonstrate the fundamental concepts of computer graphics, including output primitives and 2D/3D transformations (K2) |
| CO2 Design and evaluate the various curves and surfaces through interactive control point manipulation (K4) |
| CO3 Use color space conversions and apply illumination models to render scenes with proper visible surface detection (K3) |
| CO4 Design and implement keyframe animation sequences by applying interpolation methods, analyzing kinematic systems and creating procedural motion effects. (K5) |
| CO5 Create fractal terrains and procedural textures using algorithmic methods (K6) |
| CO6 Create an application using computer graphics principles depicting a real-world scenario and analyze its ethical implications regarding privacy, bias, and societal impact. (K6) |

TEXT BOOKS

- | |
|---|
| 1. Donald Hearn, Pauline Baker M, "Computer Graphics with OpenGL", Pearson Education, 4 th Edition, 2013. (Units I to V) |
| 2. Hughes, John F., van Dam, Andries, McGuire, Morgan, Sklar, David F., Foley, James D., Feiner, Steven K., & Akeley, Kurt. (2014). Computer graphics: Principles and practice (3rd ed.), Addison-Wesley Professional, ISBN: 978-0321399526 (Unit II to IV) |

REFERENCE BOOKS

1. Angel, Edward, & Shreiner, Dave “Interactive computer graphics: A top-down approach with WebGL” (7th ed.), Pearson (2015), ISBN: 978-0133574845
2. Parent, Rick, “Computer animation: Algorithms and techniques” (3rd ed.). Morgan Kaufmann, 2012, ISBN: 978-01241584
3. Lasseter, John, & Daly, Steve, “The art of 3D computer animation and effects” (5th ed.). Wiley, 2021, ISBN: 978-111957563129
4. Hill, F. S., Jr, “Computer graphics using OpenGL” (3rd ed.), Pearson Prentice Hall, 2007, ISBN-13: 978-0131496705

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2		2		3								3	
CO3	3	2										3	
CO4			3	2	1								2
CO5	3		3		2							3	
CO6			3		3	2		2	2		2		3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3611	LINUX KERNEL PROGRAMMING	0	0	45	15	60	2

PREAMBLE

This laboratory course is designed to provide hands-on exposure to essential embedded Linux workflows, including cross-compilation, QEMU-based system emulation, interrupt handling, inter-process communication, and debugging using industry-standard tools such as GDB. It further introduces students to Linux Kernel Modules (LKMs), memory management mechanisms, and basic driver modification techniques, enabling them to understand how operating system components function internally. The first 5 experiments are designed to develop proficiency in setting up embedded development environments, including cross-compilers, QEMU emulation, and debugging tools. (Reference: Textbook 1). The remaining experiments are for providing hands-on experience in Linux kernel programming, covering interrupt handling, memory management, device drivers, and kernel module development (Reference: Textbook 2).

OBJECTIVES

- To develop proficiency in setting up embedded development environments, including cross-compilers, QEMU emulation, and debugging tools.
- To provide hands-on experience in Linux kernel programming, covering interrupt handling, memory management, device drivers, and kernel module development.
- To enable students to integrate user-space and kernel-space components by implementing IPC mechanisms and system monitoring tasks.

SUGGESTED EXPERIMENTS

1. Set up the cross-compilation toolkit in QEMU Emulator.
2. Define an Interrupt Service Routine and execute it by passing the parameters.
3. Demonstrate the debugging of an application running on the GDB.
4. Pre-allocate a memory segment and use it from an embedded application.
5. Use Linux shared memory API for data exchange between embedded applications.
6. Study of Linux kernel module (LKM) and implement a dynamically loadable simple program as Linux kernel module.
7. Implementation of memory management task as a kernel module.
8. Modification of USB device driver in Linux kernel module.
9. Compiling a Linux kernel with modified LKMs, installing and updating the grub.
10. Mini project – Monitoring critical tasks of Operating system as LKMs (Eg: Reading of battery charge level, status of I/O devices).

SOFTWARE REQUIREMENTS

QEMU Emulator

TOTAL PERIODS

60

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Build embedded development environments and demonstrate cross-compilation, emulation, and debugging of applications on QEMU and GDB. (K3)
CO2 Develop ISR routines and memory management operations using API calls. (K3)
CO3 Develop and integrate kernel modules for managing the memory, modifying the device drivers, and monitoring critical tasks of operating system. (K6)

TEXT BOOKS

1. Igor Viarheichyk, "Embedded Programming with Modern C++ Cookbook", Packt Publishing, 2020
2. Kaiwan N Billimoria, "Linux Kernel Programming - Second Edition: A comprehensive and practical guide to kernel internals, writing modules, and kernel synchronization", Packt Publishing, 2024

REFERENCE BOOKS

1. Robert Johnson , "Embedded Systems Programming with C++", HiTeX Press, 2024
2. Israel Gbati, "Embedded Systems Object-Oriented Programming in C and C++", 2020
3. Robert Love, "Linux Kernel Development - Third Edition", Pearson, 2010

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		3			2	2		2	2	2
CO2	3	2	2		3			2	2		2	2	2
CO3	3	2	2		3			2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3617	MINI PROJECT	0	0	45	45	90	3

OBJECTIVES

- Develop skills to design and implement a technical project.
- Estimate the ability of the student to transform theoretical knowledge of computer science into practical solutions, such as software applications, algorithms, or system designs.
- Learn the use of modern programming tools, frameworks, and techniques required for project development.
- Gain understanding of testing procedures, validation techniques, and the analysis of system efficiency and cost-effectiveness.
- Acquire experience in organizing and implementing a small-scale project, preparing students for their final-year capstone projects.
- Prepare a detailed technical report documenting the project.

GUIDELINES

1. The mini project should be software-based, addressing real-world problems defined by industry, academia, or societal needs, and carried out under the guidance of a faculty supervisor.
2. Students may undertake the project individually or in groups not exceeding three members.
3. A minimum of three periodical progress reviews, including oral presentations, will be conducted by a review committee comprising three expert members.
4. A comprehensive report must be submitted before the end-semester review. Final evaluation will consider the report, presentation, viva-voce, and the functional demonstration of the software solution.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Identify and articulate a problem statement by applying computer science concepts, and plan an appropriate methodology based on existing literature. (K3)
- CO2 Select and utilize appropriate software development tools, frameworks, and techniques to design and implement solutions, and analyze the results to draw meaningful conclusions. (K5)
- CO3 Choose societal, environmental, safety, and ethical considerations while designing and implementing computer-based solutions. (K5)
- CO4 Develop the project while considering project management principles, resource allocation, and functioning effectively as an individual or as part of a team. (K3)
- CO5 Evaluate document project progress effectively and recognize the importance of lifelong learning to adapt to advancements in computer science and technology. (K5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2		2	3									2	
CO3		3										2	
CO4			2		3							2	
CO5			2	3	3				3	3			2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3701	NETWORK AND COMPUTER SECURITY	45	0	0	45	90	3

OBJECTIVES

- Understand the fundamentals of computer, network, and information security, including threat modeling and vulnerability assessment.
- Define and implement security policies, disaster recovery strategies, and auditing processes.
- Apply access control, authorization, and authentication mechanisms to secure systems.
- Explore and implement cryptographic algorithms and network security protocols.
Deploy defensive security tools including firewalls, IDS/IPS, and digital forensics techniques

UNIT I	COMPUTER SECURITY FUNDAMENTALS	9
Computer Security – Information Security - Forms of Protection - Security Standards; Sources of Security Threats - Security Threat Management- Sources of Vulnerabilities- Vulnerability Assessment- System Security Policy - Building A Security Policy - Security Requirement Specification		

UNIT II	SECURITY POLICIES	9
Network Security - Securing the Computer Network -Threat Identification and Analysis - Vulnerability Identification and Assessment - Security Monitoring and Auditing; Disaster Management – Prevention – Response - Recovery		

UNIT III	ACCESS CONTROL	9
Access Rights - Access Control Systems - Authorization- Mechanisms - Types - Principles - and Granularity; Authentication - Factors and Effectiveness - Elements - Types - Methods and Policy		

UNIT IV	CRYPTOGRAPHIC TECHNIQUES AND SECURITY PROTOCOLS	9
Symmetric Encryption - Public Key Encryption - Enhancing Security and Key Management; Public Key Infrastructure - Hash Function and Digital Signatures; SSL/TLS – HTTPS – IPSec- VPN		

UNIT V	DEFENSIVE MECHANISMS AND SECURE SYSTEMS	9
Firewalls: Types - DMZ - Configuration; Intrusion Detection and Prevention: Types - Tools - Challenges - Intrusion Prevention Systems (IPSs); Computer Forensics - Network Forensics - System Monitoring - Tools; Virus and Content Filtering - Scanning, Filtering, and Blocking - Virus Filtering - Content Filtering		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the concepts of computer and information security and assess the sources of threats and vulnerabilities. (K2)
CO2 Analyze network security principles and evaluate network-specific threats, vulnerabilities, and protection mechanisms. (K4)
CO3 Implement access control, authentication, and authorization techniques to secure digital systems. (K3)
CO4 Apply cryptographic techniques and security protocols (e.g., SSL, TLS, IPSec) for secure communication. (K3)
CO5 Choose and deploy defensive mechanisms including firewalls, IDS/IPS, and digital forensics tools to maintain secure system environments.(K6)

TEXT BOOKS
1. Joseph Migga Kizza, A Guide to Computer Network Security, Springer 2009 (Units:1-5)
2. William Stallings, Cryptography and Network Security Principles and Practice Eighth Edition, Global Edition, Pearson, 2023.

REFERENCE BOOKS
1. Matt Bishop, Computer Security: Art and Science, 2 nd edition, Addison Wesley, 2019.
2. Menezes, A., van Oorschot, P., Vanstone, S, Handbook of Applied Cryptography, CRC Press 2018.
3. Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, Second Edition, CRC Press, 2015
4. Christopher Swenson, Modern Cryptanalysis: Techniques for Advanced Code Breaking 1, 1st Edition, 2022
5. A Graduate Course in Applied Cryptography Dan Boneh and Victor Shoup Version 0.6, Jan. 2023
6. Wenliang Du, Computer Security: A Hands-on Approach, CreateSpace Independent Publishing Platform, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	
CO2	3	3										3	
CO3	3	3	3									3	
CO4	3	2										3	
CO5	3	2										3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3711	NETWORK SECURITY LABORATORY	0	0	60	0	60	2

OBJECTIVES

- To apply authentication, integrity, and access control techniques in secure system design.
- To implement and evaluate classical, symmetric, and asymmetric cryptographic algorithms through hands-on exercises and analyze their vulnerabilities.
- To design and validate real-world security applications using cryptographic tools and threat modelling.

SUGGESTED EXPERIMENTS

1. Simulate and demonstrate types of network threats (e.g., sniffing, spoofing) using tools like Wireshark or Scapy.
2. Design and implement a brute-force attack simulation in Python against a multi-user authentication system with rate-limiting and logging mechanisms and analyze its impact on system security.
3. Develop a Role-Based Access Control (RBAC) model in Python with support for hierarchical roles, dynamic permission assignment, and real-time audit logging, and test it against various access scenarios.
4. Build a multi-factor authentication system in Python that integrates OTP via email and biometric simulation (e.g., facial recognition API mock), and evaluate its resistance to spoofing and replay attacks.
5. Implement and compare strong password policies with enforced entropy requirements, and evaluate the performance and security trade-offs of hash storage techniques using bcrypt, Argon2, and scrypt under simulated attack conditions.
6. Implement Caesar Cipher, Vigenère Cipher, and analyze weaknesses.
7. Implement RSA encryption and decryption, analyze the effect of key sizes.
8. Simulate secure communication using TLS in Python (e.g., using ssl module).
9. Use OpenSSL to generate a self-signed certificate and simulate HTTPS communication.
10. Configure and test a firewall (iptables or pfSense) with custom rules.
11. Install and evaluate an Intrusion Detection System (e.g., Snort or Suricata).
12. Analyze live network traffic and identify anomalies using Wireshark.
13. Mini Projects similar to,
 - Design a secure healthcare portal that protects patient records using access control and encryption policies.
 - Develop an e-voting prototype with secure authentication, encrypted ballots, and tamper-evident storage.
 - Build a mobile app for secure photo and video storage with encryption and biometric unlock.

Create a chatbot that explains basic cryptographic concepts and safe online practices.

SOFTWARE REQUIREMENTS

- Python
- OpenSSL,
- Wireshark or Scapy

TOTAL PERIODS

60

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Implement and simulate fundamental network security threats and protection mechanisms using tools and scripting languages (K3)

CO2 Analyze authentication, access control, encryption, and intrusion detection systems to evaluate the effectiveness of security strategies. (K4)

CO3 Design and develop secure, real-world systems and applications integrating multiple security concepts including cryptography, secure communication, and digital forensics. (K6)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	1							3	2
CO2	3	3	2	3	1							3	2
CO3	3	3	2	3	1	2		3	3		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3718	PROJECT WORK PHASE 1	0	0	45	45	90	3

OBJECTIVES

- To develop skills to formulate a complex engineering problem with an awareness of issues pertaining to society, health, safety, law, environment, culture, and to examine the impact of the proposed solution on these issues.
- To carry out the survey of related literature and find out the research gap
- To explore use of new tools, techniques and algorithms required to carry out the projects.
- To gain experience in organization and implementation of a project and extending it (in Phase 2)
- To be able to follow the guidelines and prepare technical report of the project
- To develop skills in team management and presentation

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Formulate complex engineering problems and choose suitable technologies and tools required to solve them effectively (K5)

CO2 Study the relevant research literature to investigate the proposed problem and its feasibility (K5)

CO3 Design high level solutions by applying software engineering principles (K6)

CO4 Divide the work among team members to optimally manage time and complexity

CO5 : Document and present the proposed solution effectively by following ethical practices, addressing issues related to society, health, safety, law, environment, and culture, and evaluating the impact of the developed solution on these aspects.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3							3	3
CO2		3									3		3
CO3			3	3								3	3
CO4								3		3			
CO5						3	3		3				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3716	INDUSTRIAL TRAINING / INTERNSHIP	0	0	0	60	60	2

OBJECTIVES

- To provide comprehensive learning opportunity to students where they can enhance their employability skills and become job-ready with corporate exposure
- To increase the teamwork skills and self-confidence of students
- To inculcate responsibility in students to execute the assigned tasks
- To expose students to hands-on work in real environment
- To gain knowledge in writing technical report, build good communication skill and to learn to practice ethics

TOTAL PERIODS

160

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply principles of engineering in solving complex engineering problems (K3)

CO2 Identify the problems in software and find engineering solution (K3)

CO3 Adapt to emerging technologies in solving engineering problems (K6)

CO4 Demonstrate the ability to communicate effectively

CO5 Develop self-confidence, team work skills, and life-long learning

CO6 Develop knowledge of social, ethical, cultural, global and environmental issues.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	
CO2	3	3	3											
CO3				3	3									
CO4									3	3				
CO5											3	3		3
CO6						3	3	3						

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3818	PROJECT WORK PHASE II	0	0	120	120	240	8

OBJECTIVES

- To apply knowledge gained at various stages of the degree program
- To develop ability to solve problems from its identification and literature survey till the successful solution
- To prepare project reports and to present the work in reviews before panels

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Choose appropriate technologies and tools to address complex engineering challenges effectively. (K5)

CO2 Study the related research literature on the identified problem to validate the proposed solution. (K5)

CO3 Design and evaluate optimal software solutions by applying software engineering principles and appropriate performance metrics. (K6)

CO4 Divide the work among team members to optimally manage time and complexity

CO5 Analyse the impact of the proposed solution on societal, health, safety, legal, environmental, and cultural aspects, adhere to ethical principles, and effectively document, present, and publish the research outcomes in journals, conferences, or patents.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3							3	3	3
CO2		3									3		3	
CO3			3	3								3	3	
CO4								3		3				
CO5						3	3		3				3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3561	FOUNDATIONS OF DATA SCIENCE	30	0	30	30	90	3

OBJECTIVES

- To learn the fundamentals of Data Science using Python.
- To understand descriptive statistics using Python libraries.
- To understand probability distributions and perform statistical inference.
- To understand the various approaches in time series analysis.
- To be familiar with supervised and unsupervised methods in machine learning.

UNIT I	DATA SCIENCE PROCESS & DATA PREPROCESSING	5
Data science process: Defining Research goals- Retrieving data- Cleansing, integrating and transforming data – Data analysis – Build the models – Presenting findings and building applications. Data manipulation: Reading and selection – Filtering missing data – Sorting – Grouping – Ranking and plotting; Data Manipulation with Pandas; Data visualization- Types of Data: Ordinal, Nominal, Discrete, Continuous.		

UNIT II	DESCRIPTIVE STATISTICS	6
The Population and The Sample - Descriptive Analysis of Sample Values: Frequency Distribution of Discrete Random Variable - Frequency Distribution of Continuous Random Variable ; Techniques of Exploratory Data Analysis : Density plot, Box plot, Quantile plot; Distribution: Binomial Distribution - Normal Distribution.		

UNIT III	STATISTICAL INFERENCE & BOOTSTRAPPING	7
Point Estimate - Methods of Point Estimation - Confidence Intervals - Tolerance Intervals - Random Sampling - Bootstrap Sampling - Bootstrap Testing of Hypothesis - Chi-Square Test.		

UNIT IV	TIME SERIES ANALYSIS	6
Components of Time Series: Trend and Covariance- Analyzing Time Series; Covariance Stationary Time Series: Moving Averages - Auto- Regressive Time Series - Auto- Regressive Moving Averages Time Series.		

UNIT V	TIME SERIES PREDICTION	6
Linear Predictors for Covariance Stationary Time Series: Optimal Linear Predictors; Predictors for Non-stationary Time Series: Quadratic LSE Predictors – Moving Average Smoothing Predictors; Dynamic Linear Models.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Creating a Data Frame with default index and user-defined index for data available as dictionaries using Pandas.

2. Data Frame creation with different file formats using Pandas.
3. Perform data manipulation on the input CSV file using Pandas Package.
4. Perform data preparation and visualization on the input CSV file using Pandas and Matplotlib packages.
5. Perform Exploratory Data Analysis on a CSV file. Import any CSV file and perform Exploratory Data Analysis by plotting histogram based on frequency count and probability.
6. Develop a Python program to compute estimators using Pandas and Numpy.
7. Demonstrate the different sampling techniques using Pandas and Numpy.
8. Develop a Python code to perform time series analysis.
9. Develop a Python code to examine a population and make inferences using statistical inference.
10. Develop a Python program to analyze a time series dataset by identifying its components such as trend, seasonality, and covariance. Implement Moving Average and Auto-Regressive models to study the behavior of time-dependent data.
11. Develop a Python program to perform time series forecasting by implementing Optimal Linear Predictors and Moving Average Smoothing Predictors for non-stationary datasets. Compare prediction performance using appropriate error metrics.

Software:

Any Python IDE

Python Packages: Pandas, Numpy, SkLearn, Matplotlib

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Develop Python programs for data manipulation and data visualization K3

CO2 Apply statistical techniques to explain and analyze the data K3

CO3 Examine a population and make inferences using statistical inference K4

CO4 Apply time series analysis on time variant data K3

CO5 Design a machine learning based solution in teams to solve a real-world socially relevant problem and document the findings K6

TEXT BOOKS

1. Ron S. Kenett, Shelemyahu Zacks, Peter Gedeck, "Modern Statistics: A Computer-Based Approach with Python", Springer, 2022. (UNIT II-V)
2. José Unpingco, "Python for Probability, Statistics, and Machine Learning", Second Edition, Springer, 2016. (UNIT I, II)

REFERENCE BOOKS

1. Davy Cielen, Arno D B Meysman, Mohamed Ali, "Introducing Data Science – Big data, Machine Learning, and more using Python tools", Manning Publications Co, 2016.

2. Laura Igual, Santi Segua, "Introduction to Data Science – A Python Approach to Concepts, Techniques and Applications", Springer Nature, 2017
3. Alan Agresti and Maria Kateri, "Foundations of Statistics for Data Scientists With R and Python ", First Edition, CRC Press, 2022.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					3							3	
CO2	3	2		3	3							3	
CO3		2		3								3	
CO4	3	2		3	3						2	3	
CO5			3	3	3			3	3		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3562	USER EXPERIENCE DESIGN	30	0	30	30	90	3

OBJECTIVES

- To understand the goals and principles of interface design
- To study life cycle models and identify the requirements for interface design
- To learn effective prototypes for construction of user interface design
- To know about user testing
- To use tools to develop UI design for mobile app.

UNIT I	FOUNDATIONS OF INTERACTION DESIGN	5
Interaction design, Good and poor design, Design and usability principles, Conceptual models, Interface metaphors, Interaction paradigms, Conceptual models to physical design.		

UNIT II	PROCESS AND REQUIREMENTS	5
Activities of interaction design – Key characteristics of interaction design process – Lifecycle models; Different kinds of requirements – Data gathering and Data interpretation, Elicit Implementation Intensions		

UNIT III	DESIGN AND CONSTRUCTION	5
Prototyping and construction – Low-fidelity prototyping – High-fidelity prototyping – Construction: from design to implementation; Business Model Canvas, Conceptual Design, Expanding the conceptual model –User-centered approach.		

UNIT IV	EVALUATION AND TESTING	5
Evaluation paradigms and techniques, Leverage Loss Aversion, User testing, Predictive models, Refinement based on feedback.		

UNIT V	MOBILE HCI	5
Types of Mobile Applications, Widgets, Games, Mobile Information Architecture – Mobile 2.0 –Elements of Mobile Design and Tools.		

TOTAL PERIODS	90
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SUGGESTED EXPERIEMNTS
1. Given a scenario, create a design system and components using Figma 2. Create a design for desktop interface using design principles 3. Create a wireframe using Figma 4. Create High-Fidelity prototype

5. Create an application from the given requirements to design
6. Create a mobile application using predictive model and redesign from user feedback
7. Create an information architecture using Fig jam.
8. Design components and interface elements for mobile applications
9. Given the scenario, create a case study using Figma

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Illustrate the fundamentals of user interaction design (K2)

CO2 Identify the user requirements and interpret data (K3)

CO3 Develop an efficient prototype to communicate and model the design definitions (K3)

CO4 Evaluate UX design for a case study (K3)

CO5 Examine Mobile HCI principles in designing and developing user-centered mobile applications (K4)

TEXT BOOKS

1. Preece J, Rogers Y, Sharp H, "Interaction design: Beyond Human-Computer Interaction", 4th edition John Wiley & Sons Ltd, 2015. (Unit 1 to 4)
2. Brian Fling, "Mobile Design and Development", 1st Edition, O'Reilly Media Inc, 2009. (Unit 5)

REFERENCE BOOKS

1. Preece J, Rogers Y, Sharp H, Baniyon D, Holland S and Carey T, "Human Computer Inter- action", Addison-Wesley, 1994.
2. B. Shneiderman, "Designing the User Interface", Addison Wesley 2000 (Indian Reprint).
3. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004.
4. Bill Scott and Theresa Neil, "Designing Web Interfaces", 1st Edition, O'Reilly, 2009.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3								
CO2	3												
CO3	3	2	3		3								2
CO4	3	2			3								
CO5	3	2	3		3				2		3		2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3563	EXPLORATORY DATA ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- To outline an overview of exploratory data analysis
- To perform univariate and bivariate data exploration and analysis
- To use data exploration and visualization techniques for multivariate and time series data
- To gain meaningful insights from raw data to support decision-making, identify patterns, and extract valuable information

UNIT I	FUNDAMENTALS OF EXPLORATORY DATA ANALYSIS	6
Exploratory Data Analysis (EDA) Fundamentals: Significance of EDA - Making sense of data – Software tools for EDA; Visual Aids for EDA: Scatter plot, Bubble chart, Area plot, stacked plot, table chart, Polar chart, Lollipop chart, Heatmap, Choosing the best chart.		

UNIT II	UNIVARIATE ANALYSIS	6
Introduction to Single Variables: Summaries of levels and spread – Choosing between measures – Individual and aggregate level data; Scaling and Standardizing.		

UNIT III	BIVARIATE ANALYSIS	6
Relationship between two Variables: Percentage Tables - Analyzing Contingency Tables - Handling Several Batches: Multiple boxplots -Joint Plot – ANOVA- T-test.		

UNIT IV	MULTIVARIATE ANALYSIS	6
Causal Explanations – Three-variable Contingency Tables: Trust and reciprocity – Controlling for a prior variable – Causal path models for three variables – logistic regression models – More complex model-Going beyond three variables – Estimating a more complex model with interactions - Pair plot for multivariate EDA – Cluster based EDA.		

UNIT V	TIME-SERIES ANALYSIS	6
Understanding Time-series Dataset – Time-series Analysis with Open Power System Data: Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling; Introduction to Data Visualization Tool: Tableau.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Perform EDA on simple datasets using plots and charts (E.g., Boston Housing dataset, Online Retail dataset) and assess data quality using a real-world dataset
2. Conduct EDA to analyze the data patterns and the behavior of data (Analyzing email data to find out the usage patterns and communication behaviors)

3. Generate percentage tables and contingency tables for real time scenarios (Any customer-product dataset analyzing the relationship between two variables)
4. Demonstrate simple problems showing how a third variable controls the relationship between two variables and perform Cluster based EDA. (Identify the relationship among multiple variables for Titanic dataset)
5. Visualizing time series data (E.g., Open Power System Dataset).
6. Perform EDA on a sample dataset and generate reports using any data visualization tool. (E.g., Wine Quality Data Set).

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply visual aids for exploratory data analysis and demonstrate the fundamentals of EDA. K3

CO2 Apply univariate and bivariate analysis techniques for analyzing the data. K3

CO3 Analyse multivariate data exploration techniques to demonstrate the causal dependence among the variables. K4

CO4 Examine time-series data to identify patterns, trends, and anomalies using exploratory analysis techniques K4

CO5 Evaluate forecasting models using real-world time series data. K5

TEXT BOOKS

1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 2020. (Unit 1,5)

2. Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008. (Unit 2,3,4)

REFERENCE BOOKS

1. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017

2. Ayodele Oluleye, "Exploratory Data Analysis with Python Cookbook", Packt Publishing, 2023

3. Tamraparni Dasu & Theodore Johnson, "Exploratory data mining and data cleaning", John Wiley & Sons, 2003.

4. Claus O. Wilke, "Fundamentals of Data Visualization", O'reilly publications, 2019

5. Daniel G Murray, Tableau your Data! Fast and Easy Visual Analysis with Tableau Software, Wiley, second edition, 2016 (Unit 5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2										2	
CO3	3	2	3									2	
CO4	3	2	3	3								2	
CO5	3	2	3	3	2			1	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3521	STATISTICAL METHODS IN DATA ANALYSIS	45	0	0	45	90	3

OBJECTIVES

- Introduce basic statistical concepts and techniques for data analysis.
- Understand probability models and their applications.
- Learn parameter estimation and sampling distribution concepts.
- Develop skills in confidence intervals and hypothesis testing.
- Apply regression analysis for modelling and prediction.

UNIT I	INTRODUCTION TO STATISTICS	9
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Data Collection and Descriptive Statistics- Inferential Statistics and Probability Models- Types of data- Populations and Samples- Describing Data Sets- Data visualization: pie charts, histograms, box plots, and scatterplots-Summarizing Data Sets- Measures of central tendency: mean, median, and mode- Measures of dispersion: variance, standard deviation, and range- Automation in Analytics: AI-assisted data preprocessing, exploration, and visualization techniques; Effect of AI on modern analytical workflows and decision-making.

UNIT II	PROBABILITY AND DISTRIBUTIONS	9
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Sample Space and Events- Axioms of Probability- Conditional Probability- Bayes' Theorem- Independent Events- Random Variables- Types of Random Variables- Discrete Random Variables- Continuous Random Variables- Probability mass and density functions- Distributions: Bernoulli, Binomial, Poisson Distribution, Uniform, Normal, Exponential Distribution- Joint probability distributions- Two or More Random Variables- Covariance and Correlation

UNIT III	SAMPLING DISTRIBUTION AND PARAMETER ESTIMATION	9
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Point Estimation- Sampling Distributions and the Central Limit Theorem- Unbiased Estimators- Variance of a Point Estimator- Standard Error- Mean Squared Error of an Estimator- Methods of Point Estimation- Moments- Maximum Likelihood- Bayesian Estimation of Parameters

UNIT IV	CONFIDENCE INTERVALS AND HYPOTHESIS TESTING	9
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Confidence Interval on the Mean of a Normal Distribution (Variance Known)- Confidence Interval on the Mean of a Normal Distribution (Variance Unknown)- t Distribution- Hypothesis Testing- null and alternative hypotheses- Type I and Type II errors- significance levels- p-values, Z-test and t-test, Relationship between confidence intervals and hypothesis tests- chi-square test- Goodness of fit

UNIT V	REGRESSION ANALYSIS	9
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Simple Linear Regression – Properties of Least Squares Estimators – Statistical Inferences about Regression Parameters – Prediction of New Observations – Coefficient of Determination and Sample Correlation – Analysis of Residuals – Polynomial Regression – Multiple Linear Regression – Logistic Regression – Applied Model Diagnostics: multicollinearity, heteroscedasticity, autocorrelation – Model Diagnostic Plots: residual plots, Q-Q plots – Regularization Techniques

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply descriptive statistics and data visualization techniques to explore and summarize real-world datasets. (K3)

CO2 Select and apply appropriate probability models to handle uncertain events in engineering applications. (K5)

CO3 Compute parameter estimates using statistical inference methods. (K3)

CO4 Evaluate hypotheses and interpret results using confidence intervals, p-values, and statistical tests in engineering scenarios (K5)

CO5 Create regression models to detect patterns in complex datasets. (K6)

CO6 Design research-driven statistical methods to investigate real-world data, draw valid conclusions and communicate statistical findings effectively (K6)

TEXT BOOKS

1. Douglas C. Montgomery, George C. Runger, "Applied Statistics and Probability for Engineers", John Wiley & Sons, 2018, (Unit 1-4)
2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 2020, Academic Press (Unit 5)

REFERENCE BOOKS

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying E. Ye, "Probability and Statistics for Engineers and Scientists", Pearson, 2016.
2. Johnson R A, Gupta C B, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
3. Milton J S, Arnold J C, "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 2014

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	3										3	
CO3	3			3									
CO4	3			3								3	
CO5	2	3	3	3					2			3	
CO6	3	3	3	3				3	3			3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3522	MATHEMATICS FOR MACHINE LEARNING	45	0	0	45	90	3

OBJECTIVES

- To impart knowledge on concepts of vector space and matrix of transformation.
- To understand the application of calculus in optimization problems.
- To provide a strong foundation in probability theory.

UNIT I	LINEAR ALGEBRA	9
Introduction to systems of linear equations – Vector spaces - Linear independence – Basis and rank - Linear Mappings, Matrix of Linear mappings -Norms – inner products - orthonormal basis - Rotations.		

UNIT II	MATRIX DECOMPOSITIONS	9
Determinant and trace – Eigenvalues and Eigen vectors - diagonalization – Cholesky decomposition – Application in dimensionality reduction: Singular value decomposition		

UNIT III	VECTOR CALCULUS	9
Partial differentiation – Total derivative - Gradient: Vector valued functions – Higher order derivatives - Multivariate Taylor's Series – Application to data classification through linear fit.		

UNIT IV	PROBABILITY AND DISTRIBUTIONS	9
Sample space- discrete and continuous probabilities – Baye's theorem -Independence – Normal distribution: Properties - Change of variables – Data Analysis through summary statistics		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Solve the problems in vector spaces, subspaces.

CO2 Compute the matrix of linear transformation and apply SVD for dimensionality reduction.

CO3 Find approximation of multi variable functions using Taylor's series expansion and classify the data using linear fit.

CO4 Apply the concepts of Baye's theorem in decision making and analyze the given data.

CO5 Apply concepts of calculus in solving optimization problems.

TEXT BOOKS

1. Deisenroth. M.P., Faisal. A.A., and Ong. C.S., Mathematics for machine learning, Cambridge University Press, 2020.
2. Goodfellow. I, Bengio. Y, Courville. A, Deep learning, MIT Press, 2016.

REFERENCE BOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publishers, 45th Edition, 2020.
2. O'Neil. P. V., Advanced Engineering Mathematics, 8th Edition, Cengage Learning India Pvt., Ltd, New Delhi, 2018.
3. Mokhtar S. Bazaraa, John J Jarvis and Hanif D. Sherali , Linear Programming and Network Flows, Wiley; 4th edition , 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	2											
CO5	3	2											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3564	NATURAL LANGUAGE PROCESSING	30	0	30	30	90	3

OBJECTIVES

- To learn language models and apply text normalization techniques.
- To learn word level and syntactic analysis in language processing.
- To learn semantics for word embeddings.
- To learn coreference resolution for discourse analysis and to learn machine translation.
- To learn transformers for solving real time problems.

UNIT I	INTRODUCTION AND LANGUAGE MODELS	6
Knowledge in language processing – Ambiguity -- NLP Applications; Text Normalization: Word tokenization -- Lemmatization and Stemming; N-gram Language Models -- Sampling -- Smoothing; RNNs and LSTM as language models.		

UNIT II	WORD LEVEL AND SYNTACTIC ANALYSIS	6
English Word Classes -- Part-of-Speech Tagging; Constituency Grammar: Context-Free Grammar -- Grammar rules for English -- Treebanks; Dependency Parsing: Dependency Relations – Formalisms.		

UNIT III	SEMANTIC ANALYSIS	6
Lexical Semantics: Word Senses Relations -- WordNet -- Word Sense Disambiguation – Vector Semantics -- Words and vectors -- Cosine similarity -- TF-IDF -- PPMI – Word2Vec.		

UNIT IV	COREFERENCE RESOLUTION AND MACHINE TRANSLATION	6
Coreference Resolution: Coreference phenomena – Mention detection – Mention-pair architecture; RNNs for sequence labeling and classification – Stacked and Bi-directional RNN – Machine Translation: Encoder-Decoder with RNNs and LSTM – MT Evaluation.		

UNIT V	LANGUAGE MODELLING USING TRANSFORMERS	6
The Transformer: A self-Attention Network – Multi-head Attention – Transformer Block – The Input – The language modeling Head; Bidirectional Transformer Encoders: Architecture – Masked language modeling – Next Sentence Prediction.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS	
1.	Apply tokenizer, n-grams in text normalization.
2.	Apply treebanks for context-free and dependency parsing.
3.	Apply TF-IDF, Word2Vec, GloVe, FastText and BERT to vectorize the given text data for classification and word similarity.
4.	Use Neural Machine Translation models for machine translation.
5.	Use BERT for solving binary classification problem.
6.	Apply transformers for solving sequence labeling problems.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply text pre-processing techniques and build the language models K3

CO2 Apply basic levels of knowledge at word level and syntax level in language Processing K3

CO3 Apply computational methods in lexical and vector semantics K3

CO4 Explain discourse processing and develop machine translation systems K3

CO5 Apply transformers and bidirectional transformer encoders for solving classification and sequence labeling and evaluate on real time applications. (K5)

TEXT BOOKS

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 3rd Edition, e-book, August 2024 (Units I to V)

2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008 (Unit I)

REFERENCE BOOKS

1. Christopher D. Manning, Hinrich Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.

2. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python", O'Reilly, 2009

3. Nitin Indurkha, Fred J. Damerau, "Handbook of Natural Language Processing", 2nd Edition, CRC Press, 2010

4. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.

5. Li Deng, Yang Liu, "Deep Learning in Natural Language Processing", Springer, 2018

6. Taweh Beysolow II, "Applied Natural Language Processing - Implementing Machine Learning and Deep Learning Algorithms for Natural Language Processing", Apress, 2018 Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Pearson Education, 2013

7. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Pearson Education, 2013

8. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3							3	
CO2	3				3							3	
CO3	3	3		3	3						2	3	
CO4	3	3	3	3	3							3	2
CO5	3	3	3	3	3	2		3	2	2	3	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3565	UNIX AND SHELL PROGRAMMING	30	0	30	30	90	3

OBJECTIVES

- To understand the basics of UNIX operating system
- To learn basic UNIX commands and scripts
- To understand the principles of Unix File system
- To learn Shell Programming

UNIT I	UNIX ENVIRONMENT	6
Unix organization and structure - Introduction to flavours of Unix - Unix environment - Types of Shell - Editors: nano and vi - Environment variables - Customizing the prompt.		

UNIT II	UNIX FILE SYSTEM	6
Terminal - File Systems Navigation - Exploring the File Systems - Manipulating Files and Directories - Getting Commands Documentation - File and Permissions - Users and Groups		

UNIT III	UNIX COMMANDS AND UTILITIES	6
Redirection: Output, Input and Errors - Pipelines - Filters; Expansion and Quoting - Command line editing - Searching for files - Archiving and Backup - Regular Expressions- Text Processing (sed)		

UNIT IV	SHELL PROGRAMMING	6
Shell scripts – PATH - Variables and Constants - Shell functions and Local variables- Flow Control: Branching with if & Case - Reading from standard input		

UNIT V	LOOPS AND PROCESSES	6
Looping with while/until/for - Positional Parameters - Strings and Numbers: Parameter expansion, Arithmetic Evaluation and Expansion – Arrays - Processes		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Experiment with basic Unix commands.
2. Make use of Unix commands for file and directory handling.
3. Experiment with security and file permissions.
4. Make use of pipes, quotes, aliases and variables.
5. Make use of filters.
6. Experiment with sed
7. Develop Bash shell scripts to search for a pattern in a file
8. Develop Bash shell script to reverse and print the digits of a number.
9. Develop scripts using signals and cron jobs

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the structure and environment of Unix Operating System. (K2)

CO2 Make use of Unix commands to manage files, directories, and permissions. (K3)

CO3 Demonstrate the working of Unix command line utilities. (K3)

CO4 Develop shell scripts using variables and control statements. (K3)

CO5 Construct shell scripts to automate tasks and manage processes (K3)

TEXT BOOKS

1. Behrouz Forouzan, Richard Gilberg “UNIX and Shell Programming: A Textbook”, Thomson Learning, 2005 (Unit I).
2. William Shotts A “The Linux Command Line”, Sixth Internet Edition (Units I-V)
3. Brian W. Kernighan and Rob Pike, “Unix Programming Environment”, AT&T Murray Hills, NewJersey.(Unit II)

REFERENCE BOOKS

1. Mike Loukides, Tim O'Reilly, Jerry Peek, Shelley Powers, “Unix Power Tools”, 3rd Edition, O'Reilly, 2009
2. Sumitabha Das, “Unix: Concepts and Applications”, Tata McGraw Hill, 2017.
3. Richard Blum, Christine Bresnahan, “Linux Command Line and Shell Scripting Bible”, Wiley, 2015.
4. Stephen Kochan, Patrick Wood, “Shell Programming in UNIX, Linux and OSX”, Addison Wesley, 2016
5. Randal K Michael, “Mastering Unix Shell Scripting”, 2nd Edition, Wiley, 2008.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2										2	
CO3	3	3	2	3								2	2
CO4	3	3	2	3					3			2	2
CO5	3	3	2	3					3			2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3566	IMAGE PROCESSING AND ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- To understand basics of digital images
- To understand spatial and frequency domain processing
- To learn image segmentation techniques
- To learn feature detection and multi-resolution analysis
- To learn various applications of image processing

UNIT I	FUNDAMENTALS OF IMAGEPROCESSING	6
Introduction -- Fields that use digital image processing -- Steps in Image Processing Systems -- Image Acquisition -- Sampling and Quantization -- Pixel Relationships. Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, Enhancement using arithmetic and logic operators.		

UNIT II	IMAGEENHANCEMENTANDRESTORATION	6
Basic spatial filtering: Smoothing filters; Sharpening filters; Frequency Domain processing: Fourier Transform -- DFT and FFT; Filtering operations in frequency domain; Restoration: Model of Image Degradation/Restoration Process, Noise Models -- Filters for noise removal in Spatial domain, Adaptive filters.		

UNIT III	IMAGE SEGMENTATION	6
Thresholding techniques: Region growing -- splitting and merging -- Adaptive -- Otsu method; Edge detection; Edge linking via Hough transform -- Template matching; Gradient operation; Hysteresis Thresholding - Canny operator – Laplacian operator; Image morphology -- Binary and Gray Level morphology operations		

UNIT IV	IMAGE DESCRIPTORS AND FEATURES	6
Object Boundary and Shape Representations, Texture Descriptors, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Speeded up Robust Features, Principal components as Feature descriptors.		

UNIT V	IMAGE PATTERN CLASSIFICATION	6
Patterns and Pattern classes, Basic Concepts of Decision Functions, Pattern classification by prototype matching: Minimum distance classifier, Optimum Statistical Classifiers, Deep Convolution Neural Networks: A basic CNN architecture for image classification, Case study: LeNet architecture for character recognition.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS (30 Hours)

1. Perform basic image operations:

Image resizing, type conversion, color band extraction, and creation of synthetic images using MATLAB or Python.

2. Spatial domain enhancement:

Apply gray-level transformations and histogram equalization to enhance contrast in low-light images.

3. Noise modelling and filtering:

Add Gaussian, Salt & Pepper, and Uniform noise to images and evaluate the performance of smoothing and median filters.

4. Frequency domain filtering:

Implement DFT/FFT-based low-pass and high-pass filters (Ideal, Butterworth, Gaussian) and analyze their effects.

5. Image restoration:

Model degradation and perform restoration using inverse and Wiener filters for noisy or blurred images.

6. Image segmentation:

Apply global thresholding, adaptive thresholding, Otsu's method, and watershed algorithm for object separation.

7. Morphological processing:

Perform erosion, dilation, opening, and closing using different structuring elements on binary and gray-scale images.

8. Edge detection and boundary extraction:

Generate edges using Roberts, Sobel, Prewitt, Laplacian, and Canny operators and compare outputs.

9. Feature extraction and recognition:

Extract texture, boundary, and region descriptors; perform object recognition using decision-theoretic or neural approaches.

10. Color image processing:

Perform color model conversions (RGB–HSV–CMY) and implement color-based segmentation.

11. Image compression and evaluation:

Implement and compare JPEG and WebP compression; analyze visual quality and compression ratios.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals of digital image formation and enhancement. (K2)

CO2 Apply spatial and frequency domain filtering for image enhancement and restoration. (K3)

CO3 Apply segmentation and morphological methods for object detection (K3)

CO4 Analyze feature extraction and recognition techniques for classification (K4)

CO5 Evaluate color image processing and compression models using transforms (K5)

TEXT BOOKS

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed., Pearson Education, 2018 (Units I, II, III, IV).
2. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, *Digital Image Processing*, 2nd ed., McGraw Hill Education, 2020 (Unit V).

REFERENCE BOOKS

1. A. K. Jain, *Fundamentals of Digital Image Processing*, PHI Learning, 2006.
2. R. C. Gonzalez, R. E. Woods, and S. L. Eddins, *Digital Image Processing Using MATLAB*, 2nd ed., Tata McGraw-Hill, 2009.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	
CO2	3	3		3	3	2						3	
CO3	3	3		3	3	2						3	
CO4	3	3		3	3	2			3				3
CO5	3	3		3	3	2						3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3567	MULTIMEDIA TECHNIQUES	30	0	30	30	90	3

OBJECTIVES

- To introduce the basic concepts and components of multimedia systems, including text, image, audio, and video.
- To understand digital media representation techniques, such as sampling, quantization, color models, and file formats.
- To learn fundamental image, audio, and video compression techniques, including JPEG, MPEG, and related standards.
- To explore multimedia storage, retrieval, and database concepts, including content-based search and indexing methods.
- To understand the principles of networked and cloud-based multimedia delivery, including streaming and transport protocols.

UNIT I	INTRODUCTION TO MULTIMEDIA & DIGITAL MEDIA FUNDAMENTALS	6
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Multimedia elements: text, image, audio, video - Multimedia applications - Characteristics of multimedia systems - Digital representation of media - Sampling and quantization (audio & image) - Human perception basics: psychoacoustics, color perception - Data stream characteristics: discrete vs. continuous media

UNIT II	IMAGES, COLOR MODELS & IMAGE COMPRESSION TECHNIQUES	6
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Digital image representation, image file formats - Color models: RGB, CMYK, HSV, YCbCr - Lossless compression: Run-Length, Huffman, Arithmetic, LZW - Lossy image compression: Predictive coding, Transform coding - The JPEG standard: DCT, Quantization, Zig-zag scanning, Entropy coding, Progressive & hierarchical JPEG.

UNIT III	AUDIO, VIDEO & MULTIMEDIA COMPRESSION STANDARDS	6
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Audio representation and compression: PCM, DPCM, ADPCM - Psychoacoustic models - MP3 basics; Video representation and compression: Spatial vs temporal redundancy, Motion estimation & motion compensation, Intra-frame and inter-frame coding, MPEG video coding pipeline (I-, P-, B- frames), Overview of H.264 / H.265 / H.266.

UNIT IV	MULTIMEDIA SYSTEMS, STORAGE, RETRIEVAL, AND DATABASES	6
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Multimedia file formats (JPEG, PNG, MP3, MP4, AVI, MKV) - Multimedia storage: RAID, optical media, streaming storage, Multimedia databases, Content-based retrieval: Image features (color histogram, edges, texture), Audio features (MFCC, spectral components) - Query-by-example methods - Indexing techniques for images/audio/video

UNIT V	MULTIMEDIA NETWORKING & CLOUD MULTIMEDIA SYSTEMS	6
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Network Services & Protocols for Multimedia: Characteristics of multimedia data on networks - multimedia transport protocols (Real-Time Transport Protocol & Real-Time Control Protocol) - Timing reconstruction, buffering for jitter control; Internet Multimedia Content Distribution: **Content Delivery Network** fundamentals (Caching, Edge distribution, Load balancing); Cloud Multimedia Services: High-level cloud media pipeline (ingest → process → deliver) - Cloud advantages for multimedia

SUGGESTED EXERCISES

1. Study how changes in sampling rate and bit depth affect audio quality, and analyze quantization noise and waveform distortion.
2. Convert an image between RGB, HSV, and YCbCr color models, examine each color channel, and compare color histograms.
3. Implement lossless compression methods such as Huffman coding and LZW on grayscale images and compare the resulting compression ratios.
4. Apply block-based DCT, quantization, and inverse DCT on an image, then observe reconstruction errors and blocking artifacts.
5. Compress an audio file at different bitrates and compare the resulting file sizes and perceptual differences in audio quality.
6. Encode a video using a standard compression technique and analyze the roles of I-frames, P-frames, and B-frames in reducing redundancy.
7. Extract features such as color histograms or texture descriptors from a set of images and perform a query-by-example similarity search.
8. Conduct a streaming experiment and measure how buffering, delay, jitter, and packet loss impact the quality of multimedia playback.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 **Illustrate** the fundamental concepts of multimedia, digital media representation, sampling, quantization, and human perception mechanisms involved in multimedia systems. (K2)

CO2 **Apply** image representation principles, color models, and compression techniques to process and optimize digital images (K3)

CO3 **Evaluate** audio and video compression approaches by examining psychoacoustic models, motion-compensated video coding, and standard multimedia compression frameworks. (K5)

CO4 **Analyze** multimedia storage structures, database organization, and content-based retrieval mechanisms for images, audio, and video. (K4)

CO5 **Demonstrate** an understanding of networked multimedia systems by applying multimedia transport protocols, timing reconstruction, jitter control, and cloud-based media delivery concepts.

SOFTWARE REQUIREMENTS

Python (with NumPy, OpenCV, SciPy, Matplotlib), **FFmpeg**/ Audacity

TEXT BOOKS

1. **Ze-Nian Li, Mark S. Drew, Jiangchuan Liu**, *Fundamentals of Multimedia*, 3rd Edition, Springer, 2021.

REFERENCE BOOKS

1. **Ranjan Parekh**, *Principles of Multimedia*, 2nd Edition, McGraw Hill, 2013.
2. **Tay Vaughan**, *Multimedia: Making It Work*, 9th Edition, McGraw Hill, 2014.
3. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", Pearson, 2nd Edition, 2015.
4. D. P. Mukherjee & S. K. Mitra, "Fundamentals of Image and Video Processing", Academic Press, 2020.
5. Ralf Steinmetz & Klara Nahrstedt, "Multimedia: Computing, Communications & Applications", Pearson, 2nd Edition, 2020.
6. **Prabhat K. Andleigh, Kiran Thakrar**, *Multimedia Systems and Design*, PHI, 2007.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				1								
CO2	3	2			1						2	3	
CO3	3	3	3	3	3				3		2	3	2
CO4	3	3		3	3						2	3	
CO5	3										2		2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3568	ETHICAL HACKING	30	0	30	30	90	3

OBJECTIVES

- To understand the basics of computer-based vulnerabilities.
- To explore different foot printing, reconnaissance and scanning methods
- To expose the enumeration and vulnerability analysis methods
- To understand hacking options available in Web and wireless applications
- To practice tools to perform ethical hacking to expose the vulnerabilities

UNIT I	INTRODUCTION	6
Ethical Hacking Overview - Role of Security and Penetration Testers - Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing- Network and Computer Attacks - Malware - Protecting Against Malware Attacks- Intruder Attacks - Addressing Physical Security		

UNIT II	RECONNAISSANCE AND SCANNING NETWORKS	6
Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering - Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques - Scanning Beyond IDS and Firewall.		

UNIT III	ENUMERATION AND VULNERABILITY ANALYSIS	6
Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- LinuxOS Vulnerabilities- Vulnerabilities of Embedded Operating systems.		

UNIT IV	SYSTEM HACKING	6
Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network – Wardriving- Wireless Hacking - Tools of the Trade		

UNIT V	NETWORK PROTECTION SYSTEMS	6
Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - Network Based and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Install Kali or Backtrack Linux / Metasploitable/ Windows XP 2. Practice the basics of reconnaissance. 3. Using FOCA / SearchDiggity tools, extract metadata and expanding the target list. 4. Aggregates information from public databases using online free tools like Paterva's Maltego. 5. Information gathering using tools like Robtex. 6. Scan the target using tools like Nessus. 7. View and capture network traffic using Wireshark. 8. Automate dig for vulnerabilities and match exploits using Armitage FOCA : http://www.informatica64.com/foca.aspx Nessus : http://www.tenable.com/products/nessus. Wireshark : http://www.wireshark.org. Armitage : http://www.fastandeasyhacking.com/. Kali or Backtrack Linux, Metasploitable, Windows XP

COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Apply the knowledge of TCP/IP model, ethical hacking roles, penetration-testing methodologies, and the legal framework governing cybersecurity. (K3)
CO2 Make use of different foot printing, reconnaissance and scanning methods. (K3)
CO3 Identify and demonstrate the enumeration and vulnerability analysis methods. (K3)
CO4 Plan sophisticated attacks on web and wireless networks (K3)
CO5 Evaluate the advanced network protection systems to enhance the security posture of a network. (K5)
TEXT BOOKS
1. Michael T. Simpson, Nicholas D. Antill, Robert S. Wilson, "Hands-On Ethical Hacking and Network Defense", Fourth Edition, Cengage Learning, 2023. (Unit II & III)
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy", SYNGRESS, 2013 (Unit I)
3. Dafydd Stuttard, Marcus Pinto, "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws", Wiley 2011. (Unit IV & V)

REFERENCE BOOKS
1. Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz , 2014

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3				2			3			2		
CO3	3		2	3	2			3				2	
CO4	3	2									2		
CO5	3	2	2	3	2			3			2	2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3523	ADVANCED GRAPH THEORY	45	0	0	45	90	3

OBJECTIVES

- Familiarize with flows, connectivity and matching in graphs.
- Explain problems concerning graph coloring and Ramsey theory.
- Study the structure of random graphs and its properties.
- Study random walks on groups, matrices, and graphs.
- Understand the concept of Tutte's Polynomial in Graph Theory.

UNIT I	FLows, CONNECTIVITY, AND MATCHING	9
Flows in Directed Graphs - Connectivity and Menger's Theorem – Matching - Tutte's 1-Factor Theorem - Stable Matchings - Paths and Cycles - Complete Subgraphs - Hamilton Paths and Cycles - The Structure of Graphs - Szemerédi's Regularity Lemma - Simple Applications		

UNIT II	COLORING AND RAMSEY THEORY	9
Vertex Colouring - Edge Colouring - Graphs on Surfaces - List Colouring - Perfect Graphs - The Fundamental Ramsey Theorems - Canonical Ramsey Theorems - Ramsey Theory for Graphs - Ramsey Theory for Integers - Subsequences		

UNIT III	RANDOM GRAPHS	9
The Basic Models—The Use of the Expectation - Simple Properties of Almost All Graphs - Almost Determined Variables—The Use of the Variance - Hamilton Cycles—The Use of Graph Theoretic Tools - The Phase Transition Graph.		

UNIT IV	MATRIX AND RANDOM WALKS	9
Cayley and Schreier Diagrams - The Adjacency Matrix and the Laplacian - Strongly Regular Graphs - Enumeration and Pólya's Theorem - Electrical Networks - Random Walks - Hitting Times and Commute Times - Conductance and Rapid Mixing		

UNIT V	TUTTE POLYNOMIAL	9
Basic Properties of the Tutte Polynomial - The Universal Form of the Tutte Polynomial - The Tutte Polynomial in Statistical Mechanics - Special Values of the Tutte Polynomial - A Spanning Tree Expansion of the Tutte Polynomial - Polynomials of Knots and Links		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Solve problems related to flows, connectivity and matching problems in graphs (K3)
CO2 Solve problems concerning graph coloring and Ramsey theory (K3)
CO3 Analyse the structure of random graphs and its properties (K4)
CO4 Analyse random walks on groups, matrices, and graphs (K4)
CO5 Summarize the concept of Tutte's Polynomial in Graph Theory (K2)
CO6 Build solution for emerging problems in graph theory using flow-based algorithms (K6)

TEXT BOOKS

1. Béla Bollobás, "Modern Graph Theory", Springer, 2011 (Units 1 to 5).

REFERENCE BOOKS

1. Reinhard Diestel, "Graph Theory", 5th Edition, Springer, 2017
2. Douglas B. West, "Introduction to Graph Theory", 2nd Edition, Prentice Hall, 2001
3. Chris Godsil and Gordon Royle, "Algebraic Graph Theory", Springer, 2001

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3		3								2	
CO2	3	2		2								2	
CO3	3	2		2								3	
CO4	3	2		2								3	
CO5	3	3		2								2	
CO6	3	3		2								3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3524	ADVANCED DATA STRUCTURES AND ALGORITHMS	45	0	0	45	90	3

OBJECTIVES

- To provide understanding of algorithm analysis and advanced data structures.
- To explore the design, implementation, and applications of non-linear data structures.
- To develop the ability to solve optimization problems using greedy strategies.
- To gain proficiency in dynamic programming paradigms for solving complex problems.
- To introduce the principles of randomness in algorithm design, analyze their expected performance.

UNIT I	ANALYSIS OF ALGORITHMS	8
Analyzing algorithms -- Asymptotic notation -- Recurrences -- Methods for solving recurrences – Substitution – Recursion tree --Masters theorem. Worst case and Average case analysis of iterative and recursive algorithms - Amortized analysis; Aggregate analysis – Accounting method – Potential Method. Divide and Conquer Technique – Heap sort and Quick sort algorithms – Sorting in linear time – Applications.		

UNIT II	NON-LINEAR DATA STRUCTURES	9
Binary search trees, Balanced Search Trees: Red Black Tree - Randomized BST: Splay trees Amortized analysis – Suffix trees – Suffix / LCP arrays - Interval Trees – Graphs – Flow networks.		

UNIT III	STRING MATCHING AND APPROXIMATION ALGORITHMS	9
The naive string-matching algorithm -- The Rabin-Karp algorithm -- String matching with finite automata -- The Knuth-Morris-Pratt algorithm. Approximation algorithms: Vertex-cover problem -- Traveling-salesman problem -- Set-covering problem -- Randomization and linear programming -- Subset-sum problem		

UNIT IV	RANDOMIZED ALGORITHMS	9
A case study for Randomization - Contention resolution in distributed systems, Random variables and their expectations, Randomized divide and conquer – Median finding and Quicksort. Randomized Skip Lists. Hashing – A randomized implementation of Dictionaries.		

UNIT V	CONCURRENT ALGORITHMS	10
Shared Objects and Synchronization-- The Producer–Consumer Problem – The Readers–Writers Problem—Mutual Exclusion – Critical Sections – Concurrent Objects – Monitor Locks – Linked Lists -- Coarse-Grained and fine-grained Synchronization – Concurrent Queues – Concurrent Stacks – Concurrent Skip lists -- Concurrent hashing		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze algorithm efficiency using asymptotic notation. (K4)

CO2 Choose suitable Non-linear data structures for solving problems and analyse their time complexities (K5)

CO3 Use string matching and approximation algorithms for solving optimization problems. (K3)

CO4 Develop randomized algorithms for a given application (K3)

CO5 Construct shared objects and apply concurrent data structures and algorithms (K3)

TEXT BOOKS

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Prentice-Hall, 201 (Unit I, II, III, IV)

2. Jon Kleinberg and Tardos, E., 2006. "Algorithm design". Pearson Education India., 2006 (Unit V)

REFERENCE BOOKS

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

2. Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Pearson Education, 2012

3. S. Sridhar, "Design and Analysis of Algorithms", First Edition, Oxford University Press, 2014

4. Gusfield, Dan. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology. Cambridge University Press, 1997

5. Herlihy, Maurice, and Nir Shavit. The Art of Multiprocessor Programming. Revised 2nd Edition, Morgan Kaufmann, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	
CO2	3	3		3	2						3	3	2
CO3	3		3									3	2
CO4	3		3									3	2
CO5	3		3									3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3525	ADVANCED JAVA PROGRAMMING	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamental concepts of full-stack web development, including front-end and back-end technologies
- To develop proficiency in advanced Java enterprise frameworks, focusing on Spring Boot, Hibernate (JPA)
- To provide an in-depth understanding of Java Enterprise Edition (Java EE), including Java Server Faces (JSF) for building dynamic, component-based web interfaces and handling AJAX-enabled applications.
- To explore the concepts and implementation of Enterprise JavaBeans (EJB)
- To introduce DevOps practices and cloud deployment concepts, emphasizing build automation using Maven and Gradle, version control with Git/GitHub.

UNIT I	OVERVIEW OF FULL STACK	9
Understanding the Basic Web Development Framework - Browser –HTML-CSS- JavaScript – XML-JSON - Webserver – Backend Services – MVC Architecture - different stacks – The MEAN / MERN stacks, APIs, Middleware - MongoDB - Express.js - Angular - React - Node.js		

UNIT II	ADVANCED FRAMEWORKS	9
MVC framework – JPA-Hibernate - Introduction to ORM, JPA Hibernate – Using Annotations – JPA - SessionFactory, Session, Transaction - Performing CRUD Operations with Annotations - Different ID Generation Strategies - Hibernate with Inheritance Hibernate Query language – ORM mapping – Spring Framework – Spring Bean Factory and application Context- Spring Boot - Introduction to STS (Spring Tool Suite) - Di with STS - MVC, AOP		

UNIT III	JAVA ENTERPRISE EDITION (EE) AND JAVA SERVER FACES (JSF)	9
Concept and Overview of One standard, multiple implementations: Java EE, J2EE and the Spring framework - Java Server Faces: Introduction (JSF) - Custom data Validation - JSF Default messagesAJAX enabling JSF application- JSF HTML5 support- Injecting JSF artifacts- JSF Web Socket support - Additional JSF component libraries - Object Relational Mapping with the Java Persistence API.		

UNIT IV	ENTERPRISE JAVABEANS	9
Enterprise JavaBeans-Session Beans-Asynchronous method calls - Message-driven BeansTransactions in enterprise Java Beans - Enterprise JavaBean life cycles-EJB timer service-EJB security - Contexts and Dependency Injection: Named Beans - Dependency injection – Qualifiers -Named bean scopes- CDI events.		

UNIT V	DEVOPS	9
Devops Essentials – Introduction To AWS, GCP, Azure – Version control systems: Git and Github - Installation of Maven, POM files, Maven Build lifecycle, Build phases(compile build, test, package) Maven Profiles, Maven repositories(local, central, global),Maven plugins, Maven create and build Artifacts, Dependency management, Installation of Gradle, Understand build using Gradle.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the architecture and components of full-stack web development frameworks, including front-end, back-end, and middleware technologies.(K2)
CO2 Apply advanced Java frameworks such as Spring Boot and Hibernate (JPA) to develop modular, database-driven enterprise applications. (K3)
CO3 Develop Java EE components using JSF and JPA to create dynamic, interactive, and data-centric web applications. (K3)
CO4 Analyze enterprise application requirements and Design solutions by integrating EJB and CDI concepts to build secure, scalable, and transactional systems.(K4)
CO5 Apply DevOps tools and cloud environments effectively for version control, build automation, and deployment of full-stack Java applications.(K3)
TEXT BOOKS
1. Vasan Subramanian, Pro MERN Stack: Full-Stack Web App Development with Mongo, Express, React, Node, Apress, 2019 (Unit I)
2. Narcisa Buta-Czyz & Andrew Lee, Spring Persistence with Hibernate (2nd Edition), Springer, 2014 (Unit II, III)
REFERENCE BOOKS
1. Narendra M. Thumbhekodige, Jai Krishna, Padmanabhan Manavazhi, et al., The Oracle J2EE Companion, Tata McGraw-Hill, 2004 (Unit III, IV)
2. Tekin Duman & Abdul-Mujeeb Shah, DevOps for Developers: Integrating Version Control, Automation, and Cloud Services, Packt Publishing, 2021 (Unit V)
3. Christian Bauer, Gavin King & Gary Gregory, Java Persistence with Hibernate (2nd Edition), Manning Publications, 2015 (Unit II, III)
4. Chris Severance, <i>Node.js, MongoDB and Angular Web Development</i> (Developer's Library), Pearson Education, 2016 (Unit I)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3		3			–				2	
CO2	3	3	3		3			2			2	3	
CO3	3	3	3	3	3			2			2	3	3
CO4	3	3	3	3	3			2			2	3	3
CO5	3	3	3		3			2				3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3526	PRINCIPLES OF BLOCKCHAIN TECHNOLOGY	45	0	0	45	90	3

OBJECTIVES

- To Introduce basics of Block chain, structure and Merkle trees.
- To understand the process involved in mining and consensus.
- To learn about Hyper ledger framework and Ethereum.
- To introduce Bit coin network.
- To become familiar with Block chain use cases.

UNIT I	INTRODUCTION TO BLOCKCHAIN	9
History of Blockchain, Types of Blockchain; Structure of block - block header-block identifiers-The Genesis block-linking blocks in the block chain - Merkle trees.		

UNIT II	MINING AND CONSENSUS	9
Introduction - Decentralized Consensus – Independent verification of transactions – Mining nodes - Aggregating transactions in to blocks - constructing the block header - Mining the block - Validating a new block.		

UNIT III	HYPERLEDGER FABRIC AND ETHEREUM	9
Hyperledger frameworks- Tools and Building blocks – Hyperledger fabric component design- Hyperledger fabric-The journey of a sample transaction- Hyperledger explored; Introduction to Ethereum - Ethereum Network - Components of Ethereum.		

UNIT IV	THE BITCOIN NETWORK	9
Peer to peer Network Architecture - Node types and roles – The extended Bitcoin Network – Network Discovery – Full nodes – Exchanging Inventory- Simplified payment verification nodes- Bloom filters – Bloom filters and Inventory updates – Transaction pools – Alert messages. Transaction Lifecycle, Transaction Structure, Transaction Outputs and Inputs, Transaction Fees, Adding Fees to Transactions, Transaction Chaining and Orphan Transactions.		

UNIT V	BLOCKCHAIN APPLICATIONS	9
Digital identity verification-Digital art: Blockchain attestation services – Notary - Intellectual Property protection – Key considerations and challenges in applying blockchain in government system - Internet of Things (IoT) technology - managing medical records.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the basics of Blockchain, structure and Merkle trees. (K2)

CO2 Apply mining and consensus to construct block chain (K3)

CO3 Apply Hyperledger framework and Ethereum to build a: blockchain. (K3)

CO4 Experiment block chain in Bitcoin network. (K3)

CO5 Justify the application of Blockchain to various use cases. (K5)

TEXT BOOKS

1. Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly Media, 2014. (Unit 1: Chapter 7; Unit II: Chapter 8; Unit IV: Chapter 5, 6)
2. Melanie Swan, O'Reilly "Blockchain - Blue print for a New Economy", O'Reilly Media, 2015. (Unit 5: Chapter 3)
3. Salman A. Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Blockchain with Hyperledger Building Decentralized Applications with Hyperledger Fabric and Composer", Packt Publishing, 2018. (Unit III: Chapter 2)
4. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018. (Unit 1: Chapter 1) (Unit III: Chapter 9,10)

REFERENCE BOOKS

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
2. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
3. Daniel Drescher, "Blockchain Basics a Non-Technical Introduction in 25 Steps". Apress, 2017

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2	3	2	2	1	2							2	
CO3	3	2	2	1	2							2	
CO4	3	2	2		2							2	
CO5	3	2	2								1	2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3527	INTRODUCTION TO NUMBER THEORY AND CRYPTOGRAPHY	45	0	0	45	90	3

OBJECTIVES

- Introduce the fundamental concepts of number theory and their role in secure computation.
- Explain the principles and techniques of classical and symmetric cryptographic systems.
- Develop understanding of number-theoretic algorithms used in public-key cryptography.
- Familiarize students with the design and evaluation of encryption, authentication, and digital signature schemes.
- Expose learners to advanced cryptographic tools, hash functions, message authentication codes, and emerging post-quantum approaches.

UNIT I	FOUNDATIONS OF NUMBER THEORY	9
Divisibility, primes, GCD, Euclidean & Extended Euclidean algorithms - Modular arithmetic, congruences, residue classes - Chinese Remainder Theorem and its applications - Euler's ϕ -function, Fermat's Little Theorem, Euler's theorem - Introduction to groups, rings, and fields for cryptographic use		

UNIT II	CLASSICAL CRYPTOGRAPHY AND SYMMETRIC TECHNIQUES	9
Historical ciphers: Caesar, shift, monoalphabetic substitution, Vigenère - Kerckhoffs' Principle, key space and frequency analysis - Perfect secrecy & the One-Time Pad - Symmetric encryption: definitions and computational security - Pseudorandom generators, block ciphers (DES, AES), modes of operation		

UNIT III	NUMBER THEORY FOR PUBLIC-KEY CRYPTOGRAPHY	9
Large prime generation; primality testing (Fermat, Miller–Rabin) - The factoring problem and RSA assumption - Modular exponentiation and fast algorithms - Discrete logarithm problem, Diffie–Hellman, ElGamal - Elliptic-curve groups and cryptographic relevance		

UNIT IV	PUBLIC-KEY ENCRYPTION AND DIGITAL SIGNATURES	9
Public-key concepts & key-management challenges - RSA encryption (textbook & padded), ElGamal, hybrid schemes - Digital signatures: RSA, hash-and-sign paradigm, Lamport's one-time signatures - Certificates & Public Key Infrastructures (PKI)		

UNIT V	ADVANCED TOPICS AND APPLICATIONS	9
Message authentication codes (MAC), HMAC - Collision-resistant hash functions, Merkle–Damgård - Cryptographic protocols: key exchange, authentication - Provable security and hardness assumptions (random oracle model) - Post-quantum directions (overview)		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1	Apply the principles of elementary number theory to solve computational and algebraic problems. (K3)
CO2	Analyze the strengths and weaknesses of classical and symmetric cryptographic techniques. (K4)
CO3	Apply number-theoretic algorithms to design and evaluate public-key cryptosystems. (K3)
CO4	Design, implement, and assess secure encryption, authentication, and digital signature schemes. (K5)
CO5	Evaluate and propose modern cryptographic solutions, including hash functions, MACs, and emerging post-quantum approaches. (K6)

TEXT BOOKS

1. Yan, S. (2022). *Number Theory for Computing* (6th ed.). Springer. (Units I, III)
2. Stinson, D. R., & Paterson, M. B. (2021). *Cryptography: Theory and Practice* (4th ed.). CRC Press. (Units II, IV, V)

REFERENCE BOOKS

1. Neal Koblitz, *A Course in Number Theory and Cryptography*, 2nd Edition, Graduate Texts in Mathematics, Vol. 114, Springer
2. Jonathan Katz and Yehuda Lindell, *Introduction to Modern Cryptography*, CRC Press, 2007.
3. Hoffstein, J., Pipher, J., & Silverman, J. H. (2021). *An Introduction to Mathematical Cryptography* (2nd ed.). Springer.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												2
CO2	3	3	3										2
CO3	3	3	3		2								3
CO4	3		3	2	2	2							3
CO5				2									3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3569	FUNDAMENTALS OF RTOS WITH QNX	30	0	30	30	90	3

OBJECTIVES

- To understand the architecture and core concepts of the QNX RTOS.
- To learn to develop and debug applications using the QNX Momentics IDE.
- To gain knowledge of process and thread management, including synchronization techniques.
- To explore inter-process communication (IPC) methods and their applications in QNX
- To understand hardware programming concepts, including interrupt handling and memory access.

UNIT I	INTRODUCTION TO QNX OS ARCHITECTURE	6
Operating Systems - Types of OS - Services of OS - Overview of QNX OS architecture: microkernel, process manager, and standards - Protected address spaces, process/thread model, and scheduling - Introduction to inter-process communication (IPC) and synchronization - Resource managers and shared objects.		

UNIT II	PROCESSES, THREADS, AND SYNCHRONIZATION	6
Process management: creation, termination, and memory protection - Thread management: creation, termination, and synchronization - Synchronization techniques: mutexes, semaphores, and condition variables - Example for process/thread creation and synchronization.		

UNIT III	INTER-PROCESS COMMUNICATION (IPC)	6
Overview of IPC methods in QNX: message passing, pulses, and shared memory - Comparing IPC methods: advantages and disadvantages - Implementation of IPC in QNX - Message passing and shared memory.		

UNIT IV	HARDWARE PROGRAMMING AND TIMING	6
Hardware access methods: IO-mapped and memory-mapped IO - Interrupt handling and DMA-safe memory allocation - Timing architecture: periodic timing, one-shot timing, and timeouts -Example for Interrupt handling and timing mechanisms.		

UNIT V	BUILDING AND CONFIGURING QNX BOOT/OS IMAGES	6
Overview of QNX boot/OS image structure - Components of a boot image: startup code, kernel, drivers, and scripts - Building and loading boot images onto target hardware - Introduction to resource managers and their implementation.		

SUGGESTED EXPERIMENTS		
QNX configuration and application development using QNX Momentics IDE. 2. Process and thread creation, management, and synchronization. 3. Implementation of IPC methods: passing message and shared memory. 4. Interrupt handling and hardware access programming. 5. Building and deploying QNX boot/OS images.		

6. Mini project: Design and implement a QNX-based solution for real time embedded systems.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Describe the QNX OS architecture and its microkernel-based design. (K2)
- CO2 Develop and debug QNX-based applications using appropriate tools. (K3)
- CO3 Apply process/thread management and synchronization techniques in QNX. (K3)
- CO4 Implement inter-process communication methods for real-time systems. (K3)
- CO5 Configure and build QNX boot/OS images for specific hardware platforms. (K3)
- CO6 Develop on the POSIX standards that help in System Application Development. (K5)

TEXT BOOKS

1. QNX Neutrino RTOS User's Guide, QNX Software Systems. 2009
2. Michael Barr, Programming for Embedded Systems, O'Reilly Media. 2006
3. Brian Amos, Hands-on RTOS with Microcontrollers, Packt Publishing, 2020.
4. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9th Edition, Wiley, 2018.
5. Online Resources
 - QNX online training ; QNX training material
 - QNX Documentation for SDP 8.0
 - QNX Everywhere page - <https://blackberry.qnx.com/en/products/qnx-everywhere>
 - QNX Gitlab page - <https://gitlab.com/qnx>
 - QNX Developer Community: Access to forums and communities where they can ask questions and interact with other QNX developers.
 - QNX on Reddit: <https://www.reddit.com/r/QNX/>
 - QNX on StackOverflow: <https://stackoverflow.com/questions/tagged/qnx>
 - QNX on YouTube: <https://www.youtube.com/qnxcam>
 - Collection of open-source projects (incl Links) for QNX: <https://gitlab.com/qnx/projects>
 - Ported libraries that work on QNX: <https://github.com/qnx-ports>

HARDWARE REQUIREMENTS

- I5 10th gen or Later PC /Laptop with USB Ports and Ethernet Support
- Raspberry Pi 4 Kit
- LCD monitor , Wireless Keyboard and Mouse

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	3	3		3							3	
CO3	3	3	3		3							3	
CO4	3	3	3		3							3	
CO5	3				3							3	
CO6	3	3	3	3	3	2		2	2		2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3665	BIG DATA MANAGEMENT	30	0	30	30	90	3

OBJECTIVES

- To know the fundamental concepts of big data management.
- To understand the basics of data modelling and its implications.
- To learn different data models adopted in big data.
- To get introduced to big data management systems like key-value stores and graph databases.
- To learn various supporting tools for developing an application using document and columnar databases.

UNIT I	BIG DATA MANAGEMENT	5
Introduction to Big Data and Data Management - Data Modelling and Management Platforms - Defining Data Models - Structures of Data Models - Modelling with Unstructured and Streaming Data.		

UNIT II	HADOOP & SPARK	7
Hadoop Introduction - HDFS - Internals of MapReduce - Hadoop Ecosystem - Spark Introduction - Spark Transformations and Actions - Spark Data Frames and SQL.		

UNIT III	DATA LAKE DEVELOPMENT WITH BIG DATA	5
Introduction - Need for Data Lake - Data Intake - Data Integration, Quality and Enrichment - Data Pipelines: ETL vs ELT- Data Discovery and Consumption - Data Governance.		

UNIT IV	DOCUMENT AND GRAPH DATABASES	7
Introduction - JSON and Data Operations - Working with Databases: Pruning data from MongoDB; Programmatic Access: Accessing MongoDB using PHP and Python – Graph Databases an Overview – Neo4j – Modelling data for Neo4j – Use Case Examples: Recommender Systems & Impact Analysis and Simulation.		

UNIT V	KEY-VALUE STORE AND COLUMNAR DATABASES	6
Approaches to Big Data –Introduction to NoSQL – Key-Value Store: Redis - Introduction to Cassandra – Architecture – CassandraQL (CQL) – Configuring and Managing a Cluster – Integrating with Apache Spark.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
Using Hadoop First char count: Count first letter of each word in each sentence(s) 1. Log parser:

▪ For any given file with log records like: 10.223.157.186 - - [15/Jul/2022:14:58:59 -0700] "GET / HTTP/1.1" 403 202 • It first filters those whose status code is not 2XX. • Then, count the number of requests for each URL. Then, count the number of requests for each month for 2022. Finally, the count of requests for each hour for the year 2022. • Bakery • Given a dataset which consists of the following files: • customers.csv: information about the bakery's customers • goods.csv: information about the baked goods offered for sale by the bakery. • items.csv: itemized receipt information for purchases • receipts.csv: general receipt information for purchases • We count the total amount of money spent by each user, which users have bought more than once per day, the list of those dates and the total number of units sold for each product. • Using Spark: • Importing and viewing a dataset using PySpark. • Data cleaning and preprocessing using PySpark. • Using SparkSQL to run SQL-like queries on the dataset. • Calculating various statistics, such as sum, average, and count. • Grouping and aggregating data based on specific attributes. • Creating temporary tables and views in SparkSQL.
3. Explore the Data Lake with Azure Synapse Serverless SQL and Spark
4. Develop an application for the following concepts, i) fraud detection and/or ii) digital asset management using GraphDB and Redis.
5. Develop an application for the bi-cycle rental system in a university using MongoDB.
6. Develop a simple project using Cassandra Cloud Database Management System.

COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Illustrate the different data models and identify data operations needed for designing information systems. (K2)
CO2 Build distributed data processing applications using Apache Hadoop and Spark. (K3)
CO3 Apply a data model to suit the characteristics of Data Lake. (K3)
CO4 Apply Big Data Management System for building a system using MongoDB and Graph Databases. (K3)
CO5 Build and deploy a simple project using document and columnar databases. (K6)

TEXT BOOKS
1. James Lee, Tao Wei, Suresh Kumar Mukhiya, "Hands-On Big Data Modeling", Packt Publication, 2018. (Unit 1)
2. Chanchal Singh, Manish Kumar, "Mastering Hadoop 3", Packt Publication, 2019. (Unit 2)
3. Pradeep Pasupuleti, Beulah Salome Purra, "Data Lake Development with Big Data", Packt Publication, 2015. (Unit 3)

REFERENCE BOOKS

1. Vinoo Das, “Learning Redis”, Packt Publications, 2015. (Unit 5)
2. Jerome Baton, Rik Van Bruggen, “Learning Neo4j 3.x”, 2nd Edition, Packt Publishers, 2017 (Unit 4)
3. Aaron Ploetz, Tejaswi Malepati, Nishant Neeraj, “Mastering Apache Cassandra 3.x”, 3rd Edition, Packt Publishers, 2018 (Unit 5).
4. Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, “MongoDB: The Definitive Guide”, 3rd Edition, 2019 (Unit 4).

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2									2	
CO2	3	3	2		3				3	2		2	2
CO3	3	3	2		3				3	2		2	3
CO4	3	3	2	3	3				3	2		2	3
CO5	3	3	2	3	3				3	2		2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3621	INFORMATION RETRIEVAL TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of information retrieval with pertinence to modelling
- To understand various components of IR system
- To understand machine learning techniques for text classification and clustering
- To explore various IR applications.

UNIT I	INTRODUCTION TO IRT AND VARIOUS MODELS	9
Basic Concepts: Retrieval process – Architecture – Boolean retrieval; IR Models: Taxonomy and characterization of IR models – Classical IR models – Alternative algebraic models – Models for Browsing – Retrieval Evaluation; LEMUR.		

UNIT II	INDEXING, QUERYING AND WEB LANGUAGES	9
Indexing: Inverted indices – Suffix trees – Suffix arrays – Compression; Querying: Query languages; Query Operations: Relevance feedback and query expansion; Semantic Web Technologies – Structured Web Documents – Describing Web Resources – Applications and Challenges – Rule Interchange Format (RIF) – SPARQL -Web Ontology Language – OWL.		

UNIT III	SEARCHING	9
Searching: Sequential searching – Pattern matching; Searching the Web: Characterizing the Web – Search engines – Browsing – Searching using hyperlinks. Search Engine Architectures: Search Engine Ranking – Simple Ranking Functions – Learning to Rank – Evaluations - Search Engine User Interaction – Browsing – Applications of a Web Crawler – Evaluation- INDRI SEARCH ENGINE.		

UNIT IV	TEXT CLASSIFICATION AND CLUSTERING	9
Text classification and Naive Bayes: The text classification problem - Naive Bayes text classification - The Bernoulli model - Properties of Naive Bayes - Feature selection - Evaluation of text classification. Vector space classification: Rocchio classification - SVM based text classification - Extensions to the SVM model: Flat and Hierarchical clustering for text; Matrix decompositions and latent semantic indexing.		

UNIT V	APPLICATIONS OF IR	9
XML Retrieval – Multimedia IR – Parallel and Distributed IR – Digital Libraries – Social Media Retrieval – Content-based Image Retrieval – Online Public Access Catalogs (OPACs).		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the concepts, models, and evaluation techniques of Information Retrieval systems. (K2)

CO2 Apply indexing and querying methods for effective document organization and retrieval. (K3)

CO3 Apply searching algorithms and web-based retrieval strategies using ranking and evaluation methods.(K3)

CO4 Analyze text classification and clustering techniques using machine learning models for efficient retrieval.(K4)

CO5 Evaluate and design Information Retrieval applications across different domains such as multimedia, digital libraries, and online catalogs.(K5)

TEXT BOOKS

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008. (Unit-I, IV)
2. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The concepts and Technology behind Search ", (ACM Press Books), Second Edition, 2011. (Unit- II, III, V)

REFERENCE BOOKS

1. Crestani F, Mizzaro S, Scagnetto I, "Mobile Information Retrieval" Germany : Springer International Publishing, 2017.
2. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016.
3. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2nd edition, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2		3	3									2	
CO3			2									2	
CO4		2	3									2	2
CO5			2					3	2			2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3622	COMPUTER VISION	45	0	0	45	90	3

OBJECTIVES

To get knowledge about image formation and feature representation.

- To understand image detection and segmentation.
- To understand image alignment and motion estimation.
- To learn about depth estimation suitable for 3d reconstruction.
- To learn recent trends of deep learning applicable for vision systems.

UNIT I	IMAGE FORMATION AND VISUAL FEATURES REPRESENTATION	9
Introduction to Computer Vision, Image formation: Photometric image formation - Digital camera; Image representation: Point operators, Linear filtering, nonlinear filtering, Fourier Transforms, Pyramids and Wavelets.		

UNIT II	IMAGE SEGMENTATION AND FEATURE EXTRACTION	9
Image Segmentation: Region Growing, Edge Based approaches to segmentation, Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Graph-Cut, Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG.		

UNIT III	IMAGE ALIGNMENT AND STITCHING & MOTION ESTIMATION	9
Image Alignment AND Stitching: Pairwise alignment and image stitching; Motion Estimation – Translational alignment – Parametric motion – Optical flow – Layered motion.		

UNIT IV	DEPTH ESTIMATION & 3D RECONSTRUCTION	9
Pose estimation – Geometric intrinsic calibration – Triangulation – Two-frame structure from motion – Factorization – Bundle adjustment; Shape from X: Shape from shading and photometric stereo, shape from texture.		

UNIT V	DEEP LEARNING IN VISION SYSTEMS	9
Image classification models (VGG, ResNet); Object detection (R-CNN, YOLO, SSD) – Semantic and instance segmentation (U-Net, Mask R-CNN); Generative models: GANs, VAEs.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply conventional computer vision concepts. (K3)

CO2 Apply the different techniques used for image segmentation and feature extraction.(K3)

CO3 Apply feature-based alignment and motion estimation for any real time applications.(K3)

CO4 Apply 3D vision algorithms for geometric understanding. (K3)
CO5 Develop visual computing solutions for real life applications using graphics and modern tools and document the findings. (K5)

TEXT BOOKS
1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010. (Unit I - IV)
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, An MIT Press book, 2016. (Unit V)

REFERENCE BOOKS
1. Dr. Adrian Rosebrock, Deep Learning for Computer Vision with Python, Practitioner Bundle, PyImageSearch, 2017.
2. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, Practical Machine Learning for ComputerVision, O’riley, 2021.
3. Simon Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
4. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson Education 2002.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2									2	
CO2		3	2									2	
CO3		3	3									2	2
CO4		2	3	3								3	2
CO5		2	3	3	2				3			3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEC3733	DEEP LEARNING TECHNIQUES	45	0	0	45	90	3

PREAMBLE

With the recent developments in computing facilities, several neural network approaches have been explored in many state-of-the-art recognition problems to improve their performance for applications related to agriculture, healthcare, autonomous vehicles, etc., All these applications rely on efficient, accurate and robust solutions for basic tasks such as text/audio/image/video classification, localization, and detection. In this course, the students will be given exposure to the details of deep learning architectures and to develop end-to-end models for such problems. Moreover, the students will learn to train and apply deep learning architectures for real-world problems. Some prerequisites that may help students for a better understanding include the basic concepts of linear algebra, calculus, probability theory, optimization, and machine learning.

OBJECTIVES

- To introduce the concept of deep neural networks.
- To comprehend the mathematical foundations of deep learning, including linear algebra, probability, and optimization.
- To learn the architecture and functionality of various deep learning techniques.
- To gain knowledge in popular Python frameworks such as TensorFlow, Keras or Pytorch.

UNIT I	FUNDAMENTALS OF DEEP LEARNING	9
Basic concepts of neural networks – the perceptron model, multi-layered neural network, activation functions – deep neural networks – layers and activation functions – softmax, sigmoid, tanh, leaky reLU – Loss functions - Introduction to python libraries – numpy, pandas and matplotlib, python frameworks – TensorFlow/Pytorch, implementation a basic feedforward network for classification using keras API in TensorFlow.		

UNIT II	TRAINING DEEP NEURAL NETWORKS	9
Training deep networks – gradient descent – stochastic gradient descent and mini batch gradient - back propagation – forward and backward pass, challenges in training – vanishing and exploding gradient, overfitting, underfitting, regularization, implementation of gradient descent and regularization techniques using Keras/TensorFlow.		

UNIT III	CONVOLUTIONAL NEURAL NETWORKS	9
Introduction to Convolution Neural Networks (CNNs): convolution and pooling operations, Deep CNN layers - Deep CNN architectures: Resnet, U-net- Training a CNN: weights initialization, batch normalization, hyperparameter optimization, Implementation of Resnet in Keras for image classification.		

UNIT IV	RECURRENT NEURAL NETWORKS AND SEQUENCE MODELS	9
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Sequence modelling and time series analysis using Recurrent Neural Networks (RNNs) – Backpropagation through time – Long Short-Term Memory (LSTMs) – Bidirectional LSTMs – Bidirectional RNNs– Gated Recurrent units (GRUs), Implement an RNN model for sequential data analysis, and build a text prediction model using LSTM in Keras on a text dataset.

UNIT V	MODERN DEEP LEARNING ARCHITECTURES	9
Autoencoders - Generative Models - Boltzmann Machines, Deep Belief Networks, Generative Adversarial Networks, Transformer Architectures – Self attention, Bidirectional Encoder Representations from Transformers (BERT), HuBERT, Zipformer, Branchformer - Implement a simple GAN in TensorFlow/Keras for speech applications.		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Demonstrate an understanding of the fundamentals of deep neural networks including architectures, activation functions and optimization.
CO2 Demonstrate an ability to apply techniques to optimize models, including regularization, dropout, batch normalization, and hyperparameter tuning.
CO3 Describe the differences between various deep learning models such as CNN, RNN, LSTM and Transformers.
CO4 Implement deep learning models using frameworks such as Tensorflow or Pytorch.
CO5 Solve domain specific real-world problems using deep learning techniques for speech, image, and text processing.

TEXT BOOKS
1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep learning, MIT Press 2016
REFERENCE BOOKS
1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer 2018
2. S. Haykin, Neural Networks, and Learning Machines, Prentice Hall of India, 2010
3. Bishop C.M, Pattern Recognition and Machine Learning, Springer, 2006
4. Sudharsan Ravichandran, Hands-On Deep Learning Algorithms with Python, Packt publishing, 2019.
5. Kenneth Graham, Uday Kamath, and Wael Emara, "Transformers for Machine Learning: A Deep Dive", CRC Press; 1st edition, 2022.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1									2	2	3	2
CO2	3	3	2	2	3						2	2	3	2
CO3	3	2		2	2						2	2	3	2
CO4	2	2	2	3	3						2	2	3	2
CO5	2	3	3	3	3	2	2	2	2	2	2	2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3623	PRINCIPLES OF REINFORCEMENT LEARNING	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of reinforcement learning techniques
- To explore various methods used in reinforcement learning
- To learn methods for approximating value functions in large scale problems.
- To understand the concept of transfer learning in reinforcement Learning
- To apply reinforcement learning techniques for various case studies.

UNIT I	INTRODUCTION	9
Reinforcement Learning Examples Elements of Reinforcement Learning Limitations and Scope Tic-Tac-Toe; Multi-armed Bandits; Finite Markov Decision Processes; Introduction to Agents - Intelligent Agents – Problem Solving – Searching, Logical Agents.		

UNIT II	TABULAR SOLUTION METHODS	9
Dynamic Programming: Policy evaluation – Policy improvement – Policy iteration – Value iteration; Monte Carlo Methods: Prediction Estimation of Action Values Control Off-policy Prediction via Importance Sampling Incremental Implementation Off-policy Monte Carlo Control.		

UNIT III	INTEGRATION OF TABULAR METHODS AND APPROXIMATE SOLUTION METHODS	11
Temporal-Difference Learning: n-step Bootstrapping TD Prediction; TD control: Sarsa Q-Learning; Planning and Learning with Tabular Methods; On-policy Prediction with Approximation: Value-function approximation –Stochastic gradient – Linear methods;		

UNIT IV	TRANSFER IN REINFORCEMENT LEARNING	8
Framework and Taxonomy for Transfer in Reinforcement Learning: Transfer framework – Taxonomy- Methods for transfer across tasks with a fixed and different state-action spaces.		

UNIT V	APPLICATIONS AND CASE STUDIES	8
Watson's Daily-Double Wagering; Human-level Video Game Play; TD-Gammon; Optimizing Memory Control; Applying RL for Real-World Problems		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Illustrate the basics of reinforcement learning problem (K2)

CO2 Solve various problems using tabular solution methods (K3)

CO3 Apply the integrated tabular methods and approximate solution methods for larger state space problems (K3)

CO4 Apply transfer learning approaches across varying tasks and state-action spaces in reinforcement learning (K3)
CO5 Evaluate the use of reinforcement learning techniques for different real-world applications (K5)

TEXT BOOKS

1. Richard S. Sutton & Andrew G. Barto, "Reinforcement Learning: An Introduction", The MIT Press, 2nd Edition, 2018. (Units: I, II, III, V).
2. Marco Wiering & Martijn van Otterlo, "Reinforcement Learning State-of-the-Art", Springer, 2012. (Unit: IV).

REFERENCE BOOKS

1. Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi & Jan Peters
2. "Reinforcement Learning Algorithms: Analysis and Applications", Springer, 1st edition, 2021.
3. Micheal Lanham, "Hands-On Reinforcement Learning for Games", Packt Publishing Ltd., 2020.
4. Taweh Beysolow II, "Applied Reinforcement Learning with Python", Apress, 2019.
5. Dimitri Bertsekas, "Reinforcement Learning and Optimal Control", Athena Scientific, 2019.
6. HM Schwartz, "Multi-Agent Machine Learning - A Reinforcement Approach", John Wiley & Sons Inc, 1st edition, 2014.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2		2	3									2	
CO3	3											2	
CO4		2	3									2	
CO5		2	3	3	3				3	3		2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3624	IOT TECHNOLOGIES	45	0	0	45	90	3

- To understand the basics of IoT devices, protocols, communication APIs and deployment templates
- To design the simple IoT systems using Raspberry Pi/Arduino
- To understand various IoT protocols
- To design an IoT system using cloud environments
- To develop IoT solutions for industries.

UNIT I	INTRODUCTION TO INTERNET OF THINGS	9
Basic computer networking to Internet of things: Network Types -- Layered network models -- Addressing -- TCP/IP transport Layer. Definition and Characteristics of IoT -- Physical Design of IoT -- Logical Design of IoT -- IoT Enabling Technologies -- IoT Levels & Deployment Templates -- IoT and M2M		

UNIT II	BUILDING IoT SYSTEMS	9
IoT Physical devices and Endpoints: Basic building blocks of IoT Device -- Raspberry Pi -- Linux on Raspberry Pi -- Interfaces -- Programming Raspberry Pi with Python -- Python packages for IOT: JSON -- XML -- HTTPClient -- URLLib -- SMTPLib -- XMPP -- Contiki OS -- RFID and basic sensors -- Other IoT Platforms: Arduino -- Intel Galileo and Beaglebone boards.		

UNIT III	IoT PROTOCOLS	9
Introduction to IoT Protocols -- IEEE 802.15.4 -- 6LoWPAN -- Zigbee -- CoAP -- Bluetooth -- IEEE 802.11 Wi-Fi -- OPCUA - AMQP		

UNIT IV	CLOUD OFFERINGS AND IoT CASE STUDIES	9
Cloud Storage Models and Communication APIs for IoT-- WAMP- Python Web Application framework-- Designing a RESTful Web API-- Amazon Web Services for IoT--MQTT -- Case studies for IoT Design: Home automation-- Smart Agriculture.		

UNIT V	INDUSTRIAL INTERNET OF THINGS (IIoT)	9
Introduction -- Industrial Process-- The Computer Integrated Manufacturing Pyramid (CIM)-- IIoT data flow-- Understanding the IIoT edge: features of the edge -- architecture and implementations. Implementing IOT industrial solution with cloud services.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the basics of IoT devices, protocols, communication APIs and deployment templates (K2)
CO2 Develop the simple IoT systems using Raspberry Pi/Arduino. (K3)
CO3 Choose various IoT protocols (K3)
CO4 Select appropriate hardware and software resources to design an IoT system using

cloud environments (K5)
CO5 Develop IoT solutions for industries. (K3).

TEXT BOOKS

1. Sudip Misra, Anandarup Mukherjee and Arijit Roy, "Introduction to IoT", Cambridge University Press: 09 January 2021(Unit 1, 2, 3)
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on Approach, University Press, 2015 (1st edition) (Unit 2, 4)
3. Giacomo Veneri, "Antonio Capasso, "Hands-On Industrial Internet of Things Create a Powerful Industrial IoT Infrastructure Using Industry 4.0", 2018 (Unit5)

REFERENCE BOOKS

1. Adrian McEwen Hakim Cassimally, Designing the Internet of Things, Wiley, Nov2013, (1st edition)
2. Olivier Hersent, David Boswarthick, Omar Elloum, "The Internet of Things Key applications and Protocols", Wiley, 2012.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis ,Karnouskos, Stefan Avesand,David Boyle,"From Machine - to-Machine to the Internet of Things - Introduction to a New Age of Intelligence" Elsevier, 2014.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2	2								2	2	
CO3	3	2									2	2	
CO4	3	2	2		2			3	3			2	2
CO5	3	2	2		2						2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3625	OBJECT ORIENTED ANALYSIS AND DESIGN	45	0	0	45	90	3

OBJECTIVES

- To understand and differentiate Unified Process from other approaches
- To understand object-oriented software design using UML's static diagrams
- To understand software modeling using the UML's dynamic diagrams
- To learn improving software design with design patterns
- To learn testing the software with its requirements specification.

UNIT I	DEVELOPMENT PROCESS & USE-CASE DIAGRAM (STATIC)	9
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Introduction to OOAD with OO Basics – Unified process – UML diagrams – Use case – Case study – The Next Gen POS system, Inception – Use case modelling – Relating use cases – Include, extend and generalization – When to use use-cases.

UNIT II	UNIFIED PROCESS & CLASS DIAGRAM (STATIC)	9
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Class diagram – Elaboration – Domain model – Finding conceptual classes and description classes – Associations – Attributes – Domain model refinement – Finding conceptual class hierarchies – Aggregation and composition – Relationship between sequence diagrams and use cases – When to use class diagrams.

UNIT III	DYNAMIC & IMPLEMENTATION DIAGRAMS	9
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Dynamic Diagrams: UML interaction diagrams – System sequence diagram – Collaboration diagram – When to use communication diagrams – State machine diagram and modelling – When to use state diagrams – Activity diagram – When to use activity diagrams. Implementation Diagrams: UML package diagram – When to use package diagrams – Component and deployment diagrams – When to use component and deployment diagrams.

UNIT IV	DESIGN PATTERNS	9
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Designing objects with responsibilities – Creator – Information expert – Low coupling – High cohesion – Controller design patterns – Creational patterns: Factory, Builder, Prototype, Singleton - Structural: Adapter, Bridge, Facade, Proxy – Behavioural: Chain of responsibility, Observer, Strategy, Template – Applying GoF design patterns – Mapping design to code.

UNIT V	TEST DRIVEN DEVELOPMENT AND REFACTORING	9
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Object oriented methodologies – Software quality assurance – Impact of object orientation on testing – Develop test cases and test plans.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Model the given problem using Use case diagrams (K3)
CO2 Apply OO concepts for project development (K3)
CO3 Construct appropriate UML diagrams for modeling user requirements (K3)
CO4 Make use of the design patterns to transform UML based software design into pattern- based design (K3)
CO5 Develop test cases and test plans for object-oriented software (K3)
CO6 Analyze a real-world problem and develop an integrated object-oriented model using UML diagrams, applying suitable design principles and patterns to represent structure and behavior effectively. (K5)

TEXT BOOKS

1. Larman, Craig, "Applying UML and Patterns", Pearson Education Asia, 2008. (Units I – V)
2. Ali Bahrami, "Object Oriented Systems Development", McGraw Hill International Edition, 1999. (Units I – V)

REFERENCE BOOKS

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design patterns: Elements of Reusable Object Oriented Software", Pearson Education, 2015.
2. Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", 3rd edition, Addison Wesley, 2003.
3. Booch, G, Jacobson I, Rumbaugh J, "The Unified Modeling Language User Guide", Addison Wesley, 2008.
4. Roger S Pressman, "Software Engineering – A Practitioner's Approach", 7th edition, 2010.
5. Aditya P Mathur, "Foundations of Software Testing – Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		1				2	2			2
CO2	3	2	2		1				2	2			2
CO3	3	3	3		1				2				2
CO4	3	2	2					3					2
CO5	3	3	2										3
CO6	3	3	2	1	1			3	2	2			2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3626	PRINCIPLES OF PROGRAMMING LANGUAGES	45	0	0	45	90	3

OBJECTIVES

- To understand the syntax and semantics of programming languages using formal methods.
- To analyze data types, type systems, and binding mechanisms across paradigms.
- To design subprograms, parameter passing mechanisms, and runtime environments.
- To explore object orientation, concurrency, exception, and event-handling mechanisms.
- To develop programs using functional and logic programming paradigms.

UNIT I	LANGUAGE FUNDAMENTALS & SYNTAX SPECIFICATION	9
Programming paradigms – Language evaluation criteria – Influences on design – Implementation methods – BNF, EBNF, and regular expressions – Context-free grammars – Parsing methods (top-down, bottom-up) – Attribute grammars – Lambda calculus introduction – Semantics: dynamic and static.		

UNIT II	DATA TYPES, BINDINGS & CONTROL STRUCTURES	9
Names, variables, and bindings – Scope and lifetime – Referencing environments – Primitive data types – User-defined types: arrays, records, unions, tuples, pointers, associative arrays – Type checking, type equivalence – Strong typing and compatibility – Arithmetic, relational, and boolean expressions – Mixed-mode and short-circuit evaluation – Control structures: selection, iteration, branching – Referential transparency.		

UNIT III	SUBPROGRAMS & RUNTIME ENVIRONMENTS	9
Subprogram fundamentals – Design issues for subprograms and functions – Parameter passing mechanisms: value, reference, name – Overloaded and generic subprograms – Closures and coroutines – Activation records and runtime stack – Nested subprograms and blocks – Dynamic local variables – Exception propagation and handling.		

UNIT IV	OBJECT-ORIENTATION & CONCURRENCY	9
Abstract data types – Encapsulation constructs – Object-oriented principles (inheritance, polymorphism, abstraction) – Implementation in Java and C++ – Subprogram-level concurrency – Semaphores, monitors, message passing – Threads and statement-level concurrency – Exception handling models and event handling.		

UNIT V	FUNCTIONAL & LOGIC PROGRAMMING	9
Lambda calculus – Fundamentals of functional programming – Scheme programming constructs – Haskell syntax and higher-order functions – Concurrency in functional		

programming – Predicate calculus and theorem proving – Logic programming overview – PROLOG basics – Applications and limitations of logic programming.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain syntax and semantics of programming languages using formal methods. (K2)

CO2 Construct and implement data types, bindings, and control structures. (K3)

CO3 Construct subprograms with appropriate parameter passing and runtime support mechanisms. (K3)

CO4 Analyze object-oriented, concurrent, and exception-handling implementations (K4)

CO5 Evaluate and justify functional and logic programming paradigms. (K5)

TEXT BOOKS

1. Sebesta, R. W., “Concepts of Programming Languages”, 12th Ed., Addison Wesley, 2016. (Unit 1-5)

2. Scott, M. L., “Programming Language Pragmatics”, 4th Ed., Morgan Kaufmann, 2015.

REFERENCE BOOKS

1. Harper, R., “Practical Foundations for Programming Languages”, 2nd Ed., Cambridge, 2016.

2. Krishnamurthi, S., “Programming Languages: Application and Interpretation”, 2nd Ed., 2022.

3. Hutton, G., “Programming in Haskell”, 2nd Ed., Cambridge, 2016.

4. Bratko, I., “Prolog Programming for Artificial Intelligence”, 4th Ed., Addison-Wesley, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2		2							2	3	
CO2	3	3			2						2	3	
CO3	3	3	3	2	2			2				3	2
CO4	2	3	3	2	3	2		2	2			3	3
CO5	3	3	3	2	3				2		2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3627	EMBEDDED SYSTEMS FOR INDUSTRIAL APPLICATIONS	45	0	0	45	90	3

OBJECTIVES

- To Provide foundational knowledge of embedded systems architecture and industrial embedded platforms.
- To understand interfacing with sensors, actuators, and industrial communication protocols.
- To familiarize real-time operating systems (RTOS) and their role in industrial automation.
- To develop industrial control strategies using embedded controllers and PLC integration.
- To design embedded solutions for industrial monitoring, control, and safety applications.

UNIT I	INTRODUCTION TO EMBEDDED SYSTEMS	9
Embedded system overview – Characteristics, design metrics; Embedded system architecture – Microcontrollers vs. microprocessors; ARM Cortex-M architecture; Memory hierarchy; I/O subsystems; Industrial embedded requirements: Reliability, availability, fault tolerance; Industrial case studies: Packaging systems, robotic pick-and-place, smart meters.		

UNIT II	SENSORS, ACTUATORS & INDUSTRIAL INTERFACING	9
Industrial sensors: Temperature, pressure, flow, proximity, vibration, optical and humidity sensors. Actuators: Relays, solenoids, stepper and servo motors, pneumatic & hydraulic actuators; Interfacing: ADC/DAC, GPIO, PWM, UART, SPI, I2C; Industrial hardware interfaces: 4–20 mA loops, HART basics, Modbus RTU framing.		

UNIT III	INDUSTRIAL COMMUNICATION & NETWORKING	9
Industrial communication: Modbus TCP, CAN, CAN-FD, Profibus, Profinet, EtherCAT, OPC-UA; Networking models for automation; Industrial Ethernet requirements; Deterministic communication; SCADA architectures – HMI design principles; Edge computing for industrial IoT; Sensor fusion gateways.		

UNIT IV	REAL-TIME SYSTEMS & CONTROL APPLICATIONS	9
RTOS concepts – Tasks, scheduling, context switching, semaphores, mutex, timers; FreeRTOS programming basics - Industrial control: PID controllers, fuzzy logic basics; PLC basics – Ladder logic, scan cycle, interfacing embedded controllers with PLC systems; Embedded data acquisition systems.		

UNIT V	INDUSTRIAL EMBEDDED APPLICATION DESIGN	9
Design methodology – Requirement analysis, hardware selection, PCB considerations; Safety standards: IEC 61131, IEC 61508 (SIL), functional safety requirements; Vibration monitoring, predictive maintenance, energy monitoring systems;		

Smart factory applications – Digital twins, cyber-physical systems; Capstone: Designing a complete embedded solution for an industrial use case.

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Describe embedded system architecture and industrial embedded hardware requirements.(K2)

CO2 Interface industrial sensors, actuators, and communication peripherals. (K3)

CO3 Apply industrial communication protocols for automation and control. (K3)

CO4 Develop real-time embedded applications using RTOS and industrial controllers. (K4)

CO5 Design embedded solutions for industrial monitoring, control, and safety applications. (K6)

TEXT BOOKS

1. Jonathan W. Valvano, Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers, 2021. (Units 1, 2, 3)
2. Krishnakumar, K., Industrial Instrumentation and Control, New Age International, 2015.(Units 4, 5)

REFERENCE BOOKS

1. Jack Ganssle, The Art of Designing Embedded Systems, Newnes, 2008.
2. Stenerson Jon, Industrial Automation and Process Control, Cengage, 2020.
3. Berger, Hans, Automating with PROFINET, Wiley, 2014.
4. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2									3		2
CO2	3	2			2								2
CO3		3	2		3							3	
CO4			2	3	2								2
CO5			3			3				3	2		3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3628	WIRELESS SENSOR NETWORKS AND PROTOCOLS	45	0	0	45	90	3

OBJECTIVES

- To study sensor node hardware and design principles.
- To study the functionalities of various MAC protocols for WSNs.
- To understand the working of data centric routing protocols in WSNs.
- To understand the working of localization and topology control in WSNs.
- To explore the various platforms and tools for WSN.

UNIT I	INTRODUCTION TO WIRELESS SENSOR NETWORKS	9
Introduction: Challenges, Applications - Single node architecture: Hardware components, Energy consumption of sensor nodes - Network architecture: Sensor network scenarios - Optimization goals - Design principles - Service interfaces - Gateway concepts.		

UNIT II	MEDIUM ACCESS CONTROL LAYER	9
Fundamentals of wireless MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule-Based protocols - The IEEE 802.15.4 MAC protocol.		

UNIT III	DATA CENTRIC ROUTING	9
Query processing - Data aggregation - Localized vs Centralized protocols - Data gathering without memorizing links towards the sink - Data dissemination from the sink - Data gathering based on memorized broadcasting trees - Periodic reports by all sensors - Data gathering with data aggregation.		

UNIT IV	LOCALIZATION AND TOPOLOGY CONTROL	9
Localization and positioning: Properties of localization and positioning procedures - Approaches - Mathematical basics for the localization problem - Single-hop localization - Positioning in multihop environments - Case Study: Localize a sensor node in WSN to send and receive data. Topology control: Concepts - Controlling topology in flat networks - Hierarchical networks by dominating sets - Hierarchical networks by clustering - Combining hierarchical topologies and power control - Case Study: Designing types of WSN topology and disseminating data.		

UNIT V	SENSOR NETWORK PLATFORMS AND TOOLS	9
Sensor Network Hardware: Berkeley Motes -- Arduino IDE -- Node Level Software: Platforms -- Tiny OS -- Imperative Language -- nesC -- Simulators: NS-3, Contiki OS and COOJA IDE, TOSSIM -- State Centric Programming: PIECES.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Explain sensor node architecture and design principles. (K2)
CO2 Apply the knowledge of MAC protocols to choose appropriate protocols based on given application requirements. (K3)
CO3 Choose appropriate data-centric routing strategies according to the specific requirements of a given WSN application. (K3)
CO4 Choose appropriate localization and topology control strategies tailored to the requirements of specific WSN applications (K3)
CO5 Design and develop sensor network architectures by creating simulation models using WSN simulation tools for specific application scenarios in teams (K6)

TEXT BOOKS

1. Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005. (Unit - 1, 2, 4)
2. Ivan Stojmenovic, Handbook of Sensor Networks: Algorithms and Architectures, Wiley Interscience, 2005. (Unit 3)
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufmann, 2004 (Unit 5)

REFERENCE BOOKS

1. K. Sohrawy, D. Minoli, and T. Znati, Wireless Sensor Networks: Technology, Protocols, and Applications. Hoboken, NJ, USA: Wiley, 2007.
2. Zheng, J. Jamalipour A, "Wireless Sensor Networks: A Networking Perspective", Wiley, 2009.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2		3	3									3	
CO3		3	3									3	
CO4		3	3	2								3	
CO5	3	3	2	3	2			3	2			3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3664	AUGMENTED REALITY AND VIRTUAL REALITY(TCP)	30	0	30	30	90	3

OBJECTIVES

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.
- To learn about the tracking methods of objects in AR applications.

UNIT I	INTRODUCTION TO VR AND AR	6
Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices		

UNIT II	VR MODELLING	6
Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.		

UNIT III	VR PROGRAMMING AND APPLICATIONS	6
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D – Unity3D – Unreal Engine- Oculus SDK - Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business		

UNIT IV	AUGMENTED REALITY HARDWARE	6
Taxonomy- Technology and Features of Augmented Reality- Difference between AR and VR, Challenges with AR - AR Systems and Functionality - Augmented Reality Methods - Visualization Techniques for Augmented Reality - Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model, Processor System Architecture, Processor Specifications.		

UNIT V	AR TECHNIQUES – MARKER BASED & MARKERLESS TRACKING	6
Introduction to Vuforia Engine - Marker-based Approach: Types of markers, Marker Camera Pose and Identification, Visual Tracking - Marker Types: Template Markers, 2D Barcode markers, Imperceptible Markers. Marker-less approach: Localization based Augmentation, Real World examples, Tracking Methods: Visual Tracking, Feature based Tracking, Hybrid Tracking		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use primitive objects and apply various projection types by handling cameras.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them. (Eg: Interior scenes like rooms, houses etc or vehicles like cars, airplanes, spaceships etc)
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity. (Eg: Training and gaming applications)
8. Develop AR enabled applications with interactivity like E-learning environment, Virtual walkthroughs and visualization of historic places.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the basics of VR and AR along with the types of trackers, input and output devices. **(K2)**

CO2 Build various 3D objects for VR applications using geometric, physical and behavior modeling. **(K3)**

CO3 Develop VR applications by using different tools and technologies of VR Programming for a real-world application. **(K3)**

CO4 Choose the hardware elements required for AR application and apply AR techniques. **(K6)**

CO5 Build AR systems in teams using marker-based and marker less approach by choosing appropriate hardware elements and document its overall working. **(K6)**

TEXT BOOKS

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006. (Units 1, 2, 3)
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016. (Units 4, 5)

REFERENCE BOOKS

1. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
2. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
3. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003.
4. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												2
CO2			2									3	3
CO3					3								2
CO4		3						3	3				2
CO5				3								3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3629	SPEECH PROCESSING AND SYNTHESIS	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamentals of speech production and processing.
- To extract meaningful features from speech in both time and frequency domains.
- To explore modern deep learning models for speech representation.
- To develop end-to-end speech recognition and synthesis systems.
- To evaluate speech systems using standard performance metrics.

UNIT I	FUNDAMENTALS OF SPEECH PROCESSING	9
Basics of Digital Signal Processing for Speech - Sampling, Quantization, and Anti-aliasing - Overview of Human Speech Production Mechanism - Acoustic and Articulatory Phonetics - Digital Models of Speech: Source-Filter Model - Introduction to Phonemes and Phones - Speech Data Collection and Annotation Tools (Praat, Wavesurfer) - Overview of Speech Technology Applications		

UNIT II	TIME AND FREQUENCY DOMAIN FEATURES FOR DEEP MODELS	9
Time-Domain Features: Energy, ZCR, Short-Time Energy; Frequency-Domain Features: Spectrograms, Mel-Spectrograms-MFCC, PLP, and Filterbanks-Advanced Pitch and Formant Estimation-Feature Normalization Techniques (CMVN, Delta-Delta)-Data Augmentation Techniques (SpecAugment, Noise Injection)		

UNIT III	DEEP LEARNING FOR SPEECH REPRESENTATION	9
Deep Neural Networks for Feature Learning-CNNs, RNNs, LSTMs, GRUs in Speech Applications-Self-supervised Speech Models: Wav2Vec2.0, HuBERT, Whisper- Embedding-based Features: x-vectors, d-vectors-Transfer Learning for Low-Resource Speech Tasks-Acoustic Model Training Pipelines		

UNIT IV	AUTOMATIC SPEECH RECOGNITION (ASR)	9
ASR Pipeline Overview-End-to-End ASR Architectures: CTC-based models-Sequence-to- Sequence with Attention-RNN-T (Transducer models); Pretrained ASR Models: Whisper, NeMo, Wav2Vec2.0-Subword Tokenization: BPE, WordPiece-Decoding Strategies: Greedy, Beam Search, LM Integration-Evaluation Metrics: WER, CER, SER		

UNIT V	SPEECH SYNTHESIS AND CONVERSATIONAL SYSTEMS	9
Text-To-Speech System Overview-Neural TTS Models: Tacotron2, FastSpeech2, VITS- Neural Vocoder: Griffin-Lim, WaveNet, WaveGlow, HiFi-GAN-Prosody Modeling and Control-Multilingual and Zero-shot TTS-Speech-to-Speech Translation-Conversational AI Systems: Smart Assistants, Voicebots-Evaluation Metrics for TTS: MOS, MCD		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Demonstrate understanding of modern speech production and processing techniques. (K3)

CO2 Implement advanced time and frequency domain features for speech applications. (K3)

CO3 Utilize deep learning and self-supervised models for speech representation. (K3)

CO4 Design and develop an end-to-end ASR system using state-of-the-art models. (K6)

CO5 Build a neural TTS system and evaluate its naturalness and intelligibility. (K3)

TEXT BOOKS

1. L R Rabiner, R W Schafer, "Digital Processing of Speech Signals", Pearson Education, Delhi, India, 2004. (Unit 1,2,3)
2. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd Edition Draft, Online: <https://web.stanford.edu/~jurafsky/slp3/> (Unit 4,5)
3. Dong Yu and Li Deng, "Deep Learning for Speech and Language Processing", Springer, 2015. (Unit 5)

REFERENCE BOOKS

1. Christopher M. Bishop, "Neural Networks for Pattern Recognition", Oxford University Press, 1995.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
3. Thierry Dutoit, Heiga Zen (Eds.), "Text-to-Speech Synthesis: New Paradigms and Advances", Springer, 2021.
4. Dong Yu and Michael Seltzer, "Automatic Speech Recognition: A Deep Learning Approach", SpringerBriefs, 2014.
5. Research and Open-Source Resources
 - OpenAI Whisper Documentation
 - Hugging Face Transformers & Datasets
 - ESPnet & NeMo Frameworks
 - Tacotron2, FastSpeech, HiFi-GAN official repositories

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3							2	
CO2	3				3							2	
CO3	3				3							2	
CO4	3	3			3							2	2
CO5	3	3	3	3	3			3	2	3	2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3630	GAME THEORY	45	0	0	45	90	3

OBJECTIVES

- Introduce the fundamental concepts of strategic and non-cooperative games.
- Understand rational choice, strategy formulation, and equilibrium analysis.
- Develop the ability to analyze games with perfect and imperfect information.
- Explore computational approaches to finding equilibria in multi-agent settings.
- Apply mechanism design principles to real-world systems such as auctions and online platforms.

UNIT I	INTRODUCTION TO GAME THEORY	9
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Introduction – Rational decision making and strategic interaction – Preferences and payoffs – Representation of games: strategic and extensive forms – Cooperative and non-cooperative games – Pure and mixed strategies – Dominant strategies and rational choice – Basic computational issues in finding equilibria – Applications: Google Ads auctions, eBay, and electricity trading markets.

UNIT II	STATIC GAMES WITH PERFECT INFORMATION	9
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Definition of static (strategic) games – Best-response and dominance – Nash equilibrium: definition, examples, and existence – Mixed strategy equilibria – Zero-sum games and minimax theorem – Prisoner's Dilemma, Battle of the Sexes, Matching Pennies – Oligopoly models: Cournot and Bertrand competition – Auctions and bidding strategies – Repeated games and subgame perfect equilibrium – Computational aspects of equilibrium finding.

UNIT III	GAMES WITH IMPERFECT INFORMATION	9
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Games with incomplete information – Bayesian games: motivation, formal definitions, and examples – Beliefs and consistency – Sequential equilibrium – Signaling and screening – Extensive games with imperfect information – Repeated interactions under uncertainty – Bargaining and negotiation – Applications in economics and distributed systems.

UNIT IV	NON-COOPERATIVE GAME THEORY	9
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Self-interested agents and normal-form games – Identifying dominated strategies – From optimality to equilibrium – Existence and computation of Nash equilibria in two-player zero-sum and general-sum games – Learning in games and evolutionary dynamics – Convergence properties – Algorithmic approaches for equilibrium computation.

UNIT V	MECHANISM DESIGN AND APPLICATIONS	9
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Social choice and aggregation of preferences – Voting systems and ranking mechanisms – Incentive compatibility and mechanism design principles – Vickrey and Vickrey-Clarke-Groves (VCG) mechanisms – Combinatorial auctions and profit maximization – Mechanism design under unrestricted preferences – Computational applications: shortest paths, online marketplaces, and multi-armed bandits – Case studies: Google's sponsored search and eBay auctions.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the notion of strategic games, equilibria, and identify the characteristics of main applications of these concepts. (K2)

CO2 Analyze and predict rational outcomes in various scenarios using Nash Equilibrium. (K4)

CO3 Examine key strategic aspects of real-world systems and map them to appropriate game-theoretic concepts. (K4)

CO4 Analyze games with incomplete information and evaluate the role of beliefs and Bayesian equilibrium. (K4)

CO5 Create incentive-compatible mechanisms and evaluate their performance in computational applications. (K6)

TEXT BOOKS

1. M. J. Osborne, *An Introduction to Game Theory*, Oxford University Press, 2012. (All Units)

REFERENCE BOOKS

1. Y. Narahari, *Game Theory and Mechanism Design*, IISc Press & World Scientific, 2015.
2. Steven Tadelis, *Game Theory: An Introduction*, Princeton University Press, 2013.
3. Yoav Shoham and Kevin Leyton-Brown, *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*, Cambridge University Press, 2008.
4. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar, and Hjongungh, *Game Theory in Wireless and Communication Networks*, Cambridge University Press, 2012.
5. Anna R. Karlin and Yuval Peres, *Game Theory Alive*, AMS, 2016.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										3	
CO2	3		2									2	
CO3		3	3									3	
CO4	2	3		3					3		3	3	
CO5	3	2	3			2		2	3		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3631	INFORMATION SECURITY	45	0	0	45	90	3

OBJECTIVES

- To know the various forms of attacks
- To understand the risk management and framing of various security models.
- To learn, to protect using physical secure design and cryptographic techniques
- To know the standard algorithms used to provide authentication and authorization
- To understand real world security protocols

UNIT I	INFORMATION SYSTEMS & SOFTWARE ATTACKS	9
Introduction to Information Systems - Trustworthiness of information systems - Security and Access -Security SDLC - Ethical and Professional Issues - Use of Malware - Virus-Worm - Trojan Horse - Logic Bomb - Rootkit - Spyware - Adware – Password Cracking - DoS and DDoS - Spoofing - Sniffing - Man-in-Middle Attack - Phishing - Pharming		

UNIT II	RISK MANAGEMENT AND SECURITY MODELS	9
Importance of risk Management - Integration of Risk Management in SDLC - Risk Assessment –System Characterizations - Threat Identification - Vulnerability Identification - Control Analysis - Impact Analysis - Risk Determination - Risk Level Matrix - Control Recommendations - Bell-LaPadula model - Biba model - Clark-Wilson model - Information flow model – Noninterference model - Brewer and Nash model - Graham-Denning model - Harrison-Ruzzo-Ullman model.		

UNIT III	NETWORK SECURITY	9
Security Technology - Digital certificate - Digital Signatures - Firewall – Firewall Configuration Strategies - Packet Filtering– IDS -Cryptography and Network Security - Symmetric Key Encipherment - Asymmetric Key- Encipherment - Integrity, Authentication, and Key Management		

UNIT IV	AUTHENTICATION & AUTHORIZATION	9
Introduction – Authentication methods – Passwords – Key versus Password – Attacking systems via passwords – Password verification – Biometrics – types of error – Biometric error rates – Introduction – Access control matrix – Compartments – Covert Channel – Inference Control – CAPTCHA		

UNIT V	CERTIFICATION, ACCREDITATION, AND SECURITY ASSESSMENTS & PROTOCOLS	9
Certification, Accreditation, and Security Assessments Roles and Responsibilities - Delegation of Roles - The Security Certification and Accreditation Process - Security Certification Documentation Accreditation Decisions - Continuous Monitoring - Introduction – SSH – SSL -IPSec – Kerbose – WEP		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain software security development life cycle, list of attacks in Network, Host and Information and describe the consequences of the attack (K2)

CO2 Identify risks in each activity and describe the impact of risk. Apply security models and suggest best model for the given risk (K3)

CO3 Apply various approaches of intrusion detection systems for network security (K3)

CO4 Evaluate and integrate authentication and authorization techniques to design a secure access control framework. (K5)

CO5 Identify security assessments and protocols for the management activities in an organization (K3)

TEXT BOOKS

1. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill Education, Third Edition, 2015. (Unit III)
2. Information Security Handbook: A Guide for Managers, National Institute of Standards and Technology, 2006. (Unit I, II, V)
3. Mark Stamp, "Information Security: Principles and Practice", John Wiley & Sons, Third Edition, 2021. (Unit IV)

REFERENCE BOOKS

1. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", Cengage Learning, 7th Edition, 2021
2. Jason Andress, "Foundations of Information Security: A Straightforward Introduction", No Starch Press, 2019
3. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning, 3rd Edition, 2016
4. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson, 8th Edition, 2017

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2		2	2									2	2
CO3	3											2	2
CO4												2	2
CO5						2						2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3632	CLOUD SECURITY AND DATA PRIVACY	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of privacy and microdata.
- To understand static data anonymization on multidimensional data.
- To understand static data anonymization on complex data structures.
- To understand the threat to Static Data Anonymization and need for dynamic data protection.
- To utilize risk assessment methods.

UNIT I	INTRODUCTION	9
Data Privacy and its importance - Need for Sharing Data - Methods of Protecting Data – Importance of Balancing Data Privacy and Utility; Disclosure - Tabular Data - Micro data Approaches to Statistical disclosure control; Microdata concepts – Disclosure risk - Estimating re-identification risk - Microdata masking - Perturbative microdata masking - Information loss in microdata.		
UNIT II	STATIC DATA ANONYMIZATION ON MULTIDIMENSIONAL DATA	9
Classification of Privacy Preserving Methods - Classification of Data in a Multidimensional Data Set - Group-Based Anonymization - k-Anonymity - l-Diversity - t-closeness.		
UNIT III	STATIC DATA ANONYMIZATION ON COMPLEX DATA STRUCTURES	9
Privacy Preserving Graph Data - Privacy Preserving Time Series Data - Time Series Data Protection Methods - Privacy Preservation of Longitudinal Data - Privacy Preservation of Transaction Data.		
UNIT IV	THREATS AND DATA PROTECTION	9
Threats to Data Structures - Threats by Anonymization Techniques; Tokenization – Understanding Tokenization - Use Cases for Dynamic Data Protection - Benefits of Tokenization Compared to Other Methods - Components for Tokenization.		
UNIT V	RISK AND TRUST ASSESMENT	9
Risk Analysis, Assessment and Management – Top threats for the Cloud – Cloud risk assessment – Risk and Trust models – Managing risk in the Cloud – Cloud security risk management – Risk mitigation methods		
TOTAL PERIODS		90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Summarize the fundamentals of data privacy, microdata, disclosure risks, and basic masking techniques. (K2)

CO2 Apply static anonymization techniques like k-anonymity, l-diversity, and t-closeness on multidimensional datasets. (K3)

CO3 Analyze anonymization strategies used for complex data structures including graphs, Time series, and transaction data. (K4)

CO4 Apply dynamic data protection techniques such as tokenization to mitigate anonymization threats. (K3)

CO5 Apply risk and trust assessment methods for solving Cloud security problems (K3)

TEXT BOOKS

1. Venkataramanan and A. Shriram, "Data privacy: Principles and practice". CRC Press, 2016. ISBN: 978-1-49-872104-2 (Units 1-4)

2. John R Vacca, "Cloud Computing Security: Foundations and Challenges", Second Edition, CRC Press, 2020. ISBN: 9780429055126 (Unit 5)

REFERENCE BOOKS

1. G. T. Duncan, M. Elliot, J.-J. Salazar-González, J.-J. Salazar-Gonzalez, and J. J. Salazar, "Statistical confidentiality: Principles and practice", Springer-Verlag New York, 2011. ISBN: 978-1-44-197801-1

2. C. C. Aggarwal and P. S. Yu, "Privacy-preserving data mining: Models and Algorithms", Springer-Verlag New York, 2008. (ISBN No.: 978-0-387-70992-5)

3. A. Hundepool, J. Domingo-Ferrer, L. Franconi, S. Giessing, and E. S. Nordholt, P.D. Wolf, "Statistical disclosure control", Wiley, John & Sons, 2012. ISBN No.: 978-1-11-997815-2

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	2	2	3								2	
CO3	3			3								3	
CO4			2										3
CO5				3									3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3633	SOFTWARE TESTING	45	0	0	45	90	3

OBJECTIVES

- Understand principles, goals, and processes of software testing, and the role of testing across SDLC.
- Apply black-box and white-box techniques to design systematic test suites with measurable adequacy.
- Engineer test automation, CI, and performance testing assets aligned with maintainability and reliability.
- Evaluate non-functional qualities (performance, reliability, security) and testing strategies for modern architecture.
- Adopt evidence-driven practices, metrics, and reporting to support high-quality releases.

UNIT I	FUNDAMENTALS OF SOFTWARE TESTING	9
Testing principles - Quality attributes - Error/fault/failure - Verification vs. Validation; SDLC models: V-model; Agile/DevOps view of testing - Test process & documentation - Test planning: Scope – Strategy - Risk-based testing - Test policy - Master test plan - Test case design basics and traceability to requirements; Defect lifecycle & severity/priority.		

UNIT II	BLACK-BOX (SPECIFICATION-BASED) TEST DESIGN	9
Equivalence partitioning and boundary value analysis; Robust & Worst-case BVA - Decision tables and cause-effect graphs; Combinatorial testing (pairwise) - State transition testing and Use-case/scenario testing - Requirements-based testing and Test oracles; Mutation of specifications.		

UNIT III	WHITE BOX AND STRUCTURAL TESTING	9
Control flow graphs; Statement, Branch/decision, Condition/MC/DC coverage - Data flow testing (du-paths), Slice-based testing; Path selection strategies - Mutation testing concepts and operators; Adequacy and Cost trade-offs - Unit testing patterns; Test doubles and seams; Code smells & Refactoring triggers.		

UNIT IV	NON-FUNCTIONAL TESTING AND AUTOMATION ENGINEERING	9
Performance: Load, Stress, Endurance; SLAs & SLOs; Workload modeling; Metrics and Interpretation - Security testing fundamentals (Input validation, Injection, Fuzzing basics) - Automation architecture: Layered test Frameworks, Fixtures, Data-driven & Keyword-driven testing - CI/CD integration: Versioning, Pipelines, Flaky-test management, Test impact analysis.		

UNIT V	MODERN TOPICS: DEVOPS, MICROSERVICES & AI-ADJACENT TESTING	9
TDD/BDD workflows; property-based testing; contract testing for microservices - Testability for legacy systems; characterization tests; dependency-breaking techniques - Observability & reliability: SLO-driven testing, chaos testing basics, canary & A/B		

validations - Test metrics, dashboards, defect analytics; economics of testing & technical debt.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain goals of testing, fault/defect taxonomy, and the test process. (K2)

CO2 Analyze black-box and white-box test cases with justification and adequacy measures. (K4)

CO3 Build and evaluate automation frameworks and integrate tests into CI pipelines. (K5)

CO4 Analyze performance, security, and reliability tests with appropriate tools. (K4)

CO5 Use metrics and defect analytics to analyze processes. (K4)

TEXT BOOKS

1. Paul Ammann & Jeff Offutt, "Introduction to Software Testing", 2nd Edition, Cambridge University Press, 2016. (Unit II, & III)
2. Srinivasan Desikan & Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson., 2007. (Unit I, IV & V)

REFERENCE BOOKS

1. Dorothy Graham, Erik van Veenendaal, & Isabel Evans, Foundations of Software Testing (ISTQB), 4th Edition, Cengage, 2020.
2. Ron Patton, "Software Testing", 2nd Edition., Pearson, 2005.
3. Glenford J. Myers, Corey Sandler, & Tom Badgett, "The Art of Software Testing", 3rd Edition, Wiley, 2011.
4. Gerard Meszaros, "xUnit Test Patterns: Refactoring Test Code", Addison-Wesley, 2010.
5. Jez Humble & David Farley, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation", 1st Edition, Addison-Wesley, 2010.
6. Michael Feathers, "Working Effectively with Legacy Code", Pearson, 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		1								
CO2	3	2											3
CO3	3	3		3					3		3		3
CO4	3	2											3
CO5	3	3		3					3		3		3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3634	CYBER CRIME AND LAWS	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamental concepts and terminology related to cybercrime and laws, including cyber threats, hacking, data breaches, and legal frameworks.
- To explore the various types of cybercrime prevalent in today's digital landscape, such as identity theft, cyber fraud, online harassment, and intellectual property violations.
- To analyze the legal and ethical implications of cybercrime and develop an awareness of the laws, regulations, and international treaties governing cybersecurity and privacy.
- To learn how cyber forensics is used in cybercrime investigations.

UNIT I	INTRODUCTION TO CYBERCRIME	9
Cybercrime and Information Security - Classification of Cybercrimes-Cyberoffness-Social Engineering-Cyberstalking-Botnets for Cybercrime-Mobile and Wireless Devices-Authentication Service Security-Organizational Security Policies and Measures in Mobile Devices.		

UNIT II	TOOLS AND METHODS IN CYBERCRIME	9
Proxy Servers and Anonymizers-Phishing-Password Cracking-Keyloggers and Spywares-DoS and DDoS Attacks-SQL Injection-Buffer Overflow-Attacks on Wireless Networks-Types of Phishing Scams-Identity Theft		

UNIT III	CYBERCRIME AND CYBERSECURITY	9
Cybercrime and the Legal Landscape Around the World-The Indian IT Act and Challenges-Digital Signatures- Amendments to the Indian IT Act-Cybercrime and Punishment-Cyberlaw, Technology, and Students: Indian Scenario- Cyberforensics:Digital Forensics and Network Forensics-Computer Forensics Investigation and Compliances-Special Tools and Techniques		

UNIT IV	CYBERSECURITY: ORGANIZATIONAL IMPLICATIONS	9
Insider Attacks-Cost of Cybercrimes and IPR Issues-Security and Privacy Implications-Social Media Marketing: Security Risks, Incident Handling-Forensics Best Practices for Organizations- Intellectual Property in the Cyberspace-Sociology of Cybercriminals-Information Warfare		

UNIT V	CYBERCRIME:ILLUSTRATIONS, MINI-CASES	9
Real-Life Examples-Mini-Cases-Illustrations of Financial Frauds in Cyber Domain-Online Scams-IT Security Organization-Career Paths in Cybersecurity-Assurance and Compliance Security Audit-Cybercrime Investigations and Litigation-Certifications and Classifications		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Demonstrate a comprehensive understanding of cybercrime and related laws, including the ability to identify and differentiate between various types of cyber offenses. (K2)
CO2 Apply critical thinking skills to evaluate real-life cybercrime cases, assess legal consequences, and propose preventive measures to mitigate cyber threats. (K3)
CO3 Develop ethical awareness and responsible digital citizenship by adhering to legal and ethical principles while engaging in online activities and promoting cyber security best practices. (K3)
CO4 Develop skills on cybersecurity organizational implications and its best practices and also to learn intellectual property for cyberspace. (K3)
CO5 Apply cybercrime tools and techniques skills on various real-life examples and learn cybersecurity assurance and compliance security audit.(K3)

TEXT BOOKS
1. "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives" by Nina Godbole, Sunit Belapure, Wiley, 2018 edition. (Unit 4,5)
2. "Cyber Crimes and Laws: An Introduction" by Dr. Pavan Duggal, Publisher: Universal Law Publishing, 2022 edition. (Unit 1-3)

REFERENCE BOOKS
1. Michael E. Whitman, Herbert J. Mattord, (2018). Principles of Information Security, 6th edition, Cengage Learning, N. Delhi.
2. "Cyber Laws: A Comprehensive Guide" by Rohas Nagpal , Publisher: McGraw Hill Education , 2020 edition.
3. "Cyber Crime and the Law: Challenges, Issues, and Response" by Yogesh K. Dwivedi, Himanshu Gupta, and Matthew K. O. Lee , Publisher: Springer India , 2019 edition.
4. Van Kessel, P. Is cyber security about more than protection? EY Global Information Security Survey 2018-2019.
5. Subramanian R. Security, privacy and politics in India: a historical review. Journal of Information Systems Security (JISec), 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3				2	3					3	
CO2		3	3	2		3	2				2	3	
CO3						3	3		2			3	
CO4		2	3	3	3	3				2		3	2
CO5		2	3	3	3	3				3		3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3667	LLM AND GENERATIVE AI	30	0	30	30	90	3

OBJECTIVES

- To provide a comprehensive understanding of the fundamental principles and architectures of Large Language Models (LLMs) and Generative AI.
- To equip students with the theoretical knowledge and practical skills to design, implement, and evaluate various generative models, including LLMs.
- To explore the applications of LLMs and Generative AI across diverse domains and understand their societal impact.
- To critically analyze the ethical considerations, challenges, and limitations associated with LLMs and Generative AI technologies.
- To foster research aptitude and prepare students for advanced studies or industry roles in the rapidly evolving field of Generative AI.

UNIT I	LLMs AND TRANSFORMERS	6
Overview of Natural Language Processing – Emergence of Large Language Models – Sequence Modeling Challenges – Transformer Architecture: Self-Attention Mechanism – Positional Encoding – Encoder-Decoder Structure – Comparison with RNNs and CNNs – Tokenization and Vocabulary – Pretraining Objectives: Masked Language Modeling, Causal Language Modeling – BERT vs. GPT Paradigms.		

UNIT II	TRAINING AND FINE-TUNING LLMs	6
Data Preparation for LLMs – Transfer Learning in NLP – Pretraining vs. Fine-tuning – Prompt Engineering Basics – In-context Learning – Instruction Tuning – RLHF (Reinforcement Learning with Human Feedback) – Evaluation Metrics: BLEU, ROUGE, Perplexity – Safety, Bias, and Fairness Considerations – Few-shot and Zero-shot Capabilities.		

UNIT III	GENERATIVE AI MODELS AND APPLICATIONS	6
Generative Adversarial Networks (GANs) – Variational Autoencoders (VAEs) – Diffusion Models – Text Generation using LLMs – Image Generation using Generative AI – Cross-modal Generation (Text-to-Image, Image-to-Text) – Multimodal AI Models – Applications: Chatbots, Code Generation, Text Summarization, Style Transfer.		

UNIT IV	DEPLOYMENT & SCALING OF LLMs	6
Model Compression Techniques – Quantization and Pruning – Knowledge Distillation – Efficient LLMs: DistilBERT, LLaMA, Mistral – Serving Large Models with Transformers and TensorRT – GPU and TPU Considerations – Cost Optimization – Latency vs. Accuracy Trade-offs – Cloud-based Deployment (AWS, GCP, Azure) – Inference Pipelines.		

UNIT V	ETHICS, ALIGNMENT & FUTURE TRENDS	6
AI Alignment and Human Preferences – Hallucination in LLMs – Guardrails and Content Filtering – Copyright and IP Challenges – Open Source vs. Proprietary Models – Role of LLMs in Education, Healthcare, Business – Autonomous Agents and Tool Use – Federated Learning for LLMs – OpenAI GPT, Google Gemini, Meta LLaMA, Claude – The Path Towards AGI.		

SUGGESTED EXPERIMENTS	
• Load a pre-trained transformer model and generate contextual embeddings for sample sentences. • 2.Fine-tune a BERT model on a sentiment classification dataset using Hugging Face Transformers. • 3.Implement prompt engineering techniques for text summarization and question answering. • 4.Generate synthetic text using a causal language model like GPT-2 on a custom prompt. • 5.Build a simple chatbot using a local LLM or OpenAI API to simulate human conversation. • 6.Train a Variational Autoencoder (VAE) to reconstruct and generate handwritten digits (MNIST). • 7.Generate realistic images using a basic Generative Adversarial Network (GAN) model. • 8.Evaluate the ethical implications of generated outputs by identifying bias and hallucinations in LLM responses.	

TOTAL PERIODS	90
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COURSE OUTCOMES	
On successful completion of this course, students will be able to	
CO1 Explain the architecture and functioning of transformer-based models and the evolution of Large Language Models. (K2)	
CO2 Apply fine-tuning techniques, prompt engineering, and evaluation strategies to optimize performance of LLMs for specific NLP tasks. (K3)	
CO3 Compare the working of generative AI models such as GANs, VAEs, and diffusion models for text and image generation. (K5)	
CO4 Identify the deployment challenges of LLMs in production environments with a focus on performance, scalability, and cost-efficiency. (K3)	
CO5 Identify the ethical, legal, and societal implications of deploying generative AI systems and explore current trends and future directions. (K3)	

TEXT BOOKS	
1. Sinan Ozdemir , “Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs”, Addison-Wesley Professional, 2023 (Units I, II, V)	
2. Alger Fraley , “The Artificial Intelligence and Generative AI Bible: [5 in 1] The Most Updated and Complete Guide”, Author's Republic, 2024 (Units III, IV, V)	

REFERENCE BOOKS	
1. Edward Y. Chang, “Unlocking the Wisdom of Large Language Models: An Introduction to The Path to Artificial General Intelligence”, SocraSynth, 2024. (Unit V)	
2. Ray Islam, “Generative AI, Cybersecurity, and Ethics”, John Wiley & Sons, 2024.(Unit V)	
3. Chris Fregly, Antje Barth, and Shelbee Eigenbrode, “Generative AI on AWS”, O’Reilly, 2023. (Unit IV)	
4. Ben Auffarth, “Generative AI with LangChain”, O’Reilly, 2023. (Units III, IV)	

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	3	3									3	2
CO3	3	3	3	3	3			3	3		2	3	2
CO4	3	3	3									3	2
CO5	3	3										3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3635	DATA WAREHOUSE TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- Explore the fundamental concepts, architecture, and characteristics of data warehouses.
- Analyze ETL processes, OLAP technologies, and their role in data-driven decision-making.
- Design effective data models using dimensional modeling, star and snowflake schemas.
- Evaluate metadata management, data marts, and partitioning strategies for performance optimization.
- Implement system and process management techniques for efficient data warehouse operation and maintenance.

UNIT I	INTRODUCTION TO DATA WAREHOUSE	9
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Data warehouse Introduction – The need for Data Warehousing – Paradigm Shift- Data Warehouse Characteristics- Data Warehouse Architecture: Environment, Data Warehouse and Operational Data Stores- Two Tier architecture and multitiered architecture- Data Warehouse Database- Sourcing, Acquisition, Cleanup, Transformation Tools - Access tools

UNIT II	ETL AND OLAP TECHNOLOGY	9
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Building a Data Warehouse- Design Considerations- Implementation Considerations: Access Tools, ETL, Data Replacement strategies- Data warehouse Design and Modeling – Delivery Process – Online Analytical Processing (OLAP) – Characteristics of OLAP – Online Transaction Processing (OLTP) Vs OLAP – OLAP operations- Types of OLAP- ROLAP Vs MOLAP Vs HOLAP.

UNIT III	META DATA, DATA MART AND PARTITION STRATEGY	9
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Data Warehousing Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Challenges for Meta Management – Data Mart – Need of Data Mart- Cost Effective Data Mart- Designing Data Marts- Cost of Data Marts- Partitioning Strategy – Vertical partition – Normalization – Row Splitting – Horizontal Partition

UNIT IV	DIMENSIONAL MODELING AND SCHEMA	9
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Dimensional Modeling- Multi-Dimensional Data Modeling – Data Cube- Star Schema- Snowflake schema- Star Vs Snowflake schema- Fact constellation Schema- Schema Definition – Process Architecture- Types of Data Base Parallelism – Datawarehouse Tools

UNIT V	SYSTEM & PROCESS MANAGERS	9
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Data Warehousing System Managers: System Configuration Manager- System Scheduling Manager – System Event Manager – System Database Manager – System Backup Recovery Manager – Data Warehousing Process Managers: Load Manager – Warehouse Manager- Query Manager – Tuning – Testing

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental concepts, characteristics, and need for data warehousing in modern business environments. (K2)

CO2 Develop data warehouse models and delivery processes suitable for analytical applications. (K3)

CO3 Apply the concept of metadata to organize and manage data within a data warehouse environment. (K3)

CO4 Analyze the principles of multidimensional data modelling used in data warehouse design. (K4)

CO5 Apply tuning and testing techniques to enhance the performance and reliability of the data warehouse system. (K3)

TEXT BOOKS

1. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008. (Units I to III)
2. C.S.R. Prabhu Data Warehousing: Concepts, Techniques, Products and Applications, 3rd edition, PHI, (Unit IV & V)

REFERENCE BOOKS

1. Ralph Kimball, “The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling”, Third edition, Wiley Computer Publishing, 2013
2. Paul Raj Ponniah, “Data warehousing fundamentals for IT Professionals”, A John Wiley & Sons, Inc. Publication, 2012.
3. K.P. Soman, ShyamDiwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2										2	
CO3		3										2	
CO4	3	3		3	2				3				2
CO5	3	3										2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3635	DATA WAREHOUSE TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- Explore the fundamental concepts, architecture, and characteristics of data warehouses.
- Analyze ETL processes, OLAP technologies, and their role in data-driven decision-making.
- Design effective data models using dimensional modeling, star and snowflake schemas.
- Evaluate metadata management, data marts, and partitioning strategies for performance optimization.
- Implement system and process management techniques for efficient data warehouse operation and maintenance.

UNIT I	INTRODUCTION TO DATA WAREHOUSE	9
Data warehouse Introduction – The need for Data Warehousing – Paradigm Shift- Data Warehouse Characteristics- Data Warehouse Architecture: Environment, Data Warehouse and Operational Data Stores- Two Tier architecture and multitiered architecture- Data Warehouse Database- Sourcing, Acquisition, Cleanup, Transformation Tools - Access tools		

UNIT II	ETL AND OLAP TECHNOLOGY	9
Building a Data Warehouse- Design Considerations- Implementation Considerations: Access Tools, ETL, Data Replacement strategies- Data warehouse Design and Modeling – Delivery Process – Online Analytical Processing (OLAP) – Characteristics of OLAP – Online Transaction Processing (OLTP) Vs OLAP – OLAP operations- Types of OLAP- ROLAP Vs MOLAP Vs HOLAP.		

UNIT III	META DATA, DATA MART AND PARTITION STRATEGY	9
Data Warehousing Meta Data – Categories of Metadata – Role of Metadata – Metadata Repository – Challenges for Meta Management – Data Mart – Need of Data Mart- Cost Effective Data Mart- Designing Data Marts- Cost of Data Marts- Partitioning Strategy – Vertical partition – Normalization – Row Splitting – Horizontal Partition		

UNIT IV	DIMENSIONAL MODELING AND SCHEMA	9
Dimensional Modeling- Multi-Dimensional Data Modeling – Data Cube- Star Schema- Snowflake schema- Star Vs Snowflake schema- Fact constellation Schema- Schema Definition – Process Architecture- Types of Data Base Parallelism – Datawarehouse Tools		

UNIT V	SYSTEM & PROCESS MANAGERS	9
Data Warehousing System Managers: System Configuration Manager- System Scheduling Manager – System Event Manager – System Database Manager – System Backup Recovery Manager – Data Warehousing Process Managers: Load Manager – Warehouse Manager- Query Manager – Tuning – Testing		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental concepts, characteristics, and need for data warehousing in modern business environments. (K2)

CO2 Develop data warehouse models and delivery processes suitable for analytical applications. (K3)

CO3 Apply the concept of metadata to organize and manage data within a data warehouse environment. (K3)

CO4 Analyze the principles of multidimensional data modelling used in data warehouse design. (K4)

CO5 Apply tuning and testing techniques to enhance the performance and reliability of the data warehouse system. (K3)

TEXT BOOKS

1. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008. (Units I to III)

2. C.S.R. Prabhu Data Warehousing: Concepts, Techniques, Products and Applications, 3rd edition, PHI, (Unit IV & V)

REFERENCE BOOKS

1. Ralph Kimball, “The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling”, Third edition, Wiley Computer Publishing, 2013

2. Paul Raj Ponniah, “Data warehousing fundamentals for IT Professionals”, A John Wiley & Sons, Inc. Publication, 2012.

3. K.P. Soman, ShyamDiwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2										2	
CO3		3										2	
CO4	3	3		3	2				3				2
CO5	3	3										2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3636	HEALTHCARE DATA ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- Discuss the role of basic and advanced data analytics in healthcare systems
- Describe the statistical and computational methods and techniques used for data analytics in EHR, Image and Sensor data
- Describe the statistical and computational methods and techniques used for data analytics in Signal, Genome and Text Data
- Describe the Advanced Data Analytics techniques used to analyze and interpret healthcare data effectively in Healthcare Organizations
- Identify techniques to communicate insights gained from data analysis in Healthcare Applications

UNIT I	INTRODUCTION TO HEALTHCARE DATA ANALYTICS	9
Introduction – Healthcare Data Sources and Basic Analytics – Advanced Data Analytics for Healthcare – Applications and Practical Systems for Healthcare – Resources for Healthcare Data Analytics		

UNIT II	HEALTHCARE DATA SOURCES	9
Electronic Health Records: A Survey: Components of EHR – Coding Systems – Challenges of Using EHR Data – Phenotyping Algorithms; Biomedical Image Analysis: Biomedical Imaging Modalities – Object Detection – Image Segmentation – Image Registration – Feature Extraction; Mining of Sensor Data in Healthcare: A Survey: Mining Sensor Data in Medical Informatics: Scope and Challenges – Challenges in Healthcare Data Analysis – Sensor Data Mining Applications – Nonclinical Healthcare Applications.		

UNIT III	BIOMEDICAL AND CLINICAL DATA ANALYSIS TECHNIQUES	9
Biomedical Signal Analysis: ECG Signal Analysis – Denoising of Signals – Multivariate Biomedical Signal Analysis – Cross-Correlation Analysis; Genomic Data Analysis: Genomic Data Generation – Methods and Standards for Genomic Data Analysis; Natural Language Processing and Data Mining for Clinical Text: Mining Information from Clinical Text – Challenges of Processing Clinical Reports – Clinical Applications: EHR and Decision Support.		

UNIT IV	ADVANCED DATA ANALYTICS FOR HEALTHCARE	9
A Review of Clinical Prediction Models: Basic Statistical Prediction Models – Alternative Clinical Prediction Models – Survival Models – Evaluation and Validation; Temporal Data Mining for Healthcare Data: Association Analysis – Temporal Pattern Mining – Sensor Data Analysis – Other Temporal Modeling Methods; Visual Analytics for Healthcare: Introduction to Visual Analytics and Medical Data Visualization – Visual Analytics in Healthcare; Predictive Models for Integrating Clinical and Genomic Data: Issues and Challenges in Integrating Clinical and Genomic Data – Different Types of Integration – Different Goals of Integrative Studies – Validation.		

UNIT V	APPLICATIONS AND PRACTICAL SYSTEMS FOR HEALTHCARE	9
Fraud Detection in Healthcare: Definition and Types of Healthcare Fraud – Identifying Health-care Fraud from Data – Knowledge Discovery-Based Solutions for Identifying Fraud; Data Analytics for Pharmaceutical Discoveries: Introduction – Chemical and Biological Data – Spontaneous Reporting Systems (SRSs); Clinical Decision Support Systems: Various Types of CDSS, Diagnostic Decision Support.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the basic and advanced data analytics in public health (K2)
CO2 Apply and analyze patient data from EHR, Image and Sensor Data into data models using analytics tools (K4)
CO3 Apply and analyze patient data from multiple sources (Signal, Genome and Text Data) into data models using analytics tools (K4)
CO4 Apply meaningful patterns and trends in advanced data analytics systems (K3)
CO5 Apply descriptive and inferential methodologies according to the type of study design in Healthcare practical systems (K3)

TEXT BOOKS
1. Chandan K. Reddy and Charu C. Aggarwal, "Healthcare Data Analytics", CRC Press, Taylor & Francis Group, LLC., 2015 (Unit I, II)
2. Vikas, "Healthcare Analytics Made Simple: Techniques in Healthcare Computing using Machine Learning", PACKT publishers, 2018 (Unit III)

REFERENCE BOOKS
1. Trevor L. Strome, "Healthcare Analytics for Quality and Performance Improvement", John Wiley & Sons, 2013
2. Sergio Consoli, Diego Reforgiato Recupero and Milan Petkovi, "Data Science for Health-care Methodologies and Applications", Springer Nature Switzerland AG., 2019 (Unit IV, V)
3. Joseph M. Woodside, "Applied Health Analytics and Informatics Using SAS", SAS Institute, O'Reilly, 2018

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2										2	
CO3	3	2									2	3	
CO4	3	2	2									3	
CO5	3	2	2									3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3637	BAYESIAN DATA ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- Understand the core principles of Bayesian inference, including priors, likelihood, and posteriors.
- Apply Bayesian methods to estimate parameters in single, multiparameter, and hierarchical models.
- Implement basic and advanced Markov Chain Monte Carlo (MCMC) algorithms for posterior computation.
- Analyze and evaluate the efficiency of different Bayesian computational methods, including variational inference.
- Use Gaussian and Dirichlet process models for regression, density estimation, and hierarchical modeling.

UNIT I	INTRODUCTION TO BAYESIAN INFERENCE	9
Overview of Bayesian Statistics – General notation for statistical inference – Bayesian Inference – Priors, Likelihood and Posterior analysis – Some discrete examples using Baye’s rule in R – Probability as a measure of uncertainty - Bayesian inference from Binomial and Multinomial data - Elicitation of prior knowledge from a subject-matter expert. Analytic, discrete approximation, and Monte Carlo posterior calculation methods.		

UNIT II	SINGLE, MULTIPARAMETER AND HIERARCHICAL MODELS	9
Single parametric models: Estimating a probability from binomial data - Summarizing posterior inference-Informative prior distributions- Normal distribution with known variance -Other standard single-parameter models – Noninformative and Weakly informative prior distributions. Multiparameter Models: Introduction to multivariate normal distribution - Multinomial model for categorical data - Multivariate normal model with known variance - Multivariate normal with unknown mean and variance. Hierarchical Models: Exchangeability and hierarchical models - Bayesian analysis of conjugate hierarchical models		

UNIT III	INTRODUCTION TO BAYESIAN COMPUTATION	9
Overview of deterministic and Monte Carlo approximations of posterior distributions. Rejection and importance sampling - An introduction to Markov Chain Monte Carlo and the Metropolis-Hastings algorithm - The Gibbs sampler - MCMC practicalities and advanced techniques.		

UNIT IV	ADVANCED MCMC ALGORITHMS	9
Efficient Gibbs samplers- Efficient Metropolis jumping rules - Hamiltonian Monte Carlo - Applications of Hamiltonian Monte Carlo for logistic regression - Hamiltonian Monte Carlo for a hierarchical model. Modal and distributional approximations: Finding posterior modes - Normal and related mixture approximations - Finding marginal posterior modes using EM -Conditional and marginal posterior approximations - Variational inference – Expectation Propagation		

UNIT V	GAUSSIAN AND DIRICHLET PROCESS MODELS	9
Gaussian process models: Gaussian process regression - Latent Gaussian process models - Functional data analysis - Density estimation and regression. Dirichlet process models: Bayesian histograms -Dirichlet process prior distributions - Dirichlet process mixtures - Beyond density estimation - Hierarchical dependence - Density regression		

TOTAL PERIODS	90
COURSE OUTCOMES	
On successful completion of this course, students will be able to	
CO1 Illustrate the key components of Bayesian inference and demonstrate the application of Bayes' rule in simple discrete examples (K2)	
CO2 Apply Bayesian inference to single parameter, multiparameter and hierarchical models (K3)	
CO3 Apply the Metropolis-Hastings algorithm and Gibbs sampling to sample from posterior distributions (K3)	
CO4 Analyze the efficiency of advanced MCMC techniques in solving complex Bayesian models (K4)	
CO5 Use Gaussian and Dirichlet process models for density estimation (K3)	
CO6 Evaluate societal problems using Bayesian inference adhering to ethical principles in model formulation and prior elicitation, while effectively communicating statistical findings through visualizations and technical reports (K5)	

TEXT BOOKS	
1. Gelman A., Carlin J.B., Stern H.S., Dunson D.B., Vehtari A., Rubin D.B. (2021). <i>Bayesian Data Analysis</i> (3rd ed.). Chapman and Hall/CRC. ISBN 978-1439840955. (Unit 1,2,3,4,5)	
2. Alicia A. Johnson, Miles Q. Ott, Mine Dogucu (2022). <i>Bayes Rules! An Introduction to Applied Bayesian Modeling</i> , Chapman & Hall/CRC Texts in Statistical Science (Unit 2)	
3. Ronald Christensen, Wesley Johnson, Adam Branscum, Timothy E Hanson, (2011). <i>Bayesian Ideas</i>	
4. <i>and Data Analysis: An Introduction for Scientists and Statisticians</i> . Chapman and Hall/CRC. ISBN 978-1439803547 (Unit	
REFERENCE BOOKS	
1. D.S.Sivia , <i>Data Analysis - A Bayesian Tutorial</i> 2 nd Edition (2006), OUP Oxford Carlin B.P., Louis T.A. (2008). <i>Bayesian Methods for Data Analysis</i> (3rd ed.). Chapman and Hall/CRC. ISBN 978-1584886976.	
2. Kruschke, J. K. <i>Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan</i> (2nd ed.). (2015). Academic Press	
2. McElreath, R. <i>Statistical rethinking: A Bayesian course with examples in R and Stan</i> (2nd ed.). (2020). CRC Press.	

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										3	
CO3	3	2										3	
CO4	2		3	3								3	
CO5	3			3								3	
CO6				3	3		3		3			3	3

CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3638	DATA ENGINEERING	45	0	0	45	90	3

OBJECTIVES

- To understand the foundational principles of data engineering, including data modeling, storage architectures, and the data lifecycle.
- To develop robust batch data pipelines using ETL/ELT processes and data warehousing techniques.
- To apply distributed computing frameworks like Apache Spark for processing large-scale datasets.
- To implement real-time data streaming solutions for handling continuous data flows.
- To design and manage scalable data solutions on cloud platforms, incorporating governance and security best practices.

UNIT I	FOUNDATIONS OF DATA ENGINEERING	9
Introduction to Data Engineering: Role, responsibilities, and the data lifecycle. Data Modeling: Entity-Relationship diagrams, normalization, and dimensional modeling (star/snowflake schemas). Data Storage Architectures: Relational Databases (OLTP), Data Warehouses (OLAP), Data Lakes, and Data Lakehouses. Overview of Data Pipelines: Batch vs. Stream processing.		

UNIT II	BATCH PROCESSING AND DATA WAREHOUSING	9
ETL vs. ELT: Patterns, trade-offs, and modern data stack approaches. Data Extraction: Connecting to sources (databases, APIs, files). Data Transformation: Cleaning, enrichment, and structuring data using tools like Python (Pandas) and SQL. Data Loading: Loading data into a data warehouse. Introduction to Data Warehousing: Schema design, partitioning, and performance tuning.		

UNIT III	BIG DATA PROCESSING WITH APACHE SPARK	9
Introduction to Big Data: The 3 V's (Volume, Velocity, Variety) and the need for distributed systems. Apache Hadoop Ecosystem: HDFS and MapReduce (Conceptual Overview). Apache Spark Fundamentals: Architecture, RDDs, DataFrames, and Spark SQL. Performing Data Processing with Spark: Transformations, Actions, and handling structured data. Introduction to Spark Streaming for micro-batch processing.		

UNIT IV	REAL-TIME DATA STREAMING	9
Introduction to Streaming Architectures: Lambda and Kappa architectures. Message Brokers: Role and use cases. Apache Kafka Fundamentals: Topics, Partitions, Producers, and Consumers. Stream Processing Paradigms: At-least-once, at-most-once, and exactly-once semantics. Introduction to Stream Processing Frameworks: Apache Flink and Spark Structured Streaming.		

UNIT V	ORCHESTRATION, CLOUD, AND GOVERNANCE	9
Workflow Orchestration: The need for scheduling and managing complex pipelines. Apache Airflow: Core concepts (DAGs, Operators, Tasks) and writing workflows. Cloud Data Platforms: Overview of AWS (S3, Redshift, Glue), GCP (BigQuery, Dataflow), and Azure (Data Lake, Synapse). Data Governance: Data quality, metadata management, and security. Future Trends: Data Mesh, DataOps, and Serverless data processing.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Illustrate business requirements to design appropriate data models and select suitable storage architectures (K2).
CO2 Develop and implement batch data pipelines using ETL/ELT patterns and data warehousing principles (K3).
CO3 Apply distributed computing frameworks like Apache Spark to process and analyze large-scale datasets (K3).
CO4 Evaluate and implement real-time streaming solutions using technologies like Apache Kafka and stream processing frameworks (K5).
CO5 Evaluate an end-to-end data solution on a cloud platform, incorporating orchestration, governance, and security best practices (K5).

TEXT BOOKS
1. Martin Kleppmann, “Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems”, O'Reilly Media, 1st Edition, 2017. (Units 1, 3, 4)
2. Joe Reis & Matt Housley, “Fundamentals of Data Engineering: From Planning and Prototyping to Deploying and Maintaining Data Pipelines”, O'Reilly Media, 1st Edition, 2022. (Units 1, 2, 5)
3. Bill Chambers & Matei Zaharia, “Spark: The Definitive Guide: Big Data Processing Made Simple”, O'Reilly Media, 1st Edition, 2018. (Units 3, 4)

REFERENCE BOOKS
1. Tyler Akidau, Slava Chernyak, & Reuven Lax, “Streaming Systems: The What, Where, When, and How of Large-Scale Data Processing”, O'Reilly Media, 1st Edition, 2018.
2. Zhamak Dehghani, “Data Mesh: Delivering Data-Driven Value at Scale”, O'Reilly Media, 1st Edition, 2022.
3. O'Reilly Media (Ed.), “97 Things Every Data Engineer Should Know: Collective Wisdom from the Experts”, O'Reilly Media, 1st Edition, 2021.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2	—	—	—	—	—	—	2	—
CO2	3	2	3	2	3	—	—	—	—	—	—	—	3
CO3	3	2	3	2	3	—	—	—	—	—	—	3	—
CO4	2	3	2	3	2	—	—	—	—	—	—	2	—
CO5	3	2	3	2	3	—	—	—	—	—	—	—	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3668	PRINCIPLES OF DEEP LEARNING	30	0	30	30	90	3

OBJECTIVES

- To understand basics of deep neural networks
- To understand CNN and RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn deep learning algorithms and their applications to solve real world problems

UNIT I	DEEP NETWORKS BASICS	6
Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning; Deep Networks: Deep feedforward networks.		

UNIT II	CONVOLUTIONAL NEURAL NETWORKS	6
Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling- - Convolution Variants: Strided - Tiled-- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions - Loss Functions - Regularization - Optimizers - Gradient Computation – CNN through Visualization.		

UNIT III	RECURRENT NEURAL NETWORKS	6
Unfolding Graphs - RNN Design Patterns: Acceptor - Encoder-- Transducer; Gradient Computation - Sequence Modeling Conditioned on Contexts - Bidirectional RNN - Sequence to Sequence RNN – Deep Recurrent Networks - Long Term Dependencies; Leaky Units: Skip connections and dropouts.		

UNIT IV	AUTOENCODERS AND GENERATIVE MODELS	6
Autoencoders: Undercomplete autoencoders - Regularized autoencoders - Stochastic encoders and decoders - Learning with autoencoders; Deep Generative Models: Variational autoencoders -Generative adversarial networks		

UNIT V	TRANSFORMER MODELS AND ETHICAL ASPECTS	6
The Encoder-Decoder Framework - Attention Mechanisms - Hugging Face Transformers – BERT- Interpretability: SHAP, LIME, Grad-CAM- Fairness and Bias in Deep Learning- Explainable AI (XAI).		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the core principles of deep neural networks and their training mechanisms. (K2)
CO2 Apply convolutional and recurrent neural network architectures to solve vision and sequence modeling tasks.(K3)
CO3 Experiment with autoencoders and generative models to learn and generate structured representations of data.(K3)
CO4 Develop and interpret transformer-based models with attention mechanisms and explore ethical concerns in AI.(K3)
CO5 Solve real-world problems and develop deep learning-based solutions using advanced architectures and interpretation techniques.(K6)

TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. (Units 1,2,3,4)
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, “Natural Language Processing with Transformers”, O'Reilly Media, Inc., May 2022. (Unit 5)

REFERENCE BOOKS

1. Seth Weidman. “Deep Learning from Scratch: Building with Python from First Principles”, O'Reilly Media, Inc, September 2019.
2. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, “A Guide to Convolutional Neural Networks for Computer Vision”, Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
3. Yoav Goldberg, “Neural Network Methods for Natural Language Processing”, Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
4. Santanu Pattanayak, “Pro Deep Learning with TensorFlow: A Mathematical Approach to Advanced Artificial Intelligence in Python”, Apress, 2017.
5. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner's Approach” First Edition, O'Reilly Media, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1							3	2
CO2	3	3									2	3	
CO3	3	3	2									3	
CO4	3	2										3	2
CO5	3	2		3	2	2		3	3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3668	PRINCIPLES OF DEEP LEARNING	30	0	30	30	90	3

OBJECTIVES

- To understand basics of deep neural networks
- To understand CNN and RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn deep learning algorithms and their applications to solve real world problems

UNIT I	DEEP NETWORKS BASICS	6
Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning; Deep Networks: Deep feedforward networks.		

UNIT II	CONVOLUTIONAL NEURAL NETWORKS	
Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling- - Convolution Variants: Strided - Tiled-- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions - Loss Functions - Regularization - Optimizers - Gradient Computation – CNN through Visualization.		

UNIT III	RECURRENT NEURAL NETWORKS	6
Unfolding Graphs - RNN Design Patterns: Acceptor - Encoder-- Transducer; Gradient Computation - Sequence Modeling Conditioned on Contexts - Bidirectional RNN - Sequence to Sequence RNN – Deep Recurrent Networks - Long Term Dependencies; Leaky Units: Skip connections and dropouts.		

UNIT IV	AUTOENCODERS AND GENERATIVE MODELS	6
Autoencoders: Undercomplete autoencoders - Regularized autoencoders - Stochastic encoders and decoders - Learning with autoencoders; Deep Generative Models: Variational autoencoders -Generative adversarial networks		

UNIT V	TRANSFORMER MODELS AND ETHICAL ASPECTS	6
The Encoder-Decoder Framework - Attention Mechanisms - Hugging Face Transformers – BERT- Interpretability: SHAP, LIME, Grad-CAM- Fairness and Bias in Deep Learning- Explainable AI (XAI).		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the core principles of deep neural networks and their training mechanisms.(K2)

CO2 Apply convolutional and recurrent neural network architectures to solve vision and sequence modeling tasks.(K3)
CO3 Experiment with autoencoders and generative models to learn and generate structured representations of data.(K3)
CO4 Develop and interpret transformer-based models with attention mechanisms and explore ethical concerns in AI.(K3)
CO5 Solve real-world problems and develop deep learning-based solutions using advanced architectures and interpretation techniques.(K6)

TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. (Units 1,2,3,4)
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, “Natural Language Processing with Transformers”, O'Reilly Media, Inc., May 2022. (Unit 5)

REFERENCE BOOKS

1. Seth Weidman. “Deep Learning from Scratch: Building with Python from First Principles”, O'Reilly Media, Inc, September 2019.
2. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, “A Guide to Convolutional Neural Networks for Computer Vision”, Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
3. Yoav Goldberg, “Neural Network Methods for Natural Language Processing”, Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
4. Santanu Pattanayak, “Pro Deep Learning with TensorFlow: A Mathematical Approach to Advanced Artificial Intelligence in Python”, Apress, 2017.
5. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner's Approach” First Edition, O'Reilly Media, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1							3	2
CO2	3	3									2	3	
CO3	3	3	2									3	
CO4	3	2										3	2
CO5	3	2		3	2	2		3	3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3639	PRINCIPLES OF PATTERN RECOGNITION	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamental concepts of pattern recognition
- To understand and apply Bayesian Decision Theory for classification using continuous and discrete features
- To provide knowledge of parameter estimation techniques
- To familiarize non-parametric pattern recognition methods
- To apply neural network-based and stochastic methods for pattern recognition

UNIT I	INTRODUCTION TO PATTERN RECOGNITION	9
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Machine perception, Pattern recognition systems - Sensing, Segmentation and grouping, Feature extraction - Classification - post processing, The design cycle - Learning and adaptation; Basics of Probability, Random Processes and Linear Algebra: Probability: independence of events, conditional and joint probability.

UNIT II	BAYESIAN DECISION THEORY	9
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Bayes Decision Theory: Continuous features-Two category classification; Minimum-error-rate classification - Classifiers, Discriminant functions, Decision surfaces- Normal density: Univariate- Multivariate - Discriminant functions; Discrete features – Independent binary features – Missing and Noisy features.

UNIT III	PARAMETER ESTIMATION	9
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Maximum-Likelihood estimation: Principle-Gaussian case- Bias; Bayesian Estimation: Class Conditional Densities- Parameter Distribution; Bayesian Parameter Estimation: Gaussian case Recursive Bayes learning – Gibbs algorithm; Problem of Dimensionality - Component Analysis and Discriminants - Expectation Maximization (EM) -Hidden Markov Models.

UNIT IV	NON-PARAMETRIC TECHNIQUES	9
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Density Estimation - Parzen-window method. K-Nearest Neighbour estimation - The nearest neighbor rule - Linear discriminant functions: Generalized linear discriminant functions - Gradient descent procedures, Perceptron, Support vector machines.

UNIT V	NEURAL NETWORKS AND STOCHASTIC METHODS	9
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Introduction - Feedforward operation and classification - Backpropagation algorithm - Error surfaces - Backpropagation as feature mapping - Improving Backpropagation - Stochastic methods - Stochastic search - Boltzmann learning - Boltzmann Networks and Graphical models - Evolutionary methods - Genetic algorithms.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals of the design cycle of pattern recognition system and the underlying probability and linear algebra. **(K2)**

CO2 Apply Bayesian decision theory to perform classification using continuous and discrete features in pattern recognition tasks. **(K3)**

CO3 Make use of parameter estimation techniques such as Maximum Likelihood Estimation, Bayesian Estimation, and Expectation Maximization for model building. **(K3)**

CO4 Apply non-parametric methods like Parzen windows and K-Nearest Neighbour for density estimation and classification. **(K3)**

CO5 Design and develop a pattern recognition system using neural networks and stochastic learning methods in teams for real-world applications and document its functionalities. **(K6)**

TEXT BOOKS

1. O. Duda, P.E. Hart and D.G. Stork, Pattern Classification, John Wiley, 2007. (UNIT I - IV)

2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer 2006. (UNIT I - V)

REFERENCE BOOKS

1. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.

2. M. Narasimha Murthy, V. Susheela Devi, "Pattern Recognition", Springer 2011.

3. Menahem Friedman, Abraham Kandel, "Introduction to Pattern Recognition Statistical Structural, Neural and Fuzzy Logic Approaches", World Scientific Publishing Co. Ltd, 2000.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												2
CO2			2									3	3
CO3			2										2
CO4		3						3	3				2
CO5				3								3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3640	BIOMETRICS	45	0	0	45	90	3

OBJECTIVES

- To understand the principles of biometric recognition using physiological and behavioral traits.
- To learn the design, architecture, and working of fingerprint, face, and iris recognition systems.
- To study AI-based advancements in biometric authentication and security.
- To explore privacy, ethics, and vulnerability issues in biometric systems.
- To introduce emerging biometric technologies such as multimodal and blockchain-based systems.

UNIT I	INTRODUCTION TO BIOMETRICS	9
Definition, scope, and history of biometrics; Person recognition vs. authentication; Physiological vs. behavioral biometrics; Generic biometric system architecture (enrollment, template creation, matching); Performance evaluation metrics (FAR, FRR, EER, ROC); Life cycle of biometric implementation.		

UNIT II	FINGERPRINT BIOMETRICS	9
Fingerprint sensing and acquisition ink-based, optical, capacitive, ultrasound; Feature extraction – ridges, minutiae, singularities; Matching techniques: correlation-based, minutiae-based, ridge feature-based; Fingerprint classification and indexing; Synthetic fingerprints; Case studies and forensic applications.		

UNIT III	FACE AND IRIS BIOMETRICS	9
Face detection and recognition: 2D/3D face modeling, handling illumination, pose, and expression variations; Iris recognition: segmentation, encoding (Gabor wavelets), matching techniques; Performance factors in face and iris recognition; Applications in travel documents, surveillance, and mobile devices.		

UNIT IV	AI-BASED ADVANCEMENTS IN BIOMETRICS	9
Role of AI/ML/DL in biometrics; Deep biometrics using CNNs, GANs, and transformers; AI-driven fingerprint, voice, and face recognition; Security and privacy issues in AI-based biometric systems; Case studies in finance, healthcare, and access control; 3D biometric systems and immersive technologies.		

UNIT V	MULTIMODAL BIOMETRICS AND FUTURE TRENDS	9
Multibiometric systems: fusion levels (image, feature, score, decision); Soft biometrics (gait, ear, tattoos); Blockchain-based biometric systems; Biometric template security and liveness detection; Ethical, legal, and privacy challenges; Future directions – quantum biometrics, digital forensics, cybersecurity integration.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the principles and system architecture of biometric recognition. (K2)

CO2 Apply fingerprint acquisition, feature extraction, and classification techniques. (K3)

CO3 Analyze the methods used in face and iris recognition systems. (K4)

CO4 Evaluate AI-based advancements in biometric systems and their applications. (K4)

CO5 Examine multimodal biometric approaches, security issues, ethical concerns and future directions. (K4)

TEXT BOOKS

1. Anil K. Jain, Arun A. Ross, Karthik Nandakumar, Introduction to Biometrics, Springer, 2011. (Units – I, III, V)
2. D. Maltoni, D. Maio, A.K. Jain, S. Prabhakar, Handbook of Fingerprint Recognition, 2nd Edition, Springer, 2009. (Unit II)
3. Balasubramaniam S., Seifedine Kadry, A. Prasanth, Rajesh K. Dhanaraj (Eds.), *AI Based Advancements in Biometrics and its Applications*, CRC Press, 2025. (Unit IV)

REFERENCE BOOKS

1. John Daugman, "How Iris Recognition Works," IEEE Transactions on Circuits and Systems for Video Technology, 2004.
2. Wayman J., Jain A., Maltoni D., Maio D., Biometric Systems: Technology, Design and Performance Evaluation, Springer, 2005.
3. Jain A.K., Ross A., Pankanti S., "Biometrics: A Tool for Information Security," IEEE Transactions on Information Forensics and Security, 2006.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2					2					3	2
CO2	3	3	2		2							3	2
CO3	2	3	3	2		2						3	2
CO4		2	3	3	2	2						3	3
CO5	2		3		2	3	2					3	3
CO6													

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3691	GPU COMPUTING	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of GPU architectures
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To understand the concepts of OpenCL

UNIT I	GPU ARCHITECTURE	12
Evolution of GPU architectures -- Understanding Parallelism with GPU -- Typical GPU Architecture -- CUDA Hardware Overview -- Threads, Blocks, Grids, Warps, Scheduling -- Memory Handling with CUDA: Shared memory, Global memory, Constant memory and Texture memory.		

UNIT II	CUDA PROGRAMMING	9
Using CUDA -- Multi GPU -- Multi GPU Solutions -- Optimizing CUDA Applications: Problem decomposition, Memory considerations, Transfers, Thread usage, Resource contentions.		

UNIT III	PROGRAMMING ISSUES	8
Common Problems: CUDA error handling, Parallel programming issues, Synchronization, Algorithmic issues, Finding and avoiding errors.		

UNIT IV	OPENCL BASICS	8
OpenCL Standard -- Kernels -- Host Device Interaction -- Execution Environment -- Memory Model -- Basic OpenCL Examples.		

UNIT V	ALGORITHMS ON GPU	8
Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix -- Matrix Multiplication -- Parallel Graph algorithms- Programming Heterogeneous Cluster.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the architectural features of GPU processors, including CUDA hardware. (K2)

CO2 Develop and analyze GPU solutions for computational problems using CUDA programming. (K3)

CO3 Analyze CUDA programs using error handling techniques. (K4)

CO4 Develop and Analyze GPU solutions computational problems using OpenCL

programming . (K3)
CO5 :Develop parallel patterns like convolution, prefix sum, and sparse matrix operations. (K3)

TEXT BOOKS
1. Shane Cook, “CUDA Programming: A Developer ’s Guide to Parallel Computing withGPUs (Applications of GPU Computing)”, 1st Edition,Morgan Kaufmann, 2012. (Unit-1,2, and 3)
2. DavidRkaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, “Heterogeneous Computing with OpenCL”, 3rd Edition, Morgan Kauffman, 2015. (Unit-4)

REFERENCE BOOKS
1. DavidB Kirk, Wen-mei W Hwu, “Programming Massively parallel Processors – A Hands-on Approach”, 3rd Edition,Morgan Kaufmann, 2016. (Unit-5)
2. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guideto GPU Programming”, Addison - Wesley, 2013. (Unit-5)
3. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison - Wesley, 2010. (Unit-1)
4. http://www.nvidia.com/object/cuda_home_new.html

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3											
CO2	3	2	3	3								3	
CO3	3	3											
CO4	3	3	3	3								3	
CO5	3	3											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3692	SOFTWARE CONFIGURATION MANAGEMENT	45	0	0	45	90	3

OBJECTIVES

- To introduce the principles and need for software configuration management in modern software engineering.
- To explain configuration identification, change control, versioning, and release management processes.
- To demonstrate the use of configuration management tools such as Git and CI/CD pipelines.
- To develop skills for establishing baselines, handling multiple versions, and managing change requests.
- To emphasize the role of SCM in DevOps, Agile, and continuous-delivery environments.
- To align SCM practices with IEEE/ISO standards and process improvement models.

UNIT I	INTRODUCTION TO SCM	9
Definition, need, and scope of SCM – Configuration items – Versioning concepts – Baselines – Benefits of SCM – SCM process activities – IEEE and ISO standards – SCM plan structure.		

UNIT II	CONFIGURATION IDENTIFICATION AND CHANGE CONTROL	9
Configuration identification – Item naming, numbering, and versioning – Change control process – Change request evaluation and approval – Configuration Control Board (CCB) – Impact analysis – Release baselines – Documentation management.		

UNIT III	STATUS ACCOUNTING, AUDITS, AND RELEASE MANAGEMENT	9
Status accounting – Change tracking – Reporting – Functional and physical configuration audits – Verification and validation – Release planning – Build automation – Package management – Metrics for SCM.		

UNIT IV	SCM TOOLS AND AUTOMATION	9
Version control systems (Git, SVN, Mercurial) – Branching and merging strategies – CI/CD pipelines – GitHub Actions, Jenkins, GitLab CI – Automated builds and testing – Repository management and integration tools.		

UNIT V	ADVANCED SCM AND INDUSTRY PRACTICES	9
Enterprise-level SCM practices – SCM for distributed systems – Product-line and variant configuration management – Continuous delivery and release trains – SCM for microservices and containerized applications – SCM in cloud and mobile environments – Case studies (Google, Microsoft, Red Hat) – SCM metrics and process improvement.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the principles and need for software configuration management in modern software engineering. (K2)
CO2 Apply configuration identification, change control, versioning, and release management processes.(K3)
CO3 Utilize SCM tools like Git, Jenkins, and CI/CD pipelines to implement version control and automation. (K3)
CO4 Design baselines and manage multiple versions and change requests effectively.(K4)
CO5 Evaluate SCM integration in DevOps, Agile, and continuous-delivery environments.(K5)
CO6 Apply IEEE/ISO standards to develop and manage SCM processes for project implementation. (K3)

TEXT BOOKS

1. Alexis Leon, Software Configuration Management Handbook, 3rd Edition, Artech House, 2015. (Unit- I,II,III,IV,V)
2. Stephen P. Berczuk and Brad Appleton, Software Configuration Management Patterns: Effective Teamwork, Practical Integration, Addison-Wesley, 2002. (Unit-
3. Gene Kim, Jez Humble, Patrick Debois, and John Willis, The DevOps Handbook, IT Revolution Press, 2021.(Unit- III,IV,V)
4. Shirley Lacy and David Norfolk, Configuration Management: Expert Guidance for IT Service Managers and Practitioners, Revised Edition, BCS Learning and Development Ltd., UK, 2014.(Unit- I,II,III,V)
5. Berczuk, Steve, and Appleton, Brad. Software Configuration Management Patterns: Effective Teamwork, Practical Integration. United Kingdom, Pearson Education, 2020.(Unit- I,II,IV)

REFERENCE BOOKS

1. IEEE Computer Society, IEEE Standard 828-2012: Software Configuration Management Plans, IEEE Press, USA, 2012.
2. William M. Osborne, NIST Special Publication 500-161: A Guide to Software Configuration Management, National Institute of Standards and Technology (NIST), USA, 1991.
3. Atlassian Corporation Plc, Atlassian Git Tutorials and GitHub Learning Lab, Online Learning Resources, 2024.
4. Ian Sommerville, Software Engineering, 10th Edition, Pearson Education Ltd., London, 2021.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2	2		3							2	
CO3				3	3							2	3
CO4		2	2	3	3	2		1				2	3
CO5				3	3	2	2		2	2		2	3
CO6					3	2	2					2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3693	AGILE METHODOLOGIES	45	0	0	45	90	3

OBJECTIVES

- To understand the basic concepts of Agile software process
- To learn about agile requirement engineering
- To learn planning and management in agile software development
- To study various agile methods
- To learn the principles of agile testing and quality assurance.

UNIT I	INTRODUCTION	9
Iterative and Evolutionary Development; Introduction to Agile: Agile development – Classification of methods – Agile manifesto and principles – Communication and feedback – Specific agile methods – Agile modelling; Theories for Agile Management; Management Accounting for Systems; Agile Project Management: Traditional versus RAD model for project management – Task planning and effort tracking – The project manager’s new work.		

UNIT II	REQUIREMENTS ENGINEERING FOR AGILE METHODS	9
Traditional and Agile Requirement Engineering; Methods and Tools for Agile Practitioners: Requirements elicitation – Requirements representation and documentation – Requirements analysis – Requirements management; Agile Approaches to Requirements Engineering: The customer – Requirements evolution – Non-functional requirements; Tools for Requirements Management in AMs.		

UNIT III	AGILE PROJECT PLANNING AND DEVELOPMENT MANAGEMENT	9
Agile Project Planning: The Project buffer and its usage – Logical collection of inventories – Critical path – Parallel path – Critical chain – Project tracking metrics; Agile Development Management: Identifying and monitoring the flow – Bottleneck; Agile Maturity Model: A new maturity model.		

UNIT IV	AGILE METHODS	9
Scrum: Method overview – Life cycle – Work products – Values – Roles and practices – Process mixtures – Adoption strategies; Extreme Programming; Unified Process; EVO.		

UNIT V	AGILE TESTING AND QUALITY ASSURANCE	9
Agile testing: Nine principles and six concrete practices for testing on agile teams; Agile Metrics: Feature driven development (FDD) – Financial and production metrics in FDD – Agile approach to quality assurance – Test driven development; SMM: A process improvement frame- work for agile requirements engineering practices–case study.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain evolutionary, iterative and adaptive development methods (K2)

CO2 Evaluate and select agile software processes for effective requirement engineering in complex software projects (K5)

CO3 Apply agile methods for effective project planning and development management (K3)
CO4 Choose agile methods for software design (K3)
CO5 Apply agile based testing with quality assurance (K3)

TEXT BOOKS

1. David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results", Prentice Hall, 2003. (Unit 1-5)
2. Craig Larman, "Agile and Iterative Development: A Manager's Guide", Addison-Wesley, 3rd Edition, 2004. (Unit 1 and 4)
3. Elisabeth Hendrickson, "Agile Testing", Quality Tree Software Inc 2008. (Unit 5)

REFERENCE BOOKS

1. Hazza, Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science", Springer, 2009. (Unit 5)
2. Chetankumar Patel, Muthu Ramachandran, "Story Card Maturity Model (SMM): A Process Improvement Framework for Agile Requirements Engineering Practices", Journal of Software, Academy Publishers, Vol 4, No 5, 422-435, Jul 2009. (Unit 5)
5. Kevin C Desouza, "Agile Information Systems: Conceptualization, Construction, and Management", Butterworth-Heinemann, 2007.
6. Didar Zowghi, Zhi Jin, "Requirements Engineering", Springer, chapter 15, 2014. (Unit 2)
7. Aybuke Aurum, Claes Wohlin, "Engineering and Managing Software Requirements", Springer 2005, chapter 14. (Unit 2)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2											3
CO2	2	3	2	3								2	3
CO3		2	3	2	3								3
CO4	2		3	2	2							2	3
CO5			2	3	3		2						3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3694	SMART SENSORS	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamentals of smart sensors and their computational relevance in IoT.
- To explore sensor architectures, interfacing, and signal processing for embedded systems.
- To study the working and applications of different types of sensors.
- To understand MEMS and nanotechnology-based sensor design and fabrication.
- To examine communication protocols and networking standards used in IoT sensor systems.

UNIT I	FUNDAMENTALS OF SMART SENSORS	9
Introduction to sensors and smart sensor systems - Sensor characteristics, classification, terminology, and measurands - Physical principles of sensing: Electric charges, fields, capacitance, magnetism, induction, resistance - Piezoelectric, pyroelectric, Hall, Seebeck, and Peltier effects - Smart sensors in nature (vision, hearing, touch, smell)- Relevance of smart sensors in IoT and cyber-physical systems.		

UNIT II	SMART SENSOR ARCHITECTURE AND DATA INTERFACES	9
Smart sensor architecture: functional blocks and embedded intelligence – Signal conditioning, data acquisition, and calibration - Buses and interfaces: SPI, I ² C, UART, USB, and CAN - Embedded firmware and software layers in sensor systems - Reliability, diagnostics, and edge data preprocessing - Integration of smart sensors with microcontrollers and IoT platforms.		

UNIT III	ACOUSTIC, MAGNETIC, AND MECHANICAL SENSORS	9
Acoustic sensors: Acoustic waves, piezoelectric materials, SAW sensors, and applications - Magnetic sensors: Hall sensors, magneto-transistors, magneto resistive sensors, and materials - Mechanical sensors: Piezoresistive and capacitive sensors; strain and displacement measurement - Applications in robotics, wearables, and automation - Machine learning based signal calibration and interpretation.		

UNIT IV	RADIATION, THERMAL, AND CHEMICAL SENSORS	9
Radiation sensors: Infrared (HgCdTe), visible-light color sensors, high-energy photodiodes- Thermal sensors: Heat transfer, thermal structures, thermal sensing elements, temperature sensors - Chemical sensors: Gas and ion sensing, catalytic effects, thin-film sensors, and FET-based devices - Smart sensing applications in environmental, industrial, and healthcare IoT systems.		

UNIT V	MEMS, NANOTECHNOLOGY, AND IOT SENSOR NETWORKS	9
Micro and nanotechnology in sensor design - MEMS fabrication techniques: Bulk, surface micromachining, LIGA, and microfluidics - Nanostructures and ultrathin film sensors –		

fabrication and applications - Sensor communication and IoT networking protocols: IEEE 802.15.4 (Zigbee), IEEE 802.11 (Wi-Fi), IEEE 1451.2, BLE, LoRa, MQTT, CAN - Sensor network architecture, MAC and routing protocols, automotive and industrial IoT integration.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals, classifications, and characteristics of smart sensors and their importance in IoT systems. (K2)

CO2 Apply interfacing and signal conditioning methods to integrate smart sensors with embedded systems and IoT platforms. (K3)

CO3 Apply the working principles of acoustic, magnetic, mechanical, thermal, and chemical sensors for various real-world applications. (K3)

CO4 Evaluate MEMS and nanotechnology-based sensing devices for enhanced performance and miniaturization. (K4)

CO5 Design and implement smart sensor networks with modern communication and IoT protocols for industrial and cyber-physical systems (K6)

TEXT BOOKS

1. Manabendra Bhuyan, Intelligent Instrumentation: Principles and Applications, Taylor and Francis. (Unit-1, Unit-2 and Unit-5)

2. Randy Frank, Understanding Smart Sensors, Artech House. (Unit-1, Unit-3)

REFERENCE BOOKS

1. Youn-Long Lin et al., Smart Sensors and Systems, Springer. (Unit-2, Unit-4, and Unit-5)

2. Kofi Makinwa, Gerard Meijer, Michiel Pertijs, Smart Sensor Systems: Emerging Technologies and Applications, Wiley, 2014. (Unit-3 and Unit-5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2		3
CO2	3	2										2		3
CO3	3		3	3								3		3
CO4	3	3	3									3		3
CO5		3		3		3		3	3		2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3669	3D MODELING AND ANIMATION	30	0	30	30	90	3

OBJECTIVES

- To understand the basic of 3D object creation.
- To use a 3D modeling tool to create basic and complex objects
- To apply lighting, textures and visual effects to a scene
- To create animations and render scenes with special effects

UNIT I	INTRODUCTION TO 3D MODELING	6
Introduction to 3D modeling and animation - Overview of popular 3D modeling software (e.g., Blender, Autodesk Maya) – Understanding Blender’s Interface - Installation and basic interface navigation – Working with Objects - Understanding basic geometric shapes – Transformation Basics- Introduction to modeling tools (extrude, bevel, etc.) - Introduction to more complex modeling techniques (subdivision surfaces, boolean operations).		

UNIT II	TEXTURING AND MATERIALS	6
Texturing: Understanding UV mapping - Basic texture creation and application – Adding an image texture - Painting Custom Textures – Live Mattes. Materials and Shading: Introduction to materials and shaders - Applying realistic materials to 3D objects		

UNIT III	ANIMATION BASICS	6
Animation Fundamentals: Introduction to keyframes and timeline - Basic animation principles (e.g., squash and stretch, anticipation). Rigging Basics: Introduction to rigging - Basics of skeletal and character rigging – Rig testing and adjustment – Rigging with constraints		

UNIT IV	ADVANCED ANIMATION	6
Character Animation: Character creation – Refining facial features – modeling joints - Advanced character animation techniques - Walk cycles, expressions, and emotions - Morphing. Dynamics and Simulations: Introduction to physics-based animation - Simulating cloth, particles, and fluids		

UNIT V	RENDERING AND OUTPUT	6
Rendering Basics: Introduction to rendering settings - Lighting and camera techniques – Directional and Non-directional lighting – Overall effects (Depth of field, motion blur, glow and glare, color changes and grading) Output and Export: Exporting 3D models and animations - File formats and settings.		

SUGGESTED EXPERIMENTS:	
1. Create simple objects - Model a simple room with furniture. Apply basic modeling tools to create walls, floors, and furniture using cubes, cylinders, and other basic shapes.	

2. Practice creating more detailed 3D objects - Design a futuristic building or object. Experiment with subdivision surfaces and Boolean operations to create a more complex and intricate 3D model.
3. Texture a simple 3D model - Texture a wooden crate or a simple prop. Practice UV mapping and apply a texture to simulate realistic materials like wood. Apply different materials to objects in a scene, considering factors like reflectivity, transparency, and surface properties.
4. Rig a simple character and animate a walk cycle to understand character movement.
5. Create a character animation - Animate a character expressing emotions. Use advanced character animation techniques to create a short scene where a character expresses various emotions.
6. Simulate a dynamic scene - Simulate a dynamic scene like a falling object or a cloth draped over an object. Explore Blender's physics-based animation by simulating dynamics in a scene.
7. Render a scene with realistic lighting. Experiment with different lighting setups and render a scene with attention to shadows, reflections, and overall visual aesthetics.

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Apply fundamental 3D modeling techniques using industry-standard tools to construct and manipulate geometric shapes through transformations and boolean operations (K3)
CO2 Apply UV mapping, material shading, and procedural/custom textures to achieve realistic surface properties (K3)
CO3 Create basic animations by applying keyframe principles and rigging techniques to create controlled character movements. (K6)
CO4 Construct advanced character animations and physics-based simulations by configuring rendering parameters to demonstrate dynamic interactions in a 3D environment. (K6)
CO5 Collaborate in a team to plan, develop, and present a 3D animation project by integrating modeling, texturing, animation, and rendering workflows, while demonstrating effective communication, time management, and adherence to technical and aesthetic standards. (K6)

TEXT BOOKS
1. Roland Hess, "Blender Foundations", Focal Press, 2 nd edition, 2017.(Unit 1,2,3,4,5)
2. Jason van Gumster, "Blender For Dummies", For Dummies, 4 th Edition, 2020.

REFERENCE BOOKS
1. Oscar Baechler, Xury Greer, "Blender 3D By Example", Packt Publishing, 2 nd Edition, 2020.
2. John M. Blain, "The Complete Guide to Blender Graphics: Computer Modeling and Animation", Taylor & Francis Ltd, 7th Edition, 2022.
3. Ben Simonds, "Blender Master Class: A Hands-On Guide to Modeling, Sculpting, Materials, and Rendering", No Starch Press, 1st Edition, 2013.

4. Lance Flavell, “Beginning Blender: Open Source 3D Modeling, Animation, and Game Design”, Apress, 2010

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3							3	
CO2	3				3							3	
CO3	3		3		3							3	
CO4	3		3		3							3	
CO5	3		3		3		3	3	2		3	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3666	GAME PROGRAMMING	30	0	30	30	90	3

OBJECTIVES

- To know the basics of 2D and 3D graphics for game development
- To know the stages of game development.
- To understand the basics of a game engine.
- To survey the gaming development environment and tool kits.
- To learn and develop simple games.

UNIT I	3D GRAPHICS FOR GAME DESIGN	6
Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components – 2D and 3D Transformations – Projections – Color Models – Illumination and Shader Models – Animation – Controller Based Animation.		

UNIT II	GAME DESIGN PRINCIPLES	6
Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design – Proposals – Writing for Preproduction, Production and Post – Production.		

UNIT III	GAME ENGINE DESIGN	6
Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting algorithms – Algorithms for Game Engine– Collision Detection – Game Logic – Game AI – Pathfinding.		

UNIT IV	OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS	6
Pygame Game development – Unity – Unity Scripts – Mobile Gaming, Game Studio, Unity Single player and multi-Player games.		

UNIT V	GAME DEVELOPMENT USING PYGAME	6
Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D And 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development – Device Handling in Pygame – Overview of Isometric and Tile Based arcade Games– Puzzle Games.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Installation of a game engine, e.g., Unity, Unreal Engine, familiarization of the GUI. Conceptualize the theme for a 2D game.
2. Character design, sprites, movement, and character control
3. Level design: design of the world in the form of tiles along with interactive and collectible objects.

4. Design of interaction between the player and the world, optionally using the physics engine.
 5. Developing a 2D interactive using Pygame
 6. Developing a Puzzle game
 7. Design of menus and user interaction in mobile platforms.
 8. Developing a 3D Game using Unreal
- Developing a Multiplayer game using unity

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply the concepts of 2D and 3D Graphics.(K3)

CO2 Build the game design documents.(K3)

CO3 Design the gaming engines (K5)

CO4 Develop applications using gaming environments and frameworks. (K3)

CO5 Build simple games using gaming softwares (K6)

TEXT BOOKS

1. Sanjay Madhav, "Game Programming Algorithms and Techniques: A Platform Agnostic Approach", Addison Wesley, 2013. (Unit-4)
2. Will McGugan, "Beginning Game Development with Python and Pygame: From Novice to Professional", Apress, 2007. (Unit-5)

REFERENCE BOOKS

1. Paul Craven, "Python Arcade games", Apress Publishers, 2016
2. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press, 2006. (Unit-2,3)
3. Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011.
4. (Unit-1,2)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	3	2	2	2				2			2	2
CO4	3	3											
CO5	3	2	2	2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3695	MOBILE AND WIRELESS SECURITY	45	0	0	45	90	3

OBJECTIVES

- To Understand vulnerabilities of wired and wireless networks
- To acquire knowledge on Bluetooth, Wi-Fi and Ad Hoc Networks Security
- To Understand the security in cellular networks
- To learn about mobile hardware and software security

UNIT I	VULNERABILITIES OF WIRED AND WIRELESS NETWORKS	9
Introduction: Security in the digital age – Threats and risks to telecommunications systems – From wireline vulnerabilities to vulnerabilities in wireless communications. Fundamental Security Mechanisms: Basics on security – Authentication –Access control.		

UNIT II	WIRELESS SECURITY	9
Bluetooth technical specification – Bluetooth security. Wi-Fi Security: Attacks on wireless networks – Security in the IEEE 802.11– Security in 802.1x – Authentication in wireless networks – Layer 3 security mechanisms. Security in Ad Hoc Networks: Attacks to routing protocols – Security mechanisms.		

UNIT III	SECURITY IN MOBILE TELECOMMUNICATION NETWORKS	9
Security in the GSM: Security mechanisms in GSM – Security flaws in GSM radio access – Security flaws in GSM signaling; GPRS security: GPRS architecture – GPRS security mechanisms – 3G security: UMTS infrastructure – UMTS security ; 4G Security.		

UNIT IV	MOBILE HARDWARE SECURITY	9
Platform Boot Integrity – Secure Storage – Isolated Execution – Device Identification – Device Authentication – Hardware Security Architectures – TEE Standards.		

UNIT V	MOBILE PLATFORM SECURITY	9
Android Based Security: Attacks and Threats – Security extensions for Android. iOS Based security: Limits of Apple’s application vetting process – iOS security extensions.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply the knowledge of network security to identify and outline vulnerabilities in wired and wireless networks. (K3)

CO2 Evaluate and compare the security mechanisms in Bluetooth, Wi-Fi, and Ad Hoc

networks. (K5)
CO3 Analyze and compare the security mechanisms used in telecommunication networks. (K4)
CO4 Explain hardware security architectures in mobile devices, comparing the security features of Android and iOS platforms. (K2)
CO5 Evaluate and compare security mechanisms across various communication technologies - Bluetooth, Wi-Fi, Telecommunication networks by identifying vulnerabilities in wired and wireless networks and document & present the analysis report in teams. (K5)

TEXT BOOKS

1. Hakima Chaouchi, Maryline Laurent-Maknavicius, "Wireless and Mobile Network Security- Security Basics, Security in On-the-shelf and Emerging Technologies", Wiley-ISTE, June 2009. (Unit 1, 2, 3)
2. N. Asokan, Lucas Vincenzo Davi, Alexandra Dmitrienko, Stephan Heuser, Kari Kostianen, Elena Reshetova, Ahmad-Reza Sadeghi, "Mobile Platform Security", Synthesis Lectures on Information Security, Privacy, and Trust, Morgan & Claypool Publishers, 2013. (Unit 4, 5)

REFERENCE BOOKS

1. Xiao, Yang, Shen, Xuemin Sherman, Du, Ding-Zhu, "Wireless Network Security", Springer, 2007.
2. Nouredine Boudriga, "Security of Mobile Communications", CRC Press, 2019
3. Levente Buttyan, Jean-Pierre Hubaux, "Security and Cooperation in Wireless Networks", Cambridge University Press, 2012
4. James Kempf, "Wireless Internet Security: Architectures and Protocols", Cambridge University Press, 2010
5. Patrick Traynor, Patrick McDaniel, Thomas La Porta, "Security for Telecommunications Networks", Springer, 2008

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3											
CO2			3	3								3	
CO3		3	3	3								2	
CO4	3												
CO5	3	3	3	3	2			3	3			3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3682	CLOUD COMPUTING AND MICRO SERVICES	30	0	30	30	90	3

OBJECTIVES

- To understand the concepts of virtualization and virtual machines.
- To explore and experiment with various Cloud deployment environments.
- Understand and demonstrate microservices.
- Explore and deploy microservices in a container.
- Modify configuration techniques using Kubernetes and Jenkins.

UNIT I	CLOUD MODELS AND VIRTUALIZATION	6
NIST Cloud Computing Reference Architecture – Cloud Characteristics – Cloud deployment models – Cloud service models – Pros and Cons of Cloud; Basics of Virtualization – Virtualization Types - Virtualization of CPU, Memory, I/O Devices.		

UNIT II	CLOUD DEPLOYMENT ENVIRONMENT	
Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.		

UNIT III	MICROSERVICES	
An Introduction to Microservices; A case study on Migration to Microservices -- Planning for Migration -- Applying Microservices Criteria -- Converting to Microservices – Building and Deployment of Application.		

UNIT IV	CONTAINERS	6
Docker Containers: Virtual Machines -- Containers -- A Simple Example; Docker Interface: Key Docker Commands -- Docker file -- Docker Compose; Case Study: Containerizing a Helpdesk Application: Containerizing Microservices.		

UNIT V	ORCHESTRATION AND DESIGN PATTERNS	7
Container Orchestration: Kubernetes -- Kubectl -- Kubernetes Cluster – Jenkins -- Benefits of using microservices architecture patterns—Design Patterns: Aggregator pattern -- API Gateway pattern — Pub Sub patten—Circuit Breaker pattern – Decomposition pattern.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Install Virtualbox/VMware/ Equivalent open-source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above. 2. Find a procedure to transfer the files from one virtual machine to another virtual machine. 3. Install Hadoop single node cluster and run simple applications like wordcount. 4. Create a Catalog application as a Microservice. 5. Working with Docker, Docker Commands, Docker Images and Containers for content a management. 6. Develop a simple containerized application using Docker.

7. Install and set up Kubernetes, explore the environment.
8. Automate the process of running containerized application developed using Kubernetes.
9. Install and set up Jenkins, explore the environment.
10. Demonstrate continuous integration and development using Jenkins.

SOFTWARE REQUIREMENTS

- Virtual Box
- Java
- Hadoop
- Docker and Docker Desktop
- Kubernetes
- Jenkins

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain cloud computing models, characteristics, and virtualization concepts and their applications. (K2)

CO2 Compare various cloud deployment environments and platforms such as AWS, Azure, and OpenStack. (K4)

CO3 Develop and deploy applications using microservices architecture. (K6)

CO4 Build and manage containers using Docker and Docker Compose for microservice deployment. (K3)

CO5 Choose orchestration and CI/CD tools like Kubernetes and Jenkins to automate application deployment. (K5)

CO6 Examine and implement design patterns suitable for microservices-based systems. (K4)

TEXT BOOKS

1. Kai Hwang, Geoffrey Fox, Jack J. Dongarra, Morgan Kaufmann, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things," 1st Edition, 2011. (Unit 1,2)
2. Parminder Singh, Kocher Boston, "Microservices and Containers", Addison-Wesley, 2018. (Unit 3,4,5)

REFERENCE BOOKS

1. Srinivasan A, Suresh J, "Cloud Computing: A practical Approach for Learning and Implementation", Pearson Education India, 2014.
2. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, 2011.
3. Richardson, Chris. *Microservices patterns: with examples in Java*. Simon and Schuster, Manning, 2018. (Unit 5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2			2						1	3	2
CO2	3	2	2		3						1	3	3
CO3	2	2	3		2			2		1	2	3	3
CO4	2		2		3			2			2	3	3
CO5	2	2	3		3			2	1	2	3	3	3
CO6	2	2	3		2	1			1		1	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3620	CYBER SECURITY	45	0	0	45	90	3

OBJECTIVES

- To get introduced to cyber security cybercrime and law
- To understand the attacks and tools
- To understand information gathering
- To understand how to detect an attack
- To understand how to prevent an attack

UNIT I	INTRODUCTION TO CYBER SECURITY	9
Cyber Security the need of the hour -- History of Internet -- Impact of Internet -- CIA Triad; Reason for Cyber Crime -- Need for cyber security -- History of cybercrime; Cybercriminals -- Classifications of Cybercrimes -- A Global Perspective on Cybercrimes; Need Cyber laws – The Indian IT Act -- Cyber Crime and Punishment.		

UNIT II	ATTACKS AND COUNTERMEASURES	9
OSWAP; Malicious attack Threats and Vulnerabilities: Scope of cyber-attacks -- Security breach -- Types of malicious attack -- Malicious software -- Common attack vectors -- Social Engineering attack -- Wireless Network attack -- Web application attack -- Attack tools -- Countermeasures.		

UNIT III	RECONNAISSANCE	9
The Harvester -- Whois -- Netcraft -- Host -- Extracting Information from DNS – Extracting Information from E-mail Servers -- Social Engineering Reconnaissance; Scanning – Port Scanning - - Network Scanning and Vulnerability Scanning -- Understand Scanning Methodology -- Ping Sweep Techniques -- Nmap Command Switches -- SYN -- Stealth -- XMAS -- NULL -- IDLE -- FIN Scans -- Banner Grabbing and OS Fingerprinting Techniques; Enumeration -- Null Sessions -- SNMP Enumeration – Steps involved in Enumeration.		

UNIT IV	INTRUSION DETECTION	9
Intrusion Detection; Host-Based Intrusion Detection -- Network-Based Intrusion Detection -Distributed or Hybrid Intrusion Detection -- Intrusion Detection Exchange Format -- Honeypots -- Example System Snort.		

UNIT V	INTRUSION PREVENTION	9
Firewalls and Intrusion Prevention Systems:The Need for Firewalls – Firewall Characteristics and Access Policy -- Types of Firewalls -- Firewall Basing -- Firewall Location and Configurations -- Intrusion Prevention Systems -- Example Unified Threat Management Products.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the basics of cyber security, cyber crime and law (K2)

CO2 Analyze various types of attacks and learn the tools to launch the attacks (K4)
CO3 Choose tools to perform information gathering (K5)
CO4 Apply intrusion detection techniques to detect intrusion (K3)
CO5 Apply intrusion prevention techniques to prevent intrusion (K3)

TEXT BOOKS

1. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021 (Unit 1)
2. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", Third Edition, Pearson Education, 2015 (Units 4 and 5)
3. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley publisher, 2011 (Unit 1)

REFERENCE BOOKS

1. <https://owasp.org/Top10/>, 2021 (Unit 2)
2. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning publisher, 2013 (Unit 2)
3. Patrick Engebretson, "The Basics of Hacking and Penetration Testing Ethical Hacking and Penetration Testing Made Easy", Elsevier, 2011 (Unit 3)
4. Kimberly Graves, "CEH Official Certified Ethical Hacker Review Guide", Wiley publisher, 2007 (Unit 3)
5. Georgia Weidman, "Penetration testing A Hands-On Introduction to Hacking", San Francisco, 2014

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												3
CO2			2									3	
CO3			3		2							3	
CO4				3								3	
CO5				3		3						3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3761	MOBILE APPLICATION DEVELOPMENT	30	0	30	30	90	3

OBJECTIVES

- To understand mobile application design patterns for navigation, input, content, and collaboration.
- To develop Android applications using Android Studio, including UI design, activities, and intents.
- To implement database integration, multithreading, and location services in Android applications.
- To create basic iOS applications using Xcode, Swift, and Interface Builder.
- To design iOS applications with advanced UI controls and view controller containers.
- To apply software engineering principles to build robust mobile applications for Android and iOS platforms.

UNIT I	MOBILE APPLICATION DESIGN PATTERNS	6
Introduction to Mobile Design Patterns; Navigation Patterns, Input and Content Patterns, Social and Collaboration Patterns		

UNIT II	ANDROID APPLICATION BASIS	6
First Android Application: Creating an Android Project, Navigating in Android Studio, Laying Out the User Interface, Wiring Up Widgets, setting listeners, Running on the Emulator; Activity, Intents, Layouts, Widgets, UI fragments and arguments.		

UNIT III	DATABASES, MULTITHREADING AND LOCATION SERVICES	6
SQLite Databases, Assets, Audio Playback with SoundPool, HTTP & Background Tasks, Location and Libraries.		

UNIT IV	IOS PROGRAMMING BASICS	6
A Simple iOS Application: Creating an Xcode Project, Interface Builder, Building the Interface, Model Layer, Building the Finished Application; Swift Language, Views, Views hierarchy, Working with text input.		

UNIT V	IOS UICONTROLS AND VIEWCONTROLLER CONTAINERS	6
View Controllers, Programmatic Views, UITableView and UITableViewController, Editing UITableView, Stack Views, UINavigationController.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain mobile design patterns for navigation, input, and collaboration (K2)
CO2 Develop Android applications using Android Studio, layouts, intents, and widgets (K3)
CO3 Apply databases, multithreading, and location services in Android applications (K3)
CO4 Develop basic iOS applications using Xcode, Swift, and Interface Builder (K3)
CO5 Apply advanced iOS UI controls and view controllers for robust application design (K3)
CO6 Create robust mobile applications for Android and iOS, applying software engineering principles and considering ethical and societal impacts (K6)

TEXT BOOKS

1. Neil, Theresa. *Mobile design pattern gallery: UI patterns for smartphone apps.* "O'Reilly Media, Inc.", 2014. (Unit 1)
2. Ranch, Big Nerd. "Android Programming: The Big Nerd Ranch Guide." (2015). (Unit 2,3)
3. Keur, Christian, and Aaron Hillegass. *iOS programming: the Big Nerd Ranch guide.* Pearson Technology Group, 2016.(Unit 4,5)

REFERENCE BOOKS

1. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: 1

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3									2		2	
CO2	3		3							2		3	3
CO3		3	3									3	
CO4		3	3	3				1	2			3	3
CO5			3		3			1	2			3	3
CO6					3			1				3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3721	BIOINFORMATICS	45	0	0	45	90	3

OBJECTIVES

- Identify and summarize the structure and function of key bioinformatics databases, such as the Protein Data Bank and secondary resources
- Apply data mining techniques to extract meaningful patterns from biomedical, DNA, and protein datasets.
- Analyze the architecture and functioning of machine learning algorithms such as neural networks, genetic algorithms, and fuzzy systems in bioinformatics applications
- Apply various modeling techniques, including Hidden Markov Models and molecular modeling, for biological sequence and structure analysis.
- Interpret gene expression data from microarray experiments and perform pattern discovery using appropriate analytical tools.

UNIT I	INTRODUCTION	9
Introduction to Bioinformatics: Need for Bioinformatics technologies – Overview of Bioinformatics technologies; Overview of structural bioinformatics: Organization of Structural bioinformatics – Primary resource: protein data bank – Secondary resources and applications.		

UNIT II	DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS	9
Data warehousing in Bioinformatics: Bioinformatics data – Transforming data to knowledge – Data warehousing architecture – Data quality; Data mining for Bioinformatics: Biomedical data analysis – DNA data analysis – Protein data analysis.		

UNIT III	MACHINE LEARNING IN BIOINFORMATICS	9
Machine learning in Bioinformatics: Artificial Neural network – Neural network architecture and applications – Genetic algorithm – Fuzzy system.		

UNIT IV	MODELING FOR BIOINFORMATICS	9
Modeling for Bioinformatics: Hidden Markov modeling for biological data analysis – Comparative modeling – Probabilistic modeling – Molecular modeling.		

UNIT V	MICROARRAY DATA ANALYSIS	9
Microarray Data Analysis: Microarray technology for genome expression study – Image analysis for data extraction – Data Analysis for Pattern Discovery.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 : Explain the structure, function, and significance of primary and secondary bioinformatics databases in supporting biological research. (K2)

CO2 Apply concepts of data warehousing to organize and manage biological datasets for efficient retrieval and knowledge discovery (K3)

CO3 Analyze DNA, RNA, and protein data using data mining techniques to extract meaningful biomedical insights (K4)

CO4 Apply machine learning algorithms such as neural networks, genetic algorithms, and fuzzy logic to solve biological classification and prediction problems (K3)

CO5 Evaluate the effectiveness of probabilistic modeling techniques, including Hidden Markov Models and molecular modeling, for biological sequence analysis. (K5)

CO6 Create an analytical pipeline for microarray gene expression analysis, integrating image processing and pattern discovery tools. (K6)

TEXT BOOKS

1. Yi-Ping Phoebe Chen (Ed), "Bioinformatics Technologies", First Indian Reprint, Springer Verlag, 2007.

REFERENCE BOOKS

1. Arthur M Lesk, "Introduction to Bioinformatics", Fourth Edition, Oxford University Press, 2008
2. Rui Jiang, Xuegong Zhang, Michael Q Zhang, "Basics of Bioinformatics", Tsinghua University Press, Springer, 2013

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2		3								2	
CO3	3	2		3								3	
CO4	3	2										3	
CO5	3	2										3	
CO6	3	3		3								3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3762	SOFT COMPUTING	30	0	30	30	90	3

OBJECTIVES

- To introduce the ideas of fuzzy sets and fuzzy logic
- To study the characteristics of various types of associative memory networks
- To provide the mathematical background for carrying out the optimization associated with neural network learning and genetic algorithms
- To gain insight in Hybrid Learning Models

UNIT I	INTRODUCTION	6
Difference between Hard and Soft computing, Requirement of Soft computing, Applications of Soft Computing. Fuzzy Systems: Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.		

UNIT II	ASSOCIATIVE MEMORY NETWORK	6
Training algorithm for Pattern Association – Auto associative Memory Network – Hetero associative Memory Network - Bidirectional Associative Memory (BAM) - Hopfield Networks: Discrete Hopfield Network, Continuous Hopfield Network		

UNIT III	CONVENTIONAL OPTIMIZATION	6
Derivative-based Optimization: Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Conjugate gradient Methods – Analysis of Quadratic Case		

UNIT IV	HEURISTIC OPTIMIZATION ALGORITHMS	6
Genetic Algorithms: Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification; Simulated Annealing – Random Search – Particle Swarm Optimization – Ant Colony Optimization		

UNIT V	NEURO FUZZY MODELING	6
Adaptive Neuro-Fuzzy Inference Systems: Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN; Coactive Neuro Fuzzy Modeling: Framework Neuron Functions for Adaptive Networks		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Implement basic operations of fuzzy sets (union, intersection, complement)

2. Develop fuzzy logic systems for tasks such as automatic washing machines or traffic light control and analyze their performance under different input conditions.
3. Implement the auto associative memory network using the Hebbian learning rule.
4. Implement the BAM algorithm and train the network to establish bidirectional associations between pairs of patterns.
5. Implement Classical Newton's Method for optimizing a given function.
6. Implement the simulated annealing algorithm for solving a combinatorial optimization problem (e.g., traveling salesman problem).
7. Implement a genetic algorithm to solve a basic optimization problem (e.g., finding the maximum value of a function).
8. Implement an ANFIS model using a sample dataset and train it using the hybrid learning algorithm

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply fuzzy set theory and fuzzy inference mechanisms to implement rule-based decision-making systems (K3)

CO2 Apply the concepts of associate memory networks in solving computational problems (K3)

CO3 Analyse derivative-based optimization techniques on computational problems(K4)

CO4 Choose an appropriate heuristic optimization algorithm to solve the given problem (K5)

CO5 Explain the use of neuro-fuzzy hybrid models (K2)

TEXT BOOKS

1. J S R Jang, C T Sun, E Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education, 2004. (Unit I, III & V)
2. S. N. Sivanandan, S. N. Deepa, "Principles of Soft Computing", Wiley Publications, 3rd Edition, 2018 (Unit II, IV)

REFERENCE BOOKS

1. S Rajasekaran, G A Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, International Editions, Electrical Engineering Series, Singapore, 1997
3. Davis E Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Stamatios V Kartalopoulos, "Understanding Neural Networks and Fuzzy Logic Basic concepts& Applications", IEEE Press, PHI, New Delhi, 2004.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2	3		2							2	
CO4	3	2	3	3	2			1	2		2	2	2
CO5	3	2											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3722	AGENTIC PROCESS AUTOMATION	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamentals of intelligent agents and agent-based systems for process automation.
- To study models of planning, scheduling, and decision-making for autonomous agents.
- To explore multi-agent coordination, negotiation, and distributed optimization.
- To integrate learning, reasoning, and adaptation into automated agentic systems.
- To apply agentic automation principles in real-world applications such as business processes, robotics, and CPS.

UNIT I	FUNDAMENTALS OF AGENTIC SYSTEMS	9
Agents and Environments – Agent architectures: reactive, deliberative, hybrid – Properties of intelligent agents (autonomy, reactivity, proactivity, social ability) – Rationality and utility – Applications in automation and decision support		

UNIT II	PLANNING AND AUTOMATED REASONING	9
Classical planning concepts – State-space search and heuristics – STRIPS and operator-based models – Planning graphs and SAT-based planning – Plan execution under uncertainty – Case studies in process automation		

UNIT III	MULTI-AGENT SYSTEMS AND COORDINATION	9
Distributed constraint satisfaction – Negotiation and contract-net protocols – Auctions and mechanism design – Coalitional game theory – Resource allocation strategies – Communication and coordination among agents.		

UNIT IV	LEARNING AND ADAPTION IN AGENTIC AUTOMATION	9
Reinforcement learning for agents – Belief revision and probabilistic reasoning – Multi-agent reinforcement learning – Evolutionary learning and adaptation – Emergent behaviors in large-scale agentic systems.		

UNIT V	APPLICATIONS OF AGENTIC PROCESS AUTOMATION	9
Robotic process automation – Workflow automation in enterprises – Intelligent decision support systems – Cyber-Physical Systems and IoT – Ethical, security, and societal implications – Case studies across business, robotics, and CPS		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental principles of intelligent agents and their role in process

automation. (K2)
CO2 Apply planning and reasoning models for autonomous task execution. (K3)
CO3 Analyze multi-agent coordination mechanisms such as negotiation, auctions, and coalition formation. (K4)
CO4 Evaluate agent learning strategies and adaptive behaviours in dynamic environments. (K5)
CO5 Apply agentic process automation techniques to real-world domains including business processes, CPS, and IoT. (K3)

TEXT BOOKS

1. Stuart J. Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Edition, Pearson, 2010 (Units – I, IV, V)
2. Stuart J. Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Edition, Pearson, 2010 (Units – I, IV, V)
3. Yoav Shoham & Kevin Leyton-Brown, *Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*, Cambridge University Press, 2009. (Units – III, IV, V)

REFERENCE BOOKS

1. Michael Wooldridge, *An Introduction to MultiAgent Systems*, Wiley, 2015.
2. Gerhard Weiss (Ed.), *Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence*, MIT Press, 2013.
3. Ian Millington, *Artificial Intelligence for Games*, CRC Press, 2019 (for applied agentic decision-making).

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										3	2
CO2	3	3	2		2							3	2
CO3		3	3	2		2						3	
CO4		2	3	3	2	2		3	2			3	3
CO5	2		3		2	3	2					3	3
CO6													

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3723	ARTIFICIAL INTELLIGENCE BASED SEARCH METHODS FOR PROBLEM SOLVING	45	0	0	45	90	3

OBJECTIVES

- To introduce students to the fundamental concepts of state-space search and its role in solving AI problems.
- To learn various uninformed and informed search strategies for state-space exploration.
- To understand constraint satisfaction problems (CSPs) and their applications in problem-solving.
- To provide exposure to adversarial search and reasoning techniques.

UNIT I	INTRODUCTION TO AI AND PROBLEM SOLVING	9
Definition of AI and its applications- AI problem formulation and state space representation- Characteristics of AI problems; Problem-solving as a search activity- Uninformed search techniques: Breadth-First Search (BFS), Depth-First Search (DFS), Depth-Limited Search, Iterative Deepening DFS.		

UNIT II	HEURISTIC AND POPULATION-BASED SEARCH	9
Heuristics and evaluation functions - Best-First Search, Hill Climbing, Escaping Local Optima, Stochastic Local Search- Hill Climbing, Escaping Local Optima, Stochastic Local Search - Solution Space and optimization problems: Traveling Salesman Problem (TSP) - Population-Based Methods: Genetic Algorithms (GA), Ant Colony Optimization, SAT problem-solving.		

UNIT III	OPTIMAL PATH SEARCH	9
Pathfinding Algorithms: Branch and Bound, A* Search, Admissibility of A* - Informed heuristic functions and their design - Space-Saving Variants of A*: Weighted A*, IDA*, RBFS - Sequence Alignment, Monotone Condition, DCFS, Beam Stack Search.		

UNIT IV	GAME PLAYING AND AUTOMATED PLANNING	9
Game Playing: Game Theory, Game Trees, Minimax Algorithm, Alpha-Beta Pruning, SSS* - Automated Planning: Domain-independent planning, Forward and Backward Search, Goal Stack Planning, Plan Space Planning - Applications in Blocks World and problem decomposition (Means-Ends Analysis, Algorithm GraphPlan, AO* Algorithm).		

UNIT V	RULE-BASED SYSTEMS AND CONSTRAINT PROCESSING	9
Rule-Based Expert Systems: Production Systems, Inference Engines, Match-Resolve-Execute Cycle, Rete Net; Deduction as Search: First-Order Logic, Soundness,		

Completeness, Forward and Backward Chaining; Constraint Satisfaction Problems (CSPs): Consistency-Based Diagnosis, Backtracking, Arc Consistency, Forward Checking.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the principles of state-space search and its role in solving AI problems. (K2)

CO2 Apply heuristic and population-based search methods to complex problems. (K3)

CO3 Analyse and implement optimal path-finding techniques for various applications. (K4)

CO4 Design and evaluate algorithms for game-playing and automated planning. (K5)

CO5 Solve constraint satisfaction problems and design rule-based expert systems. (K3)

CO6 Design and implement AI-based problem-solving strategies by applying uninformed, informed, population-based, and adversarial search methods, and evaluate their effectiveness for optimization, planning, and constraint satisfaction tasks. (K5)

TEXT BOOKS

1. Deepak Khemani “A First Course in Artificial Intelligence”, McGraw Hill, 2014. (Unit I – V)

2. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 4th Edition, Pearson Education / Prentice Hall of India, 2015. (Unit II - V)

REFERENCE BOOKS

1. Elaine Rich, Kevin Knight, “Artificial Intelligence”, 2nd Edition, Tata McGraw-Hill, 2003.

2. Dawn W Patterson, “Introduction to Artificial Intelligence and Expert Systems”, 1st Edition, Pearson Education India, 2015.

3. Andreas Muller, Sarah Guido, “Introduction to Machine Learning with Python: A Guide for Data Scientists”, Shroff/O’Reilly, 1st edition, 2016.

4. Prateek Joshi, “Artificial Intelligence with Python”, 1st edition, Packt Publishing Limited, 2017.

5. David Poole, Alan Mackworth, “Artificial Intelligence: Foundation of Computational Agents”, 2nd Edition, Cambridge University Press, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3		2		2							2	
CO3	3		3	3								2	
CO4	3	2	3									2	
CO5	3	2	3									2	
CO6	3	2	3	3	2			3	2			2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3763	WEARABLE COMPUTING	30	0	30	30	90	3

OBJECTIVES

- To explore and understand the building blocks of Wearable Computing
- To enumerate the details of Body Sensor Networks (BSN).
- To understand the features of various types of BSNs.
- To integrate Wearable and Cloud Computing.
- To explore different software tools required and develop BSN applications

UNIT I	INTRODUCTION TO WEARABLE COMPONENTS AND BUILDING BLOCKS	6
History - Internet of Things and Wearables - Wearables' Mass Market Enablers - Human Computer Interface and Human Computer Relationship. Bluetooth Low Energy (BLE) - Embedded Software Programming - Sensors for Wearables - Android Wear: Notification Settings and Control, Wear Network - Android Wear API: DataItem – DataMapItem – DataMap - Google Fit API		

UNIT II	BODY SENSOR NETWORKS	6
Typical m-Health System Architecture - Hardware Architecture of a Sensor Node - Communication Medium - Power Consumption Considerations - Communication Standards - Network Topologies - Commercial Sensor Node Platforms - Bio-physiological Signals and Sensors - BSN Application Domains – Developing BSN Applications		

UNIT III	AUTONOMIC AND AGENT - ORIENTED BODY SENSOR NETWORKS	6
Task-Oriented Programming in BSNs - SPINE framework - Task-Based Autonomic Architecture - Autonomic Physical Activity Recognition - Agent-Oriented Computing and Wireless Sensor Networks - Mobile Agent Platform for SUN SPOT (MAPS) - Agent-Based Modeling and Implementation of BSNs - Reference Architecture for Collaborative BSNs		

UNIT IV	INTEGRATION OF WEARABLE AND CLOUD COMPUTING	6
Background - Motivations and Challenges- Reference Architecture for Cloud-Assisted BSNs - BodyCloud: A Cloud-based Platform for Community BSN Applications - Engineering Body Cloud Applications - SPINE Based Design Methodology		

UNIT V	SPINE-BASED BODY SENSOR NETWORK APPLICATIONS	6
Introduction - SPINE1.x - Install SPINE 1.x - Use SPINE - Run a Simple Desktop Application Using SPINE1.3 - SPINE Logging Capabilities - SPINE2 - Install SPINE2 - Use the SPINE2 API - Run a Simple Application Using SPINE2, Physical Activity Recognition - Step Counter - Emotion Recognition - Handshake Detection		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Study of wearable development platforms (Hardware and Software).
2. Data acquisition from accelerometer and gyroscope and visualization in real-time.

3. Integration of heart rate monitor and data analysis.
4. Integration of temperature and pressure sensors.
5. ECG monitoring with compact sensors.
6. Designing an effective wearable user interface.
7. Implementation of power saving strategies for energy efficient node designs.
8. Development of wearable applications (Eg: Fall detection system, Healthcare monitoring, Physical activity tracking using SPINE framework etc.)

COURSE OUTCOMES

On successful completion of this course, students will be able to

- | | |
|---|-----------|
| CO1 Demonstrate knowledge of wearable computing and its building blocks | K2 |
| CO2 Use programming frameworks for BSNs to solve real-world applications. | K3 |
| CO3 Model automatic and agent-based body sensor networks. | K3 |
| CO4 Develop applications using body sensor networks by integrating cloud environments for real-world scenarios. | K3 |
| CO5 Evaluate various tools and develop body sensor networks applications using required tools. | K5 |

TEXT BOOKS

1. Fortino, Giancarlo, Raffaele Gravina, and Stefano Galzarano, Wearable computing: from modelling to implementation of wearable systems based on body sensor networks, 2018, 1st edition, John Wiley & Sons, USA. (Unit II to V)
2. Barfield, Woodrow, ed. Fundamentals of wearable computers and augmented reality, 2015, 1st edition, CRC press, USA (Unit I)

REFERENCE BOOKS

1. Sanjay M. Mishra, Wearable Android™: Android wear & Google Fit app development, 2015, 1st edition, John Wiley & Sons, USA (Unit I)
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013. (Unit IV)
3. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012. (Unit III, V)
4. Guang-Zhong Yang (Ed.), "Body Sensor Networks, "Springer, 2006. (Unit II)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										2	
CO3	3	2			2							2	
CO4	3	2	2		2							3	2
CO5	3				2			3	3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3764	SOFTWARE PROJECT MANAGEMENT	30	0	30	30	90	3

OBJECTIVES

- To understand the basic concept of project management
- To learn the various costings and life cycle management
- To understand the role played by risk in software projects
- To appreciate the use of metrics for software project management
- To know the challenges in people management

UNIT I	PROJECT MANAGEMENT	6
Software Project Management: Approaches- Project Life Cycle - Project Evaluation - Project acquisition - Initiation - Planning - Execution control - Change management - Scheduling - Network planning models - Identifying critical activities - Project closure		

UNIT II	PROCESS MODELS & LIFECYCLE MANAGEMENT	6
Introduction to life cycle models - Agile development models: Extreme programming, Scrum - Project planning - Metrics of project size estimation: Function Point Analysis, Object Point - Project estimation techniques: Empirical techniques, COCOMO, Halstead - Staffing level - Quality Standards: ISO 9000, SEI CMM, SPICE, PSP		

UNIT III	RISK MANAGEMENT	6
Perspectives of Risk Management - Risk Definition - Risk Categories - Risk planning, Management and Control - Risk Assessment: Approaches, techniques - Risk Identification - Risk Analysis - Risk Prioritization - Risk Control - Risk Retention - Risk Transfer - Failure Mode and Effects Analysis (FMEA) - Operational Risks - Supply Chain Risk Management		

UNIT IV	SOFTWARE METRICES	6
Need for Software Metrics: scope, basics, framework - Product Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality Metrics - Process metrics: Empirical Models, Statistical Models, Theory-based Models, Composite Models, Reliability Models - Measuring Internal/External Attributes - Monitoring and control: Visualizing Progress, Earned value analysis - Resource Allocation: Requirements, scheduling, critical paths - Creating critical paths - Publishing schedule - Cost schedules - Sequence schedule.		

UNIT V	PEOPLE MANAGEMENT	6
Leadership styles - Leadership assessment - Organizational strategy - Management - Team building - Delegation - Team Management - Rewarding - Client Relationship Management - Organizational structures - Stress: Stress management - Health and safety - Ethical and professional concerns- Working in teams - Decision making - Organization and team		

structure - Coordination dependencies – Dispersed and virtual teams - Communication genres and plan.

TOTAL PERIODS

90

SUGGESTED EXPERIMENTS

1. Using MS Project/OpenProject, prepare a *Project Charter* and *Scope Document* for a case study (e.g., Hospital Management System). Develop a Work Breakdown Structure (WBS), milestones, and task dependencies. Generate a Gantt Chart and Network Diagram.
2. Apply PERT/CPM techniques to a project using MS Project/Primavera. Identify the critical path, slack time, and perform resource leveling. Submit the critical path analysis report.
3. Using **Jira/Trello**, simulate **Agile Scrum project management**. Create backlog items, assign Scrum roles, conduct sprint planning, and generate a **burndown chart** for sprint tracking.
4. Perform **Function Point Analysis (FPA)** and **COCOMO II estimation** for a software project of your choice. Compare results with empirical estimation techniques and submit a **Cost & Effort Estimation Report**.
5. Prepare a **Risk Register** for a sample software project. Identify risks, classify them into categories (technical, operational, financial, people-related), and use a **Probability–Impact Matrix** to prioritize them.
6. Apply **Failure Mode and Effects Analysis (FMEA)** to the requirements/design phase of a software project. Identify potential failures, compute risk priority numbers (RPN), and propose mitigation strategies.
7. Select an **open-source software project** and use **SonarQube/Understand** to compute metrics such as **Cyclomatic Complexity, Halstead Metrics, and Quality Metrics**. Analyze and interpret the results in a metrics report.
8. Using sample project data, perform an **Earned Value Analysis (EVA)**. Compute PV, EV, AC, SV, and CV. Present results as a **Project Health Report** with performance interpretation.
9. Conduct a **leadership simulation activity** for project team management. Assign responsibilities using a **RACI Matrix**. Compare the effectiveness of different leadership styles and submit a **Team Reflection Report**.
10. Simulate a **project team conflict scenario**. Develop a **Communication Management Plan** specifying communication channels, frequency, escalation hierarchy, and resolution strategy.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Summarize various steps involved in software project management (K2)

CO2 Choose an appropriate process model and estimate project cost and effort required (K5)

CO3 Identify existing risks and perform risk assessment (K3)

CO4 Select appropriate metrics for software project management (K3)

CO5 Analyze leadership styles and team building strategies to improve people management in projects (K4)

TEXT BOOKS

1. Gerard O'Regan, "Guide to Software Project Management", Springer, 2025. (Units I, II, III, IV, V)
2. Rajib Mall, "Fundamentals of Software Engineering", 3rd ed., PHI, 2009. (Unit II)
3. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management", 6th ed., McGraw Hill, 2018. (Unit I, V)
4. Norman Fenton, James Bieman, "Software Metrics", 3rd ed., CRC Press, 2015. (Unit IV)

REFERENCE BOOKS

1. Ravindranath Pandian, "Applied Software Risk Management", Auerbach, 2007. (Unit III)
2. Antonio Borghesi, Barbara Gaudenzi, "Risk Management", Springer, 2012. (Unit III)
3. Roger S. Pressman, *Software Engineering – "A Practitioner's Approach"*, 8th ed., McGraw-Hill, 2014. (Unit I, II)
4. Jalote P., "Software Project Management in Practice", 2nd ed., Pearson, 2003. (Unit V)
5. Murali Chemuturi & Thomas M. Cagley, *Mastering Software Project Management*, 2nd ed., CRC Press, 2022. (Unit I)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2						2	2	2	
CO2		3	3	2	3	2				2		2	
CO3		3	3	3	2	2	2			2		3	
CO4		2	3	3	3	2				2		3	
CO5			3	3	2	3	3	3	3	3	2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3765	APPLICATION DEVELOPMENT USING AR, VR AND MR	30	0	30	30	90	3

OBJECTIVES

- To impart the fundamental development principles of AR/VR/MR applications.
- To gain knowledge about VR application development with unity.
- To gain knowledge about AR application development with unity.
- To learn the scripting languages for AR/VR applications.
- To design and develop real-time AR/VR/MR applications.

UNIT I	FUNDAMENTALS OF AR, VR AND MR	6
Categorizing the realities – Virtual Reality, Augmented Reality & Mixed Reality – Features and application areas of Virtual Reality, Augmented Reality & Mixed Reality - Integration of VR techniques - Contents objects and scale - Gaze- based Control - Handy Interactables - IDE setup with package files - concepts and features of VR - Working with AR techniques - compatibility with the environment - system architecture - AR terminology - application areas of AR - Integration of AR toolkits with existing IDE's.		

UNIT II	VR APPLICATION DEVELOPMENT	6
VR SDK'S and Frameworks – OpenVR SDK - StreamVR SDK – VRTK - Oculus SDK - Google VR SDK - VR Concept Integration: Motion Tracking – Controllers - Camera - Hardware and Software requirements - Setting up Unity with VR: Framework/SDK Integration with Unity - Debugging VR projects - Unity XR API's - Mobile VR Controller Tracking - Object Manipulation - Text optimizing and UI for VR.		

UNIT III	AR APPLICATION DEVELOPMENT	6
Detection of surfaces - Identifying feature points - Track virtual objects in real world - Face and object tracking - SLAM Algorithm (Simultaneous Localization and Mapping) - Understanding uncertain spatial relationship - Loop detection and Loop closing - Unity AR concepts: Pose tracking -Environmental detection - Raycasting and physics for AR - Light estimation, Occlusion – ARCore – ARToolkit – Vuforia.		

UNIT IV	PROGRAMMING LANGUAGES FOR AR & VR APPLICATIONS	6
C# with Unity – Classes in C# - Setting up visual studio or code editor for C# - 3D models compatibility with C# - C# for AR and VR C++ with Unreal Engine – Building and compiling C++ programs with unreal engine - Variables and memory - Looping and if else structures with unreal Engine - Functions and macros - Adding actors to the scene - Dynamic memory allocations.		

UNIT V	USE CASES FOR AR, VR AND MR	6
Gaming and Entertainment: Immersive video/Cinematic VR - Architecture and Construction: Artificial Spaces - Science and Engineering: Automotive Engineering - Health		

and Medicine: Training and Treatment - Aerospace and Defense: Flight Simulation and Training – Education: Tangible Skills Education - Telerobotics and Telepresence - Human Factors Considerations - Legal and Social Considerations.

TOTAL PERIODS

90

SUGGESTED EXPERIMENTS

1. Develop a virtual science lab for performing experiments.
2. Develop a virtual tour of a home with 2 rooms.
3. Develop a marker based augmented reality learning application for kids.
4. Develop an interior design application for planning and organizing the furniture.
5. Develop a QR code-based index retrieval system for library.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the basics of AR, VR and MR (K2)

CO2 Develop VR applications using various toolkits in Unity (K3).

CO3 Develop AR applications using various toolkits in Unity (K3)

CO4 Apply scripting languages to objects for interacting in AR/VR/MR environment (K3).

CO5 Design and develop VR applications by using different tools and technologies of VR programming (K6).

TEXT BOOKS

1. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13 : 978-1838648183 (Unit 1, 2 and 3)
2. William Sherif- Learning C++ by Creating Games with UE4 ||, Packt Publishing, 2015, ISBN 978-1-78439-657-2 (Unit 4)
3. Steve Aukstakalnis- Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, September 2016, ISBN: 9780134094328 (Unit 5)

REFERENCE BOOKS

1. Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178.
2. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2	2		2				2		2	2	
CO3	3	2	2		2				2		2	2	
CO4	3	2	2		2				2		2	2	2
CO5	3	2	2		2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3724	CRYPTOGRAPHY AND DATA SECURITY	45	0	0	45	90	3

OBJECTIVES

- To understand the foundational principles of cryptography and its role in secure communication.
- To explore symmetric and asymmetric encryption algorithms and their applications.
- To study cryptographic data integrity algorithms and their importance in modern security.
- To develop knowledge of access control models and security policies in cryptographic systems.
- To introduce concepts in lightweight and post-quantum cryptographic algorithms.

UNIT I	INTRODUCTION TO CRYPTOGRAPHY	9
The OSI Security Architecture - Security Attacks, Services, Mechanisms, Introduction to Number Theory: Euclidean Algorithm - Modular Arithmetic - Prime Numbers - Fermat's and Euler's Theorems - Testing for Primality - The Chinese Remainder - Discrete Logarithms.		

UNIT II	SYMMETRIC CIPHERS	9
Classical Encryption Techniques: Symmetric Cipher Model - Substitution Techniques Transposition Techniques - Block Ciphers and the Data Encryption Standard – Strengths – Design Principles - Finite Fields – AES - Multiple Encryption and Triple DES – Stream Ciphers – RC4.		

UNIT III	ASYMMETRIC CIPHERS	9
Public-Key Cryptography - Principles of Public-Key Cryptosystems - The RSA Algorithm – Diffie-Hellman Key Exchange - Elgamal Cryptographic System - Elliptic Curve Arithmetic - Elliptic Curve Cryptography.		

UNIT IV	CRYPTOGRAPHIC DATA INTEGRITY ALGORITHMS	9
Applications of Cryptographic Hash Functions - Requirements and Security - Secure Hash Algorithm (SHA) - Message Authentication Codes: Requirements - Functions - Security of MACs - HMAC - DAA and CMAC. Digital Signatures: -ElGamal Digital Signature Scheme -Schnorr Digital Signature Scheme Lightweight Cryptography: Concepts – Algorithms - Post-Quantum Cryptographic Algorithms.		

UNIT V	CRYPTOGRAPHIC DATA INTEGRITY ALGORITHMS	9
Access Control Matrix - Security Policies - Types of Security Policies -The Role of Trust - Types of Access Control - Confidentiality Policies: Goals - The Bell-LaPadula Model. Integrity Policies: Biba Integrity Model - Clark-Wilson Integrity Model. Hybrid Policies: Chinese Wall - Bell-LaPadula and Chinese Wall Models - Clark-Wilson and Chinese Wall Models - Clinical Information Systems Security Policy- Bell-LaPadula and Clark-Wilson Models - Originator Controlled Access - Role-Based Access Control.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Explain fundamental security services, attacks, and mechanisms, and apply basic number theory concepts in cryptographic algorithms. (K2)
CO2 Analyze classical and modern symmetric encryption and evaluate their design principles and strengths. (K4)
CO3 Apply and compare asymmetric cryptographic techniques including RSA, Diffie-Hellman and Elliptic Curve Cryptography. (K3)
CO4 Apply cryptographic data integrity algorithms and security models to secure real-world systems and understanding emerging trends in lightweight and post-quantum cryptography. (K3)
CO5 Design and implement a secure system or policy framework using cryptographic techniques, integrating access control models and post-quantum cryptography principles. (K6)

TEXT BOOKS

1. William Stallings, Cryptography and Network Security Principles and Practice Eighth Edition, Global Edition, Pearson, 2023. (Units: 1- 4)
2. Matt Bishop, Computer Security: Art and Science, 2nd edition, Addison Wesley, 2019. (Unit: 5)

REFERENCE BOOKS

1. Menezes, A., van Oorschot, P., Vanstone, S, Handbook of Applied Cryptography, CRC Press 2018.
2. Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, Second Edition, CRC Press, 2015
3. Christopher Swenson, Modern Cryptanalysis: Techniques for Advanced Code Breaking 1, 1st Edition, 2022
4. A Graduate Course in Applied Cryptography Dan Boneh and Victor Shoup Version 0.6, Jan. 2023
5. Wenliang Du, Computer Security: A Hands-on Approach, CreateSpace Independent Publishing Platform, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	
CO2	3	3										3	
CO3	3	3	3									3	
CO4	3	2										3	
CO5	3	2										3	
CO6	3	2	3		2	3		3			2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3766	MALWARE ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- To introduce malware fundamentals, types, and their system effects.
- To explore advanced static analysis of malware, including x86 architecture and PE file formats, with tools like IDA Pro.
- To learn advanced dynamic analysis, debugging, and tracing malware behavior using tools like OllyDbg and Process Monitor.
- To study malware functionalities, persistence mechanisms, and detection methods like YARA and network analysis.
- To analyze rootkits, kernel-level malware, and Android malware using specialized tools and techniques.

UNIT I	INTRODUCTION AND BASIC ANALYSIS	6
Overview of Malware: Goals of Malware Analysis, AV Scanning, Hashing, Finding Strings, Packing and Obfuscation, Portable Executable (PE) file format, Static, Linked Libraries and Functions, Static Analysis tools. Basic Malware Analysis: Virtual Machines and Sandboxing, Basic dynamic analysis, Malware execution, Process Monitoring, viewing processes, Registry snapshots, Creating fake networks.		

UNIT II	ADVANCED STATIC ANALYSIS	7
X86 Architecture and PE File Format: X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, Disassembly, Portable Executable File Format, The PE File Headers and Sections. Tools for Static Analysis: IDA Pro and Ghidra, obfuscation techniques, packing, metamorphism, polymorphism, Anti-static Analysis Techniques.		

UNIT III	ADVANCED DYNAMIC ANALYSIS	7
Live and Dead Malware Analysis: Live malware analysis, System Behavior, Evasion techniques: VM detection, anti-debugging, and anti-dynamic analysis techniques. Debugging and Tracing Malware: Kernel vs. User-Mode Debugging, Tools: OllyDbg, WinDbg, Process Monitor for debugging malware, Techniques: Breakpoints, tracing, patching, exception handling, and reverse engineering.		

UNIT IV	MALWARE FUNCTIONALITY AND DETECTION	6
Malware Functionalities: Downloaders and Launchers, Backdoors and Credential Stealers, Persistence Mechanisms, Privilege Escalation, Covert malware launching, process injection, process replacement, hook injection, and APC injection. Malware Detection: YARA Rule-Based Detection, Network Detection, Indicators of Compromise (IOCs).		

UNIT V	ROOTKITS, KERNEL-LEVEL ANALYSIS, AND ANDROID MALWARE	4
Rootkits and Kernel-Level Analysis: Rootkits Overview, Anti-forensics, Kernel Debugging, IDA Pro and WinDbg. Android Malware Overview: Android Architecture and Malware Analysis, Static and Dynamic Analysis for Android Malware: APK Tool, APK Inspector, Dex2Jar, and JD-GUI for Android malware analysis.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Experimentation on Initial Infection Vectors and Malware Discovery. 2. Implementation on Sandboxing Malware and Gathering Information from Runtime Analysis using IDA Pro, Cuckoo Sandbox. 3. Implementation on Portable Executable (PE32) File Format using PE Explorer, OllyDbg. 4. Implementation on Executable Metadata and Executable Packers. 5. Experimentation on Malware Self - Defense, Compression, and Obfuscation Techniques. 6. Experimentation on Malware behaviour analysis using Procmon. 7. Experimentation on analyzing Malicious Microsoft Office and Adobe PDF Documents. 8. Experimentation on Mobile malware analysis using Androguard, MSTG, Dex2Jar. 9. Experimentation on Packing and Unpacking of malware using UPX. 10. Experimentation on Rootkit AntiForensics and Covert Channels using Autopsy tool. 11. Experimentation on Modern Rootkit Analysis using GMER. 12. Experimentation on Malware traffic analysis using Wireshark.

COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 : Explain malware types, goals, and basic analysis methods, examining PE file formats and behaviours with tools like PE Explorer. (K2)
CO2 Apply advanced static analysis concepts and obfuscation techniques, analyzing x86 architecture with tools like IDA Pro and Ghidra. (K2)
CO3 Apply dynamic analysis to debug malware, countering evasion techniques with tools like OllyDbg and Process Monitor. (K3)
CO4 Apply detection methods to analyze malware functionalities, creating YARA rules and identifying IOCs with tools like Wireshark. (K3)
CO5 Apply static and dynamic analysis to study malware persistence and network behaviors, using tools like Cuckoo Sandbox and Process Monitor. (K3)
CO6 Create secure mitigation strategies for rootkits and Android malware, synthesizing ethical implications and tool-based analysis with WinDbg and APK Tool. (K6)

TEXT BOOKS

1. Michael Sikorski and Andrew Honig, "Practical Malware Analysis" by No Starch Press, 2012, ISBN: 9781593272906 (Unit I, II, III, IV)
2. Ken Dunham, Shane Hartman, Manu Quintans, Jose Andre Morales, Tim Strazzere, "Android Malware and Analysis", CRC Press, Taylor & Francis Group, 2015, ISBN: 9781482252194 (Unit V)

REFERENCE BOOKS

1. Bill Blunden, "The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System", Second Edition, Jones & Bartlett Publishers, 2009.
2. Jamie Butler and Greg Hoglund, "Rootkits: Subverting the Windows Kernel" by 2005, Addison-Wesley Professional, ISBN: 978-0-321-29431-9
3. Bruce Dang, Alexandre Gazet, Elias Bachaalany, Sébastien Josse, "Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation", 2014, ISBN: 978-1-118-78731-1.
4. Victor Marak, "Windows Malware Analysis Essentials" Packt Publishing, O'Reilly, 2015, ISBN: 9781785281518
5. Windows Malware Analysis Essentials by Victor Marak, Packt Publishing, 2015.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2			2							3	2
CO2	3	3	3		3							3	2
CO3		3	3	3	2							3	3
CO4		3	2	3	2							3	3
CO5			3	3	2							3	
CO6		2	3		2	2	2	3	2		2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3725	CYBER FORENSICS	45	0	0	45	90	3

OBJECTIVES

- To learn basics of computer forensics
- To familiarize with forensics tools
- To analyze and validate forensics data
- To Identify the vulnerabilities in a given network infrastructure
- To understand hacking techniques to test system security

UNIT I	INTRODUCTION TO COMPUTER FORENSICS	9
Computer Forensics Fundamentals: Introduction to Computer Forensics -- Use of Computer Forensics in Law Enforcement -- Computer Forensics Services -- Benefits of Professional Forensics Methodology -- Who Can Use Computer Forensic Evidence; Types of Computer Forensics Technology; Types of Computer Forensics Systems.		

UNIT II	INCIDENT RESPONSE	9
Incident Response Methodology -- Pre-Incident Preparation -- Detection of Incidents -- Initial Response -- Formulate a Response Strategy; Preparing Individual Hosts -- Preparing a Network -- Establishing Appropriate Policies and Procedures; Preparing for Computer Investigations.		

UNIT III	INVESTIGATION	9
Understanding Computer Investigations: Preparing a Computer Investigation--Taking a Systematic Approach--Procedures for Corporate High-Tech Investigations -- Understanding Data Recovery Workstations and Software -- Conducting an Investigation. Creating a Response Toolkit.		

UNIT IV	EVIDENCE COLLECTION AND FORENSICS TOOLS	9
Processing Crime and Incident Scenes – Working with Windows and DOS Systems. Current Computer Forensics Tools: Software/ Hardware Tools.		

UNIT V	ANALYSIS AND VALIDATION	9
Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the principles, services, systems, and technologies related to computer forensics and its applications. (K2)

CO2 Apply structured incident response methodologies to prepare for, detect, and respond

to cybersecurity events. (K3)
CO3 Analyze computer investigation procedures, data recovery strategies, and digital evidence handling techniques. (K4)
CO4 Demonstrate the use of forensics tools to collect and process evidence from different system environments. (K3)
CO5 Compare and interpret various digital forensics techniques such as remote acquisition, email tracing, and mobile device forensics. (K4)

TEXT BOOKS

1. John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Cengage Learning, 2nd Edition, 2005. (Unit 1 Chapter 1,2,3)
2. Kevin Mandia, Chris Prosise, "Incident Response & Computer Forensics", Second Edition. (Unit 2 chapter 2,3, unit 3 chapter 3)
3. Nelson, Phillips, Enfinger, Steuart, "Computer Forensics and Investigations", Cengage Learning, India Edition, 2008. (Unit 2 chapter 1, Unit 3 chapter 2, Unit 4 chapter 5,6,7, Unit 5 chapter 9-13)

REFERENCE BOOKS

1. CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2015.
2. Richard E. Smith, "Internet Cryptography", 3rd Edition Pearson Education, 2008.
3. Marjie T. Britz, "Computer Forensics and Cyber Crime": An Introduction", 3rd Edition, Prentice Hall, 2013. Milton J S, Arnold J C, "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 2014

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2	2	3								3	3
CO3	3	2		3								2	
CO4	3	2	2	3									
CO5	3	2	2	3								3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3726	DISTRIBUTED SYSTEMS	45	0	0	45	90	3

OBJECTIVES

- To introduce the computation and communication models of distributed systems
- To suggest solutions for synchronization and consistency issues of distributed systems
- To utilize distributed mutual exclusion and distributed deadlock detection techniques
- To elucidate agreement protocols and Fault Tolerance mechanisms in Distributed Systems
- To explore the features of Peer-to-Peer systems and memory consistency models.

UNIT I	INTRODUCTION	8
Introduction: Definition-Relation to computer system components -- Motivation -- Relation to parallel multiprocessor/multicomputer systems -- Message-passing systems versus shared memory systems -- Primitives for distributed communication -- Synchronous versus asynchronous executions -- Design issues and challenges; A model of distributed computations: A distributed program -- A model of distributed executions -- Models of communication networks -- Global state of a distributed system -- Cuts of a distributed computation -- Past and future cones of an event -- Models of process communications.		

UNIT II	LOGICAL TIME AND GLOBAL STATE	10
Logical Time: Physical clock synchronization: NTP -- A framework for a system of logical clocks -- Scalar time -- Vector time; Message ordering and group communication: Message ordering paradigms -- Asynchronous execution with synchronous communication -- Synchronous program order on an asynchronous system -- Group communication -- Causal order (CO) Total order; Global state and snapshot recording algorithms: Introduction -- System model and definitions -- Snapshot algorithms for FIFO channels.		

UNIT III	DISTRIBUTED MUTEX AND DEADLOCK	10
Distributed mutual exclusion algorithms: Introduction -- Preliminaries -- Lamport's algorithm -- Ricart-Agrawala algorithm -- Quorum-based mutual exclusion algorithms -- Maekawa's algorithm -- Token-based algorithms -- Suzuki-Kasami's broadcast algorithm; Deadlock detection in distributed systems: Introduction -- System model -- Preliminaries -- Models of deadlocks -- Knapp's classification of distributed deadlock detection algorithms -- Mitchell and Merritt's algorithm for the single resource model -- Chandy-Misra-Haas algorithm for the AND model -- Chandy-Misra-Haas algorithm for the OR model.		

UNIT IV	CONSENSUS AND RECOVERY	10
Consensus and agreement algorithms: Problem definition -- Overview of results -- Agreement in a failure-free system (synchronous or asynchronous) -- Agreement in (message-passing) synchronous systems with failures -- Agreement in asynchronous message-passing systems with failures; Check pointing and rollback recovery: Introduction -- Background and definitions -- Issues in failure recovery -- Checkpoint-based recovery -- Koo-Toueg coordinated check pointing algorithm -- Juang- Venkatesan algorithm for asynchronous checkpointing and recovery.		

UNIT V	PEER TO PEER AND DISTRIBUTED SHARED MEMORY	7
Peer-to-peer computing and overlay graphs: Introduction – Data indexing and overlays -- Tapestry; Distributed shared memory: Abstraction and advantages -- Memory consistency models -- Lamport's Bakery Algorithm.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1: Illustrate the foundations of Distributed Systems (K2)
CO2: Propose solutions for synchronization and state consistency problems (K6)
CO3: Apply the resource sharing techniques of Distributed systems for the problems involving mutual exclusion (K3)
CO4: Model solutions for the fault tolerance issues of Distributed Systems (K3)
CO5: Apply the problem-solving techniques to solve indexing and memory consistency problems of Distributed Systems (K3)
CO6: Adapt the fundamental solutions of distributed systems to modern computing paradigms (K6)

TEXT BOOKS
1. Kshemkalyani Ajay D, Mukesh Singhal. "Distributed computing: Principles, Algorithms and Systems". Cambridge University Press, 2011. (Units 1,2,4,5)
2. Mukesh Singhal, Niranjan G Shivaratri. "Advanced Concepts in Operating Systems". McGraw-Hill, 1994. (Unit 3)

REFERENCE BOOKS
1. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.
2. Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", PrenticeHall of India, 2007.
3. Tanenbaum A S, Van Steen M, "Distributed Systems: Principles and Paradigms", Pearson Education, 2007.
4. Liu M L, "Distributed Computing, Principles and Applications", Pearson Education, 2004.
5. Nancy A Lynch, "Distributed Algorithms", Morgan Kaufman Publishers, USA, 2003.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2										2	
CO3	3	2										3	
CO4	3	2										3	
CO5	3	2										2	
CO6	3	3		3				2	2			3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3767	BIG DATA TECHNOLOGIES	30	0	30	30	90	3

OBJECTIVES

- To understand the fundamentals of big data for efficient data management
- To be familiar with core big data technologies used for handling big data
- To comprehend big data frameworks for faster querying and stream processing

UNIT I	SOFTWARE PROCESS AND PLANNING	5
Understanding Big Data: Concepts and terminology, Big Data Characteristics, Different types of Data, Identifying Data Characteristics - Big Data Architecture - Big Data Storage: File system and Distributed File System, NoSQL, Sharding, Replication, Sharding and Replication, ACID and BASE Properties.		

UNIT II	HADOOP CORE COMPONENTS	6
Hadoop Architecture - Hadoop Distributed File System (HDFS) –YARN – Hadoop I/O – Map Reduce (MR): Developing MR application – MR working procedure – Types and Formats - Features of Map reduce: sorting and joins- Pipelining MapReduce jobs.		

UNIT III	DATA MANIPULATION USING PIG	6
Introduction - Pig Architecture – Grunt shell - Pig Data Model: Data Types, Arithmetic operators, Relational operators – Build-in functions: Eval, Load/Store, Math, String, DateTime, Tuple, Bag, Map – Writing UDF – Control Structures: Embedded PIG using Java – Working with Scripts.		

UNIT IV	HIVE QUERY LANGUAGE	6
Introduction-Hive modules - Data types and file formats - Hive QL-Data Definition and Data Manipulation - Hive QL queries - Hive QL views- Hive scripts, Hive QL Indexes- Aggregate functions-Bucketing vs Partitioning.		

UNIT V	UNIFIED ANALYTICS USING SPARK	7
Overview of Spark – Hadoop Overview of Spark – Hadoop vs. Spark – Cluster Design – Cluster Management – performance, Application Programming interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, and Saving RDD - Lazy Operation – Spark Jobs - Developing SPARK applications.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Installing and configuring the Hadoop framework. HDFS Commands. 2. Map Reduce Program to show the need of combiner. 3. Map Reduce I/O Formats – Text, Key – Value 4. Map Reduce I/O Formats – NLine – Multiline 5. Installing and Configuring Apache PIG and HIVE 6. Querying datasets using PIG LATIN Language

7. Analyse datasets using HIVEQL
 8. Sequence File Input / Output Formats
 9. Distributed Cache & Map side Join, Reduce Side Join
- Building Spark Streaming application

COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Explain the characteristics of big data and data management strategies (K2)
- CO2 Develop MapReduce programs using HDFS (K3)
- CO3 Make use of PIG and HIVE to query and analyze large datasets (K3)
- CO4 Develop streaming applications using Apache Spark (K3)
- CO5 Build application using Big Data Frameworks in teams applying best practices (K6)

TEXT BOOKS

1. Big Data Fundamentals: Concepts, Drivers & Technique, Thomas Erl, Wajid Khattak, Paul Buhler, Pearson, January 2016 (unit 1)
2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media, Inc., Fourth Edition, 2015. (unit 2)
3. Beginning Apache Pig: Big Data Processing Made Easy, Balaswamy Vaddeman, Apress, 2016. (unit 3)
4. Programming Hive, Edward Capriolo, Dean Wampler, Jason Rutherglen, O'REILLY, September 2012. (unit 4)
5. Spark – The Definitive Guide: Big data processing made simple Paperback – 9 March 2018, Bill Chambers, Matei Zaharia, O'REILLY (unit 5)

REFERENCE BOOKS

1. Mike Frampton "Mastering Apache Spark" – Packt Publishing 2015.
2. Adam Shook and Donald Mine, "MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems" - O'Reilly 2012.
3. Matei Zaharia, Bill Chambers, "Spark: The Definitive Guide - Big Data Processing Made Simple (Greyscale Indian Edition) 2018.
4. Jisha Mariam Jose , "Hadoop Practice Guide : SQOOP, PIG, HIVE, HBASE for Beginners", Kindle edition, 2019.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2			3		1								
CO3			3	3	1								
CO4			3		1								
CO5	3	3	3	3	2			3	3			2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3727	MULTIVARIATE STATISTICAL ANALYSIS	45	0	0	45	90	3

OBJECTIVES

- To understand the basic concepts of random vectors and matrices.
- To represent a model for multivariate data.
- To develop different inference methods, such as Multivariate Analysis of Variance (MANOVA).
- To predict the value of one dependent variable based on two or more independent variables using Multiple linear regression model.
- To represent the directions of the data that explain a maximal amount of variance.

UNIT I	MATRICES AND RANDOM VECTORS	9
Basics of Matrices – Positive Definite Matrices – Square Root Matrices - Random vectors – Mean vectors and covariance matrices – Matrix Inequalities and Maximization.		

UNIT II	MULTIVARIATE NORMAL DISTRIBUTION	9
Multivariate Normal density and its properties – Sampling from a Multivariate normal distribution and Maximum Likelihood estimation – Detecting Outliers and Cleaning Data – Transformation to near normality.		

UNIT III	COMPARISONS OF SEVERAL MULTIVARIATE MEANS	9
Comparing mean vectors from two populations – One-way MANOVA (Multivariate ANOVA) Simultaneous Confidence Interval for Treatment effects – Testing for equality of Covariance Matrices.		

UNIT IV	MULTIVARIATE LINEAR REGRESSION	9
Classical Linear Regression Model -Least Square Estimation-Inferences about the Regression Model – Inferences from the Estimated regression function- Multiple regression model with time dependent errors.		

UNIT V	PRINCIPAL COMPONENTS	9
Principal components – Population principal components – Principal components from standardized variables - Principal Components for covariance matrices – Summarizing sample variation by Principal Components – Graphing the Principal Components.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the concepts of positive definite matrices, random vectors, and multivariate normal distribution along with their statistical properties. **(K2)**

CO2 Apply matrix operations and inequalities to evaluate mean and covariance matrices in multivariate data. **(K3)**

CO3	Make use of multivariate statistical techniques such as MANOVA and Simultaneous Confidence Intervals to compare several populations mean. (K3)
CO4	Apply multivariate linear regression models to estimate and infer relationships among variables, including time-dependent errors. (K3)
CO5	Develop a real-life application using data reduction strategies to summarize and visualize multivariate sample variation in teams and document the findings. (K6)

TEXT BOOKS

1. Wolfgang Karl Härdle, Léopold Simar, Matthias R. Fengler, “Applied Multivariate Statistical Analysis”, 6th Edition, Springer, 2024. (Unit I –V)
2. Debbie L. Hahs-Vaughn, “Applied Multivariate Statistical Concepts”, 2nd Edition, Routledge, 2024. (Unit I –V)

REFERENCE BOOKS

1. Johnson, R.A. & Wichern, D.W., Applied Multivariate Statistical Analysis (6th ed.), Pearson Prentice Hall, 2007.
2. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan and Sons, New Delhi, 2001.
3. Richard A. Johnson and Dean W. Wichern, Applied Multivariate Statistical Analysis, Pearson Education, Asia, 5 Edition, 2002.
4. Giri, N.C., Multivariate Statistical Analysis (2nd ed., Revised and Expanded), Marcel Dekker, 2004.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	2										3	
CO3		2										3	
CO4	3	3										3	
CO5				3				3	3				2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3727	FINANCIAL DATA ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of finance data
- To learn about assets and volatility
- To understand the characteristics of high frequency finance data and its risks
- To learn estimation of stochastic models

UNIT I	INTRODUCTION TO FINANCIAL ANALYTICS	6
Introduction to Financial Analytics: Definition, relevance and scope, recent trends, Financial Time Series and Their Characteristics: Asset Returns, Distributional Properties of Returns, Review of Statistical Distributions, and properties of financial time series		

UNIT II	LINEAR MODELS FOR FINANCIAL DATA	6
Stationarity of data, Simple Auto regressive models, ARMA model, Exponential Smoothing and Seasonal models, Model Averaging		

UNIT III	ASSET VOLATILITY AND VOLATILITY MODELS	6
Characteristics of Volatility, Model Building, Testing for ARCH Effect, ARCH model, GARCH model, GARCH-M model, Exponential GARCH model		

UNIT IV	HIGH FREQUENCY FINANCIAL DATA ANALYSIS AND RISK	6
High-Frequency Data Analysis: Nonsynchronous Trading, Bid–Ask Spread of trading Prices, Empirical Characteristics of Trading Data, Models for Price Changes, Duration Models, Risk Measure and Coherence, Risk Metrics		

UNIT V	ESTIMATION OF STOCHASTIC MODELS FOR FINANCE	6
Derivative Pricing: Issues regarding derivative markets. Brownian motion, Short-term interest rates models, Exponential Lévy model, Black - Scholes model. Modeling derivative prices		

SUGGESTED EXPERIMENTS
1. Visualization of financial data 2. Implementation of linear time series – Prediction of Weekly Regular Gasoline Price 3. Asset Portfolio construction from BSE 4. Modeling Stock market volatility using ARCH/GARCH models 5. Visualizing Empirical Characteristics of Trading Data 6. Value-at-Risk(VaR) estimation for IBM stocks 7. Estimation of Sectoral Index derivative

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the fundamental concepts of financial analytics, including time series properties, asset returns, and statistical distributions, and apply them to real-world financial datasets (K2)
CO2 Develop and implement linear time series models (ARMA, Exponential Smoothing) for forecasting financial data and evaluate their performance (K4)
CO3 Analyze volatility in financial markets using ARCH/GARCH models, test for ARCH effects, and interpret results for risk assessment (K4)
CO4 Examine high-frequency trading data, duration models, and Value-at-Risk (VaR) metrics to assess market risks, trading behaviors and ethical implications (K4)
CO5 Choose derivative pricing models and critique their assumptions and limitations in real-market scenarios (K5)

TEXT BOOKS
1. Ruey S. Tsay (2014), “An Introduction to Analysis of Financial Data with R”, Wiley, ISBN: 978-0-470-89081-3 (Unit 1,2,3,4)
2. Stefano M. Iacus (2011), Option Pricing and Estimation of Financial Models with R”, First Edition. Wiley, ISBN: 978-0-470-74584-7 (Unit 5)

REFERENCE BOOKS
1. Bernhard Pfaff (2013), “Financial risk modelling and portfolio optimization with R”, Wiley, ISBN 978-0-470-97870
2. Cairns, A.J. G (2004), “Interest Rate Models: An Introduction”, Princeton University Press, ISBN: 9780691118949
3. Christian Gourieroux & Joann Jasiak (2002), “Financial Econometrics: Problems, Models, and Methods”, Princeton University Press, ISBN: 9780691088723
4. Argimiro Arratia (2014), “Computational Finance An Introductory Course with R”, Atlantis Press, ISBN 978-94-6239-069-0
5. Duffie, D. and Singleton, K.J (2003), “Credit Risk: Pricing, Measurement, and Management”, Princeton University Press, ISBN: 9780691090467

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2			3		2								2
CO3				3		3						3	
CO4				3			3						3
CO5			3						3	2		3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3728	FUNDAMENTALS OF EDGE COMPUTING	45	0	0	45	90	3

OBJECTIVES

- To introduce the foundational concepts and architecture of edge computing.
- To explore edge computing platforms and communication protocols.
- To understand data processing, analytics, and middleware in edge systems.
- To study real-world edge computing applications and challenges.
- To encourage students to develop edge-based IoT applications through team projects.

UNIT I	INTRODUCTION TO EDGE COMPUTING	9
Definition and Evolution – Edge vs. Cloud and Fog – Architecture of Edge Systems – Enabling Technologies: IoT, 5G, AI – Edge Hardware: Raspberry Pi, Jetson Nano; Key characteristics of Edge Computing: Low latency, high bandwidth, and decentralized processing - Applications and Use Cases – Benefits and Challenges.		

UNIT II	NETWORKING AND VIRTUALIZATION IN EDGE COMPUTING	9
Edge Network Architecture – Protocols (MQTT, CoAP, HTTP) – 5G and IoT Integration – Virtualization: VMs and Containers – Docker Basics – Software Defined Networking (SDN) – Network Function Virtualization (NFV) – Security at the Edge.		

UNIT III	DATA MANAGEMENT AND ANALYTICS AT THE EDGE	9
Data Collection and Characteristics – Edge Data Lifecycle – Real-Time Data Processing – Edge Analytics – Stream Processing – AI at the Edge – Data Privacy and Security – Storage and Offloading Strategies.		

UNIT IV	EDGE MIDDLEWARE AND SYSTEM DESIGN	9
Role of Middleware – Edge Middleware Architectures – Resource Allocation – Device Management – System Performance Metrics – Programming Edge Devices – Lightweight Operating Systems – Middleware Examples.		

UNIT V	APPLICATIONS AND INNOVATIONS IN EDGE COMPUTING	9
Smart Healthcare and Wearables – Smart Surveillance – Smart Transport Systems – Industrial Automation – Environmental Monitoring – Federated Learning – TinyML – Legal and Ethical Considerations – Capstone Project Concepts.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the core architecture, components, and enabling technologies of edge computing systems. (K2)
CO2 Apply networking and virtualization principles in designing edge communication systems. (K3)
CO3 Utilize data analytics and middleware tools for efficient edge-based processing and management. (K3)

CO4 Demonstrate understanding of real-time edge applications in various domains. (K3)
CO5 Design and develop an innovative edge-enabled IoT application as part of a team project. (K6)

TEXT BOOKS
1. Perry Lea, IoT and Edge Computing for Architects - Second Edition, Packt Publishing, 2020, ISBN: 9781839214806(UNIT I-V)
2. Rajkumar Buyya, and Satish Narayana Srirama, Fog and Edge computing: Principles and Paradigms, 2019, 1st edition, John Wiley & Sons, USA. (Unit V)

REFERENCE BOOKS
1 Bahga, Arshdeep, and Vijay Madiseti, Cloud computing: A hands-on approach, 2014, 2 nd edition, CreateSpace Independent Publishing Platform, USA.
2 Ovidiu Vermesan, Peter Friess, “Internet of Things –From Research and Innovation to Market Deployment”, 2014, 1st edition, River Publishers, India.
3 Flavio Bonomi, Rodolfo Milito, Jiang Zhu, Sateesh Addepalli, —Fog Computing and Its Role on the Internet of Things, MCC’12, August 17, 2012, Helsinki, Finland. Copyright 2012 ACM 978- 1-4503-1519-7/12/08.
4 David Jensen, “Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												2
CO2		2											2
CO3			2		3						2	3	2
CO4		3						3	3				2
CO5				3	3						2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3769	SOCIAL NETWORK ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- To understand the social network measures and various models.
- To understand patterns of relationships and similarity of the actors in social network.
- To identify communities in the social network.
- To analyze and predict links using link predictions methods.
- To understand the visualization techniques and applications of social networks.

UNIT I	SOCIAL NETWORK MEASURES AND MODELS	6
Introduction: Social Network Perspective - Fundamentals concepts in Network Analysis; Introduction to Network Data: Types of Networks – Centrality of Prestige: Prominence – Directional Relations – Non-Directional Relations - Network growth models.		

UNIT II	STRUCTURAL BALANCE AND STRUCTURAL EQUIVALENCE	6
Structural Balance: Clusterability Theorems - Clustering Coefficient and Transitivity; Structural Equivalence: Definition - Positional Analysis - Measuring Structural Equivalence - Representation of Network Positions.		

UNIT III	COMMUNITY DETECTION	6
Applications of Community Detection – Types of Communities – Community Detection Methods – Disjoint Community Detection – Overlapping Community Detection – Local Community Detection – Community Detection Vs Community Search – Evaluation of Community detection methods.		

UNIT IV	LINK ANALYSIS AND LINK PREDICTION	6
Link Analysis: Applications – Signed Networks – strong and Weak Ties - Link Analysis Algorithms: PageRank – DivRank – SimRank; Link Prediction: Applications - Temporal Changes in a Network – evaluating link Prediction Methods – Heuristics Models – Probabilistic Models – Supervised Random Walk – Information- theoretic Model.		

UNIT V	VISUALIZATION AND APPLICATIONS	6
Visualization: Node-Edge Diagrams - Matrix Representation - Visualizing Online Social Network - Fundamentals of Gephi - A Network Graph Framework - Selecting the Layout - Network Patterns - Working with Filters - Graph Statistics.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Installation and setting up GEPHI.
2. Design a social network for a given dataset to perform visualization using layout algorithms, measure centralities, change the node properties and interpret the network from visual perception.
3. Simulate random and scale-free networks using GEPHI to visualize their topology and interpret the centrality and clustering metrics in the context of real-world social networks.

4. Develop a signed network to identify the balanced and unbalanced Triads in social networks.
5. Apply community detection algorithms to a social network to identify disjoint and overlapping communities and analyse the structure to perform community structure interpretation.
6. To implement and compare key link analysis algorithms—PageRank, DivRank, and SimRank—and evaluate their effectiveness in identifying influential nodes.
7. Evaluate the performance of heuristics and machine learning link prediction approaches using appropriate performance metrics.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain various models in social networks and describe their use in real-world scenarios. (K2)

CO2 Apply techniques to analyze patterns of relationships and determine structural equivalence in social networks. (K3)

CO3 Apply community detection techniques to analyze social network structures. (K3)

CO4 Apply link prediction algorithms to social networks. (K3)

CO5 Work in teams to create and present visual models of real-world social networks by applying social network principles supported by clear documentation and impactful presentations. (K6)

REFERENCE BOOKS

1. Peter Mika, "Social Networks and the Semantic Web", 1st Edition, Springer, 2007.
2. Maksim Tsvetovat and Alexander Kouznetsov, "Social Network Analysis for Startups", O'Reilly, 2011.
3. John Scott, Social Network Analysis, 4th Edition, 2017.
4. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Start-ups: Finding connections on the social web", O'Reilly, 2015.
5. Stephen P Borgatti, Martin G Everett, Jeffrey C Johnson, "Analyzing Social Networks" 2nd Edition, 2018.

TEXT BOOKS

1. Stanley Wasserman, Katherine Faust, "Social Network Analysis Methods and Applications", 1st Edition, Cambridge University Press, 1994. (Unit 1)
2. Social Network Analysis, Tanmoy Chakraborty, Wiley, 2021 (Unit 1, 2, 3, 4)
3. Mastering Gephi Network Visualization, Ken Cherven Packt Publishing Ltd, 2015 (unit 5)
4. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010. (Unit 5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												3
CO2	3	2		3								3	3
CO3	3	2		3								3	3
CO4	3	3	3	3								3	3
CO5	3	3	3	3	2			3	2			3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3729	APPLIED OPTIMIZATION TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- To provide a foundational understanding of optimization techniques and their role in solving real-world problems.
- To explore deterministic and gradient-based methods for solving optimization problems systematically.
- To introduce stochastic and population-based approaches for handling complex and non-convex optimization problems.
- To familiarize learners with multiobjective optimization and surrogate modeling techniques for complex decision-making scenarios.
- To investigate advanced optimization techniques, including discrete and multidisciplinary optimization, to handle specialized challenges.

UNIT I	FUNDAMENTALS OF OPTIMIZATION TECHNIQUES	9
History - Optimization Process - Basic Optimization Problem - Constraints and Critical Points - Conditions for Local Minima - Contour Plots and Visualization, Derivatives and Gradients: Numerical and Automatic Differentiation; Bracketing Methods - Fibonacci Search - Golden Section Search - Quadratic Fit Search - Bisection Method, Local Descent Methods: Descent Direction Iteration - Line Search and Approximate Line Search - Termination Conditions		

UNIT II	DETERMINISTIC OPTIMIZATION METHODS	9
Gradient Descent - Conjugate Gradient - Momentum - Nesterov Momentum - Adagrad - RMSProp - Adadelta - Adam - Hypergradient Descent. Second-Order Methods - Newton's Method - Secant Method - Quasi-Newton Methods. Constraints: Constrained Optimization - Constraint Types - Transformations to Remove Constraints - Lagrange Multipliers - Inequality Constraints - Duality - Penalty Methods - Augmented Lagrange Method - Interior Point Methods - Problem Formulation - Simplex Algorithm		

UNIT III	STOCHASTIC AND POPULATION-BASED METHODS	9
Stochastic Methods: Noisy Descent - Mesh Adaptive Direct Search - Simulated Annealing - Cross-Entropy Method - Covariance Matrix Adaptation, Population-Based Methods: Genetic Algorithms - Differential Evolution - Particle Swarm Optimization - Firefly Algorithm - Hybrid methods		

UNIT IV	MULTIOBJECTIVE OPTIMIZATION & SURROGATE MODELS	9
Multiobjective Optimization: Pareto Optimality - Weight Methods and Constraint Methods Multiobjective Population Methods - Preference Elicitation, Surrogate Models: Fitting Surrogate Models - Linear Models - Basis Functions - Fitting Noisy Objective Functions - Model Selection; Probabilistic Surrogate Models : Gaussian Distribution - Gaussian Processes - Prediction		

UNIT V	ADVANCED OPTIMIZATION TECHNIQUES	9
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Discrete Optimization: Integer Programs - Rounding - Cutting Planes - Branch and Bound - Dynamic Programming - Ant Colony Optimization Multidisciplinary Optimization: Disciplinary Analyses - Interdisciplinary Compatibility -Architectures - Multidisciplinary Design Feasible - Sequential Optimization - Collaborative Optimization - Simultaneous Analysis and Design

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals of optimization, including classical methods, derivative-based techniques, and mathematical foundations for optimization modeling. **K2**

CO2 Apply deterministic and stochastic methods, including gradient-based, population-based, and penalty approaches, to solve real-world constrained and unconstrained optimization problems. **K3**

CO3 Analyze multiobjective optimization problems and surrogate modeling techniques for complex engineering decision-making. **K4**

CO4 Implement and analyze advanced optimization methods such as discrete, hybrid, and multidisciplinary optimization for high-dimensional or domain-specific applications. **K4**

CO5 Design and develop an optimized solution for a complex engineering problem using appropriate algorithms and modeling techniques, integrating real-world constraints and objectives. **K6**

TEXT BOOKS

1. Mykel J. Kochenderfer, Tim A. Wheeler, Algorithms for Optimization, The MIT Press, 2019.

2. Rao S. S. – ‘Engineering Optimization, Theory and Practice’ – New Age International Publishers – 2012 – 4th Edition (All Units)

REFERENCE BOOKS

1. Alaa Khamis, Optimization Algorithms- AI techniques for design, planning, and control problems, Manning, 2024.

2. Joaquim R. R. A. Martins, Andrew Ning, Engineering Design Optimization, Cambridge University Press, 2021

3. R. Horst, P. M. Pardalos, and N. V. Thoai, , Global Optimization, Springer, 2000

4. Hammad, M. M., and M. M. Yahia. Mathematics for Machine Learning and Data Science: Optimization with Mathematica Applications, arXiv preprint arXiv:2302.05964 (2023).

5. Michael Emmerich, André Deutz, Multicriteria Optimization and Decision Making: Principles, Algorithms and Case Studies, arXiv preprint arXiv:2407.00359, 2024

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1							3	2
CO2	3	3									2	3	
CO3	3	3	2									3	
CO4	3	2										3	2
CO5	3	2		3	2	2		3			2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3731	PRINCIPLES OF BRAIN COMPUTER INTERFACE	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamental concepts, history, and architecture of Brain-Computer Interfaces.
- To analyze different types of brain signals and methods for their acquisition and preprocessing.
- To apply machine learning techniques for feature extraction and classification of brain signals.
- To evaluate various BCI paradigms and their real-world applications.
- To explore advanced topics like hybrid BCIs, deep learning, and the ethical considerations in BCI research and deployment.

UNIT I	INTRODUCTION TO BRAIN-COMPUTER INTERFACES	9
History and Evolution of BCI; Definition and Core Concepts. Types of BCI: Invasive, Non-invasive, and Semi-invasive; Active, Reactive, and Passive BCIs. The BCI Loop: Signal Acquisition, Signal Processing, Feature Extraction, Translation/Classification, Application Interface, and Feedback. Applications and Motivation: Assistive Technology, Neurorehabilitation, Gaming and Control, Neuroscience Research.		

UNIT II	SIGNAL ACQUISITION AND PREPROCESSING	9
Non-invasive Signal Modalities: Electroencephalography (EEG), Functional Near-Infrared Spectroscopy (fNIRS), Magnetoencephalography (MEG). Invasive Modalities: Electrocorticography (ECoG), Microelectrode Arrays. EEG in Detail: Electrode Placement (10-20 System), Brain Rhythms (Delta, Theta, Alpha, Beta, Gamma). Signal Preprocessing: Noise and Artifact Removal (e.g., eye blinks, muscle noise), Filtering (Band-pass, Notch), Signal Segmentation (Epoching), and Spatial Filtering.		

UNIT III	FEATURE EXTRACTION AND MACHINE LEARNING FOR BCI	9
Feature Extraction Techniques: Time-Domain Features (Mean, Variance, Hjorth Parameters), Frequency-Domain Features (Band Power using FFT), Spatial Filtering (Common Spatial Patterns - CSP). Machine Learning Classifiers: Linear Discriminant Analysis (LDA), Support Vector Machines (SVM), Neural Networks. Training and Testing Methodologies: Cross-validation, Confusion Matrix, Performance Metrics (Accuracy, Precision, Recall).		

UNIT IV	BCI PARADIGMS AND APPLICATIONS	9
Major BCI Paradigms: Motor Imagery (MI), P300 Event-Related Potential, Steady-State Visually Evoked Potentials (SSVEP). Designing a BCI Experiment: Protocol, User Training, and Feedback. Performance Evaluation: Information Transfer Rate (ITR), Latency, and User Workload. Case Studies: BCI for Wheelchair Control, Speller Systems, Neuroprosthetics, and Neurofeedback for Attention Enhancement.		

UNIT V	ADVANCED TOPICS AND FUTURE TRENDS IN BCI	9
Hybrid Brain-Computer Interfaces: Combining multiple signals (e.g., EEG + EOG) or paradigms. Deep Learning in BCI: Using Convolutional Neural Networks (CNNs) and		

Recurrent Neural Networks (RNNs) for end-to-end classification. Co-adaptive and Closed-loop BCIs: Systems that adapt to the user in real-time. Ethical, Legal, and Social Implications (ELSI): Privacy of Brain Data, Agency, Security, and Accessibility. Future Directions: Practical Challenges and Emerging Applications.

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental architecture of a Brain–Computer Interface and classify different types based on invasiveness and operation mode. (K2)

CO2 Apply basic signal processing techniques to acquire and preprocess brain signals, particularly EEG, for artifact and noise removal. (K3)

CO3 Develop and evaluate feature extraction and machine learning models to classify brain states for BCI control applications. (K5)

CO4 Analyze and compare various BCI paradigms to evaluate their performance using standard metrics for specific use cases. (K4)

CO5 Design and evaluate hybrid BCI systems incorporating deep learning, and assess ethical implications in emerging neurotechnology. (K5)

TEXT BOOKS

1. Rajesh P. N. Rao, “Brain-Computer Interfacing: An Introduction”, Cambridge University Press, 2nd Edition, 2013. (Units 1, 2, 3)

2. Jonathan Wolpaw and Elizabeth Winter Wolpaw, “Brain-Computer Interfaces: Principles and Practice”, Oxford University Press, 1st Edition, 2012. (Units 1, 3, 4)

3. Gernot Müller-Putz, et al., “Functional Brain Imaging with BCI: Practical Applications and Neural Decoding”, Springer, 1st Edition, 2021. (Units 2, 4, 5)

REFERENCE BOOKS

1. B. Graimann, G. Pfurtscheller, B. Allison (Eds.), “Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction”, Springer, 1st Edition, 2009.

2. C. T. Leeb, et al., “Brain-Computer Interface Research: A State-of-the-Art Summary”, Springer, 5th Edition, 2022.

3. D. S. Tan, A. Nijholt (Eds.), “Brain-Computer Interfaces: Applying our Minds to Human-Computer Interaction”, Springer, 1st Edition, 2010

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2							2	
CO2	3	2	3	2	3								3
CO3	3	2	3	2	3							3	
CO4	3	2	3	2	3							2	
CO5	2	3	2	3	2								3

SSNCE-R2024-UG-CSE

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3732	ROBOTIC PROCESS AUTOMATION	45	0	0	45	90	3

OBJECTIVES

- To understand the fundamental concepts, benefits, and business drivers of Robotic Process Automation.
- To develop automation solutions using RPA tools by implementing UI automation, data manipulation, and control flow.
- To apply advanced RPA techniques for error handling, debugging, and interacting with various applications (e.g., web, desktop, PDFs).
- To use RPA orchestration tools for deploying, scheduling, and managing digital workforce.
- To explore the integration of RPA with cognitive technologies and analyze the governance and security aspects of an enterprise RPA program.

UNIT I	INTRODUCTION TO ROBOTIC PROCESS AUTOMATION	9
Introduction to RPA: Definition and Evolution; RPA vs. Traditional Automation; Benefits and Business Value; RPA Use Cases across Industries (Finance, HR, Supply Chain). The RPA Technology Landscape: Major RPA Vendors (UiPath, Automation Anywhere, Blue Prism); Choosing the Right RPA Tool. The RPA Lifecycle: Discovery, Design, Development, Testing, Deployment, and Support.		

UNIT II	CORE RPA DEVELOPMENT CONCEPTS	9
Introduction to RPA Development Environment: Studio Interface, Projects, and Activities. UI Automation: Understanding Selectors (Static vs. Dynamic), UI Explorer, and Simulating User Actions (Click, Type, Select). Data Manipulation: Variables and Data Types; Working with Strings, Dates, and Numbers; Using Collections (Lists, Dictionaries, Tables). Control Flow and Automation: Loops (For, While), Conditionals (If-Else, Switch), and Flowcharts.		

UNIT III	ADVANCED AUTOMATION TECHNIQUES	9
Working with Applications: Automating Desktop Applications; Web Automation (using browsers); Excel and CSV Automation; PDF and Email Automation. Error Handling and Debugging: Try-Catch Activities; Rethrowing and Throwing Exceptions; Debugging Tools (Breakpoints, Logging). Robotic Enterprise Framework (REFramework): Understanding the Template; Transactional Business Processes; State Machine Implementation.		

UNIT IV	ORCHESTRATION AND MANAGEMENT	9
Introduction to RPA Orchestrator: Architecture and Components; Packages, Environments, and Robots. Managing Digital Workforce: Creating and Publishing Processes; Scheduling Jobs; Managing Queues and Transactions. Monitoring and Logging: Viewing Logs and Execution History; Setting Up Alerts; Auditing and Compliance in Orchestrator. Attended vs. Unattended Automation: Use Cases and Implementation Strategies.		

UNIT V	RPA GOVERNANCE AND EMERGING TRENDS	9
RPA Center of Excellence (CoE): Roles and Responsibilities; Best Practices for Implementation and Scaling. RPA and Cognitive Automation: Introduction to AI/ML in		

RPA; Computer Vision, Natural Language Processing (NLP), and Chatbot Integration. Security and Governance in RPA: Credential Management; Code Review and Security Best Practices; Managing Bot Access and Permissions. Future of RPA: Hyperautomation; Process Mining; RPA as a Service (RaaS).

TOTAL PERIODS

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals of Robotic Process Automation and identify suitable business processes for automation (K2).

CO2 Develop automation workflows using RPA tools with appropriate control structures, data handling, and UI interaction. (K3).

CO3 Evaluate and implement advanced automation techniques including exception handling, application integration, and ReFramework-based design. (K5).

CO4 Analyze and manage the orchestration of digital bots for deployment, scheduling, and monitoring through RPA platforms. (K4).

CO5 Design and assess RPA solutions integrating cognitive technologies and governance best practices. (K5).

TEXT BOOKS

1. Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018. (Unit 1-4)
2. Mary C. Lacity & Leslie P. Willcocks, "Robotic Process Automation and Cognitive Automation: The Next Phase", SB Publishing, 2018. (Unit 1, 5)
3. Pascal Bornet, Ian Barkin, Jochen Wirtz, "Intelligent Automation: Welcome to the World of Hyperautomation", World Scientific Publishing, 2020. (Unit 5)

REFERENCE BOOKS

1. Husan Mahey, "Robotic Process Automation with Automation Anywhere", Packt Publishing, 2020.
2. UiPath, "UiPath Studio Guide", Official Documentation, Available at: <https://docs.uipath.com>
3. UiPath Academy, "Online Learning Platform", Available at: <https://academy.uipath.com>
4. Automation Anywhere, "University Learning Resources", Available at: <https://university.automationanywhere.com>

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2							2	
CO2	3	3	3	2	3								3
CO3	3	3	3	2	3							3	
CO4	2	3	2	3	2		2	2				2	
CO5	3	3	3	2	3					3	3		3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3733	ROBOTICS	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamentals of robot programming
- To explain the fundamentals of Embedded programming
- To acquire knowledge for selection and calibration of sensors, actuator and how to interface with Robot
- To understand the Robot operating system fundamentals
- To understand the integration of Hardware controllers with Robot Operating System

UNIT I	ROBOT FUNDAMENTALS	9
Robot Anatomy: Robot Configurations, Motions, Joint Notation; Work Volume – Robot Drive systems – Control Systems – Movement – End Effectors.		

UNIT II	EMBEDDED PROGRAMMING	9
Basic Embedded File system – hex files - Simulators and Emulators - Integrated development environments - commonly used IDE. Basics of Embedded C for Robot Programming.		

UNIT III	ROBOT PROGRAMMING INTERFACE	9
Sensor- Principle of sensors - Analog signal - Digital signal - I/O of Sensors – Calibration of sensors – Interfacing -Serial - I2C. Actuator – Types – I/O of Actuator, Direct control, and speed control, PWM, analog control. Programming and interfacing of sensors. Programming and interfacing of actuators.		

UNIT IV	ROBOT OPERATING SYSTEM	9
ROS Basics- Sensors and Robots Supporting ROS - ROS Architecture and Concepts - ROS File system - ROS Computation Graph Level, ROS Community Level - Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS - Interfacing Arduino with ROS, ROS on a Raspberry Pi.		

UNIT V	BUILDING THE ROBOTS	9
Introduction to Wheeled Robot - Building Robot Hardware - Block Diagram and Assembling Robot Hardware - Programming Robot Firmware - path planning. Case study: Tetrix – NAO – Ned Niryo.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamentals of robotic systems including anatomy, motion types, drive mechanisms, control systems, and embedded development environments. **(K2)**

CO2 Apply embedded C programming concepts to interface and control sensors and actuators used in robotic systems. **(K3)**

CO3 Apply communication protocols such as Serial and I2C for sensor and actuator

interfacing in a robotic environment. (K3)
CO4 Make use of Robot Operating System (ROS) to build packages, interface with Embedded hardware, and deploy applications on platforms such as Arduino and Raspberry Pi. (K3)
CO5 Construct a functional robotic system by integrating hardware components, programming firmware, and developing path planning algorithms for real-world applications. (K6)

TEXT BOOKS

1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012. (Unit 1)
2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018. (Unit 4, 5)
3. Mark Siegesmund, "Embedded C Programming Techniques and Applications of C and PIC® MCUS", Newnes, 2014 (Unit 2,3)

REFERENCE BOOKS

1. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.
2. John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2008.
3. Jacob Fraden, "Handbook of Modern Sensors", Springer 2016
4. W. Bolton, "Mechatronics", Pearson, 2018

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3				2								3
CO3		2										3	
CO4	3				2								2
CO5			3	3				3	3				2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3734	REALTIME SYSTEMS	45	0	0	45	90	3

OBJECTIVES

- Recall and explain the fundamental principles, classifications, and characteristics of real-time systems.
- Interpret and apply real-time scheduling, synchronization, and task management concepts using RTOS features.
- Solve issues related to inter-process communication and memory management.
- Evaluate scheduling algorithms for emerging scenarios.
- Compare and contrast various resource handling techniques for real time tasks.

UNIT I	FUNDAMENTALS OF REAL-TIME SYSTEMS	9
Definition and characteristics of real-time systems - Types: Hard, Firm, and Soft real-time systems - Examples and applications - Real-time vs. general-purpose systems - Timing constraints and parameters - Structure of a real-time system		

UNIT II	REAL-TIME OPERATING SYSTEMS	9
Role and functions of an RTOS - Task states, task control blocks - Process and thread concepts in RTOS - Task management and priorities - Time management and clock services - Introduction to interrupts and context switching		

UNIT III	TASK COMMUNICATION AND MEMORY MANAGEMENT	9
Interprocess communication (IPC) mechanisms - Shared memory, message passing - Synchronization: semaphores, mutexes - Deadlock and starvation - Memory hierarchy and management in RTOS - Static vs. dynamic memory allocation - Real-time file systems		

UNIT IV	SCHEDULING IN REAL-TIME SYSTEMS	9
Introduction – Applications – Basic Model – Characteristics of Real time system – Safety – Task types – Timing Constraints – Concepts and Characteristics of types of Real Time Task Scheduling – Clock Driven Scheduling – Event Driven Scheduling – Earliest Deadline First – Rate Monotonic Algorithm.		

UNIT V	RESOURCE HANDLING TECHNIQUES IN REAL-TIME SYSTEMS	9
Resource Sharing – Priority Inversion – Priority Inheritance Protocol – Highest Locker Protocol – Priority Ceiling Protocol– Types of Priority Inversions – Important Features – Issues and Task Dependencies.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain key characteristics, classifications, and components of real-time systems (K2).

CO2 Demonstrate the ability to implement basic task scheduling and RTOS features for real-time applications (K3).

CO3 Apply algorithms for solving problems related to memory management (K3).
CO4 Apply algorithms for solving problems related to inter-process communication (K3).
CO5 Adapt scheduling algorithms for the problems in modern real time systems (K6).
CO6 Analyze resource handling techniques for multi-tasking problems in real time systems (K4).

TEXT BOOKS

1. Philip A Laplante, Seppo J Ovaska, "Real-Time Systems Design and Analysis", Wiley & IEEE Press, 2012 (Units 1, 2 and 3)
2. Rajib Mall, "Real Time Systems: Theory and Practice", Pearson, 2007 (Units 4 and 5).

REFERENCE BOOKS

1. Andrew S. Tanenbaum and Herbert Bos, "Modern Operating Systems", 5th Edition, Pearson, 2023.
2. Jerome Saltzer M. and Frans Kaashoek, "Principles of Computer System Design", 1st Edition, Elsevier, 2009.
3. Francis Cottet, Joelle Delacroix, et al, "Scheduling in Real-Time Systems", Wiley, 2002.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	3
CO2	3	2										2	3
CO3	3	2										3	3
CO4	3	2										3	3
CO5	3	2										2	3
CO6	3	3	3									3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3781	SOFTWARE VERIFICATION & VALIDATION	30	0	30	30	90	3

OBJECTIVES

- Identify the different techniques for verification and validation.
- Use available traceability analysis tools on sample requirements.
- Modify existing coverage analyzers in terms of functionality or features used.
- Design system test cases.
- Use test case generators and test management tools

UNIT I	INTRODUCTION	6
Principles Of Verification and Validation – Software Architecture Frameworks – Model Driven Architecture – UML – Systems Modeling Language – Verification, Validation and Accreditation.		

UNIT II	SOFTWARE VERIFICATION	6
Verification and Validation Life Cycle – Traceability Analysis – Interface Analysis – Design and Code Verification – Test Analysis – Reviews – Inspections – Walkthroughs – Audits – Tracing – Formal Proofs – Model Based Verification and Validation.		

UNIT III	TESTING STRATEGIES	6
Stages of Testing: Test Planning – Test Design – Test Case Definition – Test Procedure – Test Reporting – Unit Testing: White Box, Black Box and Performance Testing; System Testing: Function, Performance, Interface, Operations, Resource, Security, Portability, Reliability, Maintainability, Safety, Regression and Stress Testing.\		

UNIT IV	TOOLS	6
Tools For Verification and Validation: Static Analyser – Configuration Management Tools– Reverse Engineering Tools – Tracing Tools – Tools for Formal Analysis.		

UNIT V	ACCESSIBLE SOFTWARE VERIFICATION WITH DAFNY	6
Dafny: Language, Verifier, and IDEs - Verifying an Imperative Procedure - Integers - Ghost vs. Compiled - Stating and Proving a Lemma.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS
1. Develop the UML diagram for a given problem statement. 2. Develop the code and use the agile platform to store the code. 3. Apply the configuration techniques in agile platform. 4. Apply the black box and white box testing using the automated tools. 5. Test the precondition and post conditions using automated testing platform. 6. Perform testing to prove the partial correctness of this program. 7. Apply validation tool, a given problem statement to perform validation testing. Eg1. Check that a surname is always entered into each record in a database of addresses. 8. Demonstrate the traceability in software testing.

Eg1. Login is ability to trace tests forward and backward through the development lifecycle.
Eg2. Identify and fix the bug.
9. Demonstrate the data flow testing.

COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the principles of software verification, validation, and architectural frameworks including UML and SysML. (K2)
CO2 Apply various verification techniques such as inspections, walkthroughs, audits, and formal proofs throughout the software lifecycle. (K3)
CO3 Analyze different software testing strategies including black-box, white-box, and system testing methods for various quality attributes. (K4)
CO4 Demonstrate the use of software verification and validation tools such as static analyzers, tracing tools, and configuration management tools. (K3)
CO5 Evaluate software correctness using Dafny by verifying procedures, conditions, and lemmas through automated formal verification. (K5)
CO6. Develop and test software artifacts using traceability techniques, automated tools, and validation procedures to ensure software reliability and maintainability. (K6)

TEXT BOOKS
1. Mourad Debbabi, Hassaine F, Jarrya Y., Soeanu A., Alawneh L., “Verification and Validation in Systems Engineering”, Springer, 2010. (Unit 1)
2. ESA Board for Software Standardization and Control (BSSC), “Guide to Software verification and Validation”, European Space Agency ESA PSS05-10 Issue 1 Revision 1, 1995. (Unit 2,3,4)

REFERENCE BOOKS
1. K. R. M. Leino, "Accessible Software Verification with Dafny," in IEEE Software, vol. 34, no. 6, pp. 94-97, 2017. (Unit 5)
2. Aditya Mathur, "Foundations of Software Testing", Pearson Education, 2008.
3. Marcus S. Fisher, “Software Verification and Validation: An Engineering and Scientific Approach”, Springer, 2007.
4. Avner Engel, “Verification, Validation & Testing of Engineered Systems”, Wiley series in systems Engineering and Management, 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	3		2	2							2	2
CO3	2	3	3	2	3						1	2	2
CO4			2		3							3	2
CO5	3	2		3	3						2	3	2
CO6	2	3	3	2	3			2	2	2	3	2	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3735	VIDEO PROCESSING & ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the principles of video formation, display, and digital representation techniques.
- To learn video sampling theories and analyze spatial-temporal aliasing in 2D and 3D domains.
- To study motion estimation techniques including optical flow and block-matching algorithms.
- To explore video coding techniques such as transform and predictive coding standards.
- To introduce deep learning-based video analytics using ResNet and Inception architectures.

UNIT I	VIDEO FORMATION, PERCEPTION AND REPRESENTATION	9
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Video Capture and Display: Principles of Color Video, Video Cameras, Video Display, Gamma Correction, Analog Video Raster: Progressive vs Interlaced scans, Characterisation of Video Raster, Spatial and Temporal resolution, Signal Bandwidth, Multiplexing of Luminance, Chrominance and Audio, Digital Video: ITU-R.BT.601 Digital Video Format, Other Digital Video Formats and Applications and Digital Video Quality Measure.

UNIT II	VIDEO SAMPLING	9
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Basics of the Lattice Theory, Sampling of Video Signals Over Lattices: Required Sampling Rates, Sampling Video in Two Dimensions: Progressive versus Interlaced Scans, Sampling a Raster Scan: BT.601 Format, Sampling Video in Three Dimensions, Spatial and Temporal Aliasing.

UNIT III	TWO-DIMENSIONAL MOTION ESTIMATION	9
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Optical Flow: Two-Dimensional Motion versus Optical Flow, Optical Flow Equation and Ambiguity in Motion Estimation, Pixel-Based Motion Estimation, Block-Matching Algorithm: The Exhaustive Block-Matching Algorithm, Fractional Accuracy Search, Phase Correlation Method, Binary Feature Matching.

UNIT IV	WAVEFORM-BASED VIDEO CODING	9
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Block-Based Transform Coding: Bit Allocation and Transform Coding Gain, DCT-Based Image Coders and the JPEG Standard, Predictive Coding: Optimal Predictor Design and Predictive Coding Gain, Spatial-Domain linear Prediction, Motion-Compensated Temporal Prediction

UNIT V	VIDEO ANALYTICS	9
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Video Processing: Use cases of video analytics, Vanishing Gradient and exploding gradient problem, ResNet architecture: ResNet and skip connection, Inception network, GoogLeNet architecture, Improvements in Inception v2, Case studies using ResNet and Inception V3.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain video formation, perception, and representation in analog and digital domains. (K2)

CO2 Apply video sampling techniques and analyze aliasing in spatial and temporal domains. (K3)

CO3 Apply motion estimation methods for 2D video analysis. (K3)

CO4 Analyze video coding techniques including transform and predictive coding. (K4)

CO5 Examine deep learning architectures like ResNet and Inception for video analytics applications. (K4)

CO5 Evaluate video processing and analytics techniques for diverse applications using appropriate standards and models. Justify method selection through analytical comparison and structured reporting. (K5)

TEXT BOOKS

1. A. Murat Tekalp, "Digital Video Processing", 2nd Edition, Prentice Hall Press, 2015 (Units I, II, III, IV)

2. Vaibhav Verdhan, "Computer Vision Using Deep Learning", 1st Edition, Academic press, Berkeley, CA, 2021 (Unit V).

REFERENCE BOOKS

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", 2nd Edition, Springer Nature, 2022.

2. A. C. Bovik, "Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2		3	3									2	
CO3		3	3			2						3	
CO4				3	2	2						3	
CO5					2							3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3736	NETWORK AND SERVER SECURITY	45	0	0	45	90	3

OBJECTIVES

- To study about the essentials of computer security
- To acquire knowledge on TCP/IP security, firewalls, IPSec, Virtual Private Networks, and intrusion detection systems
- To understand how various security mechanisms work and correlate these security mechanisms with security principles.
- To learn the security aspects of data center
- To learn the security protocols and technologies with respect to infrastructure.

UNIT I	INTRODUCTION	9
Computer Security Concepts–Security Attacks–Security Services–Security Mechanisms–A Model for Network Security–Standards.Attack on Public Key Cryptography–Public Key Certificates: X.509 Authentication services–Attacks on PKI–Types of Digital Certificates.		

UNIT II	SECURITY PRACTICES & SYSTEM SECURITY	9
Internet Firewalls for Trusted System: Roles of Firewalls – Types of Firewalls – Net filter – IPtables Firewall design Principles–DNS Attacks–Cache Poisoning–SET(Secure Electronic Transaction) for E- Commerce Transactions. Intruder – Intrusion detection system – Virus and related threats – Countermeasures.		

UNIT III	IP & WEB SECURITY	9
IP Security: Overview of IPsec – IP and IPv6 – Authentication Header – Encapsulation Security Payload (ESP) – Internet Key Exchange; Web Security: SSL/TLS Basic Protocol – Computing the keys – Client authentication – PKI as deployed by SSL Attacks fixed in v3 – Exportability-Encoding - SET.		

UNIT IV	DATA CENTER SECURITY OVERVIEW	9
Data center security overview: Need for a secure data center – Vulnerabilities and common attacks; Network Security Infrastructure; Security Fundamentals; Datacenter security frame- works: Security policies – Security lifecycle; Secure Management Framework.		

UNIT V	SECURITY PROTOCOLS AND TECHNOLOGIES	9
Security Protocols and Technologies: Cryptography – PKI – Transport Security – Authentication Protocols and Technologies; Network management security; Integrating security into the infrastructure: Defining security zone – Internet Edge – Intranet Server Farm – Server-Farm Design Alternative – Management Network.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to K2

CO1 Summarize the essentials of computer security K3

CO2 Experiment with the security practices available in system security K5

CO3 Determine the security practices followed in email, IP and web Security K3

CO4 Select the security aspects in designing a data center K3

CO5 Identify the security protocols for the infrastructure K3

TEXT BOOKS

1. William Stallings, “Network Security Essentials: Applications and Standards”, Sixth Edition, Pearson, 2017. (Units-1,2,3)
2. Mauricio Arregoces, Maurizio Portolani, “Data Center Fundamentals”, Cisco Press, 2003. (Units-4,5)

REFERENCE BOOKS

1. Charlie Kaufman, Radia Perlman and Mike Speciner, “Network Security: Private Communication in a
2. Public World”, Second Edition, Pearson Education, 2017.
3. Wen liang Du, “Computer Security: A Hands- on Approach”, Create Space Independent Publishing Platform, First Edition, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2										2	
CO3	3	2									2	2	
CO4	3	2										2	
CO5	3	2										2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3737	PRIVACY AND SECURITY IN SOCIAL NETWORKS	45	0	0	45	90	3

OBJECTIVES

- To introduce the fundamental concepts of online social networks, their vulnerabilities, and the impact on users.
- To understand classical, advanced, and emerging threats in social platforms, along with mitigation strategies.
- To study algorithms, tools, and analytical frameworks for detecting fake accounts and malicious activities.
- To explore identity management models and security practices for preserving privacy in online environments.
- To analyze case studies on data breaches and evaluate legal and ethical frameworks for social network security.

UNIT I	OVERVIEW OF ONLINE SOCIAL NETWORKS AND THEIR IMPACTS ON USERS	9
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Online Social Network vulnerabilities – Functional parameters – Statistical analysis based on usage – Usage of social network based on requirements – online social networks issues and impacts – difficulties in detection and mitigation of attacks.

UNIT II	SECURITY CHALLENGES IN SOCIAL NETWORKING	9
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Advanced Persistent threats, Classical threats, social threats – Inbuilt security solutions, Third party software solutions, other security solutions against online social network attacks. Branding – building of social authority in social platform – COBRAS – Hashtag – Collective intelligence – security vs. usability trade-offs

UNIT III	DETECTING ATTACKS IN ONLINE SOCIAL NETWORKS	9
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Fake Account detection – Twitter account feature analysis – Selection of behavioral and structural features – Petri net-based analyzers – Simulation using PN2 environment – Evaluation with SPIN model checker – Attack detection performance analysis.

UNIT IV	VARIOUS THREATS AND THREAT HANDLING TOOLS	9
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Categories of attackers and account-based threats – Cybersecurity tools for protecting accounts and sensitive information – Principles and best practices for account protection – Digital identity and identity theft – Evolution of Identity Management Models (Identity 1.0 to Identity 2.0) – Self-preservation and open security issues in OSNs.

UNIT V	DATA THEFT – A CASE STUDY IN FACEBOOK	9
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Case study: Facebook data breach in Indonesia – Expert opinions, countermeasures, and consequences – Violation of privacy rights: Singapore Facebook case – International and national laws for data protection – Regulatory compliance and governance in OSN security.

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain OSN vulnerabilities, functional parameters, and user impacts. (K2)

CO2 Analyze different types of social network security threats and evaluate existing solutions. (K4)

CO3 Apply algorithmic and analytical approaches for detecting fake accounts and malicious activities. (K3)

CO4 Examine threat categories, identity management models, and principles of secure account handling. (K4)

CO5 Evaluate real-world OSN data breaches and propose countermeasures within legal and ethical frameworks. (K5)

TEXT BOOKS

1. Brij gupta, somya ranjan sahu, “online social network security – principles, algorithms, applications and perspectives”, CTC Press, 2021. (Units I, II, III)

2. Micheal cross, “Social media security”, O’Reilly Syngress, 2017. (Units IV, V)

REFERENCE BOOKS

1. Borko furht, “handbook of social network technologies and application”, springer, 2016.

2. Debashis De, *Online Social Networks: Security, Privacy, and Forensics*, Springer, 2019.

3. Xiaohui Liang, Rongxing Lu, Xiaodong Lin, Xuemin Shen “Security and privacy in mobile social networks”, springer, 2013.

4. Al-Sakib Khan Pathan, “Securing social network in cyberspace”, CRC Press, 2021.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2							2	
CO2	3	3		3		2							2	
CO3	3	3	3		2								3	
CO4	3			2		2							3	
CO5				2		2					3		3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3738	DRONE TECHNOLOGY	45	0	0	45	90	3

OBJECTIVES

- To introduce drone classifications, components, and regulatory frameworks.
- To understand aerodynamics, propulsion systems, and avionics integration.
- To learn sensor technologies, control systems, and programming for autonomous operations.
- To develop safety protocols, ethical compliance, and risk assessment skills.
- To apply advanced concepts in swarm robotics, AI integration, and future trends for innovative solutions.

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY	9
Drone Concept – Vocabulary Terminology- History of drone evolution- Types of drones based on propulsion: fixed-wing, multirotor, hybrid, VTOL- Impact of drone technology on businesses- Entrepreneurship opportunities- Regulatory frameworks: DGCA India, global standards - Case studies of drone startups.		

UNIT II	PROBABILITY AND DISTRIBUTIONS	9
Classifications of UAVs- Overview of main drone - Technical characteristics and functions of components- Assembling a drone- Energy sources - Levels of autonomy- Drone configurations- Programming methods: firmware, SDKs- Program installation and execution- Multirotor stabilization: PID control, Kalman filtering- Flight modes - Communication setup.		

UNIT III	SAMPLING DISTRIBUTION AND PARAMETER ESTIMATION	9
Flight controllers: PX4/ArduPilot architecture- Sensor integration: IMU, GPS, LiDAR, vision sensors - Sensor fusion algorithms- Communication systems - Control theory: PID, LQR, adaptive control- Navigation systems - Actuators and power management- Real-time operating systems- Simulation tool.		

UNIT IV	CONFIDENCE INTERVALS AND HYPOTHESIS TESTING	9
Application-based drone selection- Drones in insurance - Drones in logistics - Drones in agriculture - Drones in infrastructure inspection: transmission lines, power distribution- Drones in cinematography: filming, panoramic imaging - Business models and ROI analysis.		

UNIT V	REGRESSION ANALYSIS	9
Safety risks - Safety guidelines - Aviation regulations and standardization - Drone licensing and certification- Miniaturization trends- Increasing autonomy: AI, machine learning-Swarm robotics - Emerging trends - Ethical considerations		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain drone classifications, components, applications, and regulations. (K2)

CO2 Apply engineering principles to design, fabricate, and program drone systems. (K3)
CO3 Utilize sensors, avionics, and control systems for autonomous operation. (K3)
CO4 Assess safety risks, regulatory compliance, and ethical implications of drone operations through case studies or assignments. (K5)
CO5 Compare and select advanced drone solutions using swarm robotics, AI, and future technologies, and recommend optimal strategies for implementation. (K5)

TEXT BOOKS

1. Reg Austin, "Unmanned Aircraft Systems: UAV Design, Development and Deployment", Wiley, 2010. (Unit 1-2)
2. Robert C. Nelson, "Flight Stability and Automatic Control, McGraw-Hill", 7th Edition, McGraw-Hill, 2020. (Unit 3)
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007. (Unit 4-5)

REFERENCE BOOKS

1. Paul G Fahlstrom, "Introduction to UAV Systems", 4th Edition, Wiley, 2012.
2. DGCA, "Civil Aviation Requirements (CAR) for Drones", Latest Edition.
3. Adam Juniper, "The Complete Guide to Drones", 5th Edition, Thames & Hudson, 2020.
4. Randal W. Beard, "Small Unmanned Aircraft: Theory and Practice", 2nd Edition, Princeton University Press, 2020.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										2	
CO2	3	3	3		3								3
CO3	3	3	3		3							3	
CO4				3			3	2					
CO5	3		3							3	3		3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3861	PENETRATION TESTING AND VULNERABILITY ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- Understand the concepts of penetration testing as a means of securing systems.
- Know the working process to gather information and scan the target.
- Know the working process of exploitation and social engineering on the target.
- Learn how web application vulnerability assessment can be carried out by using tools.
- Learn to set security posture in an organization

UNIT I	INTRODUCTION TO PENETRATION TESTING	6
Defining Security Assessments - Overview of Penetration Testing Methodologies – Penetration Testing Steps - Overview of the Pen-Test Legal Framework - Automated Penetration Testing Tools - Overview of the Pen-Test Deliverables; Phases of a penetration test; penetration testing tools.		

UNIT II	RECONNAISSANCE AND SCANNING	6
Reconnaissance - HTTRACK website copier- Google directives practicing your google-Fu - attack of the drones; Scanning - pings and ping sweeps- port scanning - NMAP; vulnerability scanning.		

UNIT III	EXPLOITATION AND SOCIAL ENGINEERING	6
Exploitation - MEDUSA - METASPLOIT - Remote password cracking - LINUX password cracking - Wireshark; Social engineering - the basics of set - website attack vectors - QR Code through SET; Web hacking - NIKTO - W3AF.		

UNIT IV	WEB APPLICATION VULNERABILITIES	6
Approaches to Code Review - Black-Box Versus White-Box Testing - Code Review Methodology; Signatures of Common Vulnerabilities; Web Vulnerability Scanners - Burp suite.		

UNIT V	SECURITY POSTURE FOR ORGANIZATION	6
Setting Up - Monitor Mode - Capturing Packets - Open Wireless - Wired Equivalent Privacy; Wi-Fi Protected Access-The Enterprise Connection Process-The Personal Connection Process-The Four- Way Handshake-Cracking WPA/WPA2 Keys.		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Perform Threat Modeling with Attack Trees and generated Risk Assessment Report.

2. Carry out Penetration Test using various tools & Report with Mitigations.
3. Perform Vulnerability Scanning for an organization.
4. Perform Exploitation for the systems and report.
5. Software Engineering Attacks.
6. Password Cracking.
7. Web Privacy and Anonymity.

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the phases, tools, and legal considerations involved in penetration testing. (K2)

CO2 Experiment reconnaissance and scanning techniques using tools like NMAP and HTTRACK. (K3)

CO3 Apply exploitation techniques and simulate social engineering attacks using relevant tools. (K3)

CO4 Identify and evaluate web application vulnerabilities using code review and web scanners. (K5)

CO5 Apply wireless security testing techniques and assess Wi-Fi vulnerabilities in organizational settings. (K3)

CO6 Interpret the penetration test report including risk assessment, findings, and mitigation strategies. (K5)

TEXT BOOKS

1. Patrick Engebretson, "The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy", Syngress Media, Second Revised Edition, Elsevier, 2013. ISBN :978-0-12-411644-3. (Unit 1,2,3)
2. Georgia Weidman, "Penetration testing A Hands-On Introduction to Hacking", San Francisco, 2014. (Unit 1,5)

REFERENCE BOOKS

1. Dafydd Stuttard & Marcus Pinto, "The Web Application Hacker's Handbook, Finding and Exploiting Security Flaws Second Edition, ISBN: 978-1-118-02647-2. (unit 4).
2. Kimberly Graves, "CEH Official Certified Ethical Hacker Review Guide", Wiley publisher, 2007 (Unit 1)
3. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, CRC Press, 2015. ISBN: 78-1-4822-3161-8.
4. Bugcrowd, "The Ultimate Guide to Penetration Testing", 2020 edition.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2			2	1	2		2		2	3	2
CO2	2	2			3				1		2	3	2
CO3	2	2			3	1	2				2	3	2
CO4	2	3	2		3						2	3	2
CO5	3	2	2		3	1	1				2	3	2
CO6	2	3	3	2	3	1	2	2	3	2	2	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3821	QUANTUM COMPUTING	45	0	0	45	90	3

OBJECTIVES

- Understand about quantum computing and quantum mechanics.
- Analyse the Quantum Circuits.
- Utilize Open source Qiskit for quantum programming.
- Learn about quantum algorithms.
- Learn the quantum cryptography algorithms.

UNIT I	INTRODUCTION TO QUANTUM COMPUTING	9
Need for Quantum Computing and fundamental concepts- Complex Numbers, Vector Space, and Dirac Notation- Basics of Quantum Mechanics - Matrices and Operators – Quantum Information Processing: Quantum Computation, The Quantum Bit and Its Representations, Superposition in Quantum Systems, Quantum Register		

UNIT II	QUANTUM GATES AND CIRCUITS	9
Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development - Quantum error correction. Programming concepts in Qiskit- Analysis of Qiskit- Exploring Qiskit- Programming in quantum.		

UNIT III	QUANTUM ALGORITHMS	9
Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Grover's Search Algorithm, Shor's Factoring Algorithm.		

UNIT IV	QUANTUM INFORMATION THEORY	9
Classical noise and Markov processes- Quantum operations - Examples of quantum noise and quantum operations - Applications of quantum operations - Limitations of the quantum operations formalism- Distance measures for quantum information		

UNIT V	QUANTUM CRYPTOGRAPHY	9
Principles of Information Security - One-Time Pad - Public Key Cryptography - RSA Coding Scheme - Quantum Cryptography - Quantum Key Distribution - BB84 - Ekert 91.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental principles of quantum computing, including vector spaces, Dirac notation, and quantum superposition. **K2**

CO2 Construct basic quantum circuits using single and multi-qubit gates in Qiskit. **K3**

CO3 Apply quantum algorithms such as Grover's and Deutsch-Jozsa to solve computational problems. **K3**

CO4 Make use of quantum operations to model and simulate quantum noise in quantum information systems. **K3**

CO5 Develop quantum key distribution protocols using BB84 or Ekert 91 for secure communication systems.

TEXT BOOKS

1. Parag K Lala, Quantum Computing, A Beginners Introduction, First edition, Mc Graw Hill Education , Nov 2020. (Units:1, 2, 3, 5)
2. Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Information", Cambridge, 2010. (Unit:4)

REFERENCE BOOKS

1. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press, 2008
2. N. David Mermin, "Quantum Computer Science", Cambridge, 2007
3. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
4. Lala, P.K., *Quantum Computing: A Beginner's Introduction*. McGraw-Hill Education. 2019.
5. Preskill Lecture notes: Available online: <http://www.theory.caltech.edu/~preskill/ph229/>
6. Open source Quantum Information Science Tool Kit (Qiskit), <https://qiskit.org/> IBM, (Unit 2)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2					3								3
CO3		2										3	
CO4				3	2							3	
CO5			3	3				3	3				3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3822	EDGE ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the various computing paradigms and challenges of edge computing environment.
- To explore the various hardware needed for edge architecture.
- To learn about federated learning techniques and inferences at edge systems.
- To understand the technologies and components used to create an edge analytics application.
- To learn different applications of edge computing.

UNIT I	INTRODUCTION TO NEW COMPUTING PARADIGMS	9
Introduction - Relevant Technologies - Fog and Edge Computing - Hierarchy of Fog and Edge Computing. Edge computing characteristics: Compute in context -- Capability oriented -- Centralized management, distributed computer -- Secured -- Heterogeneity; Edge computing scenarios -- IoT scenarios -- Hardware as a service -- Hybrid scenarios -- 5G scenarios.		

UNIT II	EDGE COMPUTING HARDWARE & SIMULATORS	9
Edge Computing Architecture: Edge Devices -- Edge Server-Cluster -- Cloud Server; Background Essentials: IoT Devices -- Sensors -- Actuators; Networking Architecture- Network Management and Control -- Orchestration; Edge Computing State-of-the-Art. Edge Computing Simulators: PureEdgeSim -- IoTSim-Edge -- iFogSim -- EdgeCloudSim.		

UNIT III	ARTIFICIAL INTELLIGENCE FOR EDGE COMPUTING	9
Artificial Intelligence Training at Edge: Distributed Training at Edge -- Vanilla Federated Learning (FL) at Edge -- Communication-Efficient FL -- Resource--Optimized FL -- Security-Enhanced FL; Artificial Intelligence Inference in Edge: Optimization of AI Models in Edge -- Segmentation of AI Models -- Early Exit of Inference (EEoI) -- Sharing of AI Computation.		

UNIT IV	ANALYTICS AT EDGE	9
Edge Data Analysis: Challenge and Needs -- Combination of Big Data and Edge Data Process -- Architecture for Edge Data Process; Communication and Computation Modes for Edge: Integral Offloading -- Partial Offloading -- Vertical Collaboration -- Horizontal Collaboration. Working with Microsoft Azure IoT Hub -- Using the Raspberry Pi with Azure IoT Edge; Types of attacks against our edge analytics applications -- Protecting our edge analytics applications -- Monitoring and auditing our edge analytics applications.		

UNIT V	EDGE COMPUTING APPLICATIONS	9
Industrial Internet of Things (IIoT) Applications of Edge and Fog Computing: A Review and Future Directions - Leveraging Edge Computing for Mobile Augmented Reality; Real-time Video Analytic - Autonomous Internet of Vehicles (IoVs) - Intelligent Manufacturing - Smart Home and City.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the fundamental concepts, characteristics, and scenarios of edge computing and fog computing. K2
CO2 Utilize edge simulators and hardware components to implement edge computing solutions. K3
CO3 Apply federated learning techniques and AI inference techniques for intelligence at the edge. K3
CO4 Implement secure edge analytics pipelines using cloud platforms and IoT integration. K3
CO5 Investigate real-world edge computing problems using research-based knowledge and conduct experiments involving design, implementation, and evaluation of intelligent edge solutions. K6

TEXT BOOKS
1. K. Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjanamurthy, Edge Computing Fundamentals, Advances and Applications, CRC Press, 2022. (Units: 2)
2. Xiaofei Wang, Yiwen Han, Victor C.M.Leung, Dusit Niyato, Xueqiang Yan, Xu Chen Edge, AI Convergence of Edge Computing and Artificial Intelligence, Springer, 2020. (Units: 3, 4- first half, 5 – second half)

REFERENCE BOOKS
1. Wei Chang, Jie Wu Fog, Edge Computing for Security, Privacy, and Applications, Springer, 2021. (Unit 5 – first half)
3. Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing Principles and Paradigms, Wiley, 2019. (Units 1- First half)
4. Haishi Bai and Boris Scholl, Edge Computing and Capability-Oriented Architecture Taylor & Francis Group, CRC Press, First Edition 2022. (Unit 1 – Second Half)
5. Colin Dow, Hands-On Edge Analytics with Azure IoT- Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Packt Publishing, 2020. (Unit 4 – second half)
6. Atakan Aral, Vincenzo DeMaio, Edge Computing: Models, Technologies and Applications, December 2020, DOI: 10.1049/PBPC033E_ch14, Publisher: IET.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1							3	2
CO2	3	3									2	3	
CO3	3	3	2									3	
CO4	3	2										3	2
CO5	3	2		3	2	2		3			2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3823	LOGIC PROGRAMMING	45	0	0	45	90	3

OBJECTIVES

- To understand the foundations of Logic programming
- To learn programming in PROLOG
- To implement informed and uninformed search algorithms in PROLOG
- To implement Expert system shell in PROLOG.

UNIT I	INTRODUCTION TO LOGIC	9
Foundations of Propositional Logic: Syntax and semantics – Semantic entailment; Normal Forms; Resolution in PL; Horn Logic; Foundations of First Order Logic: Syntax and semantics; Normal Forms; Undecidability of Predicate Logic; Resolution in FOL: Unification; Refinements of resolution: P-resolution – N-resolution – Linear resolution – Unit resolution – SLD resolution.		

UNIT II	INTRODUCTION TO LOGIC PROGRAMMING	9
Foundations: Answer generation; Horn Clause Programs: Semantics of logic program – Procedural semantics – Model-theoretic semantics; Evaluation Strategies: Swapping lemma – PROLOG's evaluation strategy – DFS – BFS.		

UNIT III	PROGRAMMING IN PROLOG	9
Syntax & Semantics of PROLOG – Programming with relations – Facts – Questions – Variables – Conjunctions of goals – Backtracking – Rules – Structures – Recursive programs – Lists – Operators – Arithmetic – Controlling execution – The cut – Input output – Exception handling.		

UNIT IV	PROLOG AND ARTIFICIAL INTELLIGENCE	9
Data structures – Eight Queens Problem – Simulation of Automata; Operations on Data Structures: Representing and sorting lists – Representing sets by binary trees – Insertion & deletion in binary dictionary – Displaying trees – Graphs; Problem Solving Strategies in AI: DFS – BFS – A* Search; Problem Reduction & AND/OR Graph: Basic AND/OR search procedure; Game Playing: The minimax principle – The alpha-beta algorithm.		

UNIT V	PROLOG AND EXPERT SYSTEMS	
Foundations: Introduction to expert systems – Features of expert systems – Functions of an expert system – Structure of an expert system; If-then rules for representing knowledge; Developing a Simple Shell: Implementation – Dealing with uncertainty;		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Apply propositional logic and predicate logic for knowledge representation (K3)
CO2 Apply different types of semantics for logic programming (K3)
CO3 Develop programs in PROLOG (K3)
CO4 Solve AI problems using search algorithms in PROLOG (K3)
CO5 Create an expert system shell in PROLOG for real time applications (K6).

TEXT BOOKS

1. Uwe Schoning, "Logic for Computer Scientists", Birkhauser Boston Inc, 2008 (Units I, II).
2. Ivan Bratko, "PROLOG: Best for Artificial Intelligence Programming" 3rd Edition, Gamma Publications, 2021 (Units III, IV, V).

REFERENCE BOOKS

1. Ivan Bratko, "PROLOG: Programming for Artificial Intelligence", 4th Edition, Pearson, 2011.
2. Kees Doets, "From Logic to Logic Programming", MIT Press 1994.
3. Patrick Blackburn, Johan Bos, Kristina Streignitz, "Learn PROLOG Now", College Publications, 2006.
4. Dennis Merritt, "Building Expert Systems in PROLOG", Amzi Inc. 2000
5. Helder Coelho, Jose C Cotta, "PROLOG by Example: How to Learn, Teach and Use It", Springer-Verlag, 2011.
6. W F Clocksin, C S Mellish, "Programming in PROLOG", Springer-Verlag, 2016. Logic Programming

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3										3	
CO2	3											3	
CO3	3											3	
CO4	3	3	3									3	2
CO5	3											3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3824	FORMAL SYSTEM VERIFICATION	45	0	0	45	90	3

OBJECTIVES

- To introduce the principles of formal logic, including propositional, predicate, and temporal logic, for system verification.
- To explore system modeling techniques using Kripke structures and transition systems.
- To learn the fundamentals of model checking for finite-state systems and associated tools like SPIN and NuSMV.
- To understand advanced model checking techniques to address challenges like state-space explosion.
- To analyze the practical applications, limitations, and ethical considerations of formal verification in real-world systems.

UNIT I	INTRODUCTION TO FORMAL LOGIC	9
Introduction to Propositional and Predicate Logic - Syntax, Semantics, and Logical Consequence - Logical Equivalences and Normal Forms - Proof Techniques: Natural Deduction and Resolution - Basics of Temporal Logic: Linear Temporal Logic (LTL) and Computational Tree Logic (CTL) - Introduction to Logical Frameworks for Verification.		

UNIT II	MODELING SYSTEMS	9
System Representation: States, Transitions, and Properties - Kripke Structures and Transition Systems - Temporal Logic Specification of System Properties - Safety and Liveness Properties - Modeling Examples in Hardware and Software Systems - Introduction to State-Space Diagrams and Graphical Modeling Tools.		

UNIT III	MODEL CHECKING BASICS	9
Overview of Model Checking - Verification of Finite-State Systems - Explicit-State Model Checking - Algorithms for Model Checking: Depth-First and Breadth-First Search - Counterexamples and Debugging - Case Studies in Simple System Verification - Tools for Model Checking: SPIN and NuSMV.		

UNIT IV	ADVANCED MODEL CHECKING TECHNIQUES	9
Challenges in Model Checking: State-Space Explosion - Symbolic Model Checking: Binary Decision Diagrams (BDDs) and SAT Solvers - Probabilistic Model Checking: Markov Chains and Markov Decision Processes - Partial Order Reduction - Real-Time System Verification - Applications of Advanced Techniques in Practical Scenarios.		

UNIT V	LIMITATIONS AND APPLICATIONS OF FORMAL VERIFICATION	9
Scalability and Complexity in Formal Verification - Verification of Industrial Systems: Case Studies - Comparison of Formal Methods: Model Checking vs. Theorem Proving - Open Problems and Future Research Directions - Industrial Trends in Formal Verification - Limitations and Ethical Considerations in Formal Methods.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply propositional, predicate, and temporal logic to analyze system properties and construct proofs using natural deduction and resolution techniques. (K3)

CO2 Model hardware and software systems using Kripke structures and transition systems, specifying safety and liveness properties with temporal logic. (K3)

CO3 Apply explicit-state model for finite-state systems using algorithms like DFS/BFS and tools such as SPIN and NuSMV, interpreting counterexamples for debugging. (K3)

CO4 Apply advanced model checking techniques, including symbolic and probabilistic methods, to address state-space explosion and verify real-time systems. (K3)

CO4 Evaluate the scalability, limitations, and ethical implications of formal verification methods, designing solutions for industrial applications using advanced model checking and NoSQL technologies. (K5)

TEXT BOOKS

1. M Huth, M Ryan, "Logic in Computer Science – Modeling and Reasoning About Systems", 2nd Edition, Cambridge University Press, 2004 (Units I, II).
2. Edmund Clarke, Orna Grumberg, Doron Peled, "Model Checking", The MIT Press, 2018 (Units III, IV, V).
3. C Baier, J Katoen, "Principles of Model Checking", The MIT Press, 2008 (Unit I,II,III, IV,V).

REFERENCE BOOKS

1. Michael Clarke, Thomas Henzinger, Helmut Veith, Roderick Bloem, "Handbook of Model Checking", Springer 2018.
3. Orna Grumberg, Helmut Veith, "25 Years of Model Checking: History, Achievements, Perspectives" Springer-Verlag, 2008.
4. Zohar Manna, Amir Pnueli, "Temporal Verification of Reactive Systems: Safety", Springer- Verlag, 2012.
5. Krzysztof R. Apt, Frank S. de Boer, Ernst-Rüdiger Olderog, "Verification of Sequential and Concurrent Programs", Springer, 3rd edition, 2009.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										3	
CO2	3	3	2	3								2	2
CO3		3	3	2	2							2	2
CO4		2	3	3	3							2	2
CO5	3	3	3	3	2	3	3	3	3		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3825	DATABASE TUNING	45	0	0	45	90	3

OBJECTIVES

- To comprehend the basic principles of database tuning
- To understand the basics of indexing and Relational Systems tuning.
- To understand the principles of E-commerce applications.
- To understand the principles of Datawarehouse tuning and Column Family Database.
- To understand document databases and Graph Database Design.

UNIT I	PRINCIPLES OF TUNING	8
Basic principles – Tuning the Guts: Lock and Concurrency Control Tuning – Tuning the Recovery subsystem- Operating Systems Considerations – Hardware Tuning.		

UNIT II	INDEX TUNING AND RELATIONAL SYSTEMS TUNING	10
Types of Queries and Keys- Data structures for in-memory database - Sparse versus Dense Indexes- Clustered and non-clustered Indexes – Joins, Foreign Key Constraints, and Indexes – Tuning Relational Systems: Normalization – Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Tuning – Trigger Performance.		

UNIT III	APPLICATION INTERFACE AND E-COMMERCE APPLICATIONS TUNING	9
Client Server Mechanisms – Objects - Application Tools and Performance – Tuning the Application Interface – Bulk Loading Data – E-Commerce Architecture – Tuning E-Commerce Architecture – Case Study – Shop comparison Portal.		

UNIT IV	DATA WAREHOUSE TUNING AND COLUMN FAMILY DATABASE DESIGN	9
DBMS Subsystems – Data Warehousing Tuning – Technology for Data warehousing – Tuning for customer relationship Management systems - Federated Data Warehouse Tuning - Designing for Column Family Databases - Guidelines for Designing Tables- Guidelines for Indexing		

UNIT V	DOCUMENT DATABASES AND GRAPH DATABASE DESIGN	9
Document Databases: Designing for Document Databases- Denormalization – Planning for Mutable Documents- Indexes and modelling Common Relations; Graph Databases: Designing for Graph Databases- Graph design for social Network graph database - Tips and Traps of Graph Database Design.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the database tuning principles and apply for a database Systems. (K3)
CO2 Apply suitable indexing technique, normalization/denormalization and query optimization strategies for relational systems. (K3)
CO3 Apply caching, connection pooling, and session management techniques to tune E-Commerce architectures (K3)
CO4 Apply data warehouse tuning techniques and column-family database design

principles for optimized performance. (K3)
CO5 Apply suitable techniques to tune the document and Graph database design. (K3)
CO6 Formulate and implement effective solutions to complex database performance issues by analyzing and applying suitable tuning strategies across various database systems.

TEXTBOOKS

1. Dennis Shasha and Philippe Bonnet, "Database Tuning, Principles, Experiments, and Troubleshooting Techniques", Morgan Kaufmann, An Imprint of Elsevier, Revised Edition, 2004. (Units 1- 4)
2. Dan Sullivan, "NoSQL for Mere Mortals", Addison- Wesley-2015 (unit 5)

REFERENCE BOOKS:

1. C.J. Date," Database Systems", Addison Wesley 2004
2. Thomas Connolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, Pearson Education, 2003.
3. M.TamerOzsu, Patrick Valduriez and S.Sridhar, "Principles of Distributed Database Systems", Pearson Education, 2007.
4. Hector Garcia – Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Prentice Hall, 2008

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2			3							2	
CO3		3			3							2	
CO4	3	3			3							2	
CO5	3	3			3							2	
CO6	3	3		3	3				3	3			2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3862	SOFTWARE DEFINED NETWORKS	30	0	30	30	90	3

OBJECTIVES

- Understand the limitations of traditional network architectures and the motivation behind the emergence of SDN.
- Describe the components of SDN architecture, including the separation of control and data planes and their respective interfaces.
- Build applications using the principles of the OpenFlow protocol to solve networking problems
- Analyse the role of SDN controllers and virtualization in achieving programmable and flexible networking environments.
- Use SDN concepts towards efficient networking of data centres.

UNIT I	INTRODUCTION TO SDN	6
Basic packet Switching Terminology – Historical Background – The Modern Data Center – Traditional Switch Architecture -Autonomous and Dynamic Forwarding Tables – Evolution of Switches and Control Planes		

UNIT II	GENESIS OF SDN	6
The Evolution of Networking technology and Forerunners – Birth of SDN and Sustaining it – Open source contributions – Network Virtualization – Fundamental Characteristics – Operations, Devices and Controller		

UNIT III	OPENFLOW SPECIFICATION AND SDN ALTERNATIVES	6
OpenFlow Overview – Basics in OpenFlow 1.0 – Potential drawbacks – SDN via APIs – Hypervisor based overlays – SDN via Opening up the device – Network Function Virtualization		

UNIT IV	EMERGING THINGS	6
Expanded definitions – Additional Protocol Models – Using NETCONF, BGP, PCE, MPLS – Controllers built for Intents-based applications – The P4 language.		

UNIT V	SDN IN DATA CENTER	6
Data Center Demands – Overcoming Network Limitations – Tunneling Technologies – Path Technologies – Ethernet Fabrics – Use Cases		

TOTAL PERIODS	90
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SUGGESTED EXPERIMENTS

1. Setting up a software defined environment using Mininet, Ryu and Wireshark
2. Implementation of L2 Forwarding Switch using OpenFlow 1.3
3. Network Telemetry of Open Virtual Switch using OpenFlow 1.3
4. Implementation of Network Load Balancer using OpenFlow 1.3
5. Implementation of a customized Programmable switch using P4
6. Implementation of eviction policies in OVS like FIFO, LRU, SRT.
7. Implementation of Firewall as a virtualized network function on cloud

8. Implementation of Data Plane Packet Processing using P4
9. Implementation of Explicit Congestion Notification using P4

COURSE OUTCOMES

On successful completion of this course, students will be able to

- CO1 Explain the fundamental concepts, architecture, and evolution of Software Defined Networking and how it addresses limitations of traditional networks (K2).
- CO2 Apply fundamental knowledge of SDN for solving network problems (K3).
- CO3 Apply OpenFlow concepts in managing flow-based forwarding and controller-switch communication in SDN (K3).
- CO4 Build applications using OpenFlow frameworks for SDN (K6).
- CO5 Analyse the design and functionalities of SDN controllers and protocol models (K4).
- CO6 Apply SDN concepts for Data centre management (K3).

TEXT BOOKS

1. Gorensson P, Black C, Culver T, “Software Defined Networks: A Comprehensive Approach” 2nd Edition,, Morgan Kauffman, 2017 (Units 1 to 5)

REFERENCE BOOKS

1. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, 1st Edition, CRC Press, 2014.
2. Guy Pujolle, “Software Networks: Virtualization, SDN, 5G, Security”, 2nd Edition, Wiley 2020.
3. James F. Ransome, John W. Rittinghouse,” Cloud Computing: Implementation, Management, and Security”, 1st Edition, CRC Press, 2009.
4. Thomas D. Nadeau and Ken Gray, “SDN: Software Defined Networks”, O Reilly, 2013

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3		3								2	
CO2	3	2		3								2	
CO3	3	2		3	2							3	
CO4	3	2		3	3			2	2			3	
CO5	3	3		3								2	
CO6	3	2		3								3	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3826	MULTICORE ARCHITECTURES AND PROGRAMMING	45	0	0	45	90	3

OBJECTIVES

- To understand the need for multi-core processors, and their architecture
- To understand the challenges in parallel and multi-threaded programming
- To learn about the various parallel programming paradigms
- To develop OpenMP programs and design parallel solutions
- To develop an application using MPI programming.

UNIT I	MULTI-CORE PROCESSORS	9
Single core to Multi-core architectures – SIMD and MIMD systems – Interconnection networks -Symmetric and Distributed Shared Memory Architectures – Cache coherence - Performance Issues –Parallel program design.		

UNIT II	PARALLEL PROGRAM CHALLENGES	9
Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads (condition variables, signals, message queues and pipes).		

UNIT III	SHARED MEMORY PROGRAMMING WITH OpenMP	9
OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs – Libraryfunctions – Handling Data and Functional Parallelism – Handling Loops - Performance Considerations.		

UNIT IV	DISTRIBUTED MEMORY PROGRAMMING WITH MPI	9
MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation		

UNIT V	PARALLEL PROGRAM DEVELOPMENT	9
Case studies - n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the architectural features of Multicore processors. (K2).

CO2 Explain the issues in programming parallel processors. (K2)

CO3 Develop solutions for computational problems using OpenMP programming. (K3)

CO4 Develop solutions computational problems using MPI programming. (K3)

CO5 Develop parallel patterns like n-Body solvers, Tree Search. (K3)

TEXT BOOKS

1. Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan-Kaufman/Elsevier, 2011. (Unit-1, 3 & 4)

2. Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle

REFERENCE BOOKS

1. 1. Michael J Quinn, “Parallel programming in C with MPI and OpenMP”, Tata McGraw Hill, 2003. (Unit-3 & 4)
2. Victor Alessandrini, “Shared Memory Application Programming, Concepts and Strategies in Multicore Application Programming”, 1st Edition, Morgan Kaufmann, 2015 (Unit-5)
3. Yan Solihin, “Fundamentals of Parallel Multicore Architecture”, CRC Press, 2015.
4. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr, Dror Maydan and Jeff McDonald, “Parallel Programming in OpenMP”, 1st Edition, Morgan Kaufmann, 2000.
5. Gerassimos Barlas, “Multicore and GPU Programming”, Morgan Kaufmann, 2014. (Unit-1)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2	3												
CO3	3	3	3	3	3							3	
CO4	3	3	3	3	3							3	
CO5	3	3											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3827	INFORMATION VISUALIZATION	45	0	0	45	90	3

OBJECTIVES

- To develop the core skills for visual analysis.
- To create visualizations for time-series data and perform ranking and deviation analysis.
- To analyse data distribution, correlation among data and multi-variate data.
- To design information dashboard by applying visualization techniques.

UNIT I	INTRODUCTION TO VISUAL ANALYSIS	9
Introduction to Information Visualization – Effective Data Analysis – Traits of Meaningful Data –Power of Visual Perception – Making Abstract Data Visible - Analytical Interaction and Navigation – Optimal Quantitative Scales – Reference Lines and Regions – Trellises and Crosstabs – Multiple Concurrent Views – Focus and Context – Details on Demand – Overplotting Reduction – Analytical Patterns: Pattern examples.		

UNIT II	TIME-SERIES, RANKING, AND DEVIATION ANALYSIS	9
Time-series Analysis: Time-series patterns – Time-series displays – Time-series analysis techniques and best practices; Part-to-whole and Ranking Analysis: Part-to-whole and ranking patterns – Part- to-whole and ranking displays – Part-to-whole and ranking techniques and best practices; Deviation Analysis: Deviation analysis displays – Deviation analysis techniques and best practices.		

UNIT III	DISTRIBUTION, CORRELATION, AND MULTIVARIATE ANALYSIS	9
Distribution Analysis: Describing distributions – Distribution patterns – Distribution displays – Distribution analysis techniques and best practices; Correlation Analysis: Describing correlations– Correlation patterns – Correlation displays – Correlation analysis techniques and best practices; Multivariate Analysis: Multivariate patterns – Multivariate displays – Multivariate analysis techniques and best practices.		

UNIT IV	DATA VISUALIZATION TOOLS	9
Tableau: Introducing the Tableau Desktop workspace – Connecting to your Data – Building yourfirst visualization – Creating calculations to enhance your data – Creating a standard map view Plotting your own locations on a map		

UNIT V	DASH BOARD DESIGN	9
Best Practices for Dashboard Building – Building Your First Advanced Dashboard – Use Cases for Rapid-Fire Visual Analytics: Aggregating disparate data sources at a large University – Analysis in a major railway logistics team – Quality metrics in a hospital – Employing visual analytics to aid succession planning.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to
CO1 Apply analytical techniques and practices for visualizing the data (K3)
CO2 Apply visualization techniques for analysing time-series data, ranking the data and for practicing deviation analysis (K3)
CO3 Analyze and evaluate techniques for data distribution, correlation, and multivariate patterns to support decision-making. (K4)
CO4 Make use of visualization tools for visualizing the given data (K3)
CO5 Build interactive dashboards for a real-world applications using best practices in visual analytics with comprehensive documentation. (K6)

TEXT BOOKS

1. Stephen Few, Now you see it: Simple Visualization techniques for quantitative analysis Analytics Press, 2009.
2. Daniel G Murray, Tableau your data!: Fast and easy visual analysis with Tableau software, Wiley, second edition, 2016.

REFERENCE BOOKS

1. Stephen Few, Information dashboard design: Displaying data for at-a-glance monitoring, Analytics Press, second edition, 2013.
2. Ben Fry, Visualizing data: Exploring and explaining data with the processing environment, O'Reilly, 2008.
3. Edward R. Tufte, The visual display of quantitative information, Graphics Press, Second Edition, 2001.
4. Nathan Yau, Data Points: Visualization that means something, Wiley, 2013.
5. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2										2	
CO2	3	2			3								2
CO3		3	3		3							2	
CO4		3										2	2
CO5		3	3	3	3				3			2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3828	COGNITIVE COMPUTING	45	0	0	45	90	3

OBJECTIVES

- To know the theoretical background of cognition.
- To understand the link between cognition and computational intelligence.
- To explore probabilistic programming language.
- To study the computational inference models of cognition.
- To study the computational learning models of cognition.

UNIT I	PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE	10
Philosophy: Mental-physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing –Cognitive Neuroscience – Perception – Decision – Learning and Memory –Language Understanding and Processing.		

UNIT II	COMPUTATIONAL INTELLIGENCE	9
Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge Based Systems – Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision.		

UNIT III	PROBABILISTIC PROGRAMMING LANGUAGE	10
WebPPL Language – Syntax – Using Javascript Libraries – Manipulating probability types and distributions – Finding Inference – Exploring random computation – Coroutines: Functions that receive continuations –Enumeration.		

UNIT IV	INFERENCE MODELS OF COGNITION	7
Generative Models – Conditioning – Causal and statistical dependence – Conditional dependence – Data Analysis – Algorithms for Inference.		

UNIT V	LEARNING MODELS OF COGNITION	9
Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models– Learning (Deep) Continuous Functions – Mixture Models – Case Studies: Cognitive Systems in Healthcare.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the underlying theory behind cognition. (K2)

CO2 Apply computational intelligence to connect the cognition elements for reasoning and decision making (K3)

CO3 Build mathematical functions through WebPPL. (K3)

CO4 Develop applications using cognitive inference model and analyze different generative models. (K4)

CO5 Build applications using cognitive learning models. (K3)

TEXTBOOKS

1. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", MIT Press, 1999. (Unit I)
2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, <https://probmods.org/>. (Unit IV)

REFERENCE BOOKS

1. Jose Luis Bermúdez, Cognitive Science - An Introduction to the Science of the Mind, Cambridge University Press, 2020. (Unit I)
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015. (Unit II)
3. Noah D. Goodman, Andreas Stuhlmüller, "The Design and Implementation of Probabilistic Programming Languages", Electronic version of book, <https://dippl.org/>. 2024. (Unit III)
4. Vijay V Raghavan, Venkat N. Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016 (Unit V)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2	2											2
CO3	3	2	2							2			2	2
CO4	3	2	2							2			2	2
CO5	3	2	2							2			2	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3829	PRIVACY AND SECURITY IN IOT	45	0	0	45	90	3

OBJECTIVES

- To understand the layer wise security requirements in IoT architecture along with possible threats and attacks.
- To introduce the cryptographic fundamentals required for securing IoT.
- To gain in-depth knowledge about identity and access management solutions.
- To explore the possible privacy challenges and the corresponding solutions.
- To understand the need for security from cloud perspective

UNIT I	SECURING THE IoT	9
Security requirements in IoT architecture – Security issues in enabling technologies – Security concerns in IoT applications – IoT Security Architecture – Sensing layer, network layer, service layer and application layer – Threats to authorization/authentication, access control, privacy and availability – Attacks specific to IoT.		

UNIT II	CRYPTOGRAPHIC FUNDAMENTALS FOR IoT	9
Types and uses of cryptographic primitives in IoT – Encryption and Decryption – Hashes – Digital Signatures – Cryptographic key management fundamentals – Examining cryptographic controls build into IoT messaging and communication protocols.		

UNIT III	IDENTITY AND ACCESS MANAGEMENT SOLUTIONS	9
Introduction to identity and access management for IoT – Authentication credentials – passwords, symmetric keys, certificates, and biometrics – Identity and Access Management (IAM) Infrastructure – Authorization and access control, Case Study: Aadhar Registered Devices Authentication.		

UNIT IV	MITIGATING IOT PRIVACY CONCERNS	9
Privacy challenges introduced by IoT – Privacy Impact Assessment – Privacy by design principles – Privacy engineering recommendations.		

UNIT V	CLOUD SECURITY FOR INTERNET OF THINGS	9
Cloud Services for IoT – Asset and inventory management, Service provisioning billing and entitle management, Real time monitoring, Sensor coordination, Customer intelligence and marketing, Information sharing, Message transport & broadcast – Examining IoT threats from cloud perspective – Exploring cloud service provider IoT offerings – Cloud IoT security control – Tailoring an enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the layer-wise attacks possible in IoT (K2).

CO2 Apply the fundamentals of cryptography in IoT (K3).
CO3 Apply the methods and solutions for authorization and access control (K3).
CO4 Analyse the principles, practices and policies associated with privacy issues (K4).
CO5 Select and analyse various security controls in cloud service providers for IoT applications (K5)

TEXTBOOKS
1. Shancang Li, Li Da Xu, "Securing the Internet of Things", Syngress, Elsevier Publishing, 2017. (Unit 1 and 4, 5)
2. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Packt Publishing, 2018. (Unit 2 and 3)
3. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms and Implementations", CRC Press, 2016. (Unit 2)

REFERENCE BOOKS
1. Alasdair Gilchrist, "IoT Security Issues", Walter de Gruyter GmbH & Co KG, 2017.
2. Shivani Agarwal, Sandhya Makkar, Duc-Tan Tran, "Privacy Vulnerabilities and Data Security Challenges in the IoT", CRC Press, 2020.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											2	
CO2	3	2	2						2			2	
CO3	3	2	2									2	
CO4	3	2										2	
CO5	3	2							2			2	

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3831	TIME SERIES ANALYSIS	45	0	0	45	90	3

OBJECTIVES

- To understand the foundational principles of data engineering, including data modeling, storage architectures, and the data lifecycle.
- To develop robust batch data pipelines using ETL/ELT processes and data warehousing techniques.
- To apply distributed computing frameworks like Apache Spark for processing large-scale datasets.
- To implement real-time data streaming solutions for handling continuous data flows.
- To design and manage scalable data solutions on cloud platforms, incorporating governance and security best practices.

UNIT I	INTRODUCTION TO TIME SERIES ANALYSIS	9
Introduction: Definition and Examples of Time Series Data. Time Series Components: Trend, Seasonality, Cyclical, and Irregular Components. Exploratory Data Analysis: Visualization techniques (time plots, seasonal plots, lag plots). Basic Descriptive Statistics and Transformations: Log and Box-Cox transformations for stabilizing variance.		

UNIT II	SMOOTHING AND DECOMPOSITION METHODS	9
Moving Average Smoothing: Simple and Weighted Moving Averages. Exponential Smoothing: Simple Exponential Smoothing, Holt's Linear Trend Method, Holt-Winters Seasonal Method. Classical Decomposition: Additive and Multiplicative Decomposition. STL (Seasonal and Trend decomposition using Loess).		

UNIT III	BOX-JENKINS AND ARIMA MODELS	9
Stationarity: Concept, tests (ADF, KPSS), and transformations (Differencing). Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). Autoregressive (AR) Models: Properties and Identification. Moving Average (MA) Models: Properties and Identification. ARIMA Models: The (p,d,q) framework, Model Identification, Estimation, and Diagnostic Checking. Seasonal ARIMA (SARIMA) Models.		

UNIT IV	MACHINE LEARNING AND DEEP LEARNING FOR FORECASTING	9
Feature Engineering for Supervised Learning: Lag features, window features, and time-based features. Forecasting with Linear Models and Tree-based Models (e.g., XGBoost, Random Forest). Introduction to Facebook's Prophet Model. Neural Networks for Time Series: Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks for sequence prediction.		

UNIT V		9
Multivariate Time Series: Vector Autoregression (VAR). Volatility Modeling: ARCH and GARCH models. Forecast Accuracy Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE). Model Selection and Cross-Validation for Time Series. Case Studies: Applications in finance, weather, and retail.		

TOTAL PERIODS	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Identify the components of a time series and perform exploratory data analysis to understand its structure.(K3)
CO2 Apply smoothing and decomposition techniques to model the trend and seasonality in a time series. (K3).
CO3 Analyze ARIMA and SARIMA models for univariate time series forecasting. (K4).
CO4 Design machine learning and deep learning models for forecasting by engineering features and selecting appropriate architectures. (K5).
CO5 Evaluate forecasting models using performance metrics and select optimal solutions. (K5).

TEXT BOOKS
1. Robert H. Shumway & David S. Stoffer, “Time Series Analysis and Its Applications: With R Examples”, Springer, 4th Edition, 2017. (Units 1, 2, 3, 5)
2. Peter J. Brockwell & Richard A. Davis, “Introduction to Time Series and Forecasting”, Springer, 3rd Edition, 2016. (Units 1, 3, 5)
3. Rob J Hyndman & George Athanasopoulos, “Forecasting: Principles and Practice”, OTexts, 3rd Edition, 2021. (Units 1, 2, 3, 4, 5)

REFERENCE BOOKS
1. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, & Greta M. Ljung, “Time Series Analysis: Forecasting and Control”, Wiley, 5th Edition, 2015.
2. Ruey S. Tsay, “Analysis of Financial Time Series”, Wiley, 3rd Edition, 2010.
3. Jason Brownlee, “Introduction to Time Series Forecasting with Python: How to Prepare Data and Develop Models to Predict the Future”, Machine Learning Mastery, 2020.
4. Galit Shmueli & Kenneth C. Lichtendahl Jr., “Practical Time Series Forecasting with R: A Hands-On Guide”, Axelrod Schnall Publishers, 2nd Edition, 2016.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2							2	
CO2	3	2	3	2	3								3
CO3	3	2	3	2	3							3	
CO4	2	3	2	3	2							2	
CO5	3	2	3	2	3								3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3832	AI DATA GOVERNANCE	45	0	0	45	90	3

OBJECTIVES

- To provide foundational understanding of data governance concepts, frameworks, and regulatory standards.
- To analyze organizational, technical and human challenges in implementing data governance and formulate strategic approaches.
- To introduce AI governance frameworks, model risk management principles, and compliance mechanisms with global standards.
- To evaluate fairness, accountability, transparency, and ethical principles in responsible and explainable AI systems.
- To examine integrated data and AI governance applications through case studies, emerging technologies, and future governance trends.

UNIT I	INTRODUCTION TO DATA GOVERNANCE	9
Overview of Data Governance and Frameworks – Importance of Data Quality, Assurance, and Trust – Data Audit, Lineage and Provenance – Metadata Management and Semantic Interoperability – Data Architecture, Data Lakes and Cloud Governance – Introduction to Data Privacy Regulations.		

UNIT II	CHALLENGES AND STRATEGIES IN DATA GOVERNANCE	9
Common Challenges: Data Silos, Legacy Systems, Inconsistent Standards – Human and Organizational Factors: Resistance to Change, Lack of Ownership, Skills Gaps – Strategic Approaches: Integrating People, Processes and Technology – Developing a Robust Data Governance Strategy – Advanced Governance Strategies (cloud, big data and multi-modal systems).		

UNIT III	INTRODUCTION TO AI GOVERNANCE	9
Overview of AI Governance: Scope and Frameworks – Model Validation Techniques – Model Risk Management (MRM): Operational, Ethical and Security Risks – ISO/IEC 42001:2023 Standard – Global Regulatory Compliance – AI Assurance and Algorithmic Impact Assessments (AIA).		

UNIT IV	PRINCIPLES OF AI GOVERNANCE	9
Fairness in AI – Accountability and Transparency in AI Models – Responsible and Ethical AI – Explainable AI (XAI): Interpretable Models, Post-hoc Methods, Counterfactual Explanations – Trustworthy AI: Privacy-Preserving AI, Federated Learning, Adversarial Robustness.		

UNIT V	CASE STUDIES AND APPLICATIONS	9
Case Studies on Data Governance (Healthcare, Finance) – Applications of AI Governance in industry – Best Practices for Integrating Data and AI Governance – Future Trends: Quantum Governance, AI for Governance, Automated Compliance Monitoring – Governance Challenges in Large Language Models and Generative AI.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply foundational concepts of data governance and frameworks in enterprise and regulatory contexts. (K3)

CO2 Utilize governance strategies to overcome data governance challenges. (K3)

CO3 Apply AI governance practices including model validation, risk management and compliance with global standards. (K3)

CO4 Analyze the principles and frameworks of AI governance, ethical considerations in AI systems and appraise methods ensuring explainability, privacy and trustworthiness. (K4)

CO5 Assess governance strategies for emerging technologies by synthesizing lessons from case studies and best practices. (K5)

TEXT BOOKS

1. John Ladley, *Data Governance: How to Design, Deploy, and Sustain an Effective Data Governance Program*, 2nd Ed., Academic Press, 2020. (Units – I, II, V)
2. Justin B. Bullock et al. (Eds.), *The Oxford Handbook of AI Governance*, Oxford University Press, 2022. (Units – III, IV, V)

REFERENCE BOOKS

1. Stuart Russell, *Human Compatible: Artificial Intelligence and the Problem of Control*, Penguin, 2020.
2. Kate Crawford, *Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence*, Yale University Press, 2021.
3. Ismael Caballero & Mario Piattini (Eds.), *Data Governance: From the Fundamentals to Real Cases*, Springer, 2023. (Units – I, II, V)
4. Sunil Gregory & Anindya Sircar, *AI Governance Handbook: A Practical Guide for Enterprise AI Adoption*, Springer, 2025. (Units – II, III, IV, V)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2					2					2	
CO2	3	3	2		2							2	
CO3	2	3	3	2		2						2	2
CO4		2	3	3	2	2						3	3
CO5	2	2	3		2	3	2					3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3833	DESIGN THINKING IN AI	45	0	0	45	90	3

OBJECTIVES

- To introduce a learner to the principles of Design Thinking.
- To familiarize a learner with the process (stages) of Design Thinking.
- To understand the principles of Design Thinking and the fundamentals of Artificial Intelligence, Machine Learning, NLP, and Generative AI.
- To apply AI tools and techniques across the five phases of Design Thinking (Empathise, Define, Ideate, Prototype, Test) to address real-world problems.
- To analyze the challenges, ethical considerations, data privacy issues, and human-centered concerns in AI-driven design processes.

UNIT I	INTRODUCTION TO DESIGN THINKING	9
Introduction to Design Thinking: Definition, Comparison of Design Thinking and traditional problem-solving approach, Need for Design Thinking approach, Key tenets of Design Thinking, 5 stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test)		

UNIT II	AI FUNDAMENTALS	9
Basic Concepts: Artificial Intelligence, Machine Learning, Natural Language Processing, Generative AI, Tools and Techniques: (TensorFlow, PyTorch, OpenAI, Google Colab, etc.) - The Intersection of Design Thinking and AI, Methodology: Literature Review, Peer-Reviewed Journals and Conferences-Reference Management: Zotera, Mendeley-Databases: Google Scholar, IEEE Xplore, ACM Digital Library.		

UNIT III	AI IN DESIGN THINKING	9
Benefits of Applying AI in Design Thinking-Challenges of Applying AI in Design Thinking: Maintaining Human-Centricity, Ethical Considerations and Bias, Overreliance on AI-Generated Solutions-Data Privacy and Security-Integrating AI Across the Design Thinking Process-Best Practices for AI Integration in Design Thinking.		

UNIT IV	AI INTEGRATION ACROSS DESIGN THINKING PHASES	9
Phases-Empathise: User Needs and Experience- AI Applications in the Empathise Phase-Define: Synthesise Information and Define Problems; Affinity Mapping-Cognitive Biases-AI Applications in the Define Phase-Ideation: Generate Problem Solution- Brainstorming-Mind Mapping- SCAMPER- Six Thinking Hats-Analogical Thinking-AI Applications in the Ideation Phase-Prototype: Paper Prototypes-Digital Wireframes-3D 3D Printing- Role-Playing- AI Applications in the Prototype Phase-Test: User Testing-A/B Testing-Surveys and Questionnaires-Heatmaps and Click Tracking-Focus Groups.		

UNIT V	ETHICAL CONSIDERATIONS	9
Ethical Considerations-Black Box AI Systems-Data Protection, Privacy and Regulations-Human Centered AI in Design Thinking-Future Trends: Generative Models, Multimodal-Continuous Learning-Convergence of AI and IoT Technologies-Collaborative AI		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Compare the traditional approach to problem-solving from the Design Thinking approach, and explain the key principles of Design Thinking. (K2)

CO2 Demonstrate understanding of Design Thinking methodology and AI fundamentals to identify problems suitable for AI-enabled human-centered design. (K3)

CO3 Apply appropriate AI tools and techniques across various Design Thinking phases to develop and test innovative solutions. (K3)

CO4 Analyze ethical, legal, and societal challenges associated with AI-driven Design Thinking and propose suitable mitigation strategies. (K4)

CO5 Design and develop human-centered AI solutions by integrating empathy research, ideation, prototyping, and testing into a complete design cycle. (K6)

TEXT BOOKS

1. AI in Design Thinking: Methodology and Trends, Bjorn.P.Jacobsen, Management Innovation Lab, HOST, 2025. (Units 1-V)
https://www.hochschule-stralsund.de/storages/hs-stralsund/FAK_WS/INNO/MIL/20250301_BJ_ai_in_dt.pdf
2. Borenstein, J. and Arkin, R. (2017) 'Robotic nudges: the ethics of engineering a more socially just human being', Science and Engineering Ethics, 23(1), pp. 31-46.

REFERENCE BOOKS

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013.
2. American Marketing Association (2024) The 5 Phases of Design Thinking. Available at: <https://www.ama.org/marketing-news/the-5-phases-of-design-thinking/> (Accessed: 4 February 2025).
3. Appnova (2024) How AI is going to Transform the Design Thinking Framework? Available at: <https://www.appnova.com/how-ai-is-going-to-transform-the-design-thinking-framework/> (Accessed: 4 February 2025).
4. Autodesk (2024) Generative Design. Available at: <https://www.autodesk.com/solutions/generativedesign> (Accessed: 4 February 2025).

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	1								2	
CO2	3	3	2	1	2							3	2
CO3	2	2	3	2	3				1			3	3
CO4	1	2		3		3	3	1				2	
CO5	2	2	3	2	3	2	2	2	3	2	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3834	ETHICS IN AI	45	0	0	45	90	3

OBJECTIVES

- Study the morality and ethics in AI
- Learn about the Ethical initiatives in the field of artificial intelligence
- Study about AI standards and Regulations
- Study about social and ethical issues of Robot Ethics
- Study about AI and Ethics- challenges and opportunities

UNIT I	INTRODUCTION	9
Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust.		

UNIT II	ETHICAL INITIATIVES IN AI	9
International ethical initiatives-Ethical harms and concerns-Case study: Healthcare robots, Autonomous Vehicles, Warfare and weaponization.		

UNIT III	AI STANDARDS AND REGULATION	9
Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems.		

UNIT IV	ROBOETHICS: SOCIAL AND ETHICAL IMPLICATIONS OF ROBOTICS	9
Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility-Roboethics Taxonomy.		

UNIT V	AI AND ETHICS- CHALLENGES AND OPPORTUNITIES	9
Challenges-Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI.		

TOTAL PERIODS	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the concepts of morality and ethics in Artificial Intelligence. (K2)

CO2 Identify and describe real-time ethical issues, challenges, and applications of AI. (K3)

CO3 Analyze the ethical harms and evaluate the ethical initiatives in AI. (K4)

CO4 Examine and apply AI standards and regulations related to AI agents and the safe design of autonomous systems. (K4)

CO5 Evaluate the principles of roboethics and morality in relation to professional and societal responsibilities. (K5)

CO6 Design and propose strategies to address societal issues in AI at national and international levels. (K6)

TEXTBOOKS

1. Y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield, "The ethics of artificial intelligence: Issues and initiatives", EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020. (Unit 1 and II)
2. Patrick Lin, Keith Abney, George A Bekey, "Robot Ethics: The Ethical and Social Implications of Robotics", The MIT Press- January 2014. (Unit III-V)

REFERENCE BOOKS

1. Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017. (Unit 1-3)
2. Mark Coeckelbergh, "AI Ethics", The MIT Press Essential Knowledge series, April 2020. (Unit 4&5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2				2	2					1	
CO2	2	3				3	2					2	1
CO3	2	3		2		3	3					2	
CO4	2	2	2	2	2	3	3					3	2
CO5		2				3	3	2				2	1
CO6		2	3		2	3	3	2	2		3	3	3

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3768	FINANCIAL DATA ANALYTICS	30	0	30	30	90	3

OBJECTIVES

- To understand the basics of finance data
- To learn about assets and volatility
- To understand the characteristics of high frequency finance data and its risks
- To learn estimation of stochastic models

UNIT I	INTRODUCTION TO FINANCIAL ANALYTICS	6
Introduction to Financial Analytics: Definition, relevance and scope, recent trends, Financial Time Series and Their Characteristics: Asset Returns, Distributional Properties of Returns, Review of Statistical Distributions, and properties of financial time series		

UNIT II	LINEAR MODELS FOR FINANCIAL DATA	6
Stationarity of data, Simple Auto regressive models, ARMA model, Exponential Smoothing and Seasonal models, Model Averaging		

UNIT III	ASSET VOLATILITY AND VOLATILITY MODELS	6
Characteristics of Volatility, Model Building, Testing for ARCH Effect, ARCH model, GARCH model, GARCH-M model, Exponential GARCH model		

UNIT IV	HIGH FREQUENCY FINANCIAL DATA ANALYSIS AND RISK	6
High-Frequency Data Analysis: Nonsynchronous Trading, Bid–Ask Spread of trading Prices, Empirical Characteristics of Trading Data, Models for Price Changes, Duration Models, Risk Measure and Coherence, Risk Metrics		

UNIT V	ESTIMATION OF STOCHASTIC MODELS FOR FINANCE	6
Derivative Pricing: Issues regarding derivative markets. Brownian motion, Short-term interest rates models, Exponential Lévy model, Black - Sholes model. Modeling derivative prices.		

SUGGESTED EXPERIMENTS

1. Visualization of financial data
2. Implementation of linear time series – Prediction of Weekly Regular Gasoline Price
3. Asset Portfolio construction from BSE
4. Modeling Stock market volatility using ARCH/GARCH models
5. Visualizing Empirical Characteristics of Trading Data
6. Value-at-Risk(VaR) estimation for IBM stocks
7. Estimation of Sectoral Index derivative

TOTAL PERIODS(L,P,TW & SL)	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the fundamental concepts of financial analytics, including time series properties, asset returns, and statistical distributions, and apply them to real-world financial datasets (K2)
CO2 Develop and implement linear time series models (ARMA, Exponential Smoothing) for forecasting financial data and evaluate their performance (K4)
CO3 Analyze volatility in financial markets using ARCH/GARCH models, test for ARCH effects, and interpret results for risk assessment (K4)
CO4 Examine high-frequency trading data, duration models, and Value-at-Risk (VaR) metrics to assess market risks, trading behaviors and ethical implications (K4)
CO5 Choose derivative pricing models and critique their assumptions and limitations in real-market scenarios (K5)

TEXT BOOKS
1. Ruey S. Tsay (2014), "An Introduction to Analysis of Financial Data with R", Wiley, ISBN: 978-0-470-89081-3 (Unit 1,2,3,4)
2. Stefano M. Iacus (2011), Option Pricing and Estimation of Financial Models with R", First Edition. Wiley, ISBN: 978-0-470-74584-7 (Unit 5)

REFERENCE BOOKS
1. Bernhard Pfaff (2013), "Financial risk modelling and portfolio optimization with R", Wiley, ISBN 978-0-470-97870
2. Cairns, A.J. G (2004), "Interest Rate Models: An Introduction", Princeton University Press, ISBN: 9780691118949
3. Christian Gouriéroux & Joann Jasiak (2002), "Financial Econometrics: Problems, Models, and Methods", Princeton University Press, ISBN: 9780691088723
4. Argimiro Arratia (2014), "Computational Finance An Introductory Course with R", Atlantis Press, ISBN 978-94-6239-069-0
5. Duffie, D. and Singleton, K.J (2003), "Credit Risk: Pricing, Measurement, and Management", Princeton University Press, ISBN: 9780691090467

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2			3		2								2
CO3				3		3						3	
CO4				3			3						3
CO5			3						3	2		3	
Average	3		3	3	2	3	3		3	2		3	2.5

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3H61	LARGE LANGUAGE MODELS AND GENERATIVE AI	30	0	30	30	90	3

OBJECTIVES

- To provide a comprehensive understanding of the fundamental principles and architectures of Large Language Models (LLMs) and Generative AI.
- To equip students with the theoretical knowledge and practical skills to design, implement, and evaluate various generative models, including LLMs.
- To explore the applications of LLMs and Generative AI across diverse domains and understand their societal impact.
- To critically analyze the ethical considerations, challenges, and limitations associated with LLMs and Generative AI technologies.
- To foster research aptitude and prepare students for advanced studies or industry roles in the rapidly evolving field of Generative AI.

UNIT I	LLMs AND TRANSFORMERS	6
Overview of Natural Language Processing – Emergence of Large Language Models – Sequence Modeling Challenges – Transformer Architecture: Self-Attention Mechanism – Positional Encoding – Encoder-Decoder Structure – Comparison with RNNs and CNNs – Tokenization and Vocabulary – Pretraining Objectives: Masked Language Modeling, Causal Language Modeling – BERT vs. GPT Paradigms.		

UNIT II	TRAINING AND FINE-TUNING LLMs	6
Data Preparation for LLMs – Transfer Learning in NLP – Pretraining vs. Fine-tuning – Prompt Engineering Basics – In-context Learning – Instruction Tuning – RLHF (Reinforcement Learning with Human Feedback) – Evaluation Metrics: BLEU, ROUGE, Perplexity – Safety, Bias, and Fairness Considerations – Few-shot and Zero-shot Capabilities.		

UNIT III	GENERATIVE AI MODELS AND APPLICATIONS	6
Generative Adversarial Networks (GANs) – Variational Autoencoders (VAEs) – Diffusion Models – Text Generation using LLMs – Image Generation using Generative AI – Cross-modal Generation (Text-to-Image, Image-to-Text) – Multimodal AI Models – Applications: Chatbots, Code Generation, Text Summarization, Style Transfer.		

UNIT IV	DEPLOYMENT & SCALING OF LLMs	6
Model Compression Techniques – Quantization and Pruning – Knowledge Distillation – Efficient LLMs: DistilBERT, LLaMA, Mistral – Serving Large Models with Transformers and TensorRT – GPU and TPU Considerations – Cost Optimization – Latency vs. Accuracy Trade-offs – Cloud-based Deployment (AWS, GCP, Azure) – Inference Pipelines.		

UNIT V	ETHICS, ALIGNMENT & FUTURE TRENDS	6
AI Alignment and Human Preferences – Hallucination in LLMs – Guardrails and Content Filtering – Copyright and IP Challenges – Open Source vs. Proprietary Models – Role of LLMs in Education, Healthcare, Business – Autonomous Agents and Tool Use – Federated Learning for LLMs – OpenAI GPT, Google Gemini, Meta LLaMA, Claude – The Path Towards AGI.		

SUGGESTED EXPERIMENTS

1. Load a pre-trained transformer model and generate contextual embeddings for sample sentences.
2. Fine-tune a BERT model on a sentiment classification dataset using Hugging Face Transformers.
3. Implement prompt engineering techniques for text summarization and question answering.
4. Generate synthetic text using a causal language model like GPT-2 on a custom prompt.
5. Build a simple chatbot using a local LLM or OpenAI API to simulate human conversation.
6. Train a Variational Autoencoder (VAE) to reconstruct and generate handwritten digits (MNIST).
7. Generate realistic images using a basic Generative Adversarial Network (GAN) model.
8. Evaluate the ethical implications of generated outputs by identifying bias and hallucinations in LLM responses.

TOTAL PERIODS(L,P,TW &SL)**90****COURSE OUTCOMES**

On successful completion of this course, students will be able to

- CO1 Explain the architecture and functioning of transformer-based models and the evolution of Large Language Models. (K2)
- CO2 Apply fine-tuning techniques, prompt engineering, and evaluation strategies to optimize performance of LLMs for specific NLP tasks. (K3)
- CO3 Compare the working of generative AI models such as GANs, VAEs, and diffusion models for text and image generation. (K5)
- CO4 Identify the deployment challenges of LLMs in production environments with a focus on performance, scalability, and cost-efficiency. (K3)
- CO5 Identify the ethical, legal, and societal implications of deploying generative AI systems and explore current trends and future directions. (K3)

TEXT BOOKS

1. Sinan Ozdemir , “Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs”, Addison-Wesley Professional, 2023 (Units I, II, V)
2. Alger Fraley , “The Artificial Intelligence and Generative AI Bible: [5 in 1] The Most Updated and Complete Guide”, Author's Republic, 2024 (Units III, IV, V)

REFERENCE BOOKS

1. Edward Y. Chang, “Unlocking the Wisdom of Large Language Models: An Introduction to The Path to Artificial General Intelligence”, SocraSynth, 2024. (Unit V)
2. Ray Islam, “Generative AI, Cybersecurity, and Ethics”, John Wiley & Sons, 2024.(Unit V)
3. Chris Fregly, Antje Barth, and Shelbee Eigenbrode, “Generative AI on AWS”, O’Reilly, 2023. (Unit IV)

4. Ben Auffarth, “Generative AI with LangChain”, O’Reilly, 2023. (Units III, IV)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	3	3	3									3	2
CO3	3	3	3	3	3			3	3		2	3	2
CO4	3	3	3									3	2
CO5	3	3										3	
Average	3	3	3	3	3			3	3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M61	PRINCIPLES OF DATA SCIENCE	30	0	30	30	90	3

OBJECTIVES

- To learn the fundamentals of Data Science using Python.
- To understand descriptive statistics using Python libraries.
- To understand probability distributions and perform statistical inference.
- To understand the various approaches in time series analysis.
- To be familiar with supervised and unsupervised methods in machine learning.

UNIT I	DATA SCIENCE PROCESS & DATA PREPROCESSING	5
Data science process: Defining Research goals- Retrieving data- Cleansing, integrating and transforming data – Data analysis – Build the models – Presenting findings and building applications. Data manipulation: Reading and selection – Filtering missing data – Sorting – Grouping – Ranking and plotting; Data Manipulation with Pandas; Data visualization- Types of Data: Ordinal, Nominal, Discrete, Continuous.		

UNIT II	DESCRIPTIVE STATISTICS	6
The Population and The Sample - Descriptive Analysis of Sample Values: Frequency Distribution of Discrete Random Variable - Frequency Distribution of Continuous Random Variable ; Techniques of Exploratory Data Analysis : Density plot, Box plot, Quantile plot; Distribution: Binomial Distribution - Normal Distribution.		

UNIT III	STATISTICAL INFERENCE & BOOTSTRAPPING	7
Point Estimate - Methods of Point Estimation - Confidence Intervals - Tolerance Intervals - Random Sampling - Bootstrap Sampling - Bootstrap Testing of Hypothesis - Chi-Square Test.		

UNIT IV	TIME SERIES ANALYSIS	6
Components of Time Series: Trend and Covariance- Analyzing Time Series; Covariance Stationary Time Series: Moving Averages - Auto- Regressive Time Series - Auto- Regressive Moving Averages Time Series.		

UNIT V	TIME SERIES PREDICTION	6
Linear Predictors for Covariance Stationary Time Series: Optimal Linear Predictors; Predictors for Non-stationary Time Series: Quadratic LSE Predictors – Moving Average Smoothing Predictors; Dynamic Linear Models.		

SUGGESTED EXPERIMENTS

1. Creating a Data Frame with default index and user-defined index for data available as dictionaries using Pandas.
2. Data Frame creation with different file formats using Pandas.
3. Perform data manipulation on the input CSV file using Pandas Package.
5. Perform data preparation and visualization on the input CSV file using Pandas and Matplotlib packages.

6. Perform Exploratory Data Analysis on a CSV file. Import any CSV file and perform Exploratory Data Analysis by plotting histogram based on frequency count and probability.
7. Develop a Python program to compute estimators using Pandas and Numpy.
8. Demonstrate the different sampling techniques using Pandas and Numpy.
9. Develop a Python code to perform time series analysis.
10. Develop a Python code to examine a population and make inferences using statistical inference.
11. Develop a Python program to analyze a time series dataset by identifying its components such as trend, seasonality, and covariance. Implement Moving Average and Auto-Regressive models to study the behavior of time-dependent data.
12. Develop a Python program to perform time series forecasting by implementing Optimal Linear Predictors and Moving Average Smoothing Predictors for non-stationary datasets. Compare prediction performance using appropriate error metrics.

TOTAL PERIODS(L,P,TW&SL)	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Develop Python programs for data manipulation and data visualization(K3)
CO2 Apply statistical techniques to explain and analyze the data(K3)
CO3 Examine a population and make inferences using statistical inference(K4)
CO4 Apply time series analysis on time variant data(K3)
CO5 Design a machine learning based solution in teams to solve a real-world socially relevant problem and document the findings(K6)

TEXT BOOKS
1. Ron S. Kenett, Shelemyahu Zacks, Peter Gedeck, "Modern Statistics: A Computer-Based Approach with Python", Springer, 2022. (UNIT II-V)
2. José Unpingco, "Python for Probability, Statistics, and Machine Learning", Second Edition, Springer, 2016. (UNIT I, II)

REFERENCE BOOKS
1. Davy Cielen, Arno D B Meysman, Mohamed Ali, "Introducing Data Science – Big data, Machine Learning, and more using Python tools", Manning Publications Co, 2016.
2. Laura Igual, Santi Segua, "Introduction to Data Science – A Python Approach to Concepts, Techniques and Applications", Springer Nature, 2017
3. Alan Agresti and Maria Kateri, "Foundations of Statistics for Data Scientists With R and Python ", First Edition, CRC Press, 2022.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					3								
CO2	3	2		3	3								
CO3		2		3									
CO4	3	2		3	3						2		
CO5			3	3	3			3	3		2		
Average	3	2	3	3	3			3	3		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M62	MACHINE LEARNING	30	0	30	30	90	3

OBJECTIVES

- To understand machine learning problems.
- To study the various supervised, unsupervised and reinforcement learning algorithms in machine learning.
- To study the dimensionality reduction techniques to represent the data and their dependencies.
- To understand the need of optimization techniques.
- To analyze the ethical implications of machine learning models and suggest improvements

UNIT I	INTRODUCTION	6
Introduction: Machine learning; Examples of Machine Learning Applications: Learning associations – Classification – Regression – Unsupervised learning – Reinforcement learning; Evaluation metrics for supervised learning-training testing and validation -Turning data into probabilities – Basic statistics – Bias-variance trade off.		

UNIT II	SUPERVISED & UNSUPERVISED LEARNING	6
Neural Networks and Linear Discriminants: Brain and the neuron – Neural networks – Perceptron – Linear separability – Linear regression; Multi-layer Perceptron: Forward and Backward propagation-loss functions-activation functions-regularization methods; Support Vector Machines- linear and non-linear kernels, K-means algorithm		

UNIT III	PROBABILISTIC LEARNING, LEARNING WITH TREES	6
Probabilistic Learning: Naive Bayes Classifier, Gaussian mixture models – Nearest neighbour methods; Learning with Trees: Constructing decision trees –Entropy, Information Gain, Gini Index-Classification and Regression trees – overfitting and pruning in decision trees. Classification example; Ensemble Learning: Boosting – Bagging – Random forests.		

UNIT IV	REINFORCEMENT LEARNING	6
Reinforcement learning: State and action space – Reward function – Discounting – Action selection – Policy – Value- Value iteration and Policy iteration- Markov decision process – Monte Carlo-Temporal Difference Learning- SARSA and Q-learning.		

UNIT V	DIMENSIONALITY REDUCTION	6
Dimensionality Reduction Techniques: Linear Discriminant analysis, Principal Component Analysis		

SUGGESTED EXPERIMENTS

1. Working with Python packages - Numpy, Scipy, Scikit-learn, Matplotlib
2. Loan amount prediction using linear regression and visualize the interpretation
3. Handwritten character recognition using neural networks
4. Classification of Email spam and MNIST data using Support Vector Machines.
5. Predicting Diabetes using decision tree

6. Applications of Random Forest and AdaBoost ensemble techniques
7. K-means clustering for Euclidean distance metric
8. Applications of dimensionality reduction techniques on any dataset

TOTAL PERIODS(L,P&TW&SL)

90

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the basic concepts of machine learning (K2)

CO2 Apply supervised algorithms for different classification problems (K5)

CO3 Apply the concepts of ensemble learning methods (K3)

CO4 Apply unsupervised and reinforcement learning techniques to various problems (K5)

CO5 Apply dimensionality reduction techniques (K3)

TEXT BOOKS

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015. (Units 1-4)
2. Ethem Alpaydin, "Introduction to Machine Learning", 3rd Edition, The MIT Press, 2014. (Unit 5)

REFERENCE BOOKS

1. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2014.
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", 1st Edition, Cambridge University Press, 2012.
3. Richert, Willi, "Building machine learning systems with Python", Packt Publishing, 2013.
4. Tom M Mitchell, "Machine Learning", McGraw-Hill Education (India), 2013.
5. Y S Abu-Mostafa, M Magdon-Ismail, H T Lin, "Learning from Data", AML Book Publishers, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3											
CO2	3	3	3		3								
CO3		2	3		2								
CO4		3	3	3									
CO5	3	2			3								
Average	3	2.6	3	3	2.7	3	3	3	2				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M21	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE	45	0	0	45	90	3

OBJECTIVES

- To study the fundamental concepts of AI agents and environments.
- To explore various problem-solving techniques and search algorithms, including uninformed and informed search strategies, and their application to optimization and constraint satisfaction problems.
- To learn knowledge representation and reasoning using logical formalisms and probabilistic models, enabling AI systems to make decisions under uncertainty.
- To apply AI methods to real-world challenges, including decision-making in dynamic environments, game theory, and autonomous systems, using appropriate algorithms and models.

UNIT I	INTELLIGENT AGENTS AND PROBLEM SOLVING	8
Introduction: What is AI; Intelligent Agents: Agents and environments – Good behavior – The nature of environments – Structure of agents; Problem solving agents – Example problems		

UNIT II	SEARCH TECHNIQUES	10
Solving Problems by Searching: Searching for solutions – Uninformed search strategies – Informed search strategies – Heuristic functions; Beyond Classical Search: Local search algorithms – Hill climbing – Simulated annealing – Adversarial Search: Games – Optimal decisions in games – Alpha-beta pruning; Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems – Constraint propagation – Inference in CSPs – Backtracking search for CSPs – Local search for CSPs.		

UNIT III	KNOWLEDGE REPRESENTATION AND REASONING	9
Knowledge-based Agents: Knowledge representation – Propositional logic – Propositional theorem proving; First-order Logic: Syntax and semantics for first-order logic – Using first-order logic; Inference in first-order logic: Propositional versus first-order logic – Unification and lifting – Forward chaining – Backward chaining – Resolution.		

UNIT IV	UNCERTAINTY AND PROBABILISTIC REASON	9
Quantifying Uncertainty: Acting under uncertainty – Basic probability notation – Inference using full joint distributions – Bayes' rule & its use; Probabilistic Reasoning: The semantics of Bayesian networks – Exact inference in Bayesian networks.		

UNIT V	PLANNING AND DECISION MAKING	9
Automated Planning: Definition of Classical Planning - Example domains - Algorithms for Classical Planning - Hierarchical Planning. Making Simple Decisions: Combining beliefs and desires under uncertainty – The basis of utility theory – Utility functions – multi-attribute utility functions – Decision networks.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze the characteristics of intelligent agents and their interaction with environments to determine optimal agent behavior and design effective agent architectures (K4)

CO2 Evaluate and design appropriate search strategies—including uninformed, informed, local, and adversarial methods—as well as constraint satisfaction approaches for solving complex AI problems (K5)

CO3 Construct logical representations of knowledge using propositional and first-order logic, and implement reasoning techniques such as unification, forward/backward chaining, and resolution (K3)

CO4 Apply probabilistic reasoning models and evaluate the use of Bayesian networks and Bayes' rule to make informed decisions under uncertainty (K3)

CO5 Analyze classical and hierarchical planning strategies along with decision-making models using utility theory and decision networks to handle uncertainty in intelligent systems (K4)

TEXT BOOKS

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 4th Edition, Pearson Education / Prentice Hall of India, 2015 (Units 2, 3, 4 and 5)
2. David Poole, Alan Mackworth, "Artificial Intelligence: Foundation of Computational Agents", 2nd Edition, Cambridge University Press, 2017 (Unit 1).

REFERENCE BOOKS

1. Elaine Rich, Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.
2. Dawn W Patterson, "Introduction to Artificial Intelligence and Expert Systems", 1st Edition, Pearson Education India, 2015.
3. Andreas Muller, Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 1st edition, 2016.
4. Prateek Joshi, "Artificial Intelligence with Python", 1st edition, Packt Publishing Limited, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2	2										
CO3	3	2	2										
CO4	3	2	2										
CO5	3	2	2										
Average	3	2	2	3	1								

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M22	DEEP LEARNING	45	0	0	45	90	3

OBJECTIVES

- To understand basics of deep neural networks
- To understand CNN and RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn deep learning algorithms and their applications to solve real world problems

UNIT I	DEEP NETWORKS BASICS	9
Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning; Deep Networks: Deep feedforward networks.		

UNIT II	CONVOLUTIONAL NEURAL NETWORKS	9
Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling-Convolution Variants: Strided - Tiled-- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions - Loss Functions - Regularization - Optimizers - Gradient Computation – CNN through Visualization.		

UNIT III	RECURRENT NEURAL NETWORKS	9
Unfolding Graphs - RNN Design Patterns: Acceptor - Encoder-- Transducer; Gradient Computation - Sequence Modeling Conditioned on Contexts - Bidirectional RNN - Sequence to Sequence RNN – Deep Recurrent Networks - Long Term Dependencies; Leaky Units: Skip connections and dropouts.		

UNIT IV	AUTOENCODERS AND GENERATIVE MODELS	9
Autoencoders: Undercomplete autoencoders - Regularized autoencoders - Stochastic encoders and decoders - Learning with autoencoders; Deep Generative Models: Variational autoencoders -Generative adversarial networks.		

UNIT V	TRANSFORMER MODELS AND ETHICAL ASPECTS	9
The Encoder-Decoder Framework - Attention Mechanisms - Hugging Face Transformers – BERT- Interpretability: SHAP, LIME, Grad-CAM- Fairness and Bias in Deep Learning- Explainable AI (XAI).		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the core principles of deep neural networks and their training mechanisms. (K2)
CO2 Apply convolutional and recurrent neural network architectures to solve vision and sequence modeling tasks.(K3)
CO3 Experiment with autoencoders and generative models to learn and generate structured representations of data.(K3)
CO4 Develop and interpret transformer-based models with attention mechanisms and explore ethical concerns in AI.(K3)
CO5 Solve real-world problems and develop deep learning-based solutions using advanced architectures and interpretation techniques.(K6)

TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016. (Units 1,2,3,4)
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, “Natural Language Processing with Transformers”, O'Reilly Media, Inc., May 2022. (Unit 5)

REFERENCE BOOKS

1. Seth Weidman. “Deep Learning from Scratch: Building with Python from First Principles”, O'Reilly Media, Inc, September 2019.
2. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, “A Guide to Convolutional Neural Networks for Computer Vision”, Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
3. Yoav Goldberg, “Neural Network Methods for Natural Language Processing”, Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
4. Santanu Pattanayak, “Pro Deep Learning with TensorFlow: A Mathematical Approach to Advanced Artificial Intelligence in Python”, Apress, 2017.
5. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner's Approach” First Edition, O'Reilly Media, 2017.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3			1								
CO2	3	3									2		
CO3	3	3	2										
CO4	3	2											
CO5	3	2		3	2	2		3	3		2		
Average	3	2.3	2	3	1.5	2		3	3		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M63	IMAGE PROCESSING	30	0	30	30	90	3

OBJECTIVES

- To understand basics of digital images
- To understand spatial and frequency domain processing
- To learn image segmentation techniques
- To learn feature detection and multi-resolution analysis
- To learn various applications of image processing

UNIT I	FUNDAMENTALS OF IMAGE PROCESSING	6
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Introduction -- Fields that use digital image processing -- Steps in Image Processing Systems – Image Acquisition -- Sampling and Quantization -- Pixel Relationships. Image Enhancement in the spatial domain: Basic gray-level transformation, histogram processing, Enhancement using arithmetic and logic operators.

UNIT II	IMAGE ENHANCEMENT AND RESTORATION	6
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Basic spatial filtering: Smoothing filters; Sharpening filters; Frequency Domain processing: Fourier Transform -- DFT and FFT; Filtering operations in frequency domain; Restoration: Model of Image Degradation/Restoration Process, Noise Models -- Filters for noise removal in Spatial and Frequency domain.

UNIT III	IMAGE SEGMENTATION	6
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Thresholding techniques: Region growing -- splitting and merging -- Adaptive -- Otsu method; Edge detection; Edge linking via Hough transform -- Template matching; Gradient operation; Hysteresis Thresholding - Canny operator – Laplacian operator; Image morphology -- Binary and Gray Level morphology operations -- Morphological watersheds.

UNIT IV	FEATURE DETECTION AND RECOGNITION	6
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Boundary representation and detections – Boundary Descriptors --- texture descriptors – regional descriptors; Object Recognition: Patterns and patterns classes, recognition based on decision– theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching.

UNIT V	MULTI RESOLUTION ANALYSIS, COLOR IMAGE PROCESSING AND IMAGE COMPRESSION	6
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Multi Resolution Analysis: Image Pyramids -- Multi resolution expansion -- Wavelet Transforms; Fast Wavelet transforms. Color Image Processing: Color models, color transforms, smoothing and sharpening, color segmentation. Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards.

SUGGESTED EXPERIMENTS

1. Perform the following tasks:

- Image resizing
- Image type conversion
- Extraction of color bands
- Creation of synthetic image

2. Generate noisy images by adding Uniform, Gaussian, Salt and pepper noise to an input image. Observe the performance of smoothing filters in the spatial domain.

3. Identify a night vision dataset. Apply suitable filtering techniques to improve the contrast of the images.

4. Take a low contrast image and do the following:

- Generate a histogram of the image and observe how the intensity values are distributed.
- Apply histogram equalization and matching.

5. Select a noisy image dataset. Apply smoothing / sharpening filters in the frequency domain to improve the quality of the images.

6. Segment an image

- By calculating a threshold setting using the histogram of brightness values.
- Using adaptive thresholding
- Using watershed algorithm

5. Take a microscope cell image that has undergone a threshold operation. Perform the following morphological transform.

- erosion and dilation with a circular structuring element
- erosion and dilation with a square structuring element
- closing and opening with a cross shaped structuring element

6. Generate the edges of an image by applying the following edge detection operators: Roberts, Sobel, Prewitt, Laplacian and Canny operators.

7. Perform line, circle, and ellipse detection using Hough transform for medical images.

8. Write a program to implement a discrete wavelet transform and its inverse for an image. (The user can decide the number of decomposition). Apply Daubechies, Haar and Morlet.

9. Consider images of following characteristics:

- With features of varying sizes
- With features of varying sizes that are not convex
- With a series of lines of approximately the same length
- With features with different numbers of internal holes.

Develop a program to count the features, label the pixels with a unique identifying number, and measure the area, total perimeter for the images.

10. Case study of Google's WebP image format

TOTAL PERIODS(L,P,TE &SL)	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the fundamental concepts of a digital image processing system K2
CO2 Apply image enhancement and restoration techniques in spatial and frequency domains K3

CO3 Make use of image segmentation techniques for object detection K3
CO4 Choose appropriate techniques for object enhancement, detection, recognition, and classification in various applications K5
CO5 Analyze the multi resolution methods and image transforms for color images K4

TEXT BOOKS

1. Rafael C.Gonzalez, Richard E.Woods, "Digital Image Processing", Fourth Edition, Pearson Education, 2018 (Units I, II, III, IV)
2. Wilhelm Burger, Mark J. Burge, "Principles of Digital Image Processing : Core Algorithm", Springer, 2009 (Unit V)

REFERENCE BOOKS

1. Anil K.Jain, "Fundamentals of Digital Image Processing", PHI, 2006.
2. Rafael C. Gonzalez, Richard E.Woods, Eddins, "Digital Image Processing using MATLAB", Second Edition, Tata McGraw-Hill, 2009.
3. Davis, E. R., "Machine Vision", Second Edition, 1997.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	3	3	3	3					2	2		
CO5	3	2	2										
Average	3	2.2	2.5	3	3					2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M23	INTRODUCTION TO NATURAL LANGUAGE PROCESSING	45	0	0	45	90	3

OBJECTIVES

- To learn language models
- To learn text preprocessing techniques
- To understand the levels of knowledge in language processing
- To develop NLP applications.
- To apply traditional learning and deep learning for NLP applications.

UNIT I	TEXT PRE-PROCESSING AND LANGUAGE MODELLING	9
Knowledge in language processing – NLP applications; – Regular Expressions – Words – Corpora – Text Normalization – Minimum Edit distance – N-gram language models – Neural language models - RNNs as language models		

UNIT II	WORD LEVEL AND SYNTACTIC ANALYSIS	9
Word Level Analysis: Word classes – Part-of-Speech Tagging: HMM POS tagging; Named Entities (NE): NE Tagging – Conditional Random Field NE recognizer; Syntactic Analysis: Constituency – Context-free grammar – Grammar rules – Treebanks; Parsing: Top-down – Bottom- up – Ambiguity – CKY Parsing – Shallow parsing – Dependency parsing		

UNIT III	SEMANTIC ANALYSIS	9
Vector Semantics – Words and Vectors – Cosine similarity – Tf-idf – Positive PMI – Word2vec– Semantic properties of embeddings; Lexical Semantics: Word Senses – Relations between senses – WordNet – Word Sense Disambiguation		

UNIT IV	COREFERENCE RESOLUTION AND MACHINE TRANSLATION	9
Coreference Resolution: Coreference phenomena – Mention detection – Mention-pair architecture; RNNs for sequence labeling and classification – Stacked and Bi-directional RNN – Machine Translation(MT): Lexical divergence and typology – Encoder-Decoder with RNNs – MT Evaluation;		

UNIT V	NLP APPLICATIONS	9
Sentiment Classification: Naive Bayes classifier – Optimizing for Sentiment Analysis – Evaluation; Information Extraction: Relation extraction; Information Retrieval; IR-based Factoid Question Answering: IR-based QA Datasets – Answer span extraction.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply text pre-processing techniques and build the language models (K3)

CO2 Apply basic levels of knowledge at word level and syntax level in language processing (K3)
CO3 Apply computational methods in lexical and vector semantics (K3)
CO4 Explain discourse processing and machine translation systems (K2)
CO5 Apply learning algorithms for various NLP applications (K3)

TEXT BOOKS

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2008.

REFERENCE BOOKS

1. Christopher D Manning, Hinrich Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
2. Steven Bird, Ewan Klien and Edward Loper, Natural Language Processing with Python, O'Reilly, 2009.
3. Nitin Indurkha, Fred J Damerau, "Handbook of Natural Language Processing", 2nd Edition, CRC Press, 2010.
4. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
5. Li Deng, Yang Liu, "Deep Learning in Natural Language Processing", Springer, 2018
6. Taweh Beysolow II, "Applied Natural Language Processing - Implementing Machine Learning and Deep Learning Algorithms for Natural Language Processing", Apress, 2018

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	2											
CO5	3	3		3									
Average	3	2.2		3									

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M24	SPEECH PROCESSING TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- To explore the fundamentals of digital speech process
- To understand the basic concepts and algorithms of speech processing
- To be familiar with the various speech signal representation, coding and recognition techniques
- To study the concepts and evaluation methods of speech synthesis.

UNIT I	FUNDAMENTALS OF DIGITAL SPEECH PROCESSING	9
Introduction: Discrete-time signals and systems – Transform representation of signals and systems – Fundamentals of digital filters – Sampling; Process of speech production – Acoustic theory of speech production – Digital models for speech signals.		

UNIT II	SPEECH SIGNAL ANALYSIS IN TIME DOMAIN	9
Time-dependent processing of speech – Methods for extracting the Parameters: Energy – Average magnitude – Zero-crossing rate; Silence discrimination using ZCR and energy – Short-time auto correlation function – Pitch period estimation using autocorrelation function.		

UNIT III	SPEECH SIGNAL ANALYSIS IN FREQUENCY DOMAIN	9
Spectrographic displays – Formant extraction – Pitch extraction – Linear predictive coding: Autocorrelation method – Covariance method; Solution of LPC equations – Durbin's Recursive solution – Application of LPC parameters – Pitch detection.		

UNIT IV	SPEECH RECOGNITION	9
Introduction – Preprocessing – Parametric representation – Speech segmentation – Dynamic time warping – Vector quantization – Hidden Markov Model – Language Models – Developing speech recognition system for real time applications.		

UNIT V	SPEECH SYNTHESIS	9
Attributes of speech synthesis – Formant speech synthesis – Concatenative speech synthesis – Prosodic modification of speech – Source filter models for prosody modification – Evaluation of TTS system.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Illustrate how the speech production is modelled K2

CO2 Utilize the speech signal in time domain K3

CO3 Utilize the speech signal in frequency domain K3

CO4 Choose the appropriate technique to develop automatic speech recognition system for

the real word application K5
CO5 Identify the suitable method in speech synthesis for the given application K3

TEXT BOOKS

1. L R Rabiner, R W Schafer, "Digital Processing of Speech Signals", Pearson Education, Delhi, India, 2004. (Unit 1,2,3)
2. Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, "Spoken Language Processing – A guide to Theory, Algorithm and System Development", Prentice Hall PTR, 2001. (Unit 4,5)

REFERENCE BOOKS

1. L R Rabiner, B H Jhuang, B Yegnanarayana, "Fundamentals of Speech Recognition", Pearson Education, 2009.
2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing", Pearson Education, 2002.
3. Ben Gold, Nelson Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc, 2004.
4. J R Deller Jr, J H L Hansen, J G Proakis, "Discrete-Time Processing of Speech Signals", Wiley-IEEE Press, NY, USA, 1999.
5. Daniel Jurafsky, James H Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 3rd edition, Draft, 2024.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2											
CO3	3	2											
CO4	3	3	3		2					2	2		
CO5	3	2	2										
Average	3	2.2	2.5		2					2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M25	BIG DATA ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the competitive advantages of big data analytics
- To understand the distributed storage for big data
- To learn distributed method for processing of big data
- To understand how to represent unstructured data using NoSQL and processing
- To learn how statistical methods used for analyzing big data

UNIT I	INTRODUCTION TO BIG DATA	9
Introduction to Big Data – Characteristics of Big Data (5Vs: Volume, Velocity, Variety, Veracity, Value) – Sources of Big Data – Benefits and applications of Big Data – Big Data lifecycle – Managing and organizing large-scale data – Data analytics and learning from large datasets – Big Data ecosystem and architecture – Technology challenges for Big Data – Overview of Hadoop ecosystem – Big Data use cases in industry.		

UNIT II	HADOOP DISTRIBUTED FILE SYSTEM (HDFS)	9
Introduction to distributed storage systems – Distributed file system concepts – Google File System (GFS) architecture – Hadoop ecosystem overview – HDFS architecture and design goals – NameNode and DataNode architecture – HDFS block structure and replication – HDFS read/write operations – HDFS commands and file management – Fault tolerance and data reliability – HDFS federation and high availability.		

UNIT III	DATA PROCESSING USING MAPREDUCE	9
Introduction to parallel data processing – MapReduce programming model – MapReduce architecture – Working of MapReduce framework – Input splits and record readers – Mapper, combiner, reducer functions – Shuffle and sort phase – Writing and testing MapReduce programs – Performance tuning in MapReduce – Limitations of MapReduce – Introduction to higher-level frameworks such as Pig and Spark.		

UNIT IV	NOSQL	9
Introduction to NoSQL databases – Need for NoSQL – Characteristics of NoSQL systems – CAP theorem – Types of NoSQL databases: Key-value stores, Document databases, Column-family databases, Graph databases – Advantages and limitations of NoSQL – Data modeling in NoSQL – NoSQL database frameworks: Hive and HBase – Querying data in Hive – HBase architecture and data storage.		

UNIT V	BIG DATA ANALYSIS	9
Data analysis techniques for large datasets – Statistical methods: Regression modeling – Multivariate analysis – Data preprocessing and feature engineering – Classification techniques: Support Vector Machines (SVM), Decision Trees, Linear classifiers – Clustering concepts – Introduction to machine learning for big data – Visualization techniques for big data – Applications of big data analytics in business and science.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explore how to leverage the insights from big data analytics (K2)

CO2 Apply distributed computing for better storage of data (K3)

CO3 Develop applications using Hadoop related tools (K4)

CO4 Adapt database frameworks, Hive and Hbase for data analytics (K3)

CO5 Solve applications using statistical and data analytic methods (K3).

TEXT BOOKS

1. Parag Kulkarni, Sarang Joshi, "Big Data Analytics", PHI Learning Pvt. Ltd, 2016.

2. Anil Maheshwari, "Big Data Essentials", McGraw Hill, 2019

REFERENCE BOOKS

1. Arshdeep Bahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", Published by A Hands-on Approach Textbooks, 2016.

2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.

3. Gaurav Vaish, "Getting Started with NoSQL", Packt Publishing Ltd, 2013.

4. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012.

5. Lars George, "HBase: The Definitive Guide", O'Reilly, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1				3								
CO2	2	3	1	3	2								
CO3	2	3	1	3	2		1	3	3				
CO4	2	3	1	3	2		1	3	3				
CO5	2	3	1	3	2		1	3	3				
Average	2	3	1	3	3		1	2	2				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M26	FOUNDATIONS AND APPLICATIONS OF MACHINE LEARNING	45	0	0	45	90	3

OBJECTIVES

- To understand machine learning problems
- To study the various supervised, unsupervised and reinforcement learning algorithms in machine learning
- To study the method to deploy machine learning models in production.

UNIT I	INTRODUCTION	9
Introduction: Machine learning; Examples of Machine Learning Applications: Learning associations – Classification – Regression – Unsupervised learning – Reinforcement learning; Fundamentals: Weight space, Dimensionality, Testing machine learning algorithms, Turning data into probabilities, Basic statistics, Bias-variance tradeoff .		

UNIT II	SUPERVISED LEARNING	9
Neurons, Neural Networks and Linear Discriminants - Perceptron – Linear separability – Linear regression; Multi-layer Perceptron: Forward and Backward propagation; Support Vector Machines.		

UNIT III	PROBABILISTIC LEARNING, LEARNING WITH TREES	9
Probabilistic Learning: Gaussian mixture models – Nearest neighbour methods; Constructing decision trees – Classification and Regression trees – Classification example; Ensemble Learning: Boosting – Bagging – Random forests.		

UNIT IV	UNSUPERVISED LEARNING, REINFORCEMENT LEARNING	9
Unsupervised: Clustering, K-means algorithm, Vector quantization, Self organizing feature map; Reinforcement learning: State and action space – Reward function – Discounting – Action selection – Policy – Markov decision process – Values – SARSA and Q-learning.		

UNIT V	DEPLOYMENT OF MACHINE LEARNING MODELS	9
Model Deployment: Strategies for deploying machine learning models in production - Hyperparameter Tuning: Techniques for optimizing model performance - Case Studies: Real world applications of supervised and unsupervised learning.		

TOTAL PERIODS	
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Explain the basic concepts of machine learning (K2)
CO2 Apply supervised algorithms for different classification problems (K3)
CO3 Apply ensemble methods for classification problems (K3)
CO4 Apply unsupervised and reinforcement learning techniques to various problems (K3)

CO5 Apply machine learning algorithms to solve real world applications and deploy the model (K3)

TEXT BOOKS

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015.
2. Ethem Alpaydin, "Introduction to Machine Learning", 3rd Edition, The MIT Press, 2014.

REFERENCE BOOKS

1. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2014.
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", 1st Edition, Cambridge University Press, 2012.
3. Richert, Willi, "Building machine learning systems with Python", Packt Publishing, 2013.
4. Tom M Mitchell, "Machine Learning", McGraw-Hill Education (India), 2013.
5. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", 2nd Edition, O'Reilly, 2019.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1											
CO2	3	2											
CO3	2	1											
CO4	3	2											
CO5	3	2											
Average	2.6	1.6											

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M64	INTRODUCTION TO EXPLORATORY DATA ANALYSIS	30	0	30	30	90	3

OBJECTIVES

- To outline an overview of exploratory data analysis
- To perform univariate and bivariate data exploration and analysis
- To use data exploration and visualization techniques for multivariate and time series data
- To gain meaningful insights from raw data to support decision-making, identify patterns, and extract valuable information.

UNIT I	FUNDAMENTALS OF EXPLORATORY DATA ANALYSIS	6
Exploratory Data Analysis (EDA) Fundamentals: Significance of EDA - Making sense of data –Software tools for EDA; Visual Aids for EDA: Scatter plot, Bubble chart, Area plot, stacked plot, table chart, Polar chart, Lollipop chart, Choosing the best chart.		

UNIT II	UNIVARIATE ANALYSIS	6
Introduction to Single Variables: Summaries of levels and spread – Choosing between measures –Individual and aggregate level data; Scaling and Standardizing.		

UNIT III	BIVARIATE ANALYSIS	6
Relationship between two Variables: Percentage Tables - Analyzing Contingency Tables – Handling Several Batches: Multiple boxplots -T-test.		

UNIT IV	MULTIVARIATE ANALYSIS	6
Causal Explanations – Three-variable Contingency Tables: Trust and reciprocity – Controlling for a prior variable – Causal path models for three variables – logistic regression models – More complex model-Going beyond three variables – Estimating a more complex model with interactions.		

UNIT V	TIME-SERIES ANALYSIS	6
Understanding Time-series Dataset – Time-series Analysis with Open Power System Data: Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling; Introduction to Data Visualization Tool: Tableau.		

SUGGESTED EXPERIMENTS

1. Perform EDA on simple datasets using plots and charts (E.g., Boston Housing dataset, Online Retail dataset)
2. Conduct EDA to analyze the data patterns and the behavior of data (Analyzing email data to find out the usage patterns and communication behaviors)
3. Generate percentage tables and contingency tables for real time scenarios (Any customer-product dataset analyzing the relationship between two variables)

4. Demonstrate simple problems showing how a third variable controls the relationship between two variables (Identify the relationship among multiple variables for Titanic dataset)
5. Visualizing time series data (E.g., Open Power System Dataset).
6. Perform EDA on a sample dataset and generate report using any data visualization tool. (E.g., Wine Quality Data Set).

TOTAL PERIODS(L,P,TW&SL)	90
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply visual aids for exploratory data analysis and demonstrate the fundamentals of EDA.K3

CO2 Apply univariate data exploration techniques for analyzing the data. K3

CO3 Make use of bivariate data exploration techniques for data analysis. K3

CO4 Apply multivariate analysis techniques to demonstrate the causal dependence among the variables. K3

CO5 Analyze the time-series data by applying exploratory analysis techniques. K4

TEXT BOOKS

1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 2020. (Unit 1,5)
2. Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008. (Unit 2,3,4)

REFERENCE BOOKS

1. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017
2. Ayodele Oluleye, "Exploratory Data Analysis with Python Cookbook", Packt Publishing, 2023
3. Eric Pimpler, "Data Visualization and Exploration with R", GeoSpatial Training service, 2017.
4. Claus O. Wilke, "Fundamentals of Data Visualization", O'reilly publications, 2019
5. Daniel G Murray, Tableau your Data! Fast and Easy Visual Analysis with Tableau Software, Wiley, second edition, 2016 (Unit 5)

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2											
CO2	3	2	2		2					2			
CO3	3	2											
CO4	3	2											
CO5	3	2	3	2	2					2	2		
Average	3	2	2.5	2	2					2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M27	FUNDAMENTALS OF INFORMATION RETRIEVAL TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- To understand the basics of information retrieval with pertinence to modeling
- To understand various components of IR system
- To understand machine learning techniques for text classification and clustering
- To explore various IR applications.

UNIT I	INTRODUCTION TO IRT AND VARIOUS MODELS	9
Basic Concepts: Retrieval process – Architecture – Boolean retrieval; IR Models: Taxonomy and characterization of IR models – Classical IR models – Alternative algebraic models – Models for Browsing – Retrieval Evaluation; LEMUR.		

UNIT II	INDEXING, QUERYING AND WEB LANGUAGES	9
Indexing: Inverted indices – Suffix trees – Suffix arrays – Compression; Querying: Query languages; Query Operations: Relevance feedback and query expansion; Semantic Web Technologies – Structured Web Documents – Describing Web Resources – Applications and Challenges – Rule Interchange Format (RIF) – SPARQL -Web Ontology Language – OWL.		

UNIT III	SEARCHING	9
Searching: Sequential searching – Pattern matching; Searching the Web: Characterizing the Web – Search engines – Browsing – Searching using hyperlinks. Search Engine Architectures: Search Engine Ranking – Simple Ranking Functions – Learning to Rank – Evaluations - Search Engine User Interaction – Browsing – Applications of a Web Crawler – Evaluation- INDRI SEARCH ENGINE.		

UNIT IV	TEXT CLASSIFICATION AND CLUSTERING	9
Text classification and Naive Bayes: The text classification problem - Naive Bayes text classification - The Bernoulli model - Properties of Naive Bayes - Feature selection - Evaluation of text classification. Vector space classification: Rocchio classification - SVM based text classification - Extensions to the SVM model: Flat and Hierarchical clustering for text; Matrix decompositions and latent semantic indexing.		

UNIT V	APPLICATIONS OF IR	9
XML Retrieval – Multimedia IR – Parallel and Distributed IR – Digital Libraries – Social Media Retrieval – Content-based Image Retrieval – Online Public Access Catalogs (OPACs).		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Apply the IR modeling techniques for the document retrieval problem and measure the performance of IR systems by making use of IR evaluation metrics. K3
CO2 Construct the basic components of an IR system namely indexing and querying K3
CO3 Explain the searching techniques for IR and Web K2
CO4 Analyze machine learning techniques used in text classification and clustering for efficient Information Retrieval K4
CO5 Demonstrate the use of IR applications in different domains K2

TEXT BOOKS

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008. (Unit-I, IV)
2. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The concepts and Technology behind Search ", (ACM Press Books), Second Edition, 2011. (Unit- II, III, V)

REFERENCE BOOKS

1. Crestani F, Mizzaro S, Scagnetto I, "Mobile Information Retrieval" Germany : Springer International Publishing, 2017.
2. Stefan Butcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016.
3. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2nd edition, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2		2						2		
CO2	3	2		2									
CO3	3			2	2						2		
CO4	3	2		2							2		
CO5	2	2	2	2	2			2		2	2		
Average	2.8	2	2	2	2			2		2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3M28	FUNDAMENTALS OF EDGE ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the various computing paradigms and challenges of edge computing environment.
- To explore the various hardware needed for edge architecture.
- To learn about federated learning techniques and inferences at edge systems.
- To understand the technologies and components used to create an edge analytics application.
- To learn different applications of edge computing.

UNIT I	INTRODUCTION TO NEW COMPUTING PARADIGMS	9
Introduction - Relevant Technologies - Fog and Edge Computing - Hierarchy of Fog and Edge Computing. Edge computing characteristics: Compute in context -- Capability oriented – Centralized management, distributed computer -- Secured -- Heterogeneity; Edge computing scenarios – IoT scenarios -- Hardware as a service -- Hybrid scenarios -- 5G scenarios.		

UNIT II	EDGE COMPUTING HARDWARE & SIMULATORS	9
Edge Computing Architecture: Edge Devices -- Edge Server-Cluster -- Cloud Server; Background Essentials: IoT Devices -- Sensors -- Actuators; Networking Architecture-Network Management and Control -- Orchestration; Edge Computing State-of-the-Art. Edge Computing Simulators: PureEdgeSim -- IoTsim-Edge -- iFogSim -- EdgeCloudSim.		

UNIT III	ARTIFICIAL INTELLIGENCE FOR EDGE COMPUTING	9
Artificial Intelligence Training at Edge: Distributed Training at Edge -- Vanilla Federated Learning (FL) at Edge -- Communication-Efficient FL -- Resource--Optimized FL -- Security-Enhanced FL; Artificial Intelligence Inference in Edge: Optimization of AI Models in Edge -- Segmentation of AI Models -- Early Exit of Inference (EEoI) -- Sharing of AI Computation.		

UNIT IV	ANALYTICS AT EDGE	9
Edge Data Analysis: Challenge and Needs -- Combination of Big Data and Edge Data Process -- Architecture for Edge Data Process; Communication and Computation Modes for Edge: Integral Offloading -- Partial Offloading -- Vertical Collaboration -- Horizontal Collaboration. Working with Microsoft Azure IoT Hub -- Using the Raspberry Pi with Azure IoT Edge; Types of attacks against our edge analytics applications -- Protecting our edge analytics applications -- Monitoring and auditing our edge analytics applications.		

UNIT V	EDGE COMPUTING APPLICATIONS	9
Industrial Internet of Things (IIoT) Applications of Edge and Fog Computing: A Review and Future Directions - Leveraging Edge Computing for Mobile Augmented Reality. Real-time		

Video Analytic - Autonomous Internet of Vehicles (IoVs) - Intelligent Manufacturing -Smart Home and City.

TOTAL PERIODS

45

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Describe the fundamentals and characteristics of edge computing. K2

CO2 Apply the features of edge simulators and different hardware components to solve applications. K3

CO3 Apply the advanced concepts and frameworks of edge AI. K3

CO4 Apply the technologies used for edge analytics and developing solutions. K3

CO5 Develop applications to solve real world problems using edge architecture and evaluate their performance. K5

TEXT BOOKS

1. Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing Principles and Paradigms, Wiley, 2019. (Units 1- First half)
2. K. Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjnamurthy, Edge Computing Fundamentals, Advances and Applications, CRC Press, 2022. (Units: 2)
3. Haishi Bai and Boris Scholl, Edge Computing and Capability-Oriented Architecture Taylor & Francis Group, CRC Press, First Edition 2022. (Unit 1 – Second Half)
4. Xiaofei Wang, Yiwen Han, Victor C.M.Leung, Dusit Niyato, Xueqiang Yan, Xu Chen Edge, AI Convergence of Edge Computing and Artificial Intelligence, Springer, 2020. (Units: 3, 4- first half, 5 – second half)
5. Wei Chang, Jie Wu Fog, Edge Computing for Security, Privacy, and Applications, Springer, 2021. (Unit 5 – first half)

REFERENCE BOOKS

1. Colin Dow, Hands-On Edge Analytics with Azure IoT- Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Packt Publishing, 2020. (Unit 4 – second half)
2. Atakan Aral, Vincenzo DeMaio, Edge Computing: Models, Technologies and Applications, December 2020, DOI: 10.1049/PBPC033E_ch14, Publisher: IET.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2								2		
CO2	3	3											
CO3	3	2								2	2		
CO4	3	2			2						2		
CO5	3	2	2								2		
Average	3	2.4	2		2					2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3941	INTRODUCTION TO DATA STRUCTURES	45	0	0	45	90	3

OBJECTIVES

- To understand the concepts of sorting and searching techniques
- To comprehend the notion of linear and nonlinear data structures
- To use a suitable data structure for the given problem and implement them in a high-level programming language.

UNIT I	SORTING AND SEARCHING TECHNIQUES	9
Sorting: Insertion sort – Merge sort – Quicksort; Searching: Linear search – Binary search.		

UNIT II	LIST	9
List – Array implementation – Linked lists – Applications of Lists: Polynomial addition		

UNIT III	STACK AND QUEUE	9
Stack: Array implementation of stack – Linked list implementation of Stack Applications: Evaluating postfix expressions; Queue: Array implementation of queues – Linked list implementation of Queue - Applications of queues.		

UNIT IV	TREES	9
Tree: Preliminaries – Tree traversals – Binary Search Trees – AVL Trees- Binary Heaps – Applications of trees.		

UNIT V	GRAPHS	9
Graph algorithms: Definitions – Representation of graphs – Breadth first traversal – Depth first traversal – Shortest-path algorithm: Dijkstra's algorithm.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Develop various sorting and searching algorithms (K3)

CO2 Solve various problems using List operations (K3)

CO3 Apply stack and queue to different problems (K3)

CO4 Develop programs using trees and perform traversals (K3)

CO5 Make use of graphs to perform traversal and to find the shortest path (K3).

TEXT BOOKS

1. M A Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2006.
2. Richard F Gilberg, Behrouz A Forouzan, "Data Structures: A Pseudocode Approach with C", 2nd Edition, Cengage India, 2007.

REFERENCE BOOKS

1. V Aho, J E Hopcroft, and J D Ullman, “Data Structures and Algorithms”, Pearson Education, 1st Edition, 2003.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, 2nd Edition, University Press, 2008
3. Byron Gottfried, Jitender Chhabra, “Programming with C” (Schaum’s Outlines Series), Mcgraw Hill Higher Ed, 3rd Edition, 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	2	0	0	0	1	0	0	2		
CO2	2	3	2	2	0	0	0	1	3	2	2		
CO3	2	3	2	2	0	0	0	1	3	2	2		
CO4	2	3	2	2	0	0	0	1	3	2	2		
CO5	2	3	2	2	0	0	0	1	3	2	2		
Average	2	3	2	2	0	0	0	1	3	2	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3942	OBJECT ORIENTED PROGRAMMING TECHNIQUES	45	0	0	45	90	3

OBJECTIVES

- To learn the basics of Object-Oriented Programming
- To learn the programming constructs of Java
- To know the principles of inheritance and polymorphism.

UNIT I	INTRODUCTION	9
Principles of OOP: Classes – Objects – Data hiding – Data encapsulation – Inheritance – Polymorphism. Definition of classes: objects - methods – Access specifiers – Static and final classes and members; Object construction and destruction.		

UNIT II	BASICS OF JAVA	9
Features of Java – Basics of Java programming: Data types - Variables – Operators – Control structures – Arrays – Strings.		

UNIT III	CLASSES AND OBJECTS	9
Objects and Classes in Java: Defining classes – Methods – Access specifiers – Static members; Constructors: Constructor overloading; Method overloading – Recursion – Passing and returning object from method – Packages in Java.		

UNIT IV	INHERITANCE	9
Inheritance: Definition – Types of inheritance: Single – multilevel - multiple – hierarchical – hybrid; Subclass constructors – Interfaces in Java: Definition, Implementation – Extending interfaces – Examples in Java.		

UNIT V	POLYMORPHISM	9
Polymorphism: Method overloading and overriding – Dynamic method dispatch; Exceptions: Hierarchy, Built-in exceptions, Creating own exception; Definition and Concepts: Generic methods – Generic types.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Outline the features of object -oriented programming (K2)

CO2 Develop programs using basic constructs of Java (K3)

CO3 Experiment with classes and methods for problem solving (K3)

CO4 Develop programs using inheritance and interfaces (K3)

CO5 Apply the concept of polymorphism (K3).

TEXT BOOKS

1. Herbert Schildt, “Java: The Complete Reference”, 8th Edition, McGraw

REFERENCE BOOKS

1. Timothy Budd, "Understanding Object-oriented Programming with Java", Updated Edition, Pearson Education, 2000.
2. C Thomas Wu, "An introduction to Object-oriented Programming with Java", Fourth Edition, Tata McGraw-Hill Publishing company Ltd., 2006.
3. Cay S Horstmann, Gary Cornell, "Core Java Volume – I Fundamentals" 9th Edition, PrenticeHall, 2013.
4. Paul Deitel, Harvey Deitel, "Java SE 8 for Programmers", 3rd Edition, Pearson, 2015.
5. Steven Holzner, "Java 2 Black Book", Dreamtech Press, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	3	1	0	0	0	0	0	0	0		
CO2	2	3	3	2	0	0	1	2	2	0	2		
CO3	2	3	3	1	0	0	1	2	2	0	0		
CO4	2	3	3	2	0	0	1	2	2	0	2		
CO5	2	3	3	1	0	0	1	2	2	0	0		
Average	2	3	3	2	0	0	1	2	2	0	1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3943	PROBLEM SOLVING AND PROGRAMMING IN C	45	0	0	45	90	3

OBJECTIVES

- To use basic programming concepts of C
- To develop programs using loops, functions, arrays, pointers, strings, structures and files.

UNIT I	BASICS	9
Algorithm – Structure of a C program – Data Types: built-in, user-defined – Variables and constants – Input and output statements – Operators, expressions, and assignment statements – Control statements.		

UNIT II	FUNCTIONS	9
Function prototype – Function definition and call – Passing parameters – Built-in functions – Recursion; Command line arguments.		

UNIT III	ARRAYS AND STRINGS	9
Arrays: Declaration, initialization – One-dimensional arrays – multi-dimensional arrays; Strings: Constants and variables, reading and writing strings, string operations, string library.		

UNIT IV	POINTERS, STRUCTURES AND UNIONS	9
Pointers: Pointer operations – Array of pointers – Passing arrays to functions; Structures: Structures and functions – Array of structures – Pointer to a structure – unions.		

UNIT V	FILES	9
Files: opening and closing a data file – Creating a data file – Processing a data file – Unformatted data files – Formatted input and output – Line input and output – File error handling.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Develop programs using basic programming constructs in C (K3)

CO2 Develop modular programs using functions (K3)

CO3 Develop applications using arrays and strings (K3)

CO4 Solve problems using pointers and structures (K3)

CO5 Develop applications using file operations in C (K3).

TEXT BOOKS

1. Byron Gottfried, "Programming with C", (Schaum's Outlines Series),

McGraw-Hill Education, 3rd Edition, 2017.
2. Brian WKernighan, Dennis MRitchie, "The C Programming Language", Pearson Education India, 2nd Edition, 2015.

REFERENCE BOOKS
1. Reema Thareja, "Programming in C", Oxford University Press, 2nd Edition, 2016.
2. Yashwant Kanetkar, "Let Us C", BPB Publications, 14th Edition, 2016.
3. King K N, "C Programming: A Modern Approach", W. W. Norton & Company, 2nd Edition, 2008.
4. Herbert Schildt, "C The Complete Reference", McGraw Hill Education, 4th Edition, 2017.
5. Stephen G Kochan, "Programming in C", 3rd edition, Pearson Ed, 2004

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	0	0	0	0	0	0	0		
CO2	2	3	3	2	0	0	0	0	2	0	1		
CO3	2	3	3	2	0	0	1	3	2	0	1		
CO4	2	3	3	2	0	0	1	3	2	0	0		
CO5	2	3	3	2	0	0	1	3	2	0	1		
Average	2	3	2	2	0	0	1	2	2	0	1		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3041	INTRODUCTION TO BIG DATA ANALYTICS	45	0	0	45	90	3

OBJECTIVES

- To understand the competitive advantages of big data analytics
- To understand the distributed storage for big data
- To learn distributed method for processing of big data
- To understand how to represent unstructured data using NoSQL and processing
- To learn how statistical methods used for analyzing big data

UNIT I	INTRODUCTION TO BIG DATA	9
Introduction – Understanding Big Data – Big Data: Benifitting – Managing – Organizing and Analyzing Big Data: Learning and Analytics; Technology Challenges for Big Data		

UNIT II	HDFS	9
Introduction – Distributed File System – Google File System – HDFS Design Goals – Using HDFS.		

UNIT III	DATA PROCESSING USING MAPREDUCE	9
Introduction – MapReduce Overview – Working of MapReduce – Programming – Writing and Testing MapReduce Programs.		

UNIT IV	NOSQL	9
Introduction to NoSQL – Characteristics of NoSQL – NoSQL Storage Types Advantages and Drawbacks - NoSQL Database Framework: Hive and HBase		

UNIT V	DATA ANALYSIS	9
Statistical Methods: Regression modelling – Multivariate analysis; Classification: SVM – Decision Trees; Linear Classifiers		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explore how to leverage the insights from big data analytics (K2)

CO2 Apply distributed computing for better storage of data (K3)

CO3 Develop applications using Hadoop related tools (K4)

CO4 Adapt database frameworks, Hive and Hbase for data analytics (K3)

CO5 Solve applications using statistical and data analytic methods (K3).

TEXT BOOKS

1. Parag Kulkarni, Sarang Joshi, "Big Data Anlytics", PHI Learning Pvt. Ltd, 2016.
2. Anil Maheshwari, "Big Data Essentials", McGraw Hill, 2019

REFERENCE BOOKS

1. Arshdeep Bahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", Published by A Hands-on Approach Textbooks, 2016.
2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
3. Gaurav Vaish, "Getting Started with NoSQL", Packt Publishing Ltd, 2013.
4. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012.
5. Lars George, "HBase: The Definitive Guide", O'Reilly, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	0	0	0	3	0	0	0	0	0	0		
CO2	2	3	1	3	2	0	0	0	0	0	0		
CO3	2	3	1	3	2	0	1	3	3	0	0		
CO4	2	3	1	3	2	0	1	3	3	0	0		
CO5	2	3	1	3	2	0	1	3	3	0	0		
Average	2	3	1	3	3	0	1	2	2	0	0		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3042	MACHINE LEARNING APPLICATIONS	45	0	0	45	90	3

OBJECTIVES

- To understand the need and types of machine learning techniques for various problems
- To study the various supervised learning algorithms in machine learning
- To choose appropriate machine learning algorithms to solve realistic problems.

UNIT I	MACHINE LEARNING LANDSCAPE	9
Machine learning and its use; Types of machine learning; Challenges of machine learning; Testing and validating. Cross-validation techniques – Bias–variance trade-off. Performance evaluation metrics and introduction to model selection.		

UNIT II	DEVELOPING A MACHINE LEARNING APPLICATION	9
Working with real data – Look at the big picture – Get the data – Discover and visualize the data – Data preparation – Select and train model. Feature engineering techniques. Data splitting strategies for training and testing. Overview of model evaluation and deployment considerations.		

UNIT III	CLASSIFICATION AND REGRESSION	9
Classification: Training a binary classifier – Performance measures – Multiclass classification; Regression: Linear regression – Gradient descent – Logistic Regression; Support Vector Machines: Linear SVM classification – Nonlinear SVM classification. Confusion matrix and derived metrics such as precision, recall, and F1-score. ROC curve and AUC analysis.		

UNIT IV	TREE MODELS AND ENSEMBLE LEARNING	9
Decision Trees: Training and visualizing trees – Making predictions – Estimating class probabilities – CART training algorithm – Regularization of hyperparameters; Ensemble learning: Voting classifiers – Bagging – Random forests – Boosting.		

UNIT V	ARTIFICIAL NEURAL NETWORKS	9
From Biological to Artificial Neurons: Biological neurons – Logical computations with neurons – Perceptron – Multi-Layer Perceptron and backpropagation; Training a MLP network– Fine tuning neural network hyperparameters; Introduction to Deep Learning.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Explain the basic concepts and types of machine learning (K2)

CO2 Demonstrate the various steps in developing a machine learning application (K2)

CO3 Apply various algorithms for classification and regression tasks (K3)

CO4 Apply tree and ensemble models for various problems (K3)
CO5 Apply the neural network algorithm for real world problems (K3).

TEXT BOOKS

1. Aurelien Geron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, O’Reilly Media, 2017.

REFERENCE BOOKS

1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Jason Bell, “Machine learning – Hands on for Developers and Technical Professionals”, 1st Edition, Wiley, 2014.
3. Richert, Willi, “Building Machine Learning Systems with Python”, Packt Publishing Ltd, 2013.
4. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (India) Private Limited, 2013.
5. Andreas C. Muller, Sarah Guido, “Introduction to Machine Learning with Python”, O’Reilly Media, 2016.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2		2								
CO2	3	3	2								2		
CO3	3	3	2										
CO4	3	3	2										
CO5	3	3	2		2						2		
Average	2.8	2.8	2		2						2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UCS3043	WEB TECHNOLOGY	45	0	0	45	90	3

OBJECTIVES

- Learn to design static web pages using HTML5 and CSS3
- Learn to develop dynamic web pages using JavaScript
- Learn to develop web application using ExpressJS and NodeJS

UNIT I	WEB PAGE DESIGNING USING HTML	9
Introduction: HTML Basics – Document Structure – Formatting Texts – Lists and Backgrounds– Hyperlinks and Anchors; Page Layout and Navigation: Layouts – Tables – Forms – Sound and Videos. HTML 5 elements		

UNIT II	STYLING WEBPAGE WITH CSS3	9
CSS Basics: HTML for CSS – Creating Styles and Style Sheets – Selectors; Applied CSS: Formatting Texts – Margin, Padding and Borders – Adding Graphics to web pages – Navigation bars and links – Formatting Tables and Forms. Rule Cascading and Inheritance		

UNIT III	CLIENT-SIDE JAVA SCRIPT	9
Introduction to Java script: JavaScript usage – Role in Web page – Role in Web Development;Script setup; The building Blocks: Data Types, Literals, Variables; Dialog box; Operators; Conditionals & loops; Functions; Objects; Core Objects; working with images; HandlingEvents. Parse and Stringify		

UNIT IV	SERVER SIDE JAVASCRIPT WITH NODE AND EXPRESS	9
Introduction to Express; Getting started with Node; Node: Global objects, events, Asynchronous nature - Saving time with Express: Scaffolding – views and layouts – Static files and views – Dynamic content in views; Request and Response Objects; Templating with Handlebars.		

UNIT V	BUILDING WEB APPLICATIONS	9
Form Handling: Sending Client data to Server – HTML forms – Different approaches for form handling – Form Handling with Express; Persistence; Routing; Static Content; Debugging. Creating a website for college cultural.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Build static web pages using HTML5 (K3)

CO2 Use CSS3 to style the web pages (K3)

CO3 Develop dynamic web pages using JavaScript (K3)

CO4 Develop front-end for web application using ExpressJS (K3)

CO5 Develop web applications using Node.js (K3).

TEXT BOOKS

1. Faithe Wempen, "Start Here! Learn HTML5", Microsoft, O'Reilly, 2013. (Unit I)
2. David McFarland, "CSS3: The Missing Manual", 3rd Edition, , O'Reilly, December 2012. (Unit II)
3. Ellie Quigley, "JavaScript by example", 2nd Edition, Prentice Hall, 2011. (Unit III)
4. Ethan Brown, "Development with Node and Express", O'Reilly, 1st Edition, July 2014. (Unit IV, Unit V)

REFERENCE BOOKS

1. Jennifer Niederst Robbins, "Learning Web Design", O'Reilly, 4th Edition, 2012.
2. Robert WSebesta, "Programming the World Wide Web", 4th Edition, Pearson Education, 2007.
3. Shelly Powers, "Learning JavaScript", O'Reilly, 2nd Edition, 2008.
4. Basaret Ali Syed, "Beginning Node.js", Apress, December 2014.
5. Azat Mardan, "Express.js Guide", Lean Publishing, 2014.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2		3								
CO2	2	3	2		3						2		
CO3	2	3	2		3						2		
CO4	2	3	2		3						2		
CO5	2	3	3		3				3		2		
Average	2	3	2.2		3				3		2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UBA3941	PROJECT MANAGEMENT AND PLANNING (Common to All Departments)	45	0	0	45	90	3

OBJECTIVES

- Compare various models used in project selection.
- Define project planning, and estimate the cost involved.
- Apply network techniques for project scheduling and resource allocation.
- Summarize the information needed planning, monitoring, and controlling cycle of a project.
- Recognize the values of project audit

UNIT I	STRATEGIC MANAGEMENT AND PROJECT SELECTION	9
Project selection models, Project portfolio process, Analysis under uncertainty, Project organization, Matrix organization		

UNIT II	PROJECT PLANNING AND COST ESTIMATION	9
Work breakdown structure, Systems integration, Interface coordination, Project life cycle, Conflict and negotiation, Estimating Project Budgets, Process of cost estimation		

UNIT III	PROJECT IMPLEMENTATION	9
Scheduling: Network Techniques PERT and CPM, Risk analysis using simulation, CPM- crashing a project, Resource loading, leveling, and allocation.		

UNIT IV	MONITORING AND INFORMATION SYSTEMS	9
Information needs and the reporting process, computerized PMIS, Earned value analysis, Planning-Monitoring-Controlling cycle, Project control: types of control processes, design of control systems, control of change and scope		

UNIT V	PROJECT AUDITING	9
Organization Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, the termination process, The Final Report – A project history		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Understand various models used in project selection

CO2 Acquire knowledge in project planning, and estimate the cost involved.

CO3 Prepare Project Scheduling and resource allocation

CO4 Understand about planning, monitoring and controlling cycle of a project

CO5 Understand the values of project audit

TEXT BOOKS

1. Panneer selvam .R, Senthil Kumar .P, Project Management, PHI, 2009.
2. Harold Kerzner, Project Management – A Systems Approach to Planning, Scheduling and VControlling, John Wiley and Sons, 12th edition, 2017

REFERENCE BOOKS

1. Jack Ferraro, “Project Management for Non-Project Managers” AMACON, 2012
2. Jack R. Meredith, and Samuel J. Mantel Jr, Project Management – A Managerial Approach, John Wiley and Sons, 10th edition, 2017. James B. Ayers, “Handbook of Supply Chain Management”, St. Lucie Press, 2000
3. Clifford F. Gray, Erik W. Larson, ‘Project Management – The Managerial Process’ McGraw-Hill Education, 2014
4. Neil G. Siegel, “Engineering Project Management” Wiley Publications, 2020.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1								1	1	3		
CO2	1								1	1	3		
CO3	1								1	1	3		
CO4	1								1	1	3		
CO5	1								1	1	3		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UBA3942	TOTAL QUALITY MANAGEMENT (Common to All Departments)	45	0	0	45	90	3

OBJECTIVES

- To introduce principles of total quality management (TQM) and impart knowledge in TQM Tools, techniques and quality systems.

UNIT I	INTRODUCTION	9
Introduction – Need for quality – Evolution of quality – Definitions of quality – Dimensions of product and service quality-Basic concepts of TQM-TQM Framework Contributions of Deming Juran and Crosby – Barriers to TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention - Costs of quality.		

UNIT II	TQM PRINCIPLES	9
Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal- Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.		

UNIT III	TQM TOOLS AND TECHNIQUES I	9
The seven traditional tools of quality – new management tools – Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to benchmark, Bench marking process – FMEA – Stages, Types		

UNIT IV	TQM TOOLS AND TECHNIQUES II	9
Control Charts – Process Capability – Concepts of Six Sigma – Quality Function Development (QFD)- Taguchi quality loss function – TPM – Concepts, improvement needs– Performance Measures.		

UNIT V	QUALITY MANAGEMENT SYSTEMS	9
Need for ISO 9000 – ISO 9001-2008 Quality System – Elements, Documentation, Quality Auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Guidelines for Safety and Hazard (OHSAS).		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze TQM concepts for improving Quality in an Engineering System.

CO2 Utilize TQM principles for continuous process improvement

CO3 Apply TQM Tools like Six Sigma, Benchmarking and FMEA to improve manufacturing process

CO4 Apply Taguchi's Quality Loss Function, QFD and TPM to improve Performance Measures

CO5 Apply QMS in any organization system for improving overall quality

CO6 Design and Implement TQM principles and tools into any Electrical Engineering Systems to improve quality and performance measures.

TEXT BOOKS

1. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary Besterfield-Sacre, Hemant Urdhwareche, Rashmi Urdhwareche, "Total quality Management", Revised Third Edition, Pearson Education Asia, 2011.
2. Kannan S M, Jayabalan V, "Total Quality Management", RKR Publications, 2005.

REFERENCE BOOKS

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt.Ltd, 2006.
3. Janakiraman. B and Gopal. R. K., "Total Quality Management Text and Cases", Prentice Hall (India), 2005.
4. Sharma D D, "Total Quality Management", Sultan Chand and Sons, 2011.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					2	3					2		
CO2					2	3					2		
CO3					2	3					2		
CO4					2	3					2		
CO5					2	3		2	3		2		
CO6					2	3		3	2	3	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UBA3943	WORK ETHICS, CORPORATE SOCIAL RESPONSIBILITY AND GOVERNANCE (Common to All Departments)	45	0	0	45	90	3

OBJECTIVES

- To impart the value of professional practices with code of conduct and ethical values
- Discuss the various outlooks of roles and responsibilities with work ethics.
- Introduce the Indian constitutional statutes for ethical practices by citizens
- Analyze the ethical commitments to be hold by industry with protecting the environment.
- Insist on corporate and social responsibilities through Governance practices and regulation

UNIT I	INTRODUCTION	9
Ethics - Definition & nature, Characteristics, Attributes of Ethics - Business Ethics; Ethical theories; Causes of Unethical Behavior; Ethical abuses; Work ethics; Code of conduct; Public good		

UNIT II	ETHICS THEORY AND BEYOND	9
Management of Ethics - Ethics analysis [Hosmer model]; Ethical dilemma; Ethics in practice – ethics for managers; Role and function of ethical managers- Comparative ethical behaviour of managers; Code of ethics; Competitiveness, organizational size, profitability and ethics; Cost of ethics in corporate ethics evaluation		

UNIT III	LEGAL ASPECTS OF ETHICS	9
Political – legal environment; Provisions of the Indian constitution pertaining to Business; Political setup – major characteristics and their implications for business; Prominent features of MRTP & FERA. Social – cultural environment and their impact on business operations, Salient features of Indian culture and values.		

UNIT IV	ENVIRONMENTAL ETHICS	9
Economic Environment; Philosophy of economic growth and its implications for business, Main features of Economic Planning with respect to business; Industrial policy and framework of government contract over Business; Role of chamber of commerce and confederation of Indian Industries.		

UNIT V	CORPORATE SOCIAL RESPONSIBILITY AND GOVERNANCE	9
Definition- Evolution- Need for CSR; Theoretical perspectives; Corporate citizenship; Business practices; Strategies for CSR; Challenges and implementation; Evolution of corporate governance; Governance practices and regulation; Structure and development of boards; Role of capital market and government; Governance ratings; Future of governance- innovative practices; Case studies with lessons learnt.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 Analyze ethical issues in the workplace and code of conduct for mutual understanding and respect, inclusive attitudes and public good

CO2 Apply ethical theories in practice for evaluating corporate ethics

CO3 Discuss the legal aspects of ethics for protection of societal values.

CO4 Apply environmental ethics in economic development for protection of environment

CO5 Analyze corporate social responsibility for evaluating social responsibilities of corporates

CO6 Design and implement ethical governance in legal, environmental and social aspects in an Infrastructure project

TEXT BOOKS

1. Sherlekar S K, "Ethics in Management", Himalaya Publishing House, 2009.
2. William B. Werther and David B. Chandler, "Strategic corporate social responsibility", Sage Publications Inc., 2011

REFERENCE BOOKS

1. Shaw V W H, "Business Ethics", Cengage Learning, 2007.
2. Beeslory, Michel and Evens, "Corporate Social Responsibility", Taylor and Francis, 1978.
3. Philip Kotler and Nancy Lee, "Corporate social responsibility: doing the most good for company and your cause", Wiley, 2005.
4. Subhabrata Bobby Banerjee, "Corporate social responsibility: the good, the bad and the ugly", Edward Elgar Publishing, 2007.
5. Satheesh kumar, "Corporate governance", Oxford University, Press, 2010

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							3				2		
CO2							3				2		
CO3						3	3				2		
CO4						3	3			3	2		
CO5						3		3		3	2		
CO6						3	3	2	2	3	2		

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UEN3941	ADVANCED PROFESSIONAL COMMUNICATION (Common to All Departments)	30	0	30	30	90	3

PREAMBLE: In an increasingly interconnected and data-driven global economy, the ability to communicate with precision, empathy, and strategic intent is the hallmark of a true leader. The Advanced Professional Communication course is designed to transition students from foundational competency to executive-level mastery. This course goes beyond basic exchange, focusing on the nuances of high-stakes influence, strategic storytelling, and long-term career architecture. Through a blend of analytical theory and immersive practice, students will learn to navigate the complexities of modern corporate environments. Whether it is leading a high-level boardroom debate, translating complex data into a compelling narrative, or mastering the art of the behavioral interview, this course prepares professionals to command presence and drive impactful results.

OBJECTIVES

- To Master advanced soft skills essential for leadership and professional excellence
- To engage in strategic and analytical discussions with confidence and clarity
- To design and deliver compelling presentations using advanced storytelling techniques and data analytics
- To excel in job interviews through advanced behavioural and situational response strategies
- To develop and implement comprehensive career management plans for sustained professional growth

UNIT I	CRUCIAL SOFT SKILLS AND INTERPERSONAL SKILLS	6+6
Strategic Communication: Tailoring messages for diverse audiences; understanding the impact of cultural, generational, and organizational contexts - Emotional Intelligence (EI) Mastery: Diving deep into self-awareness, self-regulation, motivation, empathy, and social skills - Teamwork: Utilizing cooperative strategies and conflict-resolution techniques to foster a productive team environment - Critical Thinking & Decision Making: Applying analytical frameworks and cognitive biases to enhance problem-solving - Leadership and Influence: Persuading tactics and transformational leadership. Lab Activities: Role-playing complex scenarios, case studies, and peer feedback sessions.		

UNIT II	ADVANCED GROUP DISCUSSION SKILLS	6+6
Advanced Discussion Techniques: Socratic questioning, dialectical reasoning, and evidence-based argumentation - Facilitating high-stakes discussions: Leading teams under pressure, managing group dynamics, and steering productive debates - Crisis Communication: Strategies for handling sensitive topics and managing discussions in high-stress environments. Cross-cultural communication in GDs: Navigating cultural diversity in group settings. Lab Activities: Simulated high-pressure GDs, cross-cultural scenario exercises, and peer-led		

debate.

UNIT III	PROFESSIONAL PRESENTATION SKILLS	6+6
Strategic Presentation Design: Storyboarding, audience analysis, and visual design principles for impactful presentations - Data-driven storytelling: Integrating complex data analytics into persuasive narratives - Non-verbal mastery: Advanced techniques in body language, voice modulation, and emotional resonance - Virtual presentation skills: Practicing to engage audiences in digital environments. Lab Activities: TED-style talks, data visualization and virtual presentation simulations.		

UNIT IV	CORE INTERVIEW SKILLS	6+6
Resumes and Cover letters - SOPs - Behavioural and Situational Interviewing: Using STAR (Situation, Task, Action, Result) method and advanced behavioural question techniques - Mock Panel Interviews: Simulated real-world interview settings with feedback from industry professionals - Executive presence: Strategies for demonstrating confidence, authority, and credibility - Negotiation in interviews: Salary negotiations, counter-offers, and ethical considerations. Lab Activities: Mock interviews with live feedback, peer assessments, and reflective journaling.		

UNIT V	STRATEGIC CAREER MANAGEMENT SKILLS	6+6
Personal Branding: Crafting a professional identity through LinkedIn optimization, personal websites, and thought leadership - Advanced Goal Setting: Using SMART goals, OKRs (Objectives and Key Results), and continuous performance feedback loops - Resilience and Adaptability: Developing a growth mindset and strategies for career pivots - Mentorship and Networking: Building strategic networks, leveraging alumni connections, and mentoring for leadership development. Lab Activities: Developing career portfolio, networking simulations, and mentorship program planning.		

TOTAL PERIODS Lecture : 30 Periods Practical : 30 Periods Term work & Self-Learning : 30 Periods Total : 90 Periods	90
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COURSE OUTCOMES
On successful completion of this course, students will be able to
CO1 Exhibit advanced soft skills in leadership and strategic communication
CO2 Lead and contribute effectively to high-level discussions and debates
CO3 Deliver influential presentations that inspire and engage diverse audiences
CO4 Navigate complex interview scenarios with confidence and professionalism
CO5 Design and execute long-term career strategies for continuous growth and success

TEXT BOOKS

3. Chesebro, J. L. (2014). Professional communication at work: Interpersonal strategies for career success. Routledge
4. Plung, D. (2024). The Art of Professional Communication: Strategies that Advance Careers. Taylor & Francis

REFERENCE BOOKS
4. Beebe, S. A., & Mottet, T. P. (2021). <i>Business and Professional Communication</i> (3 rd ed). Pearson Higher Education AU.
8. Dodd, C. H. (2012). <i>Managing business and professional communication</i> (3rd ed). Allyn & Bacon/Pearson.
9. Herbert Hirsch. (2007). <i>Essential Communication Strategies: For Scientists, Engineers, and Technology Professionals</i> , 2nd edition. Wiley-IEEE Press.
10. Lawson, C., Gill, R., Feekery, A., Witsel, M., Lewis, M., & Cenere, P. (2019). <i>Communication skills for business professionals</i> . Cambridge University Press.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	3				
CO2								2	3				
CO3								1	3				
CO4								0	3				
CO5								0	3				

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3942	INTRODUCTION TO LINEAR ALGEBRA (Common to All Departments)	45	0	0	45	90	3

OBJECTIVES

- The objective of this course is to enable the student with a foundational understanding of linear algebra, including vector spaces, linear transformations, Inner product spaces and matrix decompositions.

UNIT I	VECTOR SPACES	9
Vector spaces – Subspaces – Linear combinations and system of Linear equations – Linear independence and Linear dependence – Bases and Dimensions.		

UNIT II	LINEAR TRANSFORMATIONS	9
Linear transformations – One-to-one and onto linear transformations – Null space, Range space, Dimension theorem.		

UNIT III	MATRIX OF LINEAR TRANSFORMATION	9
Matrix representation of linear transformation – Eigenvalues, Eigenvectors and Diagonalization.		

UNIT IV	INNER PRODUCT SPACES	9
Inner product and norms – Gram Schmidt orthonormalization process – Orthogonal Complement – Least square approximation.		

UNIT V	MATRIX DECOMPOSITION	9
Cholesky decomposition method - QR decomposition – Generalized inverse of a matrix, Singular value decomposition.		

TOTAL PERIODS	45
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COURSE OUTCOMES
On successful completion of this course, the student will be able to
CO1: Solve the problems in vector spaces, subspaces.
CO2: Find the matrix of linear transformation and diagonalize by finding the eigenvalues and eigenvectors
CO3: Apply Gram-Schmidt's orthogonalization process to decompose a given matrix
CO4: Compute matrix decomposition using different methods such as Cholesky and SVD

TEXTBOOKS
1. Friedberg A.H, Insel A.J. and Spence L, "Linear Algebra", Prentice Hall of India, 4th Edition, New Delhi, 2004.
2. Strang G, "Linear Algebra and its applications", 4th Edition, Brooks/Cole (Thomson Publications), New Delhi, 2006.

REFERENCE BOOKS	
1.	Kumaresan S, “Linear Algebra – A geometric approach”, Prentice Hall of India, New Delhi, Reprint, 2010.
2.	Bernard Kolman, David R. Hill, “Introductory Linear Algebra”, Pearson Education, New Delhi, 8th Edition, 2005.
3.	Richard Branson, “Matrix Operations”, Schaum's outline series, McGraw Hill, 1989.

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3944	NUMBER THEORY AND CRYPTOGRAPHY (Common to All Departments)	45	0	0	45	90	3

OBJECTIVES

- To impart knowledge on the concept of fundamental theorem of arithmetic, congruences and error correction codes.
- To equip the students with the knowledge on the concept of linear codes, generator matrices, and parity-check matrices in information security.

UNIT I DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS 9

Division algorithm – Base - b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

UNIT II CONGRUENCES AND CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS 9

Linear Diophantine equations – Congruence – Linear Congruence – Wilson's theorem – Fermat's little theorem – Euler's theorem – Euler's Phi functions.

UNIT III ERROR DETECTION, CORRECTION AND CODING 9

Communication channels- Maximum likelihood decoding- Hamming distance- Nearest neighbor/minimum distance decoding- Distance of a code.

UNIT IV APPLICATION OF CONGRUENCE AND QUADRATIC RECIPROCITY 9

Public - Key cryptography - Prime power moduli - Prime modulus - Primitive roots and power residues - Quadratic residues - The Gaussian reciprocity law.

UNIT V LINEAR CODES 9

Vector spaces over finite fields - Linear codes - Hamming weight- Bases for linear codes- Generator matrix and parity check matrix- Equivalence of linear codes- Encoding with a linear code- Decoding of linear codes.

TOTAL PERIODS 45

COURSE OUTCOMES

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

CO1: Apply techniques to solve congruences in cryptography.

CO2: Analyze information security using the concepts of coding and decoding.

CO3: Utilize the concept of quadratic residues to solve problems.

CO4: Evaluate problems in linear codes applicable to information security.

TEXTBOOKS

- Koshy, T., Elementary Number Theory with Applications, Elsevier Publications, New Delhi, 2002.
- Melvyn B. Nathanson, "Methods in Number Theory", Springer (SIE), 2005.

3. San Ling and Chaoping Xing, "Coding Theory a First Course", Cambridge University Press, 1st Edition, 2004.
4. Van Lint J.H., "Introduction to Coding Theory", Springer, 2012.

REFERENCE BOOKS
1. Niven, I., Zuckerman.H.S., and Montgomery, H.L., —An Introduction to Theory of Numbersl, John Wiley and Sons , Singapore, 2004.
2. David M. Burton, "Elementary Number Theory", 7th Edition, MC Graw Hill Education, 2012.
3. Merkow Mark S and Jim Breithaupt, "Information security Principles and practices", Pearson Education, 2nd Edition, 2014.
4. Tom M. Apostol, “Introduction to Analytic Number Theory”, Springer, 2010.

COURSE CODE	COURSE TITLE	L	T	P	TW & SL	TH	C
UMA3941	GRAPH THEORY AND APPLICATIONS (Common to CHEM , EEE, ECE ,BME, CSE, and IT)	45	0	0	45	90	3

OBJECTIVES

- To understand the concepts of graph theory including properties of trees, graph theoretical parameters and their applications.

UNIT I	GRAPHS & THEIR REPRESENTATION	9
Graphs – Sub graphs – Walks, Paths, Circuits – Connectedness – Components – Euler graphs – Hamiltonian paths and circuits – The Shortest Path Problem – Matrix representation – Incidence matrix, Adjacency matrix.		

UNIT II	TREES	9
Trees – Properties of trees – Distance and centers in a tree – Rooted and binary trees – Spanning Trees – Spanning Trees in a weighted graph.		

UNIT III	CONNECTIVITY, INDEPENDENT SETS AND COLOURING	9
Cut sets – Properties of cut set – Fundamental circuits and cut sets – Connectivity and separability – Independent sets – Colouring – Proper coloring – Chromatic number – Chromatic partitioning.		

UNIT IV	PLANARITY, DIRECTED GRAPHS AND NETWORKS	9
Planar graphs – Different representation of a planar graph – Dual graphs – Euler's formula – Directed graphs – Matrix representation of directed graphs – Directed paths and connectedness – Network flows – Max-Flow Min-Cut Theorem.		

UNIT V	APPLICATIONS OF GRAPH THEORY	9
The Connector Problem – Construction of Reliable Communication Networks – The Chinese Postman Problem – The Travelling Salesman Problem – A Storage Problem – Job sequencing Problem – Making a road system one-way.		

TOTAL PERIODS	45
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COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Use matrices to represent graphs and solve problems.

CO2: Construct the minimal spanning tree of graphs.

CO3: Find the partition the vertices through graph coloring.

CO4: Apply graph theoretical concepts to optimize network models.

TEXTBOOKS

1. Narsingh Deo, “Graph Theory: With Application to Engineering and Computer Science”, Dover Publications, First Edition, 2016.
2. Bondy. J.A, Murty. U.S.R., "Graph Theory with applications", Graduate Texts in Mathematics (244), Springer-Verlag, 2008.

REFERENCE BOOKS
1. Kenneth H Rosen, “Discrete Mathematics and its Applications”, 7th Edition, Special Indian Edition, Tata McGraw Hill, New Delhi, 2017.
2. Douglas B. West, Introduction to Graph Theory, Pearson Education, 2002.
3. Frank Harary, "Graph Theory", Addison-Wesley Publishing Company, 1995.
4. Gary Chartrand and Ping Zhang, “A First Course in Graph Theory”, Dover Publications Inc., New York, 2012.