ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Madras Institute of Technology

Department: Information Technology

Programme: B. Tech. Artificial Intelligence and Data Science

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	IOC	Total
I	-	-	3	11	-	-	7	1	-	-	**22**
II	3	-	3	14	-	-	-	1	-	-	**21**
III	16	-	-	4	-	-	-	3	-	-	**23**
IV	18	-	-	4	-	-	2	-	1	1	**26**
V	12	3	-	4	-	-	3	3	-	-	**25**
VI	6	6	-	-	3	3	2	3	-	1	**24**
VII	3	9	-	-	3	3	2	-	-	1	**21**
VIII	-	-	-	-	-	-	8	-	-	-	**8**
Total	**58**	**18**	**6**	**37**	**6**	**6**	**24**	**11**	**1**	**3**	**170**
% of Category	**34.1**	**10.5**	**3.5**	**21.7**	**3.5**	**3.5**	**14.1**	**6.4**	**0.5**	**1.75**	**100**

CATEGORY OF COURSES

PCC – Professional Core Course
PEC – Professional Elective Course
ETC – Emerging Technology Course
OEC – Open Elective Course
SLC – Self Learning Course
ESC – Engineering Science Course
HSMC – Humanities Science and Management Course
SDC – Skill Development Course
UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

CURRICULUM AND SYLLABI

Semester – I							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	ME23C01	Engineering Drawing & 3D Modelling	LIT	2-0-4	6	4	SDC
5.	EE23C02	Fundamentals of Electrical and Electronics Engineering	T	3-0-0	3	3	ESC
6.	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
7.	UC23H01	தமிழர்மரபு /Heritage of Tamils	T	1-0-0	1	1	UC*
8.	-	NCC/NSS/NSO/YRC	L	0-0-2	2	-	UC
				Total Credits		**22**	

*** TCP –** Total Contact Period(s)

#**TYPE OF COURSE**

LIT – Laboratory Integrated Theory
T – Theory
L – Laboratory Course
IPW – Internship cum Project Work
PW – Project Work
CDP – Capstone Design Project

Semester – II							
S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C05	Probability and statistics	T	3-1-0	4	4	HSMC
3.	PH23C09	Semiconductor devices and quantum technology	LIT	3-0-0	3	3	HSMC
4.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
5.	AD23201	Python Programming	LIT	2-0-2	4	3	ESC
6.	AD23202	Computer Organization	T	3-0-0	3	3	PCC
7.	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
8.	-	Audit Course–I	-	-	-	-	UC
				Total Credits		**21**	

Semester – III							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	MA23C04	Discrete Mathematics	T	3-1-0	4	4	HSMC
2.	AD23301	Object Oriented Programming and Data Structures	LIT	4-0-2	6	5	PCC
3.	AD23302	Computer Networks	T	3-0-0	3	3	PCC
4.	AD23303	Database Management Systems	LIT	4-0-2	6	5	PCC
5.	AD23304	Fundamentals of Data Science	LIT	2-0-2	4	3	PCC
6.	AD23U01	Standards – Artificial Intelligence	T	1-0-0	1	1	UC
7.	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
Total Credits						**23**	

Semester – IV							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	MA23C03	Linear Algebra and Numerical Methods	T	3-1-0	4	4	HSMC
2.	IT23C02	Operating Systems	LIT	3-0-2	5	4	PCC
3.	IT23C01	Design and Analysis of Algorithms	T	3-0-0	3	3	PCC
4.	AD23401	Data Exploration and Visualization	LIT	3-0-2	5	4	PCC
5.	AD23402	Computer Vision	LIT	3-0-2	5	4	PCC
6.	AD23403	Distributed Systems and Cloud Computing	T	3-0-0	3	3	PCC
7.	-	Industry Oriented Course I	-	-	-	1	SDC
8.	AD23L01	Self-Learning Course – I	T	1-0-0	1	1	SLC
9.	-	Skill Development Course – I	LIT	1-0-2	3	2	SDC
10.	-	Audit Course–II	-	-	-	-	UC
Total Credits						**26**	

Semester – V							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23501	Optimization Techniques	T	4-0-0	4	4	HSMC
2.	AD23502	Machine Learning Methods	LIT	3-0-2	5	4	PCC
3.	AD23503	Artificial Intelligence	LIT	3-0-2	5	4	PCC
4.	AD23504	Big Data Analytics	LIT	3-0-2	5	4	PCC
5.	-	Professional Elective I	T	3-0-0	3	3	PEC
6.	-	Skill Development Course –II	LIT	1-0-2	3	2	SDC
7.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
8.	AD23505	Societal Oriented Project	PW	0-0-2	2	1	SDC
Total Credits						**25**	
Courses for Honors Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23D01	Capstone Design Project – Level I	CDP	0-0-6	6	3	SDC
(OR)							
1.	-	Honours Elective – I	T	3-0-0	3	3	SDC
2.	-	Honours Elective – II	T	3-0-0	3	3	SDC
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – I	T	3-0-0	3	3	SDC
2.	-	Minor Elective – II	T	3-0-0	3	3	SDC

Semester – VI							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23601	Deep Learning Techniques	LIT	2-0-2	4	3	PCC
2.	AD23602	Natural Language Processing	T	3-0-0	3	3	PCC
3.	-	Emerging Technology Course - I	T	3-0-0	3	3	ETC
4.	-	Professional Elective II	T	3-0-0	3	3	PEC
5.	-	Professional Elective III	T	3-0-0	3	3	PEC
6.	-	Open Elective – I	T	3-0-0	3	3	OE
7.	-	Skill Development Course-III	LIT	1-0-2	3	2	SDC
8.	-	Industry Oriented Course – II	T	1-0-0	1	1	IOC
9.	AD23U02	Perspectives Of Sustainable Development **–** Information Technology	T	2-0-2	4	3	UC
Total Credits						**24**	
Courses for Honors Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23D02	Capstone Design Project – Level II	CDP	0-0-6	6	3	SDC
(OR)							
1.	-	Honours Elective – III	T	3-0-0	3	3	PEC
2.	-	Honours Elective – IV	T	3-0-0	3	3	PEC
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – III	T	3-0-0	3	3	PEC
2.	-	Minor Elective – IV	T	3-0-0	3	3	PEC

Semester – VII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23701	Machine Learning Operations	LIT	2-0-2	4	3	PCC
2.	-	Emerging Technology Course -II	T	3-0-0	3	3	ETC
3.	-	Professional Elective IV	T	3-0-0	3	3	PEC
4.	-	Professional Elective V	T	3-0-0	3	3	PEC
5.	-	Professional Elective VI	T	3-0-0	3	3	PEC
6.	-	Open Elective II	T	3-0-0	3	3	OE
7.	-	Industry Oriented Course – III	T	1-0-0	1	1	IOC
8.	AD23702	Software Development Project Laboratory	PW	0-0-4	4	2	SDC
Total Credits						**21**	
Courses for Honors Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23D03	Capstone Design Project – Level III	CDP	0-0-6	6	3	SDC
(OR)							
1.	-	Honours Elective – V	T	3-0-0	3	3	PEC
2.	-	Honours Elective – VI	T	3-0-0	3	3	PEC
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – V	T	3-0-0	3	3	PEC
2.	-	Minor Elective – VI	T	3-0-0	3	3	PEC

Semester – VIII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	AD23801	Project Work / Internship cum Project Work	IPW	0-0-16	16	8	SDC
Total Credits						**8**	

VERTICALS

	Vertical I Computational Systems	**Vertical II Data Technologies**	**Vertical III Multimodal Processing**	**Vertical IV Network and Security**	**Vertical V AI in Industry**
1	Computational Intelligence	Programming for Data Science	Digital Image Processing	Cryptography and Network Security	AI for Industrial Applications
2	Graph Theory	Distributed AI	Text and Speech Analytics	Blockchain and Cryptocurrency	AI in Supply chain
3	Cognitive Models for computing	Advanced Data Structures	AI based Mobile application development	Security And Privacy in Cloud	Healthcare Analytics
4	Software Design Thinking	Social Networks	Augmented and Virtual Reality	Cybersecurity	AI for Robotics
5	GPU Architecture and programming	Information Retrieval	Game design and Development	Advanced Networks	Autonomous Vehicles
6	Embedded Systems	Reinforcement Learning	Explainable AI	Ethical Hacking	Maritime AI
7	Quantum Computing Techniques	Predictive Analytics	Metaverse	Software defined Networks	Bioinformatics
8	Statistical Decision Theory				Ethics for AI
9					Responsible AI

LIST OF PROFESSIONAL ELECTIVES

VERTICAL I: COMPUTATIONAL SYSTEMS						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	AD23001	Computational Intelligence	T	3-0-0	3	3
2	AD23002	Graph Theory	T	3-0-0	3	3
3	AD23003	Cognitive Models for computing	T	3-0-0	3	3
4	AD23004	Software Design Thinking	T	3-0-0	3	3
5	AD23005	GPU Architecture and Programming	T	3-0-0	3	3
6	IT23C09	Embedded Systems	T	3-0-0	3	3
7	AD23006	Quantum Computing Techniques	T	3-0-0	3	3
8	AD23007	Statistical Decision Theory	T	3-0-0	3	3

VERTICAL II: DATA TECHNOLOGIES						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	AD23008	Programming for Data Science	T	3-0-0	3	3
2	AD23009	Distributed AI	T	3-0-0	3	3
3	AD23010	Advanced Data Structures	T	3-0-0	3	3
4	AD23011	Social Networks	T	3-0-0	3	3
5	AD23012	Information Retrieval	T	3-0-0	3	3
6	IT23C08	Reinforcement Learning	T	3-0-0	3	3
7	AD23013	Predictive Analytics	T	3-0-0	3	3

VERTICAL III: MULTIMODAL PROCESSING						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	AD23014	Digital Image Processing	T	3-0-0	3	3
2	AD23025	Text and Speech Analytics	T	3-0-0	3	3
3	AD23015	AI Based Mobile Application Development	T	3-0-0	3	3
4	IT23C04	Augmented and Virtual Reality	T	3-0-0	3	3
5	IT23C06	Game Design and Development	T	3-0-0	3	3
6	AD23016	Explainable AI	T	3-0-0	3	3
7	IT23C11	Metaverse	T	3-0-0	3	3

VERTICAL IV: NETWORK AND SECURITY						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	AD23017	Cryptography and Network Security	T	3-0-0	3	3
2	IT23C05	Blockchain and Cryptocurrency	T	3-0-0	3	3
3	IT23C12	Security and Privacy in Cloud	T	3-0-0	3	3
4	AD23018	Cyber Security	T	3-0-0	3	3
5	IT23C03	Advanced Networks	T	3-0-0	3	3
6	IT23C10	Ethical Hacking	T	3-0-0	3	3
7	IT23C16	Software Defined Networks	T	3-0-0	3	3

VERTICALV: AI in Industry						
S.NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**
				L-T-P	**TCP***	
1	AD23019	AI for Industrial Applications	T	3-0-0	3	3
2	AD23020	AI in Supply chain	T	3-0-0	3	3
3	IT23C07	Healthcare Analytics	T	3-0-0	3	3
4	AD23021	AI for Robotics	T	3-0-0	3	3
5	AD23022	Autonomous Vehicles	T	3-0-0	3	3
6	AD23023	Maritime AI	T	3-0-0	3	3
7	IT23C17	Bioinformatics	T	3-0-0	3	3
8	AD23024	Ethics for AI	T	3-0-0	3	3
9	IT23C15	Responsible AI	T	3-0-0	3	3

OPEN ELECTIVE
(TO BE OFFERED TO OTHER DEPARTMENT)

S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATE GORY**	**PERIODS PER WEEK**			**TOTAL CONTACT PERIODS**	**CREDITS**
				L	**T**	**P**		
1	AD23901	Information Technology Essentials	OEC	3	0	0	3	3
2	AD23902	Software Engineering	OEC	3	0	0	3	3
3	AD23903	Data Structures	OEC	3	0	0	3	3
4	IT23902	Data Science Fundamentals	OEC	3	0	0	3	3
5	AD23201	Python Programming	OEC	3	0	0	3	3
6	AD23905	Artificial Intelligence	OEC	3	0	0	3	3
7	IT23903	Machine Learning	OEC	3	0	0	3	3
8	IT23908	Augmented and Virtual Reality	OEC	3	0	0	3	3
9	IT23904	IOT Based Smart Systems	OEC	3	0	0	3	3

A minimum of one course and a maximum of two courses to be offered.

MINOR PROGRAMME ON ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
Offered by Department of Information Technology for other Branch students.

S.NO	COURSE CODE	COURSE NAME	PERIODS PER WEEK			CREDITS
			L	T	P	
1	IT23001	Artificial Intelligence	3	0	0	3
2	IT23003	Big Data Analytics	3	0	0	3
3	IT23004	Data Visualization	3	0	0	3
4	IT23C08	Machine Learning	3	0	0	3
5	IT23009	Deep Learning	3	0	0	3
6	IT23039	MLOPS	3	0	0	3
7	IT23002	IoT Based Smart Systems	3	0	0	3

HSMC COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EN23C01	Foundation English	HSMC	2	0	2	4	3
2	MA23C01	Matrices and calculus	HSMC	3	1	0	4	4
3	PH23C01	Engineering Physics	HSMC	3	0	2	5	4
4	EN23C02	Professional Communication	HSMC	2	0	2	4	3
5	MA23C05	Probability and statistics	HSMC	3	1	0	4	4
6	PH23C09	Semiconductor devices and quantum technology	HSMC	3	0	3	6	3
7	CY23C01	Engineering Chemistry	HSMC	3	0	2	5	4
8	MA23C04	Discrete Mathematics	HSMC	4	0	0	4	4
9	MA23C03	Linear Algebra and Numerical Methods	HSMC	4	0	0	4	4
10	AD23501	Optimization Techniques	HSMC	4	0	0	4	4

UC COURSES

S. NO.	COURSECODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	UC23H01	தமிழர்மரபு / Heritage of Tamils	UC	1	0	0	1	1
2	UC23P01	NCC/NSS/NSO/YRC	UC	0	0	2	2	0
3	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	UC	1	0	0	1	1
4	-	Audit Course – I**	UC	2	0	0	0	0
5	AD23U01	Standards – AI & DS	UC	1	0	0	1	1
6	UC23U01	Universal Human Values	UC	1	0	2	3	2
7	-	Audit Course II**	UC	2	0	0	0	0

8	UC23E01	Engineering Entrepreneurship Development	UC	2	0	2	4	3
9	AD23U02	Entrepreneurship Development Course & Sustainability course II	UC	3	0	0	3	3

ENGINEERING SCIENCE COURSES (ESC)

S. NO.	COURSECODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EE23C02	Fundamentals of Electrical and Electronics Engineering	ESC	3	0	0	3	3
2	AD23201	Python Programming	ESC	2	0	2	4	3

SKILL DEVELOPMENT COURSES (SDC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.		Engineering Drawing & 3D Modelling	SDC	2	0	4	6	4
2.		Makerspace	SDC	1	0	4	5	3
3.		Interactive Website Design	SDC	1	0	2	3	2
4.		Web Programming Skills	SDC	1	0	2	3	2
5.		Mobile Application Development	SDC	1	0	2	3	2
6.		Societal Oriented Project	SDC	0	0	2	2	1
7.		Natural Language Processing Techniques	SDC	1	0	2	3	2
8.		Speech Recognition Techniques	SDC	1	0	2	3	2
9.		Software Development Project Laboratory	SDC	0	0	4	4	2
10.		Project Work / Internship cum Project Work	SDC	0	0	16	16	8

EMERGING TECHNOLOGY COURSES (ETC)

S. NO.	COURSECODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	AD23E01	AI IN IoT	ETC	3	0	0	3	3
2	AD23E02	Generative AI	ETC	3	0	0	3	3

SELF LEARNING COURSES (SLC)

S. NO.	COURSECODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1		R - Programming	SLC	1	0	0	1	1

INDUSTRY ORIENTED COURSES (IOC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1		AI in Digital Marketing	IOC	1	0	0	1	1
2		AI for Digital Health	IOC	1	0	0	1	1
3		AI in BFSI / AI for Industrial Domains	IOC	1	0	0	1	1
4		Industrial IoT	IOC	1	0	0	1	1
5		IoT and Cloud	IOC	1	0	0	1	1
6		Blockchain Use Cases	IOC	1	0	0	1	1
7		AI for Extended Reality	IOC	1	0	0	1	1
8		Tensor Flow Deep Learning	IOC	1	0	0	1	1
9		AI Foundations for Business Specialization	IOC	1	0	0	1	1

EN23C01 **FOUNDATION ENGLISH** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS 6

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: 6

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
Written assessments
Assignment

Lab assessment
Listening
Speaking

External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E/B.Tech Programmes) **3 0 2 4**

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS **9+6**

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS **9+6**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

1. Non-uniform bending -Determination of Young's modulus of the material of the beam.
2. Uniform bending -Determination of Young's modulus of the material of the beam
3. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS **9+6**

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

1. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
2. Melde's string experiment - Standing waves.
3. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS **9+6**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical

feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

1. Laser - Determination of the width of the groove of the compact disc using laser.

   Laser Parameters
   Determination of the wavelength of the laser using grating
2. Air wedge -Determination of the thickness of a thin sheet/wire
3. Optical fibre - Determination of Numerical Aperture and acceptance angle

   -Determination of bending loss of fibre.
4. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

1. Photoelectric effect – Determination of Planck's constant.
2. Black Body Radiation (Demonstration)
3. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1:	Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2:	Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3:	Conceptualize and visualize the oscillations and sound.
CO4:	Grasp optical phenomenon and their applications in real life.
CO5:	Appreciate and evaluate the quantum phenomenon.
CO6	Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons,10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO9	PO10	PO11	PO1 2
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

ME23C01	ENGINEERING DRAWING AND 3D MODELING	L	T	P	C
		2	0	4	4

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal),and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT 1: CONSTRUCTION OF ENGINEERING CURVES AND THEIR APPLICATIONS

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Application based – elliptical ground, dish antenna, cooling towers, lenses, gears, spiral springs, coils, slip less rolling of cylinders, and similar applications

Software demonstration: Study exercise –Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

(6+12 = 18 Hours)

UNIT 2: PROJECTION OF POINTS, LINES, AND SURFACES

Projection of points and projection of lines – inclined to both principal planes by rotating line method and trapezoidal rule – marking traces

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Software demonstration: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

(6+12 = 18 Hours)

UNIT 3: PROJECTION OF SOLIDS AND FREE HAND SKETCHING

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Free hand sketching – I & III angle projections of engineering parts and components

Software demonstration: 3DModeling and 2D drafting ofmachine parts

(6+12 = 18 Hours)

UNIT 4: SECTION OF SOLIDS, LATERAL SURFACE DEVELOPMENT AND THEIR APPLICATIONS

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Software demonstration: Assembly ofparts with respect to engineering constraints, and sectioned drafting of assembled components,Sheet metal design and drafting, drafting of coils, springs and screw threads

(6+12 = 18 Hours)

UNIT 5: ISOMETRIC AND PERSPECTIVE PROJECTIONS

Isometric view and isometric projection – combination of solids – sectioned solids – prisms, pyramids, axisymmetric solids, and frustum

Perspective projection of prisms, pyramids and axisymmetric solids – visual ray method and vanishing point method

Software demonstration: Isometric projection drawing in AutoCAD, Isometric representation of assembled and sectioned solids in 3D modeling software.

Conversion standards – IGES, and STEP

Camera view representation of solids with respect to different position of observer (Rotation of solids with respect to different planes)

(6+12 = 18 Hours)

Total: 90 Hours

ACTIVITIES BASED LAB EXERCISES

1. Preparation of flash cards (Cardboard/ Acrylic) based on the engineering application of curves.
2. Demonstration of the instantaneous center of rotation of governors with respect to angle of inclination of the arms of the governors
3. Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches.
4. Flipped classroom for Free hand sketching
5. Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape
6. Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics
7. Jig saw activity for Isometric projection
8. Portrait drawing using grids for perspective view

Note: Activities based lab exercises should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members.

COURSE MEETING TIMES

Lectures : 2 sessions / week, 50 minutes / session

Practical : 4 session / week, 50 minutes / session

TEXT BOOK

1. “Engineering Drawing” by N S Parthasarathy and Vela Murali, Oxford University Press; UK ed. Edition, 2015.
2. “Engineering Drawing + Auto CAD” by Venugopal K, V. Prabhu Raja, New Age International Publishers, Sixth edition (1 January 2022).

REFERENCES

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta, Charotar Publishing House, 2nd edition,2018.
2. "Engineering Drawing" by BasantAgrawal and C M Agrawal, Vikas Publishing House, 3rd edition,2020.
3. "Engineering Drawing With Auto CAD" by B V R Gupta, McGraw Hill Education, 4th edition, 2019.
4. "Engineering Drawing" by P S Gill, Tata McGraw Hill Education, 5th edition,2018.
5. "Engineering Drawing with an Introduction to AutoCAD" by DhananjayJolhe, Cengage Learning, 2nd edition,2020.
6. "Engineering Drawing" by M B Shah, Charotar Publishing House, 3rd edition,2019
7. "Fundamentals of Engineering Drawing" by ImtiazHashmi, Pearson Education, 2nd edition, 2018.
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy, Scitech Publications, 3rd edition, 2020.
9. "CAED: Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B, CBS Publishers & Distributors, 2nd, 2019.
10. "Computer-Aided Engineering Drawing" by Subrata Pal, Oxford University Press, 2nd,2020

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

1. Understand the fundamental principles of engineering drawing for accurate visualization and representation of objects through software demonstration and applications of engineering drawing in the world.
2. Demonstrate the ability to communicate technical information effectively through standard drawing practices and conventions.
3. Analyze and solve geometrical problems involving projections, sections, and developments of solids used in engineering applications.
4. Construct and infer various 2D and 3D engineering drawings and create their drafts.
5. Create engineering models through activity-basedconstructive group assignments

COs	POs											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
1	3	1	0	0	3	1	0	2	3	0	2	1	0	2
2	3	0	0	0	0	1	3	1	3	1	1	3	0	1
3	3	3	3	1	0	0	0	0	0	0	0	2	0	0
4	3	3	2	1	2	0	3	0	2	0	1	3	0	2
5	3	3	3	1	2	0	2	3	3	3	2	2	1	3
PAM	3	3	3	3	3	2	3	3	3	3	3	3	1	3

EE23C02	FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I BASIC ELECTRICAL CIRCUITS 9

DC Circuits: Sources, Ohm's Law - Kirchhoff's Laws – Solution of DC circuits with Independent sources only (Steady state)

AC Circuits: AC Fundamentals: Waveforms, Average value, RMS Value, Impedance, Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor – Steady State Analysis of RL, RC and RLC Circuits.

UNIT II AC AND DC MACHINES 9

Magnetic Circuits fundamentals – DC Machines: Construction, Working Principle, Types and Applications of DC Generator and Motor, EMF and Torque equation.

AC Machines: Construction, Working and Applications of Transformer, Three phase Alternator, Synchronous motor, Single and Three Phase Induction Motor and BLDC motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS 9

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode, BJT, JFET and MOSFET– Operational Amplifiers (OPAMPs) : Characteristics and basic application circuits-555 timer IC based astable and monostable multivibrator.

Basic switching circuits – Gates and Flip-Flops-Sample and hold circuit- R-2R ladder type DAC-Successive approximation based ADC.

UNIT IV SENSORS AND TRANSDUCERS 9

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, piezo electric crystals, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION 9

Functional Elements of an Instrument, Error analysis; Operating Principle - Moving Coil and Moving Iron Instruments, Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter- DSO - Block Diagram Approach.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Compute the electric circuit parameters for simple problems.

CO 2: Explain the working principles and characteristics of electrical machines, electronic devices and measuring instruments.

CO3: Identify general applications of electrical machines, electronic devices and measuring instruments.

CO 4: Analyze the basic electrical and electronic circuits.

CO 5: Explain the types and operating principles of sensors and transducers.

TEXT BOOKS:

1. Kothari DP and Nagrath IJ, “Basic Electrical and Electronics Engineering”, McGraw Hill Education, Second Editions, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition,2017
3. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.

REFERENCES:

1. Rajendra Prasad ‘Fundamentals of Electrical Engineering’, Third Edition, Prentice Hall of India, 2014.
2. Sanjeev Sharma ‘Basics of Electrical Engineering’ Wiley, 2019.
3. Doebelin, E.O., Measurements Systems – Application and Design’, McGraw Hill Publishing Co, 2019.
4. D.Roy Choudhury, Shail B. Jain, Linear Integrated Circuits, New age international Publishers, 2018.
5. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
CO/PO & PSO Average	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I மொழி மற்றும் இலக்கியம் **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 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 & JainisminTamilLand-BakthiLiteratureAzhwarsandNayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyarand 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, Villagedeities, 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, VilluPattu, KaniyanKoothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAICONCEPTOFTAMILS 3

Flora and Fauna of Tamils&AhamandPuramConceptfromTholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import duringSangamAge -Overseas Conquestof Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils toIndian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - RoleofSiddhaMedicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - ‘Sangam City C ivilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services

Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C**
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02 PROFESSIONAL COMMUNICATION L T P C
2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments
Assignment

Lab Assessment

Group discussion (Peer assessment)
Listening

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.
2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.
3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C05	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9+3

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE 9+3

Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances –χ^2 test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9+3

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

SUGGESTED LAB EXERCISES

1. Data exploration using R
2. Visualizing Probability distributions graphically
3. Evaluation of correlation coefficient
4. Creating a Linear regression model in R

5. Maximum Likelihood Estimation in R
6. Hypothesis testing in R programming
7. Chi square goodness of fit test in R
8. Design and Analysis of experiments with R

OUTCOMES:

CO1: Can analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
CO2: Will be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
CO3: Provides an estimate or a range of values for the population parameter from random samples of population.
CO4: Helps to evaluate the strength of the claim/assumption on a sample data using hypothesis testing.
CO5: Equips to study the influence of several input variables on the key output variable.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2024.

REFERENCES:

1. Richard A. Johnson, Irwin Miller, John Freund "Miller & Freund's Probability and Statistics for Engineers", Person Education, 8th Edition, 2015.
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., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, 2016.

CO – PO Mapping:

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	3	2	3	1	2	1	1	1	1	1	3
CO2	3	3	2	3	1	2	1	1	1	1	1	3
CO3	3	3	2	3	1	2	1	1	1	1	1	3
CO4	3	3	2	3	1	2	1	1	1	1	1	3
CO5	3	3	2	3	1	2	1	1	1	1	1	3

PH23C09	SEMICONDUCTOR DEVICES AND QUANTUM TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquaint the electrical properties of materials.
- To present the principles of semiconductor physics and its applications.
- To educate the properties of magnetic and dielectric materials and their uses.
- To explicit nanodevices.
- To introduce quantum computing.

UNIT I ELECTRON THEORY OF MATERIALS 9

Classical and quantum free electron theory of metals – merits and demerits Fermi-Dirac statistics–density of states: electron concentration and Fermi Level-band theory of solids: energy band formation– electron effective mass- Intrinsic semiconductors: energy band-diagram-direct and indirect band gap semiconductors - carrier concentrations and conductivity - extrinsic semiconductors: n, p-type doping, compensation doping.

UNIT II SEMICONDUCTORS AND DISPLAY DEVICES 9

Degenerate and non-degenerate semiconductors: Hall Effect and devices-Schottky junction - Ohmic contacts–Peltier Coolers – Schottky diode; optical absorption and solar cell. Photoluminescence, injection luminescence – Phosphors – LED construction and working– White LED's – organic LEDs–Laser diode - principles of quantum well laser–liquid crystals and LCD construction and working–numeric displays.

UNIT III MAGNETIC AND OPTICAL DATA STORAGE TECHNIQUES 9

Introduction – magnetic material parameters –Ferromagnetic materials – Ferrites - Soft and Hard magnetic materials – GMR sensors - magnetic disk memories – Principle of magnetic recording – Materials for magnetic data storage - Optical data storage capacity of CD in normal use – advantages of CD –DVD – Blu-ray DVD - holographic storage – Phase change recording – Hi-tech involved in system development - magneto-optical data storage.

UNIT IV NANODEVICES 9

Introduction - quantum confinement – quantum structures: quantum wells, wires and dots – band gap of nanomaterials –- Nanodevices -An introduction - Classification of nanodevices – Nano-ordered Material systems -Semiconductor nanodevices: - JFET - Nanoscale MOSFET - Tunneling: Single electron phenomena - Coulomb blockade -: Single Electron Transistor (SET) - Resonant Tunnelling Transistor (RTT) - Microelectromechanical systems (MEMS) - Nanoelectromechanical systems (NEMS**) -** Applications of Nanomachines and Molecular Nanodevices – Spintronics Devices.

UNIT V QUANTUM COMPUTING 9

- Quantum system for information processing - quantum states – Josephson junction - classical bits – quantum bits or qubits – 2-D electron gas based qubits – Single Photon Emitters - multiple qubits – Bloch sphere - quantum gates - CNOT gate - Types of Quantum Computer: Quantum Annealer- Analog Quantum- Universal Quantum– Advantages of quantum computing over classical computing - -Silicon-Based Quantum Computer - Quantum cellular automata.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students shall be able to

CO1: Express knowledge on the electrical properties of materials.
CO2: Have an insight into the semiconductor junction and Display Devices
CO3: Explore the magnetic and optical data storage Devices
CO4: Implement the essential principles behind Nanodevices.
CO5: Envisage the basics of quantum computing

TEXTBOOKS:

1. S.O.Kasap - Principles of Electronic Materials and Devices, McGraw Hill Education, 2017.
2. Garcia, A. Damask and S.Schwarz - Physics for Computer Science Students, Springer-Verlag, 2012.
3. V.K. Mehta - Principles of Electronics - S.Chand Publications, New Delhi
4. G.J.Mithal - Electronic devices and circuits, Khanna publishers, New Delhi
5. B.L. Theraja - Basic Electronics - S.Chand Publications, New Delhi
6. Dr. Jaysukh Markna, Tulshi Shiyani, Nanodevices: Principle and Applications - 2018 Munich, GRIN Verlag
7. Nanodevices. Principle and Applications - Jaysukh Markna, Tulshi Shiyani
8. Quantum Computing for Everyone -Chris Bernhardt, MIT Press
9. Quantum computing fundamentals - Chuck Easttom

REFERENCES:

1. Jasprit Singh, Optoelectronics: An Introduction to Materials and Devices, Tata McGraw Hill,1999
2. Wilson,J and Hawkes, J.F.B, Optoelectronics, Prentice Hall, 2002
3. Bhattacharya.B, Semiconductor optoelectronic devices, Prentice Hall of India, 1995.
4. Kittel C, Introduction to Solid State Physics, JohnWiley,1996
5. Kasap S.O, Principles of Electronic Materials and Devices, Tata McGraw-Hill, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1							
CO2	3	1	1	2	1							
CO3	3	1	1	2	1							
CO4	2	1	1	1	1							
CO5	2	1	1	1	1							

CY23C01 **ENGINEERING CHEMISTRY** **L T P C**
3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery,

hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of H_2 – O_2 fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

AD23201 **PYTHON PROGRAMMING** **L T P C**
2 0 2 3

OBJECTIVIES:

This course aims to

- Learn the fundamental concepts of python programming
- Understand the control flow statements and functions
- Apply the essential data structures for the application development
- Understand how to implement the projects using powerful data structures
- Learn how to handle errors and work with files in python
- Gain knowledge about how to create graphical user interface applications (GUI) for the software development.

UNIT 1 – INTRODUCTION TO PYTHON **6L, 6P**

Overview of Python–Setting up the Python environment – Program Structure – Python Interpreter and Interactive Mode – Application Types and Tools – Data Types – Variables – Local vs Global; Input Statements – Static, Command Line and Dynamic Statements – Operators in python.

PRACTICALS:

1. Python programming using Input statements and Operators

UNIT 2 – CONTROL STRUCTURES AND FUNCTIONS **6L, 6P**

Conditional Statements –if, elif and else statements; Looping Statements – for loop, while loop, nested loops, break and continue statements, loop else; Functions – Defining and Calling Functions, Types, Parameter Passing, Return Statement, Lambda Function, Recursive Function;

PRACTICALS:

1. Problem Solving using Decision Making and Looping statements
2. Implementing programs using Variables and Functions

UNIT 3 – ESSENTIAL DATA STRUCTURES **6L, 6P**

Introduction to Strings -Built-in methods, Common Operations, Indexing and Slicing, String Immutability, Searching and Testing Strings, Formatting, Splitting and Joining Strings; Arrays – Adding, Accessing, Searching, Updating and Removing Elements; List – Creation, Retrieval, Updation, Deletion, Sorting and Reversing lists, Nested Lists, Common list operations, List comprehensions; Tuple – Creation, Retrieval, Deletion, Searching and Joining Tuples;

PRACTICALS:

1. Implementing Programs using Strings
2. Implementing Programs using Arrays
3. Developing applications using List and Tuple

UNIT 4 – SETS AND DICTIONARIES **6L, 6P**

Set – Built-in Methods, Creation, Retrieval, Updation, Deletion, Mathematical Set Operations – Union, Intersection, Difference, Symmetric Difference; Dictionary – Built-in Methods, Creation, Index based Insertion, Accessing elements, Updating and Removing elements, Nested Dictionaries.

PRACTICALS:

1. Developing projects / applications using Set and Dictionary

UNIT 5 – FILE HANDLING AND GUI PROGRAMMING **6L, 6P**

Exception Handling –Single and Multiple Exceptions; Files – Reading and Writing Text and CSV files; Modules – Importing Modules, Creating and Accessing User Defined Package, Installing & uninstalling built-in modules using pip command – Converting python script to .exe using tool- auto-py-to-exe; Introduction to Tkinter GUI – Widgets, Layout Managers, Event Handling, Creating Simple GUI Applications.

PRACTICALS:

1. Implementing programs using Exception Handling
2. Storing and Retrieving Text and CSV files using File Handling
3. Creating and applying User Defined Modules
4. Conversion of Python scripts to Exe file using tool Auto-py-to-exe
5. Developing GUI applications using Tkinter python library.

TOTAL: 30L + 30P= 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to:

- **CO1** Understand the basic concepts of python programming
- **CO2** Practice the control structures and functions using python
- **CO3** Learn and use the essential data structures in python
- **CO4** Develop applications and projects using sets and dictionaries.
- **CO5** Develop window based applications using Tkinter library.

TEXTBOOKS:

1. Udayan Das, Aubrey Lawson, Wiley Chris Mayfield, Narges Norouzi, Introduction to Python Programming, OPENSTAX, 2024 (Unit 1-4).
2. Alan D. Moore, Python GUI Programming with Tkinter, 2nd Edition, Packt Publishing, 2021. (Unit 5)

REFERENCES:

1. ACI Learning, Justin Dennison, Daniel Lowrie, Python Programming Essentials, Packt Publishing, 2024.
2. Deepali Srivastava, Ultimate Python Programming, BPB Publications, 2024.
3. ACI Learning, Justin Dennison, Vonne Smith, Introduction to Programming Using Python, Packt Publishing, 2024.
4. S.Sridhar, J. Indumathi, V.M. Hariharan, Python Programming, Pearson India, 2023.
5. https://www.geeksforgeeks.org/python-arrays/
6. https://pypi.org/project/auto-py-to-exe/

CO-PO & PSO Mapping

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	-	-	-	-	-	1	-	-	3	1	1	1
2	1	2	2	1	1	-	-	-	1	-	1	3	1	1	1
3	1	2	2	1	3	1	1	-	3	1	2	3	2	3	3
4	1	3	3	2	2	1	1	-	3	1	2	3	2	3	3
5	1	3	3	2	3	2	1	-	3	2	2	1	2	2	2
AVG	1	2	2	1	2	1	1	-	2	1	1	3	2	2	2

AD23202 COMPUTER ORGANIZATION L T P C
3 0 0 3

UNIT I DIGITAL LOGIC FUNDAMENTALS 9

Digital Systems – Binary Numbers Representation of Positive and Negative Numbers – 1's and 2's Complements –– Boolean Algebra –Theorems and Postulates – Functions – Truth Table – Logic Gates – Universal gates– Minterms and Maxterms Canonical and Standard Forms –– Simplification using K-Maps. – Combinational Circuits – Karnaugh Map - Analysis and Design Procedures- Signed Binary Number, Weighted binary codes and conversion.

UNIT II FUNDAMENTALS OF COMPUTER SYSTEM 9

Functional Units of a Digital Computer – Von Neumann Architecture - Operation and Operands of Computer Hardware – Software Interface –Instruction Set Architecture – RISC and CISC Architectures – Addressing Modes –Performance Metrics – Power Law – Amdahl's Law.

UNIT III ARITHMETIC FUNDAMENTALS IN COMPUTER 9

Binary Adder –Subtractor – Integer Arithmetic – Addition And Subtraction Of Signed Numbers- Binary Parallel Adder – Design Of Fast Adder – Multiplication Of Signed And Unsigned Numbers – Fast Multiplication - Integer Division – Floating Point Numbers And Operations

UNIT IV INSTRUCTION EXECUTION AND PIPELINING 9

Design convention of a processor - Instruction Execution – Hardware Components- Instruction Fetch and Execution – Control Signals -Hardwired Control, Microprogrammed Control – Instruction Level Parallelism – Basic concepts of Pipelining – Pipelined implementation of Data path and Control unit - Structural Hazards - Data Hazard – Control Hazards.

UNIT V MEMORY AND I/O 9

Memory Concepts and Hierarchy – Memory Management – Cache Memories: Mapping and Replacement Techniques – Performance Considerations – Virtual Memory – DMA – I/O – Accessing I/O: Parallel and Serial Interface – Interrupt I/O.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: To learn Boolean algebra and simplification of Boolean functions.
CO2: Design various combinational digital circuits using logic gates
CO3: Design sequential circuits and analyze the design procedures
CO4:State the fundamentals of computer systems and analyze the execution of an instruction
CO5: Analyze different types of control design and identify hazards
CO6:Identify the characteristics of various memory systems and I/O communication

TEXT BOOKS:

1. M. Morris Mano, Michael D. Ciletti, "Digital Design : With an Introduction to the Verilog HDL, VHDL, and System Verilog", Sixth Edition, Pearson Education, 2018.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", Sixth Edition, Tata McGraw-Hill, 1-January 2022.
3. David A. Patterson, John L. Hennessy, "Computer Organization and Design, The Hardware/Software Interface", Sixth Edition, Morgan Kaufmann/Elsevier, 2020

REFERENCES:

1. William Stallings, “Computer Organization and Architecture – Designing for Performance”,Tenth Edition, Pearson Education, 2016.
2. G. K. Kharate, “Digital Electronics”, Oxford University Press 2010.

CO-PO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	-	-	-	-	1	-	-	-	-	-	-
2	3	3	3	2	2	1	1	-	2	1	-	-	1	2	2
3	3	3	3	2	2	1	1	-	2	1	-	-	1	2	2
4	3	3	3	2	1	-	-	-	1	-	-	-	-	-	-
5	3	3	3	2	1	-	-	-	2	-	-	1	-	-	-
6	3	3	3	1	1	-	-	-	-	-		1	-	1	1
Avg.	3	3	3	2	2	1	1	-	2	1	-	1	1	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
1 0 0 1

அலகு I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu)

(Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 TAMILS AND TECHNOLOGY L T P C
1 0 0 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 NayakarMahal -ChettiNadu 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 Stonebeads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

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 : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை

வெளியீடு)

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

MA23C04	DISCRETE MATHEMATICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce Mathematical Logic, Inference Theory and proof methods.
- To provide fundamental principles of combinatorial counting techniques.
- To introduce graph models, their representation, connectivity and traversability.
- To introduce the fundamental algebraic structures and their properties.
- To provide exposure to Lattices and Boolean algebra and their utilities.

UNIT I LOGIC AND PROOFS 9+3

Propositional Logic – Propositional Equivalences – Normal Forms – Predicates and Quantifiers – Nested Quantifiers – Rules of Inference – Introduction to Proofs – Proof Methods and Strategy.

UNIT II COMBINATORICS 9+3

Mathematical Induction – Strong Induction and Well Ordering – The Basics of Counting – The Pigeonhole Principle – Permutations and Combinations – Recurrence Relations – Solving Linear Recurrence Relations Using Generating Functions – Inclusion-Exclusion Principle and its Applications.

UNIT III GRAPHS 9+3

Graphs and Graph Models – Graph Terminology and Special types of Graphs – Matrix Representation of Graphs and Graph Isomorphism – Connectivity – Euler and Hamiltonian Paths.

UNIT IV ALGEBRAIC STRUCTURES 9+3

Groups – Subgroups – Homomorphisms – Normal Subgroups and Cosets – Lagrange's Theorem – Rings and Fields (Definitions and Examples).

UNIT V LATTICES AND BOOLEAN ALGEBRA 9+3

Partial Ordering – Posets – Lattices as Posets – Properties of Lattices – Lattices as Algebraic Systems – Sublattices – Direct Product and Homomorphism – Some Special Lattices – Boolean Algebra.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Logic

1. Construction of truth table for a given statement formula with three variables, checking satisfiability of the statement formula with three variables.
2. Construct PDNF and PCNF for a given statement formula with three variables.

Combinatorics

1. Combinatorics (Ref. Rosen pg. 382 – 385)
2. Recursive and iterative algorithms for Fibonacci numbers.(Ref. Rosen pg. 316 – 317)

Graphs

1. Checking graph isomorphism using adjacency matrix.
2. Finding the shortest path in a connected weighted graph (Dijkstra's algorithm).

Algebraic Structures

1. Modular exponentiation.
2. Euclidean algorithm. (Ref. Rosen pg. 226 – 227)

Lattices

1. Minimization of the Boolean function of two or three variables using Karnaugh maps. (Ref. Rosen pg. 712)

OUTCOMES:

CO 1 :Understand the validity of the logical arguments, mathematical proofs and correctness of the algorithm.
CO 2 :Apply Combinatorial counting techniques in solving combinatorial related problems.
CO 3 :Use graph models and their connectivity, traversability in solving real world problems
CO 4 :Understand the significance of algebraic structural ideas used in coding theory and cryptography.
CO 5 :Apply Boolean laws and Boolean functions in combinatorial circuit designs.

TEXT BOOKS:

1. Kenneth H. Rosen, " Discrete Mathematics and its Applications", Tata Mc Graw Hill Pub. Co. Ltd., Seventh Edition, Special Indian Edition, New Delhi, 2011.
2. Tremblay J. P. and Manohar R, " Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Pub. Co. Ltd., Third Edition, New Delhi, 2013.

REFERENCES:

1. Thomas Koshy," Discrete Mathematics with Applications", Elsevier Publications, Boston, 2004.
2. Grimaldi R.P., "Discrete and Combinatorial Mathematics", Pearson Education Pvt. Ltd., 5th Edition, Singapore, 2004.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1	3	3	2	3	1	2	1	1	1	1	1	3
CO 2	3	3	2	3	1	2	1	1	1	1	1	3
CO 3	3	3	2	3	1	2	1	1	1	1	1	3
CO 4	3	3	2	3	1	2	1	1	1	1	1	3
CO 5	3	3	2	3	1	2	1	1	1	1	1	3

AD23301 **OBJECT ORIENTED PROGRAMMING AND DATA STRUCTURES**

L	T	P	C
4	0	2	5

COURSE OBJECTIVES:

1. Define the fundamental principles of object-oriented programming (OOP)
2. Explain the implementation and application of various data structures
3. Develop and implement efficient algorithms for sorting, searching, and manipulating data using appropriate data structures and OOP concepts
4. Explore and analyze different inheritance models, exception handling mechanisms, and memory management techniques in object-oriented programming
5. Evaluate the performance and efficiency of different data structures and algorithms.

UNIT – I **OBJECT-ORIENTED PROGRAMMING - FUNDAMENTALS** **12L, 6P**

C++ - Data abstraction – Encapsulation - Class – Object – Constructor - Copy constructor - Static member - Constant member - Member function – Pointers - Pointer Operators, Pointer Expressions, Arrays of Pointers, Pointers to Functions - String handling - Polymorphism – Function overloading - Operator overloading - Dynamic memory allocation.

PRACTICALS:

- Practice of C++ Programming using statements, expressions, decision making constructs, iterative and branching constructs, structures, arrays, functions and pointers

UNIT – II **OBJECT ORIENTED PROGRAMMING** **12L, 6P**

Inheritance – Base-Class Access Control, Protected Base Class Inheritance, Inheriting Multiple Base Classes, Granting Access, Virtual Base Classes - Exception handling – Handling Derived Class Exceptions, Exception Handling Options, Setting the Terminate and Unexpected Handlers - Templates - Generic Functions, Applying Generic Functions, Generic Classes - Virtual functions - Abstract class - STL: Containers, Algorithms, Iterators - Virtual function - Abstract class - STL: Containers, Algorithms, Iterators

PRACTICALS:

- Implementation of advanced features of C++ like polymorphism, inheritance, templates and STL

UNIT – III **LINEAR DATA STRUCTURES – LIST, STACK, QUEUE** **12L, 6P**

Array-based and Linked list-based implementation – Doubly and Circular Linked list - Applications of list – Polynomial manipulation – ADT – stack model, implementation of stacks, applications - Queue ADT - Queue model, implementation of Queues, applications – Circular queue model, implementation of Circular Queue, Applications.

PRACTICALS:

- Implementation of singly linked list and doubly linked list.
- Implementation of Stack and Queue using array and linked List.

- Implementation of applications using linked list and stack

UNIT – IV NON-LINEAR DATA STRUCTURES – TREE AND GRAPH 12L, 6P

Tree - Definitions - Binary tree – Representation - Tree Traversals - Binary Search tree – Insertion – Deletion - AVL tree – B tree – Binary Heap - Graph – Definitions – Representation – Topological Sort - Graph Traversals - Minimum Spanning Tree – Shortest Path.

PRACTICALS:

- Implementation of Binary Search tree and AVL tree.
- Implementation of Graph traversals algorithms: Breadth-First Search and Depth-First Search.

UNIT – V SEARCHING AND HASHING TECHNIQUES 12L, 6P

Heap sort - Searching: linear search – Binary search – Hashing: Hash functions – Separate chaining – Open addressing – Double hashing – Rehashing – Universal hashing – Extendible hashing

PRACTICALS:

- Implementation of heap sort algorithm.
- Implementation of linear search and binary search algorithms

TOTAL: 60L + 30P = 90 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Explore the concepts of OOP to solve the applications.
2. Analyse and design the problems using advanced concepts of OOP.
3. Select and use appropriate linear data structures for solving a given problem.
4. Apply suitable hierarchical data structures to solve practical problems.
5. Apply the graph data structures for real world problems.
6. Appropriately use sort, search, hash techniques for a given application

REFERENCES:

1. Herbert Schildt, “C++ The Complete Reference”, Fifth Edition, McGraw Hill Education, 2015.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, Fourth Edition, Pearson Education, 2013.
3. Paul Deitel, Harvey Deitel, “C++ How to Program”, 11th Edition, Pearson Education, 2023. Michael T, Goodrich, Roberto Tamassia, David Mount, ““Data Structures and Algorithms in C++”, Seventh Edition, Wiley Publishers, 2004.
4. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, 2006.
5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Fourth Edition, MIT Press, 2022.

Mapping of CO with PO

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	3	-	2	-	-	-	1	-	1	2	1	2	1
CO2	2	2	3	-	2	-	-	-	1	-	1	2	1	1	1
CO3	2	2	3	-	3	-	-	-	2	-	1	1	1	-	1
CO4	3	2	3	-	2	-	-	-	1	-	1	2	-	1	1
CO5	3	3	3	-	2	-	-	-	1	-	-	1	1	-	1
CO6	3	3	3	-	2	-	-	-	1	-	-	1	1	-	1

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23302	COMPUTER NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concept of layering in networks.
- To know the functions of protocols of each layer of TCP/IP protocol suite.
- To visualize the end-to-end flow of information.
- To understand the components required to build different types of networks.
- To learn concepts related to network addressing and routing.

UNIT – I INTRODUCTION AND APPLICATION LAYER 9L

Data communication systems - Building networks – Network Edge, Access and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Top-down Approach – Application layer - Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.

UNIT – II TRANSPORT LAYER 9L

Transport Layer functions – End to end semantics – Multiplexing and Demultiplexing – User Datagram Protocol – UDP Applications – Transmission Control Protocol – Connection establishment and release – Flow Control – Retransmission Strategies – Congestion Control – Quality of Service.

UNIT – III NETWORK LAYER 9L

Network Layer: Switching concepts – Packet switching - Routing – Distance Vector and Link State Algorithms – Routing Information Protocol, Open Shortest Path First and Broder Gateway Protocol – Congestion Control mechanisms in Routers – Software Defined Networks – Control Plane and Data Plane.

UNIT – IV IP ADDRESSING 9L

IPV4 Packet Format and Addressing – Subnetting – Classless Inter-Domain Routing – Variable Length Subnet Mask – Dynamic Host Configuration Protocol – Network Address Translation – Internet Control Message Protocol – Need for IPv6 – Addressing methods and types in IPv6 – IPv6 header – Transition from IPv4 to IPv6.

UNIT – V DATA LINK AND PHYSICAL LAYERS 9L

Data Link Layer – Framing – Flow control – Error control – Media Access Control – Ethernet Basics – Carrier Sense Multiple Access / Collision Detection – Virtual LAN – Wireless LAN - 802.11 variants – MAC Layer – CSMA/CA - Physical layer – Signals – Bandwidth and Data Rate – Encoding – Multiplexing – Shift Keying – Transmission Media.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Identify the appropriate application layer and transport layer protocols required to implement various network applications.
2. Identify better routes by applying appropriate intra AS protocols and inter AS protocols.
3. Apply effective address management techniques and configure IPv6 protocols.
4. Select the appropriate LAN technology and MAC layer protocols.

5. Select the type of medium and frequency range for data transmission

TEXTBOOKS:

1. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down and Approach”, Eighth Edition, Pearson Education, 2022.
2. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Sixth Edition, Morgan Kaufmann Publishers Inc., 2022.

REFERENCES:

1. William Stallings, “Data and Computer Communications”, Tenth Edition, Pearson Education, 2017.
2. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open-Source Approach”, McGraw Hill, 2012.
3. Andrew S Tanenbaum, Nick Feamster and David J Wetherall, “Computer Networks”, Sixth Edition, Pearson Education, 2022.

Mapping of CO with PO

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	2	1	-	-	2	-	1	3	3	3	3
CO2	2	3	2	3	1	-	-	-	-	-	1	3	3	3	3
CO3	2	3	3	3	1	-	-	-	2	-	-	3	3	3	3
CO4	2	3	3	3	1	-	-	-	1	-	1	3	3	3	3
CO5	2	2	2	3	1	2	-	-	2	-	2	3	3	3	3
AVG	**2**	**2.6**	**2.6**	**2.6**	**1.2**	**1.5**	**-**	**-**	**1.4**	**-**	**1.2**	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23303 DATABASE MANAGEMENT SYSTEMS

L	T	P	C
4	0	2	5

COURSE OBJECTIVES:

1. Define key concepts and components of database systems
2. Explain the principles and methodologies of database design
3. Implement transaction management techniques, including ACID properties, concurrency control, and recovery systems in practical database scenarios.
4. Study various database implementation techniques such as indexing, hashing, file organization, and query optimization.
5. Assess advanced database concepts and technologies, including data warehousing, distributed databases, and NoSQL databases

UNIT – I RELATIONAL DATABASES 12L, 6P

Purpose of Database System – Views of Data – Data Models – Database System Architecture – Introduction to Relational Databases – Relational Model – Keys – Relational Algebra – Relational Calculus – SQL Fundamentals – Advanced SQL features – Triggers – Embedded SQL.

PRACTICALS:

1. Create a database table, add constraints (primary key, unique, check, NOT NULL), insert rows,
2. Update, and delete rows using SQL DDL and DML commands.
3. Create set of tables, add foreign key constraints, and incorporate referential integrity.
4. Query the database tables using different 'where' clause conditions and implement aggregate functions.
5. Query the database tables and explore sub queries and simple join operations.
6. Query the database tables and explore natural, equi, and outer joins.
7. Write user defined functions and stored procedures in SQL.
8. Write SQL Triggers for insert, delete, and update operations in database table.

UNIT – II DATABASE DESIGN 12L, 6P

Entity-Relationship Model – ER Diagrams – Functional Dependencies – Non-Loss Decomposition Functional Dependencies – First Normal Form – Second Normal Form – Third Normal Form – Dependency Preservation – Boyce/Codd Normal Form – Multi-Valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

PRACTICALS:

1. Design ER diagrams for any scenario for capturing entities, relationships, and attributes.
2. Identify and analyze functional dependencies in relational database. Also normalize a set of tables up to the Boyce-Codd Normal Form (BCNF)

UNIT – III TRANSACTION MANAGEMENT 12L, 6P

Transaction Concepts – ACID Properties – Serializability – Transaction Isolation Levels – Concurrency Control – Need for Concurrency – Lock-Based Protocols - Timestamp-Based Protocols – Deadlock Handling – Recovery System – Failure Classification – Recovery Algorithm - ARIES.

PRACTICALS:

1. Execute complex transactions and realize DCL and TCL commands.

UNIT – IV IMPLEMENTATION TECHNIQUES 12L, 6P

Overview of Physical Storage Media – RAID – File Organization – Organization of Records in Files – Indexing and Hashing – Ordered Indices – B+ tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Catalog Information for Cost Estimation – Query Optimization.

PRACTICALS:

1. Create View and index for database tables with large number of records.

UNIT – V DATA WAREHOUSING AND ADVANCED DATABASES 12L, 6P

Introduction to Data Warehouse – Concepts, Modelling: Datacube, Schemas, OLAP vs OLTP, Warehouse implementation – XML Databases - Overview of Distributed Databases – Data Fragmentation – Replication – NOSQL Database: Characteristics – CAP theorem – Types of NOSQL Datastores: Column Oriented, Document, Key-Value and Graph Types – Introduction to MongoDB.

PRACTICALS:

1. Create Document, column, and document - based data using NOSQL database tools.
2. Design a data warehouse schema (star, snowflake) for any real-world scenario, including dimension and fact tables.

TOTAL: 60L + 30P = 90 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Describe the key principles, the structures, and the organization of relational databases and to formulate query using relational algebra/ SQL.
2. Identify the methodology of conceptual modelling through ER Model and use formal techniques like normalization to design a database schema.
3. Demonstrate the transactions and estimate the procedures for controlling the consequences of concurrent data access.
4. Analyse the database storage structures, access and query processing techniques.
5. Describe and differentiate the principles and common features of the distributed, and NoSQL databases.
6. Analyze, Design, Create and Evaluate the real database applications using DBMS APIs.

REFERENCES:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, Tata McGraw Hill, 2020.
2. Elmasri Ramez, Navathe Shamkant, “Fundamentals of Database System”, Seventh Edition, Pearson Education, 2017.
3. Han, Kamber, Pei, “Data Mining: Concepts and Techniques”, 3rd Edition, Elsevier-Morgan Kauffmann, 2012.
4. Shakuntala Gupta Edward and Navin Sabharwal, “Practical MongoDB: Architecting, Developing, and Administering MongoDB”, Apress, 2015.
5. C. J. Date, A. Kannan, S. Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
6. Raghu Ramakrishnan, Johannes Gehrke, “Database Management Systems”, Fourth Edition, Tata McGraw Hill, 2010.
7. Carlos Coronel, Steven Morris, Peter Rob, “Database Systems: Design, Implementation and Management”, Twelfth Edition, Cengage Learning, 2017.

Mapping of CO with PO

COURSE OUTCOMES	Program Outcomes (POs)& Program Specific Outcomes (PSOs)														
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PS O 2	PS O 3
CO1	3	2	2	2	2	-	1	-	2	-	1	1	3	3	3
CO2	2	3	2	2	2	-	2	-	2	-	1	1	3	3	3
CO3	2	3	3	2	3	-	2	-	2	-	1	2	2	2	2
CO4	1	3	2	3	2	-	3	-	3	-	2	2	3	3	3
CO5	1	2	2	2	2	-	2	-	2	-	1	2	2	2	2
CO6	1	2	3	2	3	-	3	-	3	-	2	2	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23304	FUNDAMENTALS OF DATA SCIENCE	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1. Define key concepts and terminologies in data science
2. Describe the methods used in descriptive data analysis
3. Use machine learning techniques to build and test models for both regression and classification tasks.
4. Explore data handling strategies and model evaluation techniques to ensure data quality and assess model performance.
5. Assess various data analytics approaches, including feature selection, error measurement, and predictive modeling, to derive insights from data and improve model performance.

UNIT – I INTRODUCTION 6L, 6P

Introduction to Data Science - Overview of Data - Sources of Data - Types of Data - data distribution - Small Data and Big Data - Data collection methods - Surveys - Interviews - Log and Diary data - User studies in Lab and Field - Web Scraping - Public datasets - Data cleaning - Tools for Data Science

PRACTICALS:

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.

UNIT – II DESCRIPTIVE DATA ANALYSIS 6L, 6P

Dataset Construction - Sampling of data - Stem and Leaf Plots - Frequency table - Time Series data - Central Tendency Measures of the location of data - Dispersion measures - Correlation analysis - Data reduction techniques – basics of Principal Component analysis (PCA) - Independent component analysis – Hypothesis testing – Statistical Tests

PRACTICALS:

1. Reading data from text files, Excel and the web
2. Exploring various commands for doing descriptive analytics on the Iris data set.

UNIT – III MODEL CONSTRUCTION 6L, 6P

Overview of Machine learning concepts – Rules for data splitting - Model construction using regression and Classification models - Linear regression and multiple regression models - KNN classification models - Comparison models - Training Data construction - Regression line – least squares regression line – standard error of estimate – interpretation of r^2 – multiple regression equations – regression toward the mean

PRACTICALS:

1. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:

a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
a. Bivariate analysis: Linear and logistic regression modeling
b. Multiple Regression analysis
c. Also compare the results of the above analysis for the two data sets.

2. Apply and explore various plotting functions on UCI data sets.
   a. Normal curves
   b. Density and contour plots
   c. Correlation and scatter plots
   d. Histograms
   e. Three-dimensional plotting

UNIT – IV DATA HANDLING AND MODEL EVALUATION 6L, 6P

Data aggregation – Data Transformation: merging datasets, reshaping data – Data enrichment: missing values - Normalization - Cross-validation techniques - Accuracy metrics for evaluation of models – Contingency table, ROC curve, Precision-recall curves - A/B testing

PRACTICALS:

1. Given a dataset with missing values and multiple features, perform data normalization and data transformation.
2. Also, apply cross-validation to evaluate the performance of a predictive model, and use accuracy metrics such as ROC curves and precision-recall curves to assess the model's effectiveness.

UNIT – V DATA ANALYTICS 6L, 6P

Introduction- Information-based learning- Handling alternative feature selection - Impurity metrics -Continuous descriptive features and targets- Similarity-based learning- Feature space- Predicting continuous targets-Error based learning- Measuring Error-Error surfaces.

PRACTICALS:

1. Using a dataset with continuous and categorical features, apply feature selection techniques to identify the most relevant features for predicting a continuous target.
2. Implement a similarity-based learning method and evaluate the model's performance by measuring errors and analyzing error surfaces to refine the model's accuracy.

TOTAL: 30L + 30P = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Apply the skills of data inspecting and cleansing.
2. Determine the relationship between data dependencies using statistics
3. Can handle data using primary tools used for data science in Python
4. Represent the useful information using mathematical skills
5. Can apply the knowledge for data describing and visualization using tools.

REFERENCES:

1. Chirag Shah, “A Hands-on Introduction to Data Science”, Cambridge University Press, UK, 2020.
2. Grus, Joel, “Data science from scratch: first principles with python”, O'Reilly Media, 2019.
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.
4. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
5. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
6. Peter Bruce, Andrew Bruce, Peter Gedeck,” Practical Statistics for Data Scientists”, O′Reilly; 2nd edition, 2020.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	3	2	1	1	2	1	2	3	2	3	2
2	3	2	3	2	3	2	1	1	2	1	2	3	2	2	3
3	3	2	3	2	3	2	1	1	2	2	2	3	2	2	1
4	3	2	3	2	3	2	1	1	2	2	2	3	3	3	2
5	3	2	3	2	3	2	1	1	2	2	2	3	3	3	2
Avg.	**3**	**2**	**3**	**2**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**2**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23U01 STANDARDS – ARTIFICIAL INTELLIGENCE

L	T	P	C
1	0	0	1

MODULE I – OVERVIEW OF STANDARDS **6hrs**

Basic concepts of standardization: Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II INTERNATIONAL STANDARDS IN ARTIFICIAL INTELLIGENCE **9hrs**

Introduction - Importance of standards in IT-Overview of key international standards organizations **ISO Standards** – ISO/IEC 23053:2022 Framework for AI systems using machine learning, ISO/IEC 42001:2023AI management systems, ISO/IEC 23894:2023AI – Guidance on risk management, **IEEE Standards** IEEE P3123™ – Standard for Artificial Intelligence and Machine Learning (AI/ML) Terminology and Data Formats, IEEE P7015™ – Standard for Data and Artificial Intelligence (AI) Literacy, Skills, and Readiness, IEEE P3198™ – Standard for Evaluation Method of Machine Learning Fairness, IEEE P1948.1™ – Standard for Artificial Intelligence Based Network Applications in 5G and Beyond Mobile Networks, IEEE 2801™-2022 – IEEE Recommended Practice for the Quality Management of Datasets for Medical Artificial Intelligence, IEEE 2941™-2021 – IEEE Standard for Artificial Intelligence (AI) Model Representation, Compression, Distribution, and Management, IEEE 2941.2™-2023 – IEEE Standard for Application Programming Interfaces (APIs) for Deep Learning (DL) Inference Engines, IEEE P2975.2™ – Standard for Model Verification & Validation of Industrial Artificial Intelligence Systems, IEEE P2976™ – Standard for XAI – eXplainable Artificial Intelligence – for Achieving Clarity and Interoperability of AI Systems Design, IEEE P3127™ – Guide for an Architectural Framework for Blockchain-based Federated Machine Learning, IEEE 3129™-2023 – IEEE Standard for Robustness Testing and Evaluation of Artificial Intelligence (AI)-based Image Recognition Service, IEEE 3333.1.3™-2022 – IEEE Standard for the Deep Learning-Based Assessment of Visual Experience Based on Human Factors, IEEE P3157™ – Recommended Practice for Vulnerability Test for Machine Learning Models for Computer Vision Applications, IEEE 3168™-2024 – IEEE Standard for Robustness Evaluation Test Methods for a Natural Language Processing Service That Uses Machine Learning, IEEE P3419™ – Standard for Large Language Model Evaluation, IEEE 7010™-2020 – IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being, IEEE P7018™ – Standard for Security and Trustworthiness Requirements in Generative Pretrained Artificial Intelligence (AI) Models,IEEE P7100™ – Standard for Measurement of Environmental Impacts of Artificial Intelligence Systems, **ACM Standards and Guidelines** -ACM Code of Ethics and Professional Conduct-ACM Computing Classification System (CCS) and its role in standardization

TOTAL : 15 PERIODS

REFERENCES:

1. Manual for Standards Formulation 2022, Bureau of Indian Standards
2. Kunas, Michael, “Implementing service quality based on ISO/IEC 20000: A management guide” IT Governance publishing, 2012.
3. Sid Ahmed Benraouane, AI Management System Certification According to the ISO/IEC 42001 Standard: How to Audit, Certify, and Build Responsible AI Systems, Productivity Press; 1st edition, June 2024.
4. ISO/IEC 42001:2023 Information technology — Artificial intelligence — Management system, Edition 1, 2023.
5. ISO/IEC 23894:2023 Information technology — Artificial intelligence — Guidance on risk management, Edition 1, 2023.
6. ISO/IEC 23053:2022 Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML), Edition 1, 2022.

7. IEEE portfolio of AIS technology and impact standards and standards projects [https://standards.ieee.org/initiatives/autonomous-intelligence-systems/standards/]
8. Kan, S. H. “Standards for Information Technology and Systems”, Prentice Hall, 2017.
9. Association for Computing Machinery. “ACM Code of Ethics and Professional Conduct: A Guide” ACM, 2018.

UC23U01 **UNIVERSAL HUMAN VALUES** **L T P C**
1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

MODULE I: INTRODUCTION (3L,6P)

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

MODULE II: HARMONY IN THE HUMAN BEING (3L,6P)

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, 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 Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

MODULE III: HARMONY IN THE FAMILY AND SOCIETY (3L,6P)

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc.*

Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

MODULE IV: HARMONY IN THE NATURE AND EXISTENCE (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

MODULE V: IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).

5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

MA23C03	LINEAR ALGEBRA AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand Vector spaces and its basis and dimension.
- To understand the linear maps between vector spaces and their matrix representations.
- To understand the diagonalizatition of a real symmetric matrix.
- To understand Inner product spaces and its projections.
- To understand numerical techniques for solving linear systems, eigenvalue problems and generalized inverses.

UNIT I VECTORSPACES 9+3

Vector Spaces – Subspaces – Linear Combinations - Linear Span – Linear Dependence - Linear Independence – Bases and Dimensions.

UNIT II LINEAR TRANSFORMATIONS 9+3

Linear Transformation – Null Space, Range Space - Dimension Theorem - Matrix representation of Linear Transformation – Eigenvalues and Eigenvectors of Linear Transformation – Diagonalization of Linear Transformation – Application of Diagonalization in Linear System of Differential Equations.

UNIT III INNER PRODUCT SPACES 9+3

Inner Products and Norms - Inner Product Spaces - Orthogonal Vectors – Gram Schmidt Orthogonalization Process – Orthogonal Complement – Least Square Approximations.

UNIT IV NUMERICAL SOLUTION OF LINEAR SYSTEM OF EQUATIONS 9+3

Solution of Linear System of Equations – Direct Methods: Gauss Elimination Method – Pivoting, Gauss Jordan Method, LU Decomposition Method and Cholesky Decomposition Method - Iterative Methods: Gauss-Jacobi Method, Gauss-Seidel Method and SOR Method.

UNIT V NUMERICAL SOLUTION OF EIGENVALUE PROBLEMS AND GENERALISED INVERSES 9+3

Eigen Value Problems: Power Method – Inverse Power Method – Jacobi's Rotation Method - QR Decomposition - Singular Value Decomposition Method.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Linear independence/dependence of vectors
2. Computation of eigenvalues and eigenvectors
3. Diagonalization of Linear Transformation
4. Gram Schmidt Orthogonalization Process
5. Solution of algebraic and transcendental equations
6. Matrix Decomposition methods (LU / Cholesky Decomposition)
7. Iterative methods of Gauss-Jacobi and Gauss-Seidel

8. Matrix Inversion by Gauss-Jordan method
9. Eigen values of a matrix by Power method and by Jacobi's method
10. QR decomposition method
11. Singular Value Decomposition Method

OUTCOMES:

CO1: Solve system of linear equations using matrix operations and vector spaces using Algebraic methods.
CO2: Understand the linear maps between vector spaces and its utilities.
CO3: Apply the concept of inner product of spaces in solving problems.
CO4: Understand the common numerical methods and how they are used to obtain approximate solutions
CO5: Analyse and evaluate the accuracy of common numerical methods.

TEXT BOOKS:

1. Faires, J.D. and Burden, R., "Numerical Methods", Brooks/Cole (Thomson Publications), Fourth Edition, New Delhi, 2012.
2. Friedberg, S.H., Insel, A.J. and Spence, E., "Linear Algebra", Pearson Education, Fifth Edition, New Delhi, 2018.
3. Williams, G, "Linear Algebra with Applications", Jones & Bartlett Learning, First Indian Edition, New Delhi, 2019.

REFERENCES:

1. Bernard Kolman, David R. Hill, "Introductory Linear Algebra", Pearson Education, First Reprint, New Delhi, 2010.
2. Gerald, C.F, and Wheatley, P.O., "Applied Numerical Analysis", Pearson Education, Seventh Edition, New Delhi, 2004.
3. Kumaresan, S., "Linear Algebra – A geometric approach", Prentice – Hall of India, Reprint, New Delhi, 2010.
4. Richard Branson, "Matrix Operations", Schaum's outline series, Mc Graw Hill, New York, 1989.
5. Strang, G., "Linear Algebra and its applications", Cengage Learning, New Delhi, 2005.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

IT23C02 **OPERATING SYSTEMS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To learn the basic concepts and functions of operating systems (OS).
- To learn the mechanisms of OS to handle processes and threads and their communication.
- To study the basic components of scheduling mechanism.
- To learn memory management strategies in contemporary OS.
- To learn the emerging trends in operating systems

UNIT I INTRODUCTION TO OPERATING SYSTEMS AND PROCESSES 9L, 6P

Introduction to OS – Operating System Operations – Operating System Services – User and Operating System Interface – System Calls – Operating System Structures – Process Concept – Process Scheduling – Context Switch – Operations on Processes – Inter-process Communication – IPC in Shared Memory Systems – IPC in Message Passing Systems – Examples of IPC Systems.

PRACTICALS:

- Basic Unix file system commands such as ls, cd, mkdir, rmdir, cp, rm, mv, more, lpr, man, grep, sed, etc.
- Shell script.
- Process control system calls - demonstration of fork, exec and wait

Suggested Activities:

- External learning - Introduction to xv6: download, build, boot (in virtual machine if needed).
- Implement a user program in xv6 to print “Hello World!!”.
- Study and use of system calls in xv6: getpid, fork, clone, exit, wait.
- Writing a user program to check and print the state of a process (current/all/specified) in xv6.

Suggested Evaluation Methods:

- Quiz on understanding of Linux and shell programming.
- Implementation evaluation of “Hello World!” user program.
- Quizzes on xv6 system calls.
- Assignments and implementation evaluation.

UNIT II PROCESS SYNCHRONIZATION AND SCHEDULING 9L, 6P

Multicore Programming – Multithreading Models – Thread Libraries – Threading Issues – The Critical-Section Problem – Peterson’s Solution – Hardware Support for Synchronization – Mutex Locks – Semaphores – Monitors – Liveness – Basic Concepts of CPU Scheduling– Scheduling Criteria – Scheduling Algorithms: FCFS, SJF, RR, Priority, Multilevel Queue, Multilevel Feedback Queue – Thread Scheduling –Real-Time CPU Scheduling.

PRACTICALS:

- Use of ps, ps lx, ps tree, ps –aux , top commands
- Use fork, exec, wait, exit system calls
- Thread management and Thread synchronization.
- Program to simulate preemptive and non-preemptive process scheduling algorithms.

Suggested Activities:

- Add a new system call with parameters in xv6 and invoke it in user program.
- Study of the scheduling algorithm in xv6 and making appropriate changes in the Round Robin scheduler in xv6 to print the process id and process name during scheduling.
- Assignments on thread and scheduling mechanisms.

Suggested Evaluation Methods:

- Quiz to check the understanding of the scheduling concepts in xv6.

UNIT III DEADLOCKS AND FILE SYSTEM 9L, 6P

Deadlocks – System model – Deadlock characterization – Methods for handling deadlocks – Deadlock Prevention –Deadlock Avoidance – Deadlock detection – Recovery from deadlock. File Concept – Access Methods – Directory Structure – Protection – Memory-Mapped Files – File-System Structure – File-System Operations – Directory Implementation – Allocation Methods – Free-Space Management – Recovery – File-System Internals – File-System Mounting – File Sharing – Virtual File Systems – Remote File Systems.

PRACTICALS:

- Deadlock prevention
- Program to simulate file allocation strategies.

Suggested Activities:

- Create a file in xv6 and perform read and write operations.

Suggested Evaluation Methods:

- Quiz on the understanding of the Deadlocks

UNIT IV MEMORY MANAGEMENT 9L, 6P

Contiguous Memory Allocation – Paging – Structure of the Page Table – Swapping – Demand Paging – Copy-on-Write – Page Replacement – Allocation of Frames – Thrashing – Memory Compression – Allocating Kernel Memory.

PRACTICALS:

- Interprocess communication using pipes.
- Interprocess communication using FIFOs.

Suggested Activities:

- Implementation and use of functions malloc() and free() in xv6.
- Implementation of at least one of the page replacement policies

Suggested Evaluation Methods:

- Quizzes on Memory Management

UNIT V STORAGE MANAGEMENT AND CASE STUDIES 9L, 6P

Mass-Storage Structure: Disk Structure - Disk Scheduling Algorithms – NVM Scheduling – Storage Device Management - Swap Space Management. I/O Systems: I/O Hardware – Application I/O Interface – Kernel I/O Subsystem – Transforming I/O Requests to Hardware Operations – STREAMS – I/O Performance – Case study: Linux Vs Windows: Design principles – Process management – Scheduling – Memory management – File systems and Introduction to Mobile Operating System: Android

PRACTICALS:

- Implementation of CPU scheduling policy in Linux/Windows
- Implementation of memory management policy in Linux/Windows

Suggested Activities:

- Use of system calls like create, open, read, write, close, readdir, scandir
- Flipped classroom on Storage management

Suggested Evaluation Methods:

- Quizzes on storage management systems

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understanding the main concepts, key ideas, strengths and limitations of operating systems

CO 2. Understanding process synchronization and Design of various process scheduling Algorithms.

CO 3. Understanding deadlock handling and various file management systems.

CO 4. Design and implement memory management schemes.

CO 5. Acquire a detailed understanding of various aspects of I/O, storage management and services with the recent OS.

TEXTBOOKS:

1. Silberschatz Abraham, Greg Gagne, Peter B. Galvin. “Operating System Concepts”, Tenth Edition, Wiley, 2018.
2. Andrew S. Tanenbaum, “Modern Operating Systems”, Fourth Edition, Pearson Education, 2016.
3. NPTEL course on “Operating System fundamental “https://archive.nptel.ac.in/courses/106/105/106105214/

REFERENCES:

1. D. M. Dhamdhere, “Operating Systems: A Concept–based Approach”, Third Edition. Tata McGraw–Hill, 2017.
2. William Stallings, “Operating Systems: Internals and Design Principles”, Ninth Edition, Pearson, 2019.
3. Harvey M Deitel, Paul J Deitel, David R Choffnes, "Operating Systems", 3rd Edition, Pearson Education, New Delhi, 2013.
4. https://pdos.csail.mit.edu/6.828/2014/xv6/book–rev8.pdf
5. The xv6 source code: git clone git://pdos.csail.mit.edu/xv6/xv6.git

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	-	-	-	2	2	2	3	3	3	3
CO2	3	3	3	3	2	-	-	-	2	2	2	3	3	3	3
CO3	3	3	3	3	2	-	-	-	2	2	2	3	3	3	3
CO4	3	3	3	3	2	-	-	-	2	2	2	3	3	3	3
CO5	3	3	3	3	2	-	-	-	2	2	2	3	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	2	2	**2**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C01	DESIGN AND ANALYSIS OF ALGORITHMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the process of problem solving.
- To be conversant with algorithms for common problems.
- To analyse the algorithms for time/space complexity.
- To learn to write algorithms for a given problem using different design paradigms.
- To understand computational complexity of problems

UNIT I FUNDAMENTALS 9

The Role of Algorithms in Computing – Designing Algorithms – Algorithmic Thinking – Fundamental stages of Problem-solving - Analyzing Algorithms – Iterative Algorithms - Step Count and Operation Count— measuring of Input size, Measuring Run time – Best, worst and average case complexity – Rate of growth - Recursive Algorithms: Formulation and solving recurrence equations – Guess and Verify method – Substitution method - Asymptotic analysis – asymptotic Notations – Asymptotic complexity classes.

Suggested Activities:

- Discussion on role of algorithms in computer science.
- External learning - Design of simple problems, sample problems in Hackerrank, like,diagonal difference in matrices, staircase construction.
- Computation of step count and operation count for merge sort and Quicksort.
- Design of induction proofs for algorithm verification for recursive algorithms.
- Practical - Implementation of time complexity in Python.

Suggested Evaluation Methods:

- Assignments on recursive algorithm analysis and Master Theorem.
- Quizzes on algorithm writing.

UNIT II DIVIDE AND CONQUER AND ITS VARIANTS 9

Introduction to Divide and Conquer - Merge Sort – Quicksort - Long Integer Multiplication – Divide and Conquer recurrences - Recursion Tree Method – Master Theorem –- Transform and Conquer Approach: Gaussian Elimination Method – LU and LUP Decomposition – Solving set of equations using LUP – Matrix Inverse and Determinant using LUP approach - Decrease and Conquer Paradigm - Binary Search and Insertion Sort.

Suggested Activities:

- External learning - Divide and conquer based algorithms, Hackerrank divide and conquer algorithms.
- External learning - Dynamic programming based algorithms like coin change.
- Computation of step count and operation count.
- Design of Induction Proofs for algorithm verification.
- Practical - Implementation of Merge sort and Longest Common Sequence like Spell
- Checker, Hackerrank problems like coin change.

Suggested Evaluation Methods:

- Assignment on matrix chain multiplication and longest common sequence.
- Assignments on string edit and string basics.
- Quizzes on algorithm design.

UNIT III GREEDY ALGORITHMS AND DYNAMIC PROGRAMMING APPROACH 9

Greedy Strategy—Generic Greedy Algorithm—Activity Selection—Fractional Knapsack—Dynamic Programming—Elements of Dynamic Programming—Principle of Optimizity—Computing Binominal Coefficient—Matrix Chain Multiplication—Longest Common Subsequence—String Edit—Solving

Knapsack problem using dynamic programming approach.

Suggested Activities:

- Flipped classroom on algorithm design.
- External learning - Greedy approach based algorithms like set cover and vertex. cover – Hackerrank problems like Password cracker.
- Computation of step count and operation count of Huffman code.
- Design of greedy based proofs for set cover problems.
- Practical - Implementation of matrix inverse using Gaussian Elimination problem.

Suggested Evaluation Methods:

- Assignment on Huffman code and task scheduling.
- Assignments on LUP Decomposition and Matrix Inverse using matrix decomposition.
- Quizzes on greedy approach.

UNIT IV INCREMENTAL APPROACH, BACKTRACKING AND BRANCH & BOUND 9

Linear Programming: Formulation of LPPs – Iterative development – Applications of Linear Programming - Standard form – Simple solution using Graph techniques - Simplex Algorithm – Maximization and Minimization of problems - Duality - Backtracking: Basics of Backtracking- 8-queen - Sum of Subsets, Branch and Bound: Least cost with Branch and Bound - 0/1 Knapsack.

Suggested Activities:

- Flipped classroom on Linear Algebra, Linear Programming basics
- External learning - Problems like Diet Problem in Hackerrank.
- Formulation of Duality for simple Linear Programming problems like Diet Problem.
- Practical - Implementation of Simplex algorithm.

Suggested Evaluation Methods:

- Tutorials on linear programming.
- Assignments in duality and linear programming problem formulations.
- Quizzes on linear programming

UNIT V COMPUTATIONAL COMPLEXITY 9

Understanding of Computational Complexity – Solvability - Tractability - Decision Problems - Decidability - NP-Hard – NP-Completeness – Reducibility Satisfiability Problem and Cook's Theorem - NP-Completeness Proofs for problems like SAT - 3CNF - Clique – Overview of Randomized Algorithm – Randomized Quicksort – Overview of approximation algorithm – set cover.

Suggested Activities:

- Flipped classroom on computational complexity.
- External learning - NP complexity, Turing machines.
- Computation and derivation of exponential complexity for set cover and vertex cover problems.
- Design of approximation bounds for randomized quicksort.
- Practical - Implementation of approximation algorithm for set cover problem.

Suggested Evaluation Methods:

- Tutorials on NP-complete proofs such as SAT problem.
- Assignments on set cover and vertex cover approximation problems.
- Quizzes on computational complexity

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Analyze algorithms based on time and space complexity

CO 2. Design efficient Divide and conquer and its variants for solving problems.

CO 3. Apply greedy methods and dynamic programming strategies for solving real- world problems.

CO 4. Design and implement Linear programming, backtracking, and branch and bound techniques towards efficient problem-solving.

CO 5. Understand the computational theory and the methods to prove NP-complete problems.

TEXTBOOKS:

1. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, "Introduction to Algorithms" 4th Edition, The MIT Press Cambridge, Massachusetts London, England, 2022.
2. S.Sridhar, "Design and Analysis of Algorithms", Second Edition, Oxford University Press, 2024.
3. Antany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education, 2012.

REFERENCES:

1. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2010.
2. Robert Sedgewick, Kevin Wayne, "Algorithms", Fourth Edition, Pearson Education, 2011.
3. Donald E. Knuth, "Art of Computer Programming, Volume I - Fundamental Algorithms", Third Edition, Addison Wesley, 1997.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	1	-	-	-	-	-	-	3	3	3	3
CO2	3	2	3	2	1	-	-	-	-	-	-	3	3	3	3
CO3	3	3	2	2	1	-	-	-	-	-	-	3	3	3	3
CO4	3	2	3	2	1	-	-	-	-	-	-	3	3	3	3
CO5	3	3	2	2	1	-	-	-	-	-	-	3	3	3	3
CO6	**3**	**2.6**	**2.4**	2	**1**	**-**	**-**	**-**	**-**	**-**	**-**	3	**3**	**3**	**3**
AVG	3	3	2	2	1	-	-	-	-	-	-	3	3	3	3

1-low, 2-medium, 3-high, '-"- no correlation

AD23401 DATA EXPLORATION AND VISUALIZATION

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

1. Understand the core principles of exploratory data analysis (EDA)
2. Utilize various EDA tools and techniques to perform descriptive statistics, data transformation, and time series analysis.
3. Analyze univariate, bivariate, and multivariate data using appropriate statistical and visualization methods to understand relationships and patterns.
4. Implement 2D and 3D data visualization techniques
5. Design interactive visualizations for text and document data

UNIT – I THE FUNDAMENTALS OF EXPLORATORY DATA ANALYSIS 9L, 6P

Overview of EDA – Identifying Data quality – Missing values – Irregular Cardinality – Outliers – handling data Quality - Describing Data, Preparing Data Tables, Understanding Relationships - Identifying and Understanding Groups, Building Models from Data.

PRACTICALS:

1. Generate the data quality report in terms of identifying missing values, irregular cardinality and outliers for an insurance company.

UNIT – II EDA TOOLS AND DESCRIPTIVE STATISTICS 9L, 6P

Significance of EDA - Comparing EDA with classical and Bayesian analysis - Software tools for EDA - Visual Aids for EDA - EDA with Personal Email - Data Transformation - Descriptive Statistics - Grouping Datasets Correlation - Time Series Analysis.

PRACTICALS:

1. Descriptive feature identification for predicting a target feature by visualizing relationships.
2. Data preparation for Exploration using normalization, binning and sampling methods.

UNIT – III UNIVARIATE, BIVARIATE, MULTIVARIATE DATA ANALYSIS 9L, 6P

Univariate Data Analysis - Bivariate Association - Regression Analysis - Cluster Analysis - Visualization Design Principles – Tables - Univariate Data Visualization - Bivariate Data Visualization - Multivariate Data Visualization - Visualizing Groups - Dynamic Techniques.

PRACTICALS:

1. Design and create data visualizations.

UNIT – IV DATA VISUALIZATION (2D / 3D) 9L, 6P

Simple Line Plots - Simple Scatter Plots - Visualizing Errors - Density and Contour Plots - Histograms, Binnings, and Density - Customizing Plot Legends - Customizing Colorbars - Multiple Subplots - Text and Annotation - Customizing Ticks - Customizing Stylesheets - Three-Dimensional Plots - Geographic Data with Basemap - Visualization with Seaborn.

PRACTICALS:

1. Conduct exploratory data analysis using visualization.
2. Craft visual presentations of data for effective communication.
3. Use knowledge of perception and cognition to evaluate visualization design alternatives.
4. Design and evaluate color palettes for visualization based on principles of perception.
5. Apply data transformations such as aggregation and filtering for visualization.

UNIT – V INTERACTIVE DATA VISUALIZATION 9L, 6P

Text and Document Visualization - Levels of Text Representations -Single Document Visualizations - Document Collection Visualizations- Interaction Concepts and Techniques - Designing Effective Visualizations - Comparing and Evaluating Visualization Techniques - Visualization Systems - Systems based on Data Type - Systems based on Analysis Type - Text Analysis and Visualization - Modern Integrated Visualization Systems

PRACTICALS:

1. Develop data exploration and visualization for an application - Mini Project

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the fundamentals of exploratory data analysis and its commonly used techniques.
2. Apply statistical concepts to analyze data and explore the tools used for EDA.
3. Perform multivariate data visualization and analysis.
4. Interpret results of exploratory data analysis using stylesheets
5. Implement visualization techniques in web for applications

REFERENCES:

1. Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”,Packt Publishing, 2020.
2. Thomas Cleff , “Exploratory Data Analysis in Business and Economics”, Springer International, 2013.
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly Media, 1st Edition, December 2016.
4. Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, 2nd Edition, CRC press, 2015.
5. Glenn J. Myatt, Wayne P. Johnson,” Making Sense Of Data I”, John Wiley & Sons, 2nd Edition, 2014.
6. Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019

7. Andy Kirk," Data Visualisation: A Handbook for Data Driven Design", Second Edition, Sage Publications Ltd, 2020.
8. Mike Kahn, "Data Exploration and Preparation with BigQuery: A practical guide to cleaning, transforming, and analyzing data for business insights", Kindle Edition, Packt Publishing; 1st edition, 2023.
9. Dursun Delen, "Predictive Analytics: Data Mining, Machine Learning and Data Science for Practitioners", Pearson Business Analytics Series, 2021.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	3	2	1	1	1	-	1	3	2	3	2
2	3	3	3	3	3	2	1	1	1	-	1	3	2	2	3
3	3	3	3	3	3	2	1	1	1	-	1	3	2	2	2
4	2	2	2	2	3	2	1	1	1	-	1	3	3	3	2
5	2	2	2	2	3	2	1	1	1	1	1	3	3	3	2
Avg.	2	2	2	2	3	**2**	**1**	**1**	**1**	1	**1**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high, '-"- no correlation

AD23402 **COMPUTER VISION**

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

1. Understand the fundamental concepts of digital image processing.
2. Apply depth estimation techniques and multi-camera views to solve 3D vision problems.
3. Implement feature extraction and segmentation methods.
4. Analyze motion through background subtraction, optical flow, and tracking algorithms.
5. Develop object recognition and scene analysis capabilities using models

UNIT – I DIGITAL IMAGE FUNDAMENTALS AND LOW-LEVEL PROCESSING **9L, 6P**

Basics of Image Formation, Colour Spaces - Transformation: Orthogonal, Euclidean, Affine, Projective, Fourier Transform - Linear Filtering - Image Enhancement – Restoration - Histogram Processing.

PRACTICALS:

1. Image: resizing, Normalization, cropping, augmentation, gray scale conversion and noise removal
2. Transformations: Orthogonal, Euclidean, Affine and histogram techniques for an input image

UNIT – II DEPTH ESTIMATION AND MULTI-CAMERA VIEWS **9L, 6P**

3-D Vision, Perspective - Binocular Stereopsis: Camera and Epipolar Geometry - Homography, Rectification - Direct Linear Transform, RANSAC - 3-D reconstruction framework - Auto-calibration.

PRACTICALS:

1. Using OpenCV simulate a stereo camera system. Capture synthetic stereo image pairs and apply algorithms for depth estimation and disparity map computation.

UNIT – III FEATURE EXTRACTION AND SEGMENTATION **9L, 6P**

Edges - Canny, LOG, DOG - Line detectors (Hough Transform) – Corners: Harris and Hessian Affine - Orientation Histogram, SIFT, SURF, HOG, GLOH - Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, Markov Random Fields - Texture Segmentation.

PRACTICALS:

1. Simple spatial filters like Low Pass Filters and High Pass Filters
2. Edge and corner detection for an image
3. Feature extraction algorithms

UNIT – IV MOTION ANALYSIS AND TRACKING **9L, 6P**

Background Subtraction and Modelling - Optical Flow – Lucas–Kanade method, KLT - Spatio-Temporal Analysis - Dynamic Stereo - Motion parameter estimation - Tracking considerations – Action recognition

PRACTICALS:

1. Display of Optical flow in a video
2. Estimation motion parameters in video
3. Extraction of key frames in video

UNIT – V OBJECT RECOGNITION AND SCENE ANALYSIS 9L, 6P

Object detection and recognition, Bag-of-Visual-Words model, Object classification, Face detection and recognition, Deep learning in scene analysis, Applications of computer vision.

PRACTICALS:

1. Object detection and classification in video
2. Face detection and recognition in image/video
3. Deep learning in scene analysis

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Describe the concepts related to Image formation and processing.
2. Compare the concepts related to feature detection, matching and detection.
3. Understanding feature based alignment and motion estimation.
4. Study of 3D Reconstruction.
5. Perform image based rendering and recognition.

REFERENCES:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Person Education, Second Edition, 2015.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, 4th Edition, Pearson, 2022.
4. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.
5. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision,
6. Second Edition, Cambridge University Press, March 2004.
7. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	3	2	1	2	2	2	1	3	2	1	1
2	3	3	2	2	3	2	1	2	2	2	1	3	2	3	1
3	3	2	2	2	3	2	1	2	2	2	1	3	2	3	1
4	3	2	2	2	3	2	1	2	2	2	1	3	1	3	2
5	3	3	3	2	3	2	1	2	2	2	1	3	2	3	3
Avg.	3	3	2	2	3	2	1	2	2	2	1	3	2	3	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23403 DISTRIBUTED SYSTEMS AND CLOUD COMPUTING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn about the concepts of distributed systems.
- To understand distributed resource management.
- To study the basics of cloud computing.
- To study about virtualization and cloud resource management.
- To be aware of different cloud platforms.

UNIT – I DISTRIBUTED SYSTEMS – COMMUNICATION 9L

Distributed systems, Design goals and Challenges, Distributed computing models, Issues in designing distributed systems, Inter-Process ommunication, Fundamental concepts – Message passing mechanism, Concepts of group communication, Remote Communication Remote Procedural Call (RPC), Remote Method Invocation (RMI)

UNIT – II SYNCHRONIZATION AND CONSISTENCY 9L

Clock synchronization: Introduction of clock synchronization, Global state, Mutual Exclusion Algorithms, Election algorithms Distributed Shared Memory: Fundamental concepts of DSM, types of DSM, Consistency models, issues in designing and implementing DSM systems, Fault Tolerance-Failure Models, consensus.

UNIT – III CLOUD COMPUTING AND INFRASTRUCTURE 9L

Introduction to Cloud Computing – Evolution of Cloud Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning – NIST Cloud Computing Reference Architecture– Architectural Design Challenges – Deployment Models: Public, Private and Hybrid Clouds – Service Models: IaaS – PaaS – SaaS – Benefits of Cloud Computing.

UNIT – IV CLOUD ENABLING TECHNOLOGIES 9L

Introduction to Web Service and Service Oriented Architecture – SOAP – REST – Basics of Virtualization – Full and Para Virtualization– Implementation Levels of Virtualization – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization.

UNIT – V CLOUD MANAGEMENT, STORAGE AND SECURITY 9L

Resource Provisioning and Methods – Cloud Management Products – Cloud Storage – Provisioning Cloud Storage – Managed and Unmanaged Cloud Storage – Case Studies: Openstack, Heroku, and Docker Containers –Amazon EC2, AWS, Microsoft Azure, Google Compute Engine

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the fundamental concepts of distributed and cloud computing, the fundamental principles and challenges of distributed systems and cloud computing.

2. Develop the ability to understand and implement distributed systems using appropriate communication models, synchronization and consistency techniques
3. Ability to understand consistency and replication protocols in distributed environments.
4. Implement Fault Tolerance Mechanisms:
5. Establish the architecture, and deployment models of cloud computing.
6. Navigate and utilize major cloud platforms such as AWS, Azure, and Google Cloud.

REFERENCES:

1. Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems: Principles and Paradigms", CreateSpace Independent Publisher, 2nd edition, 2016.
2. Coulouris George, Dollimore Jean, Kindberg Tim, Blair Gordon," Distributed Systems: Concepts & Design", Pearson Education, Fifth edition, 2017.
3. Unmesh joshi, Patterns of Distributed Systems, 1st edition, Addison-Wesley Professional, 2023.
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11. Rajiv Misra, Cloud and Distributed Computing: Algorithms and Systems, Wiley, 2020.
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13. Kumar Saurabh, Cloud Computing: Architecting Next-Gen Transformation Paradigms, 4th Edition, Wiley, 2017.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	1	1	2	2	2	1	2	2	1	1
2	3	3	2	2	2	2	1	2	2	2	1	2	1	1	1
3	2	2	2	2	2	1	1	2	2	2	1	2	1	1	1
4	2	2	2	2	3	1	1	2	2	2	1	2	2	3	1
5	2	2	2	2	3	1	1	2	2	2	1	2	2	3	1
6	3	3	3	2	3	2	1	2	2	2	1	2	3	2	2
Avg.	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**1**

1-low, 2-medium, 3-high, '-"- no correlation

AD23501	OPTIMIZATION TECHNIQUES	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- To equip the student with Single and Multivariable optimization methods
- To formulate and solve real life situations using Linear programming tools
- To learn methods to solve problems with limitations on the decision variables
- To solve problems when a range is prescribed for the decision variables aided with numerical methods
- To learn methods based on certain characteristics and behavior of biological, molecular, swarm of insects and neurobiological systems

UNIT – I CLASSICAL OPTIMIZATION TECHNIQUES 12L

Single-Variable Optimization – Multivariable Optimization with No Constraints – Multivariable Optimization with Equality Constraints – Multivariable Optimization with Inequality Constraints

UNIT – II LINEAR PROGRAMMING 12L

Introduction to Operations Research – assumptions of linear programming problems – Formulations of linear programming problem – Graphical method. Solutions to LPP using simplex algorithm – Two phase method – Big M method – Transportation and Assignment problems.

UNIT – III INTEGER PROGRAMMING 12L

Graphical Representation – Branch and Bound – Cutting Plane Method –All-Integer Programming Problems – Mixed-Integer Programming Problem

UNIT – IV NON-LINEAR MODELS 12L

Dichotomous Search – Fibonacci Method – Golden Section Method – Comparison of Elimination Methods – Powell's Method – Conjugate Gradient (Fletcher–Reeves) Method – Newton's Method

UNIT – V MODERN OPTIMIZATION ALGORITHMS 12L

Genetic Algorithms – Simulated Annealing – Particle Swarm Optimization – Ant Colony Optimization

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the fundamental concepts of Optimization Problems.
2. Apply linear models for optimization problems.
3. Understand and implement Integer programming models for optimization problems.
4. Apply non linear models for optimization problems.
5. Apply Bio-Inspired Algorithms for optimization problems.

REFERENCES:

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2018
2. S. S. Rao, Engineering Optimization Theory and Practice, New Age International (P), 5th Edition, 2019
3. David G.Luenberger, “Linear and Nonlinear Programming”, Springer Publications, 3rd Edition, 2008
4. Bertsekas, Dimitri P. Nonlinear Programming. 3rd Edition. Athena Scientific Press, 2016.

Mapping of CO with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3	-	-	-	-	-	3
CO2	3	3	2	3	3	3	-	-	-	-	-	3
CO3	3	3	2	3	3	3	-	-	-	-	-	3
CO4	3	3	2	3	3	3	-	-	-	-	-	3
CO5	3	3	2	3	3	3	-	-	-	-	-	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23502 **MACHINE LEARNING METHODS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

1. Understand the fundamental concepts of machine learning
2. Apply classification techniques and regularization methods
3. Implement ensemble learning strategies, clustering algorithms, and dimensionality reduction techniques
4. Utilize probabilistic learning models and graphical models
5. Develop and evaluate artificial neural networks, including perceptrons and multi-layer perceptrons, and explore reinforcement learning methods

UNIT – I **MACHINE LEARNING BASICS** **9L, 6P**

Introduction to Machine Learning (ML) - Essential concepts of ML – Types of Machine learning methods – Early trends in Machine learning – Data understanding, representation and visualization – Hypothesis - Modelling in Machine learning - Classification: Probability theory and Bayes rule – Generative vs. discriminative training – Self-supervised Learning and Transfer learning.

PRACTICALS:

1. Use a dataset (e.g., Iris or MNIST) to perform data understanding and visualization.
2. Explore data distributions, identify missing values, and create visualizations to represent data characteristics.

UNIT – II **CLASSIFICATION TECHNIQUES** **9L, 6P**

Regularization techniques - Decision Tree based Learning algorithms – Induction algorithms – Regression trees - Instance based Learning - Support Vector Machines: Hard and soft margin – Functional and Geometric margin - Maximum margin linear separators – Kernels for learning non-linear functions.

PRACTICALS:

1. Write a program to demonstrate the working of the decision tree based ID3 algorithm.
2. Write a program to handle overfitting.
3. Implement SVM algorithm for a given data set.

UNIT – III **ENSEMBLE, CLUSTERING AND DIMENSIONALITY REDUCTION** **9L, 6P**

Ensemble Learning: Using committees of multiple hypotheses. Bagging - Random Forest - Adaptive Boosting, Stacking and DECORATE - Active learning with ensembles – Clustering – K-means Clustering– Hierarchical Clustering - Expectation Maximization algorithm – Gaussian Mixture Model – Dimensionality Reduction – Principal Component Analysis (PCA) – Linear Discriminant Analysis (LDA) - Latent Variable Models (LVM) – Latent Dirichlet Allocation – Independent Component Analysis (ICA)

PRACTICALS:

1. Implement Bagging, boosting, and DECORATE algorithms with performance evaluation mechanisms.
2. Write a program to implement k-Nearest Neighbour algorithm.
3. Implement a k-means partitional clustering

UNIT – IV **PROBABILISTIC LEARNING MODEL** **9L, 6P**

Bayesian Learning - Naive Bayes Algorithm - Introduction to Graphs – Bayesian Belief Networks - Inference in Graphical Models - Markov Chain – Markov Model - Hidden Markov Models – Inference – Learning - Generalization – Undirected Graphical Models

PRACTICALS:

1. Implement Naive Bayes learning algorithm for a sample training data set.
2. Implement a linear regression method

UNIT – V **ANN & REINFORCEMENT LEARNING** **9L, 6P**

Artificial Neural Networks – Structure and Activation functions – Perceptron – Multi Layer Perceptron - Back Propagation – Gradient descent training - Radial Basis function Neural Network- Overview of Reinforcement Learning - Components of Reinforcement Learning - Markov decision process - Model Based Learning - Model Free Learning - Q Learning.

PRACTICALS:

1. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
2. Implement facial recognition application with artificial neural network
3. Choose best machine learning algorithm to implement online fraud detection
4. Implement sentiment analysis using random forest optimization algorithm.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the basics of machine learning.
2. Solve analytical problems with relevant mathematics background knowledge.
3. Explain testing and evaluation machine learning algorithms.
4. Understand ANN model apply knowledge in data analytics.
5. Explore the knowledge of unsupervised learning in data analysis.
6. Apply ML techniques to various real time applications.

REFERENCES:

1. Ameet V Joshi, “Machine Learning and Artificial Intelligence”, Springer Publications, 2020.
2. Sridhar S. and Vijayalakshmi M., “Machine Learning”, Oxford University Press, 2021.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Publications, 2011
4. John D. Kelleher, Brain Mac Namee, Aoife D’ Arcy, “Fundamentals of Machine learning for Predictive Data Analytics, Algorithms, Worked Examples and case studies”, MIT press, 2015
5. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997
6. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence: A Modern Approach, Prentice Hall, 2020
7. Machine Learning Dummies, John Paul Muller, Luca Massaron, Wiley Publications, 2021
8. Jerome Friedman, Robert Tibshirani, Trevor Hastie, “The Elements of Statistical Learning”, Springer, 2017.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	1	1	2	2	2	1	2	2	1	1
2	3	3	2	2	2	2	1	2	2	2	1	2	1	1	1
3	2	2	2	2	2	1	1	2	2	2	1	2	1	1	1
4	2	2	2	2	3	1	1	2	2	2	1	2	2	3	1
5	2	2	2	2	3	1	1	2	2	2	1	2	2	3	1
6	3	3	3	2	3	2	1	2	2	2	1	2	3	2	2
Avg.	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**1**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23503 ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

1. Understand the foundational concepts of artificial intelligence (AI), including its importance, evolution, and various applications
2. Implement adversarial search techniques to make optimal decisions in games and other stochastic environments.
3. Analyze knowledge representation and reasoning techniques to handle complex AI problems.
4. Apply planning algorithms and probabilistic reasoning methods.
5. Explore advanced AI applications and technologies

UNIT – I ARTIFICIAL INTELLIGENCE AND PROBLEM SOLVING 9L, 6P

Foundations of AI: Importance of AI, Evolution of AI, Applications of AI, Classification of AI systems with respect to environment – Intelligent Agents – Structure of Agents, Multi Agents and Collaboration systems - Heuristic search strategies – Constraint Satisfaction Problem: Backtracking and Local Search - Optimization problems.

PRACTICALS:

1. Study Experiment – AI tools: Working and Installation

UNIT – II ADVERSARIAL SEARCH AND GAMES 9L, 6P

Min-max Search, Heuristic Alpha-Bata Tree Search, Cutting of Search, Monte Carlo Tree Search - Optimal Decisions in Games: Alpha-Beta Pruning, Stochastic Games, Partially Observable Games - Card Game.

PRACTICALS:

1. Write a program to implement heuristic search procedure.
2. Design a program to implement depth limited search
3. Write a program to implement Bidirectional Search
4. Write a program to implement search problem of 3 x 3 puzzles.
5. Write a program to implement Hangman game.
6. Write a program to implement tic tac toe game for O and X.

UNIT – III KNOWLEDGE, REASONING, AND PLANNING 9L, 6P

Propositional Logic and Theorem - First- Order Logic: Knowledge Engineering, Effective Propositional Model Checking, Inference – Forward Chaining – Backward Chaining - Resolution - Knowledge Representation Techniques – Modal Logic – Temporal Logic - Reasoning Systems for Categories – Reasoning with default information

PRACTICALS:

1. Write a program to implement water jug problem.
2. Program to implement A* / AO* algorithm.

UNIT – IV AI PLANNING AND PROBABILISTIC REASONING 9L, 6P

Classical Planning – Algorithms – Heuristics – Hierarchical Planning - Planning in Nondeterministic domains - Types – Graph Plan and SAT plan – Partial Order Planning - Probabilistic Reasoning – Bayesian Networks

PRACTICALS:

1. Implementation of n-Queens problem.
2. Write a program to optimize Travelling Sales Person problem.
3. Write a program to implement Bayesian network for probabilistic reasoning.

UNIT – V ADVANCEMENTS AND APPLICATIONS IN AI 9L, 6P

HMM – language generation models – Applications of AI – Chatbot: types, architecture – Autonomous driving – AI assistants – Recommendation system – AI in security – Expert systems: medical, commerce, societal applications

PRACTICALS:

1. Design and implement a societal application.

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the mechanism of intelligent agents, environments and implement heuristic Search techniques
2. Develop and Apply Adversarial Search Techniques and Strategies for Complex Game Environments
3. Develop Proficiency in Logical Reasoning and Inference Techniques in AI Systems
4. Develop and Implement Knowledge Representation Techniques for Advanced Reasoning:
5. Master and Implement Advanced Planning and Probabilistic Reasoning Techniques in AI Systems
6. Design and Evaluate AI Applications in Various Domains.

REFERENCES:

1. Russell, S. and Norvig, P. 2020. Artificial Intelligence - A Modern Approach, 4th edition, Prentice Hall.
2. Efraim Turban and Jay E. 2002. Aronson Decision Support Systems and Intelligent Systems, 6th edition, Pearson Education
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5. Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem
6. Solving, 6th edition, Pearson.
7. Brachman, R. and Levesque, H. 2004. Knowledge Representation and Reasoning, Morgan Kaufmann.
8. Alpaydin, E. 2015. Introduction to Machine Learning. 3rd edition.
9. Sutton R.S. and Barto, A.G. 2018. Reinforcement Learning: An Introduction, 2nd Edition MIT Press.
10. Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford University Press.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	1	1	2	2	2	1	2	3	2	2
2	3	3	2	2	2	1	1	2	2	2	1	2	3	2	2
3	2	2	2	2	2	1	1	2	2	2	1	2	2	2	2
4	2	2	2	2	3	1	1	2	2	2	1	2	3	3	2
5	2	2	2	2	3	1	1	2	2	2	1	2	3	3	2
6	3	3	3	2	3	1	1	2	2	2	1	2	3	2	2
Avg.	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**2**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23504 **BIG DATA ANALYTICS**

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

1. Understand the fundamental concepts of Big Data.
2. Apply MapReduce algorithms to distributed file systems
3. Explore various Big Data technologies and understand workflow management
4. Implement streaming analytics techniques for processing and analyzing stream data
5. Analyze recommender systems and social network mining techniques

UNIT – I **INTRODUCTION TO BIG DATA** **9L, 6P**

Introduction to Big Data - Need for processing Big Data – Need for analytics- Characteristics of big data, Domain-specific examples of big data, Big Data Stack – Introduction to Hadoop - Setting up of Hadoop.

PRACTICALS:

1. Study : Installation and Setting up Hadoop

UNIT – II **MAPREDUCE AND NEW SOFTWARE STACK** **9L, 6P**

Distributed File System – MapReduce, algorithms using MapReduce - Extensions to MapReduce – Communication-cost model – Complexity Theory for MapReduce - Overview of Spark.

PRACTICALS:

1. Write a map reduce program to compute and measure the runtime and study its scaling behaviour for the following:
    1. Compute descriptive statistics such as mean, median, mode, standard deviation from a large dataset.
    2. Compute box-plots and histograms of all the numerical variables in a large multi-variate dataset.
    3. Compute correlation metrics between pairs of all the numerical variables in a large multi-variate dataset.
    4. Perform clustering of a large multi-variate dataset.
    5. Perform classification of a large multi-variate dataset into two or more classes.

UNIT – III **BIG-DATA TECHNOLOGY OVERVIEW** **9L, 6P**

Big Data Collection Systems – Apache Flume – Big data Storage – HDFS Systems – Pig and Hadoop – Grunt – Data Model – pig Latin – Hive Overview – Hive QL – Overview of HBase - Overview of Workflow – Workflow and Scheduling using Apache Oozie - Introduction to NoSQL Databases – Basics of MongoDB.

PRACTICALS:

1. Write a spark program to compute and measure the runtime and study its scaling behaviour for the following:

    Box-plots and histograms of all the numerical variables in a large dataset.

    Perform classification in a large dataset.

Perform regression in a large dataset.

UNIT – IV STREAMING ANALYTICS AND LINK ANALYSIS 9L, 6P

Introduction to Stream analytics – Stream data model – Sampling Data – filtering streams – Count distinct elements in a stream, Counting ones, Estimating moments – Decaying windows – Link Analysis – PageRank Computation – Market Basket model – Limited pass algorithms for Frequent Item sets.

PRACTICALS:

1. Write, run and debug Map reduce programs

   To analyse and build models from streaming data efficiently using systems like Apache Spark.

   To analyse and build models from non-streaming data efficiently using systems like Apache Spark.

UNIT – V RECOMMENDER SYSTEMS AND SOCIAL NETWORK MINING 9L, 6P

Advertising on the Web – Online Algorithms – Matching problem – Adwords problem and Implementation – recommendation systems – Collaborative filtering – Dimensionality reduction – Mining Social Network graphs – Clustering of social network graphs – Partitioning of graphs – Simrank – Counting Triangles – Neighborhoods properties of Graphs.

PRACTICALS:

1. Use graph dataset and perform the following:

   Perform basic analysis such as calculating node degree centrality, identifying important nodes using between-ness centrality.

   Find communities by using graph clustering

TOTAL: 45L + 30P = 75 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the basics of Big Data.
2. Know about Hadoop and MapReduce.
3. Know about Big Data Technology, Tools, and Algorithms.
4. Analyze the stream data and Link analysis.
5. Know about the role of big data in Recommender systems and social network analysis.

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Third Edition, Cambridge University Press, New Delhi.
2. Arshdeep Bagha and Vijay Madisetti, “Big Data Science & Analytics - A Hands-on Approach”, New Delhi, 2016.
3. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
4. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2014.

Mapping of CO with PO

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO2	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO3	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO4	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO5	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
AVG	3	3	3	3	3	1	1	1	2	1	2	1	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1 Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition

2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.

3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.

4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business

5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch

6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

AD23505	SOCIETAL ORIENTED PROJECT	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Identify and analyze societal problems to design IT-based solutions that align with the needs of various sectors.
2. Conduct a comprehensive feasibility study and requirement analysis to ensure the viability and effectiveness of the proposed IT solutions.
3. Develop architectural and detailed designs for IT solutions to address identified problems.
4. Implement and code solutions using appropriate programming languages, platforms, and tools to ensure functional and technical efficiency.

. Perform testing and validation of IT solutions, including component, system, and acceptance testing, to ensure quality and reliability before deployment.

Students are expected to take up problems that would directly benefit society and design and implement an IT based solution for the problem, based on the courses undertaken up to that semester. The domains of the problems may reach out to sectors like but not limited to Energy, Education, Material, Environment, Telecommunications, Defense, Healthcare, Banking, Entertainment and Agriculture. The societal value of the project is to be evaluated based on the need of the hour and request from stakeholders. The evaluation of the project would be based on the usefulness of the problem statement, formulation of the problem, stakeholders need, and the usage statistics of the solution and the technical merit of the solution.

REQUIREMENTS ENGINEERING PHASE:

- Problem identification.
- Feasibility study of domain.
- Requirement elicitation and analysis

DESIGN PHASE:

- Architectural design.
- UI design.
- Component Design.
- Database design.

IMPLEMENTATION PHASE:

- Coding in a suitable language using necessary platforms and tools.

TESTING AND VALIDATION PHASE:

- Component Testing
- System Testing
- Acceptance Testing

DOCUMENTATION:

- Report Generation

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Analyze social problems and provide IT based technical solutions in order to benefit society.
2. Design, develop and implement solutions for social problems.
3. Develop innovative technical solutions of social relevance.
4. Design, develop and implement standard solutions to social problems.
5. Apply Software engineering methodologies.
6. Evaluate the solution based on usefulness, effectiveness, and user satisfaction..

REFERENCES:

1. https://www.niti.gov.in/.
2. https://www.sih.gov.in/

Mapping of CO with PO

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	-	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	1	-	3	3	3	3	3	3	3	3	3	3
CO3	3	1	3	2	3	3	3	3	3	3	3	3	3	3	3
CO4	3	-	3	1	3	3	3	3	3	3	3	3	3	3	3
CO5	3	-	1	1	3	3	3	3	3	3	3	3	3	3	3
CO6	3	-	2	1	3	3	3	3	3	3	3	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23601 **DEEP LEARNING TECHNIQUES**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Understand and apply fundamental concepts of neural networks.
2. Implement and evaluate deep neural network architectures, focusing on optimization techniques.
3. Design and utilize Convolutional Neural Networks (CNNs) for image classification and transfer learning.
4. Develop and deploy Recurrent Neural Networks (RNNs) and their variants for sequence modeling tasks.
5. Explore and implement advanced generative models for data generation and feature learning

UNIT – I **BASICS OF NEURAL NETWORK** **6L, 6P**

Artificial Neuron - McCulloch Pitts units and Thresholding logic - Perceptron learning algorithm and Convergence - Linear separability - Feedforward Networks - Activation and Loss Functions.

PRACTICALS:

1. Write a program to generate following logic functions using McCulloch-Pitts neuron and appropriate values for weights, bias and threshold.

a. AND logic function

b. OR logic function

c. NOT logic function

d. NOR logic function

e. XOR logic function

UNIT – II **INTRODUCTION OF DEEP NEURAL NETWORKS** **6L, 6P**

Multilayer perceptron - Gradient Descent(GD) – Backpropagation - Vanishing and Exploding GD problem – Optimization Methods: Stochastic GD: Momentum based GD & Nesterov Accelerated GD, AdaGrad, RMSProp, Adam – Bias Variance tradeoff - Regularization – Dropout.

PRACTICALS:

1. Write a program to build a logistic regression classifier with a Neural Network mindset. Consider following guidelines.
   a. Consider any convenient dataset (Cats dataset etc.) and pre-process the dataset.
   b. Define the appropriate model structure.
   c. Evaluate the model performance.
   d. Analyse the obtained results
2. Design a neural network (NN) model with one hidden layer for classification problems. Use Planar data set or any other suitable data set
   a. Implement a 2-class classification neural network with a single hidden layer.
   b. Use units with a non-linear activation function, such as tanh.
   c. Compute the cross-entropy loss.
   d. Implement forward and backward propagation.
   e. Evaluate the model performance.

f. Analyse the results

UNIT – III CONVOLUTIONAL NEURAL NETWORKS 6L, 6P

Motivation – Architectural Overview –Pooling – Parameter sharing - Regularization - Popular CNN Architectures: ResNet, AlexNet, VGGNet - Transfer learning –Image classification using Transfer learning.

PRACTICALS:

1. Build a Multiclass classifier using the CNN model. Use MNIST or any other suitable dataset. Perform Exploratory Data Analysis
    a. Prepare dataset
    b. Build MLP model
    c. Evaluate Model performance
    d. Predict for test data
2. Implement the Face recognition using CNN
3. Implement a transfer learning concept for image classification

UNIT – IV RECURRENT NEURAL NETWORKS 6L, 6P

Sequence Modelling –Recurrent Neural Networks, Bidirectional RNNs – Encoder-decoder sequence to sequence architectures - Deep Recurrent Networks, Recursive Neural Networks - Long Short-Term Memory Networks – Other Gated RNNs

PRACTICALS:

1. Implement an auto encoder for image denoising
2. Implement a dialogue generation using LSTM with attention mechanism
3. Implement an opinion mining in RNN

UNIT – V AUTOENCODERS AND GENERATIVE MODELS 6L, 6P

Autoencoders – Regularized Autoencoders – stochastic Encoders and Decoders – Contractive Encoders - Deep Belief networks – Boltzmann Machines – Deep Boltzmann Machine – Directed Generative Nets - Generative Adversarial Networks

PRACTICALS:

1. Machine Translation using Encoder-Decoder model.
2. Image augmentation using GANs
3. Mini project: Real world problems

TOTAL: 30L + 30P = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand fundamental neural network concepts, including activation functions and loss functions.
2. Familiarize with different optimizers in machine learning and choose the appropriate one.
3. Design and implement deep learning architectures, such as CNNs, RNNs, autoencoders and Generative models.
4. Implement deep learning models using libraries like TensorFlow or PyTorch.
5. Apply deep learning techniques to real-world problems, with awareness of ethical considerations.

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", MIT Press, 2017.
2. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
3. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
4. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
5. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
6. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
7. Francois Chollet, "Deep Learning with Python", Manning Publications, 2018.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	1	-	-	-	-	1	1	2	3	3	3
2	3	3	3	3	1	-	-	-	-	1	1	2	3	3	3
3	3	3	3	3	3	3	2	2	3	3	3	2	3	3	3
4	3	3	3	3	3	3	2	2	3	3	3	2	3	3	3
5	3	3	3	3	3	3	2	2	3	3	3	2	3	3	3
AVg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	3	3	3

1-low, 2-medium, 3-high, '-"- no correlation

AD23602	NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand key NLP concepts and challenges, including text preprocessing and language models.
2. Apply syntax and semantic analysis techniques, such as part-of-speech tagging and named entity recognition.
3. Implement text classification and sentiment analysis methods using traditional and deep learning approaches.
4. Apply sequence models and transformers for tasks such as machine translation and sequence prediction.
5. Evaluate ethical considerations, bias, and objectivity in NLP applications and explore advanced topics like transfer learning.

UNIT – I INTRODUCTION TO NATURAL LANGUAGE PROCESSING 9L

Overview of NLP: Definition and history, Applications of NLP, Challenges in NLP - Basic Text Processing: Text pre-processing (tokenization, stemming, lemmatization), Regular expressions, NLTK library introduction - Language Models: Definition and types (unigram, bigram, trigram), Smoothing techniques, Evaluation of language models (perplexity).

UNIT – II SYNTAX AND SEMANTICS 9L

Syntax and Part-of-Speech Tagging: Grammar and syntax in language, POS tagging techniques (rule-based, stochastic, neural) - Parsing Techniques: Constituency and dependency parsing, Parsing algorithms (CKY, Earley's algorithm) - Semantic Analysis: Lexical semantics, Word sense disambiguation, Named entity recognition (NER), Word Embeddings, Distributional semantics, Word2Vec, GloVe, FastText.

UNIT – III TEXT CLASSIFICATION AND SENTIMENT ANALYSIS 9L

Text Classification: Traditional methods (Naive Bayes, SVM), Deep learning methods (CNN, RNN) - Sentiment Analysis: Techniques for sentiment analysis, Applications in social media, product reviews - Introduction to Dialogue Systems: Components of a dialogue system, Rule-based vs. data-driven approaches, Chatbot Development: Architecture of chatbots Tools and platforms.

UNIT – IV SEQUENCE MODELING AND MACHINE TRANSLATION 9L

Sequence Models: Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU) - Attention Mechanisms and Transformers: Introduction to attention, Transformer architecture (BERT, GPT) - Machine Translation: Statistical machine translation, Neural machine translation.

UNIT – V ETHICS, BIAS, FAIRNESS, AND ADVANCE TOPICS IN NLP 9L

Ethical Considerations in NLP: Privacy and security, Ethical dilemmas in language technology - Bias in NLP: Sources of bias in language models, Techniques to mitigate bias - Fairness in NLP: Ensuring fairness in NLP applications, Case studies and real-world applications - Advanced NLP Topics: Transfer learning in NLP, Zero-shot and few-shot learning - Future Directions in NLP.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the basics of NLP and Text models.
2. Apply Syntax, Semantic and Parsing Techniques in NLP.
3. Understand and implement the methods involved in text classification and Semantic Analysis.
4. Design Sequence model and perform machine translation.
5. Understand the ethics and ensure fairness in NLP applications

REFERENCES:

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", Pearson Education, 2nd edition, 2014. Third Edition 2024. Available online: https://web.stanford.edu/~jurafsky/slp3/
2. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python", O'Reilly Media, Inc, 2009. Also available online https://www.nltk.org/book/
3. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", SpringerLink 2017.
4. Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
5. Palash Goyal, Sumit Pandey, and Karan Jain, "Deep Learning for Natural Language Processing", Apress, 2018, Springer Link 2018.
6. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer (India) Private Limited, 2016

Mapping of CO with PO

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

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23U02 PERSPECTIVES OF SUSTAINABLE DEVELOPMENT – ARTIFICIAL INTELLIGENCE

L	T	P	C
2	0	2	3

UNIT I – INTRODUCTION **6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

UNIT II – ENVIRONMENTAL SUSTAINABILITY **6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

UNIT III – SOCIAL & ECONOMIC SUSTAINABILITY **9**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

UNIT IV – SUSTAINABILITY IN AI **9**

Sustainability in the Age of AI: Exploring Challenges and Innovative Solutions -Role of AI in Assessing and Achieving the Sustainable Development Goals(SDGs) - Data analysis for sustainability -Green AI and Environmental Impact - AI in circular economy-Policy and Regulation for Sustainable AI - Edge AI in cloud computing for Sustainable Development - IoT and AI Techniques for Long term sustainability - AI for sustainable applications

UNIT V – SUSTAINABILITY PRACTICES **30**

Suggested Practices not limited to

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours).
- Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans.
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED)
- Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA)
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator
- National/Sub national Status of Sustainable Development Goals.
- Develop water resource management in soil and soilless irrigation systems using AI techniques
- Develop a campus sustainability plan and prototype, integrating sustainable AI practices and energy-efficient solutions.

- Develop AI-driven solutions for efficient waste management, demonstrating the role of AI in circular economy.
- Develop an AI-driven solution for Sustainability in the Public sector: The Smart City Initiative.
- Develop an integrated AI green power monitoring system that empowers small and medium enterprises.
- Case study on Adoption of Sustainable Digital Technologies in Industry 4.0

TOTAL: 60 PERIODS

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Niklas Sundberg, (2022), Sustainable IT Playbook for Technology Leaders: Design and implement sustainable IT practices and unlock sustainable business opportunities.
8. Henrik Skaug Sætra, AI for the Sustainable Development Goals, 1st edition, CRC Press, 2022.
9. Vishal Jain, Murali Raman, Akshat Agrawal, Meenu Hans, Swati Gupta, Convergence Strategies for Green Computing and Sustainable Development, IGI Global, 2024.
10. B. Vinoth Kumar, K. Umamaheswari, S. K. Somasundaram, Artificial Intelligence for Sustainable Applications, Wiley, 1st edition, 2023.

AD23E01	AI in IoT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand IoT fundamentals and their integration with AI
2. Apply machine learning techniques to IoT data, focusing on classification, feature scaling, and model optimization.
3. Utilize genetic algorithms and reinforcement learning to solve IoT problems and optimize models.
4. Implement generative models and explore their applications in IoT scenarios.
5. Analyze and apply AI techniques for industrial IoT and smart city applications

UNIT – I PRINCIPLES AND FOUNDATIONS OF IOT AND AI 9L

loT reference model, loT platforms, loT verticals, Big data and lot, Infusion of AI- data science in IoT, Cross-industry standard process for data mining AI platforms and loT platforms and Tools, TensorFlow, Keras, Datasets, The combined cycle power plant dataset Wine quality dataset, Air quality data.

UNIT – II ML FOR IoT 9L

Cross-entropy loss function, Classifying wine using logistic regressor Classification using support vector machines, Maximum margin hyperplane, Kernel trick, Classifying wine using SVM, Naive Bayes, Gaussian Naive Bayes for wine quality, Decision trees, Decision trees in scikit, Decision trees in action, Ensemble learning Voting classifier, Bagging and pasting, Improving your model - tips and tricks Feature scaling to resolve uneven data scale, Overfitting, Regularization, Cross-validation, No Free Lunch theorem, Hyperparameter tuning and grid search.

UNIT – III GENETIC ALGORITHMS AND REINFORCEMENT LEARNING FOR IoT 9L

Deterministic and analytic methods - Gradient descent method Newton-Raphson method - Natural optimization methods Simulated annealing- Coding genetic algorithms using Distributed Evolutionary Algorithms in Python- Genetic algorithm for CNN architecture-Genetic algorithm for LSTM optimization- Deep reinforcement learning-Q learning-Q Networks.

UNIT – IV GENERATIVE MODELS FOR IOT and HOME IoT 9L

GANS - Implementing a vanilla GAN in TensorFlow Deep Convolutional GANS- Applications of GANS-Distributed AI- Apache MLlib-Regression in MLlib- Personal loT- Classification in MLlib-Continuous glucose monitoring- Hypoglycemia prediction using CGM data- Heart monitor- Digital assistants- Human activity recognition- HAR using wearable sensors- Smart home automation.

UNIT – V AI FOR INDUSTRIAL IoT AND SMART CITIES 9L

Predictive maintenance using AI- Predictive maintenance using Long Short-Term Memory-Predictive maintenance advantages and disadvantages-Electrical load forecasting in industry-STLF using LSTM- Components of a smart city-Smart traffic management-Smart parking- Smart waste management-Smart policing-Smart lighting-Smart governance-Cities with open data-Adapting lot for smart cities and the necessary steps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the basics of NLP and Text models.
2. Apply Syntax, Semantic and Parsing Techniques in NLP.
3. Understand and implement the methods involved in text classification and Semantic Analysis.
4. Design Sequence model and perform machine translation.
5. Understand the ethics and ensure fairness in NLP applications

REFERENCES:

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Mapping of CO with PO

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

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23701 **MACHINE LEARNING OPERATIONS**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Understand the principles, components, and benefits of MLOps
2. Explain SQL and NoSQL databases, and perform CRUD operations.
3. Develop and preprocess data for supervised, unsupervised, and reinforcement learning algorithms.
4. Apply Docker for isolation and MLflow for tracking and managing machine learning experiments.
5. Deploy and manage machine learning models using cloud services.

UNIT – I **INTRODUCTION TO MLOPs** **6L, 6P**

MLOps Introduction-The need of MLOps-Benefits-Components-Different Roles of MLOps-Machine Learning Life Cycle (MLLC)-open source MLOps Tools for MLLC- MLOps Vs DevOps; Types of ML Software -Data: Data Engineering pipelines, Model: Machine Learning Pipelines-Code: Deployment Pipelines.

PRACTICALS:

1. Study and use about MLOps Tools and ML Software.

UNIT – II **DATABASE FOR MLOPs** **6L, 6P**

SQL vs NoSQL-Differences-Pros and cons; Working with MySQL Database using Python-CRUD-Examples-Introduction to MongoDB- MongoDB using Python-CRUD-Examples.

PRACTICALS:

1. Connect and working with SQL Database: SQLite / MySQL
2. Connect and working with NoSQL Database: MongoDB
3. Implement database CRUD operations using SQLite / MySQL / MongoDB

UNIT – III **MACHINE LEARNING MODELS** **6L, 6P**

Introduction to Machine Learning-Data Preprocessing-Types -Supervised Learning – Algorithms; Unsupervised Learning-Algorithms; Reinforcement Learning-Algorithms; Python Libraries for Machine Learning – Scikit Learn, TensorFlow, Keras, PyTorch, Pandas-Matplotlib-Examples.

PRACTICALS:

1. Implementation of Supervised Learning Algorithm using Scikit-learn / TensorFlow / Keras /PyTorch
2. Implementation of Unsupervised Learning Algorithm using Scikit-learn / TensorFlow /PyTorch
3. Implementation of Data Manipulation Tasks using Pandas library.
4. Implementation of Data Visualization Tasks using Matplotlib libraries

UNIT – IV **TRACKING ML PROJECTS** **6L, 6P**

Docker Introduction – Pros and Cons –Features – Architecture – Installing Docker on Windows / Linux - Docker Image, Containers – Dockerfile – Deploying Simple Java / Python Application on Windows / Linux; Introduction to MLflow – Components – Key Concepts in MLflow – Installing MLflow – Tracking ML Experiments using MLflow.

PRACTICALS:

1. Deployment of Simple Java Application using Docker on Windows / Linux

2. Deployment of Simple Python Application using Docker on Windows / Linux
3. Tracking Machine Learning Projects using MLflow

UNIT – V MLOPs IN CLOUD 6L, 6P

Introduction to Cloud – Services – DevOps for Machine Learning – Machine Learning Operations with Microsoft Azure Cloud (MLOps with Azure) / Amazon Web Services (MLOps with AWS) / Google Cloud Platform (MLOps with GCP); Deployment – Simple ML project on Azure DevOps / AWS SageMaker / GCP.

PRACTICALS:

1. Deploying MLOps in Cloud CSP- Amazon Web Services / Google Cloud / Microsoft Azure.

TOTAL: 30L + 30P = 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the essential concepts of MLOps
2. Develop Database Applications using SQLite and MongoDB with Python
3. Learn and Implement the Machine Learning Models
4. Deploy applications using Docker and Track ML projects using MLFlow
5. Deploy MLOps in Cloud Platforms – AWS / Azure / GCP.

REFERENCES:

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2. Oliver Theobald "Machine Learning for Absolute Beginners", Scatterplot Press, 2nd edition, 2017.
3. Reema Thareja "Python Programming: Using Problem Solving Approach Python Programming".Oxford University Press, First Edition 2017.
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8. Andreas Muller “Introduction to Machine Learning with Python: A Guide for Data Scientists” Shroff/O'Reilly, First Edition, 2016.
9. “ML Ops: Operationalizing Data Science” by David Sweenor, Steven Hillion, Dan Rope, Dev Kannabiran, Thomas Hill, Michael O’Connell.
10. “Accelerated DevOps with AI, ML & RPA: Non-Programmer’s Guide to AIOPS & MLOPS” by Stephen Fleming.
11. Francois Duval “Python Machine Learning-Practical Guide for Beginners”, 2017.
12. “Mastering Azure Infrastructure Servicesp” (1st edition), by John Savill, 2015.
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Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	-	1	1	-	-	-	1	-	1	1	1	2
2	1	3	2	2	2	1	1	-	2	1	3	2	1	1	2
3	1	3	3	3	3	2	1	1	2	1	3	2	2	3	3
4	1	3	3	3	3	2	1	1	2	1	3	1	2	3	3
5	1	3	3	3	3	2	1	1	2	1	3	1	3	3	3
Avg	1	3	2	3	2	2	1	1	2	1	3	1	2	2	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23E02 **GENERATIVE AI**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of Generative AI.
- Know the basics of Text Generation.
- Understand the process of generating videos.
- Know about GAN and its variants.
- Understand and Apply Gen AI tools.

UNIT I INTRODUCTION TO GEN AI **9**

Historical Overview of Generative modeling - Difference between Gen AI and Discriminative Modeling – Importance of generative models in AI and Machine Learning – Types of Generative models – GANs, VAEs, autoregressive models and Vector quantized Diffusion models - Understanding if probabilistic modeling and generative process - Challenges of Generative Modeling – Future of Gen AI – Ethical Aspects of AI – Responsible AI – Use Cases.

UNIT II GENERATIVE MODELS FOR TEXT **9**

Language Models Basics – Building blocks of Language models - Transformer Architecture – Encoder and Decoder – Attention mechanisms - Generation of Text – Models like BERT and GPT models – Generation of Text - Autoencoding – Regression Models – Exploring ChatGPT – Prompt Engineering – Designing Prompts– Revising Prompts using Reinforcement Learning from Human Feedback (RLHF) - Retrieval Augmented Generation – Multimodal LLM – Issues of LLM like hallucination.

UNIT III GENERATION OF IMAGES **9**

Introduction to Generative Adversarial Networks – Adversarial Training Process – Nash Equilibrium – Variational Autoencoders – Encoder-Decoder Architectures - Stable Diffusion Models – Introduction to Transformer-based Image Generation – CLIP – Visual Transformers ViT- Dall-E2 and Dall-E3, GPT-4V – Issues of Image Generation models like Mode Collapse and Stability.

UNIT IV GENERATION OF PAINTING, MUSIC, AND PLAY **9**

Variants of GAN – Types of GAN - Cyclic GAN – Using Cyclic GAN to Generate Paintings – Neural Style Transfer – Style Transfer - Music Generating RNN – MuseGAN – Autonomous agents – Deep Q Algorithm – Actor-critic Network.

UNIT V OPEN SOURCE MODELS AND PROGRAMMING FRAMEWORKS **9**

Training and Fine tuning of Generative models – GPT4All - Transfer learning and Pretrained models - Training vision models – Google Copilot - Programming LLM – LangChain – Open Source Models – Llama - Programming for TimeSformer – Deployment – Hugging Face.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the concepts of Generative Modeling.

CO 2. Apply Gen AI to Generating Texts.

CO 3. Understand and Apply Gen AI for generating video.

CO 4. Understand and Apply Gen AI for generating video.

CO 5. Apply Open Source Tools for solving problems using Gen AI.

TEXTBOOKS:

1. Denis Rothman, “Transformers for Natural Language Processing and Computer Vision”, Third Edition , Packt Books, 2024

REFERENCES:

1. David Foster, ”Generative Deep Learning”, O’Reily Books, 2024.
2. Altaf Rehmani, “Generative AI for Everyone”, BlueRose One, 2024.

CO-PO MAPPING:

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
CO2	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
CO3	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
CO4	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
CO5	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
CO6	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3
AVG	3	3	3	1	2	2	-	1	2	-	-	2	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23702 SOFTWARE DEVELOPMENT PROJECT LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

1. Identify and analyze problems in various domains
2. Conduct feasibility studies and requirement elicitation
3. Design system architecture and components
4. Implement solutions using appropriate tools and platforms
5. Test and validate the developed solution

Students are expected to take up problems that would be extended for their consecutive project phase. Based on the courses undertaken, the problems may be chosen in the respective domains. The domains of the problems may reach out to sectors like but not limited to Energy, Education, Material, Environment, Telecommunications, Defense, Healthcare, Entertainment and Agriculture.

The project design, development and testing phases can be as shown below:

REQUIREMENTS ENGINEERING PHASE:

- Problem identification.
- Feasibility study of domain.
- Requirement elicitation and analysis

DESIGN PHASE:

- Architectural design.
- UI design.
- Component Design.
- Database design.

IMPLEMENTATION PHASE:

- Coding in a suitable language using necessary platforms and tools.

TESTING AND VALIDATION PHASE:

- Component Testing
- System Testing
- Acceptance Testing

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Survey the existing challenges and provide a feasibility study of the chosen project.
2. Analyze the problems and provide a prototype.
3. Design, develop and implement solutions for the chosen project.

4. Develop innovative technical solutions for emerging domains.
5. Design, develop and implement standard solutions to problems by applying Software engineering methodologies.
6. Evaluate the solution based on usefulness, effectiveness, and user satisfaction.

Mapping of CO with PO

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	2	1	1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	1	2	1	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	1	1	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	2	1	3	3	3	3	3	3	3
CO5	3	3	3	3	3	1	2	1	3	3	3	3	3	3	3
CO6	3	3	3	3	3	2	1	1	3	3	3	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23801 PROJECT WORK / INTERNSHIP CUM PROJECT WORK

L	T	P	C
0	0	16	8

The final year project is a capstone experience designed to demonstrate students' ability to apply the knowledge and skills acquired throughout their academic program. The project is expected to be a substantial piece of work that involves in-depth research, problem-solving, and practical implementation of a solution to a relevant and challenging problem. This involves following phases.

Literature Survey: The team is expected to conduct an extensive literature review, focusing on IEEE and ACM papers to gather insights into the latest research trends and identify potential gaps that their project could address.

Study of Implementation Issues: The team should carefully study the potential implementation challenges associated with the project, considering various factors such as technical feasibility, resource availability, and time constraints.

Tool Familiarization: The team needs to become proficient with the tools and technologies required for the project's implementation. This includes gaining hands-on experience with any necessary simulation software, programming languages, or development frameworks.

Comprehensive Design and Implementation: The project should include the design, development, and implementation of a working system, application, or model. This involves a detailed design phase, followed by the development and testing of the solution.

Implementation: The team will complete the implementation of their project, including thorough testing and validation of their solution.

Final Report: A comprehensive report documenting the entire project process must be submitted. This report should include sections on the introduction, literature review, methodology, design, implementation, testing, results, and conclusions, along with any appendices for code, diagrams, or additional documentation.

Final Review and Presentation: The project will conclude with a final review, where the team will present their work to a panel of faculty members and an external examiner. This presentation will include a live demonstration of their project, and a discussion of their findings and challenges.

Vertical 1 - Computational Intelligence

AD23001	COMPUTATIONAL INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand the historical and theoretical background of evolutionary computation and fuzzy logic.
2. Explore neural network structure, terminology, and their comparative advantages.
3. To learn genetic algorithms, evolutionary programming, and particle swarm optimization.
4. Study particle swarm optimization and ant colony optimization for practical applications.
5. Implement fuzzy logic principles in designing and applying fuzzy controllers and inferencing systems.

UNIT – I INTRODUCTION 9L

Background and history of evolutionary computation - Behavioral Motivations for Fuzzy Logic, Myths and Applications areas of Computational Intelligence. Adaption - Self organization and Evolution - Historical Views of Computational Intelligence - Adaption and Self organization for Computational Intelligence - Ability to Generalize - Computational Intelligence and Soft Computing Vs Artificial Intelligence and Hard Computing.

UNIT – II NEURAL NETWORK CONCEPTS AND PARADIGMS 9L

Neural Network History - What Neural Networks are and Why they are useful - Neural Networks Components and Terminology - Neural Networks Topology - Neural Network Adaption - Comparing Neural Networks and Other information Processing Methods - Preprocessing and Post Processing.

UNIT – III EVOLUTIONARY COMPUTATION THEORY AND CONCEPTS 9L

History of Evolutionary Computation, Evolution Computation Overview, Genetic algorithms, Evolutionary programming, Evolution strategies, genetic programming, and particle swarm optimization.

UNIT – IV SWARM INTELLIGENCE 9L

Particle Swarm Optimization: Particle Swarm Optimization Algorithm - PSO System Parameters - Modifications to PSO - Cooperative PSO - Particle Swarm Optimization versus Evolutionary Computing and Cultural Evolution – Applications. Ant Colony Optimization.

UNIT – V FUZZY SYSTEMS 9L

Fuzzy systems: Fuzzy Sets - Membership Functions - Fuzzy Operators - Fuzzy Set Characteristics - Linguistics Variables and Hedges - Fuzziness and Probability - Fuzzy Inferencing systems: Fuzzification: Inferencing – Defuzzification - Fuzzy Controllers: Components of Fuzzy Controllers - Fuzzy Controller Types.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Provide a basic exposition to the goals and methods of Computational Intelligence.

2. Understand and implement basic neural networks for solving problems.
3. Study of the design of Evolutionary Computation Theory.
4. Apply genetic algorithms to optimization problems.
5. Improve problem solving skills using the acquired knowledge in the areas of swarm intelligence,
6. Apply fuzzy logic and build fuzzy systems to handle uncertainty and solve engineering problems.

REFERENCES:

1. Eberhart, E. and Y. Shi., “Computational Intelligence: Concepts and Implementations”, Morgan Kauffmann, San Diego, 2007.
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9. MitchellMelanie, An Introduction to Genetic Algorithms, The MIT Press, 1998.

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	3	1	1	1	1	1	-	1	-	-	-	2	1	2
2	2	2	1	2	1	1	1	-	1	-	-	1	2	2	2
3	1	3	2	3	3	1	1	-	1	-	-	2	2	1	3
4	2	1	1	2	2	2	1	2	2	2	2	2	2	2	3
5	2	2	2	2	3	2	1	2	2	1	1	2	2	3	3
6	3	3	3	3	2	2	1	2	2	2	2	2	2	3	3
AVg.	2	3	2	2	2	2	1	2	2	2	2	2	2	2	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23002	GRAPH THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand key concepts of graphs including isomorphism, subgraphs, walks, paths, circuits, and Eulerian and Hamiltonian properties.
2. Study tree properties, spanning trees, cut sets, and network flows, and understand connectivity and separability concepts.
3. Analyze planar graphs, Kuratowski's graphs, chromatic numbers, and the Four Color Problem, including matching and covering.
4. Apply algorithms for connectedness, spanning trees, depth-first search, planarity testing, and shortest-path calculations.
5. Learn and implement algorithms for network flows and solve related problems

UNIT – I INTRODUCTION 9L

Graphs: Introduction – Isomorphism – Sub Graphs – Walks, Paths, Circuits –Connectedness – Components – Euler Graphs – Hamiltonian paths and circuits.

UNIT – II TREES AND CONNECTIVITY 9L

Trees – Properties of Trees – Distance and Centers in Tree – Rooted and Binary Trees. Spanning Trees – Fundamental Circuits – Spanning Trees in a Weighted Graph – Cut Sets – Properties of Cut Set – All Cut Sets – Fundamental Circuits and Cut Sets –Connectivity and Separability – Network Flows – 1–Isomorphism – 2–Isomorphism.

UNIT – III PLANARITY, COLOURING AND COVERING 9L

Combinational and Geometric Graphs – Planar Graphs – Kuratowski's Two Graphs –Different Representation of a Planar Graph – Chromatic Number – Chromatic Partitioning – Chromatic Polynomial – Matching – Covering – Four Color Problem.

UNIT – IV GRAPH ALGORITHMS 9L

Algorithms –Connectedness and Components – Spanning Tree - A set of Fundamental Circuits- Cut - Vertices and Separability – Directed Circuits - Shortest-Path Algorithms - Depth first search on a graph: Planarity Testing – Isomorphism

UNIT – V NETWORK FLOW ALGORITHMS 9L

Flow networks – Ford-Fulkerson method – Maximum bipartite matching – Shortest augmenting paths - Push-relabel algorithms – The stable marriage problem – The Hungarian algorithm for the assignment problem – The Baseball Elimination problem.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Demonstrate understanding of the fundamental theorems of graph theory.
2. Identify and differentiate the potential use of special graphs and describe the basic properties of each kind.
3. Design and develop programs involving basic graph algorithms.

4. Introduce graphs as a powerful modeling tool that can be used to solve practical problems in various fields.
5. Apply the abstract concepts of graph theory in modeling and solving non-trivial problems in different fields of study.

REFERENCES:

1. Narsingh Deo, “Graph Theory: With Application to Engineering and Computer Science”, Dover Publications Inc., 2016.
2. Hamilton, William L., “Graph Representation Learning”, Morgan and Claypool, 2020.
3. Thomas H. Cormen Charles E. Leiserson Ronald L. Rivest,” Introduction to Algorithms”, The MIT Press Cambridge,4th Edition, 2022.
4. Clark J., Holton D. A., “A First Look at Graph Theory”, Allied Publishers, 1995.
5. Mott J. L., Kandel A., Baker T. P., “Discrete Mathematics for Computer Scientists and Mathematicians”, Prentice Hall of India, 1996.
6. Liu C. L., “Elements of Discrete Mathematics”, McGraw Hill, 1985.
7. Rosen K. H., “Discrete Mathematics and Its Applications”, McGraw Hill, 2007.

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	3	1	-	-	-	-	-	2	-	1	2	2
2	2	2	2	3	1	-	-	-	-	-	1	1	1	2	2
3	2	1	2	3	3	2	-	2	2	-	2	-	1	2	2
4	2	1	2	3	2	-	1	-	-	-	3	1	2	2	2
5	2	-	2	3	2	2	-	2	2	3	1	1	3	2	2
AVg.	2	1.5	2	3	1.8	2	1	2	2	3	1.8	1	1.3	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23003 COGNITIVE MODELS FOR COMPUTING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Define cognitive modelling, its goals, approaches and benefits, and explore its role in understanding human cognition
2. To Study rule-based, connectionist and hybrid cognitive models, including production rules, connectionist concepts, and models
3. Investigate perceptual organization, attention, perception, learning and memory systems, reinforcement learning, working memory and long-term memory models.
4. Explore language processing, decision making, problem solving, rational and heuristic decision-making models.
5. Apply cognitive modelling in various fields and explore its future trends.

UNIT – I INTRODUCTION TO COGNITIVE MODELLING 9L

Definition - Goals - Approaches – Benefits – Developing Cognitive Models – Theoretical Frameworks – Cognitive Architectures and Models – Role in understanding human cognition

UNIT – II COGNITIVE MODEL TYPES 9L

Rule Based Models - Production Rules –Conditions – Actions - Build Rule based Model – Connectionist Models – Basic Concepts - Building and validating a connectionist model - Hybrid Model - ACT-R – SOAR – Production Systems and Cognitive Architectures – Building and validating a hybrid model

UNIT – III MODELLING COGNITIVE PROCESSES – I 9L

Perceptual organization - Attention – Perception – Models - Learning and Memory – Memory systems and Models – Encoding, Storage, Retrieval Processes – Reinforcement learning – Working Memory and Cognitive Control- Long Term Memory models

UNIT – IV MODELLING COGNITIVE PROCESSES – II 9L

Language Processing – Communication - Decision Making & problem Solving –Cognitive Processes in Decision making –Rational and Heuristic Decision Making Models - Decision making under uncertainty - Dynamical and Complex Systems – Large Scale Modelling

UNIT – V APPLICATIONS OF COGNITIVE MODELLING 9L

Cognitive Modelling in Engineering - Education – Human Computer interaction – User Experience Design – Cognitive Workload and Humana factors Engineering - Systems Design and Evaluation - Robotics - Linguistic applications of cognitive modelling – Future Trends

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Explore the fundamental concepts and principles of cognitive modeling and its role in understanding human cognition.
2. Explain the differences between symbolic and connectionist approaches in cognitive modeling.

3. Apply cognitive modeling techniques to analyze and simulate cognitive processes related to perception, attention, memory and long term memory.
4. Apply techniques to simulate and interpret cognitive processes related to decision-making, problem-solving in large scale systems.
5. Utilize cognitive modeling techniques to address and solve problems in various domains, such as language processing and decision-making
6. Critically analyze and interpret research studies related to cognitive modeling, identifying strengths, limitations, and implications for real-world applications.

REFERENCES:

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2. Jerome R Busemeyer and Adele Diederich, "Cognitive Modeling: A Computational Approach" SAGE publications, 2009.
3. D. Vernon, Artificial Cognitive Systems, MIT Press, 2014.
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13. Bernard J. Bears and Nicole M. Gage, "Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience", Academic Press 2010.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	2	2	2	1	2	3	1	3	3	3	3
2	3	3	3	3	2	2	2	1	2	3	1	3	3	3	3
3	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
4	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
5	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
Avg	3	3	3	3	2	2	2	1	2.6	3	1	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23004	SOFTWARE DESIGN THINKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand the phases, importance, and methods of design thinking
2. Learn to identify, clarify, and analyze problems, and use empathetic design to understand user needs.
3. Explore techniques for brainstorming, ideation, and prototyping and learn to create value propositions.
4. Understand agile principles, compare them with design thinking, and learn how to use both in software development and business.
5. Learn how to plan and conduct user tests, use feedback for improvement.

UNIT – I INTRODUCTION TO DESIGN THINKING 9L

Importance of Design Thinking – Design thinking and business- Design thinking and product- Phases in design thinking process - Empathise –Define – Ideate – Prototype – Steps in immersion activity- Explanation on Moccasin walk- Flow charts and handouts- Software Development Methodology – Waterfallmodel – V –model -Customer Example.

UNIT – II UNDERSTAND, OBSERVE AND DEFINE THE PROBLEM 9L

Search field determination - Problem clarification - Understanding of the problem – Problem analysis - Reformulation of the problem - Observation Phase - Empathetic design - Tips for observing - Methods for Empathetic Design - Point-of-View Phase - Characterization of the target group - Description of customer needs.

UNIT – III IDEATION AND PROTOTYPING 9L

Ideate Phase –Need, Uses, methods of ideation - Creativity techniques - Brainstorming - Mind maps - Ideation - Prototype Phase -Types and Guidelines of prototyping– Story telling- Importance of prototyping in design thinking – Value proposition - Guidelines to write value proposition -Lean Startup Method for Prototype Development - Visualization and presentation techniques.

UNIT – IV AGILITY AND DESIGN THINKING 9L

Agile principles- Agile Methodology Overview-Design thinking and coding – Agile Methodology – Differences between agile and design thinking - Complementing agile with design thinking Extreme Programming –Software Development using Scrum Framework –Sprints – Design Thinking related to Science and art-Design Thinking inBusiness-Linking Design Thinking Solution to Business Challenges.

UNIT – V TESTING AND IMPLEMENTATION 9L

Test Phase - Need to test –User feedback - Conducting a user test – Guidelines for planning a test – How to test - Desirable, feasible and viable solutions – Iterate phase- Tips for interviews - Tips for surveys - Kano Model - Desirability Testing - Conduct of workshops - Requirements for the space - Material requirements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Apply design thinking concepts to give solution for the problems identified
2. Implement Agile software methodology for faster development of quality software
3. Describe how to improve collaboration between development
4. Implement Automated Installations and Deployments
5. Resolve different transformations of a product or a service through brainstorming and incremental approach, etc.

REFERENCES:

1. Christian Mueller-Roterberg, Handbook of Design Thinking - Tips & Tools for how to design thinking, 2018
2. Designing for Growth: a design thinking tool kit for managers By Jeanne Liedtka and Tim Ogilvie, 2011, Columbia university press.
3. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation by Tim Brown, 2009, Harper Collins publisher.
4. Johnny Schneider, “Understanding Design Thinking, Lean and Agile”, O'Reilly Media, 2017.
5. MaurícioVianna, YsmarVianna, Brenda Lucena and Beatriz Russo,” Design thinking : Business innovation”, MJVTechnologies and innovation press, 2011.
6. Alistair Cockburn, “Agile Software Development”, 2nd ed, Pearson Education, 2007.
7. Andrew Pressman (2018) – “Design Thinking: A Guide to Creative Problem Solving for Everyone”–Routledge

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	3	3	2	2	2	1	2	3	2	1	2	1	2	1
2	2	2	3	1	3	1	1	2	3	2	2	2	1	2	1
3	1	1	2	2	2	2	1	2	3	3	2	1	1	2	-
4	2	2	3	1	3	2	1	2	2	2	2	2	-	1	-
5	2	3	3	2	2	2	1	2	3	3	2	2	-	1	-
Avg.	2	2	3	2	2	2	1	2	3	2	2	2	1	2	1

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23005 GPU ARCHITECTURE AND PROGRAMMING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Learn the fundamentals of GPU architecture.
2. Explore CUDA's programming and execution models, memory hierarchy, optimization techniques and debugging methods.
3. Understand OpenCL's architecture, platform and execution models, memory management and synchronization.
4. To explore and analyse GPU programming using PyCUDA.
5. Apply GPU algorithms and optimize memory usage with different data formats

UNIT – I GPU ARCHITECTURE 9L

Introduction - Heterogeneous parallel computing - Need for parallelism –Challenges in parallel programming – Evolution of GPU architectures – Understanding Parallelism with GPU – Architecture of a modern GPU - Block scheduling - Synchronization and transparent scalability - Warps and SIMD hardware.

UNIT – II GPU PROGRAMMING: CUDA 9L

CUDA's programming model: threads, blocks, and grids - CUDA's execution model: streaming multiprocessors and warps - CUDA compilation process - Memory hierarchy - Optimization of CUDA applications - Graphs - Warp functions - Dynamic parallelism - Debugging CUDA programs.

UNIT – III GPU AND ACCELERATOR PROGRAMMING: OpenCL 9L

The OpenCL architecture - The platform model - The execution model - The programming model - The memory model - Shared virtual memory - Atomics and synchronization - Events and profiling OpenCL programs - OpenCL and other parallel software platforms

UNIT – IV GPU PROGRAMMING: PyCUDA 9L

GPU programming using PyCUDA: kernals, threads, blocks, and grids – thread synchronization and intercommunication – Parallel prefix algorithm – Streams, events, contexts, and concurrency.

UNIT – V ALGORITHMS ON GPU 9L

Parallel Patterns: Parallel convolution: a basic algorithm, Constant memory and caching, Tiled convolution using caches for halo cells - Prefix scan: Parallel scan with the Brent-Kung algorithm, Segmented parallel scan for arbitrary-length inputs - Sparse Matrix computation: A simple SpMV kernel with the COO format - Grouping row nonzeros with the CSR format - Improving memory coalescing with the ELL format.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the need for parallel programming
2. Describe the GPU Architecture
3. Program GPU using CUDA and PyCUDA

4. Program GPU using OpenCL
5. Compare the CUDA and OpenCL programming
6. Identify efficient parallel programming patterns to solve problems

REFERENCES:

1. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors – A Hands-on Approach, Fourth Edition, Morgan Kaufmann, 2022.
2. Gerassimos Barlas, Multicore and GPU Programming: An Integrated Approach, Second Edition, Morgan Kaufmann, 2022
3. Brian Tuomanen, Hands-On Gpu Programming with Python and CUDA: Explore high-performance parallel computing with CUDA, Packt Publishing Limited, 2018
4. Shane Cook, CUDA Programming: —A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
5. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, —Heterogeneous computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015.
6. Nicholas Wilt, —CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison – Wesley, 2013.
7. Jason Sanders, Edward Kandrot, —CUDA by Example: An Introduction to General Purpose GPU Programming, Addison – Wesley, 2010.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	1	2	1	1	1	2	2	1	2	1	1	3
2	2	2	2	1	2	1	1	1	2	2	1	2	1	1	3
3	2	2	2	2	3	1	1	1	2	2	1	2	1	1	3
4	2	2	2	2	3	1	1	1	2	2	1	2	1	1	3
5	2	2	2	2	3	1	1	1	2	2	1	2	1	1	3
6	2	2	2	2	3	1	1	1	2	2	1	2	1	2	3
Avg.	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**3**

1-low, 2-medium, 3-high, '-"- no correlation

IT23C09	EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the internal architecture and programming of an embedded processor.
- To write embedded C program to design and deploy timers, interrupts and I/Os.
- To learn and design systems using ARM processor
- To learn various RTOS for embedded systems
- To design and develop embedded systems for real time applications.

UNIT I EMBEDDED CONCEPTS AND BASIC MICRO CONTROLLER 9

Introduction to Embedded Systems (ES) - ES Architecture- hardware- Software - debugging Tools - Microprocessor - Micro controller - Embedded Processor - Overview of 8 Bit Micro controller (8051) – Architecture – Instruction Set and Programming – Programming Parallel Ports - Memory And I/O Devices Interfacing.

Suggested Activities: Flipped classroom activity on different types of microcontrollers.
Assignment on writing simple assembly codes.
Practical - Developing simple application using assembly code.

Suggested Evaluation Methods: Tutorials on instruction set and programming.
Assignments on programming using machine code.
Quizzes on instruction set and programming.

UNIT II EMBEDDED C PROGRAMMING AND HARDWARE INTERFACING 9

Introduction to Embedded C - C vs Embedded C- Keywords - Data types - Simple Programming Examples -Control Structure and Loops - KEIL Compiler - Interfacing Input and Outputs - Switches- Keyboard- Motors- Sensors - Serial Communication Programming- Embedded Networking - Bluetooth - Zigbee – USB

Suggested Activities: Flipped classroom on different types of RTOS.
Practical - Writing simple embedded C codes.
Practical - Developing simple application using embedded C code.

Suggested Evaluation Methods: Tutorials on embedded C programming.
Assignment on zig bee Bluetooth wifi
Practical - Developing applications using embedded C.
Quizzes on Embedded C and netwoking.

UNIT III EMBEDDED PROCESSOR 9

ARM Processor – ARM Cortex M - Cortex M Architecture - Cortex Assembly Language - Parallel I/O Ports - ARM Thumb Instruction - GPIO - UART - PWM

Suggested Activities:
Flipped classroom on ARM processors –Instruction set.
Practical - Developing simple application using ARM processor

Suggested Evaluation Methods:
Tutorials on ARM programming.
Assignment problems on interfacing I/O based applications with ARM .
Quizzes on ARM instruction set, UART, PWM

UNIT IV PLATFORMS AND REAL TIME OS 9

Real time platforms - Embedded Linux- Device Driver- Multiple tasks and processes – Context switching – Scheduling policies – Interprocess communication mechanisms – Performance issues - Need for RTOS - Introduction to FreeRTOS - Mbed OS

S**uggested Activities:** Flipped classroom on different types of RTOS.
Practical - Writing simple embedded C codes for scheduling

Suggested Evaluation Methods: Tutorials on scheduling
Assignment on different RTOS
Quizzes on Multiple tasks and RTOS

SYSTEM DESIGN APPLICATIONS DEVELOPMENT **9**

UNIT V

Design methodologies and tools - designing hardware and software components - Complete Design of Embedded Systems – Development of Applications – System Level Design - Power issues in system Design - Automotive Embedded System - Simple Home Automation Applications.

Suggested Activities: Flipped classroom activity on different existing embedded applications. Designing simple new applications.

Case study on automation solutions.

Suggested Evaluation Methods: Tutorials on design and development of embedded system applications.

Assignment on different smart solutions.

Demonstrating real-time applications using embedded processors.

Quizzes on Design of embedded systems and IoT applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will be able to:

CO1: Write programs using various embedded processors and microcontrollers.

CO2: Write embedded C program to design and deploy timers, interrupts and I/Os.

CO3: Design simple embedded applications using ARM.

CO4: Understand various RTOS for embedded systems.

CO5: Design portable embedded systems for real time applications.

TEXT BOOKS:

1 Ünsalan, Cem, Hüseyin Deniz Gürhan, and Mehmet Erkin Yücel. Embedded System Design with ARM Cortex-M Microcontrollers. Springer International Publishing, 2022.

2 Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, Second Edition, 2014

REFERENCES:

1 Michael J. Pont, “Embedded C”, Pearson Education, 2007

2 Wayne Wolf, “Computers as Components: Principles of Embedded Computer System Design”, Elsevier, 2006

3 Andrew N Sloss, D. Symes, C. Wright, “Arm System Developers Guide”, Morgan Kauffman/ Elsevier, 2006. 6. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-on Approach”, VPT, 2014

4 Valvano, Jonathan W. *Embedded systems: real-time interfacing to ARM Cortex-M microcontrollers 2*. ARM, 2014.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	1	-	-	2	-	-	2	3	3	1
CO2	3	3	3	3	3	2	2	-	2	-	2	3	3	3	2
CO3	3	3	3	3	3	2	2	-	3	-	3	3	3	3	3
CO4	3	3	3	3	3	3	3	-	3	-	3	3	3	3	3
CO5	3	3	3	3	3	3	3	1	2	1	3	3	3	3	3
AVG	3	3	3	3	2.8	2.2	2.5	2	2.5	1	2.2	2.8	2	2	2.5

AD23006	QUANTUM COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Learn the basic concepts of quantum computation and experimental quantum information processing.
2. Study quantum mechanics principles along with traditional computational models like Turing machines and circuits.
3. To explore and acquire knowledge of quantum circuits, algorithms, universal quantum gates and the Quantum Fourier Transform.
4. To study about quantum noise, quantum operations, error correction, entropy and distance measures for quantum information.
5. Explore quantum algorithms for machine learning and understand quantum versions of linear and probabilistic models.

UNIT – I FUNDAMENTAL CONCEPTS 9L

Global Perspectives - Quantum Bits - Quantum Computation - Quantum Algorithms - Experimental Quantum Information Processing - Quantum Information.

UNIT – II QUANTUM MECHANICS AND OVERVIEW OF COMPUTATIONAL MODELS 9L

Quantum Mechanics: Linear Algebra – Postulates of Quantum Mechanics – Application: Superdense Coding – Density Operator – The Shmidt Decomposition and Purifications - EPR and the Bell Inequality – Computational Models: Turing Machines – Circuits – Analysis of Computational Problems.

UNIT – III QUANTUM COMPUTATION 9L

Quantum Circuits: Quantum Algorithms – Universal Quantum Gates – Quantum Circuit - Model of Computation – Simulation – Quantum Fourier Transform and Applications – Quantum Search Algorithms – Quantum Computers

UNIT – IV QUANTUM INFORMATION 9L

Quantum Noise and Quantum Operations: Classical Noise and Markov processes – Quantum Operations – Examples – Applications – Distance Measures for Quantum Information – Quantum Error Correction – Entropy

UNIT – V QUANTUM MACHINE LEARNING 9L

Quantum Clustering - Quantum K-Means and K-Medians- Quantum Classifiers - Nearest neighbours - Support Vector Machine (SVM) in quantum space - Quantum Principal Component Analysis - Feature Maps - Linear Models - Probabilistic Models - Quantum Neural Networks

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the basics of quantum computing.
2. Understand the background of Quantum Mechanics.

3. Analyse the computation models.
4. Model the circuits using quantum computation.
5. Understand the quantum operations such as noise and error–correction.
6. Appreciate the need of quantum machine learning.

REFERENCES:

1. Santanu Ganguly, “Quantum Machine Learning: an Applied Approach : The Theory and Application of Quantum Machine Learning in Science and Industry”, Publisher Apress L. P., 2021.
2. Parag K Lala, Mc Graw Hill Education, “Quantum Computing, A Beginners Introduction”, First edition, 2020.
3. Michael A. Nielsen, Issac L. Chuang, “Quantum Computation and Quantum Information”, Tenth Edition, Cambridge University Press, 2010.
4. Jack D. Hidary, “Quantum Computing: An Applied Approach” 1st edition, Springer, 2019.
5. Chris Bernhardt, “Quantum Computing for Everyone”, The MIT Press; Reprint edition, 2020.
6. Scott Aaronson, “Quantum Computing Since Democritus”, Cambridge University Press, 2013.
7. N. David Mermin, “Quantum Computer Science: An Introduction”, Cambridge University Press, 2007.

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	-	-	-	-	-	-	-	-	-	-	1	1
2	3	3	3	-	-	-	-	-	-	-	-	-	-	1	1
3	3	3	3	3	2	-	-	-	-	-	3	1	2	2	2
4	3	3	3	3	2	1	-	1	-	-	3	1	2	2	2
5	3	3	3	3	2	-	-	-	-	-	-	-	1	1	1
6	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
AVg.	3	3	2.83	3	2	1	-	1	-	-	3	1.33	2	1.67	1.67

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23007	STATISTICAL DECISION THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand basic elements of decision theory and Utility theory
2. Explore subjective probability, prior distributions, Bayesian inference, and decision-making principles.
3. To learn about game theory, minimax estimators, invariant decision problems and its relationship.
4. Apply statistical methods to binary and continuous distributions, small area estimation, and empirical Bayes models.
5. To learn about complete and essentially complete classes of tests, continuous risk functions, and the limits of Bayes rules.

UNIT – I INTRODUCTION 9L

Basic Elements- Expected Loss, Decision Rules and Risk - Randomized Decision Rules - Decision Principles - Foundations - Sufficient Statistics -Utility Theory - Utility of Money - The Loss Functions

UNIT – II PRIOR INFORMATION AND BAYESIAN ANALYSIS 9L

Subjective Probability - Subjective Determination of the Prior Density - Noninformative Priors- Maximum Entropy Priors -Marginal Distribution - Hierarchical Priors – Bayesian Analysis - Posterior Distribution - Bayesian Inference - Bayesian Decision Theory - Empirical Bayes Analysis - Hierarchical Bayes Analysis - Bayesian Robustness - Admissibility of Bayes Rules and Long Run Evaluations - Bayesian Calculation – Bayesian Communication – Combining Evidence and Group Decisions – Group Decision Making.

UNIT – III MINIMAX ANALYSIS AND INVARIANCE 9L

Game Theory - Statistical Games - Classes of Minimax Estimators - Evaluation of the Minimax principle - Formulation – Invariant Decision Problems and Rules - Location Parameter Problems - Maximal Invariants - Invariance and Noninformative Priors - Invariance and Minimaxity - Admissibility of Invariant Rules.

UNIT – IV DATA FROM DISTRIBUTIONS AND CLASSIFICATION 9L

Binary Outcomes - Poisson Counts - Continuous Distributions - Normally Distributed Marker - Markers with other distributions - Small Area Estimation -Composition and Empirical Bayes Models - Estimation for a Policy.

UNIT – V COMPLETE AND ESSENTIALLY COMPLETE CLASSES 9L

One Sided Testing - Monotone Decision Problems - Limits of Bayes Rules - Complete and Essentially Complete Classes of Tests and Estimation - Continuous Risk Functions - Proving Admissibility and Inadmissibility – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Explore the fundamental concepts and principles of decision theory

2. Apply Bayesian analysis techniques to incorporate prior information and subjective probability in decision-making processes.
3. Evaluate the appropriateness of different prior distributions and the impact of subjective determinations on Bayesian analysis.
4. Analyze and solve decision problems using minimax analysis and invariant decision rules.
5. Apply statistical methods for data classification and estimation based on different types of distributions.
6. Assess the completeness and essential completeness of classes of tests and estimators for decision-making and risk assessment.

REFERENCES:

1. Berger, J. O. (2013). Statistical Decision Theory and Bayesian Analysis. Springer Science & Business Media.
2. Statistical Decision Theory -Nicholas T. Longford · 2013.
3. DeGroot, M. H., & Fienberg, S. E. (2012). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer Series in Statistics.
4. Robert, C. P. (2001). The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation. Springer Science & Business Media.
5. Lindley, D. V. (2000). Understanding Uncertainty. Wiley.
6. Parmigiani, G. (2002). Modeling in Medical Decision Making: A Bayesian Approach. Wiley.
7. French, S. (1986). Decision Theory: An Introduction to the Mathematics of Rationality. Halsted Press.
8. Smith, J.Q. (2010). Bayesian Decision Analysis: Principles and Practice. Cambridge University Press.

Mapping of CO with PO

	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	3	1	1	1	2	1	1	2	2	2	1
2	3	3	3	2	3	1	1	2	2	2	2	2	2	2	1
3	3	3	2	3	3	1	1	2	2	2	1	2	2	2	1
4	3	3	2	3	3	1	1	2	2	2	2	2	2	2	1
5	2	2	3	2	3	1	1	2	2	2	2	2	2	2	1
6	3	3	2	3	2	1	1	2	2	1	1	2	2	2	1
Avg.	**3**	**3**	**2**	**3**	**3**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**

1-low, 2-medium, 3-high, ‘-“- no correlation

VERTICAL II - DATA TECHNOLOGIES

AD23008	PROGRAMMING FOR DATA SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

This course aims to

1. To understand and applying full stack development in data science
2. To learn the object-oriented programming concepts using python
3. Understand the desktop software development and deployment in windows / linux using PyQt6
4. To learn the web application development using flask python
5. To gain knowledge about how to deploy machine learning models
6. To make and understand various data science techniques and integrate them using full stack.

UNIT – I OBJECT ORIENTED PROGRAMMING IN PYTHON 9L

Object Oriented Programming Introduction-Class and Objects -Variables, Methods, Types of Access modifiers, Constructors, Inheritance-Types, Polymorphism-Operator Overloading-Types, Class Polymorphism.

UNIT – II FULL STACK DEVELOPMENT USING WINDOWS PYTHON 9L

Introduction to PyQt6-Installation-UI Widgets-Layout Management-Dialogs-Events-Example Applications-Packaging PyQt6 Applications for Windows-Deployment of PyQt6 Software in Windows / Linux. Introduction to SQlite. Working with SQlite Database with PyQt6.

UNIT – III FULL STACK DEVELOPMENT USING WEB PYTHON 9L

Overview of Flask-Routes-Templates-Forms-Creating Web Applications using Flask-Examples. Introduction to MongoDB-Working with MongoDB with Flask-Simple Application Examples.

UNIT – IV DEPLOYING MACHINE LEARNING (ML) MODELS 9L

Introduction to ML Deployment – Model Development Lifecycle - Data Collection and Preparation, Model Training and Evaluation – Deployment of Platforms and Tools – Cloud Platforms, Containerization-Docker / Kubernetes, Frameworks and Tools – Model Serving – Rest APIs with Flask / Fast API and Microservices for Model Inference – Case Studies- Real world Examples of ML model deployment.

UNIT – V DATA SCIENCE PROJECTS - DATABASE AND DATA VISUALIZATION 9L

Relational SQL-MySQL setup and queries, database optimization and integration with tools and languages. Data Visualization-Importance, Types of data visualization in data science, Visualization with open-source python libraries, Power BI, Tableau with examples. Data science projects using NLP / ML / Data Visualization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the essential oops concepts of python for data science
2. Develop and Package Desktop GUI applications using PyQt6 python.
3. Learn and Develop Web Applications with Database using Flask
4. To practice the data science techniques using data processing and modelling, machine learning
5. To practice the data science techniques using data visualization, data mining and natural language processing.

REFERENCES:

1. Steven F. Lott, Dusty Phillips, Python Object-Oriented Programming - Fourth Edition, Packt Publishing, 2021. (Unit 1)
2. Alan D Moore, Mastering GUI Programming with Python, Packt Publishing, 2019. (Unit 2)
3. Miquel Grinberg “Flask Web Development 2e: Developing Web Applications with Python”. O′Reilly, 2nd edition, 2018 (Unit 3)
4. Kyran Dale, Data Visualization with Python and JavaScript, 2nd Edition, O'Reilly Media, Inc, 2022. (Unit 4, 5)
5. Fabrizio Romano, Learn Python Programming, Second Edition, Packt Publishing, 2018.
6. Avishek Nag, Pragmatic Machine Learning with Python: Learn How to Deploy Machine Learning Models in Production, BPB Publications, 2020. (Unit 4)
7. Gareth Dwyer, “Flask by Example”, Packet Publishers, 2016.
8. https://www.geeksforgeeks.org/top-data-science-projects/
9. https://www.javatpoint.com/python-tutorial

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	2	-	-	-	-	-	2	1	-	3	1	1	1
2	1	3	3	1	3	1	1	2	3	1	2	2	1	1	2
3	1	3	3	1	3	1	1	-	3	1	2	2	3	1	2
4	1	3	3	2	2	2	1	1	3	1	2	2	2	3	3
5	1	3	3	2	2	2	1	1	3	1	2	2	2	2	3
Avg.	1	2.6	2.8	1.5	2.5	1.5	1	1	2.8	1	2	2.2	1.8	1.6	2.2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23009	DISTRIBUTED AI	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn about federated learning solutions, privacy-preserving techniques, and applications.
2. To study the concepts of intelligent agents, including their architectures, programming languages and multiagent systems.
3. To explore distributed problem-solving techniques and decision-making mechanisms like voting and auctions.
4. Understand logic-based representation, BDI implementation, coordination and practical applications of DAI in industry.
5. Explore concurrent programming techniques for multiagent systems.

UNIT – I FEDERATED LEARNING 9L

Federated Learning Solutions, Development in Federated Learning, Privacy-Preserving Machine Learning, Distributed machine Learning, Horizontal Federated Learning, Vertical Federated Learning, Federated Transfer Learning, Incentive Mechanism Design for Federated Learning, Federated Learning for Vision, Language and Recommendation, Federated Reinforcement Learning, Applications.

UNIT – II INTELLIGENT AGENTS 9L

Agents and Objects, Agents and Expert Systems, Architectures for Intelligent Agents, Agent Programming Languages, Multiagent Systems and Societies of Agents, Agent Communications, Agent Interaction Protocols, Societies of Agents

UNIT – III DISTRIBUTED PROBLEM SOLVING AND PLANNING 9L

Task Sharing, result Sharing, Distributed Planning, Distributed Plan Representations, Distributed Planning and Execution, Search algorithms for agents, Constraint Satisfaction, Path Finding Problem, Two-Player Games, Distributed rational decision Making - evaluation Criteria, Voting, Auctions, Bargaining, General Equilibrium, Contract Nets, Coalition Formation, Learning in Multiagent systems, Activity coordination, Learning from other agents, Learning and communication

UNIT – IV METHODS IN DAI 9L

Logic-Based Representation and Reasoning, Logical Background, Cognitive Primitives, BDI Implementation, Coordination, Communications, Social Primitives, Tools and Systems, Industrial and Practical Applications of DAI, Industrial Life Cycle, Development Tools, Groupware, Multi-aspect Groupware, Distributed Models for Decision Support-Decision support systems, Agent architecture for Distributed Decision

UNIT – V CONCURRENT PROGRAMMING FOR DAI 9L

Multiagent systems, Representing agents as Actors, Agent Ensembles, Distributed Control Algorithms for AI - Computation, Complexity measures, Graph Exploration, Termination Detection, Distributed Arc Consistency, Constraint Satisfaction Problem, Distributed Graph Processing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the fundamental concepts and principles of agent-based systems, multi-agent systems, and federated learning.
2. Develop skills in designing, developing, and implementing agent-based systems and federated learning algorithms.
3. Analyze and evaluate the performance of multi-agent systems and federated learning algorithms using appropriate metrics and tools.
4. Understand the role of communication and coordination in multi-agent systems and federated learning, and apply relevant techniques for effective collaboration.
5. Develop knowledge of privacy-preserving machine learning techniques and their applications in federated learning.
6. Gain practical experience in implementing and deploying agent-based systems and federated learning algorithms in real-world applications.

REFERENCES:

1. Sabry, “Distributed Artificial Intelligence: Fundamentals and Applications”, One Billion Knowledgeable, 2023.
2. Federated Learning, by Qiang Yang,Yong Cheng Yan Kang, Tianjian Chen, Han Yu Synthesis Lectures on Artificial Intelligence and Machine Learning, Springer, 2020
3. Multiagent Systems, second edition. Gerhard Weiss, 2016
4. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, by Gerhard Weiss The MIT Press Cambridge, Massachusetts London, England, 1999
5. Readings in Distributed Artificial Intelligence, Alan H.Bond, Les Gasser, Morgan Kaufmann Publishers, 2014
6. Federated Learning with Python, KIYOSHI NAKAYAMA, Springer, 2020
7. A Concise Introduction to Multiagent Systems and Distributed Artificial Intelligence Nikos Vlassis, 2007

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	2	2	2	3	3	2	3	3	3	2
2	3	3	3	2	3	2	2	3	3	3	2	3	3	3	3
3	3	3	3	3	3	2	2	2	3	3	2	3	3	3	3
4	2	2	2	2	2	1	1	2	3	3	1	2	3	3	2
5	3	2	3	2	3	2	1	3	2	2	1	2	3	3	3
6	3	3	3	3	3	2	2	2	3	3	2	3	2	2	2
Avg.	3	3	3	3	3	2	2	2	3	3	2	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23010	ADVANCED DATA STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand amortized analysis techniques and apply them to binary counters and dynamic table creation.
2. To learn about AVL trees, splay trees, B-trees, and red-black trees.
3. To study various heap structures and analyze their operations and amortized costs.
4. To analyze disjoint set data structures and their applications in connected components and spanning trees.
5. Explore algorithms for undirected and directed graphs and maximum flow techniques

UNIT – I AMORTIZED ANALYSIS 9L

Introduction to Amortized Analysis: Potential Method-Accounting Method- Aggregate Method- - Binary Counter Implementation using Amortized cost- Dynamic Table creation using Amortized operations- Deterministic Skip lists: Properties-Insertion- Find.

UNIT – II BALANCED TREES 9L

AVL Tree: Insertion-Deletion-Rotations-Search operations – Splay Tree: Splaying- Amortized analysis of Top Down Splay - B-Trees: Insertion-Deletion – Search-Red Black Tree : Insertion-Deletion- Tries – Insertion-Removal-Prefix match- Applications: Autocomplete.

UNIT – III HEAPS 9L

Leftist Heaps: Properties-Operations- Skew Heaps: Operations - Binomial Queue: Structure-Operations- Fibonacci Heap: Structure- Operations- Amortized analysis of Fibonacci Heap – Treaps: Insertion-Deletion.

UNIT – IV DISJOINT SETS 9L

Disjoint Set – Distinct Subset Problem- Equivalence Relations – The Dynamic Equivalence Problem – Disjoint Set Structure- Smart Union Algorithms – Path Compression – Applications: Connected Components – Spanning Tree.

UNIT – V ADVANCED GRAPHS 9L

Undirected Graphs – Biconnectivity – Articulation Points- Euler Circuits- Directed Graph – Strong Components – Single Source Shortest Path- Bellman Ford Algorithm- All Pair Shortest paths – Floyd Warshall algorithm – Maximum Flow: Flow networks – Ford Fulkerson method- Maxflow-Mincut Theorem.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the usage of amortized analysis and Skip lists for real world problem solving.
2. Implement balanced trees through ADTs.
3. Understand and use Heap algorithms using amortized analysis.
4. Apply Disjoint sets for suitable applications
5. Analyze and apply the graph data structures for a given problem.

REFERENCES:

1. Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to Algorithms, Fourth Edition, The MIT Press, 2022.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++” , Fourth Edition, Pearson Education, 2014.
3. Sridhar S, “Design and Analysis of Algorithms”, Second Edition, Oxford University Press, 2023
4. Marcello La Rocca, “ Advanced Algorithms and Data Structures”, First Edition, Manning Publications Company, 2021.
5. Michael T, Goodrich, Roberto Tamassia, David Mount, ““Data Structures and Algorithms in C++”, Seventh Edition, Wiley Publishers, 2004.

Mapping of CO with PO

	Program Outcomes (POs)& Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	2	2	-	-	-	-	-	1	2	3	3	3
CO2	3	3	3	3	3	-	1	1	-	-	2	2	3	3	3
CO3	3	3	3	3	2	-	-	-	-	-	1	2	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO5	3	3	3	3	2	-	1	-	-	-	1	2	3	3	3
CO6	**3**	**3**	**3**	**3**	**3**	**-**	**1**	**1**	**2**	**-**	**2**	**2**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23011	SOCIAL NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn the basics of social networks and issues of security and privacy.
2. Study methods and metrics for predicting links in social networks, community detection and characteristics of ego networks.
3. To learn the models of information diffusion, cascades, and clusters in networks.
4. Learn to model and aggregate social network data, create social-semantic applications, and apply recommendation techniques
5. Explore visualization techniques, including structural and semantic visualization, and perform mining tasks.

UNIT – I INTRODUCTION TO SOCIAL NETWORKS 9L

Complex Networks, Overview of Social Network Analysis, Social Media Content, Levels of Network Analysis, Network Statistics, Representation of the Networks, Network Models, Network Centrality, Security and Privacy in Social Networks.

UNIT – II LINK PREDICTION 9L

Link Analysis. Link Prediction, Link Prediction Methods, Metrics for Link prediction, prediction of Performance Metrics, Community Detection, Taxonomy of community criteria, Community evaluation, Ego Networks - Characteristics of Ego Networks, Ego Network Measures, Network Cohesion.

UNIT – III INFORMATION DIFFUSION 9L

Game Theoretic models, User behavior in social networks, Strategic Interaction in networks, Information Networks, Information Cascades, Cascading behavior in Networks, Diffusion in Network, Modeling, Cascades and Clusters, Diffusion, Thresholds, Six degrees of separation Decentralized search, Epidemics, Influence maximization, Outbreak detection, Markets and Information, Voting, Property Rights, Social Network Analysis Tools.

UNIT – IV SOCIAL SEMANTIC AND RECOMMENDER SYSTEM 9L

Modeling and aggregating Social Network Data – Network Data Representation, Ontological Representation of Social Individuals and Relationships – Aggregating and Reasoning with Social Network Data – Developing social-semantic applications - Recommendation in Communities - Social Collaboration Platforms-Recommendation Types- Partner Recommendation -Social Network-Based Collaboration .-Reputation Model - Structural Importance Model - Framework and Ranking Algorithm - Social Broker Recommendation - Virtual Organizations -Expert Communities - Broker Ranking .

UNIT – V VISUALIZING, MINING SOCIAL NETWORKS 9L

Taxonomy of Visualizations - Structural Visualization, Semantic and Temporal Visualization, Statistical Visualization, The Convergence of Visualization, Interaction and Analytics - Structural and Semantic Filtering with Ontologies, Centrality-based Visual Discovery and exploration, Mining Social Network Graphs - Clustering, Discovery of Communities, Partitioning, overlapping Communities, Simrank, Triangles in social networks, Neighborhoods, Transitive closure.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Grasp the fundamental principles of networks and social network analysis
2. Discover different community and analyzing information diffusion in social networks
3. Employ data mining and techniques for social network analysis.
4. Utilize advanced extraction and mining tools for social network analysis.
5. Develop personalized and immersive visualizations for social networks.
6. Design secure and ethical AI-powered social network applications.

REFERENCES:

1. Social Network Modelling and Analysis, Niyati Aggrawal, Adarsh Anand, Taylor and Francis, CRC Press, 2022
2. Social Networks and the Semantic Web, Peter Mika, Springer 2007
3. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeff Ullman, Cambridge University Press, 2011
4. Social Network data Analytics, Charu C Aggarwal, Springer, 2011
5. Networks, Crowds, and Markets reasoning about a highly connected world, David Easley and Jon Kleinberg, Cambridge University Press, 2010
6. Social Network Analysis and Education, Theory Methods & Applications by Brain V, Carolan, Sage Publications, 2014
7. Understanding Social Networks Theories, Concepts and Findings, Charles and Kadushin, Oxford University Press, 2012,
8. Analyzing Social Networks, Stephan P Borgatti, Martin G Everett, Jeffrey C Johnson, Sage Publications, 2017
9. Social Recommender Systems, Daniel Schall, Springer, 2015

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	-	-	2	2	-	2	-	-	-	2	2	2	2
2	2	2	2	-	2	-	-	2	-	-	2	2	2	2	2
3	3	2	2	2	3	1	1	2	1	1	3	2	2	2	2
4	3	2	2	3	3	2	1	1	1	2	3	2	3	3	3
5	2	2	3	3	3	2	-	2	2	2	3	3	2	2	2
6	2	3	3	3	3	2	-	2	2	2	3	3	2	2	2
AVg.	2	2	2	3	3	2	1	2	2	2	3	2	2	2	2

1-low, 2-medium, 3-high, '-"- no correlation

AD23012 **INFORMATION RETRIEVAL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To learn the goals, history, and basic models of information retrieval (IR)
2. To study tokenization, stop word removal, stemming, indexing and query operations to prepare data for effective retrieval.
3. Explore metrics such as recall, precision, and F-measure and learn about text representation.
4. To understand text categorization and clustering algorithms
5. To learn about recommender systems, collaborative and content-based filtering.

UNIT – I INTRODUCTION **9L**

Introduction – Goals and History of IR – The Impact of the Web on IR – The Role of Artificial Intelligence (AI) in IR – Basic IR Models – Boolean and Vector Space Retrieval Models – Ranked Retrieval – Text similarity metrics – TF-IDF (term frequency/inverse document frequency) Weighting – Cosine Similarity.

UNIT – II PREPROCESSING **9L**

Basic Tokenizing – Indexing and Implementation of Vector Space Retrieval – Simple Tokenizing – Stop Word Removal and Stemming – Inverted Indices –Efficient Processing with Sparse Vectors – Query Operations and Languages – Relevance Feedback – Query Expansion – Query Languages.

UNIT – III METRICS **9L**

Experimental Evaluation of IR – Performance metrics Recall, Precision and F measure – Evaluations on Benchmark Text Collections – Text Representation – Word Statistics – Zipf's Law – Porter Stemmer – Morphology – Index Term Selection using Thesauri –Metadata and Markup Languages – Web Search Engines – Spidering – Metacrawlers – Directed Spidering – Link Analysis Shopping Agents.

UNIT – IV CATEGORIZATION AND CLUSTERING **9L**

Text Categorization and Clustering – Categorization Algorithms – Naive Bayes – Decision Trees and Nearest Neighbor – Clustering Algorithms – Agglomerative Clustering – k Means – Expectation Maximization (EM) – Applications to Information Filtering – Organization and Relevance Feedback.

UNIT – V EXTRACTION AND INTEGRATION **9L**

Recommender Systems – Collaborative Filtering – Content Based Recommendation of Documents and Products – Information Extraction and Integration – Extracting Data from Text – XML – Semantic Web – Collecting and Integrating Specialized Information on the Web.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Build an Information Retrieval system using the available tools.
2. Apply indexing and query expansion techniques for efficient retrieval.
3. Apply performance metrics to validate any information retrieval system.
4. Apply machine learning techniques for text classification and clustering for efficient Information Retrieval.
5. Design and analyze the Web content structures.
6. Design and implement recommender and information extraction system.

REFERENCES:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze," Introduction to Information Retrieval", Cambridge University Press, 2008.
2. Ricci, F. Rokach, L. Shapira, B. Kantor, P.B. "Recommender Systems Handbook", Springer, 2011.
3. Brusilovsky, Peter, "The Adaptive Web Methods and Strategies of Web Personalization", Springer, 2007.
4. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Second Edition, Cambridge University Press, 2014.
5. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", Second Edition, ACM Press books, 2011.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	-	1	-	3	3	2	2	2	2	2
2	3	3	3	3	3	-	-	-	3	3	2	2	2	3	2
3	3	3	3	2	3	-	-	3	2	-	1	3	2	2	2
4	3	3	3	3	3	-	2	-	2	-	2	3	3	3	3
5	3	3	3	3	2	3	3	3	1	-	2	3	2	2	2
6	3	3	3	3	3	-	-	3	3	3	2	3	2	3	2
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**

1-low, 2-medium, 3-high, '-"- no correlation

IT23C08 **REINFORCEMENT LEARNING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce a range of topics related to Reinforcement Learning and probability concepts.
- To gain knowledge on the Markov Decision Process.
- To understand the Q-Learning and SARSA methods.
- To know about the Deep Learning in Reinforcement Learning.
- To gain knowledge on Policy Gradient Methods.

UNIT I BASICS OF REINFORCEMENTLEARNING **9**

Introduction to Reinforcement Learning–Elements of Reinforcement Learning– Scope – History of Reinforcement Learning– The Agent-Environment Interface – Examples of Reinforcement Learning – Why Study Reinforcement Learning – Challenges in Reinforcement Learning – Multi-arm Bandit Problem.

Suggested Activities:

1. Installation of Code Standards and Libraries used in RL (Python/Keras/Tensorflow).
2. Practical – Implement Tic-tac-toe and Armed Bandit Problem.

Suggested Evaluation Methods:

- Quiz on basic concepts of probability.

UNIT II MARKOV DECISION PROCESSES AND DYNAMIC PROGRAMMING **9**

Overview of Markov Chain - Overview of Markov Decision Process – Model Reinforcement Learning Problem using MDP – Markov Process – Markov Chain – Markov Decision Process – Alternative Bellman Equations for value functions – Optimal policy and optimal value functions – Using Dynamic programming to solve RL problems – Policy Evaluation – Policy Improvement – Policy Iteration – Value Iteration.

Suggested Activities:

- Practical – Develop Dynamic programming algorithms for solving MDPs, Policy Evaluation, Policy Iteration, Policy Improvement and Value Iteration.

Suggested Evaluation Methods:

- Evaluation of the practical implementations with appropriate input Dataset.

UNIT III MONTE CARLO AND TEMPORAL DIFFERENCING **9**

Monte Carlo Introduction – Policy Evaluation – Incremental Update – Exploration Vs Exploitation – Policy Improvement – Temporal Differencing Learning – TD Policy Evaluation – Epilon-Greedy policy – On-policy Vs Off-policy – Q-Learning – SARSA Learning – Double Q-Learning – Applications of Q-Learning – Grid Problems - N-Step Bootstrapping.

Suggested Activities:

Practical – Monte Carlo Prediction, Monte Carlo Off-Policy Control
Importance Sampling and SARSA
Tutorial on Deep Q Algorithm.
Practical – Implement Q-Learning (Off Policy TD Learning),

Suggested Evaluation Methods:

- Quiz on Deep Q algorithm and SARSA.
- External discussion on Monte carlo Methods
- External discussion on Temporal differencing

UNIT IV VALUE FUNCTION APPROXIMATION 9

Linear value function approximation – Challenge of Large-scale MDP – Value Function approximations – Stochastic Gradient Descent – Linear value and non-linear value approximation – Deep neural nets – Naïve Deep-Q Learning – Experience Replay – DQN for Games – DQN with Double-Q learning – Prioritized experience Replay – Advantage Function and Duelling Network Architecture.

Suggested Activities:

External discussion on Deep Learning

External discussion of CNN in Reinforcement Learning

Suggested Evaluation Methods:

- Tutorial on DQN
- Quizz on Deep Learning.

UNIT V ADVANCED DEEP REINFORCEMENT LEARNING 9

Policy Gradient Methods – Policy-Based methods – Policy Gradient – REINFORCE – Baseline – Actor-Critic Methods -Problems with Continuous Action space – Problems with Standard Methods – Policy Performance Bounds – Proximal Policy Optimization -Latest Trends – Distributed Reinforcement Learning – Curiosity Driven Exploration – Random network Distillation – Planning with AlphaZero.

Suggested Activities:

- Survey of policy gradient methods.
- Evaluation on Policy performance bounds.

Suggested Evaluation Methods:

- Survey of Latest Trends
- Study of AlphaZero Algorithms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand different terminologies of RL and Concepts of Probability.

CO 2. Illustrate the Markov Decision Process and Bellman Equation for learning.

CO 3. Apply dynamic programming techniques to the Markov decision process and Monte Carlo methods

CO 4. Implement Time difference learning for real-world problems

CO 5. Apply Approximation methods of learning and Q-learning technique.

TEXTBOOKS:

1. Richard S.Sutton and Andrew G.Barto, Reinforcement learning: An introduction, Second Edition, MIT Press, 2019.
2. Michael Hu, The Art of Reinforcement Learning – Fundamentals, Mathematics and Implementations with Python, Apress, 2024**.**

REFERENCES:

1. Sudharsan Ravichandiran, Deep Reinforcement Learning with Python, Second Edition, Packet Publishing, Birmingham, 2020.
2. Csaba Szepesvari, Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning), Morgan & Claypool Publishers, 2010.
3. Laura Graesser and Wah Loon Keng, Foundations of Deep Reinforcement learning: theory and Practice in Python, Pearson India, New Delhi, 2022.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO2	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO3	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO4	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO5	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23013	PREDICTIVE ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand the fundamentals of predictive analytics, the CRISP-DM process, data roles, and statistical tools.
2. Learn how to prepare and preprocess data, handle missing values, and select features for predictive modeling.
3. Study and use various models like decision trees, logistic regression and neural networks.
4. Understand time series analysis, including trend and seasonality, and apply forecasting methods.
5. Study deep learning, unsupervised learning, ensemble methods and consider ethical issues in predictive analysis.

UNIT – I INTRODUCTION TO PREDICTIVE ANALYTICS 9L

Overview of Predictive Analytics - The CRISP-DM Process Model for Predictive Analysis - The role of data in Predictive Analysis - Data Understanding - Data Visualization - The Value of Statistical Significance - Statistical concepts and tools for Predictive Analysis.

UNIT – II DATA PREPARATION AND FEATURE SELECTION 9L

Understanding the importance of data quality for Predictive Analysis - Data Preparation - Data pre-processing - Dealing with missing data and outliers - Feature selection/creation techniques - Exploratory data analysis for predictive modelling.

UNIT – III PREDICTIVE MODELING TECHNIQUES 9L

Introduction to Modeling - Descriptive Modeling- Data Preparation Issues with Descriptive Modeling - Predictive modeling techniques - Decision Trees - Logistic Regression -Neural Network Model – K-Nearest Neighbors – Naive Bayes – Regression Models - Linear Regression - Other Regression Algorithms - Parameter tuning and hyperparameter optimization - Evaluating model performance and metrics – Model Ensembles.

UNIT – IV TIME SERIES ANALYSIS AND FORECASTING 9L

Introduction to Time Series Analysis and Forecasting - Components of time series - Trend and Seasonality analysis – ARIMA, LSTM modeling and forecasting - Exponential smoothing techniques – Model Evaluation - Applications.

UNIT – V ADVANCED TOPICS IN PREDICTIVE ANALYSIS 9L

Deep Learning and its applications in Predictive Analysis - Unsupervised Learning techniques - Clustering and Association Rule Mining - Ensemble Learning and Model Stacking techniques - Ethical and legal considerations in Predictive Analysis – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Grasp the fundamental concepts of predictive analytics and its applications.
1. Understand the pre-processing of the data and importance of feature selection.

2. Perform exploratory data analysis to gain insights into data patterns.
3. Get hands-on practice with various predictive modeling techniques.
4. Acquire skills in model evaluation, model selection and model validation.
5. Apply predictive analytics to real-world problems using analytics software.

REFERENCES:

1. Dean Abbott, “Applied Predictive Analytics-Principles and Techniques for the Professional Data Analyst”, Wiley, 2014.
2. Daniel T. Larose, Chantal D. Larose, “Data Mining and Predictive Analytics”, Wiley, 2015.
3. Anasse Bari, Mohammad Chaouchi, Tommy Jung, Predictive Analytics for Dummies, 2nd Edition, 2017.
4. Alberto Cordoba, “Understanding the Predictive Analytics Lifecycle”, Wiley, 2014
5. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Third Edition, Elsevier, 2012.
6. Conrad Carlberg, “Predictive Analytics: Microsoft Excel”, 1st Edition, Que Publishing, 2012.
7. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. An Introduction to Statistical Learning with Applications in R Springer 2013.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	2	2	2	2	3	3	3	3	2
2	3	3	3	3	3	3	2	2	2	2	3	3	3	3	2
3	3	2	2	3	3	2	2	2	2	2	2	2	3	3	2
4	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3
5	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3
6	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3
AVg.	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**2.5**	**2.5**	**2**	**3**	**3**	**2.5**	**3**	**2.5**

1-low, 2-medium, 3-high, ‘-“- no correlation

VERTICAL III - MULTIMODAL PROCESSING

AD23014	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Learn fundamental concepts, digital imaging systems, pixel connectivity, and color models in image processing
2. Explore image transforms and enhancement methods in both spatial and frequency domains.
3. Study multi-resolution techniques, wavelet transforms, image degradation models, and restoration algorithms.
4. Learn methods for image segmentation, edge detection, and feature extraction using algorithms.
5. Understand image classification with supervised learning, and clustering with unsupervised methods.

UNIT – I FUNDAMENTALS OF IMAGE PROCESSING 9L

Introduction – Applications of Image Processing – Steps in Image Processing Applications –Digital Imaging System – Sampling and Quantization – Pixel Connectivity – Distance Measures – Colour Fundamentals and Models – File Formats – Image Operations.

UNIT – II IMAGE ENHANCEMENT 9L

Image Transforms: Discrete Fourier Transform – Fast Fourier Transform – Discrete Cosine Transform – Image Enhancement in Spatial and Frequency Domain – Grey Level Transformations – Histogram Processing –Spatial Filtering – Smoothing And Sharpening – Frequency Domain: Filtering in Frequency Domain.

UNIT – III IMAGE RESTORATION AND MULTI-RESOLUTION ANALYSIS 9L

Multi Resolution Analysis: Image Pyramids – Multi Resolution Expansion – Wavelet Transforms – Image Restoration – Image Degradation Model – Noise Modeling – Blur – Order Statistic Filters – Image Restoration Algorithms.

UNIT – IV IMAGE SEGMENTATION AND FEATURE EXTRACTION 9L

Image Segmentation – Detection of Discontinuities –Edge Operators –Edge Linking and Boundary Detection – Thresholding – Region based Segmentation – Image Features and Extraction – Image Features – Types of Features – Feature extraction – SIFT, SURF and Texture – Feature reduction algorithms.

UNIT – V IMAGE PROCESSING APPLICATIONS 9L

Image Classifiers – Supervised Learning – Support Vector Machines, Image Clustering – Unsupervised Learning – Hierarchical and Partition based Clustering Algorithms – EM Algorithm.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Implement basic image processing operations.
2. Apply and develop new techniques in the areas of image enhancement and restoration.
3. Understand the image segmentation algorithms.
4. Extract features from images.
5. Apply classifiers and clustering algorithms for image classification and clustering.
6. Design and develop an image processing application that uses different concepts of image processing..

REFERENCES:

1. Rafael Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.
2. S. Sridhar, “Digital Image Processing”, Second Edition, Oxford University Press, 2016.
3. Anil K. Jain, “Fundamentals of Digital Image Processing”, PHI, 2011.
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision”, Fourth Edition, Cengage India, 2017.

Mapping of CO with PO

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2
CO2	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2
CO3	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2
CO4	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2
CO5	2	2	3	2	2	2	1	2	2	2	2	2	2	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23025	TEXT AND SPEECH ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand the architecture, preprocessing, and key algorithms for text mining
2. Explore techniques for document representation, feature selection, various classifiers and clustering methods.
3. Study articulatory and acoustic phonetics and analyze fundamental digital signal processing techniques relevant to speech.
4. Learn methods for extracting and comparing speech features and techniques for time alignment and normalization.
5. Explore hidden Markov models for speech processing and understand large vocabulary continuous speech systems.

UNIT – I INTRODUCTION 9L

Overview of text mining- General Architecture – Algorithms – Preprocessing – basics of document classification - information retrieval - clustering and organizing documents - information extraction-prediction and evaluation - Textual information to numerical vectors - document standardization-tokenization - lemmatization vector generation for prediction - sentence boundary determination - evaluation performance-Probabilistic language models based on sequences of words: N-grams.

UNIT – II TEXT CATEGORIZATION AND CLUSTERING 9L

Text Categorization – Definition – Document Representation –Feature Selection - Decision Tree Classifiers - Rule-based Classifiers - Probabilistic and Naive Bayes Classifiers - Linear Classifiers Classification of Linked and Web Data - Meta-Algorithms– Clustering –Definition- Vector Space Models - Distance-based Algorithms- Word and Phrase-based Clustering - Semi-Supervised Clustering - Transfer Learning-Text Summarization techniques.

UNIT – III BASIC CONCEPTS IN SPEECH PROCESSING 9L

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT – IV FEATURE EXTRACTION IN SPEECH 9L

Features - Feature Extraction and Pattern Comparison Techniques - Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT – V SPEECH MODELING AND RECOGNITION 9L

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – Ngrams, context dependent sub-word units-Gaussian Mixture Models (GMMs) for acoustic modeling.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Identify the different features that can be mined from text and web documents.
2. Understand classification and clustering of text data.
3. Understand basics of digital speech processing.
4. Explore features in speech data for application development.
5. Apply concepts in speech recognition.
6. Perform speech analysis for different applications.

REFERENCES:

1. Weiss S.M., Indurkhya N., Zhang T., Damerau F., “Text Mining: Predictive Methods for Analyzing Unstructured Information”, Springer, 2005
2. Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Third Edition, 2022.
3. Ronen Feldman, James Sanger “The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data”-Cambridge University press, 2009.
4. Michael Berry, — “Survey of Text Mining: Clustering- Classification- and Retrieval”, Springer, 2004
5. Lawrence Rabinerand Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	3	2	1	2	2	3	1	3	2	3	2
2	3	3	2	2	3	2	1	2	2	3	1	3	2	3	2
3	3	2	1	2	2	1	1	2	2	3	1	3	1	1	1
4	3	2	2	3	3	1	1	2	2	3	1	3	1	3	2
5	3	3	3	3	3	2	1	2	2	3	2	3	1	1	2
6	3	3	3	3	3	2	1	2	2	3	2	3	1	3	2
AVg.	3	3	2	3	3	2	1	2	2	3	1	3	1	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23015 AI BASED MOBILE APPLICATION DEVELOPMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To identify different types of mobile applications
2. Develop Android applications using XML, Java/Kotlin, and SDK tools.
3. Create iOS applications using Objective-C/Swift, XCode, and SDK tools.
4. Integrate AI technologies into mobile applications by exploring AI-powered features and applications.
5. Apply AI tools such as CoreML, TensorFlow, ML Kit, and OpenCV to build and implement AI features in mobile applications.

UNIT – I INTRODUCTION 9L

Mobile Applications – Types of Mobile Applications – Mobile Web, Native Applications, Hybrid Applications - Characteristics and Benefits - Mobile Frameworks and Tools – Web Based Cross Frameworks-Native Based Cross Frameworks-Xamarin-Codename One-Flutter-React Native-Native Script-Pros and Cons; Mobile Platforms – Types: Mobile App UI/UX Design Tools.

UNIT – II ANDROID APPLICATION DEVELOPMENT 9L

Introduction to Android – Architecture – SDK Tools – Languages for Android - XML – Java / Kotlin - UI Widgets – Layouts – Event Handling - Overview of Application Components - Android Intents, Types - SQLite Database – CRUD.

UNIT – III IOS APPLICATION DEVELOPMENT 9L

Introduction to iOS- architecture – features – XCode and SDK tools – Objective C / Swift – UI Controls – Container Views – Event Handling - Overview of iOS Data Persistence – Connectivity: SQLite Database with iOS application.

UNIT – IV AI IN MOBILE APPLICATION DEVELOPMENT 9L

AI technologies for mobile applications - A simple AI based Chatbot using Android / iOS; AI powered mobile apps – Architecture: Google Assistant, Siri, Replika, Cortona, Elsa – FaceApp, Amazon Alexa.

UNIT – V AI TOOLS FOR MOBILE APPLICATION DEVELOPMENT 9L

Usage of AI in mobile apps; Build AI mobile apps – Implementation considerations; AI tools: CoreML-TensorFlow – ML Kit -OpenCV – Caffe2 – Emerging AI applications in smartphones.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the frameworks, platforms and tools of mobile application development.
1. Learn native Android application development using Java / kotlin.
2. Understand native iOS application development using Objective-C / Swift.
3. Learn implementation aspects of AI in mobile application development.
4. Develop AI based mobile application using Android / iOS.

REFERENCES:

1. Laurence Moroney, “AI and Machine Learning for On-Device Development: A Programmer's Guide”, O'Reilly Media, 1st Edition, 2021.
2. Dawn Griffiths and David Griffiths, “Head First Android Development: A Learner's Guide to Building Android Apps with Kotlin”, Shroff/O'Reilly, 3rd edition, 2021.
3. Ahmad Sahar and Craig Clayton, “iOS 15 Programming for Beginners: Kickstart your mobile app development journey by building iOS apps with Swift 5.5 and Xcode 13”, Packt Publishing, 6th edition, 2021.
4. Jakob Iversen, Michael Eierman, “Mobile App Development for iOS and Android”, Prospect Press, 2nd edition, 2017.
5. Reto Meier, “Professional Android 4 Development”, John Wiley and Sons, 2012
6. Professional mobile Application Development paperback,2012 Jeff Mcherter
7. (Author),Scott Gowell (Author), Wiley India Private Limited
8. https://www.apptunix.com/blog/artificial-intelligence-tools-for-mobile-app-development/
9. https://www.tensorflow.org/lite/examples
10. https://www.leewayhertz.com/how-to-build-ai-powered-mobile-apps/

Mapping of CO with PO

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	-	1	-	-	-	1	1	-	1	1	1	1
2	1	3	3	2	3	1	1	2	3	1	3	2	3	3	3
3	1	3	3	2	3	1	1	2	3	1	3	2	3	3	3
4	1	2	3	2	3	1	1	2	1	1	1	2	1	1	1
5	1	3	3	3	3	1	1	3	3	1	3	2	2	3	3
Avg	**1**	**2.4**	**2.6**	**2.25**	**2.6**	**1**	**1**	**2**	**2.2**	**1**	**2.5**	**1.8**	**2**	**2**	**2**

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C04	AUGMENTED AND VIRTUAL REALITY	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To know the fundamentals of augmented and virtual reality
- To acquire the knowledge about computing hardware related to VR
- To understand the tools and techniques used in VR implementation
- To understand the tools and techniques used in AR implementation
- To explore various application domains of AR/VR

UNIT I INTRODUCTION 9

Introduction to Virtual Reality – Definition – Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Augmented Reality – Definition – Modeling the Real Environment – Sensing & Reconstruction – Displays – User Interfaces – Applications.

Suggested Activities:

- Blended learning – mixed reality

Suggested Evaluation Methods:

- Quiz on mixed reality techniques

UNIT II VR COMPUTING ARCHITECTURE 9

Computing Architectures of VR – Rendering Principle – Graphics and Haptics Rendering – PC Graphics Architecture – Graphics Accelerators – Graphics Benchmarks – Workstation Based Architectures – SGI Infinite Reality Architecture – Distributed VR Architectures - Multi-pipeline Synchronization – Collocated Rendering Pipelines – Distributed Virtual Environments – AR Architecture

Suggested Activities:

- Flipped classroom – Graphics processing units
- Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung Gear VR

Suggested Evaluation Methods:

- Assignments on parallel computing and GPUs

UNIT III VR MODELING & PROGRAMMING 9

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 - VR Programming – Toolkits and Scene Graphs – World Toolkit – Java 3D – Comparison of World Toolkit and Java 3D – GHOST – People Shop

Suggested Activities:

- Development of AR/VR scenes

Suggested Evaluation Methods:

- Practical – Development of simple game using AR/VR techniques

UNIT IV AUGMENTED REALITY TECHNOLOGIES 9

Vision-Based 3D Tracking and Pose Estimation – AR in spatial uncertainty – HMD for AR – Projector-based AR – Mobile phone-based AR – Screen Spaces of AR - Mixed Reality for Robots – User-centered HRI – Mental Transformation in HRI – Computational Cognitive Modeling – Evaluating the usability of the virtual environment – Security Robot-Spatial Computing.

Suggested Activities:

- Flipped classroom – Various marker and marker-less AR techniques

Suggested Evaluation Methods:

- Practical - Develop a AR enabled scene in Unity

UNIT V APPLICATIONS OF VR/AR **9**

Traditional VR Applications – Medical Applications- Education, Art & Entertainment – Military – Virtual Prototyping – Manufacturing – Robotics – Visualization – AR in Industry – Augmented Virtual Environments – Memories in AR – Social & Interactive Paradigms – Future of AR Gaming-Role of Generative AI in Mixed Reality

Suggested Activities:

- Flipped classroom – Recent research trends in AR/VR

Suggested Evaluation Methods:

- Practical - Create an AR application for educational purposes

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand Virtual Reality and Augmented Reality technologies.
CO 2. Apply knowledge of computing architectures in the development of Virtual Reality systems
CO 3. Create Virtual Reality models using various modelling techniques
CO 4. Utilize AR technologies for creating AR enabled applications
CO 5. Develop domain specific interactive and immersive experience applications

TEXTBOOKS:

1. Claudia Tom Dieck,Timothy H. Jung , Sandra M. C. Lourei, “Augmented Reality and Virtual Reality: New Trends in Immersive Technology”, Packt Publisher.2021
2. Virtual Reality By Samuel Greengard, MIT Press, 2019
3. RalfDoerner, Wolfgang Broll, Paul Grimm and Bernnard Jung, “Virtual and Augmented Reality (VR/AR)”, Springer Publication, 2023
4. Burdea GC, Coiffet P, “Virtual reality technology”, Second Edition, Wiley-IEEE Press, 2006

REFERENCES:

1. Mihelj, Matjaž, Domen Novak, and Samo Beguš. "Virtual reality technology and applications" Springer Publication, 2014
2. Haller M, Billinghurst M, Thomas B, editors. “Emerging technologies of augmented reality: Interfaces and design”, IGI Global; 2006
3. Hale KS, Stanney KM, “Handbook of virtual environments: Design, implementation, and applications”. CRC Press; 2014

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	1	3	-	-	-	-	-	-	2	3	3	3
CO2	2	3	3	2	3	1	-	-	1	-	2	2	3	3	3
CO3	3	3	3	2	3	1	-	-	1	-	2	2	3	3	3
CO4	3	2	3	3	3	2	-	2	1	-	2	2	3	3	3
CO5	2	2	3	3	3	2	1	2	1	1	2	2	3	3	3
AVG	2.5	2.6	3	2.2	3	1.5	1	2	1	1	2	2	3	3	3

IT23C06	GAME DESIGN AND DEVELOPMENT	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To train the students to acquire knowledge in game design and development
- To learn the mathematics behind game development
- To know the mechanics involved in game design
- To acquire knowledge about the algorithms related to game development
- To survey the gaming development environment and tool kits

UNIT I INTRODUCTION TO GAME DESIGN 9

Games- Designing and Developing Games-Genres- Understanding: Players, Machine-Game: Concepts, Worlds-Creative and Expressive Play- Character Development-Storytelling—Screenplay-Storyboard-Pre-visulaization- Script-Creating User Experience-Game play- Introduction to Core Mechanics- Game Balancing- Level Design

Suggested Activities:

- Flipped Classroom: Get to know about different types of Game genre and animation.
- External Learning: Practical problems in game level design and Game Balancing.

Suggested Evaluation Methods:

- Tutorial – Story telling
- Assignments on creating user experience
- Quizzes on game core mechanics

UNIT II FOUNDATIONS TO GAME DESIGN 9

Cartesian Coordinate Systems-Vectors-Linear Interpolation- Multiple Coordinate Spaces-Matrices and Linear –Transformations - Polar Coordinate Systems-3D Rotations, Transformation, Scaling - Geometric Primitives-Viewing in 3D-Viewing Pipeline-Clipping Algorithms-Text Transformation.

Suggested Activities:

- Flipped Classroom: Knowing Vector and Curve generation algorithm
- External learning - problems in translation, scaling, zooming and rotation of 2D and 3D objects.

Suggested Evaluation Methods:

- Tutorial - 2D and 3D transformations.
- Quizzes on Geometric Primitives and camera viewing

UNIT III MECHANICS FOR GAME DESIGN 9

Linear Kinematics and Calculus –Linear and Rotational Dynamics –Curves and Surfaces- Curves in 3D – Lighting-Shading - Shadowing- Depth Cueing- Projections - Perspective - Orthogonal -Intersection Testing - Rigid Body Dynamics - Animation System – Controller based animation- Cameras Details.

Suggested Activities:

- Flipped Classroom : Discussion of Lighting and shading of objects, Open source language for Game development like PyGame
- Blended Classroom: Installation of PyGame and Controller based animation and sound.

Suggested Evaluation Methods:

- Tutorial –Camera Details
- Evaluation of programming exercises for Python/Unity implementation.
- Assignments on Rigid body dynamics.

UNIT IV ARCHITECTURE AND ALGORITHMS FOR GAME DEVELOPMENT 9

Foundation- Low-Level Engine System – State Based Behaviours – Strategy and Planning-Game Play - Path and Waypoints – Navigation – Behaviours - Collision Detection - Game Logic - Game Artificial Intelligence - Spatial Sorting - singleton - Object pooling-Basic Sound – 3D Sound - Event-Based Input Systems

Suggested Activities:

- Flipped classroom on game theory

- External learning –Navigation and Behaviors

Suggested Evaluation Methods:

- Tutorial problems in collision detection
- Assignments on game AI and path finding

UNIT V LANGUAGES FOR GAME DEVELOPMENT 9

Scripting Languages and Data Format – PyGame/Unity-Networked Games – Sample Game – iOS, Windows, Android-Developing 2D and 3D interactive games using Unity - DirectX – Isometric and Tile Based Games - Puzzle games - Single Player games - Multi Player game-Marker Systems

Suggested Activities:

- Flipped classroom on gaming environments
- External learning on Unity Game Engine. Pygame routines for character rendering, transformations and sound processing
- Blended Classroom: Writing story board and game level for different games and Installation of Pygame/ Unity
- Producing game level design document, detailed document.

Suggested Evaluation Methods:

- Tutorial - Writing Unity scripts and assets.
- Assignments on Unity Game Engine
- Quizzes of all topics related to Unity and Pygame., design document

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the concepts and techniques used in game development.
CO 2. Understand the mathematical and graphical concepts used for game development
CO 3. Apply the physical and mechanical concepts for interactive and real time game development
CO 4. Design and develop algorithms for effective gaming environments
CO 5. Create and implement various applications for game development.

TEXTBOOKS:

1. Adam Kramarzewski and Ennio De Nucci, " Practical Game Design: A modern and Comprehensive Guide to Video game Design" Packt Publishing Ltd.2023
2. Mastering Game Design with Unity 2021: Immersive Workflows, Visual Scripting, Physics Engine, Game Objects" , BPB Publications, 2022
3. Sanjay Madhav, "Game Programming Algorithms and Techniques: A Platform Agnostic Approach", Addison Wesley,2013
4. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", First edition, Prentice Hall 2006

REFERENCES:

1. Sebastiano M.Cossu, "Beginning Game AI with Unity: Programming Artificial Intelligence with C#", Apress, 2020.
2. James M, Van Verth, Lars M.Bishop, "Essential Mathematics for Game anf Interactive Application", Third Edition, CRC Press, 2015.
3. Michael Dawson, "Beginning C++ Through Game Programming", Fourth Edition, Cengage Learning PTR, 2015.
4. Jason Gregory, "Game Engine Architecture", Third Edition, A K Press, 2015.
5. Fletcher Dunn, LanParberry ," 3D Math Primer for Graphics and Game Development", Second Edition, CRC Press, 2011.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	3	3	3	-	-	-	-	-	-	2	3	2	3
CO2	3	3	3	3	3	-	-	-	2	-	-	2	3	2	3
CO3	3	3	3	3	3	-	-	-	2	-	-	2	3	2	3
CO4	2	3	3	3	3	1	2	1	2	1	2	2	3	3	3
CO5	2	3	3	3	3	1	2	-	2	1	2	2	3	3	3
CO6	2.5	3	3	3	3	1	2	1	2	1	2	2	3	2	3

AD23016	EXPLAINABLE AI	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamentals of Explainable AI (XAI).
2. Learn to interpret various machine learning models.
3. Explore model-agnostic XAI techniques for generating explanations across different models.
4. To apply XAI methods to deep learning models.
5. Evaluate XAI methods and address ethical considerations.

UNIT – I INTRODUCTION TO XAI 9L

Introduction to Explainable AI: Motivation, Importance - Challenges and limitations of black box models - Types of Explainability – taxonomy of explanations - Interpretability – Importance of Interpretability - Taxonomy of Interpretability Methods - Scope of Interpretability - Evaluation of Interpretability - Properties of Explanations - Human-friendly Explanations

UNIT – II INTERPRETABLE MACHINE LEARNING MODELS 9L

Overview of Interpretable Machine Learning – Decision Trees, Random Forests – principles, interpretation techniques, Rule based Models – Rule induction, Decision list, rule-based classifiers, Linear models – Interpreting Coefficients, regularization techniques, feature selection.

UNIT – III MODEL AGNOSTIC XAI TECHNIQUES 9L

Overview of model Agnostic systems – LIME – local feature importance explanations – SHAP – individual predictions and feature importance – Partial Dependence Plot – Individual Conditional Expectation Plot - Counterfactual explanations.

UNIT – IV XAI FOR DEEP LEARNING 9L

XAI for deep learning models - Gradient-based methods: Grad-CAM, Integrated gradients, Saliency Maps – Layer wise relevance propagation (LRP)– feature visualization- Deep Dream – Activation Maximization

UNIT – V EVALUATION AND ETHICAL CONSIDERATIONS 9L

Evaluating XAI Methods - Metrics and criteria for evaluating explanation - Human-in-the-loop evaluation - User studies and feedback - Ethical Considerations in XAI - Bias, fairness, and transparency - Privacy and security concerns - Social and legal aspects of XAI – Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Recall Taxonomy of explanations.
1. Understand interpretable machine learning principles of decision tree, rule based and linear models.
2. Apply Model Agnostic XAI techniques, interpret and explain predictions of machine learning models.

3. Develop XAI techniques for deep learning models.
4. Evaluate XAI methods and Propose innovative solutions to address ethical considerations
5. Apply XAI techniques in practical scenarios, for real-world datasets and problems.

REFERENCES:

1. Christoph Molnar, “Interpretable Machine Learning: A Guide for Making Black Box Models Explainable”, 2022. (This is a comprehensive book available as a free online resource: https://christophm.github.io/interpretable-ml-book/)”, Springer, 2019.
2. Uday Kamath, John Liu, “Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning”, 2021.
3. Leonida Gianfagna, Antonio Di Cecco, Explainable AI with Python, Springer, 2021.
4. Denis Rothman, “Hands-On Explainable AI (XAI) with Python: Interpret, Visualize, Explain, and Integrate Reliable AI for Fair, Secure, and Trustworthy AI Apps”, Packt Publishing Ltd, 2020.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	2	1	1	2	2	1	3	2	2	1
2	3	3	3	2	2	2	1	2	2	3	1	3	3	3	3
3	3	3	3	3	3	2	1	2	2	3	1	3	3	3	3
4	3	3	3	3	3	2	1	2	2	3	1	3	3	3	3
5	3	3	3	3	3	3	1	3	3	3	2	3	2	3	3
6	3	3	3	3	3	2	1	2	3	3	1	3	3	3	3
AVg.	3	3	3	2.83	2.83	2.16	1	2	2.33	2.8	1.16	3	2.66	2.8	2.66

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C11	METAVERSE	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To know the fundamentals related to metaverse
- To understand immersive technologies and usage of non-fungible tokens in metaverse
- To learn AI techniques related to metaverse
- To explore the learning algorithms usage in metaverse
- To survey the various real-time applications of metaverse

UNIT I INTRODUCTION OF METAVERSE 9

Evolution of metaverse – Interoperability – Architectural components and technological foundation – Metaverse vs web 3.0, Augmented Reality(AR) / Virtual Reality (VR); Blockchain/cryptocurrency – Metaverse application ecology and economy.

Suggested Activities:

- Flipped classroom: mixed reality techniques

Suggested Evaluation Methods:

- Assignment on usage of mixed reality techniques in metaverse
- Practical – Development of metaverse environment

UNIT II IMMERSIVE TECHNOLOGIES AND NFT 9

Roles of immersive technologies: AR, VR, MR - advancements in display technologies, haptics, audio – Virtual worlds within metaverse – Non Fungible Tokens(NFT) for metaverse – Decentralized governance – NFT distribution channels – NFT-based metaverse revenue model.

Suggested Activities:

- Blended learning – Distributed Non-fungible tokens

Suggested Evaluation Methods:

- Practical – Development and monetization of metaverse

UNIT III METAVERSE ESSENTIALS 9

Metaverse tokens and land - Identity and avatars in metaverse –AI mixed with Computer Generated Imagery- Photorealistic Avatars– social networks and communities – user engagement – virtual education and learning – Metaverse design dimensions and development process.

Suggested Activities:

- Tutorials – Creation of avatars in metaverse

Suggested Evaluation Methods:

- Practical – Implementation of AI algorithms and social media in metaverse development

UNIT IV METAVERSE INTELLIGENCE 9

SDKs, tools – services for natural language processing, machine learning, data mining, and recommendation systems – services for cyberspace encryption, and federated learning - UI prototyping, and accessible and inclusive UX design.

Suggested Activities:

- Blended learning – Usage of learning algorithms and NLP techniques in metaverse creation

Suggested Evaluation Methods:

- Practical – Implementation of cybersecurity techniques in metaverse

UNIT V METAVERSE CASE STUDIES 9

Metaverse prototypes for expressive arts and NFT – Digital museums in Metaverse – NFT and artworks trading, expressive art creations – Live performance – Metaverse prototypes for healthcare and mental well-being, including teletherapy, teleoperation, rehabilitation.

Suggested Activities:

- Tutorials – Metaverse in educational applications

Suggested Evaluation Methods:

- Practical – Develop a domain based metaverse application

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the evolution of the metaverse and its significance in the digital realm

CO 2. Understand the impact of immersive technologies, such as AR, VR, and MR, on the metaverse.

CO 3. Apply key metaverse essentials in design and development processes.

CO 4. Analyse the available SDKs, tools, and services for applying intelligence in the metaverse

CO 5. Implement various metaverse prototypes for creating expressive arts, NFTs, and healthcare applications

TEXTBOOKS:

1. Cathy Hackl, Dirk Lueth, and Tommaso Di Bartolo. Navigating the metaverse: A guide to limitless possibilities in a Web 3.0 world. John Wiley & Sons, 2022
2. Matthew Ball, Matthew. The metaverse: and how it will revolutionize everything. Liveright Publishing, 2022
3. Eliane Schlemmer, Luciana Backes, “Learning in Metaverses: Co-Existing in Real Virtuality”, IGI Global, 2014

REFERENCES:

1. Bruno Arnaldi, Pascal Guitton, and Guillaume Moreau, “Virtual reality and augmented reality: Myths and realities”, John Wiley & Sons, 2014

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	3	3	1	1	-	-	2	-	-	2	3	2	3
CO2	2	3	3	3	2	1	-	-	2	-	-	2	3	2	3
CO3	2	3	3	3	2	1	-	-	2	-	1	2	3	2	3
CO4	2	3	3	3	2	1	-	-	2	-	1	2	3	2	3
CO5	2	3	3	3	2	1	-	-	2	-	1	2	3	2	3
AVG	**2**	**3**	**3**	**3**	**1.8**	**1**	**-**	**-**	**2**	**-**	**1**	**2**	**3**	**2**	**3**

VERTICAL IV - NETWORK AND SECURITY

AD23017	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand fundamental cryptographic concepts.
2. Explore cryptographic systems along with their vulnerabilities and attacks, including linear and differential cryptanalysis.
3. Learn about hash functions and digital signatures.
4. Study key agreement and distribution techniques.
5. Explore and analyse security applications across various domains.

UNIT – I INTRODUCTION TO CRYPTOGRAPHY 9L

Basics of Security – CIA Triad – Threats, Attacks and Services- Trust Models.- Basics of Modular Arithmetic - Classical Cryptography – Substitution – Transposition - Cryptanalysis of substitution ciphers – Basics of Cryptographic systems – symmetric key – asymmetric key– hash functions – cryptographic algorithms - Block – Stream Ciphers – Public key algorithms

UNIT – II CRYPTOGRAPHIC SYSTEMS 9L

DES – Block Cipher modes of operation – Linear cryptanalysis – Differential Cryptanalysis – Triple DES - AES - Public Key Cryptosystems – Number Theory Concepts - RSA – ELGamal Cryptosystem, Diffie-Hellman Key Exchange, Fields, Elliptic Curve Arithmetic - Elliptic Curve Cryptography – Attacks - Side channel attack - Merkle-Hellman knapsack attack - Hellman's time-memory tradeoff (TMTO) attack.

UNIT – III HASH FUNCTIONS AND DIGITAL SIGNATURES 9L

Message Authentication and Hash Functions - Secure Hash Algorithms – SHA 512 - Message Authentication Codes – Weak and Strong MACs – HMAC - Digital Signature Schemes - RSA – Elgamal – Digital Signature Standard - Attacks on Digital Signature - Digital Signatures and Authentication Protocols.

UNIT – IV KEY AGREEMENT AND DISTRIBUTION 9L

Identification Scheme and Entity Attenuation-Challenge and Response in the Secret-key setting-Challenge and Response in the Public key Setting - Schnorr Identification Scheme - Key Pre-distribution - Unconditionally Secure key Pre-distribution - Key Agreement Scheme - Diffie-Hellman Key agreement - Public key infrastructure-PKI - Certificates - Zero Knowledge Proofs and Protocols

UNIT – V SECUIRTY APPLICATIONS 9L

Database Security- Cloud Security – XML security – OS security - Web security- Cross Site Scripting, Cross Site Request Forgery, SQL Injection – Firewalls – VPN Security- Application layer Security – PGP, Transport layer Security – SSL, Network layer Security – IPSec.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Apply the basic security algorithms and policies required for a computing system.
1. Develop skills to use both symmetric and asymmetric key cryptography to ensure confidentiality.
2. Utilize specific hash functions and Mac algorithms for security applications.
3. Evaluate the application of different digital signature schemes in solving real world problems.
4. Critically analyze the challenges in symmetric and asymmetric key distribution.

REFERENCES:

1. William Stallings, “Cryptography and Network security Principles and Practices”, Pearson/PHI, Seventh Edition, 2017.
1. Douglas R. Stinson ,“Cryptography Theory and Practice ”, Fourth Edition, Chapman & Hall/CRC,2019
2. Wenbo Mao, “Modern Cryptography Theory and Practice”, Pearson Education, 2004.
3. Pfleeger and Pfleeger, “Security in computing”, Third Edition , PHI/Pearson, 2003.
4. Behrouz Forouzan, Debdeep Mukhopadyay, “Cryptography and Network Security”, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
5. Gilles van Assche, “Quantum Cryptography and Secret-Key Distillation”, Cambridge University Press, 2010.

   Menges A. J , Oorschot P, Vanstone S.A,“Handbook of Appliled Cryptography” CRC Press, 2001 Reprint.

Mapping of CO with PO

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	2	2	1	2	3	1	3	3	3	3
2	3	3	3	3	2	2	2	1	2	3	1	3	3	3	3
3	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
4	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
5	3	3	3	3	2	2	2	1	3	3	1	3	3	3	3
Avg	3	3	3	3	2	2	2	1	2.6	3	1	3	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C05	BLOCKCHAIN AND CRYPTOCURRENCY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore the working mechanism of Blockchain technology
- To understand distribution consensus related techniques
- To learn bitcoin related methodologies.
- To explore the emerging development tools, framework in Blockchain networks
- To develop decentralized applications using various tools

UNIT I INTRODUCTION TO BLOCKCHAIN 9

The history of blockchain and Bitcoin - Electronic cash - Peer-to-peer- structure-genesis block - Distributed ledger-Cryptographically-secure Append-only - Updatable via consensus - Generic elements of a blockchain - How blockchain works -How blockchain accumulates blocks-Benefits and limitations - Tiers of blockchain technology -Features -Types of blockchain

Suggested Activities:

- Flipped classroom on peer-to-peer systems
- Implementation of hashing algorithms.
- Verifying message authentication using digital signatures

Suggested Evaluation Methods:

- Assignment to be given on public crypto systems and Digital signatures
- Explore the features of blockchain

UNIT II DISTRIBUTED LEDGERS 9

Distributed Ledger Technology - Public blockchains-Private blockchains- Semiprivate blockchains-Sidechains - Permissioned ledger- Shared ledger - Fully private and proprietary blockchains -Tokenized blockchains - Tokenless blockchains – Consensus-Consensus mechanism - Types of consensus mechanisms- Consensus in blockchain

Suggested Activities:

- External learning – emerging public/private blockchains
- Practicals on consensus algorithms

Suggested Evaluation Methods:

- Evaluation of on tokenized blockchains
- Creation of access control list using current tools

UNIT III DECENTRALIZATION 9

Methods of decentralization – Disintermediation -Contest-driven decentralization - Routes to decentralization - The decentralization framework example - Blockchain and full ecosystem decentralization -Storage – Communication -Computing power and decentralization - Smart contracts-Decentralized Organizations - Decentralized Autonomous Corporations - Decentralized Application - DApp examples -OpenBazaar - Platforms for decentralization -Ethereum -MaidSafe – Lisk

Suggested Activities:

- External learning - Developing Ethereum applications
- Practical - Setup the Dapps development environment

Suggested Evaluation Methods:

- Evaluation of decentralized application platforms
- Evaluation of developed smart contract on private Blockchain

UNIT IV BITCOIN – CRYPTOCURRENCY 9

Bitcoin definition - Digital keys and addresses - Private keys in Bitcoin -Public keys in Bitcoin -Addresses in Bitcoin – Transactions- The transaction life cycle - Transaction fee- Transaction pools -The transaction data structure -Metadata-Inputs -Outputs -Verification - The script language -Types of transactions -Coinbase transactions – Contracts - Tasks of the miners - Mining rewards - Proof of Work (PoW)

Suggested Activities:

- Creating Bitcoin wallet
- Creating Bitcoin raw transaction and adding to blockchain

- Creating and validating Bitcoin transaction

Suggested Evaluation Methods:

- Practical exercises to be given for creating Bitcoin scripts
- Developing applications for creating transactions

UNIT V DEVELOPMENT TOOLS AND FRAMEWORK 9

Ethereum network – Mainnet- Testnet - Private net - Ether cryptocurrency / tokens (ETC and ETH) - Ethereum Virtual Machine (EVM) -Solidity language-types-function types - reference types -control structures - Introducing Web3 - Contract deployment - POST requests- Truffle -Interaction with the contract – Oracles -Deployment on decentralized storage using IPFS – Hyperledger-reference architecture - Hyperledger Fabric - Membership services -Blockchain services -consensus services

Suggested Activities:

- Assignments on emerging Blockchain tools.
- Exploring NFTs.
- Presentation on Altcoins.

Suggested Evaluation Methods:

- Assignment on Hyperledger architecture
- Evaluation of decentralized application using Web3.0

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the technology components of Blockchain and decentralized Applications

CO 2. Understand distributed ledger technology and consensus mechanisms

CO 3. Develop smart contracts Ethereum with an understanding of the components of Ethereum.

CO 4. Understand Bitcoin and its limitations

CO 5. Demonstrate usage of different blockchain development frameworks

TEXTBOOKS:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Third Edition, Packt Publishing, 2020.

REFERENCES:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press ,2016.
2. Elaine Shi , Foundations of Distributed Consensus and Blockchains, Book Draft.
3. Antonopoulos, ‘Mastering Bitcoin’. Second Edition , O’Reilly Publishers .2017.
4. D. Drescher, ‘Blockchain Basics’ First Edition , Apress, 2017. Antonopoulos and G. Wood, Mastering Ethereum, First Edition, 2018.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	*2*	*2*	*3*	*3*	*3*	*2*	*1*	*1*	*3*	*3*	*3*	*3*	*2*	*3*	*3*
CO2	*3*	*2*	*3*	*2*	*3*	*3*	*2*	*3*	*3*	*3*	*3*	*3*	*2*	*3*	*3*
CO3	*3*	*3*	*2*	*3*	*3*	*2*	*3*	*1*	*3*	*3*	*3*	*3*	*3*	*3*	*2*
CO4	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*3*
CO5	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
AVG	*2.8*	*2.6*	*2.8*	*2.8*	*3*	*2.4*	*2*	*2.2*	*3*	*3*	*3*	*3*	*2.4*	*2.8*	*2.8*

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C12 **SECURITY AND PRIVACY IN CLOUD** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Understand the basics of Cloud and the need for security in cloud framework
- Understand the privacy issues and possible attacks in cloud framework and possible mitigations
- Understand the categorization of sensitive data and applying various encryption strategies over the cloud framework
- Understand identity management, access control mechanism and need of auditing in the cloud framework
- Understand the SQL Injection and DDOS attacks and the possible mitigation over the cloud framework

UNIT I CLOUD SECURITY OVERVIEW **9**

Cloud Computing: Definition and Characteristics – Service Models – Deployment Models – Service Platforms – Challenges Ahead. Cloud Security: Introduction – Cloud Security Concepts – Cloud Security Standards – CSA Cloud Reference Model – NIST Cloud Reference Model.

Suggested Activities:

- Creation of private cloud platform using open source tools like OpenStack, Opennebula, Eucalytus, etc.

Suggested Evaluation Methods:

- Short viva may be made based on the implementation of the tool.

UNIT II CLOUD SECURITY AND ATTACKS **9**

Cloud Security Goals – Issues – Security Requirements for Privacy – Privacy issues in Cloud – Thread Model – Taxonomy of Attacks – Case Study: Description of Features for Attack Analysis Based on Dataset - Classification of Intrusion Detection Systems in Cloud – Intrusion Detection Techniques in Cloud.

Suggested Activities:

- Implementation of few apt real time applications over the above mentioned cloud framework and apply few attacks over the same and possible mitigation models

Suggested Evaluation Methods:

- Group discussion among the project teams. Discussion about the Critics and suggestions of the implemented applications among the teams.

UNIT III SECURING THE CLOUD **9**

Architecture: Security Requirements for the Architecture – Security Patterns and Architectural Elements – Cloud Security Architecture – Planning key strategies for Secure operation. Cloud Data Security: Overview – Data Encryption – Sensitive Data Categorization - Cloud Data Storage – Cloud Lock-in. Key Strategies and Best Practices: Risk Management – Security Controls Overview – Limits of Security Control – Best Practices – Security Monitoring.

Suggested Activities:

- Building a system to categorize sensitive and non-sensitive data and apply apt encryption strategies to solve the security issues in cloud.

Suggested Evaluation Methods:

- Group discussion among the project teams. Discussion about the pros and cons of the implemented applications and mitigations among the teams.

UNIT IV PRIVACY AND SECURITY **9**

Security and Privacy Challenges – Case Studies & Analysis on Cloud Attacks – Privacy Considerations for Sensitive Data – Cloud Security Solutions & Monitoring – Incident Response to Attacks – Privacy Preservation for Cloud Data. Hybrid Cloud: Privacy and Security Issues – Identity Management – Safeguarding Data Transfer and Workloads – Access-based control mechanisms – Monitoring and Audits.

Suggested Activities:

- Study the possible identity, access control and auditing techniques in cloud and group discussion

Suggested Evaluation Methods:

- Conduction of quiz based on the discussion

UNIT V TOOLS AND ADVANCES 9

Attacks Tools – Security Tools – Case Study of LibVMI – Virtual Machine Introspection – Hypervisor Introspection – Threat Model in Containerized Environment – Defense Mechanisms – Case Study of SQL Injection Attack - Open Research Challenges of Container Security. Security and Privacy reservation Models in Cloud: Blockchain as a Service – Mitigate DDoS Attacks – IoT Enabled Model

Suggested Activities:

- Preparation of review documents based on the study

Suggested Evaluation Methods:

- Evolution of the review documents

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the concepts of Cloud Computing and Cloud Security.

CO 2. Classify the Security Attacks in Cloud Computing.

CO 3. Identify the strategies to secure Cloud data and architecture.

CO 4. Illustrate the challenges and solutions for Cloud Privacy Issues.

CO 5. Apply the tools to protect the data and infrastructure in the Cloud and study of emerging technologies to preserve Privacy and Security in the Cloud.

TEXTBOOKS:

1. Mishra, Preeti., Pilli, Emmanuel S., Joshi, R C., “Cloud Security: Attacks, Techniques, Tools, and Challenges”, CRC Press, 2021.
2. Katta Subba Rao, Sachi Nandan Mohanty, Sirisha Potluri, “Cloud Security: Techniques and Applications”, De Gruyter, 2021.
3. Kumar, T. Ananth., Niranjanamurthy, M., “Privacy and Security Challenges in Cloud Computing: A Holistic Approach”, Taylor & Francis Group, 2022.
4. Winkler, Vic (J.R.), “Securing the Cloud: Cloud Computer Security Techniques and Tactics”, Elsevier Science, 2011.

REFERENCES:

1. Brij B. Gupta, “Cloud Security: Concepts, Applications and Perspectives”, CRC Press, 2021.

2.Hassan Takabi, Lei Chen, Nhien-An Le-Khac, “Security, Privacy, and Digital Forensics in the Cloud”, Wiley, 2019.

3.Fatos Xhafa, Kim-Kwang Raymond Choo, Lizhe Wang, Wei Ren, “Security and Privacy for Big Data, Cloud Computing and Applications”, Institution of Engineering and Technology, 2019.

4.Krutz, Ronald L.., Vines, Russell Dean, “Cloud Security: A Comprehensive Guide to Secure Cloud Computing”, Wiley, 2010.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO2	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO3	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO4	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO5	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3
AVG	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23018 **CYBERSECURITY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. Understand the fundamentals of cybersecurity.
2. Explore network security techniques and tools.
3. Learn about application security practices.
4. Analyze malware through static and dynamic analysis, classification methods, and detection techniques.
5. Examine the role of AI in cybersecurity.

UNIT – I OVERVIEW OF CYBERSECURITY 9L

Introduction – Cyberspace – Cyber Crime – Nature of Threat – Cyber security Attacks– Policy, Mission and Vision of Cyber security Program. Cyber security management system – goals, technology categories – perimeter defense and encryption. Cyber security management framework.

UNIT – II NETWORK SECURITY 9L

Introduction to Intrusion detection – Types of IDS– IDS threat taxonomy - IDS Evaluation Metrics - AI based techniques for ID - Detecting DDos Attack – Credit Card fraud detection – Counterfeit bank note detection – Ad blocker –IoT device type identification – Deepfake recognition. Anomaly Detection – Types of anomalies – Anomaly detection with data and algorithms – Challenges in Anomaly detection.

UNIT – III APPLICATION SECURITY 9L

Phishing Webpage and Email detection - Introduction to detecting spam – Spam filters – Perceptron based spam filter – Spam detection with SVMs – Phishing detection using logistic regression and decision trees – Spam detection with Naïve Bayes.

UNIT – IV MALWARE ANALYSIS 9L

Understanding Malware – Defining Malware Classification – Static and dynamic malware analysis –Feature Generation and classification - Malware detection using decision trees – Random forest malware classifier – Clustering malware with k-means – Detecting metamorphic malware with HMMs.

UNIT – V AI IN CYBER SECURITY AND TOOLS 9L

Alert management – Raw data analysis – Risk Exposure Assessment– Cyber threat Intelligence.- Problems of AI in Cyber Security – Future of AI in Cybersecurity- Cyber Vulnerability Tools – Cyber Monitoring tools – Cyber risk assessment tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Grasp the fundamentals of Cyber security.
1. Knowledge of malware and countermeasures.

2. Ability to detect Intrusion and Anomaly detection using AI algorithms.
3. Able to realize Application security using AI.
4. Gain knowledge of other roles of AI in Cyber security.

REFERENCES:

1. Anand Shinde, “Introduction to Cyber Security Guide to the World of Cyber Security”, Notion Press, 2021.
2. Clarence Chio, David Freeman, “ Machine Learning and Security : Protecting Systems with Data and Algorithms”, O’Reilly publication, 1st Edition, ISBN -1491979909.
3. Garnett,“Cybersecurity in the Digital Age: Tools, Techniques, and Best Practices, Wolters Kluver, 2019.
4. Apruzzese, Giovanni, et al. "The role of machine learning in cybersecurity." Digital Threats: Research and Practice 4.1 (2023): 1-38.
5. Sumeet Dua, Xian Du, “Data Mining and Machine Learning in Cybersecurity”, CRC Press Publication, 1st Edition, ISBN 9781439839423
6. Nina Godbole, Sunit Belapure, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley Publishers, 2011
7. Research papers on AI for Cyber Security.

Mapping of CO with PO

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	-	-	-	1	1	-	1	-	-	2	3	2	2
2	-	2	3	2	-	1	1	-	-	-	-	1	2	2	2
3	2	2	2	2	1	2	2	2	2	2	2	2	3	2	2
4	2	2	3	2	2	2	2	2	2	2	2	2	3	2	2
5	2	2	1	-	1	2	1	1	-	-	-	2	3	2	2
Avg	2	2	3	2	1	2	1	2	2	2	2	2	3	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C03	ADVANCED NETWORKS	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To understand MPLS related concepts.
- To learn about Software Defined concepts, characteristics and protocols.
- To understand the concept of NFV and its impact in network resource utilization.
- To gain in-depth coverage of DCN fundamentals, topologies and Virtualization outcomes.
- To understand various concepts of ICN and NDN.

UNIT I MPLS NETWORKS 9

MPLS Data Plane and Related Protocols – Traffic Engineering (TE) and TE with MPLS – Quality of Service (QoS) with MPLS technology – Network recovery and restoration with MPLS technology.

Suggested Activities:

- Practical - Configure MPLS network using GNS3 / any open source tools.
- Practical - Simulate network recovery and restoration scenarios.

Suggested Evaluation Methods:

- Assess different network topology.
- Evaluate the scenarios.

UNIT II NETWORK SOFTWARIZATION – SOFTWARE DEFINED NETWORKS (SDN) 9

Genesis of Software Defined Networks – Separation of Control Plane and Data Plane – Distributed Control Plane – Characteristics of SDN – Operation – Devices – Controller – OpenFlow Protocol, messages, Flowtable entries, OpenFlow Switch Components—SDN Prospects and Challenges.

Suggested Activities:

- Practical – Using Mininet, attempt a Ping test between hosts with and without a Controller and analyze the contents of the flow table in the OpenFlow switch.
- Practical – Create a network and run simple performance tests under different parameter settings in Mininet with CPULimitedHost and TCLink classes.
- Practical - View switch configuration and capability using dpctl command in mininet.

Suggested Evaluation Methods:

- Evaluate some basic SDN applications using various open source SDN controller.

UNIT III NETWORK FUNCTION VIRTUALIZATION (NFV) 9

Building SDN Framework – Network Functions Virtualization – Introduction –Virtualization and Data Plane I/O – Service Locations and Chaining – Applications – Use Cases of SDNs: Data Centers, Overlays, Big Data and Network Function Virtualization

Suggested Activities:

- Practical - Develop SDN in a big data application (application–driven network control).
- Practical - Develop NFV/service chaining both inside and outside the data center.

Suggested Evaluation Methods:

- Evaluating the assignments for different scenarios.
- Analyzing the effect of big data application in SDN.

UNIT IV DATA CENTER NETWORKING (DCN) 9

Data Centers -- Types, components, Organization and Evolution, Switch fabric technology – Cloud Data Center Networking Topologies and Standards – Server Virtualization – Network Virtualization – Data Center TCP

Suggested Activities:

- Assignment on Data Center Network topologies.
- Identify the parameters to be considered while designing the network for a new data center that hosts a cloud service platform with virtualized workloads for an e-commerce application.

Suggested Evaluation Methods:

- Analyzing the advantages and disadvantages of the various DCN topologies with respect to a specific scenario.

UNIT V INFORMATION CENTRIC NETWORKING (ICN) AND NAMED DATA NETWORKING (NDN) 9

Content Distribution on the Internet – Web Caching, IP Multicast — Architectures for Information Centric Networking – Design Goals for ICN – Content Naming, Caching, Routing and Security in ICN – NDN overview – Naming in NDN – Routing in NDN —Caching Technique in NDN—Security in NDN

Suggested Activities:

- Use an ICN simulation tool like ndnSIM and configure a basic network topology with at least three nodes (e.g., consumers, producers, and routers) and ensure that each node can request and provide content based on named data rather than IP addresses.
- A presentation and discussion session summarizing key learnings and insights from the above activity.

Suggested Evaluation Methods:

- Evaluate the results of content retrieval under named data networking for various performance metrics with respect to traditional IP-based network.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Apply traffic engineering in MPLS.
CO 2. Understand the need for decoupling Control and Data plane in a programmable network
CO 3. Understand network services using Network Function Virtualization
CO 4. Apply topologies, standards, and server virtualization in data center networking
CO 5. Understand content naming, caching and routing in information centric routing

TEXTBOOKS:

1. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Sixth Edition, Elsevier/Morgan Kaufmann Publishers, 2022.
2. Bruce S. Davie, Adrian Farrel, “MPLS: Next Steps”, Morgan Kaufmann Publishers, 2011.
3. William Stallings, “Foundations of Modern Networking – SDN, NFC, QoE, IoT and Cloud” Third Edition, Pearson Publications, 2015.

REFERENCES:

1. Larry Peterson, Carmelo Cascone, Brian O’Connor, Thomas Vachuska, and Bruce Davie,” Software-Defined Networks: A Systems Approach”, Systems Approach LLC Publisher,2021.
2. Gabriel M. de Brito, Pedro B. Velloso, Igor M. Moraes,”Information-Centric Networks: A New Paradigm for the Internet, Wiley-ISTE; 1st edition, 2013.
3. Gary Lee,” Cloud Networking: Understanding Cloud-based Data Centre Networks”, Morgan Kaufmann Publisher, 2014.
4. Dom Robinson,” Content Delivery Networks-Fundamentals, Design, and Evolution”, WiLEY Publications,2017.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	2	-	-	2	3	3	3
CO2	2	2	2	1	3	-	-	-	2	-	-	2	3	3	3
CO3	3	3	2	2	3	-	-	-	2	-	-	2	3	3	3
CO4	3	3	3	2	3	-	2	-	2	2	2	2	3	3	3
CO5	3	3	3	2	2	-	-	-	2	2	2	2	3	3	3
AVG	2.8	2.8	2.6	1.8	2.6	-	0.4	-	2	0.8	0.8	2	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C10	ETHICAL HACKING	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To explore the concepts of security testing and the knowledge required to protect against the hacker and attackers.
- To understand reconnaissance and the publicly available tools used to gather information on potential targets.
- To discover the scanning techniques used to identify network systems open ports.
- To identify network system vulnerabilities and confirm their exploitability.
- To explore techniques for identifying web application vulnerabilities and attacks.

UNIT I INTRODUCTION TO HACKING 9

Introduction to Hacking – Important Terminologies – Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement – Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types of Penetration Tests – Vulnerability Assessment Summary – Reports.

Suggested Activities:

- In-class activity to understand the penetration testing methodologies.
- Practical - Use security tools in Kali Linux to assess the vulnerabilities.
- Prepare Vulnerability Assessment summary reports.

Suggested Evaluation Methods:

- Assignment on categories of penetration testing and vulnerability summary reports .
- Quiz on penetration testing methodologies, OSSTMM and OWASP

UNIT II INFORMATION GATHERING AND SCANNING 9

Information Gathering Techniques – Active Information Gathering – Passive Information Gathering – Sources of Information Gathering – Tracing the Location – Traceroute – ICMP Traceroute – TCP Traceroute – Usage – UDP Traceroute – Enumerating and Fingerprinting the Webservers – Google Hacking – DNS Enumeration – Enumerating SNMP – SMTP Enumeration – Target Enumeration and Port Scanning Techniques – Advanced Firewall/IDS Evading Techniques.

Suggested Activities:

- Explain different ways to gather the information of a system in the network.
- Demonstrate the network command tools to identify the system.
- Understand the network protocols and port scanning techniques using Kali linux.

Suggested Evaluation Methods:

- Assignment problems on information gathering and traceroute of ICMP, DNS and SNMP.
- Quizzes on enumeration, port scanning techniques and firewall/IDS evading techniques.

UNIT III NETWORK ATTACKS 9

Vulnerability Data Resources – Exploit Databases – Network Sniffing – Types of Sniffing – Promiscuous versus Nonpromiscuous Mode – MITM Attacks – ARP Attacks – Denial of Service Attacks – Hijacking Session with MITM Attack – SSL Strip: Stripping HTTPS Traffic – DNS Spoofing – ARP Spoofing Attack - Manipulating the DNS Records – DHCP Spoofing – Remote Exploitation – Attacking Network Remote Services – Overview of Brute Force Attacks – Traditional Brute Force – Attacking SMTP – Attacking SQL Servers – Testing for Weak Authentication.

Suggested Activities:

- Familiarizing with different types of attacks such as sniffing, spoofing etc.
- Demonstrating the MITM attack using ARP Poisoning using Kali Linux.
- Teaching with case studies: SSL Stripping, SQL Injection, Brute Force attacks.

Suggested Evaluation Methods:

- Assignment on denial of service (DoS) attack and hijacking session with MITM attack.
- Quizzes on SSL stripping, ARP spoofing and weak authentication

UNIT IV ATTACK EXPLOITATION 9

Introduction to Metasploit – Reconnaissance with Metasploit – Port Scanning with Metasploit – Compromising a Windows Host with Metasploit – Client Side Exploitation Methods – E–Mails with Malicious Attachments – Creating a Custom Executable – Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post–Exploitation – Acquiring Situation Awareness – Hashing Algorithms – Windows Hashing Methods – Cracking the Hashes – Brute force - Dictionary Attacks – Password Salts – Rainbow Tables – John the Ripper – Gathering OS Information – Harvesting Stored Credentials.

Suggested Activities:

- Case studies: Understand the Metasploit and Exploitations.
- Demonstrating email with malicious attachment and cracking the hashes.
- Practical - Implementing hashing algorithms and cracking the hashes.

Suggested Evaluation Methods:

- Assignments on social engineering toolkit and browser exploitation.
- Quizzes on reconnaissance with Metasploit and client–side exploitation methods.

UNIT V WIRELESS AND WEB HACKING 9

Wireless Hacking – Introducing Aircrack-ng– Cracking the WEP – Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng – Evil Twin Attack – Causing Denial of Service on the Original AP – Web Hacking – Attacking the Authentication – Brute Force and Dictionary Attacks – Types of Authentication – Log-In Protection Mechanisms – Captcha Validation Flaw – Captcha RESET Flaw – Manipulating User-Agents to Bypass Captcha and Other Protection – Authentication Bypass Attacks – Testing for the Vulnerability – Automating It with Burp Suite – Session Attacks – SQL Injection Attacks – XSS (Cross-Site Scripting) – Types of Cross-Site Scripting – Cross-Site Request Forgery (CSRF) – SSRF Attacks.

Suggested Activities:

- Cracking the WEP and WPA/WPA2 passphrase using Cracking tool in Kali Linux.
- Design a web application with different authentication mechanism.
- Understand the protection mechanism to prevent against various server attacks

Suggested Evaluation Methods:

- Assignment on evil twin attack and denial of service attack on access point in WLAN.
- Quizzes on types of authentication and vulnerabilities in a web application.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Use the various security tools to assess the computing system.

CO 2. Predict the vulnerabilities across any computing system using penetration testing.

CO 3. Identify prediction mechanism to prevent any kind of attacks.

CO 4. Protect the system from malicious software and worms.

CO 5. Evaluate the wireless network flaws and able to apply security patches.

TEXTBOOKS:

1. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2019.
2. Kevin Beaver, “Ethical Hacking for Dummies”, Sixth Edition, Wiley, 2018.

REFERENCES:

1. Simpson, Michael T., Kent Backman, and James Corley. Hands-on ethical hacking and network defense. Course Technology Press, 2012.
2. Hickey, Matthew, and Jennifer Arcuri. Hands on Hacking: Become an Expert at Next Gen Penetration Testing and Purple Teaming. John Wiley & Sons, 2020.
3. Hoffman, Andrew. Web Application security: exploitation and countermeasures for modern web applications. O'Reilly Media, 2020.
4. Black Hat Python: Python Programming for Hackers and Pentesters. Seitz, Justin, and Tim Arnold. No starch press, 2021.
5. Jon Erickson, “Hacking: The Art of Exploitation”, Second Edition, Rogunix, 2008.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	2	3	1	-	-	2	-	1	2	3	3	2
CO2	3	3	3	2	1	1	-	1	3	-	2	3	3	3	2
CO3	3	3	3	2	2	2	-	1	3	-	2	3	3	3	2
CO4	3	3	3	2	3	2	-	-	2	-	1	2	3	3	2
CO5	3	3	3	3	3	1	-	-	3	-	2	2	2	3	2
AVG	**3**	**3**	**3**	**2.2**	**2.4**	**1.4**	**-**	**1**	**2.6**	**-**	**1.6**	**2.4**	**2.8**	**3**	**2**

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C16 **SOFTWARE DEFINED NETWORKS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the concept of SDN and its architecture.
- To learn about the need for separate control and data plane in SDN and also about various SDN Controllers
- To understand the concept of NFV and its impact in network resource utilization
- To explore about various NFV use cases and its impact in 5G
- To know about various SDN applications and simulators

UNIT I SDN: INTRODUCTION 9

Evolving Network Requirements – Need and History of SDN– The SDN Approach – SDN architecture – SDN Software Stack- SDN Data Plane,-Control plane and Application Plane- SDN APIs-Open Networking Foundation- SDN Devices.

Suggested Activities:

- Assignment on comparing SDN approach with traditional switching.
- A group discussion about what they learned and how SDN approach can be applied in real-world scenarios

Suggested Evaluation Methods:

- Oral examination for the assignment on comparing SDN approach with traditional switching.
- Evaluating based on the chosen scenario relevant with the topic of discussion and understanding the fundamentals of SDN.

UNIT II SDN DATA PLANE AND CONTROL PLANE 9

Data Plane functions and protocols - OpenFLow Overview -Open Flow controller- Open Flow ports - Flow Table - OpenFLow Protocol -Proactive and Reactive Flow - Control Plane Functions - Southbound Interface, Northbound Interface – SDN Controllers - Ryu, OpenDaylight, ONOS - Distributed Controllers – Application of Open Flow in SDN Controller- Mininet.

Suggested Activities:

- Configure OpenFlow switches.
- Install an SDN controller and run a basic controller script to manage the Mininet network
- Use Wireshark tool and analyze the effects of the SDN controller's decisions
- View switch configuration and capability using dpctl command in mininet.

Suggested Evaluation Methods:

- Students can present their network setups and scripts to the class. The evaluation may be done based on the understanding of the script and control messages generated by the controller.

UNIT III NETWORK FUNCTION VIRTUALIZATION 9

Network Virtualization -Challenges-Building Blocks-Virtual Network Encapsulation- Virtual Switches-Microsegmentation- Virtual LANs – OpenFlow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture.

Suggested Activities:

- Establish a NFV platform like GNS3, or OpenStack DevStack, and create a basic topology and deploy the VNF. Configure it for a basic network task, such as routing between two networks and monitor the traffic using Wireshark.

Suggested Evaluation Methods:

- Evaluate the configured setup based on various network traffic considered and the understanding and analysis of the obtained results.

UNIT IV NFV FUNCTIONALITY 9

NFV Infrastructure – InLine Network Functions- Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV in 5G – Service Function Chaining - Core Network Function Virtualization- Virtualized Evolved Packet Core (vEPC).

Suggested Activities:

- Explore chaining multiple VNFs together to create a service function chain.
- Group discussion on the potential real-world applications of NFV.

Suggested Evaluation Methods:

- Verifying the configuration and traffic flow order through each VNF and ensure that the intended function is carried out by each VNF.

UNIT V SDN APPLICATIONS 9

SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering and Path Efficiency- Wide Area Traffic Management– Measurement and Monitoring – Security – Data Center Networking-Tunneling Technologies for Data Center - SDN Simulators.

Suggested Activities:

- To write a Python script for the SDN controller that implements simple traffic engineering rules like equal-cost multipath routing and to dynamically adjust the path based on network conditions (latency, link utilization etc)

Suggested Evaluation Methods:

- Evaluation may be done by asking the student to generate traffic loads using iperf and evaluate based on how the network handles congestion and varying load conditions and also test their understanding on impact of modified traffic engineering rules.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the fundamentals of Software Defined Networks.

CO 2. Understand the functionalities of data and control planes.

CO 3. Implement network services using Network Function Virtualization.

CO 4. Understand virtualization functionalities associated with NFV.

CO 5. Design and develop network applications using SDN tools.

TEXTBOOKS:

1. William Stallings, “Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud”, Pearson Education, 1st Edition, 2015.
2. Larry Peterson, Carmelo Cascone, Brian O’Connor, Thomas Vachuska, and Bruce Davie, “Software-Defined Networks: A Systems Approach”,Second Edition,Systems Approach LLC Publisher,November 2021.

REFERENCES:

1. Sahoo, Kshira Sagar, Bibhudatta Sahoo, and Brojo Kishore Mishra, eds. "Software-defined Networking for Future Internet Technology: Concepts and Applications." Apple Academic Press 2021.
2. Wang, David. Software defined-WAN for the digital age: a bold transition to next generation networking. CRC Press, 2018.
3. Zhang, Ying. Network Function Virtualization: Concepts and Applicability in 5G Networks. John Wiley & Sons, 2018.
4. Ken Gray, Thomas D. Nadeau, “Network Function Virtualization”, Morgan Kauffman, 2016.
5. Fei Hu, “Network Innovation through OpenFlow and SDN: Principles and Design”, 1st Edition, CRC Press, 2014.
6. Paul Goransson, Chuck Black Timothy Culver, “Software Defined Networks: A Comprehensive Approach”, 2nd Edition, Morgan Kaufmann Press, 2016.
   Oswald Coker, Siamak Azodolmolky, “Software-Defined Networking with OpenFlow”, 2nd Edition, O’Reilly Media, 2017.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	-	-	-	2	-	-	2	2	2	2
CO2	3	2	2	2	3	-	-	-	2	-	-	2	2	2	2
CO3	3	3	3	3	3	-	-	-	2	-	-	2	3	3	3
CO4	3	3	3	2	3	-	-	-	2	-	-	2	3	3	3
CO5	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3
AVG	2.8	2.6	2.6	2.4	2.8	-	-	-	2	0.8	0.8	2	2.6	2.6	2.6

VERTICAL V - AI IN INDUSTRY

AD23019	AI FOR INDUSTRIAL APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Explore how Industrial AI is applied in various sectors.
2. Learn about Digital Twins, their characteristics, and how they impact predictive maintenance and data-driven decision-making.
3. Explore the role of AI in decision-making, software systems, and software engineering processes.
4. Study distributed computing, cloud computing, data storage solutions, and information security.
5. Examine AI applications across various industries

UNIT – I INDUSTRIAL AI **9L**

Industrial AI- Industrial AI in action- Applying industrial AI- The IMS architecture for industrial AI- Visible and Invisible issues- Building the future with AI- Killer Applications of Industrial AI.

UNIT – II DATA ANALYTICS IN INDUSTRY 4.0 **9L**

Digital Twins(DT)- History of DT- Characteristics- Evolution- Data twin - physical world, digital world-Classifications- Level of integration- Characteristics- Modelling digital twins- Smart manufacturing and Applications- Uses of Digital Twin Technology- Digital twins maintenance - predictive maintenance- Planning the digital twin- Digital twin during operation phase- Hybrid analysis and Fleet data- Digital implementation- Digital twin impacts on industry 4.0.- Industry 4.0. Data Analytics - Data driven and model driven approaches-Types - descriptive analytics, diagnostics analytics, maintenance predictive analytics, prescriptive analytics- Data-Driven Decision making- Data quality- Data augmentation- Information logistics- Data driven challenges.

UNIT – III AI AND SOFTWARE ENGINEERING **9L**

Fundamentals in AI – Decision Making- Decision Support Systems- Business Intelligence- Database and Knowledge Base in Decision Support Systems- Inference Mechanisms in AI- Knowledge Interpretation- Data, Information Knowledge and Wisdom- AI and Software Engineering- Systems thinking and Systems Engineering- Software Engineering – Overview- System Software- Evolution- Paradigm- Architecture Models- Software Systems and Software Engineering Processes, Component based software engineering- Software maintenance overview- Applications of AI in classical software engineering

UNIT – IV DATA STORAGE AND COMPUTING MODELS **9L**

Distributed Computing, Cloud Computing, Fog and Edge Computing, Data Storage and Information Management, Data Fusion and Integration, Data Quality, Communication, Cognitive Computing, Distributed Ledger, Information Security, Cybersecurity, Block chain Security.

UNIT – V CASE STUDIES **9L**

AI factory for Railway- AI Factory, Mining, Augmented Reality and Virtual Reality, Cybersecurity, AI Transformation Roadmap, AI in Healthcare, Education, Banking, Retail and E-commerce, Gaming and Entertainment, Chatbots

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the concepts, principles, and applications of industrial AI in various domains.
1. To analyze and apply digital twin technology for smart manufacturing and other industry-specific applications.
2. Analyze and discuss the impacts and challenges of AI in industry 4.0 and other specific domains.
3. To exploit AI algorithms and methodologies in software engineering projects.
4. Design and implement various computing models, data storage and management systems and their implications for distributed systems.
5. To evaluate and analyze real-world case studies to understand the practical implementation of AI in different industries.

REFERENCES:

1. AI Factory Theories, Applications and case Studies, Ramin Karim, Diego Galar and Uday Kumar, CRC Press, 2023
2. Artificial Intelligence and Industry 4.0, Ella Hassanien, Jyotir Moy Chatterjee and Vishal Jain, Academic press, 2022, Taylor and Francis, CRC Press.
3. Artificial Intelligence in Industrial Applications, Stevan Lawrence Fernandes Tarun K.Sharma,Springer, 2022.
4. Artificial Intelligence and the Fourth Industrial Revolution, Utpal Chakraborty, Amit banerjee, Jayanta Kumar Saha, Niloy Sarkar, Chinmay Chakraborty, 2022.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	3	2	1	2	2	2	1	2	3	2	3
2	3	2	3	3	3	2	1	2	2	2	2	3	2	3	2
3	3	3	2	3	2	2	2	2	2	2	2	3	3	2	3
4	3	3	3	3	3	2	2	2	3	2	2	3	3	3	2
5	3	3	3	3	3	2	2	2	3	2	2	3	2	3	2
6	3	3	2	3	3	2	2	2	3	2	2	3	2	3	2
Avg.	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23020	AI IN SUPPLY CHAIN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Learn the basics of supply chain management, its evolution, and its role in the economy.
2. Explore distribution network design, strategies and the impact of uncertainty on network planning.
3. Study techniques for managing inventory, handling uncertainty and optimizing supply chain cycles.
4. Discover how AI enhances supply chain functions, including risk management, demand forecasting and inventory control.
5. Analyze Real-World Supply Chain Cases.

UNIT – I SUPPLY CHAIN FUNDAMENTALS 9L

Supply Chain – Fundamentals, Evolution, Role in Economy, Importance, Decision Phases, Enablers & Drivers of supply chain Performance; Supply chain strategy; Supply Chain Performance Measures.

UNIT – II SUPPLY CHAIN NETWORK 9L

Distribution Network Design – Role in supply chain, Influencing factors, design options, online sales and distribution network, Distribution Strategies; Network Design in supply chain – Role, influencing factors, framework for network design, Impact of uncertainty on Network Design.

UNIT – III PLANNING DEMAND, INVENTORY AND SUPPLY 9L

Managing supply chain cycle inventory and safety inventory - Uncertainty in the supply chain ,Analyzing impact of supply chain redesign on the inventory, Risk Pooling, Managing inventory for short life-cycle products, multiple item -multiple location inventory management; Pricing and Revenue Management

UNIT – IV APPLICATION OF AI IN SUPPLY CHAIN MANAGEMENT 9L

Adopting AI for Supply Chain: Understanding Supply chain structure – Establishing business KPIs and ROI –Benefits of AI for SCM- Applications of AI : Supplier Selection Problem – Predicting Customer behavior – Managing Supply Chain Risks – Demand/ Sales Estimation – Inventory and Storage Management – Transportation and Distribution - Production – Sustainable Development.

UNIT – V CASE STUDIES 9L

Case studies on Supply chain: Inventory management - Automation and Digitization – Real-time visibility & predictive analytics – Supply chain connectivity – Last-mile logistics- Identifying Vulnerabilities in the Machine Learning Model Supply Chain

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the need of supply chain management.
2. Design a supply chain network.
3. Plan based on inventory and supply.
4. Use AI to solve supply chain problems.

5. Implement python programs with benchmark datasets and evaluation metrics.

REFERENCES:

1. Sunil Chopra, Peter Meindl and DharamVirKalra, Supply Chain Management-Strategy Planning and Operation, Pearson Education, Seventh Edition, 2021
2. Kurt Y. Liu, " Supply Chain Analytics : Concepts, Techniques and Applications, Palgrave Macmillan Cham, 1st Edition, ISBN : 978-3-030-92223-8
3. Atour Taghipour, "Demand Forecasting and order planning in supply chains and Humanitarian Logistics", IGI Global publications, ISBN : 9781799838067, 1799838064.
4. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2007.
5. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
6. Research Papers on AI for supply chain.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	2	3	2	2	2	1	2	2	3	2	2
2	2	2	3	2	2	3	2	2	2	2	3	2	2	2	2
3	2	2	2	2	2	3	2	2	2	2	3	2	2	2	2
4	1	3	3	2	3	2	2	2	2	2	3	2	2	3	3
5	2	3	2	2	3	3	2	2	2	2	2	2	1	3	3
Avg	2	2.5	2.5	2	2	3	2	2	2	2	3	2	2	2	2

1-low, 2-medium, 3-high, '-"- no correlation

IT23C07 **HEALTHCARE ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To know the sources of healthcare data and basic analytics.
- To introduce various bio-medical imaging modalities and applications.
- To learn the application of sensors in healthcare data collection and analytics.
- To understand mining from clinical text data.
- To learn the usage of advanced analytics in healthcare applications.

UNIT I HEALTHCARE DATA SOURCES AND BASIC ANALYTICS 9

Overview of Healthcare Data Sources: Electronic Health Records (EHR), Biomedical Images, Senor Data, Biomedical signals, Genomic data, Clinical Data, Social Media data, and its analysis – EHR: History, Components, Benefits of EHR**,** Barriers to Adopting EHR**,** Challenges of Using EHR Data – Phenotyping Algorithms **-** Overview of Coding Systems: International Classification of Diseases **(**ICD - 9, 10, 11), International Classification of Functioning, Disability, and Health (ICF)**,** Unified Medical Language System (UMLS), Digital Imaging and Communications in Medicine (DICOM) - Introduction to Data Analytics for Healthcare: Clinical prediction, Temporal and visual analytics, Clinic-Genomic Data Integration, Privacy Preservation Data Publishing.

Suggested Activities:

- Form small groups of students and real-time data collection from open sources and hospitals.
- Comparing the features of the collected real-time data.
- Group discussion on various coding systems.

Suggested Evaluation Methods:

- Quiz on coding systems.
- Evaluation based on group data collection and presentation.

UNIT II BIOMEDICAL – IMAGE AND SIGNAL ANALYSIS 9

Overview of Biomedical Imaging Modalities: Computed Tomography, Positron Emission Tomography, Magnetic Resonance Imaging, Ultrasound, Microscopy, Biomedical Imaging Standards and Systems - Object Detection: Template Matching, Model-Based Detection, Data-Driven Detection Methods - Image Segmentation - Image Registration - Feature Extraction - Introduction to biomedical signals - Types of Biomedical Signals - ECG Signal Analysis - Denoising of Signals using Principal Component Analysis - Multivariate Biomedical Signal Analysis - Cross-Correlation Analysis - Recent Trends in Biomedical image and Signal Analysis.

Suggested Activities:

- Apply various image processing techniques (e.g., noise reduction, contrast enhancement) to improve the quality of medical images.
- Extract features such as edges, textures, and shapes from medical images using techniques like edge detection, Gabor filters, and morphological operations.
- Analyze ECG signals to detect and interpret different heart conditions. Use signal processing techniques to filter noise and extract meaningful features.
- Implement machine learning algorithms to classify biomedical signals (e.g., normal vs. abnormal ECG signals).

Suggested Evaluation Methods:

- Students submit detailed reports documenting their methodology, results, and interpretations from the data collected.
- Short quizzes on recent advancements in biomedical data analysis.

UNIT III MINING OF SENSOR DATA IN HEALTHCARE 9

Sensor Data in Medical Informatics: Scope and challenges - Challenges in Healthcare Data Analysis - Sensor Data Mining Applications: Intensive Care Data Mining, Sensor Data Mining in Operating Rooms, General Mining of Clinical Sensor Data - Nonclinical Healthcare Applications: Chronic Disease and Wellness Management, Activity Monitoring and Reality Mining - Data Analytics for Pervasive Health: Body area Networks, Dense/Mesh Sensor Networks, Sensor Technology –

Applications: Continuous Monitoring, Assisted Living, Therapy and Rehabilitation, Persuasive Well-Being, Emotional Well-Being and Smart Hospitals.

Suggested Activities:

- Form small student groups and perform a survey of types of sensors and their application in healthcare.
- Demonstrate data collection using simple sensors.

Suggested Evaluation Methods:

- Quiz on sensors used in the healthcare domain.
- Team evaluation for collecting and presenting research articles about applications of sensors in healthcare applications.

UNIT IV NLP AND SOCIAL MEDIA ANALYTICS FOR HEALTHCARE 9

Introduction to Natural Language Processing - Core NLP Components - Mining Information from Clinical Text: Information Extraction and Methodologies Rule-Based, pattern-based Approaches - Clinical Text Corpora and Evaluation Metrics - Challenges of Processing Clinical Reports - Clinical Applications - Social Media Analytics for Healthcare: Introduction - Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks, Public Health Research, Analysis of Social Media Use in Healthcare.

Suggested Activities:

- Explore various healthcare blogs and collect data about healthcare.
- Use NLP toolkit for demonstrating simple natural language preprocessing on text data.
- Group discussion on the application of social network analysis for prediction of disease outbreaks.

Suggested Evaluation Methods:

- Student assignment on case studies related to the application of NLP for healthcare applications.
- Mini Project (Group) – Implementing automated Real-time data collection from healthcare social blogs/websites.

UNIT V ADVANCED DATA ANALYTICS FOR HEALTHCARE 9

Introduction to Clinical Prediction Models: Basic Statistical Prediction Models, Alternative Clinical Prediction Models, Survival Models, Evaluation and Validation - Visual Analytics for Healthcare: Introduction, Visual Analytics in Public Health and Population Research, Visual Analytics for Clinical Workflow, Visual Analytics for Clinicians, Visual Analytics for Patients - Legal and Ethical Issues in Clinical Decision Support Systems - Fraud Detection in Healthcare: Definition and Types of Healthcare Fraud, Identifying Healthcare Fraud from Data, Knowledge Discovery-Based approaches for Identifying Fraud.

Suggested Activities:

- Group presentation about healthcare applications involving multimodal clinical data.
- Field trip to hospitals to learn about the recent advancements in healthcare analytics.
- Discussion using case studies on advanced analytics for healthcare.

Suggested Evaluation Methods:

- Short Quiz
- Tutorial on possible challenges and research gaps in the present state-of-art.

THEORY: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO1. Understand the various sources of healthcare data and perform basic analytics on those data.

CO2. Explore various biomedical modalities and describe the basic properties of each kind.

CO3. Recognize and articulate the foundational assumptions, definitions, and usage of sensors in healthcare analytics.

CO4. Demonstrate application of natural language processing on healthcare data collected from social media.

CO5. Apply the various advanced data analytics techniques for different real-time healthcare applications.

TEXTBOOKS:

1. Chandan K. Reddy and Charu C. Aggarwal, Healthcare Data Analytics, CRC Press, 2020.
2. A. Jaya, K. Kalaiselvi, Dinesh Goyal, Handbook on Intelligent Healthcare Analytics: Knowledge Engineering with Big Data, Wiley, 2022.

REFERENCES:

1. Pantea Keikhosrokiani, Big Data Analytics for Healthcare: Datasets, Techniques, Life Cycles, Management, and Applications, Academic Press, Elsevier, 2022

CO-PO & PSO MAPPING

CO	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	1	1	2	1	1	2	3	2	2	2
CO2	3	3	3	2	3	1	1	2	1	1	2	3	2	2	2
CO3	3	3	3	3	3	1	1	2	1	1	2	3	2	2	2
CO4	3	3	3	3	3	1	2	2	3	1	2	3	2	2	2
CO5	3	3	3	3	3	2	2	2	3	1	2	3	2	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23021	AI FOR ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Learn the history, basic concepts, and classifications of robotic systems
2. Study different types of grippers and sensors used in robotics, their design considerations, and their role in robot functionality and control.
3. Understand the various drive systems, transmission methods, actuators, and control systems used in robotics.
4. Learn Robot Programming Languages.
5. Explore various applications of robotics along with current trends and safety considerations.

UNIT – I INTRODUCTION TO ROBOTICS 9L

Brief History, Basic Concepts of Robotics such as Definition, Three laws, Elements of Robotic Systems -Robot anatomy, DOF, Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, Associated parameters - resolution, accuracy, repeatability, dexterity, compliance, RCC device, Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Scope and applications of robot.

UNIT – II GRIPPERS AND SENSORS FOR ROBOTICS 9L

Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.

UNIT – III DRIVES AND CONTROL FOR ROBOTICS 9L

Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control.

UNIT – IV PROGRAMMING LANGUAGES FOR ROBOTICS 9L

Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

UNIT – V APPLICATIONS AND TRENDS IN ROBOTICS 9L

Multiple robots and its coordination, Mobile and distributed robots, Automated guided vehicles, Robot assisted surgery, Robots in games. Robots in space research applications. Industrial robots in manufacturing applications, Hazardous and mission critical applications, Safety in robotics, Transformer robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Interpret terminologies related to laws and components of Robotics technology.

1. Understand various grippers and sensors for robotics.
2. Apply logic for selection of robotic sub systems and systems.
3. Analyze basics of principles of robot system integration.
4. Integrate knowledge of AI techniques in the area of robotic technology.
5. Identify the challenges and key issues in the design of robots

REFERENCES:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006).
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).
4. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003).
5. S. B. Niku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
6. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997).
7. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	2	2	1	2	2	2	1	2	-	1	-
2	2	2	3	2	3	1	1	2	2	2	1	2	-	-	-
3	3	3	3	2	3	2	2	2	2	2	1	2	2	2	2
4	3	2	2	2	2	2	2	2	2	2	1	2	1	2	1
5	3	2	3	2	3	2	2	2	2	2	2	3	3	2	2
6	3	3	3	2	3	2	1	2	2	2	1	2	1	1	1
Avg.	3	2	3	2	3	2	2	2	2	2	1	2	2	2	2

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23022	AUTONOMOUS VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To Understand Autonomous Driving Basics.
2. To Study the role of control in autonomous systems
3. Understand map databases, path planning techniques, and vehicle communication technologies for practical autonomous vehicle applications.
4. Learn about the use of deep learning in autonomous driving for perception, prediction, routing and reinforcement learning-based control.
5. Explore AI algorithms, data management, cognitive decision-making, and the impact of autonomous vehicle technologies on industry and society.

UNIT – I INTRODUCTION TO AUTONOMOUS GROUND VEHICLES 9L

Introduction to Autonomous Driving -Autonomous Driving Algorithms, Autonomous Driving Client System, Autonomous Driving Cloud Platform - Autonomous Vehicle Localization - Localization with GNSS, Localization with LiDAR and High-Definition Maps, Visual Odometry, Dead Reckoning and Wheel Odometry, Sensor Fusion - Perception in Autonomous Driving -Detection, Segmentation, Stereo, Optical and Scene Flow

UNIT – II CONTROL IN AUTONOMOUS SYSTEMS 9L

Role of Control in Autonomous Systems - Feedback, Autonomous Control - System Architecture and Hybrid System Modeling - System Architecture, Hybrid System Formulation, State Machines for Different Challenge Events - Sensors and Estimation - Vehicle Internal State Sensing, External World Sensing, Estimation, Situational Awareness

UNIT – III PATH PLANNING AND APPLICATIONS 9L

Maps and Path Planning - Map Databases - Raster, Vector and Utilizing Map Data - Path Planning -Vehicle to Vehicle and Vehicle to Infrastructure Communication - V2V Communications, V2I Communications, Communication Technologies, 802.11p/WAVE DSRC Architecture, Applications in Autonomous, Vehicles - Examples of Autonomy - Cruise Control, Antilock-Brake Systems, Steering Control and Lane Following, Parking

UNIT – IV DEEP LEARNING IN AUTONOMOUS DRIVING 9L

Deep Learning in Autonomous Driving Perception - Convolutional Neural Networks, Semantic Segmentation - Prediction and Routing - Planning and Control, Traffic Prediction, Lane Level Routing - Decision, Planning, and Control - Behavioral Decisions, Motion Planning, Feedback Control,BicycleModel, PID Control - Reinforcement Learning-Based Planning and Control - Reinforcement Learning, Learning-Based Planning and Control in Autonomous Driving

UNIT – V AI AND SOFTWARE ENABLERS FOR AGV 9L

Human-like reasoning - Hybrid , configurable AI algorithms - Data management environment for analyzing AI Algorithms - Dynamic Selection - Dynamic Integration - Cognitive decision making for Autonomous Driving - Autonomous Support - Automation and Autonomy - Advantages of AV Technologies - Adoptions scenarios for AVs -Industry 4.0 AVs - Major Pillars in the evolution of AVs - Spillovers and Impact of AVs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. To identify the fundamental concepts and algorithms used in autonomous ground vehicles.
2. To Comprehend and explain the principles of deep learning in autonomous driving.
3. Apply AI and software enablers in the context of autonomous ground vehicles and analyze the impact of autonomous vehicles in industry.
4. Evaluate the challenges and considerations related to control in autonomous systems.
5. Design and develop path planning algorithms and applications for autonomous vehicles and implement autonomy features.
6. Assess the security vulnerabilities and risks associated with autonomous ground vehicle systems, including potential cyber-attacks, sensor spoofing, and system vulnerabilities.

REFERENCES:

1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems”, Morgan & Claypool, 2018.
2. Autonomous Vehicles Technologies, Regulations, and Societal Impacts George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos · 2021
3. Umit Ozguner, Tankut Acarman, Keith Redmill, “Autonomous Ground Vehicles”, Artech House, 2011.
4. George A. Berkey, Autonomous Robots: From Biological Inspiration to Implementation and Control (Intelligent Robotics and Autonomous Agents series) , MIT Press, 2005
5. Hong Cheng, “Autonomous Intelligent Vehicles Theory, Algorithms, and Implementation”, Springer, 2011.
6. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, “Global Navigation Satellite Systems, Inertial Navigation, and Integration”, Third Edition, John Wiley & Sons, 2013.
7. Ian Goodfellow, Yoshua Bengio and Aaron courville, Deep Learning, MIT Press, 2016
8. Karl Johan Astrom, Richard M. Muray, Feedback System: An Introduction for scientist and Engineers, Princeton University Press, 2021

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	2	3	1	1	1	2	2	1	3	2	1	2
2	3	2	1	2	3	1	1	2	1	2	1	3	1	2	2
3	3	3	2	2	3	3	2	2	2	2	1	2	2	2	3
4	3	3	2	2	2	2	1	2	2	2	1	2	2	1	2
5	3	3	3	2	3	2	2	2	2	2	2	3	2	1	3
6	3	3	2	3	2	3	2	3	2	2	2	3	2	1	3
Avg.	3	3	2	2	3	2	2	2	2	2	1	3	2	1	3

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23023	MARITIME AI	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Explore trends and techniques in freight logistics
2. Learn about the operations, data structures, and handling techniques of container terminals
3. Study the advancements, economic impacts, and operational settings of unmanned and autonomous ships
4. Understand risk management processes, financial derivatives in shipping, and statistical tools.
5. Study the use of AI techniques for maritime data processing, analytics, vessel movement visualization, and intelligent transmission scheduling.

UNIT – I FREIGHT LOGISTICS 9L

Trends in Freight Logistics, Vehicle routing problems, Multi-objective Optimization - Multi-objective Management, Multi-objective Optimization and Pareto-Optimal Solutions, Techniques to Solve Multi-Objective Optimization Problems, Multi-Objective Optimization by Metaheuristics, Green Supply Chain Management - Green Corridors, Network Designs in a Green Supply Chain, Maritime Freight Logistics - Capacity and Service Level in a Maritime Terminal, Container Allocation in a maritime terminal, Scheduling - Inspection Operations, Customers Inspections.

UNIT – II DIGITAL MANAGEMENT OF CONTAINERS 9L

Containers and Data Structure - Operation Management in the Container Terminal - Operations of Container Transportation, Documents in the container Terminal - Handling Techniques in Conventional Container Terminal, - Handling Techniques in Automated / Semi automated Container Terminal, Import and Export Operations in the Container Terminal, Vessel Unloading Operations in the container Terminal, Vessel Unloading Processes, Information Collection and Processing, Planning and Scheduling, Intelligent Vessel Unloading System

UNIT – III AUTONOMOUS SHIPS 9L

Perspective on Advances in shipping, Making the Case for Unmanned and Autonomous Ships, Economic Perspective, Safety, Environment, Autonomy , Automation and Reasoning, Metrics of Autonomy ,Process Automation, MASS Reasoning , MASS Design and Engineering – Applications and Operational settings, Implementation of MASS – Container and Bulk Shipping.

UNIT – IV SHIPPING DERIVATIVES AND RISK MANAGEMENT 9L

Types of risks, Risk-management process, Derivatives: Contracts and applications, Applications and uses of financial derivatives, Shipping Markets - Shipping industry, Market segmentation, Shipping freight contracts, Structure of costs in shipping, Spot freight-fate formation, Time-charter rate formation, Seasonal behaviour of freight rates, The market for ships, Statistical Tools for Risk Analysis and Modelling, Data sources and data-collection methods, Descriptive statistics and moments of a variable, Time-varying volatility models, ARCH and GARCH models, Forecasting volatility. Bunker Risk Analysis and Risk management.

UNIT – V **AI TECHNIQUES IN MARITIME INDUSTRY** **9L**

Maritime Data Processing - Maritime Data Processing in Relational Databases, Maritime Data Analytics, Visual Analytics of Vessel Movement, Maritime Communications, Link Discovery for Maritime Monitoring, Intelligent Transmission scheduling based on Deep Reinforcement Learning.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Gain a thorough understanding of the current trends and issues in freight logistics, as well as green supply chain management techniques that support sustainability and environmental responsibility in logistics operations and container management.
2. Analyze the legal implications of autonomous ships and risk management and safety measures to ensure autonomous ship safety and security.
3. Apply statistical tools for risk analysis and modeling in the maritime domain including descriptive statistics, time-varying volatility models, ARCH, GARCH models, and forecasting techniques.
4. Apply maritime data processing techniques in relational databases, utilize maritime data analytics, and visualize vessel movement data for informed decision-making. and challenges of sustainable blockchain technology in maritime operations

REFERENCES:

1. Multi-objective Management in Freight Logistics, 2nd Edition, Springer, Massimiliano Caramia, Paolo Dell'Olmo, 2020.
2. Shipping Derivatives and Risk Management, Springer, Amir H. Alizadesh, Nilos K. Nomikos, 2009
3. Digital Management of Container Terminal Operations, Ning Zhao.Weijian Mi.Yuan Liu.Yifan Shen.Mengjue Xia, Springer 2022.
4. Unmanned and Autonomous Ships: An Overview of MASS by R.Glenn Wright 2020 Taylor & Francis Group, LLC.
5. Guide to maritime Informatics, Alexander Artikis, Dimitris Zissis, Springer, 2021
6. Mission-Critical Application Driven Intelligent Maritime Networks, Tingting Yang, Xuemin(Sherman)Shen, Springer,2020

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	2	2	2	2	2	3	2	3	1
2	3	3	3	2	2	2	2	2	2	2	2	3	3	2	3
3	3	3	2	3	3	2	2	2	2	2	2	3	1	2	3
4	3	3	2	3	3	1	1	2	2	2	2	3	2	3	2
5	2	2	3	2	3	1	1	2	2	2	2	3	2	3	1
6	3	3	2	3	2	2	2	2	2	2	3	3	2	3	2
Avg.	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**

1-low, 2-medium, 3-high, '-"- no correlation

IT23C17	BIOINFORMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the structural organization and functional roles of bio-molecules and their implications in genomics and proteomics.
- To gain proficiency in utilizing various biological databases and tools for sequence alignment, molecular visualization, and genome mapping.
- To develop skills in using bioinformatics tools for prediction and analysis of gene expression data and DNA microarrays.
- To explore the various drug discovery technologies and strategies.
- Apply deep learning techniques to solve complex bioinformatics problems using Python libraries.

UNIT I **INTRODUCTION TO BIO-MOLECULAR STRUCTURES** **9**

Molecules and super-molecules structure, DNA and RNA structures, Proteins: Amino acids, Protein folding and interaction, protein structure determination, Polysaccharides, Lipids, Genomics: DNA Sequencing, Gene Identification, Extrinsic methods and Intrinsic Methods, Proteomics: Transcriptomics, Proteomic analysis, protein identification, Protein microarrays, Protein Expression pattern.

Suggested Activities:

- Demonstrate molecular modeling to students using open-source 3D modeling software to build and visualize molecular structures, animations to explain molecular interactions, etc.
- Encourage students to come up with case studies related to the Analysis of specific genetic disorders related to DNA/RNA structural anomalies. Incorporate 3D models and animations to explain molecular interactions and structures.
- Group Discussions to focus on recent research articles related to molecular structures.

Suggested Evaluation Methods:

- Assignments on Modeling and describing the structure of a given molecule.
- Assessing students' ability to use tools and techniques for protein analysis.
- Quiz to test the understanding of genomic concepts and techniques.

UNIT II **BIOLOGICAL DATA SEARCH AND RETRIEVAL** **9**

Biological Database: Introduction, Databases: sequence, molecular visualization, Genome mapping database, GENBANK: Flatflile, Pairwise alignment, sequence alignment, progressive alignment, database similarity searching, working with FASTA, working with BLAST, comparison of FASTA and BLAST.

Suggested Activities:

- Create small student groups and provide group activities to Explore different biological databases and present their key features.
- Demonstrate concepts using molecular visualization tools like PyMOL or Chimera.
- Introduce the students to progressive alignment tools like Clustal Omega and demonstrate a progressive alignment of multiple sequences.

Suggested Evaluation Methods:

- Short quizzes covering key concepts such as database types, sequence retrieval, and alignment principles.
- Written assignments analyzing the strengths and weaknesses of different biological databases and alignment tools.
- Peer review and feedback on each other’s assignments, fostering collaborative learning and critical thinking skills.

UNIT III **PREDICTIVE METHODS** **9**

GENE PREDICTION: Gene introduction-gene sequencing- sequence assembly problem-gene pattern recognition, gene prediction using bioinformatics tools, Gene expression, DNA Microarrays, Sanger sequencing, RNA PREDICTION: methods of RNA structure prediction, ncRNA prediction, PROTEIN STRUCTURE PREDICTION: protein folding problem, protein structure prediction methods, predicting transmembrane proteins.

Suggested Activities:

- Group Activity: Research and present the history and advancements in gene sequencing.
- Introduce students to pattern recognition tools and encourage them to solve Pattern Identification Exercises by identifying gene patterns from a given dataset.
- Demonstrate protein structure prediction using open source tools like SWISS-MODEL and validate the results.

Suggested Evaluation Methods:

- Written assignments analyzing the strengths and limitations of different predictive methods and tools.
- Group or individual presentations on selected topics such as gene prediction tools, RNA prediction methods, or protein structure prediction projects.
- Comprehensive projects that require students to use multiple predictive methods to investigate a specific biological question or dataset.

UNIT IV **DRUG DISCOVERY: TECHNOLOGIES and STRATEGIES** **9**

Drug discovery: introduction- areas influencing drug discovery, drug discovery parameters, drug discovery technologies, drug target identification strategy, drug target validation, predicting functional important structure regions, validation of targets, Drug Design: Biomarkers: classification, combinatorial biomarkers, biomarkers in drug development, drug identification, databases for compound identification and prediction, computer-aided drug design.

Suggested Activities:

- Group Discussion: Factors influencing drug discovery and current challenges in the field.
- Case Studies: Analyse the impact of different areas such as genomics, proteomics, and bioinformatics on drug discovery.
- Tutorial: Detailed guide on strategies for drug target identification.
- Introduce students to open-source Computer-Aided Drug Design (CADD) tools and demonstrate computer-based drug design.

Suggested Evaluation Methods:

- Group or individual presentations on selected topics such as drug target identification strategies, biomarker applications, or CADD projects.
- Comprehensive projects that require students to use multiple drug discovery strategies and technologies to investigate a specific biological question or dataset.
-

UNIT V **DEEP LEARNING IN BIOINFORMATICS** **9**

Deep learning and bioinformatics-Convolutional neural networks for bioinformatics, recurrent neural networks (RNN) for bioinformatics, Long short term memory (LSTM) networks in bioinformatics, Python libraries for bioinformatics.

Suggested Activities:

- Explore Python libraries like TensorFlow, Keras, BioPython, and PyTorch for bioinformatics.
- Demonstrate using CNN model to classify protein structures or predict gene expression patterns in python.
- Use LSTM networks for bioinformatics tasks like predicting protein-protein interactions.

Suggested Evaluation Methods:

- Short quizzes on key concepts such as deep learning architectures, CNN, RNN, LSTM, and Python libraries.
- Group or individual presentations on selected topics such as CNN applications in bioinformatics, RNN-based sequence analysis, or LSTM network projects.
- Written assignments analyzing the strengths and limitations of different deep learning models in bioinformatics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:

CO1: Understanding the basics of Molecular structure.
CO2: Understanding biological databases and searching biological data.
CO3: Understanding and predicting the structures of GENE, RNA and protein structures.
CO4: Studying about drugs-discovery, design, and testing.

CO5: Applying Deep learning techniques and python libraries for the field of bioinformatics.

TEXTBOOKS:

1. Jeremy Ramsden," Bioinformatics – An Introduction", Springer Publications, 2009
2. Harisha, "Fundamentals of Bioinformatics", IK International House, 2007.
3. SC Rastogi, Parag Rastogi, and Namita Mendiratta "Bioinformatics – Methods and Applications, Genomics, Proteomics and Drug Discovery", 5th edition, PHI, 2022.
4. Habib Izadkhah, "Deep Learning in Bioinformatics', 1st edition, Elsevier, 2022.

REFERENCES:

1. Sushmita Mitra, Sujay Datta, Theodore Perkins, George Michailidis ,"Introduction to Machine Learning and Bioinformatics", CRC Computer Science & Data Analysis, 2019.
2. Faheem Masoodi, Mohammad Quasim, Syed Bukhari, Sarvottam Dixit, Shadab Alam "Applications of Machine Learning and Deep Learning on Biological Data", CRC Press, 2023.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	1	-	2	1	-	2	-	-	1	1	2	2
CO2	2	2	2	2	1	2	-	-	1	-	1	1	2	2	2
CO3	3	2	2	2	2	2	-	-	1	-	1	1	2	2	2
CO4	3	3	3	2	2	3	2	2	-	2	1	2	1	1	3
CO5	3	2	2	2	2	2	-	-	2	1	2	2	3	2	3
AVG	**2.6**	**2**	**2**	**1.8**	**1.4**	**2.2**	**0.6**	**0.4**	**1.2**	**0.6**	**0.8**	**1.4**	**1.8**	**1.8**	**2.4**

1-low, 2-medium, 3-high, '-"- no correlation

AD23024	ETHICS FOR AI	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Explore the foundational concepts of ethics related to AI
2. Study the principles of trust and fairness in AI systems, focusing on ethical guidelines, responsibility and liability with real-world examples.
3. Analyze various risks associated with AI, including business, ethical, privacy, and surveillance issues and learn strategies for managing these risks.
4. Study the social and ethical implications of robotics, including moral theories, ethical issues in technology and the taxonomy of roboethics.
5. Investigate the challenges and opportunities in AI ethics, with a focus on societal issues.

UNIT – I INTRODUCTION **9L**

Introduction to AI - Descriptive Ethics - Normative Ethics- Meta-ethics – Applied ethics - Relationship Between Ethics and Law - Machine Ethics

UNIT – II TRUST AND FAIRNESS IN AI **9L**

User Acceptance and Trust - Functional Elements of Trust - Ethical Principles for Trustworthy and Fair AI - Responsibility and Liability in AI Systems - Examples- Crash of an Autonomous Vehicle - Mistargeting by an Autonomous Weapon -Attribution of Responsibility and Liability - Moral Responsibility Versus Liability - Strict Liability

UNIT – III RISKS IN AI **9L**

General Business Risks - Ethical Risks of AI - Managing Risk of AI - Business Ethics for AI Companies - Risks of AI to Workers -- Privacy Issues of AI - What Is Privacy? - Why AI Needs Data - Private Data Collection and Its Dangers - Persistence Surveillance -Usage of Private Data for Non-intended Purposes

UNIT – IV ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS **9L**

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 **9L**

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: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand and differentiate the different ethics in AI.
1. Identify the Responsibility and Liability in AI Systems.
2. Understand the ethical risks of AI and the risks of companies and workers in AI.

3. To understand the privacy issues of the data.
4. Understand the concepts of Roboethics and Morality with professional responsibilities.
5. Learn about the societal issues in AI with National and International Strategies on AI

REFERENCES:

1. Sean Welsh, Alan R. Wagner, Christoph Lütge, Christoph Bartneck , An Introduction to Ethics in Robotics and AI, SpringerBriefs in Ethics, 2019.
2. Patrick Lin, Keith Abney, George A Bekey, Robot Ethics: The Ethical and Social Implications of Robotics, The MIT Press- January 2014.
3. Towards a Code of Ethics for Artificial Intelligence (Artificial Intelligence: Foundations, Theory, and Algorithms) by Paula Boddington, November 2017
4. 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
5. Mark Coeckelbergh," AI Ethics", The MIT Press Essential Knowledge series, April 2020
6. S.Matthew Liao, Ethics of Artificial Intelligence, Oxford University Press, 2020

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2	3	1	3	2	2	1	2	1	1	1
2	2	2	2	2	2	3	1	3	2	2	1	2	2	1	1
3	2	2	1	2	2	3	1	3	2	2	1	2	1	1	2
4	2	2	2	2	2	3	1	3	2	2	1	2	1	2	1
5	2	2	2	2	2	3	1	3	2	2	1	2	1	1	1
6	2	2	2	2	2	3	1	3	2	2	1	2	1	1	1
Avg	2	2	2	2	2	3	1	3	2	2	1	2	1	1	1

1-low, 2-medium, 3-high, '-"- no correlation

IT23C15 **RESPONSIBLE AI** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand AI basics, misconceptions, responsible AI principles, and challenges in implementation.
- To understand and analyse biases in AI, fairness metrics, and mitigation techniques.
- To understand explainability, challenges, methods, and evaluation for interpretable machine learning models.
- To understand AI safety, security, privacy, and resilience, including model and data protection.
- To explore ethical issues and implications of AI in various real-world applications.

UNIT I INTRODUCTION TO RESPONSIBLE AI **9**

Overview of AI – Common misconception of AI – Introduction to Responsible AI – Characteristics of Responsible AI – Key principles of responsible AI - Challenges in implementing responsible AI - ELSI Framework and AI - Safety and Alignment – Fairness and Privacy.

Suggested Activities:

- Flip Classroom on Key Principles and Challenges in Responsible AI
- Case Study on Implementing Responsible AI
- Analyze the ELSI Framework and AI

Suggested Evaluation Methods:

- Assignment on Overview and Misconceptions of AI
- Quiz on Characteristics and Principles of Responsible AI
- Presentation on Fairness and Privacy in AI and ELSI Framework

UNIT II FAIRNESS AND BIAS **9**

Human Bias - Types of biases - Effects of biases on different demographics - Bias vs Fairness - Sources of Biases - Exploratory data analysis - Bias Mitigation Techniques - Pre-processing techniques - In-processing techniques - Post-processing techniques - Bias detection tools - Overview of fairness in AI - Demographic parity - Equalized odds - Simpson's paradox and the risks of multiple testing - Group fairness and Individual fairness - Counterfactual fairness - Fairness metrics - Bias and disparity mitigation with Fairlearn.

Suggested Activities:

- Flip Classroom on Types of Biases and Their Effects and Bias Mitigation Techniques
- Hands-On Lab with Bias Detection Tools and Fairness Metrics
- Group Project on Fairness in AI, Including Demographic Parity and Equalized Odds

Suggested Evaluation Methods:

- Assignment on Types of Biases and Their Effects
- Quiz on Bias vs Fairness and Sources of Biases
- Presentation on Fairness Metrics and Mitigation with Fairlearn

UNIT III EXPLAINABILITY & INTERPRETABILITY **9**

Importance of Explainability and Interpretability – Challenges - Interpretability through simplification and visualization - Intrinsic interpretable methods - Post Hoc interpretability – Interpretability Evaluation methods - Explainability through causality - Model agnostic Interpretation - LIME (Local Interpretable Model-agnostic Explanations) - SHAP (SHapley Additive exPlanations).

Suggested Activities:

- Flip Classroom on Explainability and Interpretability Concepts and Visualization Techniques for Interpretability
- Case Study on Explainability through Causality

Suggested Evaluation Methods:

- Assignment on Explainability and Interpretability Concepts
- Quiz on Intrinsic vs. Post Hoc Interpretability Methods
- Presentation on Interpretability Evaluation Methods

UNIT IV SAFETY, SECURITY, AND PRIVACY 9

Overview of safety – security – privacy - resilience - Taxonomy of AI safety and Security - Adversarial attacks and mitigation - Model and data security - The ML life cycle - Adopting an ML life cycle MLOps and ModelOps - Model drift - Data drift - Concept drift - Privacy-preserving AI techniques- Differential privacy - Federated learning.

Suggested Activities:

- Flipped Classroom on AI Safety and Security Taxonomy
- Flip Classroom on ML Life Cycle and MLOps
- Case Study on Model and Data Security
- Research Report on Privacy and Security in AI

Suggested Evaluation Methods:

- Assignment on AI Safety and Security Taxonomy
- Quiz on Adversarial Attacks and Mitigation Techniques
- Presentation on Privacy and Security in AI

UNIT V CASE STUDIES 9

COMPAS Algorithm - Google Photos Tagging Controversy - ProPublica's Analysis of Recidivism Predictions - Amazon's AI Recruiting Tool - Facial Recognition Technology Misidentification - AI in Healthcare: Predictive Analytics in Patient Care - Tesla Autopilot and Ethical Implications of Autonomous Vehicles.

Suggested Activities:

- External learning on the COMPAS Algorithm
- Discussion on Amazon's AI Recruiting Tool Bias
- Case Study Analysis of Google Photos Tagging Controversy
- Ethical Analysis of Tesla Autopilot and Autonomous Vehicles

Suggested Evaluation Methods:

- Presentation and analysis report submission on the case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO1. State the aspects of Responsible AI, such as fairness, bias, privacy etc.
CO2. Enforce fairness in models and mitigate bias in data.
CO3. Understand the importance of explainability and interpretability in AI systems.
CO4. Implement strategies to manage safety, security and privacy in AI systems.
CO5. Evaluate the societal impact of AI applications.

TEXTBOOKS:

1. Virginia Dignum, "Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way", 2019.
2. Adnan Masood, Heather Dawe, "Responsible AI in the Enterprise", 2023.
3. Beena Ammanath, "Trustworthy AI", O' Reilly, 2022.
4. Christoph Molnar "Interpretable Machine Learning", 1st edition, 2019.

REFERENCES:

1. I Almeida, “Responsible AI in the Age of Generative Models: Governance, Ethics and Risk Management”, 2024.
2. Silja Voeneky, Philipp Kellmeyer et. al, “The Cambridge Handbook of Responsible Artificial Intelligence”, Cambridge University Press, 2022.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	-	-	-	-	-	2	2	3	3	3
CO2	3	3	3	3	3	-	-	-	2	-	2	2	3	2	3
CO3	3	3	3	2	3	-	-	-	2	-	2	2	3	2	3
CO4	3	3	3	2	3	-	-	-	2	-	2	2	3	2	3
CO5	2	2	2	2	3	-	-	-	2	-	2	2	2	2	2
AVG	**2.6**	**2.6**	**2.6**	**2.2**	**2.8**	**-**	**-**	**-**	**1.6**	**-**	**2**	**2**	**2.8**	**2.2**	**2.8**

1-low, 2-medium, 3-high, ‘-“- no correlation

AD23902 **SOFTWARE ENGINEERING** **L T P C**
3 0 0 3

Course Objectives

1. Getting to know about software process models.
2. Getting to know about the requirements in software design.
3. To study about Analysis and design phase in software engineering.
4. To know about various testing methods in software engineering.
5. To understand the role of RISK Analysis and Quality Assurance.

UNIT I SOFTWARE PROCESS MODELS **9**

A Generic View of Process – Process Models-The Waterfall Model-Incremental Model- Evolutionary Model-Specialized Model-The Unified Process–Agile Process – Agile Models – Planning – Software Project Scheduling.

UNIT II REQUIREMENT ENGINEERING **9**

System Engineering Hierarchy – System Modeling – Requirements Engineering: Tasks- Initiating The Process-Eliciting Requirements-Developing Use Cases- Negotiating Requirements-Validating requirements

UNIT III ANALYSIS MODELING AND DESIGNING **9**

Building the Analysis Models: Concepts - Design Concepts – Design Models – Pattern Based Design – Architectural Design – Component Level Design – User Interface – Analysis And Design.

UNIT IV TESTING **9**

Software Testing – Strategies: Conventional - Object Oriented – Validation Testing – Criteria – Alpha – Beta Testing- System Testing – Recovery – Security – Stress – Performance - Testing Tactics – Testing Fundamentals-Black Box – While Box – Selenium – JIRA.

UNIT V QUALITY MANAGEMENT **9**

Software Configuration And Management - Risk management - Software quality Assurance - Software Reviews – Software Quality Standards: ISO/IEC 5055

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On studying this course, students will be able to:

1. Understand and know about software process models.
2. Gather requirements in software design.
3. Perform Analysis and carryout design phase in software development.
4. Identify and carryout testing methods in software engineering.
5. Carryout RISK Analysis and perform Quality Assurance.

TEXT BOOK

1. Roger S. Pressman and Bruce R. Maxim, Software Engineering, A practitioner's Approach-, 8th edition, Mc Graw Hill Education, USA, 2019

REFERENCES

1. P. Fleeger, "Software Engineering", Prentice Hall, 1999.
2. Carlo Ghezzi, Mehdi Jazayari, Dino Mandrioli, "Fundamentals Of Software Engineering", Prentice Hall Of India, 1991.
3. Pankaj Jalote, A Concise Introduction to Software Engineering, Springer , New Delhi, 2011.
4. Ian Sommerville, Software Engineering, 10th edition, Addison – Wesley, New Delhi, 2017.

IT23904 IOT BASED SMART SYSTEMS L T P C
3 0 0 3

Course Objectives:

1. Getting familiar with IoT fundamentals.
2. Studying about essential wireless technologies for IoT.
3. Getting to know about cloud infrastructure for IoT.
4. Studying about IoT Design Methodologies.
5. Studying about Smart Systems for IoT.

UNIT I INTRODUCTION TO THE INTERNET OF THINGS 9

Introduction to IoT- Elements of an IoT- Technology drivers- Business drivers- Typical IoT applications- Trends and implications.

UNIT II WIRELESS TECHNOLOGIES FOR THE IOT 9

Sensors and sensor nodes - Sensing devices- Sensor modules, nodes and systems- Network connectivity and protocols- Wireless sensor networks -Protocols - RFID , NFC, Zigbee, GSM, GPRS

UNIT III THE CLOUD FOR IOT 9

The Topology of the Cloud - Cloud-to-Device Connectivity - Device Ingress/Egress - Data Normalization and Protocol Translation- Infrastructure - APIs

UNIT IV IOT DESIGN METHODOLOGY 9

IoT systems management – IoT Design Methodology – Specifications Integration and Application Development, Arduino IDE – Programming - APIs

UNIT V IOT SMART SYSTEMS 9

Smart Home Automation -Smart Lighting -Smart Appliances - Intrusion Detection - Smoke/Gas Detectors - Smart cities – Smart waste management – Smart Agriculture – Future Trends: AI-enabled IoT.

TOTAL : 45 PERIODS

OUTCOMES:

Upon the completion of the course, the student should be able to:

1. Understand IoT fundamentals.
2. Explore and get their hands on wireless technologies for IoT.
3. Understand the cloud integration for IoT.
4. Design and develop applications using Arduino IDE.
5. Understanding Smart systems and IoT for real-world applications.

REFERENCES:

1. **Misra, Sudip, Anandarup Mukherjee, and Arijit Roy. Introduction to IoT. Cambridge University Press, 2021.**
2. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.
3. **Milan Milenkovic. Internet of Things: Concepts and System Design. Springer 2020.**
4. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
5. Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions for Design and Test”, Application Note, 2016.
6. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013
7. NPTEL course on “Introduction to Internet of things” by Dr. Sudip Misra IIT Kharagpur.

AD23903 **DATA STRUCTURES** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basics of the C programming language
- To learn the concepts of Abstract Data Types.
- To understand the concepts of linear data structure like list, stack, and queue.
- To understand the concepts of non-linear data structures.
- To introduce the concepts of Sorting and Searching Techniques

UNIT I C PROGRAMMING 9

Arrays - Functions - Pointers - Structures - Union - Enumerated Data Types - File Handling - Preprocessor Directives

UNIT II LINEAR DATA STRUCTURES 9

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked list-based implementation – Doubly-Linked Lists – Circular Linked lists.

UNIT III STACKS AND QUEUES 9

Stack ADT – Implementation of Stack – Array and Linked list implementation – Applications - Balancing the parenthesis – Infix to Postfix expression - Evaluating arithmetic expressions – Queue ADT – Implementation of Queue.

UNIT IV NON-LINEAR DATA STRUCTURES 9

Trees – Binary Trees – Types of Binary Trees – Binary Search Tree – Implementation – Tree Traversals – Expression tree – Solving expressions using expression tree – Priority Queue: Binary heap.

UNIT V SORTING AND SEARCHING TECHNIQUES 9

Sorting algorithms: Insertion sort - Shell sort - Quick sort - Merge sort - Searching: Linear search - Binary search

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to:
CO1: Develop C programs for any real-world/technical application.
CO2: Apply advanced features of C in solving problems.
CO3: Write functions to implement linear and non–linear data structure operations.
CO4: Use appropriate linear/non–linear data structure operations for solving a given problem.
CO5: Solve a given expression using linear and non-linear data structures.
CO6: Appropriately use sort and search algorithms for a given application.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 2014.

REFERENCES:

1. Reema Thareja, “Data Structures using C”, Third Edition, Oxford University Press, 2023.
2. Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4. Ellis Horowitz, Sartaj Sahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.

AD23201 **PYTHON PROGRAMMING** **L T P C**
3 0 0 3

OBJECTIVIES:

This course aims to

- Essential focus on the fundamental concepts of python
- Understand the control flow statements and operators
- Learn how to solve programs using variables and functions
- Applying data structures for problem-solving
- Learn and implement how to handle with files
- Gain knowledge about how to use built-in modules and create user-defined modules.

UNIT I BASICS OF PYTHON 9

Python Introduction – Importance and careers with Python, History, Features, Installing Python SDK, Creating simple hello world using Editor / IDE – Python Interpreter – Basic Syntax and Data Types – Comments – Type Casting, Unicode System, Input Arguments – Static, Command Line and Runtime with Examples.

UNIT II CONTROL FLOW STATEMENTS AND OPERATORS 9

Conditional Statements – if, if-else, if elif else; Python Loops – while, for, range, break, continue, pass; Python Operators – Arithmetic Operators, Assignment Operator, Comparison Operator, Membership Operator, Logical and Bitwise operators, Special Operators.

UNIT III VARIABLES AND FUNCTIONS 9

Variables – Creating, Displaying, Deleting, Getting variable type, Multiple assignments, Naming convention, Local and global variables; Functions – Creating and Calling Functions, Types, Parameter Passing, Return Statement, Lambda Function, Recursive Function, Built-in Functions.

UNIT IV ESSENTIAL COLLECTIONS IN PYTHON 9

Strings – Creating, Indexing, Built-in methods; Lists – Creating, Indexing, Slicing, Built-in methods, Tuples – Creating, Indexing, Slicing, Built-in methods; Dictionary – Creating, Displaying, Updating, Removing, Built-in methods.

UNIT V MODULES AND FILES 9

Introduction to Modules – Built-in modules, Creating and applying user-defined modules, Module Attributes, import statement, Usage of pip command for installing and uninstalling built-in modules; File Handling – Reading and Writing Text files.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1 Study the basic concepts of Python programming
CO2 Learn and practice the control structures and operators in Python
CO3 Essential focus on variables and functions with implementation
CO4 Programming with Python data structures for problem solving/project.
CO5 Understanding the importance of Python modules.

TTEXTBOOKS:

1. ACI Learning, Justin Dennison, Vonne Smith, Introduction to Programming Using Python, Packt Publishing, 2024.
2. S.Sridhar, J. Indumathi, V.M. Hariharan, Python Programming, Pearson India, 2023.

REFERENCES:

1. Udayan Das, Aubrey Lawson, Wiley Chris Mayfield, Narges Norouzi, Introduction to Python Programming, OPENSTAX, 2024 (Unit 1-4).
2. ACI Learning, Justin Dennison, Daniel Lowrie, Python Programming Essentials, Packt Publishing, 2024.
3. Deepali Srivastava, Ultimate Python Programming, BPB Publications, 2024.

4. Monu singh rakesh k. Yadav, Srinivas Arukonda, "Zero to Mastery in Python Programming", Vayu Education Of India, 2021.

AD23905 ARTIFICIAL INTELLIGENCE L T P C
3 0 0 3

OBJECTIVES:

- To provide students with a strong foundation in the core principles of Artificial Intelligence.
- To equip students with the knowledge and skills to implement intelligent adversarial search strategies and use knowledge representation methods.
- To cultivate students' proficiency in using lower-order logics for reasoning within AI systems.
- To prepare students to apply AI planning methods and natural language processing
- To design simple AI applications across various domains, such as chatbots, AI assistants, and expert systems.

UNIT I INTELLIGENT AGENTS AND SEARCH TECHNIQUES 9

Foundations of AI: Importance of AI, Evolution of AI, Applications of AI – Agents and Environments – The Nature of Environments – The Structure of Agents – Problem Solving by Search – Uninformed Search– Informed State Space Search – Heuristic Search: Greedy – A* Search – Constraint Satisfaction Problems.

UNIT II ADVERSARIAL SEARCH AND KNOWLEDGE REPRESENTATION 9

Game Search - Min-max Search, Heuristic Alpha-Bata Tree Search, Cutting of Search, Knowledge Representation Issues – Approaches for Knowledge Representation: Simple Relational Knowledge – Inherited Knowledge – Semantic Nets – Frames – Semantic Web – Ontology.

UNIT III REASONING WITH LOWER ORDER LOGICS 9

Logical Agent – Proposition Logic – Syntax and Semantics – Theorem Proving – Model Checking – Inference in First Order Logic: Forward Chaining – Backward Chaining – Resolution.

UNIT IV AI PLANNING AND NATURAL LANGUAGE PROCESSING 9

Classical Planning – Types – Partial Order Planning – Graph Plan and SAT Plan – Natural Language Processing Basics: Syntax – Semantics – Introduction to Statistical NLP.

UNIT V APPLICATIONS in AI 9

Applications of AI – Chatbot: types, architecture – Autonomous driving – AI assistants – Recommendation system – AI in security – Expert systems: medical, commerce, societal applications.

TOTAL:45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Understand the foundations of AI and apply search techniques such as uninformed and heuristic search to solve complex problems.
- Implement adversarial search algorithms and demonstrate knowledge representation techniques.
- Develop the ability to construct and manipulate logical agents using propositional and first-order logic
- Gain proficiency in classical AI planning methods and understand the basics of natural language processing.
- Explore and apply AI concepts to real-world applications.

TEXT BOOKS:

1. Stuart J. Russell, Peter Norvig, “Artificial Intelligence - A Modern Approach”, Third Edition, Pearson Publishers, 2015.
2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, “Artificial Intelligence”, Third Edition, Tata McGraw-Hill Education, 2008.

REFERENCES:

1. Dheepak Khemani, “A first course in Artificial Intelligence”, McGraw Hill Education Pvt Ltd., NewDelhi, 2013.
2. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, O’Reilly, 2009, https://www.nltk.org/book/.
3. Nils J. Nilsson, “Artificial Intelligence: A New Synthesis”, Morgan Kaufmaan Publishers Inc; Second Edition, 2003.
4. NPTEL, “Artificial Intelligence”, http://nptel.ac.in/courses/106105079/2.
5. Udacity, “Introduction to Artificial Intelligence”, https://in.udacity.com/course/intro-toartificial-intelligence--cs271.

IT23001	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Develop a comprehensive understanding of the foundations of artificial intelligence, including its history, key concepts, and the structure of intelligent agents.
- Gain proficiency in problem-solving techniques and search strategies, both uninformed and informed, to find solutions to complex problems in AI.
- Learn the principles of knowledge-based agents, propositional and first-order logic, and various reasoning systems to enable intelligent decision-making.
- Explore classical planning methods, algorithms, and heuristics to design and analyze planning approaches for AI systems.
- Understand and apply probabilistic reasoning, Bayesian networks, and decision methods to represent and reason with uncertainty in AI.

UNIT I INTELLIGENT AGENT AND SEARCH 9

Foundations of AI - History of AI - Agents and Environments – Good Behavior: The Concepts of Rationality, The Nature of Environment - Structure of Agent - Problem solving Agent - Example Problem, Searching for solution - Performance, Uninformed Search Strategy: Breadth First - Depth First - Depth Limited - Iterative Deepening - Bidirectional Search - Comparison of uninformed searches, Informed Search: Heuristic Search: Greed

Suggested Activities:

- Explore and discuss the time-line of AI history with current and future trends
- Flipped Classroom on various types of search strategies
- Programming different search techniques

Suggested Evaluation Methods:

- Autograded Quiz in Moodle/ equivant platforms
- Collaborative programming using GitHub Classroom/ equivalent

UNIT II *REASONING METHODS WITH LOWER ORDER LOGICS* 9

Knowledge Based Agents - Proposition Logic - Syntax - Semantics - Theorem proving - Horn Clauses and Definite Clauses - Forward and Backward chaining - Model Checking, First Order Logic - Syntax - Semantics - Knowledge Engineering - Knowledge Engineering Process - Electronics Circuit Domain, Inference - Unification - Forward Chaining - Backward Chaining - Resolution - Ontological Engineering - Categories and Objects - Events - Mental Objects and Modal Logic - Reasoning systems for Categories.

Suggested Activities:

- Pre-class video lectures on forward and backward chaining. - In-class exercises where students construct and analyze logical proofs using these methods.
- Develop a simple expert system using forward and backward chaining to solve a defined problem (e.g., medical diagnosis or troubleshooting a device).

Suggested Evaluation Methods:

- True/False and short answer questions on propositional and first-order logic, theorem proving, and model checking.
- Group presentations of logical proofs with peer and instructor feedback. Active participation is required.
- Programming evaluation - Functionality and correctness of the expert system, quality of the knowledge base, and thoroughness of the chaining processes. Code review and demonstration.

UNIT III ***AUTOMATED PLANNING*** **9**

Definition of Classical Planning - Example domains, Algorithms: Forward - Backward - Boolean Satisfiability, Heuristics for planning - Domain independent - State abstraction, Hierarchical planning - High level actions - Searching for primitive solutions and abstract solutions, Planning in non-deterministic domains, Time schedule and resources - Analysis of planning approaches.

Suggested Activities:

- Pre-class reading on domain-independent heuristics - In-class group activity to develop heuristic-based plans for different scenarios.
- Implement a planning algorithm (e.g., forward search) to solve a planning problem (e.g., robot navigation or resource allocation).

Suggested Evaluation Methods:

- Multiple-choice and short answer questions on planning algorithms, heuristics, and hierarchical planning.
- Quality and feasibility of the proposed plans. Peer reviews and instructor feedback during presentations.
- Programming - Correctness and efficiency of the implemented algorithm, handling of different planning scenarios. Code submissions are tested against sample problems.

UNIT IV ***PROBABILISTIC REASONING AND PROGRAMMING*** **9**

Bayes Rule - Naive Bayes Model, Representing Knowledge in an Uncertain Domain - The Semantics of Bayesian Networks - Exact Inference in Bayes Networks - Approximate Inference in Bayes Networks - Inference by Markov chain Simulation - Hidden Markov Model.

Suggested Activities:

- Pre-class video lecture on Bayesian network construction and inference - In-class activity where students build and analyze a Bayesian network for a given problem.
- Develop a program to perform inference in a Bayesian network using exact methods (e.g., variable elimination) and approximate methods (e.g., Gibbs sampling).

Suggested Evaluation Methods:

- Multiple-choice and short answer questions on Bayesian networks, exact and approximate inference, and Hidden Markov Models.
- Group evaluation and instructor feedback on accuracy and completeness of the constructed network, correctness of inference results.
- Programming - Correctness of the inference results, efficiency of the program, and handling of complex networks. Code submissions and results analysis.

UNIT V ***DECISION MAKING*** **9**

Combining Beliefs and Desires under Uncertainty, The Basis of Utility Theory - Utility Functions - Multiattribute Utility Functions - Decision Networks - Sequential Decision Problems - Algorithms for Markov Decision Process - Bandit Problems - Partially Observable MDPs - Introduction to Learning Methods.

Suggested Activities:

- Pre-class reading on MDPs and sequential decision problems. In-class case studies where students analyze and propose solutions to decision-making problems.
- Implement an algorithm for solving MDPs (e.g., value iteration or policy iteration) to optimize decision-making in a simulated environment.
- Exploration of the recent trends in Generative AI

Suggested Evaluation Methods:

- True/False and multiple-choice questions on utility theory, Markov Decision Processes (MDPs), and learning methods.

- Quality and feasibility of proposed solutions, active participation in discussions. Peer and instructor feedback.
- Programming - Correctness and efficiency of the algorithm, performance in various scenarios. Code submission and performance evaluation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Design and implement various search strategies for intelligent agents to solve complex problems.

CO 2. Develop knowledge-based systems using propositional and first-order logic for effective theorem proving and model checking.

CO 3. Apply classical and hierarchical planning algorithms to develop solutions for domain-independent planning problems.

CO 4. Utilize Bayesian networks and hidden Markov models for accurate probabilistic reasoning and inference in uncertain domains.

CO 5. Apply utility theory and decision network algorithms to make optimal decisions under uncertainty.

TEXTBOOKS:

1. Stuart J. Russell, Peter Norvig, “Artificial Intelligence - A Modern Approach”, Fourth Edition, Pearson Publishers, 2021.

REFERENCES:

1. Dheepak Khemani, “A first course in Artificial Intelligence”, McGraw Hill Education Pvt Ltd., NewDelhi, 2013.
2. Artificial Intelligence (NPTEL) by Prof. Dasgupta, IIT Kharagpur, https://nptel.ac.in/courses/106105079.
3. Artificial Intelligence (SWAYAM/ NPTEL) by Prof. Deepak Khemani, IIT Madras, https://onlinecourses.nptel.ac.in/noc21_cs79/preview.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	-	1	-	-	-	1	2	3	3	3
CO2	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO3	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO5	3	3	3	3	2	-	1	-	-	-	1	2	3	3	3
CO6	***3***	***3***	***3***	***3***	***2.2***	**-**	***1***	**-**	**-**	**-**	***1***	***2***	***3***	***3***	***3***
AVG															

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23003 **BIG DATA ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To know the fundamental concepts of big data and analytics.
- To gain knowledge to work with MapReduce big data frameworks.
- To learn the basic and advanced features of open-source big data tools and frameworks.
- To study various analytics on stream data.
- To understand the fundamentals of recommender systems and social networks.

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data - Need for processing Big Data – Need for analytics- Characteristics of big data, Domain-specific examples of big data, Big Data Stack – Introduction to Hadoop - Setting up of Hadoop.

Suggested Activities:

- Case studies on big data application domain.
- Real-world domain-specific problems involving big data and listing out the challenges.
- Demonstration of data analytics tools.

Suggested Evaluation Methods:

- Student assignment on case studies related to healthcare, climate change, e-commerce, retail business, manufacturing etc.
- Group presentation on big data applications with societal need.
- Quizzes on topics like big data terminologies, big data applications, etc.

UNIT II MAPREDUCE AND NEW SOFTWARE STACK 9

Distributed File System – MapReduce, algorithms using MapReduce - Extensions to MapReduce – Communication-cost model – Complexity Theory for MapReduce - Overview of Spark.

Suggested Activities:

- Case studies on applications involving MapReduce programs.
- Demonstration of Installation and configuring Hadoop and MapReduce.
- Design and develop algorithms to be executed in Map Reduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real-time data collection, implementing analytical techniques using Map-Reduce Tasks and Result Projection.
- Quiz on MapReduce.

UNIT III BIG-DATA TECHNOLOGY OVERVIEW 9

Big Data Collection Systems – Apache Flume – Big data Storage – HDFS Systems – Pig and Hadoop – Grunt – Data Model – pig Latin – Hive Overview – Hive QL – Overview of HBase - Overview of Workflow – Workflow and Scheduling using Apache Oozie - Introduction to NoSQL Databases – Basics of MongoDB.

Suggested Activities:

- Group discussion using case studies on big data storage frameworks.
- Write and implement simple queries using Hive Query language.
- Installation of MongoDB and simple data management.

Suggested Evaluation Methods:

- Simple group projects about data collection and querying using mongo DB.
- Presentation about the mini project involving mongo DB.

UNIT IV STREAMING ANALYTICS AND LINK ANALYSIS 9

Introduction to Stream analytics – Stream data model – Sampling Data – filtering streams – Count distinct elements in a stream, Counting ones, Estimating moments – Decaying windows – Link Analysis – PageRank Computation – Market Basket model – Limited pass algorithms for Frequent Item sets.

Suggested Activities:

- Case studies on the usage of stream analytics in popular search engines.
- External learning - Real-time sentiment analysis, stock market predictions.
- Assignments on solving simple numerical problems involving moments and skewness.

Suggested Evaluation Methods:

- Assignment on the following given a problem scenario identify suitable stream analytical technique(s).
- Quiz on all topics covered in stream analytics.

UNIT V RECOMMENDER SYSTEMS AND SOCIAL NETWORK MINING 9

Advertising on the Web – Online Algorithms – Matching problem – Adwords problem and Implementation – recommendation systems – Collaboration filtering – Dimensionality reduction – Mining Social Network graphs – Clustering of social network graphs – Partitioning of graphs – Simrank – Counting Triangles – Neighborhoods properties of Graphs.

Suggested Activities:

- Survey of reach articles on recommender systems and perform gap analysis.
- Download and install open-source network analytical tools and do simple visualization of network data.

Suggested Evaluation Methods:

- Seminar on real-time recommender systems and their working.
- Evaluate the student demonstration of visualization of real-time benchmark social network data.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO1. Understand the basics of Big Data
CO2. Know about Hadoop and MapReduce
CO3. Know about Big Data Technology, Tools, and Algorithms
CO4. Analyze the stream data and Link analysis.
CO5. Know about the role of big data in Recommender systems and social network analysis.
CO6. Design and Implementation of basic data intensive applications.

TEXTBOOKS:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Third Edition, Cambridge University Press, New Delhi.
2. Arshdeep Bagha and Vijay Madisetti, “Big Data Science & Analytics - A Hands-on Approach”, New Delhi, 2016.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2014.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO2	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO3	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO4	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO5	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3
CO6	3	3	3	3	3	1	1	1	2	1	2	2	3	3	3

DEEP LEARNING 3 0 0 3

COURSE OBJECTIVES:

- Understand the basics of neural networks.
- Know the basics of Deep learning for computer vision
- Understand LSTM and Autoencoders for Deep learning
- Understand the architectures of Transformers.
- Know about the application of Reinforcement learning using Deep neural networks.

UNIT I BASICS OF NEURAL NETWORKS 9

Basic concept of Neurons – Biological neurons and Artificial neurons - Perceptron Algorithm–Feed Forward and Back Propagation Networks – Activation Functions – ReLU, sigmoidal, Tanh - Loss Functions – Mean Square Error – Cross-entropy Error - Optimizers – Stochastic Gradient – Adaptive Gradient Descent – Momentum – AdaGrad – Adam - Regularization Techniques – Bias and Variance – Drop out – Data Augmentation – Batch Normalization.

Suggested Activities:

- Discussion on neural networks.
- Flipped classroom for activation functions.
- Tutorials on probability.

Suggested Evaluation Methods:

- Quizz on History of deep learning
- Survey of deep learning applications.

UNIT II DEEP LEARNING FOR COMPUTER VISION 9

CNN Architectures – Convolution – Layers – Convolutional Layers - Pooling Layers – LeNet - Advanced CNN Architectures – AlexNet – VGG – ResNet – GoogleNet - Transfer Learning – Pretrained Models as Classifier – Feature Extractor – Fine-Tuning - Image Classification using Transfer Learning – Object Detection – R-CNN – Fast R-CNN - Faster R-CNN - Networks – YOLO.

Suggested Activities:

- Discussion on machine learning and Image processing.
- Tutorials on Image operations
- Seminar on Classification.

Suggested Evaluation Methods:

- Quizz on Image processing
- Survey on Advanced CNN architectures.
- Discussion on object detection.

UNIT III DEEP LEARNING FOR SEQUENCE DATA 9

Introduction to Sequence Data – RNN – Architecture – Deep RNN – Bidirectional RNN – Long Short Term Memory – Forget Gate – Input Gate – Output Gate - GRU – Update and Reset Gate – Sequence2Sequence models - Encoder/Decoder Architecture - Autoencoders – Standard - Variational Auto Encoders.

Suggested Activities:

- Discussion on sequence data.
- Tutorials on RNN basics.
- Discussion on Gen AI for Autoencoders.

Suggested Evaluation Methods:

- Quizz on RNN.
- Assignment on autoencoders.
- Quizz on Gen AI.

UNIT IV TRANSFORMERS AND INTRODUCTION TO LLMS 9

Generative Adversarial network – Generator – Discriminator – Minimax Optimization – GAN Adversarial Training – GAN Losses – GAN Architectures – Conditional GAN – Progressive GAN - Transformers Architecture -Encoder – Decoder - Attention Models – Large Language Models - BERT – GPT – Prompt Engineering - LLM Application Development.

Suggested Activities:

- Discussion on Transformers.
- Tutorials on Lanrge language models.
- Group Discussion on Prompt Engineering.

Suggested Evaluation Methods:

- Quizz on Transformers.
- Assignment for Prompts.
- Tutorials on BERT and GPT.

UNIT V DEEP REINFORCEMENT LEARNING 9

Introduction to Reinforcement Learning – Multi-arm Bandit – Markov Processes – Markov Decision Process – Optimal Policy —- Dynamic Programming with MDP - Value and Policy Iteration - Deep Q Networks – Deep Q Algorithm – Function approximation – Double DQN – Policy-Based Methods – REINFORCE - Actor-Critic Method.

Suggested Activities:

- Discussion on Reinforcement Learning.
- Tutorials on SARSA.
- Group Discussion on Actor-critic methods.

Suggested Evaluation Methods:

- Quizz on Reinforcement learning.
- Tutorials in Deep Q learning.
- Discussion about markov Chain

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand the basics of Shallow Neural Networks and Deep Neural Networks.

CO 2. Get familiar with concepts of Machine Vision and deep learning models for Image classification and Object Detection

CO 3. Understand sequence data and RNN networks and its variants.

CO 4. Understand generative Adversarial Networks and Transformer Architectures like BERT and GPT.

CO 5. Design and implement Deep-Q learning and DQN algorithms.

TEXTBOOKS:

1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning,” MIT Press, 2017.
2. Andrew Glassner, “Deep Learning – A visual Approach,” No Starch Press, 2021

REFERENCES:

1. Francois Chollet, “Deep Learning with Python,” Manning Publications, 2018.
2. Jon Krohn,” Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence,” Addison-Wesley, 2020.

COURS	Program Outcomes (POs) & Program Specific Outcomes (PSOs)

E OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO2	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO3	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO4	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO5	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23C08 **REINFORCEMENT LEARNING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce a range of topics related to Reinforcement Learning and probability concepts.
- To gain knowledge on the Markov Decision Process.
- To understand the Q-Learning and SARSA methods.
- To know about the Deep Learning in Reinforcement Learning.
- To gain knowledge on Policy Gradient Methods.

UNIT I BASICS OF REINFORCEMENTLEARNING 9

Introduction to Reinforcement Learning–Elements of Reinforcement Learning– Scope – History of Reinforcement Learning– The Agent-Environment Interface – Examples of Reinforcement Learning – Why Study Reinforcement Learning – Challenges in Reinforcement Learning – Multi-arm Bandit Problem.

Suggested Activities:

1. Installation of Code Standards and Libraries used in RL (Python/Keras/Tensorflow).
2. Practical – Implement Tic-tac-toe and Armed Bandit Problem.

Suggested Evaluation Methods:

- Quiz on basic concepts of probability.

UNIT II MARKOV DECISION PROCESSES AND DYNAMIC PROGRAMMING 9

Overview of Markov Chain - Overview of Markov Decision Process – Model Reinforcement Learning Problem using MDP – Markov Process – Markov Chain – Markov Decision Process – Alternative Bellman Equations for value functions – Optimal policy and optimal value functions – Using Dynamic programming to solve RL problems – Policy Evaluation – Policy Improvement – Policy Iteration – Value Iteration.

Suggested Activities:

- Practical – Develop Dynamic programming algorithms for solving MDPs, Policy Evaluation, Policy Iteration, Policy Improvement and Value Iteration.

Suggested Evaluation Methods:

- Evaluation of the practical implementations with appropriate input Dataset.

UNIT III MONTE CARLO AND TEMPORAL DIFFERENCING 9

Monte Carlo Introduction – Policy Evaluation – Incremental Update – Exploration Vs Exploitation – Policy Improvement – Temporal Differencing Learning – TD Policy Evaluation – Epilon-Greedy policy – On-policy Vs Off-policy – Q-Learning – SARSA Learning – Double Q-Learning – Applications of Q-Learning – Grid Problems - N-Step Bootstrapping.

Suggested Activities:

Practical – Monte Carlo Prediction, Monte Carlo Off-Policy Control
Importance Sampling and SARSA
Tutorial on Deep Q Algorithm.
Practical – Implement Q-Learning (Off Policy TD Learning),

Suggested Evaluation Methods:

- Quiz on Deep Q algorithm and SARSA.
- External discussion on Monte carlo Methods
- External discussion on Temporal differencing

UNIT IV VALUE FUNCTION APPROXIMATION 9

Linear value function approximation – Challenge of Large-scale MDP – Value Function approximations – Stochastic Gradient Descent – Linear value and non-linear value approximation – Deep neural nets – Naïve Deep-Q Learning – Experience Replay – DQN for Games – DQN with Double-Q learning – Prioritized experience Replay – Advantage Function and Duelling Network Architecture.

Suggested Activities:

External discussion on Deep Learning

External discussion of CNN in Reinforcement Learning

Suggested Evaluation Methods:

- Tutorial on DQN
- Quizz on Deep Learning.

UNIT V ADVANCED DEEP REINFORCEMENT LEARNING 9

Policy Gradient Methods – Policy-Based methods – Policy Gradient – REINFORCE – Baseline – Actor-Critic Methods -Problems with Continuous Action space – Problems with Standard Methods – Policy Performance Bounds – Proximal Policy Optimization -Latest Trends – Distributed Reinforcement Learning – Curiosity Driven Exploration – Random network Distillation – Planning with AlphaZero.

Suggested Activities:

- Survey of policy gradient methods.
- Evaluation on Policy performance bounds.

Suggested Evaluation Methods:

- Survey of Latest Trends
- Study of AlphaZero Algorithms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Understand different terminologies of RL and Concepts of Probability.

CO 2. Illustrate the Markov Decision Process and Bellman Equation for learning.

CO 3. Apply dynamic programming techniques to the Markov decision process and Monte Carlo methods

CO 4. Implement Time difference learning for real-world problems

CO 5. Apply Approximation methods of learning and Q-learning technique.

TEXTBOOKS:

3. Richard S.Sutton and Andrew G.Barto, Reinforcement learning: An introduction, Second Edition, MIT Press, 2019.
4. Michael Hu, The Art of Reinforcement Learning – Fundamentals, Mathematics and Implementations with Python, Apress, 2024**.**

REFERENCES:

4. Sudharsan Ravichandiran, Deep Reinforcement Learning with Python, Second Edition, Packet Publishing, Birmingham, 2020.
5. Csaba Szepesvari, Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning), Morgan & Claypool Publishers, 2010.
6. Laura Graesser and Wah Loon Keng, Foundations of Deep Reinforcement learning: theory and Practice in Python, Pearson India, New Delhi, 2022.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO2	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO3	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO4	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
CO5	3	3	3	3	2	1	1	1	1	1	2	1	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**3**

1-low, 2-medium, 3-high, ‘-“- no correlation

IT23009	MLOPS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Set up development environments, version control systems, and data preprocessing techniques essential for efficient and collaborative machine learning model development
- Provide hands-on experience in building, evaluating, optimizing, packaging, and deploying machine learning models
- Understand and implement Continuous Integration and Continuous Deployment (CI/CD) concepts specific to machine learning
- Explore Docker and containerization, create Dockerfiles, manage multi-container applications, and optimize Docker images for machine learning workloads
- Deploy, scale, and manage machine learning applications using Kubernetes

UNIT I INTRODUCTION TO MLOPS AND DATA PROCESSING 9

Version control system GIT - Collaborative programming using GitHub/ equivalent - Overview of MLOps - Importance of MLOps in Machine Learning - Development environment setup with Python and additional Libraries - Data collection and storage - Data preprocessing techniques - data augmentation - Feature Engineering - Scaling and Normalizing data.

Suggested Activities:

- Hands-on version control system with Git
- Working on raw datasets to perform data collection, storage, and various preprocessing techniques
- Development environment setup for MLOPS

Suggested Evaluation Methods:

Quizzes: Assess understanding of version control, MLOps concepts, and data preprocessing techniques.

Lab Assignments: Evaluate practical skills in setting up development environments, using Git/GitHub, and performing data preprocessing tasks.

Project: A small project where students must collect, preprocess, and prepare a dataset for machine learning.

UNIT II MACHINE LEARNING PIPELINE 9

Training Machine Learning Models - Regression - Decision Tree - Support Vector Machines - Model Evaluation Metrics - Cross Validation Techniques -Hyperparameter optimization - Model testing - Model packaging - Deployment strategies - Serving Models with REST API - Implementation with Flask or streamlit or equivalent framework.

Suggested Activities:

- Training with Machine Learning models using python libraries
- Optimizing hyperparameters for given models to achieve the best performance
- Implementation of a simple web application using Flask, Streamlit, or an equivalent framework

Suggested Evaluation Methods:

- **Practical Exams:** Test students' ability to train and evaluate machine learning models, optimize hyperparameters, and deploy models.
- **Homework Assignments:** Assign tasks related to model training, evaluation, and deployment using various frameworks and tools.
- **Project:** A comprehensive project where students build a machine learning pipeline, from data preprocessing to model deployment, including documentation and presentation.

UNIT III **CONTINUOUS INTEGRATION AND CONTINUOUS DEPLOYMENT (CI/CD) FOR ML MODELS** **9**

CI/CD concepts for machine learning - Setting up CI/CD pipelines - Tools for CI/CD in MLOps (e.g., Jenkins, GitHub Actions) - Implementation of CI/CD for ML project - Monitoring -
Importance of monitoring ML models - Setting up logging and monitoring - Tools for monitoring.

Suggested Activities:

- Set up CI/CD pipelines using tools like Jenkins or GitHub Actions, integrating version control with automated testing and deployment
- Setting up logging and monitoring for ML models, using tools like Prometheus, Grafana, or ELK Stack
- Simulate the complete CI/CD process for an ML project

Suggested Evaluation Methods:

- **Practical Exams:** Assess students' ability to set up CI/CD pipelines and implement automated testing and deployment for ML models.
- **Lab Assignments:** Evaluate hands-on skills in using CI/CD tools, monitoring, and logging setups.
- **Project:** A project where students must create and demonstrate a CI/CD pipeline for an ML project, including integration of monitoring and logging.

UNIT IV ***DOCKER FOR MLOPS*** **9**

Overview of Docker and containerization - Docker installation and setup - Exploration of Dockerhub - Dockerdesktop - Creating Dockerfiles for a web application - Dockerfile for ML applications - Building and running Docker containers - Managing multi-container applications with Docker Compose - Docker networking and storage - Optimizing Docker images for ML workloads - Using Docker volumes for data persistence.

Suggested Activities:

- Step-by-step installation of Docker and an introduction to Docker commands, followed by hands-on exercises to create and run simple Docker containers
- Create Dockerfiles for a web application and ML applications, building and running Docker containers to understand the containerization process
- Develop and manage multi-container applications using Docker Compose

Suggested Evaluation Methods:

- **Quizzes:** Test knowledge of Docker concepts, commands, and containerization principles.
- **Lab Assignments:** Assess students' ability to create Dockerfiles, build and run Docker containers, and manage multi-container applications.
- **Project:** A project where students develop a containerized ML application using Docker, including optimization and management with Docker Compose.

UNIT V **KUBERNETES FOR MLOPS** **9**

Overview of Kubernetes and container orchestration - Setting up a local Kubernetes cluster (e.g., Minikube) - Kubernetes architecture and key components using pods - Deploying ML applications on Kubernetes - Scaling ML applications with Kubernetes - Configuration Management - Monitoring and logging in Kubernetes.

Suggested Activities:

- Hands-on setup of a local Kubernetes cluster using Minikube or an equivalent tool
- Deploying ML applications in Kubernetes, including creating pods, services, and managing configurations
- Scaling applications and setting up monitoring and logging within a Kubernetes cluster

Suggested Evaluation Methods:

- **Practical Exams:** Evaluate skills in setting up and managing Kubernetes clusters, deploying ML

applications, and scaling them.

- **Lab Assignments:** Assess students' ability to create and manage Kubernetes configurations, monitor applications, and troubleshoot issues.
- **Project:** A final project where students deploy a scalable ML application on Kubernetes, demonstrating their understanding of Kubernetes architecture, deployment, scaling, and monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Set up a development environment for machine learning projects, implement data preprocessing techniques, and use version control systems to manage collaborative programming.

CO 2. Train, evaluate, optimize, and deploy machine learning models using various algorithms and frameworks, and serve models through REST APIs.

CO 3. Implement CI/CD pipelines for machine learning projects, ensuring continuous integration, deployment, and monitoring of ML models using industry-standard tools.

CO 4. Create, manage, and optimize Docker containers for machine learning applications.

CO 5. Deploy, scale, and manage machine learning applications on Kubernetes clusters.

TEXTBOOKS:

1. Emmanuel Raj, Engineering MLOps Rapidly build, test and manage production-ready machine learning life cycles at scale, Packt Publications, 2021.
2. Jeff Nickoloff and Stephen Kuenzli, Docker in Action, Third Edition, Manning, 2019.
3. Kelsey Hightower, Brendan Burns, and Joe Beda, Kubernetes Up & Running: Dive into the Future of Infrastructure", OReilly 2017.

REFERENCES:

1. Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, Lynn Heidmann, Introducing MLOps: How to Scale Machine Learning in the Enterprise: O'Reilly Media: 2020

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	3	1	3	-	-	-	-	-	-	1	3	3	3
CO2	2	1	3	1	3	-	-	-	-	-	-	1	3	3	3
CO3	2	1	2	1	3	-	-	-	-	-	-	1	3	3	3
CO4	2	1	2	1	3	-	-	-	-	-	-	1	3	3	3
CO5	1	1	2	1	3	-	-	-	-	-	-	1	3	3	3
AVG	*1.6*	*1*	*2.4*	*1*	*3*	-	-	-	-	-	-	*1*	*3*	*3*	*3*

1-low, 2-medium, 3-high, '-"- no correlation

IT23039	IoT BASICS AND APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO IoT and ARCHITECTURE 9

Genesis of IoT - IoT and Digitization - IoT Impact - Convergence of IT and OT - IoT Challenges - Machine to Machine Communication - Physical and Logical Design of IoT- -- IoT Levels and Deployment Templates - M2M IoT Standardized Architecture -The IoT World Forum (IoTWF) - A Simplified IoT Architecture-Enabling Technologies of IoT - Emerging IoT Variants - Industrial IoT - Industry 5.0.

Suggested Activities:

- In-class activity – Discussion about the required level of complexity in IoT based systems.
- External learning – Exploring proprietary protocols used in IoT and M2M.

Suggested Evaluation Methods:

- Quiz on enabling technologies.
- Assignment on IIoT and Industry 5.0.

UNIT II IOT HARDWARE AND ARDUINO PROGRAMMING 9

Sensors, Actuators, and Smart Objects -Trends in Smart Objects - Microcontroller- architecture – ARM Cortex M MCU -- Arduino IDE – Programming and Developing Sketches – **Introduction to Arduino Shields – Integration of Sensors and Actuators with Arduino -** Arduino Rest APIs – Design Simple Smart Applications.

Suggested Activities:

- In-class activity – Discussion about Embedded Processor
- External learning - open source movement in hardware and SDLC for embedded systems.

Suggested Evaluation Methods:

- Assignment on Arduino sketches.
- Quiz on Python and REST APIs.

UNIT III IoT COMMUNICATION AND OPEN PLATFORMS 9

IoT Communication Models and APIs – IoT Communication Protocols- - COAP - MQTT -- – Bluetooth – WiFi -Node MCU-ESP8266 WiFi SoC– ZigBee – GPS – GSM modules – Open Platform (like Raspberry Pi) – Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Python Packages for IoT Connecting to the Cloud.

Suggested Activities:

- External learning – Explore IoT policy and IEEE Standards.
- In-class activity – Ipv6 packet header and address types.

Suggested Evaluation Methods:

- Assignment on LoRa.
- Quiz and 6LoWPAN.

UNIT IV IoT APPLICATIONS AND ANALYTICS 9

IoT Data Analytics - Types- Platform- IBM Watson -Secure device control, Synchronization and Real Time Analysis - ThingSpeak - AWS IoT Analytics – Cloud Storage and Communication APIs – Edge Computing.

Suggested Activities:

- Flipped classroom on cloud models and type of clouds.
- External learning – Cluster, grid and edge computing.

Suggested Evaluation Methods:

- Quiz on analytics tools and types of cloud APIs.
- Assignment on developing web apps for IoT ecosystems using Django framework.

UNIT V AI IN IoT 9

TinyML- ML ToolChain - Google Collab - Building Application on TinyML-- Arduino Deployment for Smart Applications- Overview of Industrial Control Systems (ICS) – ICS operations and components – SCADA Systems – Device Localization and Tracking -– Energy harvesting-– HealthCare - Battery based systems.

Suggested Activities:

- External learning – Agriculture case studies.
- In-class activity – Discussion on GPU requirements for smart IoT.

Suggested Evaluation Methods:

- Assignment on ML deployment in microcontroller.
- Quiz on IoT design methodology.

THEORY: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:

CO1: Understand the basic design of IOT and its emerging variants

CO2: Design portable IoT using Arduino and develop a simple smart applications

CO3: Apply appropriate communication protocols in various implementations of IoT based systems.

CO4: Use cloud and big data analytics tools in IoT based systems.

CO5: Design an AI based real time IoT Applications.

TEXTBOOKS:

1. Misra, Sudip, Anandarup Mukherjee, and Arijit Roy. *Introduction to IoT*. Cambridge University Press, 2021.
2. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015.

REFERENCES:

1. Halfacree, Gareth. *The official Raspberry Pi Beginner's Guide: How to use your new computer*. Raspberry Pi Press, 5th edition 2023.
2. Perry Lea, “Internet of Things for Architects”, PACKT, 2018 5. Andy King, “Programming the Internet of Things: An Introduction to Building Integrated, Device to Cloud IoT solutions”, O’REILLY’, 2021
3. Amita Kapoor: Hands-On Artificial Intelligence for IoT: Expert Machine Learning and Deep Learning Techniques for Developing Smarter IoT Systems. Packt Publishing 2019.
4. Warden, Pete, and Daniel Situnayake. *Tinyml: Machine learning with Tensorflow lite on arduino and ultra-low-power microcontrollers*. O'Reilly Media, 2019.
5. Kurniawan, Agus. "IoT Projects with NVIDIA Jetson Nano." *Apress Berkeley, CA,* 2021.
6. Raj, Pethuru, and Anupama C. Raman. The Internet of Things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.
7. David Hanes, Gonzalo Salguerio, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of Things”, Cisco Press, 2017.
8. NPTEL course on “Introduction to Internet of things” by Dr. Sudip Misra IIT Kharagpur

IT23002 **SOFT COMPUTING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To give students knowledge of soft computing theories and fundamentals.
- To understand fuzzy sets and fuzzy logic for problem solving.
- To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inferencing systems.
- To familiarize with genetic and other optimization algorithms while seeking global optimum in self-learning situations
- To implement hybrid systems using fuzzy, neural networks and optimization algorithms

UNIT I FUNDAMENTALS OF NEURAL NETWORKS 9

Hard and Soft Computing - Biological neuron and its working-Nerve structure and Synapse – Artificial Neuron and its Model – Activation Functions – Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks, Learning Techniques: supervised, unsupervised, reinforcement - Back Propagation Networks Architecture - Back Propagation Learning Methods – Effect of Learning Rule Co-Efficient: Single Layer and Multilayer Perceptron - Auto-Associative and Hetero-Associative Memory

Suggested Activities:

- Develop a supervised model to train neural net that uses the AND/OR/XOR two input binary/bipolar input and output data and learn linear models to understand the importance of initialization parameters.
- Train neural net that uses the XOR three input binary/bipolar input and output data and learn linear models to understand the importance of learning parameters.
- Train a linear / non linear model with one hidden layer, two hidden layers.
- Observe the performance with different learning rates and draw the graph depicting the error rate with iterations

Suggested Evaluation Methods:

- Implementation evaluation with appropriate input set in any available data set

UNIT II COMPETETIVE NEURAL NETWORKS 9

Kohenen's Self Organizing Map – SOM Architecture, learning procedure – Application; Learning Vector Quantization, Learning by LVQ – Adaptive Resonance Theory – Learning procedure – Weight updation – Sample problems - Applications

Suggested Activities:

- Train a neural net that uses any dataset for SOM and plot the cluster of patterns.
- Train a competitive neural net that uses any dataset for LVQ and observe the difference with other learning algorithms

Suggested Evaluation Methods:

- Implementation evaluation with new input set available in public data base

UNIT III FUZZY COMPUTING 9

Basic Concepts of Fuzzy Logic – Fuzzy Sets and Crisp Sets – Fuzzy Set Theory and Operations – Properties of Fuzzy Sets – Fuzzy and Crisp Relations – Membership Functions – Fuzzy If-Then Rules, Fuzzy propositions, implications and inferences - Aggregation of fuzzy outputs - Defuzzification methods– Fuzzy Controller design– Industrial Applications

Suggested Activities:

- Install Matlab Fuzzy Logic Toolbox and ANN toolbox to design and simulate systems

Suggested Evaluation Methods:

- Quizzes on basic concepts of fuzzy logic and operations.
- Design any simple fuzzy logic controller for sample applications like room temperature control

UNIT IV EVOLUTIONARY ALGORITHM **9**

Introduction to optimization problems – Genetic Algorithm - Working Principle – Procedures of GA – Flow Chart of GA – Genetic Representation: (Encoding) Initialization and Selection – Genetic Operators: Reproduction, Crossover, Mutation- Particle Swarm Optimization – Ant colony Optimization – Algorithmic steps and implementation - Convergence of Evolutionary Algorithm– Multi objective optimization problems

Suggested Activities:

- Implement Evolutionary algorithm for the Travelling Salesman problem to find the shortest path that visits all cities in a set exactly once

Suggested Evaluation Methods:

- Implementation evaluations by testing the code on different route maps and checking the optimal solution

UNIT V HYBRID CONTROL SCHEMES **9**

Fuzzification and rule base using ANN – Neuro fuzzy systems - ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –- Tuning Neural network parameters using Evolutionary algorithms - Introduction to Support Vector Machine - Case study of hybrid techniques – Familiarization of Neural Network, Fuzzy logic and ANFIS controllers toolbox

Suggested Activities:

- Implement a hybrid neuro fuzzy system for any application
- Implement an evolutionary algorithm to tune the parameters of neural network and for optimized input feature selection

Suggested Evaluation Methods:

- Sample case study implementation using hybrid control schemes like neuro fuzzy, ANFIS using python or Matlab toolbox

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

CO 1. Identify and describe soft computing techniques and the role of Artificial Neural Networks in building intelligent machines
CO 2. Design neural networks for pattern classification and regression problems
CO 3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
CO 4. Apply evolutionary algorithms to optimization problems
CO 5. Implement hybrid soft computing algorithms

TEXTBOOKS:

1. S. Rajasekaran, G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall of India, 2010.
2. J.S.R. Jang, C.T. Sun, E. Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education, 2004.
3. Satish Kumar, “Neural Networks : A Classroom Approach”, Second Edition McGrawHill, 2017

REFERENCES:

1. James.A.Freeman, David.M Skapura, **“**Neural Networks: Algorithms, Applications and Programming Techniques” (Computation and Neural Systems Series), ***Addison Wesley,*** 1991
2. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Second Edition, Wiley-India, 2007.
3. Siman Haykin, “Neural Networks”, Prentice Hall of India, 1999.
4. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley Publications, 2016.
5. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2008.
6. Melanie Mitchell, “An Introduction to Genetic Algorithms”, MIT Press, 2000
7. Corinna Cortes and V. Vapnik, "Support - Vector Networks, Machine Learning” 1995.

8. Snehashish Chakraverty, Deepti Moyi Sahoo, Nisha Rani Mahato, “Concepts of Soft Computing: Fuzzy and ANN with Programming”, Springer, 2019.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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CO3	3	3	2	3	3	2	1	3	2	-	3	3	3	3	3
CO4	3	3	3	3	3	2	1	3	2	-	3	3	3	3	3
CO5	3	3	3	3	3	2	1	3	2	-	3	3	3	3	3
AVG	3	3	2.6	3	3	2	1	3	2	-	2.6	2.2	3	3	3

1-low, 2-medium, 3-high, ‘-“- no correlation