ANNA UNIVERSITY: : CHENNAI: 600 025

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: College of Engineering Guindy (CEG) / Madras Institute of Technology (MIT)

Department: Information Science and Technology (CEG) / Information Technology (MIT)

Programme: B.Tech. Information Technology

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	EDS	IOC/ SDC	OEC	UC	SLC	Total
I			3	15			3		1		22
II			12	10					1		23
III	10		4	4					3		21
IV	17			4			2			1	24
V	15	3				3	4				25
VI	7	6			3	3	3	3			25
VII	4	9			3		3	3			22
VIII							8				8
Total	53	18	19	33	6	6	23	6	5	1	**170**
% of Category	31.36%	10.65%	10.65%	19.53%	3.55%	3.55%	13.61%	3.55%	2.96%	0.59%	

CATEGORY OF COURSES

PCC – Professional Core Course ESC – Engineering Science Course

PEC – Professional Elective Course HSMC – Humanities Science and Management Course

ETC – Emerging Technology Course IOC/SDC–Industry Oriented Course/Skill Development Course

OEC – Open Elective Course UC – University Course

SLC – Self Learning Course ED&S Entrepreneurship Development & Sustainability

SEMESTER I									
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Period / 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 and 3D Modeling	LIT	2	0	4	6	4	SDC
5	EE23C02	Fundamentals of Electrical and Electronics Engineering	LIT	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	-	0	0	2	2	0	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#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	EN23C02	Professional Communication	LIT	2	0	2	4	3	HSMC
2	MA23C03	Linear Algebra and Numerical Methods	T	3	1	0	4	4	HSMC
3	PH23C08	Fundamentals of Electronic Materials and Devices	T	3	0	0	3	3	HSMC
4	CY23C01	Engineering Chemistry	LIT	3	0	2	5	4	ESC
5	CS23C04	Programming in C	LIT	2	0	4	6	4	ESC
6	IT23201	Information Technology Essentials	LIT	3	0	2	5	4	ESC
7	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	T	1	0	0	1	1	UC
8		Audit Course - I	-	-	-	-	-	-	UC
TOTAL Credits								**23**	

SEMESTER III									
S. No.	Course Code	Course name	Course type#	Period / week				Credits	Category
				L	T	P	TCP*		
1	MA23C09	Finite State Automata and Discrete Structures	T	3	1	0	4	4	HSMC
2	IT23301	Digital Logic and Design	LIT	3	0	2	5	4	ESC
3	IT23302	Data Structures	LIT	3	0	2	5	4	PCC
4	IT23303	Database Management Systems	LIT	3	0	2	5	4	PCC
5	IT23304	Object Oriented Programming	LIT	1	0	2	3	2	PCC
6	IT23U01	Standards – IT	T	1	0	0	1	1	UC
7	UC23U01	Universal Human Values	T	1	0	2	3	2	UC
TOTAL CREDITS								**21**	

SEMESTER IV									
S. No.	Course Code	Course name	Course type#	Period / week				Credits	Category
				L	T	P	TCP*		
1	MA23C05	Probability and Statistics	T	3	1	0	4	4	HSMC
2	IT23401	Advanced Data Structures	LIT	3	0	2	5	4	PCC
3	IT23C01	Design and Analysis of Algorithms	T	3	0	0	3	3	PCC
4	IT23402	Computer Organization and Architecture	T	3	0	0	3	3	PCC
5	IT23403	Software Engineering	T	3	0	0	3	3	PCC
6	IT23C02	Operating Systems	LIT	3	0	2	5	4	PCC
7	IT23L01	Self-Learning Course	T	1	0	0	1	1	SLC
8		Audit Course-II	-	-	-	-	-	-	UC
9	-	Skill Development Course I	LIT	1	0	2	3	2	SDC
TOTAL CREDITS								**24**	

SEMESTER V									
S. No.	Course Code	Course name	Course Type#	Period / week				Credits	Category
				L	T	P	TCP*		
1	IT23501	Computer Networks	LIT	3	0	2	5	4	PCC
2	IT23502	Web Programming	LIT	3	0	2	5	4	PCC
3	IT23503	Compiler Design	T	3	0	0	3	3	PCC
4	IT23504	Machine Learning	LIT	3	0	2	5	4	PCC

5		Professional Elective I	T	3	0	0	3	3	PEC
6	UC23E01	Engineering Entrepreneurship Development	T	2	0	2	4	3	EDS
7		Industry Oriented Course I	T	1	0	0	1	1	IOC
8	-	Skill Development Course II	-	-	-	-	-	2	SDC
9	IT23505	Societal Oriented Project	PW	0	0	2	2	1	SDC
TOTAL CREDITS								**25**	
COURSES FOR HONOURS DEGREE									
S. No.	**Course Code**	**Course name**	**Course type#**	**Period / week**				**Credits**	**Category**
				L	**T**	**P**	**TCP**		
1	IT23D01	Capstone Design Project – Level I	CDP	0	0	12	12	6	SDC
(OR)									
1		Honours Elective - I	T	3	0	0	3	3	PEC
2		Honours Elective - II	T	3	0	0	3	3	PEC
COURSES FOR MINOR DEGREE									
1		Minor Elective - I	T	3	0	0	3	3	PEC
2		Minor Elective - II	T	3	0	0	3	3	PEC

SEMESTER VI									
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	IT23601	Distributed Systems and Computing	T	3	0	0	3	3	PCC
2	IT23602	Natural Language and Image Processing	LIT	3	0	2	5	4	PCC
3		Emerging Technology Course I	LIT	-	-	-	-	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	OEC
7	-	Skill Development Course III	-	-	-	-	-	2	SDC
8		Industry Oriented Course II	T	1	0	0	1	1	IOC
9	IT23U02	Perspectives of Sustainability Development	T	2	0	2	4	3	UC
TOTAL CREDITS								**25**	
Courses for Honours Degree									
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	IT23D02	Capstone Design Project – Level II	CDP	0	0	12	12	6	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									
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#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	IT23701	Cryptography and Network Security	LIT	3	0	2	5	4	PCC
2		Emerging Technology Course II	T	-	-	-	-	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	OEC
7		Industry Oriented Course III	T	1	0	0	1	1	IOC
8	IT23702	Software Development Project Laboratory	PW	0	0	4	4	2	SDC
TOTAL Credits								**22**	
Courses for Honours Degree									
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	IT23D03	Capstone Design Project – Level III	CDP	0	0	12	12	6	SDC
(OR)									
1		Honours Elective - V	T	3	0	0	3	3	
2		Honours Elective - VI	T	3	0	0	3	3	
Courses for Minor Degree									
1		Minor Elective - V	T	3	0	0	3	3	
2		Minor Elective - VI	T	3	0	0	3	3	

SEMESTER VIII									
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Period / Week**				**Credits**	**Category**
				L	**T**	**P**	**TCP***		
1	IT23801	Project Work / Internship cum Project Work	IPW	0	0	16	16	8	SDC
TOTAL Credits								**8**	

PROFESSIONAL ELECTIVE COURSES: VERTICALS				
Vertical I	**Vertical II**	**Vertical III**	**Vertical IV**	**Vertical V**
AI, ML and Data Science	Data, Web and cloud related Technologies	Network and Security	Multimedia Technologies	Systems and Computational Theory
Artificial Intelligence	Advanced Databases	Security in Computing	Image Processing and Computer Vision	Unix Internals
Soft Computing	Data warehousing & Mining	Ethical Hacking	Human Computer Interaction	Graph Theory
Big Data Analytics	Cloud Computing	Mobile Computing	UI and UX Design	Embedded Systems
Deep Learning	Full Stack Development	Advanced Networks	Digital Marketing	Quantum Computing
Social Network Analysis	C# & .Net programming	Security and Privacy in Cloud	Visual Effects (VFX)	Multicore Architecture and Programming
Recommender Systems	Enterprise Application Development	Cyber Forensics & Malware Analysis	Advanced Computer Graphics	
Conversational Systems	Software Testing and Automation	Blockchain and Cryptocurrency	Augmented and Virtual Reality	
Large Language Models (LLM)	Virtualization Technologies	Software Defined Networks	Metaverse	
MLops	Serverless Computing	Next Generation Wireless Networks	Game Design & Development	
Bioinformatics	Sustainable IT and Green Technologies	Privacy & Security in Online Social Media		
Healthcare Analytics	Geospatial Data Analysis			
Responsible AI				
Reinforcement Learning				
Cognitive Computing				
Autonomous vehicles				
Robotic process Automation				

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered from Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in Semester IV/VI and another in semester V/VII.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2023, Clause 4.11.

VERTICAL I: AI, ML AND DATA SCIENCE

VERTICAL I: POWER ENGINEERING						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS/WEEK		CREDITS
				L-T-P	TCP*	
1	IT23001	Artificial Intelligence	T	3-0-0	3	3
2	IT23002	Soft Computing	T	3-0-0	3	3
3	IT23003	Big Data Analytics	T	3-0-0	3	3
4	IT23004	Deep Learning	T	3-0-0	3	3
5	IT23005	Social Network Analysis	T	3-0-0	3	3
6	IT23006	Recommender Systems	T	3-0-0	3	3
7	IT23007	Conversational Systems	T	3-0-0	3	3
8	IT23008	Large Language Models(LLM)	T	3-0-0	3	3
9.	IT23009	ML ops	T	3-0-0	3	3
10.	IT23C14	Bio informatics	T	3-0-0	3	3
11.	IT23C07	Healthcare Analytics	T	3-0-0	3	3
12.	IT23C15	Responsible AI	T	3-0-0	3	3
13.	IT23C08	Reinforcement Learning	T	3-0-0	3	3
14.	IT23011	Cognitive Computing	T	3-0-0	3	3
15.	IT23012	Autonomous Ground Vehicle Systems	T	3-0-0	3	3
16.	IT23013	Robotic process Automation	T	3-0-0	3	3

VERTICAL II: DATA, WEB AND CLOUD RELATED TECHNOLOGIES						
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	IT23014	Advanced Databases	T	3-0-0	3	3
2	IT23015	Data warehousing & Mining	T	3-0-0	3	3
3	IT23016	Cloud Computing	T	3-0-0	3	3
4	IT23017	Full Stack Development	T	3-0-0	3	3
5	IT23018	C# & .Net programming	T	3-0-0	3	3
6	IT23019	Enterprise Application Development	T	3-0-0	3	3
7	IT23020	Software Testing and Automation	T	3-0-0	3	3
8	IT23021	Virtualization	T	3-0-0	3	3
9	IT23022	Serverless Computing	T	3-0-0	3	3
10.	IT23023	Sustainable IT and Green Technologies	T	3-0-0	3	3
11.	IT23024	Geospatial Data Analysis	T	3-0-0	3	3

VERTICAL III: NETWORK AND SECURITY						
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**
				L-T-P	**TCP***	
1	IT23025	Security in Computing	T	3-0-0	3	3
2	IT23C10	Ethical Hacking	T	3-0-0	3	3
3	IT23026	Mobile Computing	T	3-0-0	3	3
4	IT23C03	Advanced Networks	T	3-0-0	3	3
5	IT23C12	Security and Privacy in Cloud	T	3-0-0	3	3
6	IT23027	Cyber Forensics and Malware Analysis	T	3-0-0	3	3
7	IT23C05	Blockchain and Cryptocurrency	T	3-0-0	3	3
8	IT23C13	Software Defined Networks	T	3-0-0	3	3
9.	IT23028	Next Generation Wireless Networks	T	3-0-0	3	3
10.	IT23029	Privacy and Security in Online Social Media	T	3-0-0	3	3

VERTICAL IV: MULTIMEDIA TECHNOLOGIES						
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**
				L-T-P	**TCP***	
1	IT23030	Image Processing and Computer Vision	T	3-0-0	3	3
2	IT23031	Human Computer Interaction	T	3-0-0	3	3
3	IT23032	UI and UX Design	T	3-0-0	3	3
4	IT23033	Digital Marketing	T	3-0-0	3	3
5	IT23034	Visual Effects (VFX)	T	3-0-0	3	3
6	IT23035	Advanced Computer Graphics	T	3-0-0	3	3
7	IT23C04	Augmented and Virtual Reality	T	3-0-0	3	3
8	IT23C11	Metaverse	T	3-0-0	3	3
9.	IT23C06	Game Design and Development	T	3-0-0	3	3

VERTICAL V: SYSTEMS AND COMPUTATIONAL THEORY						
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**
				L-T-P	**TCP***	
1	IT23036	Unix Internals	T	3-0-0	3	3
2	IT23037	Graph Theory	T	3-0-0	3	3
3	IT23C09	Embedded Systems	T	3-0-0	3	3
4	IT23038	Quantum Computing	T	3-0-0	3	3
7	IT23010	Multicore Architecture and Programming	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	IT23901	Information Technology Essentials	OEC	3	0	0	3	3
2	IT23902	Data Science Fundamentals	OEC	3	0	0	3	3
3	IT23903	Fundamentals of Machine Learning	OEC	3	0	0	3	3
4	IT23904	IOT Basics and Applications	OEC	3	0	0	3	3
5	IT23905	Principles in Object Oriented Programming	OEC	3	0	0	3	3
6	IT23906	Introduction of Web Programming	OEC	3	0	0	3	3
7	IT23907	Full Stack Development	OEC	3	0	0	3	3
8	IT23908	Augmented and Virtual Reality	OEC	3	0	0	3	3

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

MINOR PROGRAMME ON ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
Offered by Department of Information Science and 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	Deep Learning	3	0	0	3
4	IT23C08	Reinforcement Learning	3	0	0	3
5	IT23009	MLOPS	3	0	0	3
6	IT23039	IOT Basics and Applications	3	0	0	3
7	IT23002	Soft Computing	3	0	0	3

EMERGING TECHNOLOGY COURSES (ETC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	IT23E01	IoT Based Smart Systems	ETC	2	0	2	4	3
2	IT23E02	Generative AI	ETC	3	0	0	3	3

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	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

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UNIT 1: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES

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

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

Lab exercises: 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)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT 2: PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING

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

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

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

(6+12 = 18 Hours)

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches

UNIT 3: 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS

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

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

(6+12 = 18 Hours)

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT 4: SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS

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 ('On the axis' and 'from the axis' conditions)

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

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

(6+12 = 18 Hours)

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT 5: LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN

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

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

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

(6+12 = 18 Hours)

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

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

COURSE OBJECTIVES

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

COURSE OUTCOMES

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

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD software

CO4: Determine the true shape of a sectioned solid and draft the assembled parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

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 Basant Agrawal 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 Dhananjay Jolhe, Cengage Learning, 2nd edition, 2020.
6. "Engineering Drawing" by M B Shah, Charotar Publishing House, 3rd edition, 2019
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi, 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.

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

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-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.

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

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

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

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

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

TOTAL : 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 C ivilization 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) (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.

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

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

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

PH23C08 FUNDAMENTALS OF ELECTRONIC MATERIALS AND DEVICES L T P C
3 0 0 3

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 optical materials and their uses.
- To elucidate digital electronics.
- To introduce nanodevices and 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 and p-type doping, compensation doping-temperature dependence of conductivity-degenerate and nondegenerate semiconductors

UNIT II SEMICONDUCTORS AND DISPLAY DEVICES 9

Hall effect and devices - Ohmic contacts – Peltier Coolers – Schottky diode - optical absorption and solar cell - Photoluminescence, cathodoluminescence, electroluminescence, injection luminescence – Phosphors – LED construction and working – White LED's – organic LEDs – principles of quantum well laser – liquid crystals and LCD construction and working– numeric displays.

UNIT III MAGNETIC/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 – Phase change recording – magneto-optical data storage – Hi-tech involved in system development – capacity of CD in normal use – advantages of CD –DVD – Blu-ray DVD - holographic storage – construction of a hologram – reconstruction of a hologram – photorefractive storage.

UNIT IV DIGITAL ELECTRONICS 9

Analog and digital signals - Digital circuits - Binary number system - conversion of Binary to decimal - decimal to binary - logic gates - OR gate - AND gate - NOT gate - Combination of Logic gates - NAND and NOR as universal building blocks. Boolean algebra and theorems: sum of products, products of sums expression, simplification by Karnaugh Map method, simplification based on basic Boolean theorems - don't care conditions.

UNIT V NANODEVICES AND QUANTUM COMPUTING 9

Introduction - quantum confinement – quantum structures: quantum wells, wires and dots – band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - single electron transistor - resonant-tunneling diode – quantum cellular automata - Quantum system for information processing - quantum states – classical bits – quantum bits or qubits –CNOT gate - multiple qubits – Bloch sphere – quantum gates – advantage of quantum computing over classical computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students should be able to

CO1: To understand and apply the electrical properties of materials.
CO2: To explore the principles of semiconductor and Display Devices
CO3: To make use of magnetic and optical data storage Devices.
CO4: To implement the essential principles of digital electronics for communication.
CO5: understand the basics of quantum structures and their applications and 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. Principles of Electronics - V.K. Mehta - S.Chan Publication, New Delhi
4. Electronic devices and circuits - G.J.Mithal, Khana publishers, New Delhi
5. Basic Electronics - B.L. Theraja - S.Chan publication, New Delhi
6. Nanodevices. Principle and Applications - Jaysukh Markna, Tulshi Shiyani Natural Science 2019
7. Quantum Computing for Everyone -Chris Bernhardt, MIT Press 2019
8. Quantum Computing fundamentals - Chuck Easttomm Pearson 2022.

REFERENCES:

1. Jasprit Singh, Optoelectronics: An Introduction to Materials and Devices, McGraw Hill, 1998.
2. Wilson, Jand 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

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

CS23C04 **PROGRAMMING IN C** **L T P C**
2 0 4 4

UNIT I BASICS OF C PROGRAMMING 6+12

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS

1. Designing programs with algorithms/flowchart
2. Programs for i/o operations with different data types

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS

1. Programs using various operators
2. Programs using decision making and branching statements
3. Programs using for, while, do-while loops and nested loops.
4. Programs using arrays and operations on arrays.
5. Programs implementing searching and sorting using arrays
6. Programs implementing string operations on arrays

UNIT Ill FUNCTIONS AND POINTERS 6+12

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation

PRACTICALS

1. Programs using functions
2. Programs using recursion
3. Programs using pointers & strings with pointers
4. Programs using Dynamic Memory Allocation

UNIT IV STRUCTURES AND UNION 6+12

Storage classes, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

PRACTICALS

1. Programs using Structures
2. Programs using Unions
3. Programs using pointers to structures and self-referential structures.

UNIT V MACROS AND FILE PROCESSING 6+12

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

PRACTICALS

1. Programs using pre-processor directives & macros
2. Programs to handle file operations
3. Programs to handle file with structure

TOTAL: 90 (30+60) PERIODS

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCES:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C"' McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

COURSE OUTCOMES:

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

CO1: Write simple C programs using basic constructs.
CO2: Design searching and sorting algorithms using arrays and strings.
CO3: Implement modular applications using Functions and pointers.
CO4: Develop and execute applications using structures and Unions.
CO5: Illustrate algorithmic solutions in C programming language using files.

Total Hours: 90 (30+60)

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	3	2	1	-	-	-	2	-	3	1	2	2
2	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
3	2	2	1	3	2	1	-	-	3	-	3	3	1	2	2
4	2	1	1	3	2	1	-	-	3	-	3	3	1	2	2
5	2	3	1	3	2	1	-	-	-	2	3	3	1	2	2

1 - low, 2 - medium, 3 – high

IT23201	INFORMATION TECHNOLOGY ESSENTIALS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

- To understand computer system basics, including components, networking, and server types.
- To learn HTML5, CSS3 fundamentals, and styling techniques for web design.
- To learn JavaScript fundamentals, including variables, functions, objects, and event handling techniques.
- To learn ReactJS fundamentals, including components, state management, routing, and error handling.
- To explore cellular network generations, information systems, privacy, and social networking applications.

UNIT I	HARDWARE AND NETWORK ESSENTIALS	9L, 6P

Basics of Computer System - Motherboard – Processors – Memory & Storage - Computer Ports - Memory hierarchy - I/O devices – Servers – Types of Servers – Web Server – Database Server – Communication Medium – Fundamentals of Computer Networking – Types of Computer Networks – Network Topologies – Network Standards: OSI Model, TCP/IP Model – Network Components.

PRACTICALS:

1. Study exercise on Component Identification and Functionality of a computer system.
2. Study exercise on Network Components.

Suggested Activities:

- Practical exposure of Personal Computer and various components.
- Case studies on different types of servers.
- Survey on data centre, cloud server and high-end server.

Suggested Evaluation Methods:

- Quizzes on hardware components.
- Presentations of case studies and survey.

UNIT II	WEB AND SCRIPTING ESSENTIALS	9L, 6P

Internet Basics – Browser Fundamentals – Introduction to HTML5 – HTML5 Tags – HTML5 Forms – HTML Graphics - HTML Media - Cascading Style Sheets (CSS3) Fundamentals - CSS Properties - CSS Styling (Background, Text Format, Controlling Fonts) - Working with Lists and Tables - CSS ID and Class – Box Model – Positioning.

PRACTICALS:

1. Design of static webpage primarily with text and CSS.
2. Design the HTML forms (text boxes, text areas, radio buttons, check boxes and other elements by understanding the input types and specified needs).
3. Format and position the text using CSS borders, background, and color by understanding the box model.

Suggested Activities:

- Browse the internet on special topics given by the instructor.
- Learn HTML basic tags for web page design.
- Identify different types of form validations in the websites that are commonly used.
- Practical - Design of a small simple website, interlinking set of web pages created using the HTML tags and CSS.

Suggested Evaluation Methods:

- Quizzes on all the topics of the unit.
- Discussion on form validation.
- Peer evaluation of the simple websites that are created.

UNIT III	JAVASCRIPT	9L, 6P

Introduction to JavaScript – Variables – Datatypes – Type Conversions - Comparisons - Assignments - Conditional Branching – Loops – Arrays - Functions – Built-in functions and methods – Function Expressions – Arrow Functions – Objects – Promises - async/await - Modules – Error Handling – DOM tree – Bubbling and capturing - Event delegation - Capturing - Bubbling - Events.

PRACTICALS:

1. Simple exercises on JavaScript Objects, functions, and Modules.
2. Working with DOM tree and Events.

Suggested Activities:

- Modern JavaScript features-based programming
- Flipped Classroom on Setting Up a JavaScript Development Environment
- Practice of Simple programs in JavaScript.

Suggested Evaluation Methods:

- Quiz on JavaScript Syntax and Features
- Programming segment evaluation on correctness and accuracy
- Collaborative assignment on Building JavaScript Applications

UNIT IV	FRONT – END ESSENTIALS	9L, 6P

ReactJS Introduction - React JSX - Understanding Components and Props – Props – React State – Component Lifecycle - React Hooks - Event Delegation - React Forms - React CSS - React Router - State Management with Redex - Fetch API - Handling errors in React applications.

PRACTICALS:

1. Front-end UI development with React JSX and Components
2. Working with React forms.

Suggested Activities:

- REACT based programming
- Exploring stateless components
- Designing components with React CSS and SaaS

- Programming exercises on REACT based component development

Suggested Evaluation Methods:

- Simple projects for specific use cases
- Programming segment evaluation on correctness and accuracy

UNIT V	**MOBILE AND APPLICATION ESSENTIALS**	**9L, 6P**

Generations of Cellular Networks – GSM - Introduction to Information Systems – Personal Information System – Ethics and Privacy – Information Retrieval System – Relevance feedback – Information retrieval system evaluation - Social Networking Applications.

PRACTICALS:

1. Develop a simple basic interactive To-Do List Application.
2. Develop a contact management database application.

Suggested Activities:

- Flipped classroom on generations of cellular networks.
- Flipped classroom on social networking applications.
- Explore the web to know more about the concepts and technologies used for the design of Information Systems. Students may present their findings orally or in a written report.

Suggested Evaluation Methods:

- Quizzes on cellular networks and social networking applications.
- Presentations on various information systems.
- Peer group evaluation of the developed application.

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

1. Understand the basic concepts of hardware, data communications and networking.
2. Create dynamic website/web-based applications using HTML5, and CSS3.
3. Understand the syntax, semantics, and dialects of the JavaScript programming language.
4. Get familiar with the use of functional components, state components, lifecycle, and routing in ReactJS.
5. Identify the fundamental concepts of mobile communications and key issues in the design of
6. Commonly used applications.

TEXTBOOKS:

1. James Kurose and Keith Ross, “Computer Networking: A Top-Down Approach”, Eighth Edition, 2021.
2. Niederst Robbins, Jennifer, “Learning Web Design: A Beginner’s Guide to HTML, CSS, Javascript, and Web Graphics”, Fifth Edition, O’Reilly Media, 2018.

3. Greg Lim, Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App, 2021.
4. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2012.
5. R. Kelly Rainer, Casey G. Cegielski, Brad Prince, “Introduction to Information Systems”, Fifth Edition, Wiley Publication, 2014.

REFERENCES:

1. Nabendu Biswas, MERN Projects for Beginners: Create Five Social Web Apps Using MongoDB, Express.js, React, and Node, Apress, 2021.
2. Vasan Subramanian, Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node, A Press Publisher, 2019.

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	2	2	2	-	-	-	-	-	2	2	3	3	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	2	3	2	3
CO4	3	2	3	2	3	-	-	-	2	-	2	2	3	2	3
CO5	2	2	2	2	3	-	-	-	-	-	2	2	2	2	2
AVG	**2.6**	**2.4**	**2.4**	**2**	**2.8**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**2.8**	**2.4**	**2.8**

UC23H02 தமிழரும் தொழில்நுட்பமும்/Tamils and Technology L T P C
1 0 0 1

அலகு I <u>நெசவு மற்றும் பானைத் தொழில்நுட்பம்</u>: 3

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

அலகு II <u>வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்</u>: 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 <u>உற்பத்தித் தொழில் நுட்பம்</u>: 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 <u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>: 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 <u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>: 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 C ivilization 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) (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.

UC23H02 TAMILS AND TECHNOLOGY L T P C
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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 C ivilization 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) (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.

MA23C09 FINITE STATE AUTOMATA AND DISCRETE STRUCTURES

L	T	P	C
3	1	0	4

OBJECTIVES:

- The students must be able to understand mathematical logic and to develop analytical solutions for logical problems.
- Apply graph model and graph techniques for solving network connectivity and other problems.
- Students will be able to comprehend the algebraic structure and formal languages with their applications to handle abstract generalizations.
- To introduce finite state automata as language acceptor of regular sets.
- To introduce context free grammars and context free languages and their normal forms.

UNIT I LOGIC **9+3**

Statements – Connectives – Truth Tables – Normal Forms – Predicate Calculus – Methods of proof – Inference Theory - Mathematical Induction.

UNIT II 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 III ALGEBRAIC STRUCTURES **9+3**

Groups – Cyclic group – Permutation group – Substructures – Homomorphism – Cosets and Lagrange's Theorem – Normal Subgroups – Rings and Fields (definition and examples).

UNIT IV FINITE STATE AUTOMATA **9+3**

Finite state automata – Deterministic and non-deterministic model – Languages accepted by Finite State Automata – Regular expressions and Regular sets – Pumping lemma for regular sets.

UNIT V CONTEXT FREE GRAMMER **9+3**

Grammar - Context-free Grammars - Derivation trees - Simplification of context free grammar (only Construction and no proof of equivalence of grammars) - Chomsky normal Form - Greibach Normal Form – Pumping lemma for context-free languages.

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 : (IST)

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.

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).

Finite State Automata

1. Construction of finite state automaton for a given regular set.
2. Finding language accepted by a given finite state automaton.

Grammars

1. Finding the language generated by a given context-free grammar.
2. Construction of a context-free grammar for generating a given context-free language.

OUTCOMES:

CO1 : The students are able to apply mathematical logic and to find analytical solutions for logical problems.

CO2 : The students are able to apply graph model and graph techniques for solving network connectivity and other problems.

CO3 : Students will be able to apply the algebraic structure and formal languages with their applications to handle abstract generalizations.

CO4 : Students will be able to design finite state automata to accept regular sets.

CO5 : Students will be able to form context-free grammar to generate context-free language.

TEXT BOOKS:

1. Trembley.J.P. and Manohar R. “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw – Hill Publishing Company Limited, New Delhi. Reprinted in 2007. (For Unit I, III, IV)
2. Hopcroft, J.E., Rajeev Motwani and Ullman, J.D. “Introduction to Automata Theory,Languages, and Computation”, Pearson Education, Second Edition, Harlow, 2014.

REFERENCES:

1. Kenneth H. Rosen, “Discrete Mathematics and its Applications”, Tata McGraw Hill Publishing Company Limited, New Delhi. Reprinted in 2007 (6th Edition).
2. Hopcroft J.E. and Ullman J.D. “Introduction to Automata Theory, Languages and Computation”, Narosa Publishing House,2002.
3. Thomas Koshy, “Discrete Mathematics with Applications”, Academic Press, Reprinted in 2005.

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

IT23301	DIGITAL LOGIC AND DESIGN	L	T	P	C
		3	0	2	4

UNIT I BOOLEAN ALGEBRA AND GATES 9

Number Systems: Binary, Octal, Hexadecimal – Representation of Negative Numbers – Complements – Arithmetic Operations – Binary Codes – Boolean Algebra – Theorems and Postulates – Functions – Truth Table – Logic Gates – Universal gates– Canonical and Standard Forms – Minterms and Maxterms – Sum of Products and Product of Sums.

UNIT II KARNAUGH MAP AND COMBINATIONAL LOGIC 9

Simplification of Boolean Functions –Karnaugh Map – 2, 3, 4 variable- Don't-care conditions, Prime and essential prime Implicants – NAND/NOR Implementations – Combinational Circuits – Arithmetic Circuits – Half and Full Adders – Subtractors – Introduction to HDL.

UNIT III COMBINATIONAL LOGIC 9

Design procedure, Binary Parallel Adder and Subtractors- Carry Look-ahead Adder – BCD Adder – Binary Multiplier – Magnitude Comparator – Code Converters – Decoder – Encoder – Priority Encoder – Multiplexers - Demultiplexers – Applications.

UNIT IV SEQUENTIAL LOGIC 9

Sequential Circuits- Latches, flip-flops- Characteristic tables and excitation tables – Analysis of clocked sequential circuits – Moore /Mealy models – Registers: Shift Registers, Universal Shift Register – Counters – Asynchronous Ripple Counters - Synchronous Counters- ring Counter- Johnson Counter.

UNIT V PROGRAMMBLE LOGIC DEVICES 9

Memory Systems – RAM – ROM – Memory Decoding – Error detection and correction - Checksum - Digital System Design using PROM – PLDs - Programmable Logic Array - Programmable Array Logic - CPLDs - Field Programmable Gate Array.

THEORY: 45 PERIODS

EXERCISES 30

1. Verification of Boolean theorems using logic gates.
2. Design and implementation of combinational circuits using gates for arbitrary functions.
3. Implementation of 4-bit binary adder/ subtractor circuits and getting started with HDL.
4. Implementation of combinational circuits using code converters.
5. Implementation of BCD adder, encoder, and decoder circuits.
6. Implementation of any one of the synchronous counters.
7. Implementation of a Universal Shift register.
8. HDL coding for any of the combinational and sequential circuits.
9. Mini project on the design of a digital circuit for solving practical problems.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Simplify complex Boolean functions.
2. Implement digital circuits using simplified methods and combinational logic ICs.
3. Design digital circuits with various combinational logic and write HDL for digital system.
4. Understand the characteristics of various sequential circuits with combinational circuits.
5. Design and implement various programmable logic devices.

TEXT BOOKS:

1. M. Morris Mano, Michael D. Ciletti, “Digital Design”, Sixth Edition, Pearson Education, 2018.

REFERENCES:

1. Charles H. Roth Jr., “Fundamentals of Logic Design”, Fifth Edition, Jaico Publishing House, 2003.
2. John F. Wakerly, “Digital Design Principles and Practices”, Fourth Edition, Pearson Education, 2007.
3. Donald D. Givone, “Digital Principles and Design”, Tata McGraw Hill, 2003.
4. G. K. Kharate, “Digital Electronics”, Oxford University Press, 2010.
5. Harris, Sarah, and David Harris. Digital Design and Computer Architecture, RISC-V Edition. Morgan Kaufmann, 2021.

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	-	-	-	-	1	-	-	2	3	3	3
CO2	3	3	3	2	-	-	-	-	2	-	-	2	3	3	3
CO3	3	3	3	2	1	1	1	-	2	-	-	2	3	3	3
CO4	3	3	3	3	-	-	-	-	2	1	1	2	3	3	3
CO5	3	3	3	3	2	-	-	-	2	1	1	2	3	3	3
AVG	**3**	**3**	**3**	**2.4**	**1.5**	**1**	**1**	**-**	**1.8**	**1**	**1**	**2**	**3**	**3**	**3**

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

IT23302	DATA STRUCTURES	L	T	P	C
		3	0	2	4

UNIT I INTRODUCTION TO DATA STRUCTURES 9

Overview of Arrays, Functions, Structures, Pointers – Classification of Data Structures- Operations on Data Structures - Abstract Data Types (ADTs) – Introduction to Time and Space Complexity- Searching Techniques – Sorting: Selection Sort- Insertion Sort – Radix Sort- Linear Sort: Counting Sort- External Sorting.

UNIT II LINEAR DATA STRUCTURES 9

List ADT – Array-Based Implementation – Linked List – Doubly-Linked Lists – Circular Linked List – Stack ADT – Applications of Stack: Infix to Postfix Conversion- Evaluation of Postfix expression- Recursion: Tower of Hanoi - Queue ADT – Linear Queue – Circular Queue – Dequeue.

UNIT III TREES 9

Introduction to Trees – Binary Trees – Tree Traversals: Inorder – Preorder- Postorder Traversals – Expression Trees – Binary Search Tree ADT- Operations: Insert- Delete - Applications of Trees- Priority Queues: Binary Heap : Properties- Operations: Insert- Findmin and Findmax- DeleteMin- Applications of Binary Heap – Heap Sort.

UNIT IV GRAPHS 9

Introduction to Graphs – Properties – Representation of Graphs – Graphs Traversals: Breadth First Search and Depth First Search – Topological Sort – Shortest path algorithm: Unweighted Shortest path – Dijkstra's algorithm – Minimum Spanning Tree: Prims algorithm – Kruskal's algorithm.

UNIT V HASHING TECHNIQUES 9

Hashing- Hash Table- Hash Functions: Division Method- Multiplication method- Mid square method- Folding method – Collision Resolution by Separate Chaining – Collision Resolution through Open Addressing: Linear Probing– Quadratic Probing – Double Hashing – Rehashing – Extendible Hashing – Applications of Hashing.

THEORY: 45 PERIODS

EXERCISES

- Practice of C Programming in solving real time problems using Structures, arrays, functions, pointers and Preprocessor Directives.
- Implementation of Array ADT using Linear Search and Binary Search.
- Implementation of Insertion Sort, Quick Sort, Merge Sort.
- Implementation of Linked List ADT.
- Implementation of Stack ADT using Arrays and Linked List.
- Implementation of Queue ADT using Arrays and Linked List.
- Implementation of Stack applications.
- Implementation of Binary Search Tree ADT with Tree Traversals.
- Implementation of Priority Queue ADT with Heap Sort.
- Implementation of Graph, Graph Traversals and Topological Sort.
- Implementation of Shortest path using Dijkstras Algorithm.

30

- Implementation of Spanning Tree using Prims Algorithm.
- Implementation of Hashing using Open Addressing technique.

TOTAL : 75 PERIODS

COURSE OUTCOMES:

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

CO1: Implement sort and search algorithms appropriately for a given application using Array ADT.
CO2: Analyze and apply suitable linear data structures for efficient data storage.
CO3: Analyze and use appropriate tree data structure operations for storage and faster access.
CO4: Understand the usage of Graph data structures to solve a real time problem.
CO5: Understand and apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 2014.
2. Reema Thareja, “Data Structures using C”, Third Edition, Oxford University Press, 2023.

REFERENCES:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
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.

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	3	3	3	3
CO2	3	3	3	3	2	-	-	-	-	-	1	3	3	3	3
CO3	3	3	3	3	2	-	-	-	-	-	1	3	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	1	3	3	3	3
CO5	3	3	3	3	2	-	-	-	-	-	1	3	3	3	3
AVG	**3**	**3**	**3**	**3**	**2.2**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**3**	**3**

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

IT23303	DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	2	4

UNIT I RELATIONAL DATABASES **9**

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.

UNIT II DATABASE DESIGN **9**

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.

UNIT III TRANSACTION MANAGEMENT **9**

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.

UNIT IV IMPLEMENTATION TECHNIQUES **9**

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.

UNIT V ADVANCED TOPICS **9**

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 – Data Model - JSON and BSON - Polymorphic Schemas - Basic Querying.

THEORY: 45 PERIODS

EXERCISES **30**

1. Create a database table, add constraints (primary key, unique, check, NOT NULL), insert rows, update, and delete rows using SQL DDL and DML commands.
2. Create set of tables, add foreign key constraints, and incorporate referential integrity.
3. Query the database tables using different ‘where’ clause conditions and implement aggregate functions.
4. Query the database tables and explore sub queries and simple join operations.
5. Query the database tables and explore natural, equi, and outer joins.
6. Write user defined functions and stored procedures in SQL.
7. Execute complex transactions and realize DCL and TCL commands.
8. Write SQL Triggers for insert, delete, and update operations in database table.
9. Create View and index for database tables with large number of records.
10. Create Document, column, and document - based data using NOSQL database tools.

11. Develop a simple GUI based database application and incorporate all the above-mentioned features.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Understand 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. Analyze the database storage structures, access and query processing techniques.
5. Understand and differentiate the principles and common features of the distributed, and NoSQL databases.

TEXT BOOKS:

1. Ramez Elmasri, Shamkant B, Navathe, 'Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2017.
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, Tata McGraw Hill, 2020.
3. Shakuntala Gupta Edward and Navin Sabharwal, "Practical MongoDB: Architecting, Developing, and Administering MongoDB", Apress, 2015.

REFERENCES:

1. C. J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", Fourth Edition, Tata McGraw Hill, 2010.
3. Carlos Coronel, Steven Morris, Peter Rob, "Database Systems: Design, Implementation and Management", Twelfth Edition, Cengage Learning, 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	2	2	2	2	-	-	-	2	-	1	2	3	3	3
CO2	2	3	2	2	2	-	-	-	2	-	1	2	3	3	3
CO3	2	3	3	2	3	-	-	-	2	-	1	2	2	2	2
CO4	1	3	2	3	2	-	-	-	3	-	2	2	3	3	3
CO5	1	2	2	2	2	-	-	-	2	-	1	2	2	2	2
AVG	**1.8**	**2.6**	**2.2**	**2.2**	**2.2**	**-**	-	**-**	**2.2**	**-**	**1.2**	2	**2.6**	**2.6**	**2.6**

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

IT23304	OBJECT ORIENTED PROGRAMMING	L	T	P	C
		1	0	2	2

UNIT I OVERVIEW OF OOP, CLASS AND OBJECTS 3

Object Oriented Programming Concepts – Procedure vs. Object-oriented programming –Tokens - Pointers - User-defined types – ADT- Classes and Objects- Member Functions – Data Members- private and public members – static, Inline, friend and constant Functions – Constructors and Destructors - this Pointer.

UNIT II OVERLOADING 3

Function Overloading - Operator Overloading – Fundamentals – Restrictions – Operator functions as Class members vs Global Functions – Overloading stream insertion and Stream extraction operators – Unary – Binary operator overloading - Dynamic Memory Management.

UNIT III INHERITANCE AND POLYMORPHISM 4

Inheritance -types– Base and derived classes - protected members -Relationship between base class and derived classes with case study - private, public and protected inheritance- Constructors and Destructors in Derived Classes – Polymorphism - Relationships among Objects in an Inheritance Hierarchy – Compile time vs Runtime Polymorphism - Virtual Functions – Abstract Classes – Pure Virtual Functions.

UNIT IV TEMPLATES AND STANDARD TEMPLATE LIBRARY 3

Function Template – Overloading Function Templates - Class Template – Non Type parameters and Default types for Class Templates – Templates and Inheritance, friend and Static Members - Name spaces- Casting- Standard Template Library – Container Classes – Vectors – Lists – Maps- Strings.

UNIT V I/O SYSTEM, FILE I/O AND EXCEPTION HANDLING 2

C++ Streams - C++ Stream classes – Formatted IO – File classes and File operations - Case Study - Exception Handling –User defined Exceptions - try, catch, throw - rethrowing an Exception – Standard Library Exception Hierarchy.

THEORY: 15 PERIODS

EXERCISES 30

1. Programs using Data types, Operators and Control Structures.
2. Programs using Arrays and Strings.
3. Programs using Functions and Pointers.
4. Programs using User-defined types.
5. Programs using Classes and Objects.
6. Programs using Constructors and Destructors.
7. Programs using Operator Overloading.
8. Programs using Inheritance, Polymorphism and its types.
9. Programs using Dynamic memory allocation.
10. Programs using Templates and Exceptions.
11. Programs using Sequential and Random access files.

12. Programs using Standard Template Library .

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the Object-oriented programming concepts and fundamentals.
CO2: Implement the features of overloading in object oriented programming.
CO3: Implement the concept of reusability and polymorphism.
CO4: Write generic programs and STL based applications.
CO5: Create and process data in files using file I/O functions with exception handling.

TEXT BOOKS

1. HM Deitel and PJ Deitel, “C++ How to Program”, Tenth Edition, Pearson Education, 2020.
2. Herbert Schildt, “The Complete Reference in C++”, Fifth Edition, Tata McGraw Hill, 2017(Reprint).

REFERENCES

1. Bjarne Stroustrup, “The C++ Programming language”, Fourth edition, Pearson Education, 2013.
2. Stephen Prata, “C++ Primer Plus”, Sixth Edition, Pearson Education, 2011.
3. E Balagurusamy, “Object oriented Programming with C++”, Eighth edition, Tata McGraw Hill, 2020.
4. Marc Gregoire, “Professional C++”, 5th Edition, Wrox, 2021.

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	-	-	-	1	-	3	2	3	3	3
CO2	2	3	3	3	3	-	-	-	1	-	3	2	3	3	3
CO3	2	3	3	3	3	-	-	-	1	-	3	2	3	3	3
CO4	2	3	3	3	3	-	-	-	1	-	3	2	3	3	3
CO5	2	3	3	3	3	-	-	-	1	-	3	2	3	3	3
AVG	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**3**	**3**	**3**

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

IT23U01	STANDARDS – IT	L	T	P	C
		1	0	0	1

MODULE I – OVERVIEW OF STANDARDS **6**

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 COMPUTER SCIENCE **9**

Introduction -Importance of standards in IT-Overview of key international standards organizations **ANSI and IEEE Standards** - ANSI standards for software engineering (e.g., ANSI/ISO/IEC 12207:2008 - Software Life Cycle Processes)- IEEE standards and their applications in software engineering (e.g., IEEE 830-1998 - Requirements Specifications)- **ISO/IEC 20000**: IT Service Management -Scope and requirements-Service delivery process-Certification and implementation challenges- ISO 9000 Series: Quality Management - Overview of ISO 9001-Quality management principles-Certification process and benefits-

ITU-T Standards in Telecommunications-Overview of ITU-T series (e.g., ITU-T X.509 for public key infrastructure)-Impact on global telecommunications standards- **IETF Standards in Internet Protocols**-Overview of key IETF standards (e.g., RFC 791 for IPv4)-Evolution and adoption of internet protocols-**W3C Standards for the World Wide Web** -Key W3C standards (e.g., HTML5, CSS3, Web Accessibility Guidelines)-Role of standards in web development and interoperability

ISO/IEC 27001: Information Security Management -Principles and Framework-Risk assessment and Management-Controls and compliance-**NIST Standards and Frameworks** - NIST Cybersecurity Framework (CSF)NIST Special Publications (e.g., SP 800 series) for cybersecurity **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. Kan, S. H. “Standards for Information Technology and Systems”, Prentice Hall, 2017.
4. IEEE Computer Society. (2014) “IEEE Guide to the Software Engineering Body of Knowledge (SWEBOK)”, Version 3.0. IEEE. Retrieved from IEEE Xplore
5. Calder, Alan. “ISO/IEC 27001:2013 – A Pocket Guide” IT Governance Publishing, 2013.
6. Sikos, Leslie,” Web Standards: Mastering HTML5, CSS3, and XML.” Apress, 2011.
7. Association for Computing Machinery. “ACM Code of Ethics and Professional Conduct: A Guide” ACM, 2018

8. Calder, Alan, “NIST Cybersecurity Framework: A Pocket Guide. IT Governance Publishing” 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

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

IT23401	ADVANCED DATA STRUCTURES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To learn about Amortized analysis
- To learn about Balanced Trees and Heaps
- To learn and implement different data structures using Object oriented concepts.
- To familiarize with Disjoint Sets and their implementation
- To learn about the advanced graph algorithms for read world problem solving.

UNIT I	AMORTIZED ANALYSIS	9L, 6P

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.

PRACTICALS:

1. Implementation of Binary Counter and Dynamic Table using amortized operations.
2. Implementation of Deterministic Skip list using Templates.

Suggested Activities:

- Exploration and implementation of few problems using Amortized analysis.
- External Learning – Applications of Deterministic Skip List

Suggested Evaluation Methods:

- Assignments and Quizzes on Deterministic Skip list operations and Applications.
- Evaluation of the Amortized analysis problems.

UNIT II	BALANCED TREES	9L, 6P

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.

PRACTICALS:

1. Implementation of AVL Tree with proper rotations
2. Implementation of Top down Splay operations using amortized analysis.
3. Implementation of Tries to Spellcheck/Auto complete a text.

Suggested Activities:

- Flipped classroom on binary search trees.
- External learning – K-D Trees and its operations.
- Exploration of application of trees where trees can be applied for real time problems.
- Design and Implementation of a suitable tree structure for solving a given real time problem such as implementation of syntax trees in compilers.

Suggested Evaluation Methods:

- Assignments on Red Black Trees
- Real time problem solving using B Trees in organizing data records.
- Quizzes on BST, K-D Trees.
- Demonstration of Tries for String matching application.

UNIT III	HEAPS	9L, 6P

Leftist Heaps: Properties-Operations- Skew Heaps: Operations - Binomial Queue: Structure-Operations- Fibonacci Heap: Structure- Operations- Amortized analysis of Fibonacci Heap – Treaps: Insertion-Deletion.

PRACTICALS:

1. Implementation of a Leftist Heap using Templates.
2. Implementation of Fibonacci Heap operations using Amortized analysis
3. Implementation of Treaps.

Suggested Activities:

- Flipped classroom on binary heaps.
- External learning – Randomized Treaps.
- Exploration of application of heaps where heaps can be applied for real time problems.
- Comparative Analysis of various heaps and its performance.

Suggested Evaluation Methods:

- Assignments on Skew Heaps and its implementation.
- Quizzes on Randomized Treaps.
- Evaluation of Practical component and its comparative analysis.

UNIT IV	**DISJOINT SETS**	**9L, 6P**

Disjoint Set – Distinct Subset Problem- Equivalence Relations – The Dynamic Equivalence Problem – Disjoint Set Structure- Smart Union Algorithms – Path Compression – Applications: Connected Components – Spanning Tree.

PRACTICALS:

1. Implementation of Disjoint Set using Union/Find algorithm

Suggested Activities:

- Flipped Classroom on Disjoint Subset problem.
- Exploration of more applications of Disjoint sets and its usage in real time problems
- Simulation of Path Compression Algorithm.

Suggested Evaluation Methods:

- Assignments on Applications of Disjoint Sets
- Evaluation of the Simulation Exercises.

UNIT V	**ADVANCED GRAPHS**	**9L, 6P**

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.

PRACTICALS:

1. Implementation of DFS application – Biconnectivity
2. Implementation of Bellman ford and Floyd Warshall algorithm
3. Implementation of Flow networks using Ford Fulkerson algorithm.

Suggested Activities:

- Flipped Classroom on BFS and its applications.
- External learning - Inline memory data structures.
- Exploration of more applications of DFS and its usage in real time scenario.
- Simulation of All Pair Shortest Path with various graphs.

Suggested Evaluation Methods:

- Assignments on inline memory data structures and application of a DFS algorithm to solve a real time problem.
- Quizzes on BFS and few more applications of DFS.
- Evaluation of simulation of Graph algorithms

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the usage of amortized analysis and Skip lists for real world problem solving.
CO 2.	Implement balanced trees through ADTs.
CO 3.	Understand and use Heap algorithms using amortized analysis.
CO 4.	Apply Disjoint sets for suitable applications
CO 5.	Analyze and apply the graph data structures for a given problem.

TEXT BOOKS:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++" , Fourth Edition, Pearson Education, 2014.
2. Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to Algorithms, Fourth Edition, PHI Learning Pvt Ltd, 2022

REFERENCES:

1. Marcello La Rocca, " Advanced Algorithms and Data Structures", First Edition, Manning Publications Company, 2021.
2. Robert Sedgewick, "Algorithms in C++", Third Edition, Pearson Education , 1998.
3. Michael T, Goodrich, Roberto Tamassia, David Mount, ""Data Structures and Algorithms in C++", Seventh Edition, Wiley Publishers, 2004.

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	-	-	-	-	-	1	2	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	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	2	3	3	3
AVG															

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.
   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

IT23402	COMPUTER ORGANIZATION AND ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the functional units in a digital computer system.
- To distinguish between the various ISA styles.
- To trace the execution sequence of an instruction through the processor.
- To evaluate different computer systems based on performance metrics.
- To understand the fundamentals of memory and I/O systems and their interface with the processor.

UNIT I	FUNDAMENTALS OF COMPUTER SYSTEMS	9

Functional Units of a Digital Computer - Operation and Operands of Computer Hardware – Software Interface – Translation from a High-Level Language to Machine Language – Instruction Set Architecture – RISC and CISC Architectures –MIPS Instruction- Addressing Modes –Assembly Language Programming- Performance Metrics – Power Law – Amdahl's Law.

Suggested Activities:

- In-class activity on performance evaluation.
- Flipped classroom – Evolution and types of computer systems, identification of benchmarks.
- Use a Simulator for RISC and CISC. Analyze the ISA supported by the architectural simulator by running simple programs on the simulator.
- Mapping and correlating a C code with its machine code.
- Practical – Opening up a computer system and studying the components.

Suggested Evaluation Methods:

- Mock test on problems for computer performance.
- Group discussion on activity four with assembly instruction, identifying the instruction type and encoding used in machine code.
- Quizzes on ISA.

UNIT II	ARITHMETIC FOR COMPUTERS	9

Addition and Subtraction – Fast Adders – Multiplication: Booths Algorithm, Bit Pair Recoding – Division: Restoring and Non-Restoring – Floating Point Numbers: Single and Double Precision – Arithmetic Operations – ALU Design.

Suggested Activities:

- Flipped classroom – Unsigned binary operations(+,–,*,/).
- Simulation of the floating point operations.
- External learning – Arithmetic algorithms for faster multiplication and division.
- Tutorials on multiplication and division (Booths algorithm, restoring and nonrestoring).

Suggested Evaluation Methods:

- Mock test on multiplication and division.
- Quizzes on floating point single precision and double precision representation.

UNIT III	PROCESSOR	9

Design Convention of a Processor – Building a Datapath and designing a Control Unit – Execution of a Complete Instruction – Hardwired and Micro programmed Control –Instruction Level Parallelism – Basic Concepts of Pipelining – Pipelined Implementation of Datapath and Control Unit – Hazards – Structural, Data and Control Hazards.

- **Suggested Activities:**

- Flipped Classroom for analyzing data path in Intel and ARM core.
- Practical – Analyzing the data path on the standard simulator.

- Practical – Study of the pipelined implementation and analysis of various hazards on a standard simulator.
- Assignment on data path design.

Suggested Evaluation Methods:

- Group discussion on pipeline depth and stages.
- Quiz on class or automatic quizzes on the flipped classroom content.

UNIT IV	**MEMORY AND I/O**	**9**

Types of Memories – Need for a hierarchical memory system – Cache memories– Memory Mapping – Improving Cache Performance – Virtual Memory – Memory Management Techniques – Accessing I/O devices – Programmed Input/output – Interrupts – Direct Memory Access.

Suggested Activities:

- Flipped classroom on memory hierarchy in Intel i7 and ARM Cortex.
- Practical – Implement a simple functional model for memory mapping in cache using C/C++.
- Study hit/miss rates for various access patterns. Experiment with different replacement policies.

Suggested Evaluation Methods:

- Mock test for problems on memory mapping.
- Quizzes on memory management in ARM and Intel processor.

UNIT V	**PARALLEL PROCESSING**	**9**

Exploitation of more ILP – Out of Order Execution - Dynamic Scheduling: Introduction to Multicore –- MultiProcessor-Superscalar Processor-VLIW- Multithreading- - Graphics Processing Units – CUDA Programming Paradigm- AI PC - Neural Processing Unit- Overview of Next Generation Processors.

Suggested Activities:

- Flipped classroom on evolution of GPU.
- External learning – Speculative dynamic scheduling.
- Survey on multicore and draw a mind map on trends of multicore processors.

Suggested Evaluation Methods:

- Quizzes on dynamic scheduling.
- Group discussion on how to reduce CPI to less than one clock cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Interpret assembly language instructions.
CO 2.	Design and analyze ALU circuits.
CO 3.	Implement a control unit as per the functional specification.
CO 4.	Design and analyze memory, I/O devices, and cache structures for processors.
CO 5.	Point out the hazards present in a pipeline. Evaluate the performance of computer systems.

TEXTBOOKS:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization and Embedded Systems”, Sixth Edition, Tata McGraw Hill, 2012.
2. David A. Patterson, John L. Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Sixth Edition, Morgan Kaufmann/Elsevier, 2020.

REFERENCES:

1. Smruti R. Sarangi, Next-Gen Computer Architecture, First Edition, White Falcon Publishing,

2023.
2. Englander, Irv, and Wilson Wong. The architecture of computer hardware, systems software, and networking: An information technology approach. 6th Edition, John Wiley & Sons, 2021.
3. William Stallings, “Computer Organization and Architecture – Designing for Performance”, Tenth Edition, Pearson Education, 2016.
4. John L. Hennessey, David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann / Elsevier Publishers, Fourth Edition, 2007.
5. V.P. Heuring, H.F. Jordan, “Computer Systems Design and Architecture”, Second Edition, Pearson Education, 2004.
6. Behrooz Parhami, “Computer Architecture”, Oxford University Press, 2007.
7. Douglas E. Comer, “Essentials of Computer Architecture”, Sixth Edition, Pearson Education, 2012.

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	1	2	1	-	-	-	2	-	-	2	3	3	3
CO2	3	3	1	2	2	-	-	-	2	-	-	2	3	3	3
CO3	3	2	2	1	1	-	-	-	1	-	-	2	3	3	3
CO4	3	2	2	1	1	-	-	-	1	-	-	2	3	3	3
CO5	3	3	3	2	1	-	-	-	2	-	-	3	3	3	3
AVG	**3**	**3**	**1.8**	**1.6**	**1.2**	**-**	**-**	**-**	**1.6**	**-**	**-**	**2.2**	**3**	**3**	**3**

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

IT23403	SOFTWARE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge about various software development lifecycle (SDLC) models.
- To learn how to elicit and formulate requirements.
- To be aware of designing a software considering the various perspectives of end user.
- To learn to develop a software component using coding standards and facilitate code reuse.
- To analyze the software using metrics and measurement and predict the complexity and the risk associated.

UNIT I	SOFTWARE PROCESSES	9

Software Problem - Cost - Schedule and Quality - Scale and Change - Process and Project - Components of Software Processes - Software Development Process Models - Waterfall Model - Prototyping - Iterative Development - Rational Unified Process - Timeboxing -Extreme Programming and Agile Processes - Using Process Models in a Project - Project Management Process.

Suggested Activities:

- In-class activity - Application specific product and process view.
- External learning - Impact of unified process models on quality software development methods and JIT software.

Suggested Evaluation Methods:

- Assignments on selection of suitable software process models for a given software specification.
- Assignment on identification of sample application for each process model and justify the same stating reasons.
- Assignments on selection of appropriate standards for each phase in software development.

UNIT II	REQUIREMENTS ANALYSIS AND SPECIFICATION	9

Requirement Process - Requirements Specification - Desirable Characteristics of an SRS - Components of an SRS - Structure of a Requirements Document - Functional Specification with Use Cases – Basics - Examples - Extensions - Developing Use Cases - Other Approaches for Analysis - Data Flow Diagrams - ER Diagrams - Validation.

Suggested Activities:

- External learning - Using open source tools for requirement engineering to understand the requirements traceability and interdependency among the functionalities provided by the software project.
- External learning - Using open source tools for conceptual data modeling of a sample application, scenario based modeling of a problem statement and class based modeling for given software requirements.

Suggested Evaluation Methods:

- Quiz on requirements elicitation mechanisms and selection of an appropriate strategy.

UNIT III	ARCHITECTURE AND DESIGN PRINCIPLES	9

Role of Software Architecture - Architectural Views - Component and Connector View Architecture Styles for C&C View - Pipe and Filter - Shared-Data Style - Client-Server Style - Documenting Architecture Design - Design Concepts - Coupling - Cohesion - The Open-Closed Principle - Function-

Oriented Design - Object-Oriented Design - OO Concepts - Unified Modeling Language (UML) - Logic/Algorithm Design - State Modeling – Verification.

Suggested Activities:

- External learning - Use open source tools to perform different modeling approaches.
- Model the object classes that might be used in the system implementation to represent a mailbox and an e-mail message.
- Develop a software design for any socially relevant project

Suggested Evaluation Methods:

- Quizzes on different modeling approaches and design methodologies

UNIT IV	**CODING AND UNIT TESTING**	**9**

Programming Principles and Guidelines - Structured Programming - Information Hiding -Programming Practices - Coding Standards - Incrementally Developing Code - An Incremental Coding Process - Test Driven Development - Pair Programming - Managing Evolving Code - Source Code Control and Build - Refactoring - Unit Testing - Procedural Units - Unit Testing of Classes - Code Inspection - Metrics- Size Measures - Complexity Metrics.

Suggested Activities:

- External learning - Understanding the requirements (SRS) and designing a suitable test suite; Determining valid interfaces for integration testing and designing necessary stub and driver modules; Software test documentation.
- External learning - Testing a simple online application on selected test cases.
- Tutorials on automation software for testing.
- In-class activity - Equivalence class partitioning, boundary value analysis

Suggested Evaluation Methods:

- Quiz and discussion on testing strategies, types of testing and their methods.
- Assignments on testing of sample application using any OSS on software test automation.
- Assignments on testing sample application using Black Box approaches and understanding the differences in selecting of test cases from the test suite.

UNIT V TESTING AND METRICS **9**

Testing Concepts – Error- Fault and Failure - Test case - Test Suite and Test Harness - Psychology of Testing - Levels of Testing - Testing Process - Test Plan - Test Case Design - Test Case Execution - Black-Box Testing - Equivalence Class Partitioning - Boundary Value Analysis - Pair-wise Testing - Special Cases - State-Based Testing - White-Box Testing - Control Flow-Based Criteria - Test Case Generation and Tool Support - Metrics - Coverage Analysis - Reliability - Defect Removal Efficiency.

Suggested Activities:

- External learning - Tools for estimating software cost.
- Flipped classroom on software project management, risk management & mitigation, configuration management, software documentation standards

Suggested Evaluation Methods:

- Assignments on using a software configuration management template for a software project.
- Quizzes on various metrics of project management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Obtain an insight into the concepts of software engineering.
CO 2.	Analyze requirements and specifications for information technology problems.

CO 3.	Design software system for real-time problems.
CO 4.	Explore various programming practices and metrics.
CO 5.	Learn the modern practices for software testing and Development

TEXTBOOKS:

1. Pankaj Jalote, A Concise Introduction to Software Engineering, Springer , New Delhi, 2011.

REFERENCES:

1. Roger S. Pressman and Bruce R. Maxim, Software Engineering, A practitioner's Approach-, 8th edition, Mc Graw Hill Education, USA, 2019.
2. Ian Sommerville, Software Engineering, 10th edition, Addison – Wesley, New Delhi, 2017. Rajib Mall, Fundamentals of Software Engineering, PHI Learning, New Delhi, 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	2	1	1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	1	2	1	3	3	3	3	2	3	3
CO3	3	3	3	3	3	2	1	1	3	3	3	3	3	3	2
CO4	3	3	3	3	3	2	2	1	3	3	3	3	2	2	3
CO5	3	3	3	3	3	1	2	1	3	3	3	3	1	3	3
AVG	**3**	**3**	**3**	**3**	**3**	**1.6**	**1.6**	**1**	**3**	**3**	**3**	**3**	**2.2**	**2.8**	**2.8**

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

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

IT23501	COMPUTER NETWORKS	L	T	P	C
		3	0	2	4

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, 6P

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.

PRACTICALS:

1. Practice different network commands available in Windows and Linux Operating Systems and troubleshoot the network.
2. Configure the network devices such as Router, Switch, Hub, Bridge and Repeater.
3. Analyzing the Network traffic using Packet Analyzer (Wireshark) and understanding the various protocol headers.

Suggested Activities:

- In-class activity - Solving problems on performance metrics.
- In-class activity - HTTP problems.
- Accessing HTTP and SMTP server through Telnet.
- External learning - HTTP/DNS format using a tool like Wireshark.
- External learning - POP3 and IMAP protocols of email application.

Suggested Evaluation Methods:

- Discussion/assignment on HTTP problems.
- Demonstrating Wireshark output.

UNIT II	TRANSPORT LAYER	9L, 6P

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.

PRACTICALS:

1. Configure IPv4 and IPv6 addressing for a network using static and dynamic approaches (SLAAC and DHCP).
2. Configure Dynamic Routing mechanism using RIP and OSPF protocols. Simulate TCP congestion control mechanism using NS2/NS3/OPNET

Suggested Activities:

- Flipped Classroom on UDP Applications.
- External learning - Wireshark for UDP, TCP packet formats.
- External learning - Transport for Real Time Applications.
- External learning - Understanding RFCs.
- Assignments on flow control analysis in class.

Suggested Evaluation Methods:

- Quiz on UDP applications.
- Quiz on real time transport protocols.

- Discussion/assignment on RFC.
- Interpreting Wireshark output

UNIT III	NETWORK LAYER	9L, 6P

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.

PRACTICALS:

1. Configure Dynamic Routing mechanism using RIP and OSPF protocols.
2. Simulate TCP congestion control mechanism using NS2/NS3/OPNET.

Suggested Activities:

- In-class activity - IP addressing.
- External learning - IPV4 Packet Format using Wireshark.
- In-class activity - Subnetting for different scenarios.
- Flipped classroom on CIDR.
- External learning - Ping and trace-route commands.
- Mini-project on the implementation of a protocol based on an RFC.

Suggested Evaluation Methods:

- Quiz on CIDR.
- Check ability to use commands

UNIT IV	IP ADDRESSING	9L, 6P

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.

PRACTICALS:

1. Performance analysis of Network using NS2/NS3/OPNET (Delay, Bandwidth etc.)
2. Develop client/server-based applications using TCP and UDP sockets.

Suggested Activities:

- Flipped classroom on generations of cellular networks.
- Explore the web to know more about the networking concepts and recent technologies. Students may present their findings orally or by a written report or through discussion forums.
- Explore the networking devices used in laboratories and homes, and their configurations.

Suggested Evaluation Methods:

- Quizzes on network transmission and communication.
- Report evaluation by peers.
- Discussion on network devices.

UNIT V	DATA LINK AND PHYSICAL LAYERS	9L, 6P

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.

PRACTICALS:

. 1. Implement the functionality of Ping and traceroute commands using raw sockets

Suggested Activities:

- Flipped classroom on social networking applications.
- Explore the web to know more about the concepts and technologies used for the design of

Information Systems. Students may present their findings orally or by a written report.

- Design a simple web or mobile application.
- Explore and analyze some of the visual analytics software.

Suggested Evaluation Methods:

- Quizzes on features of social networking applications.
- Presentations on various information systems.
- Demonstration of application.
- Discussions through forums.

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES:

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

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

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	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
CO6	**2**	**2.6**	**2.6**	**2.6**	**1.2**	**1.5**	**-**	**-**	**1.4**	**-**	**1.2**	3	3	3	3
AVG	2	2	3	1	2	1	-	-	2	-	1	3	3	3	3

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

IT23502	WEB PROGRAMMING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To learn the basic object oriented concepts using Java language.
- To understand the advanced features of Java language.
- To understand the essential client side technologies for web programming.
- To develop applications using database connectivity and server side programming in Java environment.
- To develop smart device based web application and deploy in different platforms.

UNIT I	JAVA FUNDAMENTALS	9L, 6P

Overview of Java – OOPS Fundamentals in Java: Classes, Objects, Methods and Strings–Array and Array Lists - Static methods – Abstract classes- Overloading Constructors – Method Overriding - Inheritance – Polymorphism – Interfaces: Implementing and extending interfaces – Threaded model - Multiple threads - Thread Priority - Thread Synchronization using synchronized methods - Packages – Exception Handling –Types of Exceptions.

PRACTICALS:

1. Design and Implement Java programs that deals with the following
   a. Classes, Objects and Interfaces.
   b. Exception handling using user defined exceptions.
   c. String Handling (String Class objects – string manipulation functions).
   d. Creation of User Interfaces using SWING and graphic features.
   e. Creation and Manipulation of Generic objects.
2. Implementation of simple http client/server application.

Suggested Activities:

- Simple Java programming using control statements, strings, arrays, ArrayList, passing and returning object with exception handling.
- Exploring class hierarchy using inheritance and implementing Interface based run– time polymorphism.
- String manipulation and regular expression based examples.

Suggested Evaluation Methods:

- Evaluation of simple java exercise developed
- Quizzes on string manipulation commands
- Demonstration of application developed using above mentioned features.

UNIT II	JAVA GUI AND FILE STREAMS	9L, 6P

Predefined Libraries - Using String class - Working with Data & Time - Utility framework - Java I/O -AWT & Swings – Regular Expressions – Files, Streams and Object Serialization – Generic collections – Generic Classes and Methods-Java Applet Basics- Graphics and Animation in Applet- Event Handling and Applet Communication-Reflections in Java.

PRACTICALS:

1. Reading websites using URL class.
2. Implementation of any Information System using JDBC

Suggested Activities:

- Applet and frame based application development using Swing.
- File stream and object serialization on text and binary data.
- Thread priorities and synchronization based application development.
- Simple networking programs like chat application.

Suggested Evaluation Methods:

- Quizzes on event handling Mechanics

- Assignments of GUI control based applet development
- Demonstration of application developed using I/o and Thread manipulation

UNIT III	JDBC AND WEB APPLICATION DEVELOPMENT	9L, 6P

Overview of JDBC API - Establishing a connection with the database- Servlet : Servlet Architecture – Servlet lifecycle – Generic Servlet – HttpServlet –Servlet interface-Server-Side Include: Overview of JSP – JSP Components – JSP Implicit Objects- Java Server Faces - MVC Architecture of JSF Apps – Common JSF Components.

PRACTICALS:

1. Web Application development using JSP and JSF.
2. Session Management and Implementation of Cookies using JSF.

Suggested Activities:

- Programming exercises on HTML forms with Java script and JQuery objects.

Suggested Evaluation Methods:

- Evaluation of case studies given on website development using HTML, JS and J query objects.
- Assignment on AJAX enabled website
- Demonstration of JS based special API implementation

UNIT IV	ADVANCED FRAMEWORKS	9L, 6P

MVC framework – JPA-Hibernate - Introduction to ORM, JPA Hibernate – Using Annotations – JPA - SessionFactory, Session, Transaction - Performing CRUD Operations with Annotations - Different ID Generation Strategies - Hibernate with Inheritance Hibernate Query language – ORM mapping – Spring Framework – Spring Bean Factory and application Context- Spring Boot - Introduction to STS (Spring Tool Suite) - Di with STS - MVC, AOP

PRACTICALS:

1. Development of Hibernate framework-based application for O/R mapping.
2. Web application development using Spring Framework

Suggested Activities:

- Practice of servlet program with Data base connectivity and session tracking
- Development of JSF applications with Data Base connectivity

Suggested Evaluation Methods:

- Demonstration of simple web application using Servlet and JSF.
- Session management demos using Servlet and JSF.

UNIT V	WEB SERVICES	9L, 6P

Spring Web Services - Introduction to Web Service - Basics of REST APIs – Spring REST – Micro services with Spring Boot-Spring Cloud - Introduction to MicroService architecture - Advantages with MicroService over Monolithic architecture - Develop and Deploy MicroService application in localhost - Introduction to DevOps and advantages- DevOps Tools.

PRACTICALS:

1. Creation of Micro service and deploying it in localhost

Suggested Activities:

- Asynchronous web application development.
- Android based mobile application development.
- Practical - Application deployment in web servers.

Suggested Evaluation Methods:

- Evaluating asynchronous application development.
- Evaluation of online web hosting.
- Evaluation of performance assessment like modular design factors (Cohesion

and coupling) to verify proper modular breakup.	
TOTAL: 45L + 15P = 75 PERIODS	
COURSE OUTCOMES:	
Upon successful completion of the course, the student will be able to:	
CO 1.	Implement Object-Oriented concepts in Java programming.
CO 2.	Design and implement Generics and GUI based application development.
CO 3.	Implement and solve problems using collections, I/O and Reflections in Java.
CO 4.	Develop dynamic web applications with database connectivity using server-side technologies
CO 5.	Design and develop applications using advanced frameworks and web services.
TEXTBOOKS:	
1. Paul J. Deitel, Harvey Deitel, "Java How to Program", Eleventh Edition, Pearson Education, 2017. 2. "Core and Advanced Java, Black Book", Dreamtech Press, 2018.	
REFERENCES:	

1. Felipe Gutierrez, Joseph B. Ottinger," Introducing Spring Framework 6: Learning and Building Java-based Applications With Spring, APress, 2022.
2. Moisés Macero García, Tarun Telang," Learn Microservices with Spring Boot 3: A Practical Approach Using Event-Driven Architecture, Cloud-Native Patterns, and Containerization", APress, 2023.
3. Herbert Schildt , "Java The Complete Reference", Eighth Edition, Tata McGraw Hill, 2011.
4. Cay S.Horstmann, "Core Java Volume I & II", Pearson Education, 2018.
5. Paul Dietel, Harvey Dietel, Abbey Dietel, "Internet and World Wide Web", Fifth Edition, Pearson Education, 2012.
6. Uttam K. Roy , "Advanced Java Programming", Oxford University Press, 2015.

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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CO5	2	3	3	3	3	2	2	3	3	2	3	3	3	3	3
AVG	2	3	3	2.6	3	2	2	3	3	2	3	3	3	3	3

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

IT23503	COMPILER DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about automata theory and regular expressions.
- To learn the concepts in the design of compilers.
- To learn about the runtime store organization
- To be familiar with garbage collection.
- To learn the concepts of code optimization and code generation.

UNIT I	LEXICAL ANALYSIS	9L

Introduction - The Structure of Compiler –Application of Compiler Technology- Compiler Construction Tools- Programming Language Basics- Lexical Analysis – Role of Lexical Analyzer – Specification and Recognition of Tokens -Finite Automata – Deterministic Finite Automata – Non-deterministic Finite Automata –Finite Automata with Epsilon Transitions – NFA to DFA Conversion –Minimization of Automata – Lexical Analyzer Generators.

Suggested Activities:

- Flipped classroom on Finite Automata and Regular Expressions.
- External learning - Automata, Basics of Finite Automata, NFA, DFA, Finite statemachines - Regular expressions.
- Practical - Study of Lexical analysis tools and Lexer generators

Suggested Evaluation Methods:

- Assignments on regular expressions.
- Quizzes on automata, Lexical Analyzer commands.

UNIT II	SYNTAX ANALYSIS	9L

Introduction – Context Free Grammar- Writing a Grammar - Top Down Parsing: Recursive Descent Parsing – FIRST and FOLLOW – LL(1) Grammars – Non-Recursive Predictive Parsing – Error Recovery in Predictive Parsing - Bottom Up Parsing – LR Parsers: Simple LR – Construction of SLR (1) Parsing Table, Canonical LR (1) Parsing Table and LALR (1) Parsing Table- Parser Generators.

Suggested Activities:

- Flipped classroom on languages, writing grammars for programming languages,transformations on grammars.
- External learning - Parser generators.
- Practical - Read and write grammars for programming language constructs, Perform top-down parsing, bottom-up parsing and use parser generators, Implementation of Parsers using YACC in Unix Environment.

Suggested Evaluation Methods:

- Assignments on various bottom up parsers.
- Quizzes on Top down parsers.

UNIT III	INTERMEDIATE CODE GENERATION	9L

Symbol Table – Construction – Syntax Directed Definitions – Evaluation Orders for Syntax Directed Definitions – Applications of Syntax Directed Translation – Intermediate Code Generation – Variants of Syntax Tree- Three Address Code – Types and Declarations – Expression Translation – Type Checking – Control Flow- Back Patching.

Suggested Activities:

- Flipped classroom on attributes grammars.
- External learning - Type checking, intermediate code and abstract machines.
- Practical - Perform semantic analysis including static checking, intermediate representations and attribute grammars, implementation of semantic analyzers using YACC.

Suggested Evaluation Methods:

- Quizzes on syntax directed definitions.

- Assignments on type checking.
- Evaluation of Semantic analysis implementation.

UNIT IV	RUN TIME ENVIRONMENT	9L

Storage Organization - Stack Allocation - Access To Non-Local Data on the Stack - Heap Management Introduction to Garbage Collection : Design Goals for Garbage Collectors- Reachability- Reference Counting Garbage Collectors - Trace-Based Collection: Mark and Sweep Collector – Mark and Compact Garbage Collectors.

Suggested Activities:

- Flipped Classrooms on various garbage collectors
- Tutorials on Heap management

Suggested Evaluation Methods:

- Quizzes for various garbage collection mechanism
- Assignments on heap management strategies

UNIT V	CODE OPTIMIZATION AND GENERATION	9L

Issues in the Design of Code Generator – Target Language- Addresses in the Target Code – Basic Blocks and Flow Graphs – Optimization of Basic Blocks- A Simple Code Generator – Peephole Optimization – Machine Independent Optimization : Principal Sources of Optimizations – Bootstrapping compilers.

Suggested Activities:

- Flipped classroom on Target machine.
- External learning - Code generation, Elementary optimizations. Basicblocks,Dataflow analysis.
- Practical - Code generation for sample problems.

Suggested Evaluation Methods:

- Assignment problems in flow graphs.
- Quizzes on code optimization and Code generation.
- Evaluation of code generation

TOTAL: 45L =45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the concept of Lexical analysis to construct a Lexical Analyzer.
CO 2.	Understand the usage of Syntax Analysis to construct and use a parser appropriately.
CO 3.	Design and implement intermediate Code generator.
CO 4.	Understand the usage of Run time environment to develop applications.
CO 5.	Analyze and apply the code optimization and design a code generator.

TEXTBOOKS:

Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools”, Second Edition, Pearson Education, 2009.

REFERENCES:

1. Torbengidius Mogensen, “Basics of Compiler Design”, Springer, 2011.
2. Charles N, Ron K Cytron, Richard J LeBlanc Jr., “Crafting a Complier”, Pearson Education, 2010.
3. K. D. Cooper, L. Torczon, “Engineering a Compiler”, Morgan-Kaufmann, Second Edition, 2011.
4. Micheal Sipser, “Introduction to the Theory of Computation”, Third Edition, 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	-	-	-	2	2	2	2	3	3	3
CO2	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO3	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO4	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO5	3	3	3	3	2	-	-	-	2	2	2	2	3	3	3
CO6	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

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

IT23504	MACHINE LEARNING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic concepts of machine learning and probability theory.
- To appreciate supervised learning and their applications.
- To understand unsupervised learning like clustering and EM algorithms
- To understand the theoretical and practical aspects of probabilistic graphical models
- To learn other learning aspects such as reinforcement learning, representation learning, deep learning, neural networks and other technologies.

UNIT I **INTRODUCTION** **9L, 6P**

Basic Concepts in Machine Learning – Types of Machine Learning – Supervised, Unsupervised, Semi-supervised and Reinforcement Learning - Applications of Machine Learning - Basics of Learning Theory – Concept Learning – Challenges of Machine Learning – Feature Engineering - Linear Regression – Single and Multiple Variable Regression – Polynomial Regression – Bias and variance - Logistic regression

PRACTICALS:

1. Learning of Jupyter Notebook and Google Colab Environment
2. Learning of Python packages like Scikit learn for machine Learning
3. Develop an application that makes predictions from Boston Housing Data using Linear Regression.
4. Construct a student dataset with marks. Develop an application that makes predictions from data using Logistic Regression for pass or fail.

Suggested Activities:

- Implement Find-S algorithm and Candidate Elimination Algorithm.
- Tutorial on Model selection and Validation
- External Learning - Overfitting and Underfitting
- Practical - Installing Python and exploring the packages required for machine learning

Suggested Evaluation Methods:

- Quiz on machine learning concepts and data.
- Seminar on Version spaces.
- Quiz of Python tools available for implementing machine learning applications.

UNIT II **SUPERVISED LEARNING - I** **9L, 6P**

Linear Regression – Multiple variable regression – Logistic regression – Regularization techniques - LASSO, Ridge, and Elastic Net Regression - Decision Tree Learning- ID3 - C4.5 – CART - Instance based Learning - K-Nearest Neighbor Algorithm - Neural Networks – Perceptron - Feed-Forward Networks for binary and multi-class classification - Multi Layer Perceptron - Back Propagation.

PRACTICALS:

1. Implement a classifier using ID3 algorithms.
2. Develop a system to implement a classifier using SVM.
3. Implement Ensemble Models using Random Forest and AdaBoost.

Suggested Activities:

- External Learning - Regularization
- Practical - Develop an application that makes predictions from data using Linear Regression, Logistic Regression.
- Practical – Implement ID3 algorithm.
- Practical – Implement a Perceptron and Multi-Layer Perceptron model

Suggested Evaluation Methods:

- Quiz on Regression models
- Group discussion on basics of classification and regression.
- Evaluation of the practical implementations of neural network models using the appropriate test dataset

UNIT III	SUPERVISED LEARNING II AND UNSUPERVISED LEARNING	9L, 6P

Basics of Neural Networks – Biological and Artificial Neurons - Perceptron – Perceptron Rule - Feedforward networks – backpropagation Algorithms – Classification using Neural networks – Challenges in ANN - Support Vector Machine – Optimal Hyperplane – hard and Soft margin SVM – Non-Linear SVM – Kernels – Support Vector Regression

PRACTICALS:

1. Create a simple neural network for classification of Tabular data.

Suggested Activities:

- Practical – Develop an SVM model for a two-class problem, whose training points are distributed in a 2D plane and improve the performance of the model by applying kernel methods.
- Practical – Implement a bagging and boosting approach for some case studies.
- Implement K- means algorithm for a data set.

Suggested Evaluation Methods:

- Quiz on SVM and Kernel methods.
- Group discussion on Ensemble methods.
- Quiz on Clustering Methods, Dimensionality reduction

UNIT IV	PROBABILISTIC GRAPHICAL MODELS	9L, 6P

Probability-based learning – Classification using Bayes Model - Naive Bayes Algorithm — Gibbs Algorithm - Bayes Classifier for continuous variables - Probabilistic Graphic models – Bayesian Belief Network – Construction of Bayesian Network – Bayesian Inference - Markov Chain – Markov Models - Hidden Markov Models – Applications of HMM

PRACTICALS:

1. Develop a system that extracts words from the given sentences using the Hidden Markov model.

Suggested Activities:

- Assignment on solving numerical problems using HMM.
- Practical - Classification using Naive Bayes algorithm.
- Group Discussion on Markov Random Fields (MRF) and Conditional Random Fields (CRF)

Suggested Evaluation Methods:

- Seminar on Parameterization of MRFs.
- Quiz on CRF and MRF

UNIT V	ADVANCED LEARNING	9L, 6P

Introduction to Clustering - Hierarchical Clustering – Single Linkage – Complete Linkage – Average Linkage – Partitional Clustering Algorithms – K-means - Expectation Maximization Algorithm – Linear Discriminant Analysis – Principal Component Analysis - Gaussian Mixture Models – Latest Trends – Overview and Scope of Reinforcement Learning – Components of reinforcement Learning – Model-based and Model-free models – Q-Learning Algorithm

PRACTICALS:

1. Develop a system for implementing single, average, and complete linkage algorithms.
2. Develop a system that automatically groups articles by similarity using K-means clustering.

Suggested Activities:

- Assignment on SARSA Learning
- Practical - Implement CNN, LSTM

Suggested Evaluation Methods:

- Quiz on Reinforcement Learning
- Group Discussion on Deep Neural Networks.
- Evaluation of the practical implementation of CNN, LSTM

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES:

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

CO 1.	Disseminate the key elements of machine learning and the basics of concept learning.
CO 2.	Apply regression analysis, decision tree models and neural networks for regression and classification problems.
CO 3.	Implement SVM, ensembling methods for an appropriate application
CO 4.	Apply clustering methods for learning with unsupervised data.
CO 5.	Design and implement a BBN, HMM for a sequence model type of application and implement a PGM for any real time application using an open-source tool.
CO6	Describe Reinforcement learning and use a tool to implement Deep learning algorithms.

TEXTBOOKS:

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, First Edition, Springer, 2006.
2. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.
3. Sridhar S, Vijayalakshmi M, “Machine Learning”, First Edition, Oxford University Press, 2022.

REFERENCES:

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. EthemAlpaydin, “Introduction to Machine Learning”, Third Edition, Prentice Hall of India, 2005.
3. T. Hastie, R. Tibshirani, J. Friedman, “The Elements of Statistical Learning”, Second Edition, Springer, 2008.
4. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, CRC Press, 2009.
5. T. V. Geetha, S. Sendhilkumar, “Machine Learning: Concepts, Techniques and Applications” Chapman & Hall/CRC Press, 2023.

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	1	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	2	1	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	2	1	-	-	2	1	2	-	3	3	3
CO4	3	3	3	3	2	1	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	1	-	-	2	1	2	-	3	3	3
CO6	3	2	2	2	3	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.

IT23505	SOCIETAL ORIENTED PROJECT	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To identify socially relevant problems.
- To design solutions for socially relevant problems.
- To develop projects based on software design process.
- To implement solutions for societal valued projects using relevant state of the art technologies.
- To test the implemented project based on user needs and usefulness.

Students are expected to take up problems that would directly benefit the 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, 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.

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: 30 PERIODS

COURSE OUTCOMES:

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

CO 1. Analyze social problems and provide technical solutions.

CO 2. Benefit the society by providing IT based solutions for social problems.

CO 3. Design, develop and implement solutions for social problems.

CO 4. Develop innovative technical solutions of social relevance.

CO 5. Design, develop and implement standard solutions to social problems applying and Evaluate the solution based on usefulness, effectiveness and user satisfaction.

REFERENCES:

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

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***	***PS O 1***	***PS O 2***	***PS O 3***
CO1	3	3	3	3	3	3	2	2	2	2	2	3	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	2	2	2	2	3	3	3	3
CO4	2	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO5	2	2	3	2	3	3	2	2	3	3	3	3	3	3	3
AVG	**2.6**	**2.8**	**3**	**2.8**	**3**	**3**	**2**	**2**	**2.8**	**2.8**	**2.8**	**3**	**3**	**3**	**3**

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

IT23601	DISTRIBUTED SYSTEMS AND COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the concepts and architecture of distributed systems.
- To understand distributed process communication and synchronization.
- To understand the distributed shared memory and coordination terminologies.
- To study about Peer-to-Peer computing models.
- To implement distributed computing models.

UNIT I	INTRODUCTION TO DISTRIBUTED SYSTEMS	9

Characteristics and design goals- Types of a distributed system: High-performance distributed computing, Distributed information systems, Pervasive systems- Architectures: Architecture styles, Middleware organization, System architecture: Centralized, Decentralized, Hybrid.

Suggested Activities:

- Implement RPC and Bankers algorithm.
- Create and Distribute a Torrent file to share a file in LAN Environment.

Suggested Evaluation Methods:

- Demonstration and assessment of the working of the implemented algorithm

UNIT II	PROCESS SYNCHRONIZATION AND COORDINATION	10

Threads – Virtualization - Clients and servers - Code migration - Types of communication: Message oriented communication- Multicast communication- Clock synchronization: Physical clocks and logical Clocks-Mutual exclusion algorithms - Election Algorithms. - Distributed event matching -Gossip based coordination

Suggested Activities:

- Creation of Virtual Machines
- Use clock synchronization in real time distributed applications

Suggested Evaluation Methods:

- Demonstration and assessment of the working of the implemented algorithm

UNIT III	DISTRIBUTED SHARED MEMORY and PEER-TO-PEER COMPUTING	9

Distributed shared memory: Abstraction and advantages, shared memory mutual exclusion algorithm- Peer to peer computing: Data indexing and overlays, Chord distributed hash table, Content addressable networks, Challenges in P2P systems.

Suggested Activities:

- Practice exercises on Distributed shared memory.
- Analyzing the performance of P2P systems like Napster and Gnutella.

Suggested Evaluation Methods:

- Demonstration and assessment of the working of the implemented algorithm

UNIT IV	CONSENSUS ALGORITHMS AND FAILURE RECOVERY	8

Consensus and agreement algorithms: Agreement in the failure-free system, Agreement in synchronous and asynchronous systems with failures - Check pointing and rollback recovery: Definitions, Issues in failure recovery, checkpoint-based recovery and log-based roll back recovery.

Suggested Activities:

- Use consensus algorithms and recovery mechanisms in distributed environment.
- Analyzing the performance of P2P systems like Napster and Gnutella.

Suggested Evaluation Methods:

- Demonstration and assessment of the working of the implemented algorithm

UNIT V	COMPUTING MODELS	9

Remote Procedure Call: RPC operation, parameter passing, RPC based application support-XML RPC-

Remote Method Invocation (RMI) and implementation- Java Web Service - Java API for Web Service- Message passing in Distributed Systems-Message passing interface-Group Communication.

Suggested Activities:

- Creation of Java Web services
- Practice programs on Message passing.
- Implementation of Group communication for a real time scenario

Suggested Evaluation Methods:

- Demonstration and assessment of the working of the implemented algorithm

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the principles and standard practices of distributed systems
CO 2.	Understand and implement the process and communication of distributed systems
CO 3.	Understand on mutual exclusion and deadlock detection in distributed systems
CO 4.	Analyze the features of peer-to-peer and distributed consensus algorithms
CO 5.	Implement the various distributed computing models

TEXTBOOKS:

1. Maarten van Steen, Andrew S. Tanenbaum, “Distributed systems”, Fourth edition, 2023.
2. Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 201

REFERENCES:

1. George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education, 2012.
2. Pradeep L Sinha, “Distributed Operating Systems: Concepts and Design”, Prentice Hall of India, 2007.
3. Tanenbaum A S, Van Steen M, “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007.

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	-	2	2	2	-	1	1	2	1	-	3	3	3	3
CO2	2	1	1	2	2	-	1	1	2	1	-	3	3	3	3
CO3	2	3	2	2	2	-	1	1	2	1	-	3	3	3	3
CO4	3	2	2	2	2	-	1	1	2	1	-	3	3	3	3
CO5	3	3	2	2	2	-	1	1	2	1	-	3	3	3	3
AVG	**2.2**	**2.2**	**1.8**	**2**	**2**	**-**	**1**	**1**	**2**	**1**	**-**	**3**	**3**	**3**	**3**

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

IT23602	NATURAL LANGUAGE AND IMAGE PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To know the fundamental concepts of language processing
- To understand the language models and apply them in the development of NLP applications
- To know the fundamentals of image processing
- To develop the ability to understand and implement various image processing algorithms
- To understand the concepts of the speech processing and apply them in the development of real-time multimedia applications

UNIT I	Fundamentals of NLP	9L, 6P

Introduction - Regular Expressions- Words – Corpora- Word Tokenization- Word Normalization, Lemmatization and Stemming -Sentence Segmentation - Vector Semantics and Embeddings- Lexical Semantics -Vector Semantics -Words and Vectors- Cosine for measuring similarity - TF-IDF: Weighing terms in the vector -Pointwise Mutual Information (PMI) -Applications of the tf-idf or PPMI vector models -Word2vec -Visualizing Embeddings -Semantic properties of embeddings -Bias and Embeddings - Evaluating Vector Models - Parts of Speech and Named Entities – Sentiment and Opinion Analysis-Word Sense Disambiguation- Building Datasets.

PRACTICALS:

1. Implement Stop word removal, Punctuation removal, word tokenization and topical word extraction using different tools like NLTK, PyTorch-NLP.
2. Implement different ranking algorithms.

Suggested Activities:

- Flipped classroom on natural language processing techniques like statistical text analysis, term extraction, word sense disambiguation, concept extraction and tutorial activity.
- Extended Reading from the site – https://nlp.stanford.edu/fsnlp/.

Suggested Evaluation Methods:

- Assignments on language processing techniques .
- Demonstration on term extraction and term disambiguation.

UNIT II	Language Models and NLP Applications	9L, 6P

N Gram Language Model-Evaluating Language models-Sequence Labeling-HMM- Discriminative sequence labeling-Neural sequence labeling-Applications of sequence labeling- Machine Translation-Question Answering and Information Retrieval -Chatbots and Dialogue Systems -Automatic Speech Recognition and Text-to-Speech.

PRACTICALS:

1. Design a chat bot with a simple dialog system.
2. Translate the given text from one language to other language
3. Develop a text classification system using algorithm

Suggested Activities:

- Case Studies on applications involving language models.
- Demonstration of simple application specific modules using tools.

Suggested Evaluation Methods:

- Quizzes on different NLP based applications.

UNIT III	IMAGE PROCESSING FUNDAMENTALS	9L, 6P

Introduction – Steps in Image Processing Applications-– Imaging sensors- Colour Fundamentals and Models- image operations: arithemetic-logical-geometric operations, resizing, cropping-Image Enhancement in Spatial and Frequency Domain- Histogram Processing.

PRACTICALS:

1. Implementation of simple spatial filters like Low Pass Filters and High Pass Filters in MATLAB/OpenCV.
2. Implementation of Histogram Techniques in MATLAB/Octave/OpenCV

Suggested Activities:

- Discussion on image processing applications.
- External learning – Open source tools like Octave/SciLab/OpenCV , types of images.
- Tutorials on image operations, image connectivity and distance measures.

Suggested Evaluation Methods:

- Assignments on sampling, quantization and image operations.
- Quizzes on image types.
- Evaluating the performance of Image operations exercises

UNIT IV	**IMAGE PROCESSING**	**9L, 6P**

Image segmentation– Thresholding-Global and Local thresholding-Edge detection- gradient based – laplacian of Gaussian-canny edge detector - Feature extraction-point feature-line and edge feature-Texture feature extraction-GLCM– Object recognition –object detection-template matching-viola Jones method–Image classifications-maximum likelihood, minimum distance classification-Image processing recent trends and applications.

PRACTICALS:

1. Implementation of Image Classifier using SVM, and deep learning in MATLAB/Octave/ OpenCV
2. Implementation of image clustering using MATLAB/OpenCV.

Suggested Activities:

- Flipped classroom on importance of segmentation.
- External learning – Discussion of features, feature selection and reduction.
- Tutorials on image segmentation and edge detection.

Suggested Evaluation Methods:

- Assignments on feature extraction and reduction.
- Quizzes on feature selection and extraction.
- Demonstration on image segmentation and edge detection.

UNIT V	**SPEECH PROCESSING**	**9L, 6P**

Speech processing– Central analysis of speech, format and pitch estimation, Applications of speech processing - Speech recognition task- Feature Extraction for Automatic Speech Recognition (ASR) - ASR Architecture- ASR Evaluation: Word Error Rate- Text to Speech- Speech synthesis and speaker verification - voice to text conversion- language processing-API s for audio processing-recent trends-applications.

PRACTICALS:

1. Conversion of speech-to-text and text-to-speech

Suggested Activities:

- Flipped classroom on different audio and speech processing applications
- Discussion on parameters and metrics related to audio processing

Suggested Evaluation Methods:

- Quiz on different audio and speech processing applications
- Assignment on metrics related to audio processing

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES

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

CO 1. Understand and implement the basic text processing algorithms.

CO 2. Understand the various language models and apply them in developing NLP applications.

CO 3. Implement basic image processing operations.

CO 4. Apply classifiers and clustering algorithms for images.

CO 5. Understand and implement speech processing techniques and applications

TEXTBOOKS:

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Third Edition, Pearson Education.2024
2. Jacob Eisenstein, “Introduction to Natural Language Processing”, MIT Press, 2019.
3. Rafael Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.

REFERENCES:

1.T V Geetha, Understanding Natural Language Processing (Machine Learning and Deep Learning Perspectives), Pearson, 2024
2. S. Sridhar, “Digital Image Processing”, Second Edition, Oxford Press, 2016.
3. Nikos Tsourakis “Machine Learning Techniques for Text: Apply modern techniques with Python for text processing, dimensionality reduction, classification, and evaluation”, Packt publishing, 2022.
4. Udo Zolzer , Digital Audio Signal Processing, Willey publication, 3rd Edition, 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	3	2	2	2	1	1	2	2	3	2	3	3	3
CO2	2	2	3	2	2	2	1	1	2	2	3	2	3	3	3
CO3	2	2	3	2	2	2	1	1	2	2	3	2	3	3	3
CO4	2	2	3	2	2	2	1	1	2	2	3	2	3	3	3
CO5	2	2	3	2	2	2	1	1	2	2	3	2	3	3	3
AVG	**2**	**2**	**3**	**2**	**2**	**2**	**1**	1	**2**	**2**	3	**2**	3	3	3

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

IT23U02 PERSPECTIVES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
2	0	2	3

MODULE 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.

MODULE 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

MODULE 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 – IT SUSTAINABILITY 9

Types and sources of e-waste - Environmental and health impacts of e-waste - E-waste regulations and policies - Techniques for recycling IT equipment – Safe disposal methods - E-waste stream management - Concepts of circular economy - Role of IT in promoting circular economy.

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 a campus sustainability plan and prototype, integrating sustainable IT practices and energy-efficient solutions.
- Develop AI-driven solutions for efficient water management, demonstrating the role of IT in smart environmental monitoring.

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. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.
9. Niklas Sundberg, (2022), Sustainable IT Playbook for Technology Leaders: Design and implement sustainable IT practices and unlock sustainable business opportunities.

IT23E01	IoT BASED SMART SYSTEMS	L	T	P	C
		2	0	2	3

UNIT I	INTRODUCTION TO IoT and ARCHITECTURE	6

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 - Cognitive 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 PLATFORM	6

Sensors, Actuators, and Smart Objects-Trends in Smart Objects- Microcontroller-architecture – ATmega328P - ARM Cortex M MCU -- ESP8266 -- Arduino IDE — Programming and Developing Sketches – Arduino Rest APIs – Raspberry Pi – Interfaces – Python Packages of Interests for IoT - 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 and Pi programs.
- Quiz on Python.

UNIT III	IoT COMPONENTS AND COMMUNICATION	6

IoT Communication Models and APIs – IoT Communication Protocols- - COAP - MQTT -- IEEE Standards- IEEE 802.15.4- ZigBee- LoRaWAN Private Network- 6LoWPAN – SCADA - Geographic Information Systems - GPS - GSM modules - RFID Protocols – WiFi - Bluetooth Interfacing - SDN and NFV for IoT.

Suggested Activities:

- External learning – Explore IoT policy of MEITY (GoI).
- In-class activity – Ipv6 packet header and address types.

Suggested Evaluation Methods:

- Assignment on LoRa.
- Quiz and 6LoWPAN.

UNIT IV	IoT APPLICATIONS AND ANALYTICS	6

IoT Operating Systems - Need and Challenges- TinyOS - Raspian - Mbed OS(ARM) – IoT Data Analytics - Types- Platform- IBM Watson -Secure device control, Synchronization and Real Time Analysis - ThingSpeak - AWS IoT Analytics – IoT System Management-NETCONF - YANG - Cloud Storage and Communication APIs.

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	6

TinyML- ML ToolChain- Google Collab - TensorFlow and Keras- 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: 30 PERIODS

EXERCISES **30**

1. Write an Arduino sketch to control the Light Emitting Diode (LED) with a push button.
2. Design a gesture based basic arithmetic calculator and display the answers in console or a LCD display.
3. Develop Real time applications – clock generation, signal generation, counter – using embedded C.
4. Write a ARM program to implement
    - Arithmetic series
    - Calculate quadratic Equations

5. Explore Embedded C. Write a simple Embedded C program for ARM processors.
6.Develop simple application – testing LED, infrared sensor – IoT Applications – using Arduino (Any two applications)
7. Develop simple application – testing temperature, light sensor – IOT Application – using open platform/Raspberry Pi (Any two applications).
8.Visualize IoT data with PowerBi Desktop
9.Deploy IOT applications using open source platforms
10.Project based learning to deploy ML in low power microcontrollers.

TOTAL: 60 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/Raspberry Pi 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. Milan Milenkovic. Internet of Things: Concepts and System Design. Springer 2020.
4. Lakhwani, Kamlesh, Hemant Kumar Gianey, Joseph Kofi Wireko, and Kamal Kant Hiran. Internet of Things (IoT): Principles, paradigms, and applications of IoT. Bpb Publications, 2020.
5. Amita Kapoor: Hands-On Artificial Intelligence for IoT: Expert Machine Learning and Deep Learning Techniques for Developing Smarter IoT Systems. Packt Publishing 2019.
6. Warden, Pete, and Daniel Situnayake. *Tinyml: Machine learning with Tensorflow lite on arduino and ultra-low-power microcontrollers*. O'Reilly Media, 2019.
7. Kurniawan, Agus. "IoT Projects with NVIDIA Jetson Nano." *Apress Berkeley, CA,* 2021.
8. Raj, Pethuru, and Anupama C. Raman. The Internet of Things: Enabling technologies, platforms, and use cases. Auerbach Publications, 2017.
9. 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.
10. https://www.arm.com/products/development-tools/embedded-and-software/mbed-os
11. NPTEL course on “Introduction to Internet of things” by Dr. Sudip Misra IIT Kharagpur

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	-	1	1	-	3	2	3	3	3
CO2	3	3	3	3	2	1	-	1	2	-	3	2	3	3	3
CO3	3	3	3	3	2	1	-	1	2	-	3	2	3	3	3
CO4	3	3	3	3	2	1	-	1	2	-	3	2	3	3	3
CO5	3	3	3	3	2	1	--	1	2	-	3	2	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**1**	**1.8**	**-**	**3**	**2**	**3**	**3**	**3**

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

IT23701	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To explore the basics of security and number theory.
- To study about the symmetric key cryptography and algorithms.
- To study about the asymmetric key cryptography and algorithms.
- To understand the security issues and application to design.
- To plan the security mechanisms required by system.

UNIT I	INTRODUCTION TO SECURITY AND NUMBER THEORY	9L, 6P

Basics of Security – CIA Triad – Threats, Attacks and Services – Classical Cryptography – Substitution and Transposition ciphers – One-time Pad– Number Theory – Modular Arithmetic – Euclidean Theorem – Extended Euclidean Theorem – Algebraic Structures – Galois Field – Primality test –Pseudo randomness - Fermat's Theorem – Euler's Theorem – Chinese Remainder theorem – Logarithms – Elliptic Curve Arithmetic.

PRACTICALS:

1. Implement basic mathematical requirements for cryptography.
2. Write a program to perform encryption and decryption of classic cryptosystems.
3. Perform cryptanalysis using Brute-force Attack.

Suggested Activities:

- In-class activity - Practice cryptanalysis of classical cryptography and break the classical algorithms using cryptographic attack.
- In-class activity - Solve modular exponentiation and multiplicative inverse using Fermat and Euler theorem.

Suggested Evaluation Methods:

- Assignments on cryptanalysis of classical cryptography, additive Inverse, Multiplicative Inverse and modular exponentiation using the theorem.
- Quiz on classical cryptography and number theory.
- Demonstration of the classical cryptography algorithms using Cryp-tools.

UNIT II	SYMMETRIC CRYPTOGRAPHY	9L, 6P

Modern Cryptography – Symmetric Cipher – Block and Stream Cipher – Feistel Ciphers – Data Encryption Standard – DES Structure – Key Generation – Simplified DES – Linear and Differential cryptanalysis –CPA, CCA– Advanced Encryption Standard - Analysis of AES.

PRACTICALS:

1. Write a program to demonstrate symmetric key encryption process using DES algorithm (academic versions). Also perform cryptanalysis using CCA, CPA.
2. Write a program to demonstrate symmetric key encryption process using AES algorithm.

Suggested Activities:

- Explain the importance of key size and explore some examples with brute force attack to break the key
- Demonstrate the working of DES and AES algorithms using CrypTool.
- Demonstrate various cryptographic attacks on DES and AES.

Suggested Evaluation Methods:

- Assignments on key generation, linear and differential cryptanalysis of symmetric cryptography
- Quiz on modes of operation and internal structure of DES and AES

UNIT III	ASYMMETRIC KEY CRYPTOGRAPHY	9L, 6P

Public Key Cryptosystems – RSA Algorithm – ElGamal Cryptosystems – Diffie-Hellman key exchange –

Elliptic curve cryptography – Hash functions – Hash algorithms – Secure Hash Algorithm: SHA – MD5 – Message Authentication Codes – zero knowledge protocols - Introduction to Quantum Cryptography– Threshold Cryptography.

PRACTICALS:

1. Write a program to implement RSA algorithm and demonstrate the key generation and encryption process and analyze the same using factorization attack.
2. Write a program to generate message digest for the given message using the SHA/MD5 algorithm and verify the integrity of message.

Suggested Activities:

- Highlight the mathematics behind RSA, Diffie-Hellman Key exchange and Elliptic Curve Cryptography.
- Demonstrate the Hash code generation using MD5 and SHA 256 algorithm.

Suggested Evaluation Methods:

- Assignments on RSA and ECC generation for encryption and decryption process.
- Quiz on mathematics behind the public key algorithms.

UNIT IV	**SECURITY APPLICATIONS**	**9L, 6P**

Digital Signatures Schemes– Digital Certificate – Key Management – Kerberos – Key Agreement and Distribution – PKI – X.509 Certificate – E-Mail Security – PGP – S/MIME – IP security – Virtual Private Network – Web Security – Secure Socket Layer – Transport Layer Security – Secure Electronic Transaction.

PRACTICALS:

1. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like kali Linux.
2. Study and exploration of Wireshark tool
   (i) To analyze network traffic for various protocols, e.g. ping, DNS and telnet.
   (ii) To learn about setting up ssh keys and configure the ssh client.
   (iii) To verify whether the data are encrypted or not.

Suggested Activities:

- Case studies on understand the components of X.509 Certificate and Blockchain.
- Demonstrate IP security and configure VPN connection.
- Implement the SSL/TLS in Web Server for a Web Application.

Suggested Evaluation Methods:

- Assignment on configuration of IP security and VPN connection in networks and Blockchain
- Quizzes on Key Management, SSL, TLS and Blockchain.

UNIT V	**SYSTEM SECURITY**	**9L, 6P**

Malwares –Internet scanning worms - Mobile Malware and Botnets- Password Management – Access Control in Operating Systems: Discretionary, Mandatory and Role Based Access Control - Firewall – Intrusion Detection System and types – Intrusion Prevention System –– Penetration testing: concept, types, steps – OWASP top ten vulnerabilities – Secure Coding

PRACTICALS:

1. Study and exploration of Metasploit tool to learn about cracking of hashed files in Windows environment.
2. Configure a firewall on Ubuntu platform.

Suggested Activities:

- Teaching with case studies: access control and cloud security.
- Configure the Access Control List and using firewall, mitigate DoS attack
- Understand the safety measures during the implementation of security in WLAN

- Simulate the importance of various security standards in WLAN.

Suggested Evaluation Methods:

- Assignments on buffer overflow, malicious software and types of IDS.
- Quizzes on firewall generation, WLAN security and cloud security.

TOTAL: 45L + 15P = 75 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the basic concepts of security and number theory.
CO 2.	Understand and implement symmetric cryptographic algorithms.
CO 3.	Understand and implement asymmetric cryptographic algorithms.
CO 4.	Apply SSL and TLS in secured applications.
CO 5.	Manage firewalls and design intrusion detection and prevention systems.

TEXTBOOKS:

1. William Stallings, “Cryptography and Network Security Principles and Practices”, Pearson/PHI, Seventh Edition, 2017.

REFERENCES:

1. Wenbo Mao, “Modern Cryptography Theory and Practice”, Pearson Education, 2004.
2. Pfleeger and Pfleeger, “Security in computing”, Third Edition, PHI/Pearson, 2003.
3. Behourz Forouzan, Debdeep Mukhopadyay, “Cryptography and Network Security”, Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
4. Gilles van Assche, “Quantum Cryptography and Secret-Key Distillation”, Cambridge University Press, 2010.
5. Oded Goldreich, Foundations of Cryptography (two volumes) Cambridge university Press, 2004.
6. Patrick Engebretson, “The basics of Hacking and Penetration Testing”, Elsevier, 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	3	3	3	2	3	3	-	-	2	-	2	3	3	3	3
CO2	3	3	3	3	3	3	-	-	2	-	2	3	3	3	3
CO3	3	3	3	3	3	3	-	3	2	-	2	3	3	3	3
CO4	3	1	3	1	3	3	-	3	2	-	2	3	3	3	3
CO5	3	3	3	3	3	3	-	3	2	-	2	3	3	3	3
CO6	**3**	**2.6**	**3**	**2.1**	**3**	**3**	**-**	**3**	**2**	**-**	**2**	**3**	**3**	**3**	**3**

IT23702 SOFTWARE DEVELOPMENT PROJECT LABORATORY L T P C
0 0 4 2

The 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.

IT23801 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.

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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.

IT23E02	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.

Suggested Activities:

- Assignments and Quiz
- Tutorial of history of Gen AI
- Tutorial of Probability

Suggested Evaluation Methods:

- Quiz of history of Gen AI
- Assignment of GAN

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.

Suggested Activities:

- Tutorials on BERT, GPT

Suggested Evaluation Methods:

- Assignment on regression
- Assignment on prompt Engineering

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.

Suggested Activities:

- Tutorials on Transformers
- Group discussion on attention mechanism

Suggested Evaluation Methods:

- Quizz on Transformer Architecture.
- Assignment on Image Generation.

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.		
Suggested Activities:		
● Tutorial on GAN ● Tutorial on Deep-Q-Networks		
Suggested Evaluation Methods:		
● Quiz on Deep-Q-Networks		
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.		
Suggested Activities:		
● Tutorial on Copilot ● Tutorial on LangChain ● Tutorial on GPT4all		
Suggested Evaluation Methods:		
● Quiz on Open Source models ● Quizz on 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.		

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

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**	**PO 10**	**PO 11**	**PO 12**	**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

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)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	1	3	2	-	2	1	3	3	3
CO2	3	3	2	3	3	2	1	3	2	-	2	1	3	3	3
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

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)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

IT23004	DEEP LEARNING	L	T	P	C
		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.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
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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

IT23005	SOCIAL NETWORK ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of network science and Social network analysis.
- Know the basics of Network science.
- Understand Community detection in SNA.
- Understand the Link prediction.
- Know about the online security and privacy in SNA.

UNIT I	INTRODUCTION	9

Social Network Analysis – Need for Social Network Analysis – Applications of SNA – Health care – Social media and E-commerce, Web and Cyberspace, Scientific Research - Historical Development of Social media – Three levels of Social Network Analysis - Collection of data from Online Media – APIs – Challenges – Graph Visualization Tools – Web-based Tools and Standalone Tools.

Suggested Activities:

- Discussion on Graph theory.
- Flipped classroom for Graph visualization tools.
- Tutorials on Social networks.

Suggested Evaluation Methods:

- Quizz on social networks.
- Survey of current social networks in various domain.
- Tutorials on APT of twitter and Facebook.

UNIT II	BASIC SOCIAL NETWORK ANALYSIS	9

Network basics – Networks and Graphs Node Centrality – Different Types of Networks – Network Properties Node Centrality, Degree centrality – Closeness centrality – Betweenness centrality – Katz Centrality —Transitivity – Reciprocity – Similarity – Degeneracy – K-cliques – clan – clubs – Properties of real-world networks- Network Growth models – Random Network model – Watts-Strogatz Model – Preferential Attachment Model.

Suggested Activities:

- Discussion on Graph theory.
- Tutorials on Graph algorithms.
- Problem solving in Graph theory.

Suggested Evaluation Methods:

- Quizz on Graph theory.
- Survey on graph algorithms.
- Discussion on Network growth models.

UNIT III	SOCIAL LINK ANALYSIS AND COMMUNITY STRUCTURE IN NETWORKS	9

Link Analysis – Applications – Signed Network – Strong and Weak Ties – Triadic closure – Dunbar Number - PageRank – Hub and Authority – Personalized PageRank - Applications of Community Detection – Applications - Detecting and Discovering Communities in Social Network – Disjoint Community Detection – Overlapping Community Detection – Local Community Detection - Evaluating Communities - Identifying Influential Persons.

Suggested Activities:

- Discussion on link prediction.
- Tutorials on need for community detection.

- Discussion on community detection marketing.

Suggested Evaluation Methods:

- Quizz on probability.
- Assignment on evaluation of user communities.
- Quizz on Friend recommendation algorithms.

UNIT IV	**LINK PREDICTION - CASCADE BEHAVIOR IN SOCIAL NETWORK ANALYSIS**	**9**

Application of Link Prediction – Friends Recommendations – Link prediction methods – Heuristic models and Probabilistic models – Cascade models – Decision-based models – Multiple-choice based models – Infinite chain networks - Viral posts – Epidemic models for disease prediction – SEIR, SIR and SIS models – Analyzing rumor spread - SEIR models.

Suggested Activities:

- Discussion on Link prediction.
- Tutorials on Friends recommendation algorithms.
- Group Discussion on Epidemic models.

Suggested Evaluation Methods:

- Quizz on link prediction.
- Problem solving in link prediction.
- Flipped classrooms for Epidemic and rumoure spreading models.

UNIT V	**Online Social Networks Security**	**9**

Introduction to privacy – Need for privacy in Social Networks – Social Network privacy models - Trust – Fraud profile detection - Credibility and Reputations in Social Media – Online media privacy-preserving algorithms – Hiding sensitive information using randomization and Slicing – K-anonymity – L-Divergence and T-Closeness– Social media policing – Phishing in OSM.

Suggested Activities:

- Discussion on Privacy in SNA.
- Tutorials on Cryptography techniques.
- Group Discussion on SNA attacks.

Suggested Evaluation Methods:

- Quizz on security.
- Tutorials in Cryptography.
- Discussion about trust computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand basic principles behind network analysis algorithms and develop practical skills of network analysis
CO 2.	Model and represent knowledge for social semantic Web
CO 3.	Apply data mining techniques on social networks
CO 4.	Use extraction and mining tools for analyzing Social networks
CO 5.	Develop secure social network applications
CO6	Develop personalized visualization for Social networks

TEXTBOOKS:

1. Tanmoy Chakraborty - “Social Networks Analysis”, Wiley India, 2022.
2. Social Networks – Modeling and Analysis – Niyati Aggrawal and Adarsh Anand, CRC Press – 2022.

3. Privacy and Security in Online Social Media - Ponnurangam Kumaraguru – NPTEL Course.
REFERENCES:
1. John Scott, Peter J. Carrington, “The SAGE Handbook of Social Network Analysis”, Sage Publication, 2011. 2. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 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	3	3	2	2	3	-	-	-	-	1	1	1	3	3	3
CO2	3	3	2	2	2	3	1	2	-	3	2	2	3	3	3
CO3	3	3	2	2	-	1	-	1	-	1	2	1	3	3	3
CO4	3	3	2	3	2	1	2	1	-	1	3	1	3	3	3
CO5	3	3	2	2	3	1	1	3	-	1	2	1	3	3	3
AVG	**3**	**3**	**2**	**2**	**2**	**1.5**	**1.3**	**1.7**	**-**	**1.4**	**2**	**1.2**	**3**	**3**	**3**

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

IT23006	RECOMMENDER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of recommendation systems.
- Know the basics of Colloborative filtering.
- Understand Content based recommendation.
- Understand the knowledge based recommendation.
- Know about the basics of evaluation of recommender systems.

UNIT I	INTRODUCTION	9

Basic taxonomy of recommender systems - Data mining methods for recommender systems - Recommender system functions - Understanding ratings - Applications of recommendation systems - Issues with recommender system.

Suggested Activities:

- Flipped classroom on data mining techniques used in recommender systems
- External learning - Exploration of recommender system in real-time scenarios

Suggested Evaluation Methods:

- Tutorials - Role of data mining in recommender systems
- Assignment on real-time recommender system

UNIT II	COLLABORATIVE FILTERING	9

Nearest-neighbor collaborative filtering (CF). User-based and item-based CF, comparison, Components of neighborhood methods Hybrid recommender systems. Attacks on collaborative recommender systems.

Suggested Activities:

- Flipped classroom - Study about collaborative filtering techniques.
- External learning – Survey on recommendation process that takes place in various online shopping portals.

Suggested Evaluation Methods:

- Assignments on item based and user based collaborative filtering techniques.
- Group discussion on recommendation process in a real time scenario

UNIT III	CONTENT-BASED RECOMMENDATION	9

High-level architecture of content-based systems - Advantages and drawbacks of content-based filtering, Item profiles - Discovering features of documents - Obtaining item features from tags - Representing item profiles - Methods for learning user profiles - Similarity-based retrieval - Classification algorithms.

Suggested Activities:

- Flipped classroom on similarity based retrieval and its significance
- External learning - explore classification algorithms utilized in recommender systems

Suggested Evaluation Methods:

- Tutorials - Analyze the significance of similarity based retrieval techniques
- Quizzes about content based recommender systems
- Discussion on classification algorithms used for recommender systems

UNIT IV	KNOWLEDGE-BASED RECOMMENDATION	9

Knowledge representation and reasoning - Constraint-based recommenders - Case-based recommenders - Hybrid approaches: Opportunities for hybridization - Monolithic hybridization design - Parallelized hybridization design - Pipelined hybridization design.

Suggested Activities:

- Flipped classroom - Study how hybridization aids in recommender systems
- External learning - role of knowledge representation and reasoning

Suggested Evaluation Methods:

- Tutorial - Advantage of hybridization in recommender systems
- Discussion on knowledge representation and reasoning

UNIT V	EVALUATING RECOMMENDER SYSTEM	9

Introduction - Evaluation designs - Evaluation on historical datasets - Community-Based Web Search - Social Tagging Recommenders Systems - Trust and Recommendations.

Suggested Activities:

- Flipped classroom on social tagging in recommender systems
- External learning - Techniques related to evaluation of recommender systems

Suggested Evaluation Methods:

- Tutorial - Discussion on insights of social tagging
- Assignment on evaluation designs in recommender systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Develop an understanding of recommender systems and data mining techniques used.
CO 2.	Apply collaborative filtering techniques and address attacks on collaborative recommender systems.
CO 3.	Design content-based recommender systems using similarity retrieval or classification algorithms.
CO 4.	Employ knowledge representation and reasoning in recommender systems and opportunities for hybridization.
CO 5.	Evaluate and improve recommender systems for real-time application

TEXTBOOKS:

1. Jannach D., Zanker M., and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed. 2.
2. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
3. F. Ricci, L. Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010

REFERENCES:

1. Schutze, Hinrich, Christopher D. Manning, and Prabhakar Raghavan. Introduction to information retrieval. Cambridge University Press, 2008.
2. Leskovec, Jure, Anand Rajaraman, and Jeffrey David Ullman. Mining of massive data sets. Cambridge University Press, 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	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

IT23007	CONVERSATIONAL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of conversational systems.
- Know the basics of Natural Language Processing.
- Understand Chatbots design.
- Understand the Conversational Technologies.
- Know about the Conversational analytics.

UNIT I	FUNDAMENTALS OF CONVERSATIONAL SYSTEMS	9

Introduction: Overview, Case studies, Explanation about different modes of engagement for a human being, History and impact of AI. Underlying technologies: Natural Language Processing, Artificial Intelligence and Machine Learning, NLG, Speech-To-Text, Text-To-Speech, and Computer Vision. Introduction to Top players in the Market – Google, MS, Amazon &Market Trends. Messaging Platforms (Facebook, WhatsApp) and Smart Speakers – Alexa, Google Home. Ethical and Legal Considerations in AI.

Suggested Activities:

- Installation of NLTK library
- Review of products in the market in NLP

Suggested Evaluation Methods:

- Quiz on fundamentals
- Assignments on Fundamentals of conversational systems.

UNIT II	FOUNDATIONAL BLOCKS FOR PROGRAMMING AND NATURAL LANGUAGE PROCESSING	9

Introduction: Brief History, Basic Concepts, Phases of NLP, Application of chatbots - General chatbot architecture, Basic concepts: Intents, Entities, Utterances, Variables and Slots, Fulfillment. Lexical Knowledge Networks (WordNet, Verbnet, PropBank, etc). Lexical Analysis, Part-of-Speech Tagging, Parsing/Syntactic Analysis, Semantic Analysis, and Word Sense Disambiguation. Information Extraction, Sentiment Analysis.

Suggested Activities:

- Study of wordnet
- Basics of sentiment analysis

Suggested Evaluation Methods:

- Assignment on NLTK

UNIT III	BUILDING A CHATBOT / CONVERSATIONAL AI SYSTEMS	9

Fundamentals of Conversational Systems (NLU, DM, and NLG) - Chatbot framework & Architecture, Conversational Flow & Design, Intent Classification (Machine learning and Deep Learning based techniques), Dialogue Management Strategies, Natural Language Generation. UX design, APIs and SDKs, Usage of Conversational Design Tools. Introduction to popular chatbot frameworks – Google Dialog flow, Microsoft Bot Framework, Amazon Lex, RASA Channels: Facebook Messenger, Google Home, Alexa, WhatsApp, Custom Apps. Overview of CE Testing techniques, A/B Testing, Introduction to Testing Frameworks - Botium /Mocha, Chai. Security & Compliance – Data Management, Storage, GDPR, PCI.

Suggested Activities:

- Design of chatbot

● Introduction to testing framework		
Suggested Evaluation Methods:		
● Quiz on chatbot design		
UNIT IV	**ROLE OF ML/AI IN CONVERSATIONAL TECHNOLOGIES AND CONTACT CENTERS**	**9**
Brief Understanding of how Conversational Systems use ML technologies in ASR, NLP, Advanced Dialog management, Language Translation, Emotion/Sentiment Analysis, Information extraction, Introduction to Contact centers – Impact & Terminologies. Case studies & Trends.		
Suggested Activities:		
● Discussion of ML in Chatbot		
Suggested Evaluation Methods:		
● Tutorial on role of Chatbots in call centres. ● Quiz		
UNIT V	**CONVERSATIONAL ANALYTICS**	**9**
Conversation Analytics: Need for analytics - Introduction to Conversational Metrics - Summary, Robots, and Sensory Applications overview - XR Technologies in Conversational Systems, XR-Commerce – Future trends.		
Suggested Activities:		
● Survey of conversation analysis ● Study of XR Commerce		
Suggested Evaluation Methods:		
● Survey of conversational metrics		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
Upon successful completion of the course, the student will be able to:		
CO 1.	Understand the fundamentals of conversational systems.	
CO 2.	Know the relevance of NLP and Chatbot Design.	
CO 3.	Understand the design and implementation of the Chatbot.	
CO 4.	Analyze the relationship between ML/AI in Chatbots.	
CO 5.	Know about the analytics of Chatbots	
TEXTBOOKS:		
1. Michael McTear, “Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots”, Second Edition, Moran and Claypool Publishers, 2020.		
REFERENCES:		
1. Cathy Pearl, “Designing Voice User Interfaces: Principles of Conversational Experiences”, O’Reilly, 2016.		

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	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**

IT23008	LARGE LANGUAGE MODELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the basics of Large language models
- Know about the LLM pretraining methods
- Understand the concept of tuning methods.
- Understand and apply prompt Engineering.
- Know about the evaluation methods for LLM.

UNIT I	BASICS OF MODERN LLMS	9

Language Models (LM) Basics – Overview of Language Models – Building blocks of Language Models - Language Models Architecture – Transformer Architecture- Encoders and Decoders – Attention Mechanisms – Attention is all You Need – Autoencoding Methods – Autoregression Methods – Seq2seq Tasks.

Suggested Activities:

- Turorials on Transformers.
- Problem solving in attention mechanisms.
- Group study on “Attention is all you need” paper.

Suggested Evaluation Methods:

- Quiz on fundamentals
- Assignments on attention mechanisms.

UNIT II	LLM PRETRAINING METHODS	9

Encoder-Decoder – Pretraining and Language Modeling – Autoregressive language modeling – Autoencoder language modeling – Early experiments with Encoder-Decoder – Masked Language Modeling – BERT Pretraining and Masked LM – LLM Pretraining Data – Processing clear texts – Scaling up of web data – Decoding Strategies.

Suggested Activities:

- Study of BERT
- Tutorials on autoregression methods.

Suggested Evaluation Methods:

- Assignment on NLTK

UNIT III	PARAMETER EFFICIENT TUNING METHODS	9

The basics of PETM include prefix tuning, Prompt tuning, Adapters, Compactors, Layer Freezing, Bias, Fine Tuning, Pruning, Reparameterization, Low-Rank Adaptation (LoRA), Advantages and Disadvantages, Explainability and LLMs, and Ethical Considerations.

Suggested Activities:

- Tutorials on tuning.
- External learning on LoRA

Suggested Evaluation Methods:

- Quiz on Tuning
- External discussion on Ethics of AI
- Study on Explainability.’

UNIT IV	PROMPT ENGINEERING	9

In-context learning – Fine-Tuning – Zero-Shot Learning – Few Shot Learning – Basics of Prompting – Instruction prompting – Chain of Thought prompting – Prompt Selection – Automatic Prompt design – Case Study – Visual Question and Answering system – Sentiment Training with multi-language dataset – CLIP, Learning Transferable Visual Models from natural language supervision.

Suggested Activities:

- Discussion of Prompt Engineering.
- Design on prompts

Suggested Evaluation Methods:

- Tutorial on QA systems
- External discussion on visual models.

UNIT V	GENERATION BASED AUTOMATIC EVALUATION METHODS	9

Evaluation – Human Evaluation – Intrinsic Vs Extrinsic evaluation- Ranking – Multiple Metrics – General Language Understanding Evaluation (GLUE) – Grammar Error Correction (GEM) – Beyond metrics – Human evaluation methods – RLHF – Extrinsic evaluation – Quantitative and Qualitative evaluation – Human annotation – Reporting – Challenges in evaluation – Evaluation metrics like accuracy, MAE, ranking Evaluation – Correlation Evaluation.

Suggested Activities:

- Survey of evaluation methods.
- Study of GLUE.

Suggested Evaluation Methods:

- Survey of evaluation methods.
- Quizz on evaluation methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Develop an understanding of the basics of Transformers and LLM Models.
CO 2.	Know about LLM pretraining Methods.
CO 3.	Know about Prompt Engineering.
CO 4.	Know about Prompt Engineering.
CO 5.	Know about Evaluation methods

TEXTBOOKS:

1. Ozdemir, Quick Start to Large Language Models: Strategies and Best practices for using ChatGPT and other LLMs, Addison Wesley, Pearson,2024
2. Thimura Amaratunga, Understanding Large Language Models Learning and their underlying concepts and technologies, Apress, 2023

REFERENCES:

1. Francois Chollet, “Deep Learning with Python,” Manning Publications, 2018.
2. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning,” MIT Press, 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	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**

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

IT23C14	BIO INFORMATICS	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.

TEXT BOOKS:

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)														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**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

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	PO1 0	PO1 1	PO1 2	PS O 1	PS O 2	PS O 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

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)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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

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**	**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

IT23011	COGNITIVE COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the fundamental principles and components of cognitive systems and their applications in various domains.
- Develop the skills to model cognitive systems at different levels of abstraction and build a comprehensive corpus for cognitive analysis.
- Gain proficiency in designing and developing ontologies and taxonomies for effective knowledge representation and reasoning.
- Learn evidence-based reasoning techniques and apply them to complex problem-solving tasks using cognitive systems.
- Explore emerging cognitive computing platforms and design cognitive applications for real life problems.

UNIT I | ***FOUNDATION OF COGNITIVE COMPUTING*** | **9**

Cognitive Computing - Uses of Cognitive Systems - Understanding Human Cognition – Understanding Complex Relationships between Systems- Modeling Cognitive Systems: Levels of Abstraction- Elements of a Cognitive System - Building the Corpus - Hypotheses Generation and Scoring - Evidence Extraction - Final Merging and Ranking.

Suggested Activities:

- Assign a pre-recorded lecture or readings on modeling cognitive systems and building the corpus. In the classroom, facilitate a discussion and problem-solving session.
- Organize a group discussion on hypotheses generation, evidence extraction, and final merging and ranking.
- Students create a mindmap illustrating the relationships between human cognition, cognitive systems, and their applications.

Suggested Evaluation Methods:

- Quiz covering key concepts such as uses of cognitive systems, human cognition, and elements of a cognitive system.
- Peer and instructor evaluation based on contribution to the discussion, clarity of arguments, and ability to synthesize information.
- Assessment based on completeness, accuracy, and creativity in representing the concepts in mindmap.

UNIT II | ***KNOWLEDGE REPRESENTATION*** | **9**

Developing a Cognitive System - Defining Taxonomies and Ontologies - Ontology Design and Development : Steps in Ontology Development- Domain Understanding and Concept Elicitation- Modeling based Ontology Specification – Ontology Maintenance- Models for Knowledge Representation - Semantic Web- Simple Trees - Importance of Persistence and State.

Suggested Activities:

- Assign readings or a lecture on ontology design and development. In class, discuss domain understanding, concept elicitation, and ontology maintenance.
- Facilitate a group discussion on the importance of persistence and state in cognitive systems.
- Students create a concept map on the steps involved in ontology development and models for knowledge representation.

Suggested Evaluation Methods:

- Quiz on defining taxonomies, ontologies, steps in ontology development, and models for knowledge representation
- Participation in the discussion and the ability to explain concepts clearly.
- Evaluation based on the depth of discussion, relevance of points raised, and overall group dynamics in concept map.

UNIT III | **HIGHER LEVEL COGNITION AND DESIGN PRINCIPLES** | **9**

Evidence-based Reasoning - Sample Evidence-based Reasoning Task Intelligence Analysis - Reasoning with Ontologies: Reduction and Synthesis Rules for Inference Engine- Evidence based Hypothesis Analysis- Rule and Ontology matching- Reasoning with Partially Learned Knowledge - Design Principles for Cognitive Assistants : Multi-agent and Multidomain Problem Solving - Knowledge Base

Structuring for Knowledge Reuse – Design based on a Complete Agent life cycle.

Suggested Activities:

- Assign readings or a lecture on reasoning with partially learned knowledge and knowledge base structuring. In class, facilitate problem-solving exercises.
- Organize a group discussion on multi-agent and multi-domain problem-solving using cognitive systems.
- Students build an ontology using Protege/ other equivalent software

Suggested Evaluation Methods:

- Conduct a quiz on evidence-based reasoning tasks, reasoning with ontologies, and principles for cognitive assistants.
- Assessment based on participation, problem-solving skills, and application of concepts.
- Programming evaluation for correctness

UNIT IV	**9**

Role of Cognitive Architecture – Desirable Characteristics – Core cognitive abilities – Design of Cognitive Architecture – Study of some popular Cognitive Architectures: Soar- Adaptive Control of Thought – Rational (ACT-R) architecture, Global Workspace, Learning Intelligent Distribution Agent (LIDA), BBD, Clarion, Intelligent Soft Arm Control (ISAC) architecture.

Suggested Activities:

- Assign a lecture or readings on the study of popular cognitive architectures. In class, facilitate a discussion comparing different architectures.
- Facilitate a group discussion on desirable characteristics and core cognitive abilities in cognitive architectures.
- Students create a concept map illustrating the design of a cognitive architecture and the core cognitive abilities required.

Suggested Evaluation Methods:

- Participation in the discussion, ability to compare and contrast architectures, and application of theoretical knowledge.
- Peer and instructor evaluation based on the relevance of points, depth of insight, and group interaction.
- Graded on accuracy, organization, and creativity in representing the architecture design of concept map.

UNIT V	**9**

Emerging Cognitive computing platforms- Building Cognitive applications: Defining Objectives- Domain and Attribute definition- Defining questions and exploring insights- Building Cognitive Systems in health care – Cognitive Computing in Government (building Smart cities) - Cognitive Assistant for visually impaired – Future applications for Cognitive Computing.

Suggested Activities:

- Assign readings or a lecture on cognitive computing in healthcare and smart cities. In class, facilitate a discussion on defining objectives and exploring insights.
- Organize a group discussion on future applications of cognitive computing, such as cognitive assistants for the visually impaired.
- Assign a written report on building a cognitive system for a specific domain (e.g., healthcare, government).

Suggested Evaluation Methods:

- Conduct a quiz on emerging cognitive computing platforms and building cognitive applications.
- Participation in the discussion and the ability to apply concepts to real-world scenarios.
- Graded on thoroughness, practicality, clarity, and depth of analysis in the assignment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the foundation concepts of cognitive computing.
CO 2.	Identify and design an ontology for the representation of knowledge and make an association with sematic web.

CO 3.	Understanding higher level cognition and design principles of Cognitive assistants.
CO 4.	Compare cognitive architectures using several criteria and design an outline cognitive architecture for a given application scenario.
CO 5.	Explore cognitive computing platforms and develop cognitive applications in various domains.

TEXTBOOKS:

1. D. Vernon, Artificial Cognitive Systems, MIT Press, 2014.
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley Publisher, First Edition, 2015, ISBN: 978-1-118-89662-4.
3. Tecuci, G., Marcu, D., Boicu, M., & Schum, D. A. (2016). *Knowledge engineering: building cognitive assistants for evidence-based reasoning*. Cambridge University Press.

REFERENCES:

1. Gliozzo, A., Ackerson, C., Bhattacharya, R., Goering, A., Jumba, A., Kim, S.Y., & Ribas, M. (2017). *Building cognitive applications with IBM Watson services: Volume 1 getting started*. IBM Redbooks.
2. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 1999.

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	2
CO2	2	3	2	2	2	-	-	-	-	-	-	-	2	2	2
CO3	2	2	2	3	2	-	-	-	-	-	-	-	3	3	3
CO4	2	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3
AVG	***2.2***	***2.4***	***2.4***	***2.6***	***2.2***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	***2.6***	***2.6***	***2.6***

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

IT23012	AUTONOMOUS GROUND VEHICLE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of autonomous driving systems and UAVs.
- To study the different ways of sensing internal states of Autonomous Ground Vehicles (AGVs).
- To learn the environment perception for autonomous driving.
- To explore the navigation techniques of AGVs.
- To learn the fundamentals of vehicle control systems and connected vehicles.

UNIT I | INTRODUCTION TO AUTONOMOUS DRIVING | 9

Autonomous Driving Technologies Overview – Autonomous Driving Algorithms –Autonomous Driving Client System – Autonomous Driving Cloud Platform – Components of autonomy – Difference between Unmanned and Autonomous Vehicles – Introduction to Unmanned Aerial Vehicles (UAVs) – History of UAVs – Classification: scale, lift generation method – Applications: Military, Government and Civil, Application of CARLA simulator in AGVs

Suggested Activities:

- Simulation of Autonomous Ground Vehicles using CARLA Simulator.
- External learning - Building blocks of typical Unmanned Aerial Vehicles.
- External learning - Applications of autonomous vehicles (aerial, under water, ground vehicles).
- Assignment on the design requirement specifications of autonomous vehicles (aerial, under water, ground vehicles).

Suggested Evaluation Methods:

- Viva voce on assignment topics.
- Quizzes on Advanced Driver Assistance Systems (ADAS).
- Group Discussion on Google's self-driving car.

UNIT II | SENSORS FOR AUTONOMOUS GROUND VEHICLES | 9

Sensor Characteristics –Vehicle Internal State Sensing: OEM Vehicle Sensors, GPS, Inertial Measurements, Magnetometer – External World Sensing: RADAR, Lidar, Image Processing Sensors, IMU sensor for Raspberry Pi, Jetson.

Suggested Activities:

- Flipped Classroom on sensor characteristics.
- External learning - Working principle of IMU/GPS/RADAR sensors.
- External learning - Exploring Velodyne Lidar sensor dataset in Veloview software.

Suggested Evaluation Methods:

- Practical - Experiments on interfacing IMU sensor to Raspberry Pi board and recording the acceleration of a dummy vehicle.
- Practical - Experiments on interfacing Lidar/RADAR sensor to Raspberry Pi board and recording the distances to the nearby objects.
- Practical - Experiments on interfacing camera to Raspberry Pi board and capturing images/videos

UNIT III | ENVIRONMENT PERCEPTION AND MODELING | 9

Road Recognition: Basic Mean Shift Algorithm, Mean Shift Clustering, Mean Shift Segmentation, Mean Shift Tracking, Road Recognition Algorithm –Vehicle Detection and Tracking: Generating ROIs, Multi Resolution Vehicle Hypothesis, Vehicle Validation using Gabor Features and SVM, Boosted Gabor Features – Multiple Sensor Based Multiple Object Tracking.

Suggested Activities:

- Setting CARLA simulator for obstacle detection and moving objects.
- External learning - A* algorithm, YOLO V4.
- Flipped classroom on vehicle tracking

Suggested Evaluation Methods:

- Practical - Implementation of Mean Shift Clustering / Mean Shift Segmentation Algorithm.
- Practical - Experiments on stationary obstacle detection algorithm using Lidar sensor.

UNIT IV | NAVIGATION FUNDAMENTALS | 9

Introduction – Navigation: GNSS Overview, GPS, GLONASS, Galileo, Compass – Inertial Navigation Overview: Inertial Sensor Technology – GNSS/INS Integration Overview – Case Study on Kalman

Filtering.

Suggested Activities:

- Simulation of Navigation control using GPS in CARLA Simulator
- Flipped classroom on GPS orbits/GPS Signals.
- External learning - Indian Regional Navigation Satellite System (IRNSS).
- Assignment on the working principles of Google Map.

Suggested Evaluation Methods:

- Quizzes on GNSS signal structure.
- Viva Voce on assignment topics.
- Practical - Simulation of Waypoint Navigation Algorithm

UNIT V	**VEHICLE CONTROL AND CONNECTED VEHICLE**	**9**

Vehicle Control: Cruise Control, Antilock Brake Systems, Steering Control and Lane Following, Parking – Connected Vehicles: Vehicle to Vehicle Communication, Vehicle to Infrastructure Communication, Device to Device Communication, Security for Autonomous Ground Vehicles.

Suggested Activities:

- Simulation of Collision avoidance using CARLA.
- External learning - Study on proportional integral derivative (PID) control.
- Assignment - Communication protocols for connected vehicles

Suggested Evaluation Methods:

- Viva Voce on assignment topic.
- Practical - Experiment on simple velocity control.
- Practical - Experiment on simple longitudinal motion control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Identify the requirements and design challenges of AGVs.
CO 2.	Select suitable sensors to sense the internal state and external world of AGVs
CO 3.	Implement lane detection, road detection & vehicle detection algorithms
CO 4.	Simulate/implement ground vehicle navigation and control algorithms
CO 5.	Design communication protocols for connected vehicles

TEXTBOOKS:

1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems”, Morgan & Claypool, 2018
2. A. R. Jha, “ Theory, design and applications of Unmanned Aerial Vehicles”, 2016

REFERENCES:

1. Umit Ozguner, Tankut Acarman, Keith Redmill, “Autonomous Ground Vehicles”, Artech House, 2011.
2. Hong Cheng, “Autonomous Intelligent Vehicles Theory, Algorithms, and Implementation”, Springer, 2011.
3. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, “Global Navigation Satellite Systems, Inertial Navigation, and Integration”, Third Edition, John Wiley & Sons, 2013
4. Kenzo Nonami, Muljiowidodo Kartidjo, “Autonomous Control Systems and Vehicles”, Intelligent Unmanned Systems, Springer, 2013.
5. Anthony Finn, Steve Scheding, “Development and challenges for Autonomous Unmanned Vehicles”, A compendium, Springer, 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	**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**
CO6	**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

IT23013	ROBOTIC PROCESS AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the basic concepts of RPA, where it can be applied and how it's implemented.
- To explore about RPA platforms and UiPath.
- To learn about different types of variables, Control Flow and data manipulation techniques.
- To identify and understand Image, Text and Data Tables Automation.
- To learn about how to handle the User Events and various types of Exceptions and strategies.

UNIT I | RPA FOUNDATIONS | 9

Emergence of Robotic Process Automation – Flavors of RPA – History of RPA – The Benefits of RPA – The Downsides of RPA – RPA Compared to BPO, BPM and BPA – Consumer Willingness for Automation – The Workforce of the Future – RPA Skills – AI-Cognitive Automation.

Suggested Activities:

- RPA process mapping - Identify and flowchart a repetitive task in daily lives for automation.
- RPA tool comparison - Research and present on three RPA tools for a business scenario.

Suggested Evaluation Methods:

- Open discussion about RPA cocepts.
- Quiz on RPA foundations.

UNIT II | RPA PLATFORMS | 9

Components of RPA – RPA Platforms – About UiPath – The Future of Automation – Record and Play – Downloading and Installing UiPath Studio – Learning UiPath Studio – User Interface – Task Recorder – Advanced UI Interactions - Example using the Recorder – Emptying trash in Gmail – Emptying Recycle Bin – Web Scraping.

Suggested Activities:

- Practical Learning: UiPath Studio installation - Download and set up UiPath Studio on personal computers.
- UiPath Studio tutorial completion - Work through UiPath's official "Introduction to RPA Developer Role" course on UiPath Academy
- Practical Learning: Web scraping project - Create an automation to extract data from a specific website and save it to a CSV file using UiPath

Suggested Evaluation Methods:

- Evaluation of UiPath Studio installation.
- Quiz on RPA platforms.
- Assignment: Identify processes that can be automated.

UNIT III | SEQUENCE, FLOWCHART, AND CONTROL FLOW | 9

Sequencing the Workflow – Activities – Control Flow: Types of loops, and Decision Making – Example using Sequence and Flowchart – Example using Sequence and Control Flow – Data Manipulation – Variables and Scope – Collections – Arguments –Data Table Usage – Clipboard management – File operation – CSV/Excel to data table and vice versa.

Suggested Activities:

- Flowchart creation - Design a flowchart for a common business process using standard symbols and shapes.
- Data manipulation exercise - Create a workflow that reads data from a CSV file, manipulates it using variables and collections, and writes the results to an Excel file..

Suggested Evaluation Methods:

- Assignment on flowchart creation.
- Quiz on Data Manipulations.

UNIT IV | TAKING CONTROL OF THE CONTROLS | 9

Finding and Attaching windows – Finding the Control – Techniques for Waiting for a Control – Act on Controls – Mouse and Keyboard Activities – Working with UiExplorer – Handling Events – App Integration – Recorder – Screen Scraping – Selector – Workflow Activities – Recording Mouse and Keyboard Actions – Scraping Data from Website and Writing to CSV – Process Mining.

Suggested Activities:

- Window manipulation exercise - Create an RPA workflow that opens multiple applications, resizes and positions their windows, and performs actions across them.
- OCR implementation project - Develop an RPA bot that extracts text from images or scanned documents using different OCR techniques, comparing their accuracy and performance.

Suggested Evaluation Methods:

- Evaluation of Window manipulation exercise.
- Project evaluation: OCR implementation.

UNIT V	**EXCEPTION HANDLING**	**9**

Exception Handling, Debugging and Logging – Exception handling – Common Exceptions – Ways to Handle – Logging and Taking Screenshots – Debugging Techniques – Collecting Crash Dumps – Error Reporting – Deploying and Managing Bot – Future of RPA.

Suggested Activities:

- Exception simulation exercise - Create an RPA workflow that intentionally triggers different types of common exceptions, then implement appropriate exception handling for each case.
- Future of RPA research presentation - present on emerging trends and technologies in RPA.

Suggested Evaluation Methods:

- Quiz on Exception handling.
- Tutorial on future of RPA.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Enunciate the key distinctions between RPA and existing automation techniques and platforms.
CO 2.	Understand RPA components and RPA platforms.
CO 3.	Use UiPath to design control flows and workflows for the target process and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.
CO 4.	Implement recording, web scraping and process mining by automation.
CO 5.	Use UIPath Studio to detect, and handle exceptions in automation processes.

TEXTBOOKS:

1.Tom Taulli, “The Robotic Process Automation Handbook : A Guide to Implementing RPA Systems”, Apress, 2020.
2 Alok Mani Tripathi, “Learning Robotic Process Automation”, Packt Publishing, 2018.

REFERENCES:

1. Frank Casale , Rebecca Dilla, Heidi Jaynes , Lauren Livingston, “Introduction to Robotic Process Automation: a Primer”, Institute of Robotic Process Automation, First Edition, 2015.
2. Richard Murdoch, “Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant”, 2018.
3. Srikanth Merianda & Kiwa K, “Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation”, Consulting Opportunity Holdings Llc; First edition, 2018.
4. AGerardus Blokdyk, “Robotic Process Automation RPA A Complete Guide“, 5STARCooks, 2019.
5. https://www.uipath.com/rpa/robotic-process-automation

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	-	2	1	1	3	3	3	3
CO2	3	3	3	3	3	1	1	-	2	1	1	3	3	3	3
CO3	3	3	3	3	3	1	1	1	2	1	1	3	3	3	3
CO4	3	3	3	3	3	1	1	1	2	1	1	3	3	3	3

CO5	3	3	3	3	3	1	1	1	2	1	1	3	3	3	3
CO6	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**3**	**3**	**3**	**3**
AVG	3	3	3	3	3	1	1	-	2	1	1	3	3	3	3

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

IT23014	ADVANCED DATABASES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To study the working principles of distributed databases.
To understand the basics of spatial, active and temporal databases.
To learn the fundamentals of data modeling and design in NoSQL Databases.
To learn emerging databases such as XML and Data warehouse.
To have an introductory knowledge about the query processing in object-based databases and its usage.

UNIT I DISTRIBUTED DATABASES **9**

Distributed Systems – Introduction – Architecture – Distributed Database Concepts – Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing.

Suggested Activities:

- Practical - Design of distributed database with fragmentation using any DBMS.
- Flipped classroom on distributed transaction protocols.
- Writing distributed queries

Suggested Evaluation Methods:

- Evaluation of designed Distributed Database system.
- Quizzes on distributed transactions.
- Tutorials on distributed queries

UNIT II ADVANCED DATABASES **9**

Spatial Databases- Spatial Data Types, Spatial Relationships, Spatial Data Structures, Spatial data Indexing and Access Methods – Active Databases – Languages for rule specification: Events, Conditions, Actions Temporal Databases -Time ontology, structure, and granularity, Temporal data models, Temporal relational algebras.

Suggested Activities:

- Individual/group activities for application specific data handling.
- Discussion about advantages and drawbacks of transaction models for different applications involving spatial-temporal data.

Suggested Evaluation Methods:

- Tutorials on advanced databases.
- Assignments on spatial databases.
- Quizzes

UNIT III NoSQL DATABASES **9**

NoSQL Concepts – Aggregate Data Model –Document, Key-value pair, Column Family, Graph - CAP Theorem – Document based – MongoDB Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment – HIVE: Data types, Database Operations, Partitioning – HiveQL- – Column Based-Cassandra: Data Model, Key Space, Table Operations, CRUD Operations, CQL Types– Bigtable : HyperTable- Architecture- CRUD operation.

Suggested Activities:

- Exploring MongoDB using JAVA/Python/Ruby/PHP.
- Perform Database Operations using MongoDB/Cassandra/HIVE.
- Scenario based query development for database applications.

Suggested Evaluation Methods:

- Evaluation of the database operations.
- Tutorial on scenarios to analyze the need for DB in various applications.
  Quizzes on query language features

UNIT IV XML AND DATAWAREHOUSE **9**

XML Database: XML – XML Schema – XML DOM and SAX Parsers – XSL – XSLT – XPath and XQuery – JSON and BSON– Polymorphic Schemas - Data Warehouse: Introduction – Multidimensional Data Modeling – Star and Snowflake Schema – Architecture – OLAP Operations and Queries

Suggested Activities:

- Flipped classroom on demonstrate the operations on XML data and data warehouse.

- Practical - Use tools to solve data access scenarios.

Suggested Evaluation Methods:

- Assignments on XML parsers, XSL and XQuery.
- Demonstration and presentation of the practical assignments

UNIT V	**GRAPH DATABASE**	**9**

Introduction to Graph Databases – The Power of Graph Databases – Data Modeling with Graphs – Querying Graphs – Introduction to Cypher – CQL Clauses – Write Clause – Read Clause – General Clauses – CQL Functions- Multi model database - OrientDB Graph database – OrientDB Features.

Suggested Activities:

Flipped classroom on queries in Graph database.

Suggested Evaluation Methods:

Practical demonstration on IR Queries. Quizzes on IR frameworks and related tools

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Design a distributed database system and execute distributed queries.
CO 2.	Create real time applications using Spatial, Temporal and active databases.
CO 3.	Use NoSQL database systems and manipulate the data associated with it.
CO 4.	Design XML database systems and validating with XML schema and apply OLAP operations.
CO 5.	Have knowledge of developing applications using Graph Database and develop a multi model database.

TEXTBOOKS:

1. M. Tamer Ozsu and Patrick Valduriez, “Principles of Distributed Database Systems”, Second Edition, Person Education Asia, 2020.
2. Dan McCreary and Ann Kelly,”Making Sense of NoSQL”, Manning Publication, 2014.
3. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Sixth Edition, McGraw Hill, 2011.
4. Albert K.W. Yeung, G. Brent Hall,” Spatial Database Systems: Design, Implementation and Project Management”, Springer, 2007.
5. Ian Robinson, Jim Webber and Emil Eifrem, "Graph Databases”, O’Reilly Media, Second Edition, 2015

REFERENCES:

1. C. J. Date, A. Kannan, S. Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
2. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Seventh Edition,Pearson Education/Addison Wesley, 2017.
3. Jiawei Han, Micheline Kamber , Jian Pei, “Data Mining: Concepts and Techniques”, Third Edition, Morgan Kaufmann, 2012
4. Shashi Shekhar and Sanjay Chawla,”Spatial Databases: A Tour”, Prentice Hall, 2003.

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	3	-	-	-	2	3	2	3	3	3	3
CO2	3	3	2	2	3	-	-	-	2	3	2	3	3	3	3
CO3	3	3	2	2	3	-	-	-	1	3	2	3	2	3	3
CO4	3	3	2	2	3	-	-	-	2	3	2	3	3	3	3
CO5	3	3	2	2	3	-	-	-	2	3	2	3	3	3	3
AVG	3	3	2	2	3	-	-	-	2	3	2	3	3	3	3

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

IT23015	DATA WAREHOUSING AND MINING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get exposed to the concepts of data warehousing architecture and implementation.
- To conceptualize data mining and the need for pre-processing and to analyze the mining techniques for realistic data
- To characterize the kinds of patterns that can be discovered by association rule mining.
- To implement classification and clustering techniques on large datasets.
- To identify business applications and trends of data mining.

UNIT I	DATA WAREHOUSE	9

Data Warehousing – Operational Database Systems versus Data Warehouses – Multidimensional Data Model – Schemas for Multidimensional Databases – OLAP operations – Data Warehouse Architecture – Indexing – OLAP queries & Tools.

Suggested Activities:

- Assignments on data warehouse modeling using a real time scenario.
- Assignment on describing the similarities and the differences of the multidimensional models and analyzing their advantages and disadvantages with regard to one another.
- Practical - Implementing various OLAP operations on a multidimensional data.
- Practical - Execute multidimensional data model using SQL queries.
- Discussion on the advantages of indexing structures.

Suggested Evaluation Methods:

- Tutorial - Case study on OLAP schema level representation and OLAP operations.
- Assignment on OLAP operations and schema level representation.
- Tutorial - Building a data warehouse using open source tools such as Talend.

UNIT II	DATA MINING & DATA PREPROCESSING	9

Introduction to KDD Process – Knowledge Discovery from Databases – Need for Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation.

Suggested Activities:

- Discussion on knowledge discovery database.
- Assignments on numerical problems on smoothing, normalization and attribute subset selection.
- Evaluate attribute relevance analysis on a real time application data warehouse.
- Evaluate information gain of an attribute in a real time database.

Suggested Evaluation Methods:

- Tutorial - Data cleaning and data transformation.
- Assignments on data integration and transformation.
- Assignment on data reduction and data discretization. Quizzes on data preprocessing

UNIT III	ASSOCIATION RULE MINING	9

Introduction – Data Mining Functionalities – Association Rule Mining – Mining Frequent Item sets with and without Candidate Generation – Mining various Kinds of Association Rules – Constraint – Based Association Mining.

Suggested Activities:

- Discussion and problem solving of different association rule mining algorithms (Apriori algorithms and FP-Growth algorithms).
- Practical - Implementation of association rule mining using Data mining tools such as Weka.
- Practical - Comparing the performance of each algorithm with various kinds of large data sets

Suggested Evaluation Methods:

- Quizzes on different classification methods.
- Tutorial - Accuracy and error measures different classification methods.
- Assignment on support vector machines.

UNIT IV	CLASSIFICATION & PREDICTION	9

Classification versus Prediction – Data Preparation for Classification and Prediction – Classification by Decision Tree – Bayesian Classification – Rule Based Classification – Classification by Back Propagation

– Support Vector Machines – Associative Classification – Lazy Learners – Prediction – Accuracy and Error Measures – Ensemble Methods – Model Section

Suggested Activities:

- Discussion on tree pruning.
- Assignments on calculation of the computational complexities and accuracy of the classification algorithms.
- Discussion on different real-time applications of classification and evaluating the accuracy of a classifier.
- Comparative study on different classification algorithms.

Suggested Evaluation Methods:

- Quizzes on different classification methods.
- Tutorial - Accuracy and error measures different classification methods.
- Assignment on support vector machines.

UNIT V	**CLUSTERING**	**9**

Cluster Analysis – Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical Methods – Density Based Methods – Grid Based Methods – Model Based Clustering Methods – Clustering High-Dimensional Data – Constraint Based Cluster Analysis – Outlier Analysis.

Suggested Activities:

- Comparative study on the various clustering algorithms.
- Discussion on real time applications of outlier analysis.
- Practical - Implementation of clustering algorithms using data mining tools.
- Practical - Design and implementation of a clustering method that finds clusters in large data cubes effectively and efficiently

Suggested Evaluation Methods:

- Quizzes different types of clustering methods.
- Tutorial - High-dimensional data clustering.
- Assignment on density based, grid based and model based clustering methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Design and maintain data warehouses.
CO 2.	Apply data mining techniques and methods to large data sets
CO 3.	Understand various mining techniques on complex data objects
CO 4.	Apply classification and Prediction methods in data mining.
CO 5.	Understand and apply clustering methods in data mining

TEXTBOOKS:

1. Jiawei Han, Micheline Kamber, “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2012.
2. K. P. Soman, Shyam Diwakar, V. Ajay, “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta, “Introduction to Data Min Data Mining with Case Studies”, Eastern Economy Edition, Prentice Hall of India, Third Edition, 2014.
4. Colleen Mccue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Second Edition, Elsevier, 2015

REFERENCES:

1. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2014.
2. Ian H. Witten, Eibe Frank, Mark A. Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Third Edition, Morgan Kaufmann, 2011.
3. George M. Marakas, “Modern Data Warehousing, Mining and Visualization: Core Concepts”, Prentice Hall, 2002.
4. Bruce Ratner, “Statistical and Machine Learning Data Mining: Techniques for Better Predictive

Modeling and Analysis of Big Data", Second Edition, CRC Press, 2012.

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**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	-	2	2	1	-	1	-	-	3	3	3	3
CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23016	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the cloud concepts and its models.
- To use virtual machines on Windows and Linux.
- To Deploy and manage Cloud infrastructure
- To understand the importance of Cloud security and storage services
- To understand DevOps in cloud and micro services

UNIT I	INTRODUCTION TO CLOUD COMPUTING	9

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 – Cloud Service Providers: Amazon Web Services-Microsoft Azure- Google Cloud Platform

Suggested Activities:

- Use Google Collaboration Tools: Create Google Docs, Sheets, and Slides and share it with others.
- Explore public cloud services like Amazon, Google, Sales force, and Digital Ocean etc

Suggested Evaluation Methods:

- Quiz on different architectural styles of cloud

. □ Report Submission - Comparison of various services provided by different Cloud Service Providers (Configuration of VM, Cost, Network Bandwidth etc.).

UNIT II	VIRTUALIZATION AND CONTAINERIZATION	9

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- Containers- Orchestrators of Containers -Docker- DevOps and continuous Integration.

Suggested Activities:

- Create Virtual machines and practice VM migration.
- Creation of RESTFUL Web services

Suggested Evaluation Methods:

- Report Submission - Comparison of various services provided by different Cloud Service Providers (Configuration of VM, Cost, Network Bandwidth etc.).

UNIT III	CLOUD INFRASTRUCTURE AND STORAGE	9

Physical Data Centers- Cloud infrastructure management tools- Virtual machines in Cloud- Networking infrastructure for cloud management and resource allocation- Load balancing and auto-scaling- Cloud Storage: Provisioning Cloud Storage – Managed and Unmanaged Cloud Storage – Cloud Backup Solutions – Cloud Storage Interoperability- Mobile Cloud: Mobile Market – Smartphones with the cloud – Mobile web services – Service types – Service Discovery.

Suggested Activities:

- Create a simple web service using Python Flask /Java /any language [Web service: Client-server model should be implemented using socket/http].
- Install Oracle Virtual Box/VMware Workstation and Create a chat application [Note: Launch two Virtual Machines for chat application]

Suggested Evaluation Methods:

- Demonstration and assessment of the implemented application

UNIT IV	CLOUD MANAGEMENT AND SECURITY	9

Resource Provisioning Methods – Inter Cloud Resource Management-Global exchange of Cloud resources- Cloud Management Products — Cloud Security: Overview – Security and Privacy Compliance and Governance– Access Control- Identity and Access Management- Vulnerability management- Security logging and Monitoring-Virtual Machine Security-Security Standards - Incident Response

Suggested Activities:

- Use security tools like ACUNETIX, ETTERCAP to scan web applications on the cloud, cloud networks for finding vulnerabilities, verifying leakage of information to an

unauthorized third party		
Suggested Evaluation Methods:		
● Report Submission - Generate a detailed report describing vulnerabilities along with the suitable action that can be taken to remedy the loopholes.		
UNIT V	**CLOUD SOFTWARE AND COMPUTING PLATFORMS**	**9**
Google App Engine (GAE) – Programming Environment for GAE – Architecture of GFS – Case Studies: Openstack, Heroku, and Docker Containers –Amazon EC2, AWS, Microsoft Azure, Google Compute Engine - DevOps Practices in Cloud- Infrastructure as Code –Micro services in Cloud applications.		
Suggested Activities:		
● Install and configure OpenStack all-in-one using Devstack/Packstack and Launch VMs in OpenStack through dashboard.		
Suggested Evaluation Methods:		
● OpenStack Dashboard should be accessed through web browser. Verify the working of instance by logging into it / pinging the instance.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
Upon successful completion of the course, the student will be able to:		
CO 1.	Understand the cloud concepts and its models.	
CO 2.	Use virtual machines on Windows and Linux	
CO 3.	Deploy and manage Cloud infrastructure	
CO 4.	Understand the importance of Cloud security and storage services	
CO 5.	Understand DevOps in cloud and micro services	
TEXTBOOKS:		
1. Buyya R., Broberg J., Goscinski A., “Cloud Computing: Principles and Paradigm”, John Wiley, 2011. 2. John W. Rittinghouse, James F. Ransome, “Cloud Computing: Implementation: Management and Security”, CRC Press, 2010.		
REFERENCES:		
1. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005. 2. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006.		

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	1	1	-	2	2	1	-	1	-	-	3	3	3	3
CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23017	FULL STACK DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the collaborative version control and Node applications
- To develop front end application using React
- To use Typescript in web applications
- To use Webpack for creating web applications
- To deploy applications through containers

UNIT I	SERVER SIDE ACTION	9

Node and NPM - Installation - Commands - Packaging – file system - http/ https - OS - Path - Process - - Node.js basics - Node Package Manager - Node.js Web server – Frameworks of Node.js - Collaborative version control system- git- Packaging using NPM.

Suggested Activities:

- Node and Express based web development Handling of various APIs associated with Node.js
- Node installation and packaging exercises using NPM.

Suggested Evaluation Methods:

- Programming exercise on Node.js based development
- Simple projects for specific use cases

UNIT II	CLIENT SIDE ACTION	9

ReactJS Introduction - React JSX - Understanding Components and Props – Props – React State – Component Lifecycle - React Hooks - Event Delegation - React Forms - React CSS - React Router - State Management with Redex – Async / await – Promises - Fetch API - Handling errors in React applications.

Suggested Activities:

- REACT based programming
- Exploring stateless components
- Designing components with React CSS and SaaS

Suggested Evaluation Methods:

- Programming exercise on REACT based component development
- Simple projects for specific use cases

UNIT III	TYPESCRIPT	9

Introduction to Typescript - Programming structures - Boolean - Arrays - Tuples - enum - function - Classes - Inheritance - Interfaces - Namespaces - Modules - Decorators - Debugging Typescript apps - Development of a web application with Typescript.

Suggested Activities:

- Use Typescript in Web applications.
- Practice exercises on Typescript concepts and JSX

Suggested Evaluation Methods:

- Quiz on Programming exercise on Typescript
- Simple projects for specific use cases

UNIT IV	WEBPACK	9

Introduction to Web pack - Dependency graph – Entry point – Output - Plugins – Loaders - Configurations- Modules – Module Resolution and Federation –Targets - Hot module replacement - The Manifest- Immediately Invoked Function Expressions(IIFE) - Automatic Dependency Collection - Under the Hood- REST Endpoint Creation and Use- Consuming REST API in React and Axios- Mailer App.

Suggested Activities:

- Setting up Webpack
- Creation of REST Endpoint

Suggested Evaluation Methods:

- Simple projects for specific use cases using Webpack

UNIT V	DEPLOYMENT THROUGH CONTAINERS	9

Containerization - Installation of Docker - Pulling Images - Creating Images – Image building practices- Deploying to Docker hub – Multi container App- Bind mounts - Docker Compose - Development and

deployment of js applications in Docker- Deployment and Orchestration: Kubernetes-Swarm- Cloud integrations

Suggested Activities:

- Practice exercises on Docker
- Containerization of web applications
- Multi container application using Docker Compose

Suggested Evaluation Methods:

- Demonstration and assessment of practice exercises on Docker and containerization

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the collaborative version control and Node applications
CO 2.	Develop front end application using React
CO 3.	Use Typescript in web applications.
CO 4.	Use Webpack for creating web applications
CO 5.	Deploy applications through containers

TEXTBOOKS:

1. **1.** Frank Zammetti, Modern Full-Stack Development Using TypeScript, React, Node.js, Webpack, and Docker, Apress, 2020
2. David Choi, Full-Stack React, TypeScript, and Node, Packt Publications, 2020.

REFERENCES:

1. Karl Seguin, “The Little Mongo DB Book”, https://github.com/karlseguin/the-littlemongodb-book.
2. Gareth Dwyer, “Flask by Example”, Packt Publishers, 2016.
3. https://aws.amazon.com/education/awseducate/
4. http://packaging.ubuntu.com/html/packaging-new-software.html
5. http://www.pyinstaller.org/
6. https://pypi.org/project/py2exe/0.9.2.0/

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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CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23018	C# AND .NET PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the technologies of the .NET framework.
- To cover all segments of programming in C# starting from the language basics, followed by the object oriented programming concepts.
- To update and enhance skills in writing Windows applications, ADO.NET and ASP .NET.
- To introduce advanced topics namely data connectivity, WPF, WCF and WPF with C# and .NET 4.5.
- To implement mobile applications using .Net compact framework.

UNIT I	C# LANGUAGE BASICS	9

.Net Architecture - Core C# - Variables - Data Types - Flow control - Objects and Types Classes and Structs – Inheritance - Generics - Arrays and Tuples - Operators and Casts - Indexers- Libraries - Assemblies - Shared Assemblies - CLR Hosting - Appdomains, Packages, and Nuget

Suggested Activities:

- Installation of .Net framework and experimenting simple C# programs using IDE.
- Flipped Classroom on CLR internals.
- Creation of shared assemblies.

Suggested Evaluation Methods:

-

UNIT II	C# ADVANCED FEATURES	9

Dependency Injection and Configuration – Reflection- Delegates - Lambdas - Lambda Expressions - Events - Event Publisher - Event Listener - Strings and Regular Expressions - Generics - Collections - Memory Management and Pointers - Errors and Exceptions – Reflection - Diagnostics Tasks - Metrics- Parallel Programming

Suggested Activities:

- Implementing delegates and handling events.
- Practical – Generic collections, memory management and exception handling

Suggested Evaluation Methods:

-

UNIT III	DATA MANIPULATION AND WEB BASED APPLICATIONS	9

Manipulating XML - SAX and DOM - Manipulating files and the Registry - Transactions - Data access with ADO.NET: Introduction, LINQ to Entities and the ADO.NET Entity Framework, Querying a Database with LINQ. Window Based Applications - Core ASP.NET - ASP.NET Web Forms - Server Controls, Data Binding - ASP.NET State Management - Tracing, Caching, Error Handling, Security, Deployment, User and Custom Controls

Suggested Activities:

- Implementation of Threads and Synchronization based application.
- Practical – Programs on XML and operations using parsers.
- Application development with ADO.NET.

Suggested Evaluation Methods:

-

UNIT IV	WPF AND WCF FOUNDATIONS	9

Introduction to Windows Presentation Foundation (WPF), Introduction to MVC Framework, Razor Pages and MVC - ASP.NET Core Blazor Progressive Web Application (PWA) - Windows Communication Foundation (WCF) - Introduction to Web Services - Microservices with .NET- Containers and Dockers - Architecting container and Micro Service-based Applications – Development Process for Docker Based Applications.

Suggested Activities:

- Practical – Programs using ASP.NET and State management controls.
- Flipped classroom on web services with .NET.
- Tutorials on WCF framework.

Suggested Evaluation Methods:		
●		
UNIT V	**WWF AND NETWORKING APPLICATIONS**	**9**
.Net Remoting - Windows Service – Windows Workflow Foundation (WWF) – Activities – Workflows - .Net Security - Localization - Peer-to-Peer Networking - Building P2P Applications – Signalr - Chat application - Testing and Debugging- Optimizing performance - Packaging and Deployment		
Suggested Activities:		
● Demonstration of programs using .Net Remoting and .net Security APIs. ● Demonstration of programs using .Net compact framework.		
Suggested Evaluation Methods:		
●		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Work with the basic features of C# language.
CO 2.	Create applications using advanced features of C# language
CO 3.	Create web applications using ADO.NET & ASP.NET
CO 4.	Implementation of WPF, WCF based applications
CO 5.	Develop WWF and Network applications

TEXTBOOKS:

1. Andrew Troelsen, Phil Japikse, " Pro C# 10 with .NET 6: Foundational Principles and Practices in Programming ", Apress publication, 2022.

REFERENCES:

1. Roger Ye,".NET MAUI Cross-Platform Application Development",Second Edition, Packt Publishing, O'Reilly,2024
2. Mark J. Price, "C# 12 and .NET 8 – Modern Cross-Platform Development Fundamentals: Start building websites and services with ASP.NET Core 8, Blazor, and EF Core 8", Eighth Edition, Packt Publishing, 2023
3. Christian Nagel," Professional C# and .NET ", Wiley, 2021
4. Abraham, Isaac. Get Programming with F#: A Guide for .NET Developers, Manning, 2018
5. https://dotnet.microsoft.com/en-us/download/e-book/microservices-architecture/pdf

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
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CO2	3	2	3	2	1	-	-	-	2	-	-	-	3	3	3
CO3	3	2	3	2	1	-	-	-	2	-	-	-	3	3	3
CO4	3	2	3	2	3	-	-	-	3	-	3	2	3	3	3
CO5	3	3	3	2	3	-	-	3	3	-	3	3	3	3	3
AVG	3	2	3	1.8	1.8	-	-	3	2.4	-	3	2.5	3	3	3

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

IT23019	ENTERPRISE APPLICATION DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand Java EE and work with JSF
- To develop Enterprise Java Bean applications
- To understand JSON Processing and create Web sockets
- To develop RESTful Web Service and implement JAX-RS and WS
- To design and Implement micro services in Java EE

UNIT I	INTRODUCTION TO JAVA ENTERPRISE EDITION (EE) AND JAVA SERVER FACES (JSF)	9

Concept and Overview of One standard, multiple implementations: Java EE, J2EE and the Spring framework - Java Server Faces: Introduction (JSF) - Custom data Validation - JSF Default messages- AJAX enabling JSF application- JSF HTML5 support- Injecting JSF artifacts- JSF Web Socket support - Additional JSF component libraries - Object Relational Mapping with the Java Persistence API.

Suggested Activities:

- Practice exercises on J2EE, JSF
- Use AJAX in JSF.
- Case Studies on Object Relational Mapping

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT II	ENTERPRISE JAVABEANS	9

Enterprise JavaBeans-Session Beans-Asynchronous method calls - Message-driven Beans-Transactions in enterprise Java Beans - Enterprise JavaBean life cycles-EJB timer service-EJB security - Contexts and Dependency Injection: Named Beans - Dependency injection – Qualifiers -Named bean scopes-CDI events

Suggested Activities:

- Implement Transactions using Enterprise Java Beans
- Use Dependency injection in EJB

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT III	JSON PROCESSING WITH JSON-P, JSON-B and WEB SOCKETS	9

The JSON-P Model API - The JSON-P Streaming API – JSON pointer - JSON Patch - Populating Java objects from JSON with JSON-B - Generating JSON strings from Java objects with JSON –B- Web Socket: Developing a Web Socket server endpoint and Web Socket clients- Java API for Web Socket

Suggested Activities:

- Create JSON-P objects ad strings for various web applications
- Create Web server socket endpoint for real time scenarios

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT IV	JAVA MESSAGING SERVICE AND WEB SERVICES WITH JAX	9

Message queues - Message topics - An introduction to RESTful Web Services and JAX-RS - Developing a simple RESTful Web Service - Developing a RESTful web service client - Query and path parameters - Server-sent events- Web Services with JAX-WS: Developing web services with JAX-WS - Exposing EJBs as web services.

Suggested Activities:

- Create RESTful Web Services.
- Practice exercises on JAX –RS and JAX-WS

Suggested Evaluation Methods:

- Demonstration of the implemented technologies

UNIT V	MICROSERVICES AND SERVLET DEVELOPMENT WITH JAVA EE	9

Micro services and Java EE - Developing micro services using Java EE- Servlet: Request forwarding and response redirection - Persisting application data across requests- Passing initialization parameters to a servlet via Annotations-Servlet filters and listeners - Configuring web applications Programmatically-

Asynchronous processing-HTTP/2 server push support.
Suggested Activities:
● Create Microservices using Java EE ● Create servlet code to configure web applications
Suggested Evaluation Methods:
● Demonstration of the implemented technologies
TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon successful completion of the course, the student will be able to:	
CO 1.	Understand Java EE and work with JSF
CO 2.	Develop Enterprise Java Bean applications
CO 3.	Understand JSON Processing and create Web sockets
CO 4.	Develop RESTful Web Service and implement JAX-RS and WS
CO 5.	Design and Implement micro services in Java EE

TEXTBOOKS:

1. Josh Juneau, Tarun Telang, " Java EE to Jakarta EE 10 Recipes" Apress, 2022.
2. David R.Heffelflnger, "Java EE 8 Application Development", First Edition, Packt Publishing, 2017.
3. Peter A. Pilgrim," Java EE 7 Developer Handbook "Packt Publishing, 2013.

REFERENCES:

1. Nicholas Williams," Professional Java for Web Applications", Wrox, 2014.
2. Deepak Vohra, "Java EE development with Eclipse", Packt Publishing, 2012.

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
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CO2	3	3	3	3	3	-	-	-	3	-	3	3	3	3	3
CO3	3	3	3	3	3	-	-	-	3	-	3	3	3	3	3
CO4	3	3	3	3	3	-	-	-	3	-	3	3	3	3	3
CO5	3	3	3	3	3	-	-	-	3	-	3	3	3	3	3
AVG	3	3	3	3	3	-	-	-	3	-	3	3	3	3	3

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

IT23020	SOFTWARE TESTING AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basics and necessity of software testing.
- To provide various testing techniques along with concepts of software bugs and its impact.
- To develop and validate a test plan.
- To build a testing team required.
- To understand the need for and challenges in test automation and to develop testing scripts.

UNIT I	TESTING PRINCIPLES AND AXIOMS	9

Testing as a Process – Testing Maturity Model- Testing Axioms –Software Testing Principles – Origins and Cost of Defects – Defect Classes and Examples –Developer/Tester Support of Developing a Defect Repository – Defect Analysis and Prevention Strategies.

Suggested Activities:

- Flipped classroom on testing axioms.
- Identify and analyze syntax error, semantic error, bug and defect for programs

Suggested Evaluation Methods:

- Quiz and discussion on testing axioms.
- Identifying fallacies in requirements specification.
- Identify the various types of errors, bugs and defects for a case study.

UNIT II	BLACK BOX, WHITE BOX TESTING AND TEST ADEQUACY	9

Test Case Design Strategies – Black Box Approach –Boundary Value Analysis – Equivalence Class Partitioning – Syntax testing - Finite State-Based Testing – User Documentation Testing –White Box Approach – Static Testing vs. Structural Testing – Code Functional Testing – Coverage and Control Flow Graphs – Covering Code Logic – Paths – Cyclomatic Complexity – Test Adequacy Criteria-Evaluating Test Adequacy Criteria.

Suggested Activities:

- Flipped classroom on test adequacy criteria.
- External learning – Exploring white box testing tools like veracode, eclemma, rcunit, cppunit, Junit, JSUnitetc.
- Analyzing the cyclomatic complexity of code segments.

Suggested Evaluation Methods:

- Quiz and discussion on cyclomatic complexity.
- Assignments on white box testing tools like Selenium, Appium, Robotium and carrying out simple BBT and WBT using tools.
- Solving problems related to cyclomatic complexity.

UNIT III	LEVELS OF TESTING	9

Unit Test Planning - Designing and Running the Unit Tests – Integration Test Planning – Scenario Testing – System Testing–Defect Bash Elimination System Testing- Acceptance Testing – Performance Testing – Regression Testing – Internationalization Testing – Ad-Hoc Testing – Alpha, Beta Tests.

Suggested Activities:

- External learning – Exploring the integration testing tools for various programming languages – VectorCAST/C++, CITRUS (Java), FitNesse (open source), Rational test integration tester, Protractor (Angular, Angular JS), Jasmine (JavaScript), Spock (Java) and the regression testing tools – Sahi Pro, Watir, IBM Rational Regression Tester, TestDrive etc.
- Flipped classroom on alpha and beta testing.
- Analyzing various levels of testing required for a software product.

Suggested Evaluation Methods:

- Assignments on integration testing tools and regression testing tools.
- Quiz and discussion on alpha and beta testing.
- Identifying and performing various levels of testing for a case study.

UNIT IV	TEST MANAGEMENT	9

Organization Structures for Testing Teams – Testing Services – Test Planning – Locating Test Items – Test Management – Reporting Test Results – The Role of Three Groups in Test Planning and Policy

Development – Introducing the Test Specialist – Skills Needed by a Test Specialist – Structure of Testing Group - Building a Testing Group.

Suggested Activities:

- Flipped classroom on reporting test results.
- External learning – Exploring the organization structures and organizational behaviour in the context of software testing.
- Analyzing how to build testing groups for various types of projects and organizations.

Suggested Evaluation Methods:

- Quiz and discussion on reporting test results.
- Finding out the organization structure and organizational behaviour for given case studies.
- Building test groups for given case studies.

UNIT V	**TEST AUTOMATION AND TOOLS**	**9**

Software Test Automation – Framework for test automation-Skill Needed for Automation – Scope of Automation – Generic Test Automation Architecture – Requirements & Criteria for Test Tool selection - Challenges in Automation – Test Metrics and Measurements – Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events-– Web Security testing tool: Vega - Functional testing in Cloud: Apache JMeter - CASE STUDY: Web Accessibility Testing, Disabled Object Verification Through Force.

Suggested Activities:

- Flipped classroom on Test metrics and measurements.
- External learning – Exploring the risks involved in automated testing and exploring the ways to improve your testing skills apart from using testing tools.
- Practical – Install and learn popular software testing tools like Selenium, WinRunner, LoadRunner, Performance Tester etc.
- Learning to write test scripts.

Suggested Evaluation Methods:

- Quiz and discussion on test metrics and measurements.
- Assignments on evaluating the risks involved in automated testing for given case studies.
- Assignments on w

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Obtain an insight into software testing
CO 2.	Apply both black box testing and white box testing
CO 3.	Understand and apply multiple levels of testing
CO 4.	Understand the role of a tester as an individual and as a team member.
CO 5.	Apply software testing for large projects using automated testing tools

TEXTBOOKS:

1. Jorgensen, Paul C. Software testing: a craftsman’s approach. Fifth edition, Auerbach Publications, 2021.
2. Srinivasan Desikan, Gopalaswamy Ramesh, “Software Testing – Principles and Practices”, Pearson Education, 2009.
3. Palani, N. Automated Software Testing with Cypress. Taylor & Francis. CRC Press, 2021.
4. Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" – Second Edition 2018.

REFERENCES:

1. Kossiakoff, A., Biemer, S. M., Seymour, S. J., & Flanigan, D. A. Systems engineering principles and practice. John Wiley & Sons. 2020.
2. Aniche, M. Effective Software Testing: A developer's guide. Simon and Schuster, 2022.
3. https://onlinecourses.nptel.ac.in/noc24_cs47 by By Prof. Rajib Mall | IIT Kharagpur
4. https://onlinecourses.nptel.ac.in/noc22_cs61 by By Prof. Meenakshi D'souza | IIIT Bangalore
5. Glenford J. Myers, Tom Badgett, Corey Sandler, “The Art of Software Testing”, Third Edition, John Wiley & Sons, 2012.
6. Satya Avasarala, Selenium WebDriver Practical Guide, 2014, Packet Publishing.

7. https://www.tutorialspoint.com/jmeter.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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CO4	2	3	3	3	3	1	1	-	3	-	1	2	3	3	3
CO5	3	3	3	3	3	1	-	1	3	-	3	3	3	3	3
AVG	2.8	2.6	2.4	2.6	2.8	1	1	1	3	-	1.4	2.5	3	3	3

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

IT23021	VIRTUALIZATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the significance of virtualization and role of hypervisor in virtual machines.
- To develop the skills to install, configure and manage virtual machines on desktop environment.
- To acquire knowledge about different virtualization storage technologies.
- To learn the concept of network virtualization and its optimization.
- To understand and deploy various applications within virtual environments.

UNIT I	INTRODUCTION	9

Importance of virtualization- virtualization software operation: virtualizing servers, virtualizing Desktops, virtualizing applications- Understanding Hypervisors: Types of hypervisor, role of hypervisor- understanding virtual machines-working with virtual machines.

Suggested Activities:

- Flipped Classroom – Overview of hypervisors and its role
- Practical – Setup and configure virtual machine using different virtualization software

Suggested Evaluation Methods:

- Group discussion on different types of virtualizations
- Quizzes on process virtual machines and system virtual machines

UNIT II	VIRTUAL MACHINES ON THE DESKTOP	9

VM types-Installing VM tools for windows and Linux-building windows VM and Linux VM-Managing VMs: backing up and modifying VM configurations, copying and moving VM workstation-VM CLI administration and keyboard shortcuts-monitoring and configuring VM performance.

Suggested Activities:

- Discussions on the process of installing VM tools for Windows and Linux.
- Practical – Modification of VM configurations, and copying/moving VMs between different environments

Suggested Evaluation Methods:

- Assess the proficiency in CLI tools and keyboard shortcuts
- Quiz on VM configurations and performance

UNIT III	VIRTUALIZE STORAGE	9

SCSI - FIbre channel – ISCSI- SAN backup and recovery techniques - RAID: The root for storage virtualization-SNIA shared storage Model-Applying SNIA shared storage model- Hierarchical storage management - virtual tape libraries.

Suggested Activities:

- Setup iSCSI Target and initiator in Linux
- Blended learning – SNIA storage model to design and configure virtual storage

Suggested Evaluation Methods:

- Discussions on RAID configurations and the concept of storage virtualization
- Quiz on SAN backup and recovery techniques

UNIT IV	NETWORKING VIRTUALIZATION	9

Managing networks for a virtual machine: understanding network virtualization, configuring VM network options, tuning practices for virtual networks-copying a virtual machine-managing additional devices in virtual machines.

Suggested Activities:

- Flipped classroom on concepts and importance of network virtualization
- Practical – Implement Virtual machine and manage networks for VM

Suggested Evaluation Methods:

- Assignment on network virtualization configuration and tuning practices
- Quiz on networking virtualization

UNIT V	APPLICATIONS	9

Understanding applications in a virtual machine: virtual infrastructure performance capabilities, deploying applications in a virtual environment, understanding virtual appliances and vApps, Open stack and containers.

Suggested Activities:

- Flipped classroom – Understand the concept of Openstack and containers
- Practical – Deploy an application in a virtual environment and understand the role of virtual appliances and vApps

Suggested Evaluation Methods:

- Review the work of creation, deployment and management of vApps
- Discussion on emerging trends and technologies in application virtualization

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Analyze the virtualization concepts and Hypervisor.
CO 2.	Create Virtual Machines on Windows and Linux.
CO 3.	Setup, Configure and manage virtual storage with RAID and Intelligent storage systems.
CO 4.	Manage networks for VM and additional devices in virtual machines.
CO 5.	Deploy applications in Virtual machine environments for real time applications.

TEXTBOOKS:

3. Matthew Portnoy, “virtualization essentials” Third edition, sybex 2023.
4. Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, APress, 2005.

REFERENCES:

6. James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005.
7. David Marshall, Wade A. Reynolds, “Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center”, Auerbach Publications, 2006.

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**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	-	2	2	1	-	1	-	-	3	3	3	3
CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23022	SERVERLESS COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of Serverless Computing and SDKs.
- To implement Serverless computing with AWS Lambda.
- To deploy Serverless applications on AWS
- To create Serverless Application on Microsoft Azure.
- To deploy Serverless applications on Google Cloud

UNIT I	INTRODUCTION	9

Serverless Computing: Serverless and event-driven collision-Function-as-a-Service (FaaS) –Benefits and Limitations - Comparison with Server based Computing - Development Environment, Tools : Visual Studio Code - Node.js – Postman - Serverless framework with Node.js and Core concepts - SDKs: AWS Node.js - Microsoft Azure Node.js - Google Cloud Node.js.

Suggested Activities:

- Practice exercises on Serverless framework with Node.js
- Use SDKs in Serverless computing

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT II	SERVERLESS COMPUTING WITH AWS LAMDA	9

AWS Serverless architecture and its component services- AWS Lambda & Serverless: Getting Started- Execution process - Tools to create & Test Lambda-based Applications- Configuring Options- Lambda function - Lambda function using AWS CLI- Lambda using AWS Cloud formation -AWS Lambda Use Cases – Securing AWS Lambda using IAM.

Suggested Activities:

- Explore tools to create AWS LAMBDA based applications
- Simple projects and use cases using AWS Lambda

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT III	SERVERLESS APPLICATION ON AWS	9

Triggers: API Gateway- Alexa- CloudFront - CloudWatch- CodeCommit – Cognito - AWS Config- Kinesis- S3- SNS - Event Bridge and Step Functions - Serverless Application Model (SAM): Creation of Serverless App - Deployment and Testing using SAM - Serverless Orchestration on AWS.

Suggested Activities:

- Practice exercises on Triggers and Serverless Application Model
- Creation of Serverless applications for real worl scenarios

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT IV	SERVERLESS COMPUTING ON MICROSOFT AZURE	9

AZURE: Functions and Configuration-Serverless platform-Azure Portal- Triggers and Bindings in Azure- Serverless Application: Creating HTTP Trigger based Function-Testing and managing Azure functions- Automation Script generation- Serverless App using Azure Function Core Tools - Testing and Deployment.

Suggested Activities:

- Explore tools to create Microsoft Azure based applications
- Simple projects and use cases using Azure

Suggested Evaluation Methods:

- Demonstration and assessment of implemented exercises

UNIT V	SERVERLESS APPLICATION ON GOOGLE CLOUD	9

Google Cloud Functions and App Engine- Serverless Platform: Google Cloud Console and Triggers- gCloud Serverless Application: Technical requirements-Creation-Testing and deployment of GL Server App- gCloud CLI- Reference architecture for a web App.

Suggested Activities:

- Explore tools to create Google Cloud based applications

● Simple projects and use cases using gCloud CLI
Suggested Evaluation Methods:
● Demonstration and assessment of implemented exercises
TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon successful completion of the course, the student will be able to:

CO 1.	Understand the basic concepts of Serverless Computing and SDKs.
CO 2.	Implement Serverless computing with AWS Lambda.
CO 3.	Deploy Serverless application on AWS.
CO 4.	Create Serverless Application on Microsoft Azure.
CO 5.	Deploy Serverless applications on Google Cloud.

TEXTBOOKS:

1. Kuldeep Chowhan," Hands-On Serverless Computing, Packt Publishing, 2018
2. Scott Patterson, "AWS Serverless Computing", Packt Publishing, 2019.
3. Miguel A. Calles, "Mastering AWS Serverless: Architecting, developing, and deploying serverless solutions on AWS", BPB Publication, 2024.

REFERENCES:

1. Rajalakshmi Krishnamurthi, Adarsh Kumar, Sukhpal Singh Gill, Rajkumar Buyya, " Serverless Computing: Principles and Paradigms", Lecture Notes on Data Engineering and Communications Technologies, Springer, 2023.
2. Maddie Stigler, "Beginning Serverless Computing", APress, 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	2	1	1	-	2	2	1	-	1	-	-	3	3	3	3
CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23023	SUSTAINABLE IT AND GREEN TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand sustainability, sustainable IT, and ESG drivers for IT practices.
- To explore sustainable practices in data centers and cloud computing.
- To understand sustainable software practices, green metrics, and energy-efficient techniques.
- To understand e-waste impacts, regulations, recycling techniques, and circular economy.
- To explore IT solutions for environmental monitoring and sustainable practices.

UNIT I INTRODUCTION TO SUSTAINABLE IT **7**

Definition and importance of sustainability - Sustainable IT- Sustainability in IT, sustainability by IT, and IT for society – Sustainable IT vs Green IT - Drivers for a sustainable IT - ESG considerations for IT - Building Blocks of a Sustainable IT Practice - Sustainable IT reference model.

Suggested Activities:

- Case Study on Sustainable IT Practices
- Comparison Report on Sustainable IT vs. Green IT
- Group Discussion on ESG Considerations for IT
- Workshop on Building Blocks of Sustainable IT Practice

Suggested Evaluation Methods:

- Quiz on Sustainable IT Concepts
- Presentation on Sustainable IT Reference Model

UNIT II ENERGY- EFFICIENT IT INFRASTRUCTURE **11**

Sustainable Data Centers - Sustainable IT benefits from cloud computing – Location - Energy consumption - Life cycle assessment - Choosing a sustainable cloud service provider - Cooling techniques and energy management - Energy-efficient network designs - Protocols and standards for green networking - Lifecycle analysis of IT hardware - Energy consumption from IT hardware - Energy consumption patterns.

Suggested Activities:

- Case Study on Choosing a Sustainable Cloud Service Provider
- Flipped classroom on Energy Consumption and Cooling Techniques

Suggested Evaluation Methods:

- Assignment on Sustainable IT Benefits from Cloud Computing
- Quiz on Energy Consumption and Cooling Techniques
- Group Project on Lifecycle Analysis of IT Hardware
- Presentation on Energy Consumption Patterns in IT Hardware

UNIT III SUSTAINABLE SOFTWARE DEVELOPMENT **11**

Sustainable Software: What, Why and How - Social and Individual Sustainability in SE - Choosing energy-efficient programming languages - Sustainable SDLC - Green Software Metrics - Energy consumption data analysis - Overview of Green AI - Large language models - Green data-centric AI - Model simplification - Hyper parameter tuning.

Suggested Activities:

- Flipped classroom on Social and Individual Sustainability in Software Engineering
- Case Study on Sustainable SDLC and Green Software Metrics
- Workshop on Hyperparameter Tuning for Energy Efficiency

Suggested Evaluation Methods:

- Assignment on Sustainable Software and Energy-Efficient Programming Languages
- Quiz on Social and Individual Sustainability in Software Engineering
- Presentation on Sustainable SDLC and Green Software Metrics

UNIT IV IT WASTE MANAGEMENT **7**

Types and sources of e-waste - Environmental and health impacts of e-waste - E-waste regulations and policies - Techniques for recycling IT equipment - Safe disposal methods - E-waste stream management - Concepts of circular economy - Role of IT in promoting circular economy.

Suggested Activities:

- Flipped classroom on Environmental and Health Impacts of E-Waste

- Case Study Analysis of E-Waste Regulations and Policies
- Group Discussion on Safe Disposal Methods
- Hands-On Workshop on Techniques for Recycling IT Equipment

Suggested Evaluation Methods:

- Quiz on Environmental and Health Impacts of E-Waste
- Presentation on the case studies and Role of IT in Promoting Circular Economy.

UNIT V	**IT FOR SUSTAINABILITY**	**9**

IT Solutions for Environmental Monitoring - Technologies for environmental data collection - Data analysis and visualization tools - Case studies on IT in environmental monitoring - IT for sustainable supply chain management - Green business process management.

Suggested Activities:

- Flipped classroom on Technologies for Environmental Data Collection
- Case Study Analysis on IT in Environmental Monitoring
- Group Discussion on Green Business Process Management

Suggested Evaluation Methods:

- Assignment on Technologies for Environmental Data Collection
- Quiz on Data Analysis and Visualization Tools
- Presentation on Green Business Process Management

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO6. Understand the key aspects of sustainable IT and evaluate the building blocks.
CO7. Assess and implement energy-efficient IT infrastructure.
CO8. Develop and evaluate sustainable software, green AI techniques and metrics during the SDLC.
CO9. Understand and manage IT waste recycling techniques and apply circular economy in IT.
CO10. Implement IT solutions for environmental monitoring, and sustainable business practices.

TEXTBOOKS:

1. Niklas Sundberg, “Sustainable IT Playbook for Technology Leaders: Design and implement sustainable IT practices and unlock sustainable business opportunities”, 2022.
2. Soli J. Arceivala, “Green Technologies: For a Better Future”, First Edition - Reprint, 2019.
3. San Murugesan And G.R. Gangadharan, “Harnessing Green IT: Principles and Practices”, First Edition, 2013.

REFERENCES:

3. Matthew N. O. Sadiku, “Emerging Green Technologies”, CRC Press, 2022.
4. Mike Halsey, The Green IT Guide: Ten Steps Toward Sustainable and Carbon-Neutral IT Infrastructure, Apress, 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	1	2	2	2	2	-	2	-	-	-	-	2	2	2	2
CO2	2	3	3	3	3	2	3	-	2	-	2	2	3	3	3
CO3	2	3	3	3	3	2	3	-	2	-	2	2	3	3	3
CO4	2	2	3	3	3	2	3	-	2	-	2	2	3	3	3
CO5	2	2	2	3	3	2	3	-	2	-	2	2	3	3	3
AVG	**1.8**	**2.4**	**2.6**	**2.8**	**2.8**	**2**	**2.8**	**-**	**2**	**-**	**2**	**2**	**2.8**	**2.8**	**2.8**

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

IT23024	GEOSPATIAL DATA ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand spatial data types, sources, models, formats, and georeferencing basics.
- To understand and analyze the representation of various geographic phenomena and dimensions.
- To learn stages of spatial data handling and spatial database management.
- To understand geostatistical analysis techniques, including spatial sampling, interpolation, network, and hotspot analysis.
- To gain skills in GIS visualization, cartography principles, map design, and interactive mapping techniques.

UNIT I	INTRODUCTION TO SPATIAL DATA	9

Introduction to spatial data analysis - Types of spatial data (point, line, polygon) - Sources of Spatial Data (satellite imagery, GPS, surveys) - Spatial Data Models (Vector, Raster & TIN), Structures (Regular & Irregular) & Formats (GeoJSON, GDB, Geo Package (GPKG) & Shape File) - Data Acquisition and Preprocessing – Data Quality - Coordinate Systems, Datums, and Map Projections - Georeferencing.

Suggested Activities:

- External learning on Spatial Data Models, Data Types and Sources
- Flip Classroom on Coordinate Systems
- Case Study on Data Acquisition and Preprocessing
- Hands-On Lab Exercise with GIS Software

Suggested Evaluation Methods:

- Assignment on Spatial Data Models
- Quiz on Data Types and Sources
- Group Project on Map Projections and Georeferencing

UNIT II	GEOGRAPHIC INFORMATION AND SPATIAL DATATYPES	9

Geographic phenomena – Types of geographic phenomena – Geographic fields – Geographic objects – Boundaries - Computer representation of geographic information – Regular tessellations – Irregular tessellations – Vector representations – Topology and Spatial relationships – Scale and Resolution – Representation of geographic fields – Representation of geographic objects – Temporal dimension.

Suggested Activities:

- External Learning on Geographic Phenomena and Representation
- Flip Classroom on Geographic Fields, Objects, and Boundaries
- Flip Classroom on Topology and Spatial Relationships
- Case Study on Tessellations and Scale Resolution

Suggested Evaluation Methods:

- Assignment on Geographic Phenomena and Representation.
- Quiz on Geographic Fields, Objects, and Boundaries
- Group Project on Temporal Dimension and Representation

UNIT III	SPATIAL DATA MANAGEMENT AND PROCESSING	9

Stages of spatial data handling – data capture and preparation – storage and maintenance – querying and analysis – data presentation - Spatial Database Management System (Postgresql, PostGIS, SpatiaLite, Data Ingestion, CRUD for geodata – Linking GIS and DBMS – Querying Spatial Data with SQL– Spatial mining for Big GIS.

Suggested Activities:

- External Learning on Data Handling Stages and Spatial Database Systems
- Flip Classroom on SQL Querying and Data Management
- Case Study on Spatial Mining and Big GIS

Suggested Evaluation Methods:

- Assignment on Data Handling Stages and Spatial Database Systems.
- Quiz on SQL Querying and Data Management
- Group Project on CRUD Operations and Data Presentation

UNIT IV	SPATIAL DATA ANALYSIS TECHNIQUES	9

Geostatistical Analysis – Introduction – Spatial Dependence Measures – Spatial Sampling & Point pattern

analysis – Overlay functions – Vector overlay operators – Raster overlay operators – Overlays using a decision table – Neighourhood functions – Proximity computations – Flow computation - Spatial Interpolation Methods (Kriging, Inverse Distance Weighting) - Network Analysis – Optimal path finding – Network Partitioning for Service area Analysis - Hotspot Analysis and Cluster Detection.

Suggested Activities:

- External Learning on Spatial Dependence Measures and Interpolation Methods
- Flip Classroom on Geostatistical Analysis Techniques
- Flip Classroom on Network Analysis and Path Finding
- Case Study on Spatial Mining and Big GIS

Suggested Evaluation Methods:

- Assignment on Spatial Dependence Measures and Interpolation Methods.
- Quiz on Geostatistical Analysis Techniques
- Group Project on Hotspot Analysis and Cluster Detection

UNIT V	**SPATIAL DATA VISUALIZATION**	**9**

GIS and Maps – Visualization process – Visualization strategies - Principles of Cartography and Map Design - Data Classification and Symbolization – Mapping qualitative, quantitative, terrain elevation and time series - Visualization Tools and Software (e.g., QGIS, ArcGIS) - Interactive Maps and Web Mapping - 3D Visualization Techniques – Map cosmetics – Map Dissemination.

Suggested Activities:

- External Learning on Cartography Principles and Map Design
- Flip Classroom on Interactive Maps and Web Mapping
- Case Study on 3D Visualization Techniques
- Hands-On Lab Exercise with GIS Visualization Tools

Suggested Evaluation Methods:

- Assignment on Cartography Principles and Map Design.
- Quiz on Interactive Maps and Web Mapping
- Group Project on Mapping Qualitative and Quantitative Data
- Presentation on Map Dissemination and Cosmetics

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO11. understand the basics of spatial data analysis.
CO12. analyze spatial relationships and their implications for scale and resolution
CO13. manage and query spatial databases, ensuring data integrity and quality.
CO14. apply spatial analysis techniques to analyze spatial data and derive meaningful insights.
CO15. create and interpret various types of maps using spatial visualization tools.

TEXTBOOKS:

1. Michael J De Smith, Michael F Goodchild, Paul a Longley, “Geospatial Analysis: A Comprehensive Guide”, Sixth Edition, 2024.
2. Robert P. Haining and David W. Rhind, “Spatial Data Analysis: Theory and Practice”, First Edition, 2020.
3. Otto Huisman and Rolf A.de By, “Principles of Geographic Information Systems”, Fourth Edition, 2009.

REFERENCES:

1. Peter A. Burrough, Rachael A. McDonnell, and Christopher D. Lloyd, “Principles of Geographic Information Systems, Third Edition, 2020.
2. Paul A. Zandbergen, Python Scripting for ArcGIS Pro, Second Edition, 2020.

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	-	-	-	-	-	2	2	2	2	2

CO2	2	3	2	2	2	-	-	-	-	-	-	2	2	2	2
CO3	2	3	3	3	3	-	-	-	3	-	-	2	3	2	3
CO4	2	3	3	3	3	-	-	-	3	-	2	2	3	2	3
CO5	2	3	3	2	3	-	-	-	-	-	2	2	2	2	2
AVG	**2**	**2.8**	**2.6**	**2.4**	**2.6**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2.4**	**2**	**2.4**

IT23025	SECURITY IN COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore the basics of security and cryptography
- To study about the methods and techniques to protect operating systems
- To learn the techniques to avoid the leakage of vital information from databases
- To understand the security issues and the solutions at network and web level
- To plan the security mechanisms required by information systems

UNIT I	SECURITY PRIMER	9

Threats – Harm – Vulnerabilities – Controls – Authentication: Biometrics, Tokens, Multifactor authentication and Federated identity management– Access Control: Procedure based and Role based – Cryptography: Private key and Public key – Certificates – Digital Signatures – Malicious code: Virus, Trojan horse, Worms and Technicalities of malwares– Countermeasures: For users and for developers

Suggested Activities:

- Develop programs for symmetric and asymmetric cryptographic techniques
- Explore the various biometric security schemes
- Differentiate encryption, authentication, authorization and digital signatures

Suggested Evaluation Methods:

- Assignments
- Quiz
- Surprise tests

UNIT II	OPERATING SYSTEMS SECURITY	9

Multiprogramming and shared use – Protected objects: Memory, Sharable I/O devices, Serially reusable I/O devices, Sharable programs and subprocedures – OS with self protection – OS with flexible usage of resources and security: Virtualization, Hypervisor, Sandbox, Honeypot and Fence and Base bound registers – Design level security: Layered design, Layered trust and Reference monitor – Trusted systems: TCB design and implementation

Suggested Activities:

- Explore the built in security mechanisms in popular operating systems
- Develop programs that implement base bound registers
- Differentiate honeypot, sandbox and fence

Suggested Evaluation Methods:

- Assignments
- Quiz
- Surprise tests

UNIT III	DATABASE SECURITY	9

Security requirements of a database: Auditability and Access Control – Reliability and Integrity: Two phase update – Concurrency and consistency – Database disclosure: Sensitivity, Types of disclosure – Exact data, bounds, Direct inference, Direct attack, Statistical measures – Preventing disclosure: Data suppression and modification – Perturbation techniques – Big data perspective in security

Suggested Activities:

- Develop programs to implement simple perturbation techniques
- Develop seemingly harmless queries that disclose confidential information
- Explore security issues related to big data

Suggested Evaluation Methods:

- Assignments
- Quiz
- Surprise tests

UNIT IV	NETWORK AND WEB SECURITY	9

Threats: Interception, Modification, Interruption, Port scanning – Denial of service – Traffic redirection and DNS attack – Distributed DoS – Bot, Botnet, Malicious autonomous mobile agents – Firewalls: Packet filtering gateway, Stateful inspection firewall and Application proxies – Browser attacks – Web attacks targeting users – Countermeasures: Preventing malicious web pages, Foiling data attacks – Email

attacks and Protecting against e-mail attacks

Suggested Activities:

- Work with various network administrative commands in Linux OS
- Develop programs to demonstrate and foil Denial of Service attack
- Differentiate flooding, denial of service attack and distributed denial of service attack

Suggested Evaluation Methods:

- Assignments
- Quiz
- Surprise tests

UNIT V	**SECURITY PLANNING AND RECENT TRENDS**	**9**

Security plans: Contents and team members – Business continuity planning: Assess business impact, Developing strategy and plan – Handling incidents: Incident response plans and Incident response teams – Risk analysis: Nature of risk, Steps of a risk analysis – Emerging topics: IoT security, Electronic voting, Cyber warfare – Research avenues: Information Security Breaches Survey (ISBS), Quantifying security, Impact on Economy

Suggested Activities:

- Develop a security plan for a medium sized organization
- Differentiate crime evidence and incidence response
- Explore emerging trends in cybersecurity

Suggested Evaluation Methods:

- Assignments
- Quiz
- Surprise tests

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the threats, vulnerabilities, attacks and countermeasures in computing systems
CO 2.	Design appropriate security measures for operating systems.
CO 3.	Implement countermeasure schemes to thwart attacks over DBMS.
CO 4.	Counter the threats faced by networks and the web.
CO 5.	Imbibe security plans and mitigation measures.

TEXTBOOKS:

1. Charles P Pfleeger, Shari Lawrence Pfleeger and Lizzie Coles-Kemp, “Security in Computing”, 6th Edition, Addision-Wesley Professional, 2023.

REFERENCES:

1. Ross J Anderson, “Security Engineering: A Guide to Building Dependable Distributed Systems”, 2nd edition, Wiley Publishing Inc., 2008
2. David Stuttard and Marcus Pinto, “The Web Application Hacker’s Handbook: Finding and Exploiting Security Flaws, 2nd edition, Wiley Publishing Inc., 2011
3. Matt Bishop, “Computer Security: Art and Science”, 2nd Edition, Addition Wesley Professional, 2018
4. Nick Selby and Heather Vescent, “Cyber Attack: Survival Manual”, Weldon Owen Illustrated Edition, 2017

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	-	-	2	3	-	2	-	-	-	2	3	3	3
CO2	2	3	3	2	3	2	-	1	2	2	-	2	3	3	3
CO3	2	3	3	2	3	2	-	1	2	2	-	2	3	3	3

CO4	2	3	3	2	3	2	-	1	2	2	-	2	3	3	3
CO5	1	3	3	3	2	2	-	1	3	3	2	2	3	3	3
AVG	**1.6**	**2.8**	**2.4**	**1.8**	**2.6**	**2.2**	**0**	**1.2**	**1.8**	**1.8**	**0.4**	**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)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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

IT23026	MOBILE COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basics of wireless communication and cellular networks.
- To study the popular cellular networking technologies.
- To explore various protocols that support mobility at network layer and transport layer.
- To understand the intricacies of UI required by mobile applications and the design aspects of mobile application.
- To study various mobile app development platforms and learn developing mobile applications.

UNIT I	WIRELESS TRANSMISSIONS	9

Frequencies for radio transmission – Signal propagation - Path loss of radio signals - Multi-path propagation -Multiplexing - Space division multiplexing - Frequency division multiplexing - Time division multiplexing - Code division multiplexing -Modulation - Amplitude shift keying - Frequency shift keying - Phase shift keying - Advanced frequency shift keying - Advanced phase shift keying - Spread spectrum - Direct sequence spread spectrum - Frequency hopping spread spectrum - Cellular systems

Suggested Activities:

- External learning - Performing a survey of popular mobile phones and exploring their configuration (performance in terms of processor core, clock speed, RAM), display (technology, screen size and resolution), camera features and battery features, LTESim and Players in 5G networks and exploring the structure and operation of a cell phone tower.
- Exploring frequency reuse and reuse factor in cellular network deployment.
- Flipped classroom on CDMA2000, WCDMA, HSPA, HSDPA, HSUPA and HSPA+.

Suggested Evaluation Methods:

- Assignments on features of modern mobile phones and structure and operation of a cell phone tower.
- Solving fr equency reuse relayed problems.
- Quiz and discussion on CDMA and its variants and HSPA and its variants.

UNIT II	MEDIUM ACCESS CONTROL	9

Motivation for a specialized MAC - Hidden and exposed terminals - Near and far terminals -SDMA - FDMA - TDMA - Fixed TDM - Classical Aloha - Slotted Aloha - Carrier sense multiple access - Demand assigned multiple access - PRMA packet reservation multiple access - Reservation TDMA - Multiple access with collision avoidance - Polling - Inhibit sense multiple access - CDMA - Spread Aloha multiple access.

Suggested Activities:

- External learning - Explore 5G networks.
- Flipped classroom on IP multimedia subsystem.
- Analysis and requirements of cellular networks.

Suggested Evaluation Methods:

- Assignments on 5G networks.
- Quiz and discussion on IP multimedia subsystem.
- Design a cellular network for the given case study

UNIT III	MOBILITY SUPPORT IN IP AND TCP	9

Mobile IP – Entities and terminology - IP packet delivery - Agent discovery - Registration - Tunneling and encapsulation - Optimizations - Reverse tunneling - IPv6 - IP within IP – Mobility Support in IPV6 – Mobility Header, Mobility Options -Dynamic Home Agent Address Discovery, Cache Management, Bidirectional Tunneling – TCP Over Wireless Networks – Indirect TCP –Snoop TCP – Mobile TCP- Fast retransmit/fast recovery - Transmission/time-out freezing - Selective retransmission

Suggested Activities:

- External learning - Performing a survey of popular wireless routers and exploring their configuration (Built in radio interfaces in terms of IEEE 802.11 and its variants, support for MU - MIMO technology, external antennas, clock speed of the processor,

data rate supported).
- Exploring the task list required to configure mobile IP and getting familiar with the networking operating system commands required to configure mobile IP.
- Flipped classroom on mobility support in IPv6.

Suggested Evaluation Methods:

- Assignments on features of wireless routers and their configuration.
- Configuring mobile IP using network operating system commands.
- Quiz and discussion on mobility support in IPv6.

UNIT IV	**APPLICATION DESIGN**	**9**

Aspects of Mobility – Middleware and Gateways – Mobile Devices and Profiles – Generic UI Development – Multimodal and Multichannel UI – Mobile Memory Management – Design Patterns for Limited Memory – Work Flow for Application Development – Techniques for Composing Applications – Dynamic Linking – Plug-ins and Rule of Thumb for Using DLLs – Concurrency and Resource Management

Suggested Activities:

- External learning - Exploring XForms processing model and location based services.
- Flipped classroom on GUI features supported in WAP, J2ME, BREW and Microsoft platforms.
- Analyzing problems in designing mobile applications where location and energy are the constraints.

Suggested Evaluation Methods:

- Assignments on XForms and location based services.
- Quiz and discussion on GUI features supported in WAP, J2ME, BREW and MS
- platforms.
- Designing and implementing location and energy constrained mobile applications.

UNIT V	**4G / 5G MOBILE NETWORKS**	**9**

4G LTE networks - From 4G to 5G - 5G overview - 5G Architecture – User equipment – Access networks - Mobile operator's core network - RAN and dynamic CRAN - Mobility management and Network slicing in 5G core – signaling - 5G mobile edge and fog computing - application

Suggested Activities:

- External learning - Compare the 5G network with older generations of networks.
- Flipped classroom on RAN and CRAN platforms.
- Analyzing problems in designing edge and fog computing.

Suggested Evaluation Methods:

- Assignments Historical Trends.
- Quiz and discussion on 5G mobile operators core network

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the architecture and protocols of cellular systems.
CO 2.	Understand the media accessing schemes in mobile computing.
CO 3.	Understand various network and transport layer protocols for mobility support.
CO 4.	Design applications for resource constrained mobile devices.
CO 5.	Understand 4G and 5G communication technologies.

TEXTBOOKS:

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson, 2009.
Afif Osseiran, J.F. Monserrat and Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.

REFERENCES:

1. Clint Smith and Daniel Collins, "Wireless Networks", Third Edition, McGraw Hill Publications, 2014.
2. Reza B'Far, "Mobile Computing principles", Cambridge University Press, 2005.
3. G. Aggelou, "Mobile Ad hoc Networks: From Wireless LANs to 4G Networks", McGraw-Hill Publications, 2009.

4. Asoke K Talukder, Hasan Ahmed and Roopa R Yavagal, “Mobile Computing: Technology Applications And Service Creation”, 2nd Edition, McGraw Hill Publications, 2017.
Murthy C. Siva Ram and Manoj B. S., “Ad Hoc Wireless Networks: Architectures and Protocols”, First Edition, Pearson Education, 2004.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**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	1	2	1	3	3	3	3	2	3	3
CO3	3	3	2	3	3	2	1	1	3	3	3	3	3	3	2
CO4	3	3	3	3	3	2	2	1	3	3	3	3	2	2	3
CO5	3	3	3	3	3	1	2	1	3	3	3	3	3	3	3
AVG	**2.8**	**2.6**	**2.8**	**2.8**	**3**	**1.6**	**1.6**	**1**	**3**	**3**	**3**	**3**	**2.4**	**2.8**	**2.8**

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)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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

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

IT23027	CYBER FORENSICS AND MALWARE ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Learn cybercrime and forensics
- Understand and apply forensics tools
- Learn to analyze and validate forensics data
- Understand cyber laws and the admissibility of evidence with case studies
- Learn the vulnerabilities in network infrastructure with ethical hacking

UNIT I	INTRODUCTION TO CYBER CRIME AND FORENSICS	9

Introduction to Traditional Computer Crime - Traditional problems associated with Computer Crime. Classification of Cyber Crime. The Present and future of Cybercrime - Cyber Forensics -Steps in Forensic Investigation - Forensic Examination Process - Types of CF techniques - Forensic duplication and investigation - Forensics Technology and Systems - Understanding Computer Investigation.

Suggested Activities:

- Survey of cyber crimes
- Study of Forensic process

Suggested Evaluation Methods:

- Quiz on Cyber crimes
- Study of Forensic tools.

UNIT II	EVIDENCE COLLECTION AND FORENSICS TOOLS	9

Processing Crime and Incident Scenes – Digital Evidence - Sources of Evidence -Working with File Systems. - Registry - Artifacts - Current Computer Forensics Tools: Software/ Hardware - Forensic Suite - Acquisition and Seizure of Evidence from Computers and Mobile Devices - Chain of Custody.

Suggested Activities:

- Survey of evidence collection mechanisms.
  Study of Forensic suits.

Suggested Evaluation Methods:

Quizz on Tools
Group discussion on digital evidences.

UNIT III	ANALYSIS AND CYBER LAWS	9

Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics - Analysis of Digital Evidence - Admissibility of Evidence - Cyber Laws in India - Case Studies

Suggested Activities:

Study on Cyber law in India
Flipped classrom for email investigarions
External learning on Cell phone and mobile forensics

Suggested Evaluation Methods:

- Quiz on hiding techniques
- Quizz on Registry and Linux Internals
- Extern discussion on Cyber laws.

UNIT IV	ETHICAL HACKING	9

Introduction to Ethical Hacking - Footprinting and Reconnaissance - Scanning Networks - Enumeration– Sniffing - Social Engineering - Denial of Service - Session Hijacking - Hacking Web servers - Hacking Web Applications – SQL Injection - Hacking Wireless Networks - Hacking Mobile Platforms.

Suggested Activities:

External discussion on network attacks.
External discussion of SQL Injections.

Suggested Evaluation Methods:

- Tutorial on attacks.
- Quizz on Network hacking.

UNIT V	**MALWARE THREATS**	**9**

System Hacking - Introduction to malware, Basic Static and Dynamic Analysis- Malware Behavior – malicious activities and techniques, Malware Countermeasures, Covert Launching and Execution

Suggested Activities:

- Survey of malware threats.
- Study of static and dynamic analysis

Suggested Evaluation Methods:

Quizz on malwares

Assignments on malware counter measures

Quizz on cover launching and execution plans.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the basics of cybercrime and computer forensics
CO 2.	Apply a number of different computer forensic tools to a given scenario
CO 3.	Analyzing and Admissibility of evidence in India with Cyber laws and Case Studies
CO 4.	Know about Ethical hacking in the context of cybercrime
CO 5.	Identification and mitigation of malwares in the system

TEXTBOOKS:

1. Dejey, S. Murugan, - Cyber Forensics, Oxford University Press, India, 2018
2. Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, Computer Forensics and Investigations‖, Cengage Learning, India Edition, 2016.
3. Michael Sikorski, Andrew Honig, “Practical Malware Analysis”, No Starch Press,2012

REFERENCES:

1.John R.Vacca, Computer Forensics‖, Cengage Learning, 2005.
2. MarjieT.Britz, Computer Forensics and Cyber Crime‖: An Introduction, 3rd Edition, Prentice Hall, 2013.
3. Ankit Fadia , Ethical Hacking, Second Edition, Macmillan India Ltd, 2006.

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**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	2	2	2	3	2	2	2	3	3	3	3
CO2	3	3	3	3	2	2	2	3	2	2	2	3	3	3	3
CO3	3	3	3	3	2	2	2	3	2	2	2	3	3	3	3
CO4	3	3	3	3	2	2	2	3	3	2	2	3	3	3	3
CO5	3	3	3	3	2	2	2	3	3	2	2	3	3	3	3
AVG	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2.4**	**2**	**2**	**3**	**3**	**3**	**3**

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**	**PO 10**	**PO 11**	**PO 12**	**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

IT23C13	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

IT23028	NEXT GENERATION WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of 5G internet.
- To understand the concept of small cells in 5G mobile networks.
- To learn the MAC layer protocol in 5G network context.
- To understand the role of cognitive radios in 5G networks.
- To learn the advances cellular networks and evolution of 6G.

UNIT I	5G INTERNET AND LEAP TO 6G	9

Historical Trend of Wireless Communications – Evolution of LTE Technology to Beyond 4G – 5G Roadmap – Ten Pillars of 5G – The 6G Vision – 6G Vertical Industries – Technologies enabling 6G – 6G for Industry 5.0 - Other 6G Considerations.

Suggested Activities:

- Assignment - Millimeter wave mobile communication.
- External learning - 5G in global level.

Suggested Evaluation Methods:

- Group Discussion - Different generations of telecommunication networks.
- Quiz – Spectrum allocation strategies for 5G.

UNIT II	5G SYSTEM, ARCHITECTURE AND MOBILE NETWORKS	9

5G System Concepts - Machine-Type Communication – Dynamic Radio Access -Basic RAN Architecture – High level and Functional Architecture 5G -- Introduction to Small Cells – Capacity Limits and Achievable Gains with Densification – Mobile Data Demand – Demand vs Capacity – Small Cell Challenges - Macrocell vs Small Vs Femtocell.

Suggested Activities:

- Flipped Classroom – Types of small cells.
- Assignment - Issues in femtocells.

Suggested Evaluation Methods:

- Viva Voce – on assignment topic.
- Quiz – Drawbacks of dense deployment of Wi-Fi systems.

UNIT III	COOPERATION FOR NEXT GENERATION WIRELESS NETWORKS	9

Cooperative Diversity and Relaying Strategies: Cooperation and Network Coding - Cooperative ARQ MAC Protocols – PHY Layer Impact on MAC Protocol Analysis – Overview of Cognitive Radio Technology in 5G Wireless – Spectrum Optimization using Cognitive Radio – Relevant Spectrum Optimization Literature in 5G.

Suggested Activities:

- External Learning – Cooperative MAC protocols.
- Assignment - Packet exchange in PRCSMA.

Suggested Evaluation Methods:

- Viva Voce – on Assignment topic.
- Quiz - NCCARQ operation under realistic channel conditions.
- Simulation – Assessing the performance of NC-aided MAC protocols in event-driven C++ simulator.

UNIT IV	NETWORKING TECHNIQUES AND APPLICATIONS FOR 5G NETWORK	9

5G RAN Architecture: C-RAN with NGFI- User-Centric Wireless Network for 5G - Energy Harvesting Based Green Heterogeneous Wireless Access for 5G -Resource Allocation for Cooperative D2D Communication Networks - Fog Computing and Its Applications in 5G - A Conceptual 5G Vehicular Networking -Communications Protocol Design for 5G Vehicular Networks -Next-Generation High-Efficiency WLAN -Shaping 5G for the Tactile Internet.

Suggested Activities:

- External learning – Network coding.
- Assignment – Spectrum optimization using cognitive radio.
- External Learning - Key Requirements and Challenges for 5G Cognitive Terminals.
- Assignment - Component of a cognitive radio terminal.

Suggested Evaluation Methods:

- Viva Voce – on assignment topics.
- Quiz – Carrier aggregation.

UNIT V	**TECHNOLOGICAL ASPECTS OF 6G**	**9**

6G Spectrum composition – mmWAVE - TeraHertz Communication-Network Slicing and Management - Beamforming Techniques - Aerial and satellite Components of 6G Networks - Underwater Communication Components of 6G Networks - 6G Networks-Radar Sensing - Imaging and Sensing-Localization - Other verticals 6G IoT.

Suggested Activities:

- External Learning - 7G communications system architecture.
- Flipped Classroom – intelligent cellular technology, issues and challenges in communication systems.
- Assignment – Industry 6.0 and Cellular network

Suggested Evaluation Methods:

- Viva Voce – on assignment topics.
- Group discussion - Attacks on cellular Access Network

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the concepts of the 5G network.
CO 2.	Identify suitable small cells for different applications in 5G networks.
CO 3.	Understand MAC protocols associated with 5G.
CO 4.	Understand the various applications in the 5G domain.
CO 5.	Understand the technological aspects of 6G.

TEXTBOOKS:

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.
2. Xie, Xianzhong, Bo Rong, and Michel Kadoch, eds. 6G wireless communications and mobile networking. Bentham Science Publishers, 2021.

REFERENCES:

1. Božanić, Mladen, and Saurabh Sinha, “Mobile Communication Networks: 5G and a Vision of 6G”, Springer, 2021.
2. Dahlman, Erik, Stefan Parkvall, and Johan Skold. 5G NR: The next generation wireless access technology. Academic Press, 2020
3. Saad Z. Asif, “5G Mobile Communications: Concepts and Technologies” First Edition, CRC Press, 2018.
4. Peterson, Larry, and Oğuz Sunay. 5G mobile networks: A systems approach. Morgan & Claypool Publishers, 2020.
5. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Prentice Hall, 2014. Osseiran, Afif, Jose F. Monserrat, and Patrick Marsch, eds. 5G mobile and wireless communications technology. Cambridge University Press, 2016.

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															
CO2															
CO3															
CO4															
CO5															
CO6															
AVG															

IT23029	PRIVACY AND SECURITY IN ONLINE SOCIAL MEDIA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know about types, opportunities and pitfalls of Social Media.
- To learn about the risks of Social media and to understand about risk management techniques
- To deal with Identity management and to analyze the access control mechanisms of online social media
- To gain knowledge about trust management and privacy in social media.
- To design and develop policies related to Online social media

UNIT I	SOCIAL MEDIA: INTRODUCTION AND OPPORTUNITIES	9

Understanding social media - Different types and classifications - The value of social media - Cutting edge versus bleeding edge - Security Issues with social media - Opportunities of social media - New methods of marketing to customers - Building social authority - Engaging customers - Sharing information- Identity Management in Online Social Networks, data collection from social networks, challenges, opportunities, and pitfalls in online social networks, APIs; Collecting data from Online Social Media.

Suggested Activities:

- Collection of Data from social media through APIs

Suggested Evaluation Methods:

- Assess for different applications like sentiments, reviews, etc.

UNIT II	RISKS OF SOCIAL MEDIA AND RISK MANAGEMENT	9

Good and Bad Social Media Compaigns – Social Media Hoaxes – Content Management- Risks of social media - Public embarrassment - False information - Information leakage - Retention and archiving content - Backing up social media - Loss of data/equipment - The Dark Side - The dark side of social media - Cybercrime - Social engineering - Hacked accounts - Risk management – Risk assessment – Sources - Laws and regulations – Insurance - Forensics - Police use of social media - Malware, viruses, and exploit distribution.

Suggested Activities:

- Case studies can be analyzed for information leakage, data loss, etc.

Suggested Evaluation Methods:

- Seminar can be given explaining about the technical fault in the system.

UNIT III	IDENTITY MANAGEMENT AND ACCESS CONTROL	9

Identity Management, Digital Identity, Identity Management Models: From Identity 1.0 to Identity 2.0, Identity Management in Online Social Networks, Identity as Self-Presentation, Identity thefts, Open Security Issues in Online Social Networks - Access Control Models, Access Control in Online Social Networks, Relationship-Based Access Control, Privacy Settings in Commercial Online Social Networks, Existing Access Control Approaches

Suggested Activities:

- Can be given assignments in demonstrating privacy settings in commercially available online social networks

Suggested Evaluation Methods:

- Demonstration of privacy settings

UNIT IV	POLICIES, PRIVACY AND TRUST MANAGEMENT	9

Policies – Creating a policy – Online Social Behavior – Enforcing Policies - Policies affected by Social Media - Privacy - Blocking users - Controlling app privacy - Location awareness – Location based Social Networks – Geo-tags. Trust and Policies, Trust and Reputation Systems, Trust in Online Social, Trust Properties, Trust Components, Social Trust and Social Capital, Trust Evaluation Models, Trust, credibility, and reputations in social systems;

Suggested Activities:

- Exploration of trusted entities in software applications.

Suggested Evaluation Methods:

- Analyzing the trust evaluation models qualitatively.

UNIT V	SECURITY SUGGESTIONS AND CASE STUDIES	9

Fake accounts - Passwords - Privacy and information sharing - Content security - The pitch, the promise, and the reality – Accountability – Governance – Developing plans, policies and guidelines - Monitor social media- Case Study: Privacy and security issues associated with various social media such as Facebook, Instagram, Twitter, LinkedIn etc.

Suggested Activities:

- Analysis of privacy and security issues in Online social media.

Suggested Evaluation Methods:

- Demonstration of privacy and security issues and suggestion of security solution.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand working of online social networks
CO 2.	Analyse risks and to deal with Risk Management of online social media
CO 3.	Analyse Identity Management and Access Control in Online social media
CO 4.	Understand and Describe privacy policies and trust management
CO 5.	Apply Security measures in online social networks and to compare various privacy issues associated with popular social media.

TEXTBOOKS:

1. Michael Cross, “Social Media Security”, O’Reilly Publishers, 2014. https://www.oreilly.com/library/view/social-media-security/9781597499866/xhtml/Contents.html
2. Security and Trust in Online Social Networks, Barbara Carminati, Elena Ferrari, Marco Viviani, Morgan & Claypool publications.

REFERENCES:

1. Yaniv Altshuler, Yuval Elovici, Armin B. Cremers, Nadav Aharony, Alex Pentland, “Security and Privacy in Social Networks”, Springer, 2013.
2. Security and Privacy in Social Networks, Editors: Altshuler, Y., Elovici, Y., Cremers, A.B., Aharony, N., Pentland, A. (Eds.), Springer, 2013
   Security and privacy preserving in social networks, Elie Raad & Richard Chbeir, Richard Chbeir& Bechara Al Bouna, 2013

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															
AVG															

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

IT23030	IMAGE PROCESSING AND COMPUTER VISION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge about fundamentals of computer vision.
- To understand the basics of image enhancement techniques.
- To familiarize the student with the image restoration techniques
- To understand and implement various segmentation and feature extraction techniques.
- To appreciate the use of compute vision techniques in various applications

UNIT I	FUNDAMENTALS OF IMAGE PROCESSING	9

Introduction – Applications of Image Processing – Steps in Image Processing Applications – Human vision and color perception- Digital Imaging System – Imaging Sensors - Sampling and Quantization – Pixel Connectivity – Distance Measures – Colour Fundamentals and Models – File Formats – Image Operations

Suggested Activities:

- Installation of OpenCV.
- Numerical Problems on Filtering, Masking, Smoothing and sharpening.

Suggested Evaluation Methods:

- Quizzes on various camera models and its effect.
- Practical – Programming assignments on types of filters for different applications

UNIT II	IMAGE ENHANCEMENT AND TRANSFORMS	9

Image Transforms: Discrete Fourier Transform – Fast Fourier Transform – – Wavelet Transforms -Image Enhancement in Spatial and Frequency Domain – Grey Level Transformations – Histogram Processing –Spatial Filtering – Smoothing and Sharpening – Frequency Domain: Filtering in Frequency Domain.

Suggested Activities:

- Flipped Classroom – Image transforms
- External learning – Various camera calibration methods.

Suggested Evaluation Methods:

- Practical – Image Transforms

UNIT III	RESTORATION AND BOUNDRY DETECTION	9

Image Restoration – Image Degradation Model – Noise Modeling – Blur – Order Statistic Filters – Image Restoration - Morphological operations- dilation-erosion-opening-closing- edge detection-corner detection - detection of Discontinuities Edge Linking and Boundary Detection

Suggested Activities:

- Flipped classroom on various edge detection methods.
- External learning – Optical flow algorithms

Suggested Evaluation Methods:

- Quizzes on various boundary detection methods.
- Practical – Programming assignments on object tracking algorithms.

UNIT IV	IMAGE SEGMENTATION AND FEATURE EXTRACTION	9

Image Segmentation –– Thresholding – Region based Segmentation – Image Features and Extraction – Image Features – Types of Features – Feature extraction – SIFT, SURF – Feature reduction algorithms- PCA.

Suggested Activities:

- Flipped classroom on pedestrian detection methods.
- Assignment on feature reduction algorithms.

Suggested Evaluation Methods:

- Quizzes on methods to identify the shape of an object in an image.
- Practical – Programming assignments on algorithms and methods used for identification of objects

UNIT V	IMAGE CLASSIFIER AND APPLICATIONS	9

Image Classifiers – Supervised Learning – maximum likely hood-minimum distance-parallelepiped-Support Vector Machines, Image Clustering – Unsupervised Learning – kMeans -Hierarchical and

Partition based Clustering Algorithms – ANN - Deep learning image classifier..
Suggested Activities:
● External learning – Exploring advancement in computer vision. ● Discussion on Emotion Recognition methods.
Suggested Evaluation Methods:
● Quizzes on various real time computer vision application. ● Group discussion on methods to solve the real-world problems in computer vision applications.
TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon successful completion of the course, the student will be able to:

CO 1.	Implement basic image processing operations
CO 2.	Apply and develop new techniques in the areas of image enhancement and frequency transforms.
CO 3.	Restore images from noise and to extract edges and boundaries.
CO 4.	Understand the image segmentation algorithms and identify features from images.
CO 5.	Apply classifiers and clustering algorithms for image classification and clustering.

TEXTBOOKS:

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. Digvirs.Jayas, “Image Processing: Advance in Application and Research”, Nova Publication, 2023

REFERENCES:

1. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Second Edition, Prentice Hall, 2011
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, PHI, 2011
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision”, Fourth Edition, Cengage India, 2017

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	3	3	1	1	-	1	-	1	3	2	3
CO2	1	3	3	3	3	3	1	1	1	1	-	1	3	2	3
CO3	1	3	3	3	3	2	1	3	1	-	1	1	3	3	3
CO4	1	3	3	3	3	2	1	3	1	1	1	1	3	3	3
CO5	-	3	3	3	3	2	1	3	2	1	1	1	3	2	3
AVG	1.25	2.8	2.8	2.8	3	2	1	2.2	1.25	1	1	1	3	2.5	3

IT23031	HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the principles and fundamentals of human computer interaction (HCI)
- To analyze the social and emotional aspects related to HCI
- To understand components of interfaces and screens, including windows, menus and controls.
- To understand user interface design principles, and apply them to designing an interface.
- To understand the rationale and guidelines for an effective interface evaluation methodology

UNIT I	INTRODUCTION TO INTERACTION DESIGN	9

Types of Design - Switching to Digital - What to Design- Interaction Design - People-Centred Design - Understanding People- Accessibility and Inclusiveness- Usability and User Experience Goals- Process of Interaction Design- Conceptualizing Interactions

Suggested Activities:

- Practical - Analyze various web interfaces.
- Flipped classroom on basic knowledge on the HCI design process
- External learning - Exploration of various scenarios for creating HCI system.
- Practical - Implementation of a simple user interface design using simple components

Suggested Evaluation Methods:

- Comparison table creation of web interfaces.
- Tutorials on basic design process.
- Assignment on various design paradigms.
- Demonstration of a simple user interface created using simple components.

UNIT II	COGNITIVE, SOCIAL AND EMOTIONAL ASPECTS	9

Cognition- Cognitive Frameworks- Being Social -Face-to-Face Conversations- Remote Collaboration and Communication- Co-Presence - Social Games-Emotions and Behaviour - Expressive Interfaces - Affective Computing and Emotional AI - Persuasive Technologies and Behavioural Change – Anthropomorphism.

Suggested Activities:

- Practical - Design UIs using various tools like Sketch, Flinto, Adobe XD, React.
- Flipped classroom on designing a good user interface system based on design rules.

Suggested Evaluation Methods:

- Demonstrations of created UIs and obtained evaluation metrics.
- Tutorials on UI design rules.

UNIT III	INTERFACES AND DATA	9

Interface Types- Natural User Interfaces and Beyond- Interface-Data Gathering- Capturing Data- Data Analysis, Interpretation, and Presentation -Quantitative and Qualitative - Basic Quantitative Analysis- Basic Qualitative Analysis- Analytical Frameworks- Tools to Support Data Analysis.

Suggested Activities:

- Practical - To implement interfaces using design rules and various models.
- Flipped Classroom on basic knowledge of various models used in HCI design.
- External learning - Design and implementation of various models used in HCI design.

Suggested Evaluation Methods:

- Demonstration of created UI with design rules.
- Tutorial on models of HCI design.
- Assignments on models of HCI design.

UNIT IV	MODELS AND DESIGN PATTERNS	9

Ethical Design Concerns- Discovering Requirements- What Are Requirements? - Data Gathering for Requirements-. Bringing Requirements to Life: Personas and Scenarios -Capturing Interaction with Use Cases - Prototyping - Conceptual Design - Concrete Design- Generating Prototypes- Construction- AgileUX- Design Patterns- Open Source Resources- Tools for Interaction Design

Suggested Activities:

- Practical - Statistical analysis and user testing on existing user interfaces.

Suggested Evaluation Methods:

- Demonstration of user testing with arrived results

UNIT V	DESIGN EVALUATION	9

Types of Evaluation- Evaluation Case Studies- Other Issues to Consider When Doing Evaluation- Usability Testing-Conducting Experiments-inspections: Heuristic Evaluation and Walk-Throughs- Analytics and A/B Testing- Predictive Models

Suggested Activities:

- Flipped classroom on basic concepts of dialogue notations and design.
- External learning - Usage of Virtual Reality in various real time UI application design.
- Practical - Development and validation of user interfaces using various evaluation techniques.

Suggested Evaluation Methods:

- Tutorials on various dialog notations and design.
- Assignments on UI design evaluation strategies.
- Quizzes on evaluation methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the theory and concepts of human-computer interactive systems
CO 2.	Apply Cognitive, Social and Emotional aspects to create intuitive and effective user interfaces for interactive systems
CO 3.	Analyze and apply various Interfaces and data models to design interactive systems.
CO 4.	Understand the models and design patterns in the design of user-friendly and efficient interactive systems
CO 5.	Understand the evaluation methods and techniques to assess the usability.

TEXTBOOKS:

1. Preece, J., Sharp, H., Rogers, Y., “Interaction Design: Beyond Human-Computer Interaction”, Sixth Edition, Wiley, 2022
2. Ben Shneiderman, Catherine Plaisant, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Sixth Edition, Addison Wesley, 2021.
3. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, Third Edition, Prentice Hall, 2004

REFERENCES:

1. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, “Research Methods in Human-Computer Interaction”, Second Edition, Morgan Kaufmann, 2021.
2. Jeff Johnson, “Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules”, Third Edition, Morgan Kaufmann, 2020
3. Benyon, D, “Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design”, Third Edition, Pearson Education Limited, 2019.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	2	2	1	-	-	-	-	2	1	3	3	3
CO2	2	3	3	2	2	2	1	1	1	2	-	1	3	3	3
CO3	2	3	3	2	3	2	1	1	1	2	-	1	3	3	3
CO4	2	3	2	3	3	2	1	1	1	2	-	1	3	3	3
CO5	2	3	2	2	2	2	-	1	-	3	1	1	3	3	3
AVG	2	3	2.5	2.2	2.5	1.8	1	1	1	1.8	1.5	1	3	3	3

IT23032	UI AND UX DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To survey the Content information based on people needs
- To train the students to acquire knowledge in UI & UX design
- To acquire knowledge in components of UI & UX design
- To survey the various UI systems
- To understand the user experience design techniques

UNIT I	INTRODUCTION	9

Design Thinking – Divergent- Convergent-Lateral -Context- Know your Audience – Research: Ways to Understand Context and Goals- direct Observation-Surveys-Personas-The Patterns: Cognition and Behaviour Related to Interface Design-Self Exploration-Gratification-Organizing the Content: Information Architecture and Application Structure-Meet the Goals of People and the Organization

Suggested Activities:

- Flipped Classroom: Knowing drawbacks of various product interfaces that re used in daily routine
- Blended Learning: Create a table that list the modification to be carried out in existing product interface

Suggested Evaluation Methods:

- Assignment on various interface design
- Quizzes on information representation architectures

UNIT II	DESIGN FUNDAMENTALS	9

Understanding the Information and Task Space–Navigation Models: Hub and spoke-fully connected-multilevel-pyramid-flat navigation-Patterns-clear Entry Points-Menu pages- - Signposts-Way finding-Layout of screen Elements- Visual Style and Aesthetics-Visual Design for Enterprise Applications-Laws governing UI

Suggested Activities:

- Flipped Classroom: Navigation models
- Blended Learning: Colors in UI/UX

Suggested Evaluation Methods:

- Assignment on various Page elements used in UI design
- Quizzes on navigation methods

UNIT III	DISPLAY AND ELEMENTS	9

Types of Display – Actions and Commands – Pinch-Buttons-Drop-Down Menus-Action-Hover-Keyboard action-Direct Manipulation-Showing Complex Data – Forms and Controls – Labels - Menus - Tabs - Buttons - Accordion - Carousel - Breadcrumbs — pagination-Scrollers-Two Panel Selection-Text input fields-Builder and Editors-UX writing Tools.

Suggested Activities:

- Flipped Classroom: Identify the importance UI elements
- Practicals - UI tools

Suggested Evaluation Methods:

- Evaluate simple UI design
- Quizzes on UI Patterns

UNIT IV	UI SYSTEMS	9

UI Frameworks – Smart Systems- Connected Devices – Anticipatory Systems-Assistive Systems-Natural User Interfaces- Challenges and Opportunities of Model Design-Screen Design - Text Display – Representing Physical Environment – Location – Social Influence – Various Design Pattern-Desktop Applications-Mobile Interfaces

Suggested Activities:

- Flipped Classroom: Identify the importance of different UI systems
- Blended Classroom: Discussing about different product interface

Suggested Evaluation Methods:		
● Quizzes on different User product interaction		
UNIT V	**UX DESIGN**	**9**
User Research-Interviews-Persons--Content Strategy-Transition-Design Principles-Site Maps and Task Flows-Sketching-Wireframes and Annotations-Prototyping-Design Testing With Users-Transition-Measuring UX Content Effectiveness-Analytics		
Suggested Activities:		
● Flipped Classroom: Identify the various UX design techniques		
Suggested Evaluation Methods:		
● Survey - Evaluate the UX design techniques		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the user needs and requirements to build an effective User Interface.
CO 2.	Implement UI design principles in the creation of a User Interface.
CO 3.	Design and implement perfect layouts for UI design to develop real world UX product.
CO 4.	Analyse various types of User Interface systems.
CO 5.	Create User Interfaces by applying Design Principles and evaluate the UI design .

TEXTBOOKS:

1. Uijun Park , “Introduction to Design Thinking For UX Beginners” ,Wiley 2023
2. Joel Marsh, “ UX for Beginners”, O’Reilly,2022
3. Jenifer Tidwill , Charles Brewer and Aynne Valencia , “Designing Interfaces: Patterns for Effective Interaction Design “ Third Edition, O’Reilly Publications,2020
4. Jeff Johnson , “Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules” Third Editions, Elsevier publication, 2020.

REFERENCES:

1. Jon Yabionski, “ Laws of UX using Psychology to design Better Products & services” O’Reilly, 2021
2. Torrey Podmajersky, ”Strategic Writing for UX”, O’Reilly Medis, inc, 2019
3. Ben shneiderman, Catherine Plaisant, Marine Cohen and Steven M.Jacobs, “Designing the User Interface-Strategies for Effective Human Computer Interaction”, Fifth Edition, Pearson, 2012
4. Russ Unger and Carolyn Chandler, ”A Project Guide to UX Design: For User Experience Designers in the Field or in the Making”,Second Edition, New Riders Publishers,2012

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	3	3	3	2	-	-	-	-	-	1	2	3	2	3
CO2	1	3	3	3	2	-	-	-	-	-	1	2	3	2	3
CO3	1	3	3	3	2	-	-	-	-	1	1	2	3	2	3
CO4	1	3	3	3	2	-	-	1	-	1	1	2	3	2	3
CO5	1	3	3	3	2	-	-	1	2	2	1	2	3	2	3
AVG	**1**	**3**	**3**	**3**	**2**	**1**	**-**	**1**	**2**	**1.33**	**1**	**2**	**3**	**2**	**3**

IT23033	DIGITAL MARKETING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To train the students to acquire knowledge in digital marketing
- To know the Customer behaviour in digital marketing world
- To acquire knowledge about the digital marketing strategies
- To know the social channels of digital marketing
- To understand the business analysis and optimization techniques

UNIT I	FUNDAMENTALS OF DIGITAL MARKETING	9

Introduction – Planning – Types – Strategies - Market segmentation – Online consumer behaviour – Evolution - challenges - Factor Affecting marketing - Decision process - Online buying models – Strategic digital marketing - Factors impacting digital marketing – Types of digital media and attribution model - Online marketplace analysis Micro & Macro Environment - Value chain digitization.

Suggested Activities:

- Flipped Classroom: Get to know about different types of Models in digital marketing.
- External Learning: Latest marketing technology landscape

Suggested Evaluation Methods:

- Tutorial – Value chain digitization.
- Assignments on digital market strategy.

UNIT II	KNOWING THE CUSTOMER	9

Consumer for Digital Marketing – Consumer behaviour – Web experience – website planning and development – Consumer demand – Integrated marketing communications - marketing Customer Relation Management- Importance of Customer Experience – Content Creation

Suggested Activities:

- Flipped Classroom : Discussion on 5s of Internet Marketing.
- Blended Classroom: Understanding customer journeys.

Suggested Evaluation Methods:

- Tutorial –Consumer choice and digital influence.
- Assignments on content creation.

UNIT III	STRATEGY, PLANNING AND EXECUTION	9

Digital Marketing: Analytics – Digital advertising – Assessment Phase – Strategy Definition- Communications and Channel Mix – Operation Set-ups – Campaign Management –Execution Elements – Implementation challenges – security-privacy – Ethical – social challenges.

Suggested Activities:

- Flipped Classroom : Challenges in developing and managing digital market strategy.
- Blended Classroom: Types of digital media channels.

Suggested Evaluation Methods:

- Tutorial –Difference between digital and traditional media.
- Assignments on digital marketing communication Channel.

UNIT IV	DIGITAL MARKETING CHANNELS	9

Direct Marketing – Marketing using AI - Social Media – Mobile - E-Mail – Internet – Pay-per Click – Key performance Indicators - Google ads - Affiliate – Marketing Using Artificial Intelligence- Advertising -Meta –Facebook – Mobile and Video marketing - Instagram-Twitter - You Tube - Pinterest –TikTok – LinkedIn- E-payment systems – Smart marketing – interactive marketing.

Suggested Activities:

- Flipped classroom: Different types of social media marketing tools.
- Blended Learning: Integrating online and offline communications for digital marketing.

Suggested Evaluation Methods:

- Assignment: Perform competitor benchmarking for online services for an organization of your choice.
- Quizzes on Assessing social media marketing platforms.

UNIT V	**ANALYSIS AND OPTIMIZATION**	**9**

Data-Driven Business – Optimizing – Mistakes – Tools – Search engine optimization -Rules of Marketing and PR – Reaching Buyers Directly – Web Based Communications – Analyzing Data for Success-Landscape and Emerging Area- Google analytics – Digital Marketing Environment – E-business Analytics

Suggested Activities:

- Flipped classroom: Web application frameworks and application servers related to digital marketing.
- Blended Learning: Digital certificates.

Suggested Evaluation Methods:

- Assignment: Emerging Technology in digital marketing
- Quizzes on Research tools for assessing digital markets

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 digital marketing.
CO 2.	Understand the customer behaviour and Identify the customer needs
CO 3.	Analyse the Marketing strategies for effective implementation of digital marketing.
CO 4.	Analyse and compare the current digital marketing channels
CO 5.	Create online digital marketing platforms with optimal efficiency

TEXTBOOKS:

1. Greg Jarboe, Matt Bailey and Michael Stebbins , “Digital Marketing Fundamentals “, Wiley , 2023
2. Stephanie Diamond, “Digital Marketing All-In-One For Dummies”, Wiley, 2023.
3. Satinder Kumar and Supreet Kaur, “Digital Marketing “, First Edition Taxmann , 2023
4. Nptel course online: Digital Marketing by Dr.Tejinderpal Singh Punjab University ChandigarhTech Tejinder

REFERENCES:

1. David Meerman Scott, “The New Rules of Marketing and PR”, Seventh Edition, Wiley 2020
2. Puneet Bhatia, “Fundamentals of Digital Marketing”, Second Edition, Pearson, 2019
3. Dr.Princi Gupta and Dr.Gaurab Kumar Sharma, “ Digital Marketing – An Insight to Fundamentals, Strategies &Implementations”, Notion Press, 2019.
4. Ryan Deiss and Russ Henneberry, “Digital Marketing For Dummies”, For Dummies, 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	2	2	2	2	3	3	1	1	-	1	-	1	3	2	3
CO2	1	3	3	3	3	3	1	1	1	1	-	1	3	2	3
CO3	1	3	3	3	3	2	1	3	1	-	1	1	3	3	3
CO4	1	3	3	3	3	2	1	3	1	1	1	1	3	3	3
CO5	-	3	3	3	3	2	1	3	2	1	1	1	3	2	3
AVG	1.25	2.8	2.8	2.8	3	2	1	2.2	1.25	1	1	1	3	2.5	3

IT23034	VISUAL EFFECTS (VFX)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To train the students to acquire knowledge in Visual Effect
- To survey the VFX development environment and tool kits
- To acquire knowledge about the VFX modeling techniques
- To implement the VFX design techniques
- To know the various applications of VFX

UNIT I	VFX FUNDAMENTALS	9

Core Concepts-VFX as Filmmaking Tool-From Two Dimensional to Three Dimensional - The quest for the Lost Dimension-Separation- Introduction to Digital Computing-Learning to See-Digital Representation of Visual Information

Suggested Activities:

- Flipped Classroom: Knowing Advantages of digital representation
- Blended Learning: knowing about video editing

Suggested Evaluation Methods:

- Assignment on various usage of VFX in Film industry
- Quizzes on object transformations

UNIT II	VFX CREATION	9

Image Manipulation-Image Compositing-Matte Creation and Manipulation- Time and Temporal Manipulations-Interface Interaction- Film Format- Quality and Efficiency-Creating Elements.

Suggested Activities:

- Flipped Classroom: Knowing about video and audio effects.
- Blended Learning: knowing about various media formats

Suggested Evaluation Methods:

- Assignment on video effects for color correction
- Quizzes on video effects

UNIT III	VFX ADVANCED TECHNIQUES	9

Additional Integration Techniques- Advance Digital Representation- 3D Compositing- Tools and Features: Color Correction –Filters- Geometric Transformation and Warps-Image Combination- Field Controls- Matte Generation- Timing and Animation- Tracking-Control-3D Particle Systems- 3D Particle Physics –i3D Content Publishing

Suggested Activities:

- Flipped Classroom: Knowing about 3D particle systems.
- Blended Learning: knowing about various filters and usage.

Suggested Evaluation Methods:

- Assignment on Timing and animation.
- Quizzes on particle physics

UNIT IV	BLENDER FOR VFX	9

Problem Definition – Preparation - Tracking- Scene Setup – Rendering- Masking – Compositing – Motion tracking-Character Modelling and Rigging-Color Composing-Color Sensing-Sound Editing-Remixing-Texturing - Morphing

Suggested Activities:

- Flipped Classroom: Knowing about Kinematic typography
- Blended Learning: working with image sequences.

Suggested Evaluation Methods:

- Assignment on tracking images
- Quizzes on pre and post compositions.

UNIT V	APPLICATIONS OF VFX	9
Project Portfolio Management-Introduction-Challenge –Visuals- Visual Literacy-Science Fiction- Flash Techniques-Action-Three Dimension Location-Research Design-Data Analysis-Summary, Conclusion and Recommendations		
Suggested Activities:		
● Flipped Classroom: Knowing about script editor ● Blended Learning: working with Data analysis.		
Suggested Evaluation Methods:		
● Assignment on various research methods for VFX.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
Upon successful completion of the course, the student will be able to:	
CO 1.	Understand the concepts used in digital representation of visual Information
CO 2.	Design and implement algorithms and techniques to create visual effects in Images and Films
CO 3.	Apply advanced techniques and use design tools for creating Visual effects
CO 4.	Learn and Compose futuristic visual effects using VFX design principles
CO 5.	Create various visual effects in the development of interactive applications

TEXTBOOKS:

1. Eran Dinur, “The Filmmaker’s Guide to Visual Effects”, Routledge, 2017
2. Joana Geraldi and Mario Arlt, “Visuals Matters! Designing and Using Effective Visual Representations to Support Project and Portfolio Decisions”, Project Management Institute, 2015
3. Jeffery A.Okun and Susan Zwerman, “ TheVES Handbook of Visual Effects”, Third Edition, Routledge, 2020

REFERENCES:

1. Sam Vila, “Blender for Visual Effects”, A K Peters, 2015.
2. Wallace Jackson, “VFX Fundamental Visual Special Effects Using Fusion 8.0”, Apress, 2016.
3. Ron Brinkmann, “The Art and Science of Digital Compositing”, Second Edition, Morgan Kaufmann, 2008

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	3	3	3	-	-	-	2	-	1	2	3	2	3
CO2	1	2	3	3	3	-	-	-	2	-	1	2	3	2	3
CO3	1	2	3	3	3	-	-	-	2	-	1	2	3	2	3
CO4	1	2	3	3	3	-	-	1	2	-	1	2	3	1	3
CO5	1	2	3	3	3	1	1	1	2	1	1	2	3	1	3
AVG	**1**	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**3**	**1.6**	**3**

IT23035	ADVANCED COMPUTER GRAPHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To train the students to acquire knowledge in Computer Graphics and Animation
- To understand the ray tracing algorithms
- To acquire knowledge about the 3D modeling techniques
- To survey the graphics related shading and illumination models
- To know the logic and mechanics of Animation design

UNIT I	INTRODUCTION	9

Introduction to Graphics Area – Overview of Digital and Rasterization Graphics – Graphics API – Graphic Pipe Lines – Vectors – Curves and Surfaces -2d Linear Transformation - 3D Transformation – Translation and Affine Transformation – Coordinate Transformation – Viewing Transformation – Projective – Perspective Projection – Simple Antialiasing.

Suggested Activities:

- Flipped Classroom: Implementation of Graphics algorithms.
- Blended Classroom: Knowing details about cameras and positioning

Suggested Evaluation Methods:

- Assignment: Viewing and Transformations
- Quizzes on Vector algebra

UNIT II	RAY TRACING	9

Basic Ray-Tracing Algorithm – Perspective – Computing Viewing Rays- Ray-object Intersection – Ideal Specular Reflection – Transparency and Refraction – Instancing – Constructive Solid Geometry – Distribution Ray Tracing – Radiometry – Transport Equation – Photometry – Colourmetry – Color Spaces – Chromatic Adaptation.

Suggested Activities:

- Flipped Classroom: Knowing about different light sources and positioning.
- Blended Classroom: Discussion about Ray tracing

Suggested Evaluation Methods:

- Assignment on color interaction with light.
- Quizzes on color models and ray tracing algorithms

UNIT III	MODELING	9

Modeling – Triangle Meshes - Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing And Mapping – Behavior Modeling – Reflection Models.

Suggested Activities:

- Flipped Classroom: Shading Techniques
- Blended Classroom: Discussion about modeling techniques.

Suggested Evaluation Methods:

- Assignment on Various Clipping algorithms and hidden surface removal algorithms.
- Quizzes on modeling techniques

UNIT IV	SHADING AND TEXTURE	9

Diffuse Shading – Phong Shading – Artistic Shading- Scene Graphs – Spatial Data Structures – BSP Trees for Visibility – 3D Texture Mapping – 2D Texture Mapping - Texture Mapping for Rasterized Triangles – Bump Textures – Displacement Mapping – Environment Mapping – Shadow Maps – Global Illumination.

Suggested Activities:

- Flipped classroom: Knowing about different types of real world object textures

Suggested Evaluation Methods:		
● Quizzes on texture mapping		
UNIT V	**COMPUTER ANIMATIONS**	**9**
Principle of Animation – keyframing – deformation – Character Animation – Physics-Based Animation – Procedural Transformation – Groups of Objects – Visualization: Visual Encoding Principle – Interaction Principle – Composite and Adjust Views- Data Reduction – 2D Scalar Fields – 3D Scalar Fields.		
Suggested Activities:		
● Flipped Classroom: Exploration of various animation techniques and tools. ● Blended Classroom: Modeling Fluids, Fog, Gases and other environmental elements.		
Suggested Evaluation Methods:		
● Assignment on various animation techniques and tools. ● Quizzes on object physics.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
Upon successful completion of the course, the student will be able to:		
CO 1.	Understand the concepts of transformations and projection used in graphics	
CO 2.	Apply knowledge of Ray Tracing to develop realistic three dimensional World objects.	
CO 3.	Apply various modelling techniques for the construction of Realistic three dimensional objects	
CO 4.	Create realistic animation scenes by applying shading and texturing techniques	
CO 5.	Compose interactive computer graphics applications by incorporating two dimensional and three dimensional Animations	
TEXTBOOKS:		
1. John M.Blain , “The Complete Guide to Blender Graphics”, A K Peters/CRC Press 2023 2. Hearn and Baker, "Computer Graphics with OpenGL", Pearson, Fourth edition, 2011 3. Peter Shirely and Steve Marschner “ Computer Graphics” Cengage Learning,2009 4. F.S. Hill, Jr. and Stephen M. Kelley, Jr., "Computer graphics using OpenGL", Pearson Prentice Hall, Third edition, 2007.		
REFERENCES:		
1. Hale KS, Stanney KM, “Handbook of virtual environments: Design, implementation, and applications”. CRC Press; 2014.		

COURSE OUTCOMES	**Program Outcomes (POs) & Program Specific Outcomes (PSOs)**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
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CO2	3	3	2	2	2	-	-	-	1	-	1	2	3	3	3
CO3	3	2	3	3	2	-	1	-	1	-	1	2	3	3	3
CO4	3	2	3	3	2	-	1	1	1	-	2	2	3	3	3
CO5	3	2	3	3	2	1	1	1	1	1	2	2	3	3	3
AVG	3	2.4	2.6	2.4	2.5	1	1	1	1	1	1.5	2	3	3	3

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)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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

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**	**PO 10**	**PO 11**	**PO 12**	**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**

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)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**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

IT23036	UNIX INTERNALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the design of the Unix operating system.
- To become familiar with the various data structures used learn the various low-level algorithms used in Unix.
- To understand the Unix file system and its system calls.
- To study about process management and scheduling in Unix.
- To learn about memory management and I/O systems

UNIT I	OVERVIEW	9

General Overview of the System: History – System Structure – User Perspective – Operating System Services – Assumptions about Hardware – Introduction to the Kernel Architecture of the UNIX Operating System – Introduction to System Concept – The Buffer Cache – Buffer headers – Structure of the Buffer Pool – Scenarios for Retrieval of a Buffer– Reading and Writing Disk Blocks – Advantages and Disadvantages of the Buffer Cache

Suggested Activities:

- Flipped classroom on operating system services.
- Practical -
  - Implement the system call ‘cat’ using command line arguments and generate the executable version of the program and invoke the executable file using exec system calls (fork, wait etc).
  - Implement a scenario resulting to an incorrect linked list because of context switch.
  - Implement the five scenarios in the getblk algorithm by using first in first out scheme.
  - Simulate the function of bread(), breada(), bwrite and brelse.

Suggested Evaluation Methods:

- Quiz on operating system services.
- Evaluation of the functions implemented.

UNIT II	FILE SUBSYSTEM	9

Internal Representation of Files: Inodes: Definition, Accessing Inodes, Releasing Inodes – Structure of a Regular File – Directories – Conversion of a Path Name to an Inode – Super Block – Inode Assignment to a New File – Allocation of Disk Blocks – Other File Types.

Suggested Activities:

- Flipped classroom on files and directory structure.
- Practical -
  - Implement the five scenarios in the iget algorithm by using least recently used scheme.
  - Implement the bmap algorithm and find the block number and the byte offset in file system for the given offset. Assume the disk block contain 1024 bytes.
    - 96000
    - 9999999
  - Simulate the function of iput, ialloc, ifree, alloc and ifree.
  - Write a program to display the directory entries(i.e., byte offset , inode number and the file name).

Suggested Evaluation Methods:

- Quiz on files and directory structure.
- Evaluation of the functions implemented.

UNIT III	SYSTEM CALLS FOR THE FILE SYSTEM	9

Open – Read – Write – File and Record Locking – Adjusting the Position of File I/O – lseek – Close – File Creation – Creation of Special Files – Changing Directory – Root – Owner – Mode – stat and fstat – Pipes – dup – Mounting and Unmounting File Systems – link – unlink.

Suggested Activities:

- Flipped classroom on file system and system calls.
- Practical -
  - How does the command mkdir work? (Hint: When mkdir completes, what are the inode numbers for "." and ".."?).
  - Simulate the function of chown, chmod, stat and fstat.
  - Set the whole-file lock with fcntl() and lockf().
  - Write a program to print the mount table whenever an external device is connected to the Unix system.

Suggested Evaluation Methods:

- Quiz on file system calls.
- Checking the functions implemented.

UNIT IV	**PROCESSES**	**9**

Process States and Transitions – Layout of System Memory – The Context of a Process – Saving the Context of a Process – Manipulation of the Process Address Space – Process Control – Process Creation – Signals – Process Termination – Awaiting Process Termination – Invoking other programs – User ID of a Process – Changing the Size of a Process – Shell – System Boot and the INIT Process – Process Scheduling.

Suggested Activities:

- Flipped classroom on context switching
- Practical -
  - Implement the algorithm for allocating and freeing memory pages and page tables. Which data structures would allow best performance?
  - Design an algorithm that translates virtual address to physical addresses, given the virtual address and the address of the region entry.
  - Implement an algorithm that exchange messages over pipe (use of pipe and dup and fork).
  - Write a program to communicate between two process using signals.

Suggested Evaluation Methods:

- Quiz on context switching.
- Evaluation of the functions implemented.

UNIT V	**MEMORY MANAGEMENT AND I/O**	**9**

Memory Management Policies – Swapping: Allocation of Swap Space, Swapping Processes Out , Swapping Processes in - Demand Paging: Data Structures, Fork, Exec in Paging System, Page Stealer Process, Validity Fault Handler - The I/O Subsystem: Driver Interfaces: System Configuration – System Calls and the Driver Interface – Open – Close – Read and Write – Disk Drivers – Terminal Drivers.

Suggested Activities:

- Flipped classroom on virtual memory concepts
- Practical -
  Write a program that tracks the allocation of space on a swap device.
- Write a program that verifies that the file systems on a disk do not overlap. The program should take two arguments: a device file that represents a disk volume and a descriptor file that gives section numbers and section lengths for the disk type. The program should read the super blocks to make sure that file systems do not overlap.
- Implement sty command: with no parameters, it retrieves the values of terminal settings and report them to the user.

- Encode a line disciple that writes the machine name at the beginning of each line of output.

Suggested Evaluation Methods:

- Quiz on virtual memory concepts.
- Evaluation of the functions implemented.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand UNIX architecture and explain how they interact with computer hardware
CO 2.	Analyse the internal structure of files in the UNIX system and algorithms used in the building of a kernel.
CO 3.	Implement the process state model and its control for the UNIX system
CO 4.	Implement the memory management policies in an operating system..
CO 5.	Implement the memory management policies in an operating system.

TEXTBOOKS:

Maurice J. Bach, “The Design of the Unix Operating System”, Pearson Education, 2015.

REFERENCES:

1. B. Goodheart, J. Cox, “The Magic Garden Explained”, Prentice Hall of India,1986.
2. S. J. Leffler, M. K. Mckusick, M. J. Karels, J. S. Quarterman., “The Design and Implementation of the 4.3 BSD Unix Operating System”, Addison Wesley, 1998.
3. Robert Love, “Linux Kernel Development”, Third Edition, Addison Wesley, 2010.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	2	2	1	1	-	3	3	3	3	3	3	3
CO2	2	3	3	2	2	1	2	-	3	3	3	3	3	3	3
CO3	2	3	3	2	2	1	2	-	3	3	3	3	3	3	3
CO4	2	3	3	2	2	1	1	-	3	3	3	3	3	3	3
CO5	2	3	3	2	2	1	1	-	3	3	3	3	3	3	3
CO6	2	3	3	2	2	1	1.4	-	3	3	3	3	3	3	3
AVG	2	3	3	2	2	1	1	-	3	3	3	3	3	3	3

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

IT23037	GRAPH THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To comprehend graphs as modeling and analysis tools.
- To introduce various data structures with graph theory.
- To learn graph theoretic algorithms.
- To understand graph coloring and covering.
- To learn the usage and applications of graphs in social networking and media.

UNIT I **INTRODUCTION** **9**

Graphs: Introduction to graph, history of graph theory and applications of graphs – graph theory fundamentals: incidence and degree, isolated and pendent vertices - Types of graphs – finite, infinite, and null graphs, Isomorphism – Sub Graphs – Multicolored cube puzzle - Walks, Paths, Circuits – definitions and examples – Introduction to connected, disconnected graphs and components – Euler Graphs – Operations on graphs - Hamiltonian paths and circuits - Traveling salesman problem

Suggested Activities:

- Solving simple Graph problems.
- Flipped classroom on isomorphism.
- External learning - Traveling salesman problem.
- Practical -
  - Implement a program to determine isomorphic graphs.
  - Implement a program to determine Hamiltonian circuits and Hamiltonian paths in a graph.
- Applications in real life problems.

Suggested Evaluation Methods:

- Tutorials on graph algorithms.
- Assignment problems on isomorphism, hamiltonian graphs.
- Quizzes on connected components.

UNIT II **TREES AND CONNECTIVITY** **9**

Introduction to Trees – Properties of Trees – Pendant vertices in a tree - Distance and Centers in Tree: Metric, eccentricity, radius and diameter - Rooted and Binary Trees: properties of binary tree, levels in binary tree and height, counting trees - Spanning Trees – Fundamental Circuits – Spanning Trees in a Weighted Graph - algorithm for shortest spanning tree – Cut Sets and cut vertices – Properties of Cut Set – Identifying all Cut Sets in a graph – Fundamental Circuits and Cut Sets – Connectivity and Separability – Network Flows – 1–Isomorphism – 2–Isomorphism..

Suggested Activities:

- Solving problems on tree properties and cut sets.
- Flipped classroom on spanning trees and fundamental circuits.
- External learning – Network flows.
- Practical -
  - Find all spanning trees of a graph.
  - Find all cut-sets in a graph.
- Applications in real life problems.

Suggested Evaluation Methods:

- Tutorials on spanning trees and cut sets.
- Assignment problems on fundamental circuits and cut sets.
- Quizzes on network flows.
-

UNIT III	PLANARITY, COLOURING AND COVERING	9

Introduction to Combinational and Geometric Graphs – differences - Planar Graphs – Kuratowski's Two Graphs and theorems – Different Representation of a Planar Graph: straight line, plane and embedding on a sphere representation – Introduction to Chromatic Number – Chromatic Partitioning with examples – Chromatic Polynomial: derivation and applications – Matching – Covering – Four Color Problem

Suggested Activities:

- Solving Problems on planar graphs, chromatic number.
- Flipped classroom on matching and covering.
- External learning - Self-dual graphs and digraphs.
- Practical -
  - Implement a program to determine if a given graph G is planar or nonplanar
  - Finding all maximal independent sets
- Applications in real life problems.

Suggested Evaluation Methods:

- Tutorials on planar graphs.
- Assignments on matching and covering.
- Quizzes on planar graphs, chromatic number.

UNIT IV	DIRECTED GRAPH AND GRAPH THEORETIC ALGORITHMS	9

Directed Graphs – definition and examples - Types of Directed Graphs: simple, symmetric, asymmetric and complete digraphs – Digraphs and Binary Relations: reflexive, symmetric, transitive and equivalence relations – Directed Paths and Connectedness – Condensation operation in digraphs - Euler Digraphs – Graph Theoretic Algorithms – algorithm to verify Connectedness and Components of a given graph – algorithm to find a set of Fundamental Circuits.

Suggested Activities:

- Solving problem on Euler digraphs.
- Flipped classroom on directed graphs.
- External learning - Cut-Vertices and Separability.
- Practical - Implementation of graph algorithms.
- Finding connected components.
- Finding a set of fundamental circuits in a graph.
- Applications in real life problems.

Suggested Evaluation Methods:

- Tutorials on directed graphs .
- Assignments on Euler digraphs.
- Quizzes on graph theoretic algorithms

UNIT V	GRAPHS IN SOCIAL AND DIGITAL MEDIA	9

Dominant Social Networking/Media Platforms – case studies and application of graph theoretical metrics - Collecting Data from Social Media Sites – APIs, Data formats, various graph representation techniques - Social Media Graphs – Graph Storage Formats and Visualization – Applications of Graph Analysis – game theory, signal-flow and computer programming.

Suggested Activities:

- Flipped classroom on social network analysis using graphs.
- External learning - Algebraic graph analysis.
- Practical -
  - Study of an interactive visualization tool such as Gephi for social networks.
- Applications in real life problems.

Suggested Evaluation Methods:

- Tutorials on social network analysis using graphs.

- Assignments on graph storage formats and visualization.
- Quizzes on interactive visualization tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Demonstrate understanding of the fundamental theorems of graph theory.
CO 2.	Identify and differentiate the potential use of special graphs and describe the basic properties of each kind.
CO 3.	Design and develop programs involving basic graph algorithms.
CO 4.	Introduce graphs as a powerful modeling tool that can be used to solve practical problems in various fields.
CO 5.	Apply the abstract concepts of graph theory in modeling and solving non-trivial problems in different fields of study.

TEXTBOOKS:

1. Narsingh Deo, “Graph Theory: With Application to Engineering and Computer Science”, Dover Publications Inc., 2016.
2. Ioannis Pitas, “Graph-Based Social Media Analysis”, Chapman and Hall/CRC Press, 2015.

REFERENCES:

1. Clark J., Holton D. A., “A First Look at Graph Theory”, Allied Publishers, 1995.
2. Mott J. L., Kandel A., Baker T. P., “Discrete Mathematics for Computer Scientists and Mathematicians”, Prentice Hall of India, 1996.
3. Liu C. L., “Elements of Discrete Mathematics”, McGraw Hill, 1985.
4. Rosen K. H., “Discrete Mathematics and Its Applications”, McGraw Hill, 2007.

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	1	1	1	-	1	3	1	3	2	2	2
CO2	3	3	3	2	1	1	2	-	1	3	1	3	2	2	2
CO3	3	3	3	3	3	3	3	3	3	1	3	3	2	2	2
CO4	3	3	3	3	3	1	1	-	3	-	3	3	2	2	2
CO5	3	3	3	3	1	3	3	3	3	3	3	3	2	2	2
CO6	3	3	3	2.6	1.8	1.8	2	3	2.2	2	2.2	3	2	2	2
AVG	3	3	3	2	1	1	1	-	1	3	1	3	2	2	2

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

IT23C09	EMBEDDED SYSTEMS	L	T	P	C
OBJECTIVES:		3	0	0	3

- 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

UNIT V	SYSTEM DESIGN APPLICATIONS DEVELOPMENT	9
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**	**PO10**	**PO11**	**PO12**	**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

IT23038	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Understand the basics of quantum mechanics.
- To Understand the concepts of Quantum Gates and quantum computation
- To learn the concepts of quantum error correction.
- To learn the Quantum Algorithms and analyze the computation models.
- To understand Cryptographic system.

UNIT I QUANTUM COMPUTING BASIC CONCEPTS 9

Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – Quantum Bits - Representations of Qubits.

Suggested Activities:

- Quiz on quantum bits.
- Suggested Evaluation Methods:
- •Problem solving assignment on quantum computation.

UNIT II QUANTUM GATES AND CIRCUITS 9

Universal logic gates - Universal Quantum Gates: Basic single qubit gates - Multiple qubit gates -Reversible gates- Circuit development - Superpositions - Quantum entanglement - Quantum Teleportation.

Suggested Activities:

Design of quantum circuits
Flipped classroom on quantum operations.
Suggested Evaluation Methods:
Tutorials on examples and application of quantum operations.

UNIT III QUANTUM ALGORITHMS 9

Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm - Shor's Factoring Algorithm.

Suggested Activities:

- Flipped classroom on quantum algorithms, information processing.
- Tutorials on applications of algorithms. Flipped classroom on simulation, Fourier transform.
- Tutorials on quantum search algorithms.

Suggested Evaluation Methods:

- Programming assignment on quantum algorithms.
- Problem solving assignment on text book exercise questions.
- Programming assignment on search algorithms.

UNIT IV QUANTUM INFORMATION THEORY 9

Quantum Operations - Shannon Entropy - Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels - Quantum Information over noisy Quantum Channels.

Suggested Activities:

- Flipped classroom on postulates, computational models.
- Computational analysis of common problems like Travelling Salesman.

Suggested Evaluation Methods:

- Quiz on postulates and computational models.
- Problem solving assignment on application of quantum mechanics.

UNIT V QUANTUM ERROR-CORRECTION AND QUANTUM CRYPTOGRAPHY 9

Theory of Quantum Error Correction - Constructing Quantum Codes - Stabilizer Codes - Quantum Cryptography: Quantum Key Distribution - BB84 - Ekart 91.

Suggested Activities:

- Flipped classroom on data compression, noisy quantum channels.
- Extra reading and discussion from reference books.

Suggested Evaluation Methods:

- Quiz on data compression and noisy quantum channels..
- Problem solving assignment on text book exercise questions.

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 quantum mechanics.
CO2. Understand the concepts of Quantum Gates and be able to model the circuits using quantum computation.
CO3. Understand the Quantum Algorithms and analyze the computation models.
CO4. Learn about Quantum operations and environments and understand the Quantum Information theory.
CO5. Understand the concepts of quantum error correction and quantum cryptography.
CO6. Able to develop a Quantum based Cryptographic system / Quantum based AI system for any IT applications.

TEXTBOOKS:

1. Parag K Lala, Mc Graw Hill Education, “Quantum Computing, A Beginners Introduction”, First edition, 2020.
2. Michael A. Nielsen, Issac L. Chuang, “Quantum Computation and Quantum Information”, Tenth Edition, Cambridge University Press, 2010.

REFERENCES:

1. Chris Bernhardt, “Quantum Computing for Everyone”, The MIT Press; Reprint edition, 2020.
2. Scott Aaronson, “Quantum Computing Since Democritus”, Cambridge University Press, 2013.
3. N. David Mermin, “Quantum Computer Science: An Introduction”, Cambridge University Press, 2007.

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***	***1***	***3***	***1***	***-***	***-***	***-***	***-***	***2***	***-***	***-***	***3***	***1***	***3***	***1***
CO2	***3***	***1***	***3***	***1***	***3***	***-***	***-***	***-***	***2***	***-***	***-***	***3***	***2***	***3***	***1***
CO3	***3***	***1***	***3***	***1***	***3***	***-***	***-***	***-***	***2***	***-***	***-***	***3***	***3***	***3***	***3***
CO4	***3***	***1***	***3***	***1***	***3***	***-***	***-***	***-***	***2***	***-***	***-***	***3***	***1***	***3***	***2***
CO5	***3***	***1***	***3***	***1***	***2***	***-***	***-***	***-***	***2***	***-***	***-***	***3***	***3***	***3***	***2***
CO6	***3***	***3***	***3***	***3***	***3***	***-***	***-***	***3***	***2***	***-***	***3***	***3***	***3***	***3***	***3***

IT23010	MULTICORE ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To learn multicore architectures and their characteristics.
To Introduce parallel programming
To understand serial processing and parallel processing
To understand issues occurring in parallel processing
To learn OpenMP and MPI codes

UNIT I	MULTI-CORE PROCESSORS	9

Single core to Multi-core architectures –Flynn's Taxonomy - SIMD and MIMD systems – Interconnection networks – Symmetric and Distributed Shared Memory Architectures – Message Passing in Parallel Computers-- Cache coherence – Performance Issues -– Parallel program design

SUGGESTED ACTIVITIES :

- Flipped class on generation of processor
- EL on static(compiler) scheduling for instruction execution
- Survey on multi core and draw a mind map on trends of multicore processor
- Tutorial problems for measuring processor performance

SUGGESTED EVALUATION METHODS:

- Quizzes on out of order scheduling
- Group discussion on how to reduce CPI lesser than 1

UNIT II	PARALLEL PROGRAM CHALLENGES	9

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives -mutexes- locks- semaphore- barriers – deadlocks and livelocks – communication between threads -condition variables - signals- message queues and pipes.

SUGGESTED ACTIVITIES :

- Flipped class on Flynn taxonomy
- EL on true and false sharing
- Survey on memory consistency protocol

SUGGESTED EVALUATION METHODS:

- Quizzes on memory consistency
- Group discussion on memory models

UNIT III	SHARED MEMORY PROGRAMMING WITH OpenMP	9

Shared Memory Model - OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance Considerations.

SUGGESTED ACTIVITIES :

- Write a matrix multiplication using OpenMP to parallelize for loop.
- Write a C program using Open MP to compute Fourier/Wavelet Transform and demonstrate the concepts of synchronization and operation reductions
- Write a C program using Open MP to generate different number series with different data scope in threads

SUGGESTED EVALUATION METHODS:

- Mock test for problems on OpenMP
- Quizzes on OpenMP commands for parallel processing

UNIT IV	DISTRIBUTED MEMORY PROGRAMMING WITH MPI	9

Message Passing Model - MPI Interface - MPI program compilation and execution – MPI constructs – libraries – MPI send and receive - MPI Functions – Point-to-point and Collective communication – MPI derived data types – Performance evaluation

SUGGESTED ACTIVITIES :

1. Write a MPI program to compute the dot products of two array.
2. Create a parallelization of sorting using MPI communication primitives.
3. Write man MPI program to explore process management and commination

SUGGESTED EVALUATION METHODS

1. Coding test on MPI
2. Consider a case study and Evaluate both Open MP and MPI implementation

UNIT V	**PARALLEL PROGRAM DEVELOPMENT**	**9**

Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison-Combining MPI and OpenMP - Conjugate Gradient Method - Jacobi Method.

SUGGESTED ACTIVITIES :

- Flipped class on Evolution of GPU in parallel programing
- EL on vector architecture
- Survey on multi core and draw a mind map on parallel programming paradigm

SUGGESTED EVALUATION METHODS:

- Quizzes on multicore and GPU
- Group discussion on GPU vs. vector architecture

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

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

CO1:	Describe multicore architectures and identify their characteristics and challenges
CO2:	Identify the issues in programming Parallel Processors.
CO3:	Write programs using OpenMP and MPI.
CO4:	Design parallel programming solutions using MPI.
CO5:	Compare and contrast programming for serial processors and programming for parallel processors..

TEXT BOOKS:

1	Peter S. Pacheco, “An Introduction to Parallel Programming, Morgan-Kauffman/Elsevier, 2021. .
2	Darryl Gove, “Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011 (unit 2)

REFERENCES:

1	Michael J Quinn, “Parallel programming in C with MPI and OpenMP, Tata McGraw Hill,2003
2	Victor Alessandrini, Shared Memory Application Programming, 1st Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.
3	Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015

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	2	-	-	2	3	3	3
CO2	3	3	3	3	3	2	2	1	2	-	2	3	3	3	3
CO3	3	3	3	3	3	2	2	1	3	-	3	3	3	3	3

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
CO4	3	3	3	3	3	2	2	1	3		3	3	3	3	3
CO5	3	3	3	3	3	3	3	1	2		3	3	3	3	3
AVG	3	3	3	3	2.8	2	2.25	1	2.5	-	2.75	2.8	3	3	3

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

IT23901	INFORMATION TECHNOLOGY ESSENTIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand computer system basics, including components, networking, and server types.
- To learn HTML5, CSS3 fundamentals, and styling techniques for web design.
- To learn JavaScript fundamentals, including variables, functions, objects, and event handling techniques.
- To learn ReactJS fundamentals, including components, state management, routing, and error handling.
- To explore cellular network generations, information systems, privacy, and social networking applications.

UNIT I	HARDWARE AND NETWORK ESSENTIALS	9

Basics of Computer System - Motherboard – Processors – Memory & Storage - Computer Ports - Memory hierarchy - I/O devices – Servers – Types of Servers – Web Server – Database Server – Communication Medium – Fundamentals of Computer Networking – Types of Computer Networks – Network Topologies – Network Standards: OSI Model, TCP/IP Model – Network Components.

Suggested Activities:

- Understanding Personal Computer and various components.
- Case studies on different types of servers.
- Survey on data centre, cloud server and high-end server.

Suggested Evaluation Methods:

- Quizzes on hardware components.
- Presentations of case studies and survey.

UNIT II	WEB AND SCRIPTING ESSENTIALS	9

Internet Basics – Browser Fundamentals – Introduction to HTML5 – HTML5 Tags – HTML5 Forms – HTML Graphics - HTML Media - Cascading Style Sheets (CSS3) Fundamentals - CSS Properties - CSS Styling (Background, Text Format, Controlling Fonts) - Working with Lists and Tables - CSS ID and Class – Box Model – Positioning.

Suggested Activities:

- Browse the internet on special topics given by instructor.
- Learn HTML basic tags for web page design.
- Identify different types of form validations in the websites that are commonly used.
- Practical - Design of a small simple website, interlinking set of web pages created using the HTML tags and CSS.

Suggested Evaluation Methods:

- Quizzes on all the topics of the unit.
- Discussion on form validation.
- Peer evaluation of the simple websites created.

UNIT III	JAVASCRIPT	9

Introduction to JavaScript – Variables – Datatypes – Type Conversions - Comparisons - Assignments - Conditional Branching – Loops – Arrays - Functions – Built-in functions and methods – Function Expressions – Arrow Functions – Objects – Promises - async/await - Modules – Error Handling – DOM tree – Bubbling and capturing - Event delegation - Capturing - Bubbling - Events.

Suggested Activities:

- Modern JavaScript features-based programming
- Flip Classroom on Setting Up a JavaScript Development Environment
- Simple programs in JavaScript.

Suggested Evaluation Methods:

- Quiz on JavaScript Syntax and Features
- Programming exercises on JavaScript basic and advanced features.
- Group Project on Building JavaScript Applications

UNIT IV	**FRONT – END ESSENTIALS**	**9**

ReactJS Introduction - React JSX - Understanding Components and Props – Props – React State – Component Lifecycle - React Hooks - Event Delegation - React Forms - React CSS - React Router - Handling errors in React applications.

Suggested Activities:

- REACT based programming
- Exploring stateless components
- Designing components with React CSS and SaaS

Suggested Evaluation Methods:

- Programming exercise on REACT based component development
- Simple projects for specific use cases

UNIT V	**MOBILE AND APPLICATION ESSENTIALS**	**9**

Generations of Cellular Networks – GSM - Introduction to Information Systems – Personal Information System – Ethics and Privacy – Information Retrieval System – Relevance feedback – Information retrieval system evaluation - Social Networking Applications.

Suggested Activities:

- Flipped classroom on generations of cellular networks.
- Flipped classroom on social networking applications.
- Explore the web to know more about the concepts and technologies used for the design of Information Systems. Students may present their findings orally or in a written report.

Suggested Evaluation Methods:

- Quizzes on cellular networks and social networking applications.
- Presentations on various information systems.
- Demonstration of application.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs)

Upon successful completion of the course, the student will reliably demonstrate the ability to:

CO1. understand the basic concepts of hardware, data communications and networking.
CO2. create dynamic website/web-based applications using HTML5, and CSS3.
CO3. understand the syntax, semantics, and dialects of the JavaScript programming language.
CO4. get familiar with the use of functional components, state components, lifecycle, and routing in ReactJS.
CO5. identify the fundamental concepts of mobile communications and key issues in the design of commonly used applications.

TEXT BOOKS:

1. James Kurose and Keith Ross, “Computer Networking: A Top-Down Approach”, Eighth Edition, 2021.
2. Niederst Robbins, Jennifer, “Learning Web Design: A Beginner’s Guide to HTML, CSS, JavaScript, and Web Graphics”, Fifth Edition, O’Reilly Media, 2018.
3. Greg Lim, Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App, 2021.
4. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2012.
5. R. Kelly Rainer, Casey G. Cegielski, Brad Prince, “Introduction to Information Systems”, Fifth Edition, Wiley Publication, 2014.

REFERENCES:

1. Nabendu Biswas, MERN Projects for Beginners: Create Five Social Web Apps Using MongoDB, Express.js, React, and Node, Apress, 2021.
2. Vasan Subramanian, Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node, A Press Publisher, 2019.

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	2	2	2	-	-	-	-	-	2	2	3	3	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	2	3	2	3
CO4	3	2	3	2	3	-	-	-	2	-	2	2	3	2	3
CO5	2	2	2	2	3	-	-	-	-	-	2	2	2	2	2
AVG	**2.6**	**2.4**	**2.4**	**2**	**2.8**	**-**	**-**	**-**	**2**	**-**	**2**	**2**	**2.8**	**2.4**	**2.8**

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

IT23902	DATA SCIENCE FUNDAMENTALS	L	T	P	C
		3	0	0	3

UNIT I	INTRODUCTION	9

Introduction to Data Science - Overview of Data - Sources of Data - Types of Data – 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.

Suggested Activities:

- Survey of Python tools for data science
- External Learning : Web scraping

Suggested Evaluation Methods:

- Quiz on python tools
- Seminar on web scraping

UNIT II	DESCRIPTIVE DATA ANALYSIS	9

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 - Principal Component analysis – Independent component analysis – Hypothesis testing – Statistical Tests.

Suggested Activities:

- Flipped classroom on qualitative and quantitative datasets
- Tutorial on Sampling and Frequency
- Problem solving using central tendency measures
- Tutorial on Data reduction techniques

Suggested Evaluation Methods:

- Quiz on the type of datasets
- Assignment on determining central tendency measures
- Programming exercise on correlation analysis on a large set of dat

UNIT III	DATA VISUALIZATION	9

Overview of python libraries matplotlib and seaborn - Histogram - Kernel density estimate plots - Box and violin plots - Regression plots - Heatmaps - Clustered matrices – Three Dimensional plot - Surface and Contour plot - Geographic data visualization.

Suggested Activities:

- Tutorial on the different types of plots
- Representation of data from Unit II in different types of graphs
- Analysis and inference from the graph

Suggested Evaluation Methods:

- Quiz on the different types of visualization methods
- Programming assignment on the different plots

UNIT IV	PREDICTIVE ANALYTICS AND EVALUATION	9

Overview of Machine learning concepts – Model construction using regression and Classification models - Linear regression and multiple regression models – KNN classification models - Comparison models - Training Data construction - Normalization -Cross-validation techniques - Accuracy metrics for evaluation of models – Contingency table, ROC curve, Precision-recall curves - A/B testing

Suggested Activities:

• Implement linear regression models using python		
• Implementation of KNN models		
• Construct a contingency table for classifier evaluation		
Suggested Evaluation Methods:		
• Seminar on Regression models		
• Quiz on evaluation measures		
UNIT V	**DATA SCIENCE APPLICATIONS**	**9**
Fraud Detection, Stock Market; Personalized Recommendation System, Content Development using Data Analytics, Analytics for Campaigns - Targeted marketing through Customer Segmentation, Medical Image Analysis and Diagnosis, Drug Discovery, Patient data management, Customer Sentiment Analysis, Natural Language Processing for Review Analysis – Chabot.		
Suggested Activities:		
• Survey of various research articles about the applications of data science		
• Use ChaptGPT for simple recommendations like books for specific course, etc and discuss about its working in groups.		
Suggested Evaluation Methods:		
• Seminar on applications pertaining to Natural language applications		
• Case study assignments on applications.		
TOTAL: 75 PERIODS		
OUTCOMES:		
Upon completion of this course, the student should be able to:		
CO1:	Clearly demonstrate the data collection methods.	
CO2:	Collect, investigate, clean, munge, and alter data.	
CO3:	Use Data Visualization techniques to explore data.	
CO4:	Use regression and classification models and evaluate it	
CO5:	Use Python-based toolkits to create data science applications.	
CO6:	Implement suitable data science applications.	
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	Aragues, A. Visualizing Streaming Data: Interactive Analysis beyond Static Limits.O'Reilly Media, Inc, 2018.	
4	https://www.coursehero.com/study-guides/introstats1/	
5	Géron, A. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts,Tools, and Techniques to Build Intelligent Systems O'Reilly Media, 2017.	
6	Wes McKinney, Python for Data Analysis, 3rd Edition, O' Reilly, 2022	
7	T.V.Geetha and S.Sendhilkumar, Machine Learning: Concepts,Techniques and Applications, 1 st Edition, CRC Press, Taylor and Franics, 2022.	

IT23903	FUNDAMENTALS OF MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of machine learning and probability theory.
- To appreciate supervised learning and their applications.
- To understand unsupervised learning like clustering and EM algorithms
- To understand the theoretical and practical aspects of probabilistic graphical models
- To learn other learning aspects such as reinforcement learning, representation learning, deep learning, neural networks and other technologies.

UNIT I	INTRODUCTION	9

Basic Concepts in Machine Learning – Types of Machine Learning – Supervised, Unsupervised, Semi-supervised and Reinforcement Learning - Applications of Machine Learning - Basics of Learning Theory – Concept Learning – Challenges of Machine Learning – Feature Engineering - Linear Regression – Single and Multiple Variable Regression – Polynomial Regression – Bias and variance - Logistic regression

Suggested Activities:

- Implement Find-S algorithm and Candidate Elimination Algorithm.
- Tutorial on Model selection and Validation
- External Learning - Overfitting and Underfitting
- Practical - Installing Python and exploring the packages required for machine learning

Suggested Evaluation Methods:

- Quiz on machine learning concepts and data.
- Seminar on Version spaces.
- Quiz of Python tools available for implementing machine learning applications.

UNIT II	SUPERVISED LEARNING - I	9

Linear Regression – Multiple variable regression – Logistic regression – Regularization techniques - LASSO, Ridge, and Elastic Net Regression - Decision Tree Learning- ID3 - C4.5 – CART - Instance based Learning - K-Nearest Neighbor Algorithm - Neural Networks – Perceptron - Feed-Forward Networks for binary and multi-class classification - Multi Layer Perceptron - Back Propagation.

Suggested Activities:

- External Learning - Regularization
- Practical - Develop an application that makes predictions from data using Linear Regression, Logistic Regression.
- Practical – Implement ID3 algorithm.
- Practical – Implement a Perceptron and Multi-Layer Perceptron model

Suggested Evaluation Methods:

- Quiz on Regression models
- Group discussion on basics of classification and regression.
- Evaluation of the practical implementations of neural network models using the appropriate test dataset

UNIT III	SUPERVISED LEARNING II AND UNSUPERVISED LEARNING	9

Basics of Neural Networks – Biological and Artificial Neurons - Perceptron – Perceptron Rule - Feedforward networks – backpropagation Algorithms – Classification using Neural networks – Challenges in ANN - Support Vector Machine – Optimal Hyperplane – hard and Soft margin SVM – Non-Linear SVM – Kernels – Support Vector Regression

Suggested Activities:

- Practical – Develop an SVM model for a two-class problem, whose training points are distributed in a 2D plane and improve the performance of the model by applying kernel methods.
- Practical – Implement a bagging and boosting approach for some case studies.
- Implement K- means algorithm for a data set.

Suggested Evaluation Methods:

- Quiz on SVM and Kernel methods.
- Group discussion on Ensemble methods.
- Quiz on Clustering Methods, Dimensionality reduction

UNIT IV	**PROBABILISTIC GRAPHICAL MODELS**	**9**

Probability-based learning – Classification using Bayes Model - Naive Bayes Algorithm – – Gibbs Algorithm - Bayes Classifier for continuous variables - Probabilistic Graphic models – Bayesian Belief Network – Construction of Bayesian Network – Bayesian Inference - Markov Chain – Markov Models - Hidden Markov Models – Applications of HMM

Suggested Activities:

- Assignment on solving numerical problems using HMM.
- Practical - Classification using Naive Bayes algorithm.
- Group Discussion on Markov Random Fields (MRF) and Conditional Random Fields (CRF)

Suggested Evaluation Methods:

- Group discussion on Graphical models.
- Seminar on Parameterization of MRFs.
- Quiz on CRF and MRF

UNIT V	**ADVANCED LEARNING**	**9**

Introduction to Clustering - Hierarchical Clustering – Single Linkage – Complete Linkage – Average Linkage – Partitional Clustering Algorithms – K-means - Expectation Maximization Algorithm – Linear Discriminant Analysis – Principal Component Analysis - Gaussian Mixture Models – Latest Trends – Overview and Scope of Reinforcement Learning – Components of reinforcement Learning – Model-based and Model-free models – Q-Learning Algorithm

Suggested Activities:

- Assignment on SARSA Learning
- Practical - Implement CNN, LSTM

Suggested Evaluation Methods:

- Quiz on Reinforcement Learning
- Group Discussion on Deep Neural Networks.
- Evaluation of the practical implementation of CNN, LSTM

TOTAL: 45 = 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Disseminate the key elements of machine learning and the basics of concept learning.
CO 2.	Apply regression analysis, decision tree models and neural networks for regression and classification problems.

CO 3.	Implement SVM, ensembling methods for an appropriate application
CO 4.	Apply clustering methods for learning with unsupervised data.
CO 5.	Design and implement a BBN, HMM for a sequence model type of application and implement a PGM for any real time application using an open-source tool.
CO6	Describe Reinforcement learning and use a tool to implement Deep learning algorithms.

TEXTBOOKS:

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, First Edition, Springer, 2006.
2. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.
3. Sridhar S, Vijayalakshmi M, “Machine Learning”, First Edition, Oxford University Press, 2022.

REFERENCES:

1. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
2. EthemAlpaydin, “Introduction to Machine Learning”, Third Edition, Prentice Hall of India, 2005.
3. T. Hastie, R. Tibshirani, J. Friedman, “The Elements of Statistical Learning”, Second Edition, Springer, 2008.
4. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, CRC Press, 2009.
5. T. V. Geetha, S. Sendhilkumar, “Machine Learning: Concepts, Techniques and Applications” Chapman & Hall/CRC Press, 2023.

IT23904	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

IT23905	PRINCIPLES IN OBJECT ORIENTED PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce basic concepts and advanced features of Object Oriented Programming.
- To develop various applications using overloading concepts.
- To familiarize code reusability by inheritance and polymorphism.
- To introduce the concepts of generic programming.
- To learn file manipulation and to handle exceptions in programming.

UNIT I	OVERVIEW OF OOP, CLASS AND OBJECTS	9

Object Oriented Programming Concepts – Procedure vs. Object-oriented programming – Tokens - Pointers - User-defined types – ADT- Classes and Objects- Member Functions – Data Members- private and public members – static, Inline, friend and constant Functions – Constructors and Destructors - this Pointer.

Suggested Activities:

- Flipped Classroom - Features of OOP, Pointers
- Exploration of examples on static functions and usage of 'this' pointer
- Exploration of the usage of reference variables, pointer to reference and reference to a pointer.

Suggested Evaluation Methods:

- Quizzes on pointers, access specifiers, constructors and destructors

UNIT II	OVERLOADING	9

Function Overloading - Operator Overloading – Fundamentals – Restrictions – Operator functions as Class members vs Global Functions – Overloading stream insertion and Stream extraction operators – Unary – Binary operator overloading - Dynamic Memory Management.

Suggested Activities:

- Application development using Friend functions and function overloading.
- External learning - Dynamic memory allocation operators and its usage.

Suggested Evaluation Methods:

- Assignments on the usage of dynamic memory allocation operators, Friend functions and reference variables.

UNIT III	INHERITANCE AND POLYMORPHISM	9

Inheritance -types– Base and derived classes - protected members -Relationship between base class and derived classes with case study - private, public and protected inheritance- Constructors and Destructors in Derived Classes – Polymorphism - Relationships among Objects in an Inheritance Hierarchy – Compile time vs Runtime Polymorphism - Virtual Functions – Abstract Classes – Pure Virtual Functions.

Suggested Activities:

- Flipped classroom on modes of inheritance in comparative aspect
- Exploration on the usage of Virtual Functions and Abstract Classes.
- Application development using inheritance and polymorphism

Suggested Evaluation Methods:

- Quizzes on modes of inheritance, Virtual Functions and Abstract Classes

UNIT IV	TEMPLATES AND STANDARD TEMPLATE LIBRARY	9

Function Template – Overloading Function Templates - Class Template – Non Type parameters and Default types for Class Templates – Templates and Inheritance, friend and Static Members - Name spaces- Casting- Standard Template Library – Container Classes – Vectors – Lists – Maps- Strings.

Suggested Activities:

- Application development using Function and Class Templates
- External learning - STL Containers and Iterators.

- Practical - Solve a given problem (such as Vector Manipulation, List Updation) by choosing appropriate functions from STL.

Suggested Evaluation Methods:

- Demonstration of the application development
- Assignments on problem solving using STL

UNIT V	**I/O SYSTEM, FILE I/O AND EXCEPTION HANDLING**	**9**

C++ Streams - C++ Stream classes – Formatted IO – File classes and File operations - Case Study - Exception Handling –User defined Exceptions - try, catch, throw - rethrowing an Exception – Standard Library Exception Hierarchy.

Suggested Activities:

- Flipped Classroom on basics of exception handling
- Application development using files and exception handling

Suggested Evaluation Methods:

- Quizzes on exception handling

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the Object-oriented programming concepts and fundamentals.
CO 2.	Implement the features of overloading in object-oriented programming.
CO 3.	Implement the concept of reusability and polymorphism.
CO 4.	Write generic programs and STL based applications.
CO 5.	Create and process data in files using file I/O functions and practice exception handling.

TEXTBOOKS:

1. HM Deitel and PJ Deitel, “C++ How to Program”, Tenth Edition, Pearson Education, 2020.
2. Herbert Schildt, “The Complete Reference in C++”, Fifth Edition, Tata McGraw Hill, 2017(Reprint).

REFERENCES:

1. Bjarne Stroustrup, “The C++ Programming language”, Fourth edition, Pearson Education, 2013.
2. Stephen Prata, “C++ Primer Plus”, Sixth Edition, Pearson Education, 2011.
3. E Balagurusamy, “Object oriented Programming with C++”, Eighth edition, Tata McGraw Hill, 2020.
4. Marc Gregoire, “Professional C++”, 5th Edition, Wrox, 2021.

ITXXXX	INTRODUCTION TO WEB PROGRAMMING	L 3	T 0	P 0	C 3

COURSE OBJECTIVES:

- To learn the basic object oriented concepts using Java language.
- To understand the advanced features of Java language.
- To understand the essential client side technologies for web programming.
- To develop applications using database connectivity and server side programming in Java environment.
- To develop smart device based web application and deploy in different platforms.

UNIT I	JAVA FUNDAMENTALS	9

Overview of Java – OOPS Fundamentals in Java: Classes, Objects, Methods and Strings– Array and Array Lists - Static methods – Abstract classes- Overloading Constructors – Method Overriding - Inheritance – Polymorphism – Interfaces: Implementing and extending interfaces.

Suggested Activities:

- Simple Java programming using control statements, strings, arrays, ArrayList, passing and returning object with exception handling.
- Exploring class hierarchy using inheritance and implementing Interface based run– time polymorphism.
- String manipulation and regular expression based examples.

Suggested Evaluation Methods:

- Grading system to evaluate simple java exercises.
- Tutorials on program writing skills.
- Simple application development using all the above mentioned features.

UNIT II	JAVA GUI AND FILE STREAMS	9

Predefined Libraries - Using String class - Working with Data & Time - Java I/O -AWT & Swings – Regular Expressions – Files, Streams and Object Serialization – Generic collections – Generic Classes and Methods-Java Applet Basics- Event Handling and Applet Communication.

Suggested Activities:

- Applet and frame based application development using Swing.
- File stream and object serialization on text and binary data.
- Thread priorities and synchronization based application development.
- Simple networking programs like chat application.

Suggested Evaluation Methods:

- Grading system to evaluate simple java exercises.
- Tutorials on various GUI control based applet and frame applications with event handling.
- Application development based on I/O stream and thread manipulation

UNIT III	JDBC AND WEB APPLICATION DEVELOPMENT	9

Overview of JDBC API - Establishing a connection with the database- Servlet: Servlet Architecture – Servlet lifecycle – Generic Servlet – HttpServlet –Servlet interface-Server-Side Include: Overview of JSP – JSP Components –Java Server Faces - MVC Architecture of JSF Apps.

Suggested Activities:

- Programming exercises on HTML forms with Java script and JQuery objects.

- XML and JSON based AJAX enabled rich Internet application.

Suggested Evaluation Methods:

- Case studies on simple web site with HTML, Java script and JQuery objects.
- AJAX enabled web site realization.
- Java script based speech API implementation.

UNIT IV	**ADVANCED FRAMEWORKS**	**9**

MVC framework – JPA-Hibernate - Introduction to ORM, JPA Hibernate - Different ID Generation Strategies - Hibernate with Inheritance Hibernate Query language – ORM mapping – Spring Framework – Spring Boot - Introduction to STS (Spring Tool Suite).

Suggested Activities:

- Servlet programming with database connectivity and session tracking.
- JSF applications with database connectivity and session management.

Suggested Evaluation Methods:

- Demonstration of simple web application using Servlet and JSF.
- Session management demos using Servlet and JSF.

UNIT V	**WEB SERVICES**	**9**

Spring Web Services - Introduction to Web Service - Basics of REST APIs – Spring REST – Micro services with Spring Boot-Spring Cloud - Introduction to MicroService architecture - Advantages with MicroService over Monolithic architecture - Develop and Deploy MicroService application in localhost -Introduction to DevOps and advantages- DevOps Tools.

Suggested Activities:

- Asynchronous web application development.
- Android based mobile application development.
- Practical - Application deployment in web servers.

Suggested Evaluation Methods:

- Evaluating asynchronous application development.
- Evaluation of online web hosting.
- Modular design factors like cohesion and coupling used to evaluate proper modules breakup.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Implement Object-Oriented concepts in Java programming.
CO 2.	Design and implement Generics and GUI based application development.
CO 3.	Implement and solve problems using collections, I/O and Reflections in Java.
CO 4.	Develop dynamic web applications with database connectivity using server-side technologies
CO 5.	Design and develop applications using advanced frameworks and web services.

TEXTBOOKS:

1. Paul J. Deitel, Harvey Deitel, “Java How to Program”, Eleventh Edition, Pearson Education, 2017.
2. “Core and Advanced Java, Black Book”, Dreamtech Press, 2018.

REFERENCES:

1. Felipe Gutierrez, Joseph B. Ottinger," Introducing Spring Framework 6: Learning and Building Java-based Applications With Spring, APress, 2022.
2. Moisés Macero García, Tarun Telang," Learn Microservices with Spring Boot 3: A Practical Approach Using Event-Driven Architecture, Cloud-Native Patterns, and Containerization", APress, 2023.
3. Herbert Schildt , "Java The Complete Reference", Eighth Edition, Tata McGraw Hill, 2011.
4. Cay S.Horstmann, "Core Java Volume I & II", Pearson Education, 2018.
5. Paul Dietel, Harvey Dietel, Abbey Dietel, "Internet and World Wide Web", Fifth Edition, Pearson Education, 2012.
6. Uttam K. Roy , "Advanced Java Programming", Oxford University Press, 2015.

IT23907	FULL STACK DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the collaborative version control and Node applications
- To develop front end application using React
- To use Typescript in web applications
- To use Webpack for creating web applications
- To deploy applications through containers

UNIT I	SERVER SIDE ACTION	9

Node and NPM - Installation - Commands - Packaging – file system - http/ https - OS - Path - Process - - Node.js basics - Node Package Manager - Node.js Web server – Frameworks of Node.js - Collaborative version control system- git- Packaging using NPM.

Suggested Activities:

- Node and Express based web development Handling of various APIs associated with Node.js
- Node installation and packaging exercises using NPM.

Suggested Evaluation Methods:

- Programming exercise on Node.js based development
- Simple projects for specific use cases

UNIT II	CLIENT SIDE ACTION	9

ReactJS Introduction - React JSX - Understanding Components and Props – Props – React State – Component Lifecycle - React Hooks - Event Delegation - React Forms - React CSS - React Router - State Management with Redex – Async / await – Promises - Fetch API - Handling errors in React applications.

Suggested Activities:

- REACT based programming
- Exploring stateless components
- Designing components with React CSS and SaaS

Suggested Evaluation Methods:

- Programming exercise on REACT based component development
- Simple projects for specific use cases

UNIT III	TYPESCRIPT	9

Introduction to Typescript - Programming structures - Boolean - Arrays - Tuples - enum - function - Classes - Inheritance - Interfaces - Namespaces - Modules - Decorators - Debugging Typescript apps - Development of a web application with Typescript.

Suggested Activities:

- Use Typescript in Web applications.
- Practice exercises on Typescript concepts and JSX

Suggested Evaluation Methods:

- Quiz on Programming exercise on Typescript
- Simple projects for specific use cases

UNIT IV	WEBPACK	9

Introduction to Web pack - Dependency graph – Entry point – Output - Plugins – Loaders - Configurations- Modules – Module Resolution and Federation –Targets - Hot module replacement - The Manifest- Immediately Invoked Function Expressions(IIFE) - Automatic Dependency Collection - Under the Hood- REST Endpoint Creation and Use- Consuming REST API in React and Axios- Mailer App.

Suggested Activities:

- Setting up Webpack
- Creation of REST Endpoint

Suggested Evaluation Methods:

- Simple projects for specific use cases using Webpack

UNIT V	DEPLOYMENT THROUGH CONTAINERS	9

Containerization - Installation of Docker - Pulling Images - Creating Images – Image building practices- Deploying to Docker hub – Multi container App- Bind mounts - Docker Compose - Development and deployment of js applications in Docker- Deployment and Orchestration: Kubernetes-Swarm- Cloud integrations

Suggested Activities:

- Practice exercises on Docker
- Containerization of web applications
- Multi container application using Docker Compose

Suggested Evaluation Methods:

- Demonstration and assessment of practice exercises on Docker and containerization

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO 1.	Understand the collaborative version control and Node applications
CO 2.	Develop front end application using React
CO 3.	Use Typescript in web applications.
CO 4.	Use Webpack for creating web applications
CO 5.	Deploy applications through containers

TEXTBOOKS:

1. Frank Zammetti, Modern Full-Stack Development Using TypeScript, React, Node.js, Webpack, and Docker, Apress, 2020
2. David Choi, Full-Stack React, TypeScript, and Node, Packt Publications, 2020.

REFERENCES:

1. Karl Seguin, “The Little Mongo DB Book”, https://github.com/karlseguin/the-littlemongodb-book.
2. Gareth Dwyer, “Flask by Example”, Packt Publishers, 2016.
3. https://aws.amazon.com/education/awseducate/
4. http://packaging.ubuntu.com/html/packaging-new-software.html
5. http://www.pyinstaller.org/
6. https://pypi.org/project/py2exe/0.9.2.0/

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	1	1	-	2	2	1	-	1	-	-	3	3	3	3
CO2	2	1	2	1	3	2	2	-	1	-	-	3	3	3	3
CO3	2	2	3	1	3	2	3	-	2	-	-	3	3	3	3
CO4	2	2	2	1	3	2	3	-	2	-	-	3	3	3	3
CO5	2	2	3	2	3	2	3	1	3	1	2	3	3	3	3
AVG	2	1.6	2.2	1.25	2.8	2	2.4	1	1.8	1	2	3	3	3	3

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

IT23908	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:

5. Claudia Tom Dieck,Timothy H. Jung , Sandra M. C. Lourei, “Augmented Reality and Virtual Reality: New Trends in Immersive Technology”, Packt Publisher.2021
6. Virtual Reality By Samuel Greengard, MIT Press, 2019
7. RalfDoerner, Wolfgang Broll, Paul Grimm and Bernnard Jung, “Virtual and Augmented Reality (VR/AR)”, Springer Publication, 2023
8. Burdea GC, Coiffet P, “Virtual reality technology”, Second Edition, Wiley-IEEE Press, 2006

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4. Mihelj, Matjaž, Domen Novak, and Samo Beguš. "Virtual reality technology and applications" Springer Publication, 2014
5. Haller M, Billinghurst M, Thomas B, editors. “Emerging technologies of augmented reality: Interfaces and design”, IGI Global; 2006
6. Hale KS, Stanney KM, “Handbook of virtual environments: Design, implementation, and applications”. CRC Press; 2014

COURSE OUTCOMES	Program Outcomes (POs) & Program Specific Outcomes (PSOs)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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