



Bharatiya Vidya Bhavan's

Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)

[Knowledge is Nectar]

Liberal, Pi-Model of Engineering Education @ SPIT

(Department of Computer Science and Engineering)

Department of Computer Engineering

A common scheme for "Computer Science and Engineering" and "Computer Engineering" till Semester V.

Effective from Academic Year 2024-28 [2024-2028 BATCH]

**Revised -Board of Studies Approval: 18th July 2025,
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CURRICULUM STRUCTURE FOR UNDERGRADUATE ACADEMIC PROGRAMS IN COMPUTER ENGINEERING AT SPIT W.E.F. A.Y. 2024-25 [2024-2028 BATCH]

A common scheme for “Computer Science and Engineering” and “Computer Engineering” till Semester V.

Preamble: Government of Maharashtra has directed Autonomous Colleges to revise their curriculum and step into the implementation of National Education Policy (NEP) 2020. We commit ourselves to the effective and fruitful implementation of NEP 2020 in its spirit. The holistic development of learners has always been the priority and center of focus for “Bharatiya Vidya Bhavan”. S.P.I.T. started implementing the philosophy of NEP in the year 2019 itself. We have in fact graduated the first batch of our holistic curriculum in 2023. Now based on our learnings from the implementation and recent recommendations of the Government, we are pleased to offer a 2nd iteration of our holistic curriculum for 2023-27, a Liberal Pi Model of Engineering Education.

This curriculum aims at the development of an **all-rounded** personality. It follows a **holistic** approach to education, ensures strong science, and mathematics foundation and program core, develops expertise in domain vertical through the sequel of electives, ensures significant exposure to additional discipline through a “Multidisciplinary Minor” courses, imparts state of the art practical knowledge through a semester-long industry / research internship, collaborates outside world for the imparting relevant skill courses, challenges good learners through “Honors” evaluation, and systematically develops soft skills, and social, physical, mental, spiritual personality through carefully articulated **Liberal Learning** and **Humanities** sequels. Thus, it offers a unique, liberal “**Pi-Model**” of Engineering Education.

Table 1: Nomenclature of the courses in the curriculum

Abbreviation	Course Category
BSESC	Basic Science & Engineering Science Courses
BSESEC	Basic Science & Engineering Science Elective Courses
SEC	Skill Enhancement Course
AEC	Ability Enhancement Course
HSSMC	Humanities and Social Science in Management Courses
CC	Cocurricular Courses
IKS	Indian Knowledge System
UHV	Universal Human Values
PCC	Program Core Courses
PEC	Program Elective Courses
OEC	Open Elective Courses
ELC	Experiential Learning Courses
MDM	Multidisciplinary Minor
CP	Community Project
HC	Honor Courses
DMC	Double Minor Course

Indicative List of BSE SE Courses:

- Engineering Physics
- Engineering Chemistry
- Biology for Engineers
- Engineering Mechanics
- Engineering Graphics
- Material Science
- Environmental Science
- Thermal & Fluid Engineering

Table 2: Comparison of S.P.I.T. credit structure with the G.R. recommendations

SPIT											
Sem	BSES	SE C	AE C	HSSM	CC (LLC)	PCC	PEC	OE	EXP LEARNIN G	MD M	Total
I	11	5	2		1						19
II	11	5	2		1				2		21
III	6	2		2	1	12					23
IV	3	2		2	1	12				3	23
V						19			2	4	25
VI		2				7	6		1	3	19
VII							6	3	3	4	16
VIII								3	11		14
Total	31	16	4	4	4	50	12	6	19	14	160
%	19.38	10	2.5	2.5	2.5	31.25	7.5	3.75	11.87	8.75	100
G.R. (NEP-2020) Recommended											
Total	30	10	8	4	4	44	20	8	22	14	164
%	18.3	6.1	4.88	2.44	2.44	27	12.2	4.88	13.42	8.54	100

Figure 1: Comparison of S.P.I.T. credit structure with the G.R. recommendations

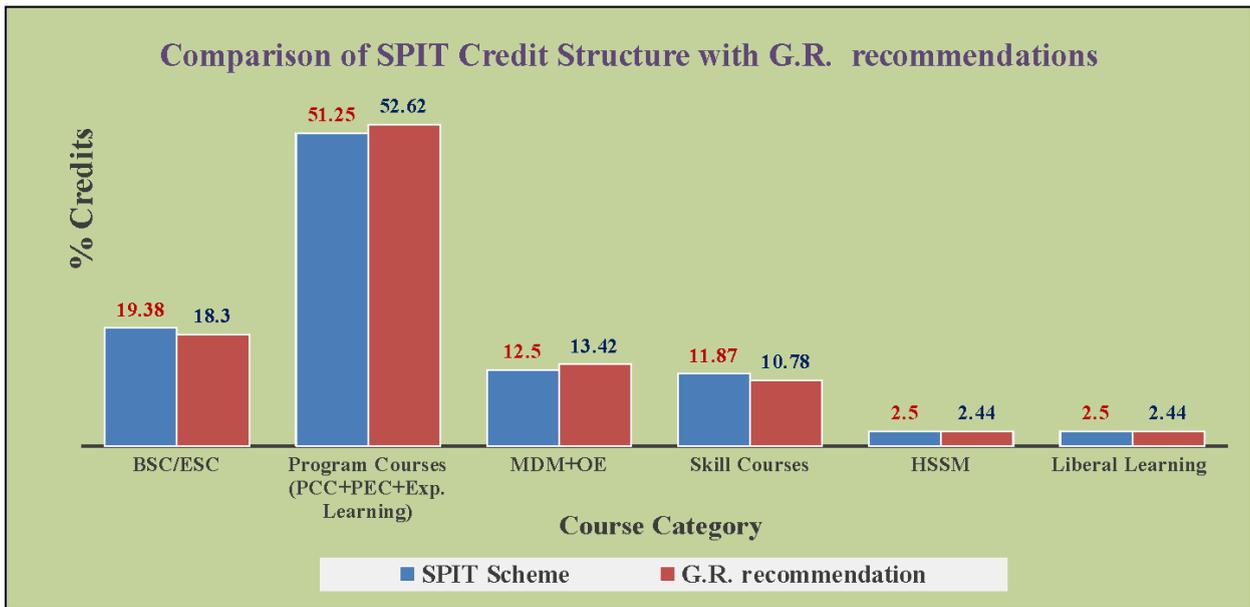


Figure 2: Pie-chart of vertical-wise allocation of credits

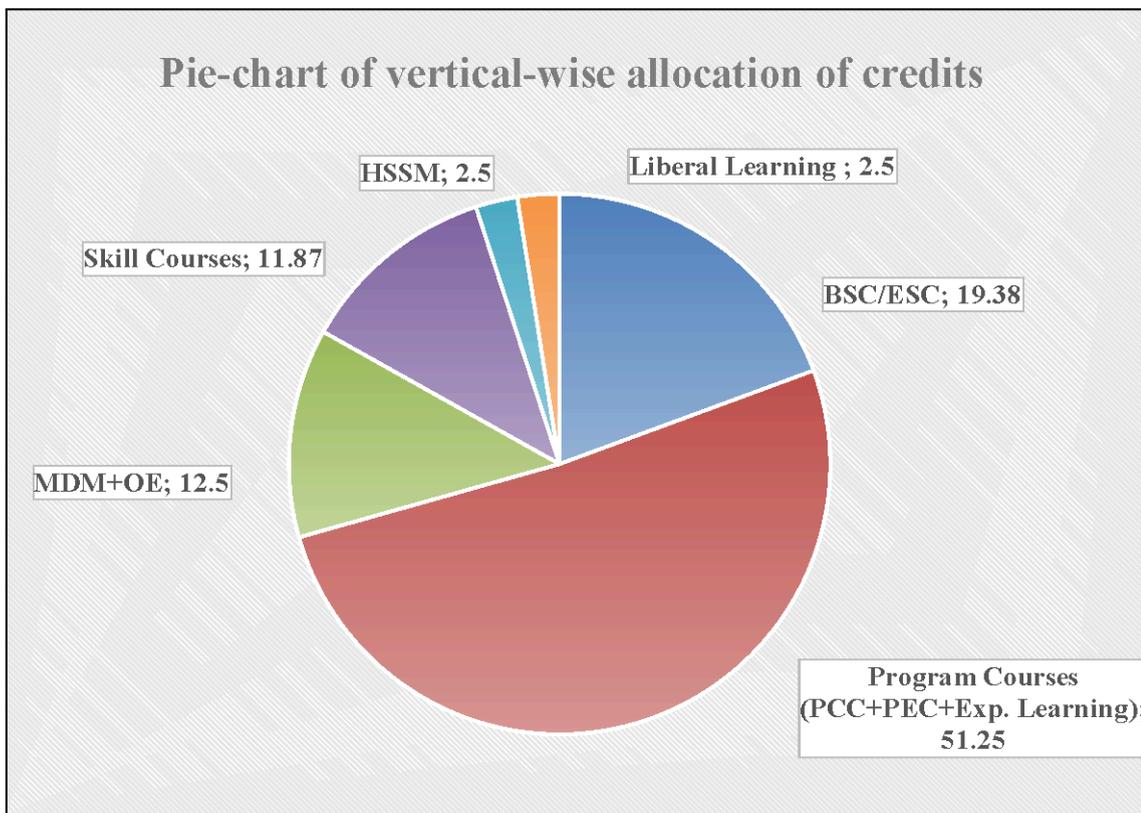


Table 3: Semester-wise allocation of credits to different verticals

SEM I										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	MA101	Mathematics I (ECL)	3	1	0	8	12	4
2	Skill Enhancement Course	SEC	CE101	Problem Solving using Imperative Programming Lab	1	0	2+2	4	9	3
3	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS110	Energy Science	2	0	2	3	7	
			AS111	Thermal & Fluid Engineering	3	0	0	3	6	
4	Skill Enhancement course	SEC	AS106	Tech Shop	1	0	2	2	5	2
			AS107	Soft Skill I						
5	Basic & Engg. Sciences	BSES	ET101	Digital Systems	3	0	2	5	10	4
			ET102	Basic Electrical Engineering						
6	Ability Enhancement -*Course	AEC	AS108	IKS	2	0	0	1	3	2
			AS109	UHV						
7	Cocurricular Courses	CC (LLC)	LLCX	LLC--I	1	0	0	2	3	1
Total					13	1	10	25	49	19

SEM-II										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	MA102	Mathematics II (DECA)	3	1	0	8	12	4
2	Skill Enhancement Course	SEC	CE102	Problem Solving using Object Oriented Programming Lab	1	0	2+2	4	9	3
3	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS111	Thermal & Fluid Engineering	3	0	0	3	6	
4	Skill Enhancement course	SEC	AS106	Tech Shop	1	0	2	2	5	2
			AS107	Soft Skill I						
5	Basic & Engg. Sciences	BSES	ET101	Digital Systems	3	0	2	5	10	4
			ET102	Basic Electrical Engineering						
6	Ability Enhancement - *Course	AEC	AS108	IKS	2	0	0	1	3	2
			AS109	UHV						
7	Cocurricular Courses	CC (LLC)	LLCX	LLC--I	1	0	0	2	3	1
Total					13	1	10	25	49	19

Summer Term										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Experiential Learning	CP (in Summer)	PR101	Community Project	0	0	4	4	8	2
2	HSSE	COI	AS112	Constitution of India (2Hrs/Week)	1	0	0	1	2	NC

SEM III										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE201	Discrete Structures and Graph Theory	3	0	0	5	8	3
2	Basic & Engg. Sciences *	FOM-I	MA202	Foundation of Mathematics-I*	2	1	0	0	3	3
3	Skill Enhancement Course	SEC	AS202	Python Programming for Data science	0	1	2	4	7	2
4	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS110	Energy Science	2	0	2	3	7	
AS111	Thermal & Fluid Engineering	3	0	0	3	6				
5	Humanities	HSSM-I	HS2XX	Course I	2	0	0	3	5	2
7	Program Core Courses (12 Credits)	PCC	CE202	Data Structures	3	0	2	4	9	4
8		PCC	CE203	Computer Organization and Architecture	3	0	2	4	9	4
9		PCC	CE204	Database Management Systems	3	0	2	4	9	4
10	Cocurricular Courses	CC (LLC)	LLCXX	LLC--III	1	0	0	1	2	1
				Total	17	1	10	28	56	23

SEM IV										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE205	Statical Methods in Computer Science	3	0	0	6	9	3
2	Basic & Engg. Sciences *	FOM-II	MA204	Foundation of Mathematics-II*	2	1	0	0	3	3
3	Skill enhancement course	SEC	AS201	Soft Skill II--Professional Communication Skills	0	1	2	4	7	2
4	Humanities	HSSM-II	HS2XX	Course II	2	0	0	3	5	2
5	Program Core Courses (12 credits)	PCC	CE206	Operating Systems	3	0	2	4	9	4
6		PCC	CE207	Design and Analysis of Algorithms	3	0	2	4	9	4
7		PCC	CE208	Computer Communications and Networks	3	0	2	4	9	4
8	Cocurricular Courses	CC (LLC)	LLCXX	LLC--IV	1	0	0	1	2	1
9	Multidisciplinary Minor	MDM	MDEC1X	MDM-I	To be defined by others					3
Total					15	1	8	26	50	23

*Only for Lateral Entry Students

Summer term (For Lateral Entry Students)										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE201	Discrete Structures and Graph Theory	3	0	0	5	8	3
2			CE205	Statical methods in Computer Science	3	0	0	6	9	3

- Students are expected to start working for the Mini Project I during the summer.
- Summer Research Phase I of minimum 2 months and Course on Research Methodology for the "Honors by Research" for 7(4+3) credits- HR21
- For Enrollment to Honors by research, Minimum CGPA must be 8.25

SEM V										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Experiential Learning	ELC	PR1	Mini Project I	0	0	4	4	8	2
2	Program Core Courses (19 Credits)	PCC	CE301	Distributed Computing	3	0	2	6	10	4
3		PCC	CE302	Software Engineering	3	0	2	6	10	4
4		PCC	CE303	Artificial Intelligence and Soft Computing	3	0	2	6	11	4
5		PCC	CE304	Theory of Computation	3	0	0	5	8	3
6		PCC	CE305	Cryptography and Network Security	3	0	2	5	10	4
7	Multidisciplinary Minor	MDM	MDEC2X	MDM-II	To be defined by others					4
Total					15	0	12	32	57	25

SEM VI										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Program Core Courses (7credits)	PCC	CE306	System Programming and Compiler Construction	3	0	2	4	9	4
2		PCC	CE307	Machine Learning	2	0	2	5	9	3
3	Multidisciplinary Minor	MDM	MDEC3X	MDM-III	To be defined by others					3
4	Experiential Learning	ELC	PR3-I	Main Project Stage I	0	0	2	4	6	1
5	Program Elective Courses	PEC	CE3X1	PE-I	2	0	2	4	8	3
6	Program Elective Courses	PEC	CE3X2	PE-II	2	0	2	4	8	3
7	Skill Enhancement Course	SEC	CE308	DevOps Lab	0	1	2	2	5	2
Total					9	1	12	23	45	19

- Summer Research Phase II of minimum 2 month and A course on Optimization for the “Honors by Research” for 7(4+3) credits HR31
- For Enrollment to Honors by research, Minimum CGPA must be 8.25

SEM VII									
Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
Multidisciplinary Minor	MDM	MDEC4X	MDM-IV	To be defined others					4
Program Elective Courses	PEC	CE4X3	PE-III	2	0	2	4	8	3
Program Elective Courses	PEC	CE4X4	PE-IV	2	0	2	4	8	3
Open Elective	OE	OE1	OE-I	2	0	2	4	8	3
Experiential Learning	ELC	PR3-II	Main Project Stage II	0	0	6	4	10	3
Total				6	0	12	16	34	16

SEM VIII										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Open Elective	OE	OE2	OE-II**	2	0	2	4	8	3
2	Experiential Learning	ELC	INTR	Research/ Industry Internship/Main	0	0	24	12	36	11
			INTI	Project Stage III***						
Total					2	0	26	16	44	14

- Extended Research Internship of minimum 2 month for the “Honors by Research” for 4 credits HR41
- For Enrollment to Honors by research, Minimum CGPA must be 8.25

** To be completed from MOOCs

***Students neither taking research or industry internships nor willing to extend their project work can earn additional 11 credits from Swayam Platform or NPTEL or registering courses from any peer institution of higher learning., besides open elective program elective courses offered by the institute.

Indicative List of Humanities courses (HSSM-I):

Course Code	Course Title	Course Code	Course Title
HS211	Law for Engineers-I	HS212	Law for Engineers-II
HS221	Psychology -I	HS222	Psychology -II
HS231	Finance for Engineers-I	HS232	Finance for Engineers-II
HS241	Economics-I	HS242	Economics-II
HS251	French-I	HS252	French-II
HS261	German-I	HS262	German-II
HS271	Japanese-I	HS272	Japanese-II
HSNP	NPTEL (HSS/Management)	HSNP	NPTEL (HSS/Management)

Indicative List of Cocurricular courses (LLC)

Course Code	Course Title
LLC01	Dance (Kathak)
LLC02	Dance (Bharatnatyam)
LLC02	Fundamentals of Photography
LLC03	Art of Short Film Making / Cinematography
LLC04	Film Appreciation
LLC05	Basics of Music Composition
LLC06	Basics of Keyboard playing
LLC07	Physical Fitness
LLC08	Self Defense for Women
LLC09	Pran-Vidya (Combo of Yoga and Pranayam)
LLC10	Jeevan Vidya (Work Life Balance)
LLC11	Integrated Personality Development-I
LLC12	Indian Knowledge System-I
LLC13	Design Thinking
LLC14	Innovation and Creativity
LLC15	Principle Centered Leadership
LLC16	Social Psychology
LLC17	Mentoring of School Children at SPIT (Abhudaya)
LLC18	Basics of Fire Safety
LLC19	Study of one of the Identified Books
LLC20	Teaching Assistantship
LLC21	Trekking
LLC22	Kannada Language
LLC23	Telugu Language
LLC24	Tamil Language
LLCXX	Any other Course approved by Dean Academics and Research

PROGRAM ELECTIVE COURSES

4 Electives are sufficient to specialize in a particular domain.

Track	PE-I CE3X1	PE-II CE3X2	PE-III CE4X3	PE-IV CE4X4
Artificial Intelligence	CE311: Natural Language Processing	CE312: Deep Learning	CE413: Generative AI	CE414: Explainable AI
Network and Security	CE321: Ethical Hacking	CE322: Information and System Security	CE423: Blockchain Technology	CE424: Digital Forensics and Cyber Security
Data Science	CE331: Big Data Analytics	CE332: Information Visualization	CE433: Time-series Data Analysis	CE434: Decision Making and Business Intelligence
General	CE341: Digital Image Processing	CE342: High Performance Computing	CE443: Quantum Computing	CE444: Edge Computing
Generative AI Mastery (by Vizvara)	CE351: Generative AI Fundamentals	CE352: Foundations of Large Language Models	CE453: Large Language Models: Production and Deployment	CE454: Capstone Project in Artificial Intelligence

LIST OF MULTIDISCIPLINARY MINORS OFFERED BY S.P.I.T.[MDM]

MDM SEQUELS FOR ELECTRONICS AND TELECOMMUNICATIONS ENGG.[EXTC]

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Computer Engineering	M051: Database Management Systems	M052: Data Structures and Algorithms	M053: Cloud Computing	M054: Internet and Web Technology
Artificial Intelligence and Machine Learning	M061: Fundamentals of NNFL (NN, Fuzzy)	M062: Machine Learning	M063: Deep Learning	M064: Generative AI and application
Data Science	M071: Fundamentals of Data Science	M072: Data Analytics and Visualization	M073: Decision Making and Business Intelligence	M074: Social Media Analytics
Interface and Experience Design	M081: UI/UX Fundamentals	M082: Fundamentals of Experience Design	M083: Human Machine Interaction	M084: Prototyping and Interaction Design [Capstone project]

MDM SEQUELS FOR CE/CSE

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Industrial IoT (MDM-01)	M011: Fundamental of Internet of Things	M012: Embedded “C” and Micro Python for IoT	M013: IOT Communication and Network Layer Protocols	M014: IoT Applications and Security
Signal Processing and Communication (MDM-02)	M021: Digital Signal Processing	M022: Principles of Communication & Systems	M023: Digital Image Processing	M024: Wireless Communication and Networks
VLSI (MDM-04)	M041: Hardware Description Language Programming	M042: Digital CMOS VLSI Design	M043: VLSI Physical Design	M044: ASIC Verification

MDM COURSE OFFERED BY INDUSTRY

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
AI (For Non CS Students) (MDM 09) (Vizura Technologies Pvt Ltd)	M091: Foundations in AI and ML	M092: Machine Learning and Deep Learning Mastery	M093: NLP and CV Mastery	M094: Large Language Models Theory and Deployment, Capstone Project
Financial & Strategic Management (MDM-11) (Six Ladders)	M111: Economics and Strategic Management	M112: Introduction to Financial Analysis	M113: Introduction to Finance	M114: Industry Project (FNSM)
UI/UX Design Programme (MDM-13) (Pearl Academy Pvt. Ltd.)	M131: Foundations of UI/UX Design	M132: Intermediate UI/UX Design	M133: Advanced UI/UX Design and Specializations	M134: Advanced Research and Emerging Practices in
Management (MDM-15) (SPJIMR Management)	M151: Fundamentals of Accounting & Finance	M152: Supply Chain Management	M153: IT for Business	M154: Marketing Management
Barclays Minor in Banking Technology (MDM-16) (Barclays)	M161: BFSI , Data Management & Analytics	M162: Enterprise Risk Management & Applied cyber security	M163: Agile Methodology	M164: Academic-Industry collab Project
Corporate Finance & Investment Banking (MDM -17) (IIT Patna)	M171_P: Data Preparation using MS Excel	M172_P: Corporate Finance & Investment Banking Fundamentals	M173_P: Detailed Investment Banking Operations Activities	M174_P: Performing Diversification in Portfolios and Investments
Business Analytics (MDM-18) (IIT Patna)	M181_P: Python for Data Science	M182_P: SQL for Business Analytics	M183_P: Stats & Machine Learning	M184_P: Data Visualization Tools: Power BI, Excel, Intro to Excel

Notes:

1. Learners who earn a minimum of total 160 credits will be awarded “**B. Tech in Engg. /Tech. with Multidisciplinary Minor**” degree.
2. Learners will have the following options to earn **B. Tech. in Engg. /Tech. degree with MDM and Honors Certification**
If they earn top grades in any 8 Program core courses and earn 80 percentile in GATE examination.
3. Learners who earn 18 additional credits through 6-month (2+2+2) Research Internships during summer breaks and a semester-long Research Internship in Semester 8, as mentioned in the scheme, are eligible for the degree: “**B.Tech. in Engg./Tech. with Multidisciplinary Minor and Honors by Research**”, subject to the conditions specified under the Honors through Research Program.
4. Learner can earn the certificates based on his/her exit from the program as follows:
 - a. After a one-year (40 credits to be earned) and 8-week summer workshop:
Certificate in Engineering.
 - b. After two-years (80 credits to be earned) and 8-week summer workshop:
Diploma in Engineering.
 - c. After three-years (120 credits to be earned) and 8-week summer workshop:
B. Sc. Engineering.

Dr. P. B. Bhavathankar
HoD Computer Engg.

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Dean Academics & Research

Dr. B. N. Chaudhari
Principal

SYLLABUS

SEMESTER I

SEM I										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	MA101	Mathematics I (ECL)	3	1	0	8	12	4
2	Skill Enhancement Course	SEC	CE101	Problem Solving using Imperative Programming Lab	1	0	2+2	4	9	3
3	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS110	Energy Science	2	0	2	3	7	
			AS111	Thermal & Fluid Engineering	3	0	0	3	6	
4	Skill Enhancement course	SEC	AS106	Tech Shop	1	0	2	2	5	2
			AS107	Soft Skill I						
5	Basic & Engg. Sciences	BSES	ET101	Digital Systems	3	0	2	5	10	4
			ET102	Basic Electrical Engineering						
6	Ability Enhancement -*Course	AEC	AS108	IKS	2	0	0	1	3	2
			AS109	UHV						
7	Cocurricular Courses	CC (LLC)	LLCX	LLC--I	1	0	0	2	3	1
Total					13	1	10	25	49	19

SEMESTER II

SEM-II										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	MA102	Mathematics II (DECA)	3	1	0	8	12	4
2	Skill Enhancement Course	SEC	CE102	Problem Solving using Object Oriented Programming Lab	1	0	2+2	4	9	3
3	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS110	Energy Science	2	0	2	3	7	
			AS111	Thermal & Fluid Engineering	3	0	0	3	6	
4	Skill Enhancement course	SEC	AS106	Tech Shop	1	0	2	2	5	2
			AS107	Soft Skill I						
5	Basic & Engg. Sciences	BSES	ET101	Digital Systems	3	0	2	5	10	4
			ET102	Basic Electrical Engineering						
6	Ability Enhancement -*Course	AEC	AS108	IKS	2	0	0	1	3	2
			AS109	UHV						
7	Cocurricular Courses	CC (LLC)	LLCX	LLC--I	1	0	0	2	3	1
Total					13	1	10	25	49	19

First Year Evaluation Scheme (Percentage)

Sr. No.	Course Code	Course Name	Credits	ISE (%)	MSE (%)	ESE (%)	Sub-total (%)	Total
1	MA101	Engineering Calculus-Theory	4	20	20	60	100	100
2	EC101	Digital Systems-Theory	3	15	15	45	75	100
		Digital Systems-Lab	1	15	0	10	25	
3	EC102	Basic Electrical Engineering-Theory	3	15	15	45	75	100
		Basic Electrical Engineering-Lab	1	15	0	10	25	
4	AS101	Engineering Physics-Theory	2	13.5	13.5	40	67	100
		Engineering Physics-Lab	1	26	0	07	33	
5	AS102	Engineering Chemistry-Theory	2	13.5	13.5	40	67	100
		Engineering Chemistry-Lab	1	26	0	07	33	
6	AS103	Biology for Engineers-Theory	3	20	20	60	100	100
7	AS104	Engineering Mechanics-Theory	2	13.5	13.5	40	67	100
		Engineering Mechanics-Lab	1	26	0	07	33	
8	AS105	Engineering Graphics-Theory	1	13	0	20	33	100
		Engineering Graphics-Lab	2	40	0	27	67	
9	AS108	Material Science and Engineering-Theory	3	20	20	60	100	100
10	AS109	Environmental Science -Theory	3	20	20	60	100	100
11	AS110	Energy Science -Theory	3	20	20	60	100	100
12	AS111	Thermal & Fluid Engineering -Theory	3	20	20	60	100	100

13	AS106	Tech Shop- Lab	2	80	0	20	100	100
14	AS107	Soft Skill I	2	80	20	0	100	100
15	CE101	Programming I -Lab	3	80	0	20	100	100
16	CE102	Programming II -Lab	3	80	0	20	100	100
17	AEC01	IKS	2	80	0	20	100	100
18	AEC02	UHV	2	80	0	20	100	100
19	LLC01	LLCXX	1	100	0	0	0	100
20	LLC02	LLCXX	1	100	0	0	0	100
21	PRJ01	Project-01	2	80	0	20	100	100

Note: Course coordinators desirous of changing the percentage allocation to ISE: MSE: ESE for Theory / Lab of any course, must seek approval of Dean Academics and the Principal,



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Engineering Calculus: Sem-I

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Engineering Calculus	3	1	0	8	12	3	1	0	4
		Examination Scheme								
MA101		Component		ISE		MSE		ESE	Total	
		Theory		20%		20%		60%	100%	
		Laboratory		--		--		--	--	

Pre-requisite Course Codes, if any.	Basics of derivatives and integration done earlier.
Course Objective: To develop mathematical skills for solving engineering problems.	
Learning Outcomes (LO): <i>At the End of the course students will be able to:-</i>	
MA101.1	Differentiate a function partially.
MA101.2	Find extreme values of a given function.
MA101.3	Find the nth order derivative of a given function.
MA101.4	Expand a given function as a power series.
MA101.5	Calculate the value of integrals in one variable using different techniques.
MA101.6	Solve multiple integral in various coordinate systems and use to calculate Area.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA101.1	3											
MA101.2	3											
MA101.3	3											
MA101.4	3											
MA101.5	3											
MA101.6	3											

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA101.1						
MA101.2						
MA101.3						
MA101.4						
MA101.5						
MA101.6						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	Partial Differentiation	1,2,3	10
	1.1	Partial derivatives of first and higher order. Partial derivatives of composite functions.		4
	1.2	Euler's theorem for homogeneous functions with two and three independent variables, deductions from Euler's theorem.		3
	1.3	Application of partial derivatives: i) Local Maxima and Minima of functions of two variables. ii) Lagrange's Method of undetermined multipliers.		3
2	Title	Successive Differentiation and Series	1,2,3	10
	2.1	Successive Differentiation: Proofs of nth derivatives of standard functions. Use of De Moivre's theorem and partial fractions to calculate nth derivatives of given functions.		3
	2.2	Leibnitz's Theorem on nth derivative of product of two functions		2
	2.3	Infinite series: 1) McLaurin's series (without proof) and derivation of series of some standard functions using Maclaurin series. Expansion of functions in powers of x by using i) Standard series method ii) Method of differentiation and integration. 2) Taylor's series and applications.		5
3	Title	Integral Calculus (one variable)	1,2,3	8
	3.1	Gamma functions: properties of gamma functions and integrals reducible to gamma functions.		2
	3.2	Beta functions: properties, relation between Beta and Gamma functions, integrals reducible to Beta functions, Duplication formula.		4
	3.3	Differentiation under Integral sign: differentiating integrals with constant limits of integration for one parameter.		2
4	Title	Integral Calculus (multi variable)	1,2,3	14
	4.1	Tracing of curves. Sketching standard solids (Spheres, Ellipsoids, Cylinders, Cones, Tetrahedrons, planes).		2
	4.2	Double Integration: definition and evaluation. Evaluate by changing the order of integration and by changing to polar form.		7
	4.3	Application of double integral to finding area of given regions.		2
	4.4	Triple integration: definition and evaluation (Cartesian and cylindrical coordinates).		3
5	Self Study	1.1 Partial differentiation of implicit functions. 2.3 Series by method of Substitution. 3.2 Proof of Duplication Formula. 3.3 Differentiation under Integral sign using two parameters. 4.1 Finding lengths of curves in Cartesian and polar form.	1,2,3	08
Total				42*

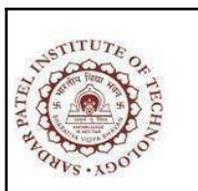
***Total of 42 hours does not include self-study hours.**

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Higher Engineering Mathematics	Forty Fourth	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Engineering Mathematics	Twenty Eighth	H.K Das	S. Chand	2014
2	Advanced Engineering Mathematics	Tenth	Erwin Kreyszig	John Wiley & Sons	2011
3	Advanced Engineering Mathematics	Fourth	Jain and Iyengar	Narosa Publications	2014
4	Higher Engineering Mathematics	Eleventh	B.V. Ramana	Tata McGraw-Hill	2010
5	Advanced Engineering Mathematics	Sixth	Dennis G. Zill	Jones and Bartlett	2016



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Differential Equations and Complex Analysis: Sem-II

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES) MA102	Differential Equations and Complex Analysis	3	1	0	8	12	3	1	0	4
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		20%		20%		60%		100%
		Laboratory		--		--		--		

Pre-requisite Course Codes, if any.	Topics from Engineering Calculus- Semester I
Course Objective: To develop mathematical skills for solving engineering problems.	
Learning Outcomes (LO): <i>At the End of the course students will be able to:-</i>	
MA102.1	Solve differential equations of first order.
MA102.2	Solve differential equations of higher order using operators.
MA102.3	Solve differential equations in electrical engineering problems.
MA102.4	Find powers, roots & logarithm of a complex number and to separate the function of a complex number into real and imaginary.
MA102.5	Check whether a given function is analytic and construct analytic functions.
MA102.6	Compute integrals of complex valued functions.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
MA102.1	3											
MA102.2	3											
MA102.3	3											
MA102.4	3											
MA102.5	3											
MA102.6	3											

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MA102.1							
MA102.2							
MA102.3							
MA102.4							
MA102.5							
MA102.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs
1	Title	Linear Differential Equations of first order	1,2,3	11
	1.1	Exact Differential Equations, Integrating Factors, and equations reducible to exact form.		3
	1.2	Linear differential equations (Definition), equations reducible to linear form, Bernoulli's equation.		2
	1.3	Simple application of differential equation of first and second order to electrical engineering problems.		2
	1.4	Numerical solution of ordinary differential equations of first order and first degree using (a) Taylor's series method (b) Euler's method (c) Modified Euler method (d) Runge-Kutta fourth order formula		4
2	Title	Linear Differential Equations of higher order	1,2,3	11
	2.1	Linear Differential Equation with constant coefficient-complementary function, particular integrals of differential equation of the type $f(D)y = X$ where X is e^{ax} , $\sin(ax+b)$, $\cos(ax+b)$, x^m , $e^{ax}V$, xV , where V is a function of x .		7
	2.2	Cauchy's homogeneous linear differential equation and Method of variation of parameters for second order.		2
	2.3	System of Differential Equations.		2
3	Title	Complex Numbers	1,2,3	8
	3.1	De Moivre's Theorem and its application to determine powers of complex numbers. Roots of complex numbers by De Moivre's Theorem.		3

	3.2	Expansion of $\sin n\theta$ and $\cos n\theta$ in terms of powers of $\sin\theta$ and $\cos\theta$. Expansion of $\sin^n\theta$ and $\cos^n\theta$ in terms of sines and cosines of multiples of θ .		1
	3.3	Hyperbolic Functions: relation between circular and hyperbolic functions, Inverse hyperbolic functions. Separation into real and imaginary parts of complex functions.		3
	3.4	Logarithm of a complex number.		1
4	Title	Analytic functions and Complex Integrals	1,2,3	12
	4.1	Analytic functions, Cauchy Riemann equations in Cartesian and polar form, construction of analytic functions using Milne-Thompson's method, Harmonic functions, poles of $f(z)$.		6
	4.2	Line Integral of complex valued function, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula (for poles lying inside or outside the curve).		6
5	Self Study	1.3 To form D.E. for given L-C-E-R circuit. 2.1 Method of undetermined coefficients to solve differential equations. 2.2 Legendre's differential equation, Method of variation of parameters for third order differential equations. 3.2 Complex examples using De Moivre's Theorem. 4.1 Construction of analytic function $f(z) = u+iv$ when $u+v$ or $u-v$ is given.		08
Total				42*

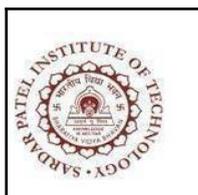
*Total of 42 hours does not include self-study hours.

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Higher Engineering Mathematics	Forty Fourth	Dr.B.S. Grewal	Khanna Publications	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Advanced Engineering Mathematics	Twenty Eighth	H.K Das	S.Chand	2014
2.	Advanced Engineering Mathematics	Tenth	Erwin Kreyszig	John Wiley & Sons	2011
3.	Advanced Engineering Mathematic	Fourth	Jain and Iyengar	Narosa Publications	2014
4.	A First Course in Differential Equations with Modelling Applications	Ninth	Dennis G. Zill	Cengage India	2009



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Engineering Physics

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
BSESE	Engineering Physics	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component		ISE %		MSE %		ESE %		Total %
AS101		Theory		13		14		40		67
		Laboratory		26		–		7		33

Pre-requisite Course Codes, if any.	HSC level physics
Course Objective: To provide the knowledge and methodology necessary for solving problems in the field of engineering	
Learning Outcomes (LO) : <i>At the End of the course students will be able to</i>	
AS101.1	Demonstrate the conceptual knowledge of quantum mechanics, semiconductors, lasers and wave optics.
AS101.2	Solve the problems by applying the basics concepts of physics.
AS101.3	Explain the working principle of various LASERS and its practical applications.
AS101.4	Develop experimental skills and practical abilities.
AS101.5	Use scientific apparatus and comprehend the importance of precision, accuracy of the experimental data.

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS101.1	1											
AS101.2		1										
AS101.3	1											
AS101.4				1								
AS101.5				1								

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS101.1							
AS101.2							
AS101.3							
AS101.4							
AS101.5							
AS101.6							
AS101.7							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Quantum Mechanics		
	1.1	de-Broglie hypothesis; experimental verification of de Broglie hypothesis; wave packet, group velocity and phase velocity; Wave function, Physical interpretation of wave function; Heisenberg's uncertainty principle; Applications of uncertainty principle	1,2,3	09
	1.2	Schrodinger's time dependent wave equation, time independent wave equation; Application of time-independent Schrodinger equation - Particle trapped in one dimensional box and Potential barrier (Tunneling)	1,2,3	
2	Title	Physics of Semiconductors and Semiconductor devices		
	2.1	Conduction in metals and semiconductors; Fermi-Dirac distribution function and Fermi level in a conductor, insulator and semiconductor	5	13
	2.2	Intrinsic and extrinsic semiconductors; intrinsic conductivity and extrinsic conductivity; Law of mass action, charge neutrality condition; intrinsic carrier concentration, electron and hole concentration; Extrinsic carrier concentration as a function of temperature; Effect of impurity concentration and temperature on the Fermi Level; Hall Effect and its applications. Drift and Diffusion current density	5	
	2.3	Formation of a P-N junction, depletion region and barrier potential; concept of carrier current densities in p-n junction in equilibrium, forward bias and reverse bias	5,6	
	2.4	P-N junction devices: LED, Zener diode, photoconductors, solar cells	5,6	
3	Title	LASERS		
	3.1	Processes - Absorption of light, spontaneous emission, stimulated emission; Einstein's equations, Population inversion; metastable states; pumping and pumping schemes; optical resonance cavity	3,4	06
	3.2	Ruby and Helium-Neon laser, semiconductor laser; Applications of lasers in industry, medicine and holography (construction & reconstruction of holograms)	3,4	
4	Self Study	Interference of light in thin films having uniform thickness, Newton's rings, Applications of interference in anti-reflecting and highly reflecting thin films. Diffraction of light, Diffraction due to single slit, double slit and diffraction grating.		05*
		Total (*Not included)		28

Laboratory Component

Sr. No.	Title of the Experiment*
1	Determination of energy band gap of a semiconductor using four probe method
2	Study of I-V characteristics of a Zener diode
3	Determination of the type of semiconductor sample, concentration of charge carriers and its mobility using Hall Effect
4	Determination of Planck's constant using photo vacuum tube
5	Measurement of ultrasonic velocity in liquid medium using ultrasonic interferometer
6	Determination of radius of curvature using Newton's Rings
7	Determination of thickness of a thin foil or wire using the interference pattern of a wedge- shaped film
8	Determination of wavelengths of a mercury source and resolving power of a plane diffraction grating
9	Study of single slit diffraction
10	Determination of grating element of a diffraction grating using a laser source
11	Determination of the numerical aperture of an optical fibre
12	Uses of a Cathode-Ray Oscilloscope

*Students will perform any 10 of the above experiments

Text Books

Reference Book

Sr. No.	Title	Edition	Authors	Publisher	Year
1	A Textbook of Engineering Physics	Eleventh	Dr. M. N. Avadhanulu & Dr. P. G. Kshirsagar	S. Chand	2018
	Engineering Physics	First	D. K. Bhattacharya & Poonam Tandon	Oxford University Press	2015

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Concepts of Modern Physics	Sixth	Arthur Beiser	McGra Hill Education	2009
2	Modern Physics	Third	Serway, Moses and Moyer	Thomson Learning	2005
3	Fundamentals of Physics	Tenth	Halliday and Resnick	Wiley	2013
4	Solid State Physics	Eighth	S. O. Pillai	New Age International Publishers	2018
5	Solid State Electronic Devices	Seventh	Ben G. Streetman and Sanjay Kumar Banerjee	Pearson Education	2016
6	Lasers: Fundamentals and Applications	Second	Ghatak and Thyagarajan	Springer	2011
7	Engineering Physics	First	B. K. Pandey and S. Chaturvedi	CENGAGE	2023



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Engineering Chemistry

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
BSESE	Engineering Chemistry	2	0	2	3	7	2	0	1	3
		Examination Scheme								
AS102	Engineering Chemistry	Component	ISE	MSE	ESE	Total				
			%	%	%	%				
		Theory	13	14	40	67				
		Laboratory	26		7	33				

Course Education Objective:

To provide necessary background of applied chemistry suited for relevant areas of engineering.

Pre-requisite Course Codes	HSC Level Chemistry
After successful completion of the course, learner will be able to	
Learning Outcomes	AS102.1 Relate thermodynamic principles and laws to crucial applications like heat engines (Understanding)
	AS102.2 Summarize properties and applications of different materials like polymers, ceramics, alloys, nanomaterials, (Understanding)
	AS102.3 Compare different sources of energy like conventional fossil fuels, alternative fuels, batteries, fuel cells with respect to availability, working principles, constitution, efficiency of performance and environmental impact (Understanding)
	AS102.4 Apply knowledge of electrochemistry and green chemistry in the interest of public health and environment (Application)
	AS102.5 Make use of analytical techniques (potentiometric and iodometric titrations) and instruments (pHmeter, conductometer and Orsats's Apparatus) for various purposes like redox reactions, neutralization reactions etc.
	AS102.6 Estimate key properties of lubricants like flash point, Viscosity and acid value

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS102.1	1											

AS102.2	1											
AS102.3	2											
AS102.4	2					1						
AS102.5						2						
AS102.6				1								

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS101.1							
AS101.2							
AS101.3							
AS101.4							
AS101.5							
AS101.6							
AS101.7							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Module No	Module Name	Unit No.	Topics	Ref.	Hrs
1	Thermodynamics	1.1	Introduction, Terminology, Concepts of Internal Energy and Thermodynamic equilibrium, Zeroth and First Law of Thermodynamics, Implications and Limitations of First law	1, 2,	1
		1.2	Joule Thomson Effect and significance of inversion temperature, Carnot's Cycle, Carnot's theorem and related numericals, Second Law of thermodynamics	1, 2	1
		1.3	Overview of applications of thermodynamics	1,2	1
2	Polymers	2.1	Introduction to polymers, Effect of heat on polymers : Glass transition temperature and melting with significance;	2, 3,4	2
		2.2	Latest Applications: Conducting polymers, Liquid crystal polymers, Engineering Polymers,	2, 3,4,5	2
3	Fuels and combustion	3.1	Definition and classification of fuels, Calorific value : Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong's formula & numericals for calculations of Gross and Net calorific values.	2,3	2
		3.2	Knocking, Octane number, Antiknock agents,		

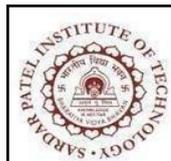
			unleaded petrol, Cetane number	2,3	1
		3.3	Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.	2,3	2
		3.4	Disadvantages of fossil fuels, Alternative (Green) Fuels : Power alcohol , Biomass, Biogas, Biodiesel, Natural Gas and CNG (Description, Utility, advantages and disadvantages)	2,3	1
4	Electro-chemistry	4.1	Introduction, concept of electrode potential, electrochemical cells, Nernst Equation with applications and numericals,	2,3,4	2
		4.2	Reference Electrodes (Hydrogen electrode, calomel electrode), Glass Electrode for pH measurements, Electrochemical sensors : Working principle, construction and applications	2,3,4	2
		4.3	Faraday's Laws of electrolysis and numericals,	2,3,4	1
5	Batteries and Battery Technology	5.1	Introduction, Important terms, Lead Acid storage Cell, Nickel-Hydrogen(metal hydride), Rechargeable Lithium ion batteries, Sodium ion batteries	2,3,6	2
		5.2	Reserve Batteries, Fuel cells, characteristics, description, construction and working of Hydrogen-oxygen fuel cells	2,3,6	2
6	Green Chemistry	6.1	12 principles of green chemistry with examples, Numericals on Atom Economy, Green Solvents (Water, Supercritical Fluids),	2,3	3
7	Engineering materials	7.1	Eutectic mixtures and soft solders Advanced Ceramic materials and cermets and applications Carbon nanomaterials : Fullerenes and Carbon nanotubes, Structure, Properties and applications	2,3,4	1
		7.2	Semiconductors, Stoichiometric and defect semiconductors.	2,3,4	1
		7.3	Superconductors, perovskite structure and 1:2:3 compound $YBa_2Cu_3O_{7-y}$, properties and applications	2,3,4	1
			Total		28
	Self Learning		Challenges pertaining to use of Li ion batteries, Different types of fuel cells, Calculation of hardness of water and COD of wastewater		

Laboratory Component

Sr. NO	Title Of the Experiment
1	Determination of total hardness of water sample
2	Removal of hardness using ion exchange column
3	Determination of Viscosity of oil by Redwood Viscometer
4	To determine flash point of a lubricating oil
5	Analysis of flue gas for its composition (by Orsat's Apparatus)
6	Estimation of acid value of lubricant
7	Determination of amount of strong acid present in a solution using a conductometer
8	Determination of strength of acid using a pH meter
9	Estimation of Copper in brass by Iodometric Titration
10	Potentiometric titration (acid-base, redox)
11	Estimation of Iron in plain Carbon steel
12	Determination of COD of wastewater sample

References:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Physical Chemistry	XIth	Peter Atkins	Oxford University Press, Oxford, UK	2017
2	Engineering Chemistry	XVIth	P. C. Jain & M. Jain	Dhanpat Rai Publishing Co. (P) Ltd., New Delhi, India	2014
3	A Textbook of Engineering Chemistry	XIIth	S. S. Dara & S. S. Umare	S. Chand & Co. Ltd., New Delhi, India	2013
4	A Textbook of Engineering Chemistry	IIIrd	S. Chawla	Dhanpat Rai & Co (Pvt.) Ltd., Delhi, India	2015
5	Engineering Chemistry Fundamentals and Applications	Ist	S. Agarwal	Cambridge Univ. Press, Delhi, India	2015
6	Understanding Batteries	Ist	Dell, Ronald M.; Rand, David A. J.	Royal Society of Chemistry	2001



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Biology for Engineers

Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSESE)	Biology for Engineers	3	0	0	4	7	3	0	0	3
		Examination Scheme (%)								
AS103		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Laboratory		0		--		0		0

Pre-requisite Course Codes, if any.	12 th
Course Objective: To motivate the students to develop a system with a multidisciplinary approach using basic biological concepts and Artificial Intelligence. Learners will gain a comprehensive understanding of how AI is revolutionizing healthcare and biomedical research.	
Learning Outcomes (LO): At the End of the course students will be able to	
AS103.1	Understand the basic biomolecules and their engineering applications.
AS103.2	Grasp how biological systems can be re-designed as substitute products for natural systems.
AS103.3	Acquire the interdisciplinary vision of biological engineering
AS103.4	Explore the use of AI in medical imaging for diagnosis and treatment planning
AS103.5	Understand AI-driven approaches for disease diagnosis, prediction, and personalized medicine with ethical, legal and social implications.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS103.1	2											
AS103.2	3											

AS103.3	3											
AS103.4	2											
AS103.5	2				2							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	Biomolecules and their applications	1,2	8
	1.1	Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting),		
	1.2	Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, alginolytic enzyme in bio-bleaching).		
2	2	Cardiovascular and Nervous System	1,2	10
	2.1	Anatomy of the heart; Heart valves, systemic and pulmonary circulation; Conduction system of the heart; Cardiac action potential, electrocardiogram (ECG); Cardiac cycle; Cardiac output; Blood pressure.		
	2.2	Divisions of the nervous system (central and peripheral nervous system); Structure and functions of the brain and spinal cord; Reflex actions and reflex arc; Functions of sympathetic and parasympathetic nervous system; Nerve action potential and nerve conduction.		
3	3	Human Organ Systems and Bio-Designs	1,2	10
	3.1	Brain as a CPU system, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).		
	3.2	Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye).		
	3.3	Heart as a pump system (architecture, electrical signaling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pacemakers, defibrillators).		
4	4	AI for Biomedical Applications	1	14

	4.1	Introduction to AI in Biomedical Applications: Overview of artificial intelligence and machine learning, Challenges and opportunities in applying AI to biomedicine, Ethical considerations in AI-driven healthcare		
	4.2	Medical Imaging and AI: Basics of medical imaging modalities, Image preprocessing and feature extraction, AI applications in medical image analysis and interpretation		
	4.3	Personalized Medicine and Precision Health: Concept of personalized medicine, AI-driven approaches to patient stratification, Precision health initiatives and challenges	2	
	4.4	Genomics and Bioinformatics: Basics of genomics and next-generation sequencing, AI-driven analysis of genomic data, Precision genomics and its applications in healthcare		
	4.5	Regulatory and Ethical Considerations: Regulatory landscape for AI in healthcare, Ethical and privacy considerations in AI-driven healthcare, Bias and fairness in AI algorithms		
5	Self Study	Trends in Bioengineering: Bioprinting techniques and materials, 3D printing of ear, bone, and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bio concrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).	1,2,3	6*
Total (6*Not included)				42

ISE Component: Presentations on the following topics

Sr. No	Biology for Engineers
1	Signal Conditioning for ECG
2	Signal Conditioning for EEG
3	Study of Robotic arm for prosthetics
4	Study of Parkinson's disease
5	Utilize Python libraries such as OpenCV and TensorFlow to preprocess medical images and develop a deep learning model for automated diagnosis or classification of medical images (e.g., X-rays, MRI scans).
6	Collect and preprocess relevant clinical data (e.g., patient demographics, lab results, symptoms) and implement predictive analytics algorithms to forecast disease progression or patient outcomes.
7	Design personalized treatment plans based on genetic profiles using decision support systems
8	Apply machine learning techniques (e.g., random forests, deep learning) to predict gene function or classify genomic variants [Access genomic datasets from repositories such as the Genomic Data Commons (GDC) or The Cancer Genome Atlas (TCGA).]
9	Develop predictive models for hospital readmission or patient risk stratification using clinical data.

10	<p>A case studies involving ethical dilemmas in AI-driven healthcare (e.g., patient privacy, algorithmic bias).</p> <p>To study and analyze regulatory frameworks (e.g., HIPAA, GDPR) governing the use of AI in healthcare and Propose strategies for addressing ethical concerns and ensuring fairness and transparency in AI algorithms.</p>
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Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Human Physiology	16th	Stuart Fox, Krista Rompolski	McGraw-Hill	2022
2	Biology for Engineers	3 rd	Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K.	Tata McGraw Hill	2012
3	Artificial Intelligence in Medicine		Adam Bohr and Gopalakrishnan Venkitaraman	Academic Press; 1st edition (21 June 2020)	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Biology for Engineers	--	Arthur T. Johnson	CRC Press, Taylor and Francis	2011
2	Biology for Engineers		Danial Schodek	MIT Press	



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Engineering Mechanics

Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
BSESE AS104	Engineering Mechanics	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component		ISE %		MSE %		ESE %		Total %
		Theory		13		14		40		67
Laboratory		26		--		7		33		

Pre-requisite Course Codes, if any.	10+2 Basics
Course Objective: To provide knowledge of force analysis methods required in engineering applications and solutions. Also, to develop analytical and computational ability.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
AS104.1	Draw free body diagram and determine reactive forces using conditions of equilibrium and Lami's theorem
AS104.2	Determine coefficient of friction for various contact surfaces
AS104.3	Analyze the three-dimensional system of space forces.
AS104.4	Analyze the kinematics of particles and obtain the various parameters of motion.
AS104.5	Determine Instantaneous center of rotation (ICR).
AS104.6	Design and conduct an experiment to demonstrate principles of statics and dynamics

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO2	PO3	PO4	PO 5	PO6	PO7	PO 8	PO9	PO1 0	PO11	PO12
AS104.1	3	3						3				
AS104.2	3	3						3				
AS104.3	3	3						3				
AS104.4	3	3						3				
AS104.5	3	3						3				
AS104.6	3	3						3				

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
AS104.1						
AS104.2						
AS104.3						
AS104.4						
AS104.5						
AS104.6						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Unit1	Equilibrium of forces		8
	1.1	Equilibrant force, conditions of equilibrium for concurrent forces, parallel forces and general force system, equilibrium of connected bodies, Lami's theorem.	1,3	
	1.2	Types of supports, types of loads, Beams, Determination of reactions at supports for various types of loads on beams	3	
2	Unit2	Friction		4
	2.1	Introduction to Laws of friction, Cone of friction, Equilibrium of bodies on inclined plane, Application to problems involving wedges, ladders.	1,2	
3	Unit3	Forces in space		5
	3.1	Rectangular Components of Forces in Space, Resultant of Space forces, Moment of a Force about a point, axis and line. Equilibrium of a particle in space.	1	
4	Unit4	Kinematics of Particle		8
	4.1	Motion along straight and curved path, Rectangular component of velocity and acceleration, Tangential & Normal component of acceleration, Motion curves(a-t, v-t, s-t curves), Projectile motion,	2,3	
5	Unit5	Kinematics of Rigid Bodies		3
	5.1	Instantaneous center of rotation for the velocity of bodies in plane motion, (up to 2 linkage mechanism)	3	
6	Self Study	1. Applications of resultant of forces, concept of couple and moments, 2. Centroid and center of gravity, analysis of trusses. 3. Kinetics of rigid body, work energy principle. 4. Principle of Law of Conservation of momentum, Impact and collision.	1,2,3	6*
Total (*Not included)				28

Laboratory Component

Sr. No	Title of the Experiment
1	Draw the force polygon and determine the equilibrant force for a concurrent coplanar force system.
2	Use the conditions of equilibrium for the parallel force system and determine the support reactions.
3	Apply the principle of moment for equilibrium of levers.
4	Determine the coefficient of friction for glass slab and a metal plate on an inclined plane.
5	Determine the axial forces using Lami's theorem for Jib crane apparatus.
6	Use the conditions of equilibrium for a non-concurrent non-parallel force system and draw the force polygon.
7	Measure the acceleration due to gravity with the help of simple pendulum apparatus.
8	Determine the range of projectile and the time of flight for the projectile motion.
9	Verify the law of conservation of momentum and determine the coefficient of restitution for collision
10	(Plot the motion of the projectile using an air-cushion table apparatus.) A small project based on the Engineering Mechanics concept.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Vector Mechanics for Engineers statics and dynamics	Nineth	Beer and Johnston	McGraw Hill	2010
2	Engineering Mechanics	Fifth	Bhavikatti S and Rajsekharappa	New Age International	2009
3	Engineering Mechanics Statics and Dynamics	Fourteenth	A K Tayal	Umesh Publication, Delhi	2012

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Engineering Mechanic: Statics and Dynamics,	Fifth	E.W. Nelson, C.L. Best, W.G. McLean,	McGraw Hill	1998
2	Singer's Engineering Mechanics Statics and Dynamics	Third	Vijaya Kumar Reddy. K. and Suresh Kumar. J	BS Publication	2012



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Engineering Graphics

Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
BSESEC	Engineering Graphics	0	1	4	2	7	0	1	2	3
		Examination Scheme								
		Component	ISE %	MSE %	ESE %	Total %				
AS105	Engineering Graphics	Theory		13	0	20	33			
		Laboratory		40	–	27	67			

Pre-requisite Course Codes, if any.	10+2 Basics
Course Objective: To develop technical drawing and visualization skills using instrumental drawing and soft tool, required for design and modeling, in Engineering Applications and Solutions.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
AS105.1	Construct basic engineering curves.
AS105.2	Draw projection of points and lines.
AS105.3	Draw projection of regular solids inclined to both the reference planes.
AS105.4	Read the 3-dimensional view and draw the orthographic and sectional orthographic projections.
AS105.5	Read the orthographic projection and draw an isometric view.
AS105.6	Draw the development of lateral surfaces of solids.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS105.1	3	3										3
AS105.2	3	3										3
AS105.3	3	3										3
AS105.4	3	3										3
AS105.5	3	3										3
AS105.6	3	3										3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Unit1	Introduction to Engineering Drawing and Construction of engineering curves	1,2	4
	1.1	Types of Lines, Dimensioning Systems as per IS conventions. First angle method of projection only		
	1.2	Basic construction of Cycloid and Involutes.		
2	Unit2	Projection of Points and Lines: -	1,2	5
	2.1	Projection of points in all four quadrants		
	2.2	Projection of lines parallel to one principal reference plane.		
	2.3	Lines inclined to both the Reference Planes (Excluding Traces of lines).		
3	Unit3	Projection of solid (Regular solids like Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron and Cone only)	1,2	5
	3.1	Projection of solid resting on plane (Single step projection)		
	3.2	Projection of solid such that base inclined to one reference plane (Two step projection)		
	3.3	Projection of solid such that base inclined to both reference planes (Three step projection/problem) (Exclude Spheres, Composite, Hollow solids and frustum of solids)		
4	Unit4	Orthographic Projection	1	Lab session (4)
	4.1	Orthographic views of a simple machine part as per the first angle method of projection recommended by I.S.		
	4.2	Full Sectional views of the Simple Machine parts.		
5	Unit5	Isometric visualization	2	Lab session (2)
	5.1	Isometric view (Natural scale only)		
6	Unit6	Development of lateral surface of solids		Lab session (2)
	6.1	Development of lateral surface of solids (Exclude DLS of a solid with a hole in it and Reverse Development)		
7	Self Study	1.2 Construction of Engineering curves like ellipse, parabola, hyperbola, helix, other types of cycloid etc. by using different method of construction. 2.1 Solve more practice examples of orthographic views. Draw different views of a machine part/any object using third angle method of projection. (Axonometric view, oblique view, perspective etc.) 2.2 Half sectional orthographic views. 3.1 Projection of lines with traces, application-based problems on Projection of lines 4.1 Projection of section of solid with cutting planes. 5.1 Development of lateral surface of solids with openings, reverse development of solid.	1,2, 3	6*
Total (*Not included)				14

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No	Engineering AutoCAD Laboratory
1	Introduction to Auto-CAD: -Basic Drawing and Editing Commands. Knowledge of setting up layers, Dimensioning, Hatching, plotting and Printing. Auto-Cad Practice sheet-1 (Two Examples)
2	Auto-Cad Practice sheet-2 (Two Examples)
3	Introduction to Orthographic projections sheet-1 (Two Problems)
4	Orthographic projections sheet-2 (Two Problems)
5	Introduction to Sectional Orthographic projections sheet-1 (Two Problems)
6	Sectional Orthographic projections sheet-2 (Two Problems)
7	Introduction to Isometric Projection/View: - Isometric View/Drawing of blocks of plain and cylindrical surfaces using plain/natural scale only. (Exclude Spherical surfaces). Isometric Projection/View sheet-1 (Two Problems)
8	Isometric Projection/View sheet-2 (Two Problems)
9	Draw development of lateral surface of solids with simple sections DLS sheet-1 (Prism and Cylinder)
10	DLS sheet-2 (Pyramid and Cone)

Text Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Engineering Drawing	53 rd	N D Bhatt	Charotar	2016
2	Engineering Drawing	3 rd	Dhananjay A Jolhe	Tata McGraw Hill	2011

Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	AutoCAD 2017	--	Sham Tickoo	DreamTech Press, Delhi	2017
2	Engineering Drawing and Graphics	Fifth	K Venugopal	New Age International	2011



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Material Science and Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
BSESE AS108	Material Science and Engineering	3	0	0	4	07	3	0	0	3
		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)		Total
		Theory		20		20		60		100
		Laboratory		-		--		-		

Pre-requisite Course Codes, if any.	12th Physics and Chemistry
Course Objective: To make learners understand the fundamental physical origins of material behavior to optimize the properties for various engineering materials.	
Learning Outcomes (LO): At the end of the course students will be able to	
AS108.1	Demonstrate the knowledge of the basics of crystallography.
AS108.2	Visualize Planes and directions using Miller Indices.
AS108.3	Classify the various magnetic materials and identify the magnetic materials for various engineering applications.
AS108.4	Comprehend the basics of physics and chemistry on the nanometer scale and applications of nano materials.
AS108.5	Comprehend the basic physical properties of smart materials with various engineering applications.
AS108.6	Comprehend the use of various analytical techniques to characterize various materials.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS108.1	1											
AS108.2	1											
AS108.3	1											
AS108.4	1											
AS108.5	1											
AS108.6	1											

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2	PSO3
AS108.1						
AS108.2						
AS108.3						
AS108.4						
AS108.5						
AS108.6						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref .	Hrs.
1	Title	Crystallography	1 & 2	10
	1.1	Introduction, types of solids, space lattice, basis, unit cell and its characterization, lattice parameters, Bravais space lattices, seven crystal systems		
	1.2	Miller Indices of planes and directions, Interplanar spacing in cubic system		
	1.3	X-rays, Bragg's law, Bragg's X-ray spectrometer and determination of crystal structure		
	1.4	Crystal imperfections: Point and Line defects		
2	Title	Magnetic properties of materials	2,3 & 4	8
	2.1	Introduction, magnetic moment of an atom, useful magnetic parameters		
	2.2	Classification of magnetic materials		
	2.3	Hysteresis, soft and hard magnetic materials and their applications		
3	Title	Nanomaterials and their applications	4	6
	3.1	Introduction, types of nanoparticles (carbon, metals, organic, and composites)		
	3.2	Molecular self assemblies, and Applications		
4	Title	Modern, Smart and Intelligent Engineering Materials	2,4	10
	4.1	Introduction, distinguish features of smart materials, Types of smart materials and their various engineering applications		
	4.2	Dielectric materials: polarization, temperature and frequency effects, electric breakdown, ferroelectric materials and its various applications		
	4.3	Metallic glasses and their various engineering applications		
	4.4	Wide-bandgap (WBG) semiconductors: Silicon Carbide, Gallium		

		nitride. Applications of WBG materials		
5	Title	Materials' Characterization Techniques	4	8
	5.1	UV and visible spectroscopy Fluorescence spectroscopy		
	5.2	X-ray photo luminescence spectroscopy, Transmission Electron Microscopy, Scanning Electron Microscopy		
	5.3	Raman effect and Raman spectroscopy		
6	Self Study	Superconductivity, Type I and Type II superconductors, Meissener effect, High temperature superconductors, various applications of superconductors.	1,2 & 4	06
			Total	42

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Electrical Engineering Materials	tenth	A.J. Dekker	Prentice- Hall India	2008
2	Nanotechnology: Principles and practices	third	Sulbha K. Kulkarni	Springer	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Solid State Physics	tenth	S.O.Pillai	New Age International	2022
2.	Materials Science and Engineering	sixth	V. Raghavan	PHI	2004
3..	Fundamentals of Materials science and engineering; an integrated approach	sixth	William Callister and Jr. David Rethwisch	John Wiley & Sons.	2021
4..	Engineering Physics	second	B.K. Pandey and S. Chatur	Cengage	2022



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Problem Solving using Imperative Programming SEM-I

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SEC)	Problem Solving using Imperative Programming	1	0	4	4	10	1	0	2	3
		Examination Scheme								
		Component	ISE %		MSE %		ESE %		Total %	
CE101		Theory		-		-		-		
		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	
Course Objective:	To develop problem solving skills using imperative programming.
Learning Outcomes (LO):	<i>At the End of the course students will be able to</i>
CE101.1	Understand and conceptualize the problem-solving aspects using various programming paradigms.
CE101.2	Solve real world problems using imperative programming approach.
CE101.3	Solve problems using control structures for real world problems.
CE101.4	Solve problems using Arrays and Text processing.
CE101.5	Develop modular code for a given problem.
CE101.6	Solve real world problems using Structures and Unions

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE101.1	1	-										
CE101.2	2	2										
CE101.3	2	2										
CE101.4	2	2										
CE101.5	2	2										
CE101.6	2	2										

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE101.1							
CE101.2							
CE101.3							
CE101.4							
CE101.5							
CE101.6							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Problem Solving and Programming Paradigms		
	1.1	What is a Problem, Characteristics of good Program, Overview of Programming Paradigms – Declarative and Imperative, Problem- solving using Algorithm and Flowcharts	3,4	2
2	Title	Basic Elements of Computer Programming and Control flow		
	2.1	Variables, keywords, Data types, Operators: Arithmetic, Relational and Logical, Assignment, Unary, Conditional, Bitwise, Expression, Statements.	1,2	1
	2.2	Branching Structures: if statement, if-else statement, multi-way decision, switch statement, continue statement, break statement Iterative Structures: while, do-while, for, nested loops	1,2	3
3	Title	Problem Solving using Array Techniques		
	3.1	Introduction to Arrays: Declaration, Definition, accessing array elements, one-dimensional array, two-dimensional array, array of characters, Solving using Arrays like Array Order Reversal, Array Counting or Histogramming.	1,2	2
	3.2	Strings and Operations on Strings.	1,2,4	1
4	Title	Problem Solving using Modular Approach		
	4.1	Defining a Function, accessing a Function, Function Prototype, Passing Arguments to a Function, call by value, pointers and call by reference.	1,2	2
	4.2	Recursion	1,2,4	1
5	Title	Structures and Unions		
	5.1	Structures and Union: Declaration, Initialization, structure within structure, Array of Structure, Operation on structures, Concept of Union, Difference between structure and union,	1,2	2
6	Self-Study	File handling: Types of Files, File operation-opening, Closing, Creating, Reading, Processing File, Command line arguments, Dynamic Memory Allocation	1,2,4	4*
Total (* not counted in total hours)				14

Laboratory Component (Minimum 10 Laboratory experiments are expected) Note: All problems should be implemented using C language.

Sr. No.	Title of the Experiment
1	Use the formatted input/output statements, operators and expressions of C language
2	Apply various control structures to solve given problems.
3	Apply the concept of functions to incorporate modularity.
4	Demonstrate the use of one-dimensional arrays to solve a given problem.
5	Demonstrate the use of two-dimensional arrays to solve a given problem.
6	Apply the concept of recursion to solve a given problem.
7	Implement various text processing problems.
8	Apply the concepts of structures/union to solve a given problem.
9	Demonstrate the use of pointers to solve a given problem.
10	Implement various operations on files to solve a given problem.

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Programming with C	Fourth	Byron Gottfried	McGraw Hill (Schaum's outline series)	2018
2	The C programming Language	Second	Kernighan , Ritchie	Pearson	2015
3	Foundations of Programming Languages	Second	Kent D. Lee	Springer	2017
4	How to Solve it by Computer	First	R. G. Dromey	Prentice Hall India	1998

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Let Us C	Sixteenth	Yashavant Kanetkar	BPB	2017
2	Programming Language Concepts	Third	Carlo Ghezzi, Mehdi Jazayeri	John Wiley & Sons	2008
3	Computer Programming in C	Second	V. Rajaraman & Neeharika Adabala	PHI Learning, Eastern Economy Edition,	2014



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Problem Solving using Object Oriented Programming SEM-II

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SEC	Problem Solving using Object Oriented Programming	1	0	4	4	8	1	0	2	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
CE102		Theory	--		--		--		--	
	Laboratory	80		--		20		100		

Pre-requisite Course Codes, if any.	Problem Solving using Imperative Programming
Course Objective: To learn problem solving using Object-Oriented programming paradigm	
Learning Outcomes (LO): At the End of the course students will be able to	
CE102.1	Apply concepts of object-oriented programming using classes and objects
CE102.2	Apply Inheritance for a given scenario
CE102.3	Solve the given problems using concept of polymorphism
CE102.4	Develop efficient programs abstraction and exception handling to.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE102.1	3	2			3							2
CE102.2	3	2			3							2
CE102.3	3	2			3							2
CE102.4	3	2			3							2

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE102.1							
CE102.2							
CE102.3							
CE102.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory (This course content delivery will be in Java. Course Contents to be taken care accordingly)

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction and Encapsulation		4
	1.1	Introduction to Object Oriented Programming, Procedural versus Object Oriented Programming, Principles, Benefits and applications of Object-Oriented Programming.	1,2	
	1.2	Encapsulation: Problem solving with Objects and Classes		
	1.3	static data members and methods, constructors and their types. Strings, Arrays		
2		Inheritance		3
	2.1	Concept of Inheritance, parent class, derived class, this and super keyword	1,2	
	2.2	Types of inheritance: single, multiple, multilevel, hierarchical, hybrid		
3		Polymorphism		3
	3.1	Static Polymorphism: Method overloading and Constructor overloading	1,2	
	3.2	Dynamic Polymorphism: Method overriding		
	3.3	Data conversion		
4		Abstraction		2
	4.1	Abstraction: abstract class, interface	1,2	
5		Exception Handling		2
	5.1	try, throw, and catch exceptions	1,2	
	5.2	Function exception declaration		
6	Self Study	File Handling, Multithreading, Packages, Collection Framework, Swings, Aggregation and Composition	1,2	5*
			Total	14+ 5*

Laboratory

Sr. No	Title of the Experiment
1	Program on Encapsulation: Write a program to demonstrate classes and objects
2	Program on Encapsulation: Write a program to demonstrate constructor
3	Program on Polymorphism: Implement a Program to demonstrate method overloading,
4	Program on Polymorphism: Implement a Program to demonstrate constructor overloading
5	Program on Polymorphism: Implement a Program to demonstrate method overriding
6	Program on Inheritance: Implement a Program to demonstrate single level Inheritance
7	Program on Inheritance: Implement a Program to demonstrate multilevel Inheritance
8	Program on Abstraction: Implement a Program to demonstrate multiple Inheritance/ interface
9	Program on Abstraction: Implement a Program to demonstrate Abstraction using abstract class
10	Program on abstraction: Implement a Program to demonstrate multithreading

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Java -The Complete Reference	10 th	Herbert Schildt	Tata McGraw-Hill	2017
2.	Java Programming From the Ground Up	1 st	Ralph Bravaco,Shai Simoson	Tata McGraw-Hill	2009

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	An introduction to Programming and Object Oriented Design using Java	3 rd	Jaime Nino, Frederick A. Hosch	Wiley Student Edition	2010
2.	Head First Java	3rd	Kathy Sierra & Bert Bates	O'Reilly	2022



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Digital Systems

Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Digital Systems	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
ET101		Theory	15		15		45		75	
	Laboratory	15		--		10		25		

Pre-requisite Course Codes, if any.		
Course Objective:		
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>		
ET101.1	Explain various logic gates, SOP, POS forms and their minimization with k- map for given combinational circuits.	
ET101.2	Construct combinational circuits using given MSI devices.	
ET101.3	Apply the knowledge of flip-flops and MSI to design sequential circuits	
ET101.4	Compare the logic families based on their characteristics	
ET101.5	Comprehend the architectural features of 8085 with basic assembly language programming	

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET101.1	3	2	1									
ET101.2	3	2	1									
ET101.3	3	2	1									
ET101.4	3	2	1									
ET101.5	3	2	1									

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET101.1							
ET101.2							
ET101.3							
ET101.4							
ET101.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Combinational Circuits		11
	1.1	Logic Gates: Basic gates, Universal gates, Sum of products and products of sum, minimization with Karnaugh Map (up to four variables), Quine Mc'Clusky method and realization.	1,4	
	1.2	Combinational Circuits using basic gates as well as MSI devices: Half adder, Full adder, Half Subtractor, Full Subtractor, Multiplexer, Demultiplexer, Decoder, Comparator	1,4	
2	Title	Sequential Circuits		11
	2.1	Sequential Logic: Latches and Flip-Flops. Conversions of Flip-Flops.	1,4	
	2.2	Counters: Asynchronous Counters, Synchronous Counters, Up Down Counters, Mod Counters, Ring and Twisted Ring Counters, Shift Registers, Universal Shift Register	1,4	
	2.3	MSI counters (IC 7490, IC 74160, IC 74163, IC 74169), MSI Shift registers (IC 74194) and their applications	2,5	
3	Title	Clocked Synchronous Machines		05
	3.1	Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques.	2,5	
4	Title	Logic Families		05
	4.1	Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND.	1,4	
5	Title	Introduction to Microprocessors		10

	5.1	Evolution of computers and Microprocessors	3	
	5.2	Essential components of a conventional Central Processing Unit (CPU)	3	
	5.3	Architecture of 8-bit microprocessor 8085	3	
	5.4	Basic instruction set with its addressing modes and concepts of Instruction cycle, Machine cycle and T states. Elementary programming in assembly language.	3	
	5.5	Elements of I/O data transfer with the concept of interrupts	3	
6	Self Study	Concepts of PROM, PAL and PLA. Timing Considerations and Metastability in Flip-Flops. Clocked synchronous state machine design. Interfacing CMOS to TTL and TTL to CMOS. Concepts of peripherals and memory with its interfacing with 8085 microprocessor		
			Total	42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To implement the combinational logic for given function using basic gates/MSI ICs. a. To study and verify the truth table of logic gates b. To study the universal NAND and NOR gate c. To study the working of half adder, full adder, half subtractor, Full subtractor along with truth table
2	To implement TTL and CMOS logic family a. To study TTL NAND gate (BJT implementation). b. To study CMOS NAND gate c. To study interfacing of the TTL /CMOS
3	To implement 4-bit, 5-bit and 8 bit comparator using given MSI
4	To design implement gate level multiplexers and MSI multiplexers
5	To design and implement gate level and MSI circuits of flip-flops
6	To design counters a. To design a MOD4 synchronous up/down counter b. To study IC 7490 – Asynchronous Decade Counter
7	To synchronous counters, synchronous counters and shift register using given MSI. a. To study IC 74160 as Synchronous Decade Counter and Mod 6 counter b. To study IC 74163 as Synchronous MOD 16 Counter and Mod 10 counter c. To verify the truth table of IC 74194 as Universal Shift Register and implement Ring and Twisted Ring Counter.
8	To perform basic arithmetic operations through assembly language program in 8085
9	To simulate COPY and PASTE operation through 8085 assembly program
10	To write a program to add N elements stored in an array of 8 bit numbers (8085)

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Modern Digital Electronics	Fourth Edition	R. P. Jain	Tata McGraw Hill	2009
2	Digital Design Principles And Practices	Third Edition	John F. Wakerly	Pearson Education	2001
3	Microprocessor Architecture, Programming, and Applications with the 8085	Sixth Edition	Ramesh S. Gaonkar	Penram International	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
4	Digital Design	Fourth Edition	Morris Mano	Pearson Education	2008
5	Fundamentals of digital logic design with VHDL	Second Edition	Stephen Brown and Zvonko Vranesic	McGraw Hill	2006



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Basic Electrical Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Basic Electrical Engineering	3	-	2	6	11	3	0	1	4
		Examination Scheme								
		Component		ISE %		MSE %		ESE %		Total %
ET102		Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	Basic concepts of electric charge, current, voltage and Power
Course Objective: To impart a basic knowledge of electrical quantities, Circuits and components.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
ET102.1	Compute various electrical quantities of given dc circuit using circuit simplification techniques and various network theorems.
ET102.2	To expose the students to different terms and concepts in AC Circuits at fundamental frequency and to expose them to basics of effects of harmonics in the waveforms
ET102.3	To study the working principles of electrical machines and their applications
ET102.4	To expose the students the fundamental concepts in Controllable Switch and Modulation based Power Conversion
ET102.5	To study Electrical Parameters of the Batteries and their selection and design criteria for a specific application

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ET102.1	3	3										
ET102.2	3	3										
ET102.3	3	3										
ET102.4	3	3										
ET102.5	3	1										

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
ET102.1							
ET102.2							
ET102.3							
ET102.4							
ET102.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs (Theory +Tut)
1	Title	DC Circuits	1,2	12
	1.1	Electrical circuit elements (R, L and C), Voltage and current sources, Equivalent resistance of circuits, Simplification using delta-star and star-delta transformation.		
	1.2	Kirchoff's current and voltage laws, Analysis of simple circuits with dc excitation. Mesh analysis, Superposition, Thevenin, Norton and Maximum Power Transfer Theorems		
	1.3	Time-domain analysis of first-order DC Transients in RL and RC circuits.		
2	Title	AC Circuits	1,2	12
	2.1	Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Harmonics, Total Harmonic Distortion, Power supplied by Harmonic voltages and currents, Power factor in case of non-sinusoidal waveforms.		
	2.2	AC Analysis of series and parallel RLC Circuits with Resonance, Concept of Bandwidth and Q-factor,		
	2.3.	Three-phase balanced circuits, voltage and current relations in star and delta connections.		
3	Title	Electromagnetic and Electro-Mechanical Energy Converters	1,2	9
	3.1	Magnetically Coupled Coils, Self and Mutual Inductance and Dot Convention		
	3.1	Single Phase Transformer: Principle of Operation, Equivalent		

		Circuits		
	3.2	Single Phase Transformer: Efficiency and Regulation		
	3.3	Introduction to Three-phase Transformers and Applications		
4	Title	Electric Power Converters	1,2	6
	4.1	Fundamental Principles of Buck, Boost and buck-boost DC-DC converters and their Transfer Characteristics, Duty Ratio Control		
	4.2	Single-phase voltage source inverters and PWM		
5	Title	Batteries: Electrical Characteristics and Applications		3
	5.1	Introduction to type of Batteries, Generalized Battery parameters such as SoC, DoD, Energy and Power Densities, Battery C-rating, etc. Comparison of Batteries, Charging and Discharging Characteristic		
	5.2	Selection and Sizing of Battery Packs for Specific Applications		
6	Self-Study	Fundamental Principles of Rotating Machines, Working Principle, Characteristics and applications of Induction motor, BLDC motor and Stepper Motor		
			Total	42

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
01	Introduction to Electrical Measuring instruments, Lamp Loads, Inductor Loads and Capacitor Bank
02	Verification of Star-Delta and Delta-star Transformation with Kirchhoff's Laws
03	Verification of Thevenin's Norton's and Maximum Power Transfer Theorem
04	Verification of DC Transient equations in RL and RC Circuits
05	Experimental study of single-phase AC circuit with R-L and R-C Load with Measurement of Power and Power factor
06	Experimental study of R-L-C series Resonance. To plot resonance curve, To compute Bandwidth and Q-factor
07	Experiment on Magnetic Circuit Fundamentals
08	Loading of a transformer: measurement of primary and secondary voltages and currents, and power. To compute efficiency and regulation.
09	Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
10	Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super-synchronous speed.
11	Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform.
12	Demonstration of V/F control of Induction motor
13	Experimental study of charge and Discharge characteristics of a Lead-acid Battery

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Basic Electrical Engineering	Third	D. P. Kothari and I. J.	Tata McGraw Hill	2010
2	Electrical Technology	Twenty Third	B. L. Theraja	S. Chand Publications	2003

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Basic Electrical Engineering	Second	D. C. Kulshreshtha	McGraw Hill	2019
2	Fundamentals of Electrical Engineering	Second	L. S. Bobrow	Oxford University Press	2011
3	Electrical and Electronics Technology	Third	E. Hughes	Pearson	2010
4	Electrical Engineering Fundamentals	Second	V. D. Toro	Prentice Hall India	1989
5	Elements of Power Electronics	Second	P. T. Krein	Oxford University Press	2015
6	Power Electronics: Converters, Application and Design	Second	Ned Mohan, T.M Undelands and W P Robbins	John Wiley and Sons. Inc.	1995
7	Electric Machinery	Sixth	A. E. Fitzgerald, C. Kingsley and S. D. Umans	McGraw-Hill	2003



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Soft Skills-I

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SEC	Soft Skills (Communication Skills)	0	1	2	2	5	0	1	1	2
		Examination Scheme								
		Component		ISE %		MSE %		ESE	Total	
AS107		Theory		--		-	--	—		
		Laboratory		50		50	-	100		

** MSE will be evaluated on the basis of a written test based on module 1 and 2.

** ISE will be evaluated on the basis of marks scored in practicals, out of 150.

Pre-requisite Course Codes, if any.	
Course Objective: To apply the principles of communication in a personal and professional environment.	
Learning Outcomes (LO): <i>At the end of the course students will be able to</i>	
AS107.1	Apply the principles of business writing for professional documents.
AS107.2	Develop advanced vocabulary and grammar for spoken and written communication.
AS107.3	Design the draft a formal speech.
AS107.4	Analyze received information by using active listening and reading skills.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS107.1									2	2		2
AS107.2									2	2		2
AS107.3									2	2		2
AS107.4									2	2		2

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS107.1							
AS107.2							
AS107.3							
AS107.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1	Title	Vocabulary Building & Grammar		2	4
	1.1	Concept of word formation, the root words from foreign languages and their use in English	7,1		
	1.2	Common errors in writing, confused pair of words, redundancies, clichés	6, 2		
2	Title	Writing Skills		7	14
	2.1	Principles of Business Writing: 7Cs of communication, sentence structures, Organizing paragraph in direct and indirect style; Summarization	4		
	2.2	Practices in Writing: E-mail Etiquettes, e-mail for business purposes	3		
	2.3	Critical Reading: understanding the concept of critical reading and applying to analyze a given text.	5		
3	Title	Oral Skills		5	10
	3.1	Listening Comprehension(audio): Pronunciation, intonation, Stress and Rhythm	5		
	3.2	Speaking Practices: 1. Common everyday situation: Conversation and dialogues (group activity, ice-breaking session) 2. Public Speaking: Extempore, formal speech	3		
4	Self-Study	1. Basic Rules of Grammar 2. GRE Vocabulary 3. Reading a book(fiction/non-fiction) and preparing a review on it		6*	
Total (*Not included)				42 hrs	

List of activities (Graded, Non-graded)

Sr. No.	Title of the assignments	Marks
1	Skit based on a given situation	-
2	ISE 1 – Summary Writing	10

3	ISE 2 – Extempore	10
4	ISE 3 – Grammar	20
5	ISE 4 – Vocabulary	20
6	Reviewing a book (fiction/ non-fiction)	10
7	ISE 5 – Email Writing (Inquiry)	20
8	ISE 6 – Email Writing (Complaint)	20
9	ISE 6 – Speech	20
10	ISE 7 – Critical Reading	20
	Total	150

Text Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Communication Skills	2013	Shirley Mathews	Technical Publication, Pune	2013
2	English Vocabulary in Use	1999	Michael McCarthy, Felicity O'Dell	Cambridge University Press, India	1999

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Oxford Practice Grammar	1999	John Eastwood	Oxford, India	1999
2	Communication Skills	2011	Meenakshi Raman, Sangeeta Sharma	Oxford, India	2011
3	Communication Skills	2010	Dr. Meera Bharwani	Synergy Knowledge ware, India	2010
4	English Grammar for Today	2005	Geoffrey Leech	Palgrave, UK	2005
5	Word Power Made Easy	1978	Norman Lewis	Anchor Books, New York	1978



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Indian Knowledge System (IKS)

Indian Knowledge System (IKS) holds a significant place in your curriculum, as recommended by NEP 2020. The Government of India has mandated a compulsory credit generic IKS course to spread the rich heritage and traditional knowledge of our country in various fields such as Arts and Literature, Agriculture, Basic Sciences, Engineering & Technology, Architecture, Management, Economics, and more. In line with this, the Government of Maharashtra has recommended a generic IKS course for UG students in the first year of your graduation.

Introduction:

The Indian knowledge system is a rich and diverse heritage of intellectual, philosophical, and scientific traditions that have evolved over thousands of years in the Indian subcontinent. It encompasses a wide range of disciplines, including philosophy, spirituality, medicine, mathematics, astronomy, and more. The Indian knowledge system reflects a deep reverence for wisdom, a holistic approach to life and well-being, and a profound understanding of the interconnectedness of various aspects of human existence. It remains a vibrant and influential part of India's cultural and intellectual heritage.

The Indian knowledge system has had a profound and lasting influence not only on the subcontinent but also on the broader world. Its teachings and practices continue to be studied, adapted, and appreciated globally, making it an integral part of human heritage.

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
AEC	Indian Knowledge System (IKS)	1	1	-	2	3	1	1	-	2
		Examination Scheme								
		Component		ISE (%)		MSE		ESE (%)		Total (%)
AEC01		Theory		--		--		20		20
		Laboratory		80		--		-		80

** ISE will be evaluated on the basis of individual and group activities.

** ESE will be evaluated on overall modules of the course.

Pre-requisite Course Codes, if any.

Course Objectives:

- To create awareness amongst the students about the true history and rich culture of the country.
- To understand the scientific value of the traditional knowledge of India.
- To explain the key features of the Indian Numeral System and appreciate the key role it has played in the advancement of Science & Technology.
- To develop familiarity with the science, engineering & technology heritage of ancient and medieval India

Learning Outcomes (LO): At the end of the course students will be able to	
AEC01.1	Develop a deep understanding of the major philosophical traditions in India.
AEC01.2	Appreciate Indian mathematics and mathematicians along with number systems.
AEC01.3	Understand the interdisciplinary nature of Indian knowledge systems and their connections to science, technology, and other fields.
AEC01.4	Establish familiarity with the classical languages and linguistics of India and exposure to key texts.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AEC01.1									2	2		2
AEC01.2									2	2		2
AEC01.3									2	2		2
AEC01.4									2	2		2

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AEC01.1							
AEC01.2							
AEC01.3							
AEC01.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1	Title	Indian Knowledge System – An Introduction		1	
	1.1	What is IKS? Why do we need IKS?			
	1.2	Organization of IKS Historicity of IKS Some salient aspects of IKS			
2	Title	The Vedic Corpus:		2	3
	2.1	Introduction to Vedas A synopsis of the four Vedas Sub-classification of Vedas Messages in Vedas			
	2.2	Introduction to Vedāngas Prologue on Śikṣā and Vyākaraṇa Basics of Nirukta and Chandas			
	2.3	Introduction to Kalpa and Jyotiṣa Vedic Life: A Distinctive Features			
3	Title	Number Systems and Units of Measurement		3	2
	3.1	Number systems in India - Historical evidence Salient aspects of Indian Mathematics Bhūta-Saṃkhyā system			
	3.2	Kaṭapayādi system Measurements for time, distance, and weight 1. Piṅgala and the Binary system			
4	Title	Mathematics		3	2
	4.1	Introduction to Indian Mathematics Unique aspects of Indian Mathematics Indian Mathematicians and their Contributions			
	4.2	Algebra Geometry Trigonometry			
	4.3	Binary mathematics and combinatorial problems in Chandaḥ Śāstra Magic squares in India			
5	Title	Linguistics		3	3
	5.1	Introduction to Linguistics Role of Sanskrit in natural language processing Aṣṭādhyāyī Phonetics			

	5.2	Word generation Computational aspects Mnemonics			
	5.3	Recursive operations Rule based operations Sentence formation Verbs and prefixes			
Total (*Not included)					12 hrs

List of activities (Graded, Non-graded)

Sr. No.	Title of the assignments	Marks
1	ISE 1 – Group Discussion	30
2	ISE 2 – Presentation	30
3	ISE 3 – Assignment (Group or Individual)	20
5	ESE	20
Total		100

Text Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	IKS: The Knowledge System of Bhārata	2023	Bhag Chand Chauhan	Garuda Prakashan	2023
2	Introduction to Indian Knowledge System: Concepts and Applications	2022	B.Mahadevan (Author), Nagendra Pavana (Author), Vinayak Rajat Bhat (Author)	PHI Learning	2022

Reference Books:

Sr. No.	Title	Edition	Authors/Editors	Publisher	Year
1	History of Science in India, Volume-1, Part-I, Part-II, Volume VIII	1st	Raha, Sibaji, et al.	National Academy of Sciences, India & The Ramkrishna Mission Institute of Culture, Kolkata	2014
2	Pride of India – A Glimpse of India’s Scientific Heritage	1st	Kohle, Pradeep et al. (Editors)	Sanskrit Bharati	2006
3	Vedic Physics	1st	Verma, Keshav Dev	Motilal Banarsidass	2012

				Publishers	
4	India's Glorious Scientific Tradition	1st	Soni, Suresh	Ocean Books Pvt. Ltd.	2010
5	Indian Knowledge Systems, Vol. 1	1st	Kapur, K. & Singh, A. K (Editors)	Indian Institute of Advanced Study, Shimla	2005
6	Tatvabodh of Shankaracharya	1st	Adi Shankaracharya	Central Chinmaya Mission Trust, Bombay	1995
7	Echoes of Ancient Indian Wisdom	1st	Nair, Shantha N.	Hindology Books, New Delhi	2008
8	Glimpse of Indian Engineering and Technology (Ancient Medieval Period)	1st	Kulkarni, R. P.	Munshiram Manoharlal Publishers Pvt. Ltd.	2018
9	Science and Technology in India	1st	Pathak, A. K.	Anshika Prakashan, Pratapgarh	2016
10	Indian Scientific Traditions (Prof. K.N. Neelakantan Elayath Felicitation Volume)	1st	N.V.P. Unithiri	Publication Division, University of Calicut	2006
11	Vedic Science and Technology	1st	Biswal, S.; B. L. Ray	DK Printworld	2009
12	Ancient Indian Leaps into Mathematics	1st	Yadav, B. S.	Brikausher Publications	2010



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Universal Human Values

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
AEC	Universal Human Values (UHV)	1	1	-	2	3	1	1	-	2
		Examination Scheme								
		Component		ISE		MSE		ESE	Total	
				%		%		%	%	
AEC02		Theory		--		--		20	20	
		Laboratory		80		--		-	80	

** ISE will be evaluated on the basis of individual and group activities.

** ESE will be evaluated on overall modules of the course.

Pre-requisite Course Codes, if any.	
Course Objectives:	
<ul style="list-style-type: none"> ● To develop a holistic perspective based on self-exploration, family, society and nature/existence. ● To understand (or developing clarity) of the harmony in the human being, family, society and nature/existence. ● To strengthen self-reflection. ● To develop commitment and courage to act. 	
Learning Outcomes (LO): At the end of the course students will be able to	
AEC02.1	Demonstrate a comprehensive understanding of what human values are and their significance in individual and societal contexts.
AEC02.2	Develop ethical awareness and the ability to critically evaluate moral and ethical dilemmas in various aspects of life.
AEC02.3	Foster a sense of social responsibility and awareness of the global community, including environmental and social justice issues.
AEC02.4	Promote interdisciplinary learning by exploring how values and ethics intersect with various academic disciplines and real-world challenges.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	P O1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2
AEC02.1								2	2	2		2
AEC02.2								2	2	2		2
AEC02.3								2	2	2		2
AEC02.4								2	2	2		2

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AEC02.1							
AEC02.2							
AEC02.3							
AEC02.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	L Hrs.	P Hrs
1	Title	Course Introduction - Need, Basic Guidelines, Content and Process for Value Education		2	2
	1.1	1. Purpose and motivation for the course, recapitulation from Universal Human Values-I 2. Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations			
	1.2	4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario 6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.			
2	Title	Understanding Harmony in the Human Being - Harmony in Myself!		2	2
	2.1	7. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’ 8. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility 9. Understanding the Body as an instrument of ‘I’ (I being the			

		doer, seer and enjoyer)		
	2.2	10. Understanding the characteristics and activities of 'I' and harmony in 'I' 11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail 12. Programs to ensure Sanyam and Health.		
3	Title	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship	3	2
	3.1	13. 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 14. Understanding the meaning of Trust; Difference between intention and competence 15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship		
	3.2	16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice 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		
4	Title	Understanding Harmony in the Nature and Existence - Whole existence as Coexistence	2	2
	4.1	18. Understanding the harmony in the Nature 19. Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self regulation in nature		
	4.2	20. Understanding Existence as Co-existence of mutually interacting units in all pervasive space 21. Holistic perception of harmony at all levels of existence. Include practice 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.		
5	Title	Implications of the above Holistic Understanding of Harmony on Professional Ethics	3	2
	5.1	22. Natural acceptance of human values 23. Definitiveness of Ethical Human Conduct 24. Basis for Humanistic Education, Humanistic		

		Constitution and Humanistic Universal Order		
	5.2	25. 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. 26. Case studies of typical holistic technologies, management models and production systems		
	5.3	27. 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 28. Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.		
			Total	12 hrs

List of activities (Graded, Non-graded)

Sr. No.	Title of the assignments	Marks
1	ISE 1 – Group Discussion	30
2	ISE 2 – Presentation	30
3	ISE 3 – Assignment (Group or Individual)	20
5	ESE	20
Total		100

Text Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Human Values and Professional Ethics	2010	R R Gaur, R Sangal, G P Bagaria	Excel Books	2010

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Jeevan Vidya: Ek Parichaya	First Edition	A. Nagaraj	Jeevan Vidya Prakashan	1999
2	Human Values	First Edition	A. N. Tripathi	New Age International	2004
3	The Story of Stuff	First Edition	Annie Leonard	Free Press	2010
4	The Story of My Experiments with Truth	50th Anniversary Edition	Mohandas Karamchand Gandhi	Navajivan Publishing	1927
5	Small is Beautiful	25th Anniversary Edition	E. F. Schumacher	Harper & Row	1973
6	Slow is Beautiful	First Edition	Cecile Andrews	New Society Publishers	2006
7	Economy of Permanence	First Edition	J. C. Kumarappa	Sarvodaya Ashram	1945
8	Bharat Mein Angreji Raj	First Edition	Pandit Sunderlal		
9	Rediscovering India	First Edition	Dharampal		
10	Hind Swaraj or Indian Home Rule	First Edition	Mohandas K. Gandhi	Navajivan Publishing	1909
11	India Wins Freedom	First Edition	Maulana Abdul Kalam Azad	Orient Longman	1959
12	Vivekananda	First Edition	Romain Rolland		
13	Gandhi	First Edition	Romain Rolland		



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Technical Shop

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
SEC	Technical Shop	0	1	2			0	1	1	2
		Examination Scheme								
		Component		ISE %		MSE %		ESE %		Total %
AS106	Technical Shop	Theory		-		-		-		
		Laboratory		50		-		50		100

Pre-requisite Course Codes, if any.	
Course Objective: To provide essential modern skills that enable today's engineers to create our tomorrow.	
Learning Outcomes (LO): At the End of the course students will be able to	
AS106.1	Assemble and disassemble computer hardware for PCs and laptops.
AS106.2	Create and troubleshoot basic computer networks.
AS106.3	Create and troubleshoot basic electrical networks.
AS106.4	Identify and troubleshoot electrical gadgets.
AS106.5	Model any object in 3d software and prepare it for 3d printing.
AS106.6	Design and fabricate PCBs.
AS106.7	Construct physical structures using acrylic and PVC materials.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS106.1					3				3			3
AS106.2					3				3			3
AS106.3					3				3			3
AS106.4					3				3			3
AS106.5			3		3				3			3
AS106.6			3		3				3			3
AS106.7			3		3				3			3

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
AS106.1	2					
AS106.2	2					
AS106.3	2					
AS106.4	2					
AS106.5	2					
AS106.6	2					
AS106.7	2					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Lecture Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Unit1	Introduction to skill shop.		1
	1.1	The need for skill shop. The utility of the contents covered. Special significance to Computer and EXTC students.		
2	Unit2	3D modeling - ideation and creation.		6
	2.1	Introduction to the various 3d software and their specialization. <u>AutoCAD</u> : brief 2d toolset, establishing 3d workspaces, 2d to 3d tools, primitive based design, sections, lofting and extrusion, revolving and other solid operations, dimensionally accurate design. <u>Blender (open source)</u> : differences in approach compared to AutoCAD, solid and surface based modeling, modifiers and symmetric modeling, advanced mesh-based and sculpting techniques.		
3	Unit3	3d printing - prototyping and fabrication.		4
	3.1	Processing 3d models for slicing, slicing models for 3d printing, slicing software (open source). File formats and conventions, watertighting. The file pipeline from .dwg/.blend to .stl to .gcode. File optimization. 3d printing - the process and the mechanisms. FDM (fused deposition modeling) based printing, printing materials and variations, best practices, troubleshooting, alternative, non-machine based 3d printing techniques using pens.		
4	Unit4	Specialized tool sets for manufacturing		1
	4.1	Autodesk Inventor/Fusion 360/ANSYS		
Total				12

Laboratory Component: comprises building and assembling various trade jobs such as:

Trade job 1: Computer Assembly (4 hours)

- Assemble all components of a computer from an OFF and disassembled state, installing CPU, RAM, hard drive, connecting data and power pins, turn it on, install an operating system.
- Additional training imparted during/for this trade:
 - Identification of components such as power supply, motherboard, processor, hard disk drive, RAM etc.
 - Assembly, disassembly, and component identification of a laptop.
 - Basic troubleshooting.

Trade job 2: Network Switch Installation (2 hours)

- Identify various components of a network assembly.
- Crimp LAN cables using crimping tools and patching them into a 10 port LAN switch and testing operation of the network.
- Adopt best practices in LAN network assembly.

Trade job 3: Electrical Networks (2 hours)

- Assemble different types of networks such as:
 - House wiring
 - Staircase wiring
 - Godown wiring
 - 3-phase wiring
 - Study wiring diagram
- Test, trace and troubleshoot these networks with tools such as multimeters

Trade job 4: Electrical Gadgets (2 hours)

- Repairing electrical household appliances: ceiling fan, electric iron.

Trade job 5: 3D Modeling and Printing (2 hours)

- Using the skills learned in the 3d sessions to develop a CAD file (.iges/.step/.dwg) of a 3D model and exporting it as an .stl file for the purpose of 3D printing.
- Importing the 3D .stl file in slicers to generate a .gcode file for 3D printing through slicing, using open source software

Trade job 6: Make a House (8 hours)

- Design a PCB using software such as Eagle for a simple miniature house with various points for patching LED lights.
- Fabricate the PCB using various tools.
 - Additional skills learned: soldering and desoldering, layout drawing, positive and negative film making, PCB etching and drilling, tinning.
- Fabricate an acrylic house using tools such as cutters, hacksaws, files, glue guns, sand paper, etc.
 - Additional skills learned: drilling holes at precise locations for installing LED lights using drill machines.
- Install a PVC fence around the house using PVC formed in L shaped joints at the corners.
- Create various additional models around the house - street light, chimneys and lights, etc.
- Connect the PCB to the electrical network and test proper operation of the network.

- Additional skills learned: integration of multiple design and fabrication techniques to create a finished product.

Trade job 7: Make a Product

Students may select one of the following jobs to create into a finished product. They are then required to either successfully sell the product or purchase it themselves to recover the cost of materials, resulting in a reduction in generated waste. The choices are:

- Keychain
- Simple extension board
- Liquid Level Sensor
- Water Level Controller
- Voice Recorded Message (Jan-Gan-Man)
- Audio Amplifier using IC386
- Lead Acid Battery Charger (6v/12v)
- LM723 IC power supply AI, 0-30v
- LED chaser

Trade job 8: Modern Plumbing

To better understand modern plumbing materials and tools, fabricate a simple stool made of PVC material, including cutting pipes into half pipes, L-shaped joints, and test it for sturdiness.

The above trades will be carried out in two labs in parallel per batch as follows:

Lab 1 (Room 202)	Lab 2 (Prayas Idealab)
Trade job 1: Computer Assembly Trade job 2: Network Switch Installation Trade job 3: Electrical Networks Trade job 4: Electrical Gadgets	Trade job 5: 3D Modeling and Printing Trade job 6: Make a House Trade job 7: Make a Product Trade job 8: Modern Plumbing

IDEALab Demonstrations: (4 hours)

Demonstrations on various IDEALab equipment, such as:

- CO2 Laser Cutter and Engraver
- Mini Lathe with Drilling
- Sewing Machine
- Vinyl Cutter and Printer (for making banners, posters, stickers, t-shirt printing)
- 3D scanner
- All-in-one PCB maker (Voltera v1) - PCB printing, heating, drilling and soldering
- PCB fabrication - reflow oven
- Computer desktop based drilling, milling and engraving machine - Roland SRM20
- Welding machines (Spot, ARC etc)
- Test and measuring equipments
- Mechanical fabrication (Wood cutter etc)

Course Evaluation:

The course is evaluated via:

- End-of-semester quiz exam. (20 marks)
- Fabrication and submission of finished jobs in all 6 included trades. (80 marks)

SEMESTER III

SEM III										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE201	Discrete Structures and Graph Theory	3	0	0	5	8	3
2	Basic & Engg. Sciences *	FOM-I	MA202	Foundation of Mathematics-I*	2	1	0	0	3	3
3	Skill Enhancement Course	SEC	AS202	Python Programming for Data science	0	1	2	4	7	2
4	Basic & Engg. Sciences Elective	BSESE		Course I						3
			AS101	Engineering Physics	2	0	2	4	8	
			AS102	Engineering Chemistry	2	0	2	3	7	
			AS103	Biology for Engineers	3	0	0	3	7	
			AS104	Engineering Mechanics	2	0	2	4	8	
			AS105	Engineering Graphics	1	0	2+2	2	7	
			AS108	Material Science	2	0	2	4	8	
			AS109	Environmental Science	3	0	0	3	6	
			AS110	Energy Science	2	0	2	3	7	
AS111	Thermal & Fluid Engineering	3	0	0	3	6				
5	Humanities	HSSM-I	HS2XX	Course I	2	0	0	3	5	2
7	Program Core Courses (12 Credits)	PCC	CE202	Data Structures	3	0	2	4	9	4
8		PCC	CE203	Computer Organization and Architecture	3	0	2	4	9	4
9		PCC	CE204	Database Management Systems	3	0	2	4	9	4
10	Cocurricular Courses	CC (LLC)	LLCXX	LLC--III	1	0	0	1	2	1
Total					17	1	10	28	56	23

*Only for Lateral Entry Students



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Discrete Structures and Graph Theory

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Discrete Structures and Graph Theory	3	0	0	5	8	3	0	0	3
		Examination Scheme								
		Component		ISE	MSE	ESE	Total			
CE201		Theory		20	20	60	100			
		Laboratory		--	--	--	--			

Pre-requisite Course Codes, if any.	
Course Objective: To teach students how to think logically and mathematically. It provides the mathematical foundation that is used in most areas of computer science.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
CE201.1	Use set theory, logic and its various proof techniques to solve given problem.
CE201.2	Analyze the problems based on the concepts of relations, functions, lattices and recurrence relations to solve problems
CE201.3	Apply the concepts of graph, trees and their various types with their traversing techniques to solve problems.
CE201.4	Apply the basics of coding theory and cryptography to solve real world problems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE201.1	3											
CE201.2	3	2										
CE201.3	3											
CE201.4	3	2	2									2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE201.1							
CE201.2							
CE201.3							
CE201.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Set Theory, Logic and Proofs	1, 2	
	1.1	Finite and infinite set, Union, Intersection, Disjoint, and Difference of two sets. Power Set, Partition of Sets, Ordered Sets, De Morgan's Laws, Principle of Inclusion Exclusion		2
	1.2	Predicates, Propositions, Conditional Propositions, Logical Connectivity, Proposition calculus, Universal and Existential Quantifiers, First order logic, Equivalence, Normal Forms, Introduction to proofs, Mathematical Induction, Strong Induction, Well-ordering principle, Logical inference		6
2	Title	Relations, Functions and Lattices	1, 2	
	2.1	Product Sets and Partitions, Paths in relations and Diagraphs, Properties of Relations, Closure of Relation, Equivalence Relations, Operations on Relations, Warshall's Algorithm, Partially Ordered Sets, External Elements of Partially Ordered Sets, Hasse Diagram		8
	2.2	Composition of Functions, Invertible Functions, Recursive Functions, Hashing, Pigeon hole Principle, Extended PHP		3
	2.3	Lattice, Sub lattice, Isomorphic Lattices, Properties of Lattice, Special Types of Lattices		4
	2.4	Recurrence Relations – Introduction, Linear Recurrence Relations with constant coefficients, Homogeneous solutions, Particular Solutions, Total Solutions, Solution by the method of Generating functions, solving Recurrence Relations		5
3	Title	Graph Theory	1, 2	
	3.1	Concepts and terminologies, Graphs as Model (Konigsberg Bridge Problem)		4
	3.2	Matrices, Isomorphism, Bipartite Graphs, Directed Graphs		
	3.3	Minimal Spanning Trees-Prim's Algorithm and Kruskal's Algorithm		
4	Title	Graph connectivity	1, 2	
	4.1	Cycles – Transport Networks, Max Flows, Matching Problems, Maximum Bipartite Matching, Perfect Matching		6
	4.2	Euler Paths- Circuits, Hamiltonian Paths- Circuits		
	4.3	Coloring Graphs, Chromatic Polynomial, Planer Graphs		
5	Title	Coding Theory	1, 2	
	5.1	Hamming Code, Minimum Distance		4
	5.2	Number Theory, Modular Arithmetic and applications to cryptography; Diffie-Hellman Algorithm		
6	Self-Study	Algebraic Structures - Semi group, Monoids, Groups, Cyclic groups, Abelian groups, Normal Subgroups	1, 2	5*
Total (*Not included)				42

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Discrete Mathematics and it's applications	Eight	Kenneth H. Rosen	Tata McGraw-Hill	2021
2	Discrete Mathematical Structures	Sixth	Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman	Pearson Education	2015

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Elements of Discrete Mathematics	Fourth	C. L. Liu	Tata McGraw-Hill	2012
2	Introduction to graph Theory	Second	Douglas B. West	Pearson Education	2015
3	Discrete Mathematical Structures with Applications to Computer Science	First	Jean-Paul, Tremblay R. Manohar	Tata McGraw-Hill	1987

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Foundations of Mathematics-I

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Foundations of Mathematics-I	2	1	0	0	3	2	1	0	3
		Examination Scheme								
MA202		Component		ISE	MSE	ESE	Total			
		Theory		20	20	60	100			
		Laboratory		--	--	--	--			

Pre-requisite Course Codes, if any.	-
Course Objective:	To develop basic foundation of mathematical skills.
Course Outcomes (CO):	<i>At the End of the course students will be able to:-</i>
MA202.1	Differentiate a function of one variable and partially differentiate a function of more than one variable.
MA202.2	Apply the concept of partial differentiation to find extreme values of a given function.
MA202.3	Find nth order derivative of a given function.
MA202.4	Expand a given function as a power series.
MA202.5	Perform operations on matrices and find inverses and determinants of them.
MA202.6	Perform vector operations and compute dot products and cross products between them.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA202.1	2											
MA202.2	2											
MA202.3	2											
MA202.4	1											
MA202.5	1											
MA202.6	1											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA202.1						
MA202.2						
MA202.3						
MA202.4						
MA202.5						
MA202.6						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Differential Calculus	1,2	18
	1.1	Partial fractions. Derivatives of standard functions, product and quotient rule for differentiation.		04
	1.2	Partial derivatives of first and higher order, composite differentiation		03
	1.3	Application of partial derivatives: Local Maxima and Minima of functions of two variables.		02
	1.4	Successive Differentiation: Proofs of nth derivatives of standard functions. Use of partial fractions to calculate nth derivatives of given functions. Leibnitz theorem for nth derivative of product of two functions.		05
	1.5	Infinite series: expansion of functions in powers of x using maclaurin series. Taylor's series.		04
2	Title	Matrices	1,2	07
	2.1	Addition and scalar multiplication of matrices. Matrix multiplication, types of matrices.		03
	2.2	Elementary row transformations, finding inverses using matrices, determinants and its properties		04
3	Title	Vectors	1,2	03
	3.1	Vector definition, addition, scalar multiplication, dot product of two vectors, angle between two vectors, cross product.		03
Total				28

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Higher Engineering Mathematics	Forty Forth	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Advanced Engineering Mathematics	Tenth	Erwin Kreysizg	John Wiley & Sons	2011
2	Advanced Engineering Mathematics	Twenty Eighth	H.K.Dass	S. Chand Publications	2014



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Python programming for Data Science Lab

Course (Category) Code	Course Name	Teaching Scheme (hours/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SEC)	Python programming for Data Science Lab	0	1	2	4	7	0	1	1	2
		Examination Scheme								
		Component	ISE			MSE		ESE		Total
AS202		Theory	--			--		--		--
	Laboratory	50			--		50		100	

Pre-requisite Course Codes, if any.	Linear Algebra, Probability and Statistics, Programming Lab-I, I
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Course Objective: To provide students with a comprehensive understanding of the fundamental concepts, tools, and techniques used in data science and data visualization. This course is designed to introduce students to the basic principles of data science and data visualization, including libraries used for Data Science, data exploration, data preprocessing, EDA, data visualization and basic model building.

Learning Outcomes (LO): *At the End of the course, students will be able to*

AS202.1	Demonstrate the need of libraries used in Data Science.
AS202.2	Make use of different tools and techniques for Data Visualization
AS202.3	Analyze the data performance using the EDA process.
AS202.4	Develop Linear Regression and Logistic Regression Models

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS202.1	3	3	3	3	3				2	2	2	
AS202.2	3	3	3	3	3				2	2	2	
AS202.3	3	3	3	3	3				2	2	2	
AS202.4	3	3	3	3	3				2	2	2	

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
AS202.1					1	1
AS202.2					1	1
AS202.3					1	1
AS202.4					1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze ✓	Evaluate ✓	Create
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Lab Experiments

Exp No.	Topics	Ref.
1	Case Study on Python Programming Fundamentals Your first program, Types, Expressions, Variables, String Operations, Conditions and Branching, Loops, Functions	1,2
2	Case Study on Python Data Structures: Lists and Tuples, Sets, and Dictionaries	1,2
3	Case Study on Python for Data Science: Numpy Library Basics of Numpy, Creating NumPy Arrays: Mathematical Operations on NumPy Arrays	1,2
4	Case Study on Python for Data Science: Pandas Library Basics of Pandas, Data Frames, Indexing and Slicing, Operations on Data Frames, GroupBy and Aggregate Functions, Merging Data Frames, and Pivot Tables	1,2,4
5	Case Study on Data Visualization Univariate Analysis using Matplotlib and Seaborn Categorical Ordered and Unordered Univariate Analysis	3,4
6	Case Study on Data Visualization Bivariate and Multivariate Analysis using Matplotlib and Seaborn Numerical-Numerical Analysis, Numerical-Categorical Analysis, Categorical-Categorical Analysis	3,4
7	Case Study on Exploratory Data Analysis Fixing the rows and columns, Overfitting and Underfitting, Impute/Remove missing values, Feature Engineering Techniques,	3,4,5
8	Case Study on Exploratory Data Analysis Feature Reduction Techniques, Handling Outliers, Normalization, and Standardizing values	3,4,5
9	Case Study on Linear Regression Simple Linear Regression, and Multiple Linear Regression	3,4,5
10	Case Study on Logistic Regression Univariate Logistic Regression, Multivariate Logistic Regression	3,4,5

Text Books

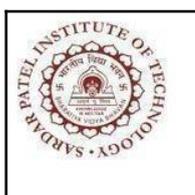
Sr. No	Title	Edition	Authors	Publisher	Year
1	Python for Data Science Handbook: Essentials Tools for Working with Data	Second	Jake VanderPlas	O'Reilly	2022
2	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter	Third	Wes McKinney	O'Reilly	2022
3	Hands-On Exploratory Data Analysis with Python	First	Suresh Kumar Mukhiya, Usman Ahmed	Packt	2020
4	Python Data Science Essentials	Third	Alberto Boschetti, Luca Massaron	Packt	2018
5	Mastering Python for data science,	First	Samir Madhavan	PACKT	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Visualization Analysis and Design	1st	Tamara Munzner	A K Peters/CRC Press	2014
2.	Python Data Visualization Essentials Guide	First	Kalilur Rahman	BPB	2021
3.	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython.		McKinney, W.	O'Reilly Media, Inc.	2012

Web References:

1. <https://www.analyticsvidhya.com/>
2. <https://www.simplilearn.com/>
3. <https://www.kaggle.com>
4. <https://matplotlib.org/>
5. <https://seaborn.pydata.org/>



Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
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 Andheri (West), Mumbai-400058

Data Structures

Course (Category)	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Data Structures	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE	Total		
CE202		Theory		15		15		45	75	
		Laboratory		15		--		10	25	

Pre-requisite Course Codes, if any.	Problem solving using imperative programming
Course Objective: To introduce the fundamentals and abstract concepts of Data Structures for Problem Solving.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE202.1	Apply various operations of linear and non-linear data structures to given problems.
CE202.2	Apply the concepts of Trees and Graphs to a given problem.
CE202.3	Understand various operations of heap data structures.
CE202.4	Implement the concepts of hashing on a given problem.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE202.1	3		3						3	3	3	
CE202.2	3		3						3	3	3	
CE202.3	3		3						3	3	3	
CE202.4	3		3						3	3	3	

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE202.1			1			1	
CE202.2			1			1	
CE202.3			1			1	
CE202.4			1			1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Data Structures		
	1.1	Concept of Linear and Nonlinear Data Structures	1,2	1
	1.2	Stack: Stack as ADT, operations on stack, Applications of Stacks	1,2	3
	1.3	Queue: Queue as ADT, Operations on Queue, Applications of Queue, Types of Queue-Circular and Priority Queue	1,2	3
	1.4	Linked List: Linked List as ADT, Operations on Singly Linked List. Types of linked list- Linear and circular linked lists, Doubly Linked List, Circular Linked List and its operations, Applications of linked List	1,2	6
2	Title	Trees		
	2.1	Trees as ADT, General tree v/s Binary Tree Terminology, Traversal of Binary Tree, Operations on Binary tree, Binary Search Tree and its operations, Expression Tree	1,2	4
	2.2	Self-balancing trees: AVL trees Properties, Rotations, Insertion, Deletion	1,2	4
	2.3	Introduction to B tree- Insertion, Deletion, Introduction to Tries (Prefix Tree) - Operations and Applications	1,2	5
3	Title	Graphs		
	3.1	Graph as ADT, Introduction to Graph, Representation of GraphAdjacency Matrix, Adjacency List, Graph Traversal Technique	1,2	3
4	Title	Heap Structure		
	4.1	Heap as ADT, Introduction to Heap Structures, Min Heap, Max Heap, Construction of Heap	1,2	4
	4.2	Binomial Heaps, Fibonacci heaps - Structure of Fibonacci heaps, Mergeable-heap, operations, decreasing a key and deleting a node	1,2	5
5	Title	Hashing		
	5.1	Introduction to Hash Table, Hash functions, Collision Resolution Techniques	1,2	4
6	Self-Study	Optimal Binary Search Tree, Probabilistic Data Structures, B+ trees, multi-dimensional trees (k-d trees, quadtrees)	1,2	5*
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implement a given problem statement using Stack
2	Implement a given problem statement using Queue
3	Implement a given problem statement using Linked List
4	Implement a given problem statement using Doubly Linked List
5	Implement a given problem statement using Binary Trees or Tries

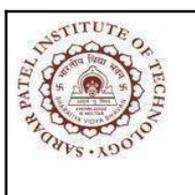
6	Implementation of Expression Tree
7	Implement insertion of node in AVL tree
8	Apply Graph Traversal Technique on a given problem statement to solve the problem
9	Implement Operations of Heap Structures
10	Implement hash functions with different collision resolution techniques

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Algorithms	Third	Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein	MIT Press	2009
2	Fundamentals of Computer Algorithms	Second	Horowitz E, Sahni S and S. Rajasekaran	Galgotia Publications	2010
3	Data Structures and Algorithm Analysis in C++	Fourth	Mark Allen Weiss	Pearson	2014
4	Probabilistic Data Structures and Algorithms for Big Data Applications	First	Andrii Gakhov	BoD GmbH, Germany	2022

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Classic Data Structures	Second	Samanta Debasis	PHI	2009
2	Data Structures with C	First	Seymour Lipschutz	Schaum's Outline Series	2010
3	Data Structures and Algorithms in Python	First	Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser	Wiley	2013
4	The Algorithm Design Manual	Second	Steven S. Skiena	Springer	2008



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Computer Organization & Architecture

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Computer Organization & Architecture	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE			MSE		ESE		Total
CE203		Theory	15			15		45		75
	Laboratory	15			--		10		25	

Pre-requisite Course Codes, if any.	Digital Systems
Course Objective: Imparting concepts of each component of computer architecture thoroughly with practical aspects including memory systems and I/O communications with interfacing	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
CE203.1	Conceptualize basic computer structure with its models and compute performance metrics.
CE203.2	Design algorithms to solve ALU operations
CE203.3	Comprehend processor organization with various design methods of CPU with comparative analysis
CE203.4	Design memory systems with analysis of mapping techniques for cache and virtual memory
CE203.5	Comprehend different types of I/O buses, compare and contrast different types of data transfer methods and arbitration techniques
CE203.6	Analyze different parallel organizations that includes pipelined and parallel processors

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE203.1	3				2							
CE203.2	3	3										
CE203.3	3	2	2		2							
CE203.4	3											
CE203.5		2	2		2							

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
CE203.1	2	2	-	-	-	-
CE203.2	2	2	-	-	-	-
CE203.3	2	2	-	-	-	-
CE203.4	2	2	-	-	-	-
CE203.5	2	2	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs .
1	Title	Overview of Computer Architecture and Organization		5
	1.1	Introduction of Computer Organization and Architecture, Basic organization of computer and block level description of the functional units, Evolution of x86 Computers, Von Neumann model, Harvard Model, Embedded system	1,2	
	1.2	Performance Issues: Designing for performance, Amdahl's Law, Multi-core, GPGPU	1,2	
2	Title	ALU, Processor Organization and Control Unit Design		10
	2.1	ALU: Integer and Floating Point Operation CPU Architecture, Register Organization , Instruction formats, basic instruction cycle. Instruction interpretation and sequencing, Case Study of 80386 architecture and Register Organization	2,3	
	2.2	Control Unit: Soft wired (Micro-programmed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations	2,3	
	2.3	RISC and CISC: Introduction to RISC and CISC architectures and design issues.	2,3	
3	Title	Memory Systems Organization		12
	3.1	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics.	2	
	3.2	Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory. Case study of Pentium Processor Cache Memory Model (MESI Protocol)	2,4	
	3.3	Virtual Memory: Concept, Segmentation and Paging, Page replacement policies. Case study of 80386 Virtual Memory Concepts	2,3	
4	Title	I/O Organization		5
	4.1	Buses: Types of Buses, Bus Arbitration, BUS standards	1,2	
	4.2	I/O Interface, I/O channels, I/O modules and IO processor, Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.	1,2	
5	Title	Parallel Processing		11
	5.1	Advanced Processor Models: Real Model, Protected Model, Virtual Model (x86 Processors)	3	
	5.2	Superscalar Architecture: Case study of Pentium processor	4	
	5.3	Pipelined Architecture: Pipeline Stages, Pipeline Hazards, Mitigation of Hazards with branch prediction and data forwarding techniques	1,2, 4	
	5.4	Introduction to parallel processing concepts, Flynn's classifications,	2	
6	Self-Study	Comparative Study of microprocessors and micro architectures with respect to their important features. Detailed analysis of Multicore and GPGPU Architectures. Vector and Array Processors with VLIW architecture. 8086 instructions set with assembler directives		
Total				42

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)
[Only for CE/CSE]**

Sr. No	Title of the Experiment
1	Installation and configure: DOS, MASM, Debug and X86 Mode
2	Implementation of various arithmetic operations through assembly language programming for 8086 using MASM and Debug.
3	Implement various String Operations in 8086 through the utilities provided by DOS and BIOS interrupts (MASM)
4	Block Transfer and Block Exchange using Index Registers
5	Drawing basic shapes like triangle, etc. using BIOS services [Use C/MASM]
6	Design Password Detection Application using BIOS and DOS interrupts along with 8086 instructions.
7	Implement file operations [DOS Interrupts in C/MASM]
8	Implement I/O interfacing using inbuilt speakers of IBM PC
9	Implement Booth's Multiplication Algorithm
10	Implement Division Algorithm (Non-Restoring and Restoring)
11	Implementation of Mapping techniques of Cache memory
12	Implementation of Page Replacement Policies

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Organization	Fifth	Carl Hamacher, Zvonko Vranesic and Safwat Zaky	Tata McGraw-Hill	2002
2	Computer Organization and Architecture: Designing for Performance	Eighth	William Stallings	Pearson	2010
3	The 80386, 80486, and Pentium Microprocessor: Hardware, Software, and Interfacing	Third	Walter Triebel	Pearson	1997
4	Pentium Pro Processor System Architecture	Third	Tom Shanely	Addison Wesley	1996

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Structured Computer Organization	Sixth	Andrew S. Tanenbaum	Pearson	2013
2	Microprocessor and Interfacing: Programming & Hardware	Third	Douglas V Hall	Tata-McGraw Hill	2012
3	Computer Architecture and Organization: Design Principles and Applications	Second	B. Govindarajulu	McGraw Hill	Paperback -2017
4	Advance Computer Architecture: Parallelism, Scalability, Programmability	Third	Kai Hwang	Tata-McGraw Hill	2017
5	Programmer's reference Manual for IBM Personal Computers	First	Steven Armburst	Tata-McGraw Hill	1986



Bharatiya Vidya Bhavan's

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Database Management systems

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Database Management systems	3	0	2	4	9	3	0	1	4
		Examination Scheme								
CE204	Database Management systems	Component		ISE		MSE		ESE		Total
		Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	-
Course Objective: To efficiently and effectively Design, develop, maintain and retrieve the Information from DBMS.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
CE204.1	Demonstrate understanding of given system to construct a database model.
CE204.2	Apply various Relational and SQL commands on the populated database.
CE204.3	Examine the functional dependencies to make a normalized database system.
CE204.4	Examine transaction processing techniques on a database.
CE204.5	Illustrate indexing, query processing and optimization method on a database.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE204.1	1	2	2	2	2	1		1	2			2
CE204.2	2	2	2		2							
CE204.3	1	2	2		2							
CE204.4	1	2			2							
CE204.5	2	2										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE204.1					3	3	
CE204.2							
CE204.3							

CE204.4							
CE204.5						2	

BLOOM'S Levels Targeted (Pl. Tick appropriate) ✓

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction: Database Concepts and ER Modeling	1,2	08
	1.1	Introduction to basic concept of Database, Characteristics of databases, File system V/s Database system, Users of Database system, Database Administrator, Data Independence, Codd's Rule, DBMS system architecture.		
	1.2	Introduction to ER model, Benefits of Data Modeling, Types of data Models, Phases of Database Modeling, The Entity-Relationship (ER) Model, Extended Entity-Relationship (EER) Model		
2	Title	Relational Algebra and SQL	1,2	15
	2.1	Introduction, Mapping the ER and EER Model to the Relational Model, Relational Algebra: Overview, Basic Operators, Extended Operators.		
	2.2	Overview of SQL, Data Definition Commands, Data Manipulation commands, Data Control commands, Set operations, aggregate function, null values, Views in SQL, Subquery, Trigger, stored procedure		
3	Title	Normalization	1,2	06
	3.1	Design guidelines for relational schema, Functional dependencies		
	3.2	Normal Forms- 1NF, 2 NF, 3NF, BCNF and 4NF,5NF		
4	Title	Transaction Processing and Recovery	1,2	07
	4.1	Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Lock-based, Timestamp-based, Validation-based protocols.		
	4.2	Shadow paging, Deadlock handling.		
5	Title	Indexing and Query Optimization:	1,2	06
	5.1	Indexing techniques: B-trees, Hashing.		
	5.2	Query processing and optimization, Query execution plans.		
6	Self Study	1. NO SQL-Data type, Database creation, Basic command for creation, updating and querying the database, Mongo dB, 2. Real-world database applications and case studies	1,2	5*

Total (*Not included)	42
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Laboratory Component:

Assign a case study for a group of 2/3 students and each group will perform the following experiments on the case study.

Exp No.	Title of the Experiment
1	Formulate a case study and create an E-R Diagram. Mapping of E-R model to Relational Model.
2	To create a database and populate using SQL commands (With constraints) Data Definition Language- Create, Alter, Drop, Rename, Truncate Data Manipulation Language- Insert, Update, Delete, Select Constraints-Not Null, Unique Key, Primary Key, Foreign Key, Check, Dropping a constraint.
3	To perform DCL, TCL commands Data Control Language: Grant, Revoke, Roles Transaction Control Language: Commit, Rollback, Save point
4	To perform Date, Time, Arithmetic and Set operation on database.
5	To perform Aggregate function and Group by- Having clause on database
6	To perform Join operations on database. Equijoins, Non-Equijoins, Self Joins, Outer Join, cross Join
7	To retrieve a data using Subquery.
8	To Create a different view of database.
9	To examine integrity of database using Triggers.
10	To Create a application using above concept using front end and back end.

Textbooks

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Database System Concepts	Seventh	Korth, Slberchatz, Sudarshan	McGraw Hill	2019
2	Fundamentals of Database Systems	Sixth	Elmasri and Navathe	PEARSON Education	2011

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Database Management Systems	Third	Raghu Ramkrishnan and Johannes Gehrke	TMH	2003
2	Database Management Systems	First	G. K. Gupta	McGraw Hill.	2018
3	SQL, PL/SQL programming language of ORACLE	Forth	Ivan Bayross	BPB	2010

SEMESTER IV

SEM IV										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE205	Statical Methods in Computer Science	3	0	0	6	9	3
2	Basic & Engg. Sciences *	FOM-II	MA204	Foundation of Mathematics-II*	2	1	0	0	3	3
3	Skill enhancement course	SEC	AS201	Soft Skill II--Professional Communication Skills	0	1	2	4	7	2
4	Humanities	HSSM-II	HS2XX	Course II	2	0	0	3	5	2
5	Program Core Courses (12 credits)	PCC	CE206	Operating Systems	3	0	2	4	9	4
6		PCC	CE207	Design and Analysis of Algorithms	3	0	2	4	9	4
7		PCC	CE208	Computer Communications and Networks	3	0	2	4	9	4
8	Cocurricular Courses	CC (LLC)	LLCXX	LLC--IV	1	0	0	1	2	1
9	Multidisciplinary Minor	MDM	MDEC1X	MDM-I	To be defined by others					3
Total					15	1	8	26	50	23

*Only for Lateral Entry Students

Summer term (For Lateral Entry Students)										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Basic & Engg. Sciences	BSES	CE201	Discrete Structures and Graph Theory	3	0	0	5	8	3
2			CE205	Statical methods in Computer Science	3	0	0	6	9	3

- Students are expected to start working for the Mini Project I during the summer.
- Summer Research Phase I of minimum 2 months and Course on Research Methodology for the “Honors by Research” for 7(4+3) credits- HR21
- For Enrollment to Honors by research, Minimum CGPA must be 8.25

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Foundations of Math

Statistical methods in Computer Science

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES) CE205	Statistical methods in Computer Science	3	0	0	6	9	3	0	0	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Laboratory				--				

Pre-requisite Course Codes, if any.	Engineering Calculus/Foundations of Mathematics-I and Differential Equations and Complex Analysis/Foundations of Mathematics-II
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Course Objective: To develop mathematical skills for solving engineering problems.

Learning Outcomes (LO): *At the End of the course students will be able to*

CE205.1	Solve a homogeneous and non-homogeneous system of linear equations using rank of a matrix
CE205.2	Apply concepts of eigenvalues and eigenvectors to calculate functions of a square matrix, google rank vector and solve systems of differential equations using diagonalisation of matrices
CE205.3	Familiarize with basic probability axioms, rules and their applicability
CE205.4	Identify the characteristics of various discrete and continuous distributions.
CE205.5	Test the hypothesis for means and variances using t and F; chi-square distribution tests
CE205.6	Find correlation and regression and fit different types of curves.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE205.1	3											
CE205.2	3											
CE205.3	3	1										
CE205.4	2											
CE205.5		2										
CE205.6		2										

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE205.1							
CE205.2							
CE205.3							
CE205.4	2						
CE205.5	2						
CE205.6	2						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref .	Hrs.
1	Title	Introduction to Linear Algebra	3,4,6,7	08
	1.1	Review of basic matrices, row echelon form, reduced row echelon form, rank of a matrix		
	1.2	Consistency and solution of simultaneous linear homogeneous and non-homogeneous equations, Applications of solving systems of equations in traffic control.		
2	Title	Eigenvalues and Eigenvectors	3,4,6,7	07
	2.1	Eigenvalues, Eigenvectors and its properties, Cayley Hamilton Theorem and its applications, Diagonalisation of matrices.		
	2.2	Application to find Google Page Rank, Function of a square matrix, Solving system of differential equations using diagonalization		
3	Title	Probability and Random Variables	1,2	14
	3.1	Classical, relative frequency and axiomatic definitions of probability, addition rule and multiplication rule, Conditional Probability, Bayes' Theorem and Independence		
	3.2	Discrete, continuous and mixed random variables, Probability Mass Function , Probability Density Function		
	3.3	Mathematical expectation, moments, moment generating function		
	3.4	Standard discrete distributions: Binomial, Poisson and Normal		
4	Title	Hypothesis Testing	1,2	9
	4.1	Statistical hypothesis, Null and Alternate Hypothesis, test of hypothesis and significance, Type I and Type II errors, Level of significance.		
	4.2	Special tests of significance for large samples and small samples- F, chi-square,z,t-test.		
5	Title	Correlation and Regression	1,2	4
	5.1	Spearman and Karl-Pearson Rank Correlation, Regression Analysis, Curve Fitting by method of least squares.		
6	Self Study	1. Applicability of Bayes Theorem 2. Examples to test goodness of fit using Chi-square 3. Normal form 4. Singular Value Decomposition 5. Derogatory and non-derogatory matrices		5
Total				42*

*Total of 42 hours does not include the self-study hours.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Probability and Statistics for Engineers and Scientists	Fourth	Sheldon M. Ross	Academic Foundation	2011

2	Probability and Statistics for Engineers and Scientists	Eighth	E.Walpole, R.H.Mayers, S.L.Mayers, K.Ye	Pearson Education	2007
3	Linear Algebra and its Applications	Fourth	Gilbert Strang	Cengage	2014
4	Higher Engineering Mathematics	Forty Fourth	Dr. B.S.Grewal	Khanna Publications	2020

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
5	Elementary Linear Algebra with Applications	Sixth	H Anton and C Rorres	John Wiley and Sons	2010
6	Advanced Engineering Mathematics	Twenty Eighth	H.K.Das	S.Chand	2014
7	Advanced Engineering Mathematics	Tenth	Erwin Kreysizg	John Wiley and Sons	2011

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Foundations of Mathematics-II

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(BSES)	Foundations of Mathematics-II	2	1	0	0	3	2	1	0	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
MA204		Theory		20		20		60		100
		Laboratory		--		--		--		--

Pre-requisite Course Codes, if any.	Foundations of Mathematics-I
Course Objective:	To develop basic foundation of mathematical skills.
Course Outcomes (CO):	<i>At the End of the course students will be able to: -</i>
MA204.1	Integrate a function of one variable using various techniques
MA204.2	Sketch basic curves and solve double and triple integrals.
MA204.3	Solve basic problems using properties of complex numbers.
MA204.4	Solve differential equations of first order.
MA204.5	Apply the techniques of solving first order differential equations to electrical engineering problems.
MA204.6	Solve differential equations of higher order

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MA204.1	1											
MA204.2	1											
MA204.3	1											
MA204.4	2											
MA204.5	1	1										
MA204.6	2											

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
MA204.1						
MA204.2						
MA204.3						
MA204.4						
MA204.5						
MA204.6						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	Integral Calculus	1,2	13
	1.1	Formulae for integral of standard functions, integration by parts, integration by method of substitution.		04
	1.2	Gamma functions, Beta functions. Differentiation under Integral sign with constant limits and one parameter.		04
	1.3	Standard curves (lines, circles, parabolas, ellipses). Concept of double integration. Evaluation of double and triple integrals.		05
2	Title	Complex Numbers	1,2	03
	2.1	Operations on complex numbers, polar form of a complex number, properties of a complex number.		03
3	Title	Differential Equations	1,2	12
	3.1	Exact differential equations. Linear differential equations of the first order and equations reducible to linear.		04
	3.2	Solving differential equations of first order in electrical networks.		01
	3.3	Linear differential equations with constant coefficients: complementary function and particular integral.		07
Total				28

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Higher Engineering Mathematics	Forty Fourth	Dr. B. S. Grewal	Khanna Publications	2020

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Advanced Engineering Mathematics	Tenth	Erwin Kreyszig	John Wiley & Sons	2011
2	Advanced Engineering Mathematics	Twenty Eighth	H.K.Dass	S.Chand	2014



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Professional Communication Skills

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(SEC)	Professional Communication Skills	0	1	2	4	7	0	1	1	2
AS201		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		--		--		--		--
		Laboratory		50		--		50	100	

Pre-requisite Course Codes, if any.	
Course Objective: To demonstrate the desired spoken and written communication skills required in early professional life, with focus on job placements.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
AS201.1	Demonstrate the spoken and written skills for job placements.
AS201.2	Draft professional documents.
AS201.3	Design written communication for social media.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AS201.1										2		
AS201.2										2		
AS201.3										2		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
AS201.1							
AS201.2							
AS201.3							

BLOOM'S Levels Targeted (Pl. appropriate)

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	L Hrs.	P Hrs
1	Title	Placement Skills		6	12
	1.1	Resume Writing & Cover Letter			
	1.2	Group Discussion			
	1.3	Case Studies/Pitching a startup			
	1.4	Team Building Skills/Work			
	1.5	Interview Skills			
2	Title	Corporate Communication		6	12
	2.1	Presentation Skills			
	2.2	Meeting: Notice, Agenda, Minutes			
	2.3	Proposal Writing			
	2.4	Report Writing: Informative, Analytical report			
3	Title	Research Writing		2	4
	3.1	Sourcing information through digital media			
	3.2	Written communication using social media: Blog			
4	Self Study	Research Paper, News Analysis		6*	
Total				42 hrs	

Theory Component

*Not included in the total

List of ISEs

Sr. No.	Title of the Experiment
1	Resume
2	Cover Letter
3	GD
4	Mock Interview
5	Presentation
6	Blog Writing
7	Team Building Activity
8	Minutes of the Meeting/Notice & Agenda
9	Proposal Writing
10	Report Writing

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Interpersonal Skills at Work	2002	John Hayes	McGraw Hill Education	2002
2	Campus Placement: A Comprehensive Guide	2016	Ankur Malhotra	McGraw Hill Education	2016

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	If I Understood You, Would I Have This Look on My Face? My Adventures in the Art and Science of Relating and Communicating	FIRST	Alan Alda	Random House	2017
2	Handbook for Writing Proposals	SECOND	Robert J. Hamper, Sue Baugh	McGraw Hill Education	2010
3	Effective Communication Skills for Scientific and Technical Professionals	2000	Harry Chambers	Paperback Basic Books	2000
4	The Art Of Writing Together	2008	William Issac	Crown Business	2008
5	Communication Skills	2011	Meenakshi Raman, Sangeeta Sharma	Oxford, India	2011



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Operating Systems

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Operating Systems	3	0	2	4	9	3	0	1	4
CE206		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		15		15		45		75
	Laboratory		15		--		10		25	

Pre-requisite Course Codes, if any.		
Course Objective:		
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>		
CE206.1	Comprehend the primitive concepts of Operating System services and System Programming functionality.	
CE206.2	Articulate process scheduling algorithms in effective execution of processes.	
CE206.3	Acquaint with efficient process synchronization techniques in effective execution of programs.	
CE206.4	Analyze virtual memory management algorithms in effective allocation of main memory usage.	
CE206.5	Evaluates various algorithms of File Storage & I/O management for performance and quality criterion.	

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE206.1	1											1
CE206.2	2	2	2	2					2			2
CE206.3	2	2	2	2					2			2
CE206.4	2	2	2	2					2			2
CE206.5	2	2	2	2					2			2

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE206.1							
CE206.2							
CE206.3						2	
CE206.4							
CE206.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Operating Systems and system software	1,2	6
	1.1	Operating Systems – Introduction, Structure and Principles of Operations of Operating Systems, Classes of Operating Systems, Batch Processing Systems, Multiprogramming Systems, Time Sharing Systems, Real Time Operating Systems, linker, loader, static and dynamic linking , virtual machine		
2	Title	Process and Threads Management	1,2	9
	2.1	Processes – Process abstraction, System calls for process management, Process execution mechanisms, Process Scheduling, Inter-process communication		
	2.2	Introduction to threads and concurrency – Single threaded process, Multithreaded process, process vs thread, Why threads, scheduling threads, creating threads, threads with shared data, race condition and synchronization .		
3	Title	Process Coordination	1,2	12
	3.1	Process Synchronization - Critical-Section Problem, Peterson’s Solution. Locks- basic idea, building a lock, hardware atomic instructions, test- and-set , Spin lock using compare - and – swap, sleeping mutex, Semaphores, Classic Problems of Synchronization, Monitors, Synchronization Examples		
	3.2	Deadlock - Characterization, Methods for Handling Deadlocks, Detection, Prevention, Avoidance, Recovery methods Deadlock.		
4	Title	Memory Management	1,2	8
	4.1	Memory Management Strategies - Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table.		
	4.2	Virtual Memory Management - Demand Paging, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory, Operating System Examples.		
5	Title	File Management		7
	5.1	Storage Management - Disk Structure, Time taken for I/O operation , Disk Scheduling, Disk Management , RAID , introduction to (solid-state storage) SSD		
	5.2	File-System - File-System Structure. Allocation Methods, Free Space Management		
	5.3	UNIX Internal File Representation – Files and directories , file abstraction, directory tree, operations on files and directories, hard links , soft links Inodes, .		
6	Self Study	1) Explore Features, characteristics and CPU scheduling of Real Time Operating System along an example 2) Explore the requirements of Kernel, CPU Scheduling, Disk Scheduling for Multimedia Systems 3) Explore all UNIX System Calls for File System.	1,2,3	

Total (*Not included)	42
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Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Introduction to Linux tools
2	Write a program for creating a static/dynamic link library
3	Write a program to implement various systems call of a process
4	Write a multithreaded program to show race condition
5	Implement different CPU scheduling algorithms
6	Program to implement shared memory and perform read and write operations on it for a given application
7	Program on process synchronization .
8	Write a program for memory management by building a custom memory manager to allocate memory dynamically .
9	Write a program to simulate disk scheduling .
10	Write a program to prevent destructive update of files

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Operating System Concepts	Ninth	Abraham Silberschatz, Peter B Galvin, Greg Gagne	Wiley	2012
2	Operating Systems: Three Easy Pieces		REMZI H. ARPACI-DUSSEAU , ANDREA C. ARPACI-DUSSEAU .	(University of Wisconsin-Madison)	2014
3	UNIX Internals: The New Frontiers	First	Uresh Vahalia	Prentice Hall	1995
4	Design of the UNIX Operating Systems	First	Maurice J. Bach	Prentice-Hall	1990

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Operating Systems: Internals and Design Principles	Eighth	William Stallings	Pearson	2014
2	Modern Operating Systems	Fourth	Andrew S. Tanenbaum, Herbert Bos	Pearson	2014



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Design and Analysis of Algorithms

Course(Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Design and Analysis of Algorithms	3	0	2	5	10	3	0	1	4
CE207		Examination Scheme								
		Component	ISE	MSE	ESE	Total				
		Theory	15	15	45	75				
		Laboratory	15	--	10	25				

Pre-requisite Course Codes, if any.	
Course Objective:	Apply various algorithmic design paradigms, analyze their asymptotic performance, and synthesize efficient algorithms for common engineering design scenarios.
Learning Outcomes (LO):	<i>At the End of the course students will be able to</i>
CE207.1	Analyze the complexity of algorithms and apply divide-and-conquer strategy to solve problems.
CE207.2	Make use of string matching algorithms to solve problems .
CE207.3	Apply the concept of greedy method, dynamic programming and Maximum Flow.
CE207.4	Apply the idea of backtracking, branch and bound strategy to solve problems.
CE207.5	Make use of NP-completeness and Approximation Algorithms

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE207.1	3	3	2	1	-	-	1	-	-	-	-	-
CE207.2	3	2	2	1	-	-	1	-	-	-	-	-
CE207.3	3	3	2	1	-	-	1	-	-	-	-	-
CE207.4	3	3	2	1	-	-	1	-	-	-	-	-
CE207.5	2	2	3	1	-	-	1	-	-	-	-	-

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE207.1	-	-	-	-	-	-	-
CE207.2	-	-	-	-	-	-	-
CE207.3	-	-	-	-	-	-	-
CE207.4	-	-	-	-	-	-	-
CE207.5	-	-	-	-	-	-	-

BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref .	Hrs.
1	Title	Introduction to Algorithm		8
	1.1	Role of Algorithms – Algorithm as Technology, Introduction to design and analysis of algorithm e.g. Insertion Sort and Selection Sort		
	1.2	Asymptotic Notations – All asymptotic (O , Θ , Ω , o , θ and ω) notations, Common Functions, Recurrence Relation and Solutions Methods: Substitution, Recursion-tree and Master Theorem.		
	1.3	Divide and Conquer – Concepts, Maximum Subarray Problem, Closest Pair, Strassen’s matrix multiplication, Quick-Sort, Merge-Sort, Sorting in Linear Time		
2	Title	Greedy Methods and String Matching		10
	2.1	Disjoint Sets DS – Disjoint set operations, Linked List Representation, Disjoint Set Forests		
	2.2	Greedy Approach – Prim’s and Kruskal’s MST algorithms, Dijkstra’s and Bellman Ford’s SSSP algorithms, Activity selection, Fractional knapsack problem, Job sequencing with deadlines problem.		
	2.3	String Matching algorithms – Naïve string matching Algorithm, Rabin Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm		
3	Title	Dynamic Programming and Maximum Flow Problem		10
	3.1	Dynamic Programming – Concepts, Longest Common Subsequence, Matrix Chain Multiplication, Optimal Binary Search Trees, 0/1 knapsack problem,		
	3.2	All Pairs Shortest Paths – Shortest Paths and Matrix Multiplications, Floyd-Warshall algorithm, Johnson’s algorithm for sparse graphs.		
	3.3	Flow Networks – Graph-theoretic definition of Flow networks, Ford-Fulkerson and Maximum Bipartite Matching		
4	Title	Backtracking and Branch-and-bound		8
	4.1	Backtracking – General method, 8-queen problem (N-queen problem), Sum of subsets, Graph coloring, 0/1 Knapsack problem		
	4.2	Branch-and-bound – General method, 0/1 knapsack problem, Travelling Salesman problem, 15 puzzle problem		
5	Title	Approximation and NP-Completeness		6
	5.1	NP-Completeness – Polynomial time, Polynomial-time verification, NP-completeness reducibility and proof.		
	5.2	Approximation – Introduction, Vertex-cover, Travelling-salesman problem and set-covering.		
6	Self Study	Amortized analysis – Aggregate analysis, accounting and Potential Method, Dynamic Table.		
Total				42

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Experiment based on common mathematical functions.
2	Experiment based on divide and conquers approach.
3	Experiment based on greedy approach
4	Experiment using dynamic programming approach
5	Experiment based on maximum flow
6	Experiment based on graph Algorithms
7	Experiment using Backtracking strategy
8	Experiment using branch and bound strategy
9	Experiment based on Approximation Algorithms
10	Experiment based on string matching/amortized analysis.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Algorithms	Third	Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein	MIT Press	2009
2	Fundamentals of Computer Algorithms	Second	Horowitz E, Sahni S and S. Rajasekaran	Galgotia Publications	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	The Design and analysis of algorithms	First	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman	Pearson Education India	2006
2	Fundamentals of Algorithmics	First	Gilles Brassard, Paul Bratley	Prentice Hall	1995



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Computer Communications and Networks

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Computer Communications and Networks	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component		ISE	MSE	ESE	Total			
CE208		Theory		15	15	45	75			
		Laboratory		15	--	10	25			

Pre-requisite Course Codes, if any.

Course Objective: The objective of the Computer Communication Networks course is to equip students with comprehensive knowledge and practical skills in the field of network engineering. The course aims to prepare individuals for various specialized roles within the networking industry, enabling them to proficiently design, implement, and manage computer communication networks. Throughout the course, students will develop expertise in areas such as network analysis, administration, architecture, and specialized technical roles. By the end of the program, graduates should be capable of seamlessly navigating between the technical and business aspects of network management, and be well-prepared for roles such as network engineer, network manager, network analyst, network administrator, network specialist, network technician, and network architect. The curriculum will emphasize hands-on experience, problem-solving, and staying abreast of the latest advancements in networking technologies, ensuring that students are well-positioned to contribute effectively to the dynamic and evolving field of computer communication networks.

Learning Outcomes (LO): At the End of the course students will be able to

CE208.1	Identify key principles and concepts of computer networking and the Internet.
CE208.2	Evaluate the effectiveness of different protocols in diverse network applications.
CE208.3	Apply knowledge of protocols to configure transport layer settings for optimal data transmission.
CE208.4	Apply the knowledge of subnetting, routing mechanisms and Software Defined Networking.
CE208.5	Analyze the performance and security of different access network technologies.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE208.1	2	2			2							1
CE208.2	2	2			2							1
CE208.3	2	2			2							1
CE208.4	2	2			2							1
CE208.5	2	2			2							1

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE208.1	2						
CE208.2	2						
CE208.3	2						
CE208.4	2						
CE208.5	2						

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Computer Communication and The Internet	1,2	06
	1.1	Internet: A Nut and Bolts Description, A Services Description, Protocol. The Network Edge: Access Network, The Network Core: Packet Switching, Circuit Switching, A Network of Networks	1,2	
	1.2	Delay, Loss, Throughput in Packet Switched Networks: Overview of Delay in Packet Switched Networks, Queuing Delay and Packet Loss, End to End Delay, Throughput in Computer Networks.	1,2	
	1.3	Protocol Layers and their Service Models: Layered Architecture and their Encapsulation.	1,2	

	1.4	Data and Signals: Analog and Digital, Periodic analog signals, Digital signals, Transmission impairment.	2	
2	Title	Application Layer	1,2	06
	2.1	Principles of Network Applications: Network Applications Architecture, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application Layer Protocols.	1,2	
	2.2	The Web and HTTP: Overview of HTTP, Non Persistent and Persistent Connections, HTTP Message Format, User Server Interaction: Cookies, Web Catching, The Conditional Get.	1,2	
	2.3	File Transfer Ftp: Ftp Commands and Replies. FTP, SMTP, Mail Access Protocol (IMAP, POP), DNS	1,2	
3	Title	Transport Layer	1,2	10
	3.1	Introduction and Transport-Layer Services: Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet	1,2	
	3.2	Multiplexing and Demultiplexing	1,2	
	3.3	Connection less Transport - UDP: UDP Segment Structure, UDP Checksum	1,2	
	3.4	Principles of Reliable Data Transfer: Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go Back-N (GBN), Selective Repeat (SR),	1,2	
	3.5	Connection-Oriented Transport - TCP: The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management	1,2	
	3.6	Principles of Congestion Control: The Causes and the Costs of Congestion, Approaches to Congestion Control. additive-increase, multiplicative-decrease (AIMD)	1,2	

4	Title	The Network Layer	1,2	10
	4.1	Introduction: Forwarding and Routing, Network Service Models.	1,2	
	4.2	Virtual Circuit and Datagram Networks: Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks.	1,2	
	4.3	Router: Input Processing, Switching, Output Processing, Queuing, The Routing Control Plane.	1,2	

	4.4	The Internet Protocol (IP): Forwarding and Addressing in the Internet, Datagram Format, IPv4 Addressing, Internet Control Message Protocol (ICMP), IPv6	1,2	
	4.5	Routing Algorithms: The Link-State (LS) Routing Algorithm, The Distance-Vector (DV) Routing Algorithm, Hierarchical Routing	1,2	
	4.6	Software Defined Networking: Introduction and Overview	R3	
5	Title	The Link Layer: Links, Access Networks, and LANs	1,2	10
	5.1	Introduction to the Link Layer: The Services Provided by the Link Layer, Implementation of the Link Layer	1,2	
	5.2	Error-Detection and Correction Techniques: Parity Checks, Check summing Methods, Cyclic Redundancy Check (CRC)	1,2	
	5.3	Multiple Access Links and Protocols: Channel Partitioning Protocols, Random Access Protocols, Taking-Turns Protocols.	1,2	
	5.4	WiFi: 802.11 Wireless LANs: The 802.11 Wireless LAN Architecture, The 802.11 MAC Protocol, The IEEE 802.11 Frame, Advanced Features in 802.11, Personal Area Networks: Bluetooth	1,2	
6*	Title	Self Study Topic	1,2	5*
	6.1	Transmission Media: Guided media, Unguided media: Wireless	1,2	
	6.2	ARP and RARP usage	1,2	
	6.3	Multicast routing and Broadcast routing	1,2	
	6.4	Routing in the Internet: Intra-AS Routing in the Internet: RIP, Intra-AS Routing in the Internet: OSPF, Inter-AS Routing: BGP	1,2	
	6.5	Network Function Virtualization	R3	
Total				42

*This module hrs. not included in Total 42 hrs

Laboratory Component (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Network Setup: Network configuration, commands and troubleshooting
2	Network Socket Programming
3	Network Socket Programming using Python Scapy
4	Server Configuration-I
5	Server Configuration-II

6	Network Protocol Analysis
7	Network Simulation using Cisco Packet Tracer
8	Software Defined Networking using Mininet
9	Switch and WLAN Configuration
10	Installation and configuration of network traffic analyzer NTOP
11	Network Server Automation using Ansible
12	Network mapping techniques using open source tools

Text Books

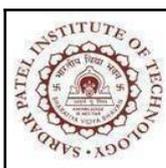
Sr. No.	Title	Edition	Authors	Publisher	Year
1	Computer Networking: Top Down Approach	8th	James Kurose and Kieth Ross	Pearson	2020
2	Data Communication and Networking	5th	Behrouz Forouzan	McGraw Hill	2020

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Computer Networks	Fifth	Andrew Tanenbaum	Pearson	2013
2	Computer Networks	Third	Larry L. Peterson and Bruce Davie	Morgan Huffman	2003
3	SDN and NFV Simplified	First	Jim Doherty	Addison Wesley	2016

SEMESTER V

SEM V										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Experiential Learning	ELC	PR1	Mini Project I	0	0	4	4	8	2
2	Program Core Courses (19 Credits)	PCC	CE301	Distributed Computing	3	0	2	6	10	4
3		PCC	CE302	Software Engineering	3	0	2	6	10	4
4		PCC	CE303	Artificial Intelligence and Soft Computing	3	0	2	6	11	4
5		PCC	CE304	Theory of Computation	3	0	0	5	8	3
6		PCC	CE305	Cryptography and Network Security	3	0	2	5	10	4
7	Multidisciplinary Minor	MDM	MDEC2X	MDM-II	To be defined by others					4
Total					15	0	12	32	57	25



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Mini Project

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
ELC	Mini Project	0	0	4	4	8	0	0	0	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
PR1	Mini Project	Theory		--		--		--		--
		Laboratory		100		--		100		200

Pre-requisite Course Codes, if any.	
Course Objective: This course inculcates self-learning, research and entrepreneurship attitude in students. Students will be able to understand the formal project development process to complete a project in a team. It will help students to develop communication, organizational skills and maturity through discussion, presentation etc.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
PR1.1	Conduct a survey of basic and contemporary literature in the preferred field by identifying problems based on societal /research needs.
PR1.2	Formulate the problem statement by making judgments on validity of ideas.
PR1.3	Apply Knowledge and skill to solve identified problem.
PR1.4	Analyze the impact of solutions in societal and environmental context for sustainable development.
PR1.5	Demonstrate capabilities of self-learning, which leads to lifelong learning.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PR1.1	2	2				2	1	3	3	3		2
PR1.2	2	3	2	2			1	3	3	3		2
PR1.3	2	2	2	2	2			3	3	3		2
PR1.4								3	3	3	3	2
PR1.5	2	2						3	3	3	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
PR1.1							
PR1.2							
PR1.3							
PR1.4							
PR1.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	✓ Create
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The **Mini Project** serves as an opportunity to cultivate research aptitude among students, encouraging them to explore, identify, and bridge research gaps while developing solutions. This hands-on experience allows students to apply theoretical knowledge to real-world issues, fostering critical thinking and problem-solving skills. By engaging in this process, students learn to assess the feasibility of various solutions, considering technical, societal, and environmental aspects.

Steps:

Phase 1-

- 1) **Project Selection and Idea Generation**- Choose a project topic that is relevant, feasible, and aligns with your interests or course requirements.
- 2) **Research and Literature Review** - Understand the existing solutions, theories, and technologies related to your project topic.
- 3) **Problem Definition, Objective Setting and Planning** - Clearly define the problem you're addressing and set specific, achievable project objectives. Create a plan for how you will approach the project

Phase 2-

- 1) **Design**- Design the solution.
- 2) **Development and Implementation**- Build and implement the solution based on the design.
- 3) **Testing** - Test the solution to ensure it meets the objectives and solves the problem effectively.

Students can seek guidance from teachers, other experts and make effective use of other sources of information available around them. Students must ensure that the problem be manageable in one semester.

Criteria of a good project:

- ✓ Appropriate idea, clear understanding and proper presentation of the concept
- ✓ Quality of work
- ✓ Project plan and its execution
- ✓ Credibility of the work
- ✓ Probable impact of the work on the attitude of students and society
- ✓ Scientific attitude, creativity and novelty reflected in project work and analysis of the situation
- ✓ Utility and innovation of the remedial measures
- ✓ Desirability, Feasibility and Viability in real life

Evaluation:

Phase 1-

Rubric for Phase 1 -Total 50 marks

Field/Market Survey & Literature Survey (15)	Problem Definition (10)	Presentation (15)	Project Planning (10)	Total Marks out of (50)
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Phase 2-

Rubric for Phase 2 -Total 50 marks

P1: Technical Competency (Understand project technicality/Design exceeds project objectives)

P2: Work done (100 % Implementation/ Meets project objectives/result analysis/test cases/solution shows originality)

P3: Presentation (Coverage of topic/use of graphics/Delivery & Speaking skills/Presentation length) and Ethics (Attitude/Deadline/Distribution of Work)

P4: Report with appropriate citations

P1 (10)	P2 (20)	P3 (10)	P4 (10)	Total Marks (Max=50)
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ESE-

Rubric for ESE -Total 100 marks

P1: Problem Definition (Idea/Originality/Novelty/Feasibility/Application in Society)

P2: Presentation (Demo/Oral/Written) and Ethics (Attitude/Deadline/Distribution of Work)

P3: Work Done (Survey/Design/Simulation/Experimentation/Tools Usage/Budget Plan/Execution Plan)

P4: Knowledge (Question-answer)

P5: Poster

P1 (20)	P2 (20)	P3 (30)	P4 (20)	P5 (10)	Total Marks (Max=100) (Passing=40)
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Distributed Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	Total	
(PC)	Distributed Computing	3	0	2	5	10	3	0	1	4	
		Examination Scheme									
		Component	ISE	MSE	ESE	Total					
CE301		Theory		15	15	45	75				
		Laboratory		15	--	10	25				

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CS301/CE301 .1	Understand the fundamental concepts and design principles of distributed systems.
CS301/CE301 .2	Analyze and apply synchronization techniques and algorithms in distributed environments.
CS301/CE301 .3	Evaluate consistency models and replication strategies for distributed data management.
CS301/CE301 .4	Design and assess distributed file systems and understand their real-world applications.
CS301/CE301 .5	Explore emerging trends and technologies in distributed computing.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS301/CE301 .1	3	2	2	2	1	-	-	-	-	-	-	-
CS301/CE301 .2	3	3	3	2	2	-	-	-	1	-	-	-
CS301/CE301 .3	3	3	3	2	2	-	-	-	1	-	-	-
CS301/CE301 .4	3	2	3	2	2	-	-	-	1	-	-	-
CS301/CE301 .5	3	2	2	2	2	-	-	-	1	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS301/CE301.1							
CS301/CE301.2							
CS301/CE301.3							
CS301/CE301.4							
CS301/CE301.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Distributed Systems		8
	1.1	Definition, Goals, Types of Distributed Computing Models, Issues in Distributed Systems.	T1,T2	
	1.2	Hardware Concepts, Software Concepts, The Client-Server Model, Positioning Middleware, Models of Middleware, Services offered by Middleware.	T1	
2	Title	Communication in Distributed Systems		10
	2.1	Interprocess Communication: Message passing, RPC, RMI, Message Oriented Communication: Persistence and synchronicity in communication, Message Oriented Transient and Persistent Communications sockets.	T1,T2	
	2.2	Desirable features of message passing, message structure, Issues in IPC by message passing, message synchronization, Buffering, Multi datagram message, failure handling, Group communication and multicast.	T1,T2	
3	Title	Process and Clock Synchronization and Coordination		10
	3.1	Introduction to Threads, Threads in Distributed Systems, Clients, Server, Code Migration: Approaches to Code Migration, Models, Migration and Local Resources.	T1	
	3.2	Clock Synchronization: Cristian's and Berkeley algorithms, Logical Clocks: Lamport's Timestamps, Vector Clocks, Mutual Exclusion: Token based, Non token based and Quorum based. Election Algorithms: Bully and Ring Algorithm.	T1,T2	
4	Title	Consistency and Replication		6
	4.1	Data-centric and client-centric consistency models, Replication strategies, quorum consensus, and consistency protocols.	T1,T2	
	4.2	Types of Failures and Replication Techniques, Fault Tolerance.	T1,T2	
5	Title	Distributed File Systems & Case Studies		8
	5.1	Design and implementation of DFS: NFS, AFS, HDFS, Google File System (GFS), Hadoop, Apache Kafka.	T1, R1,2,3, 4	
	5.2	Emerging trends: Blockchain, types of Blockchain, Bitcoin, High performance computoin, Microservices, Distributed AI & Machine Learning.	R1,2,3, 4	
6	Self Study	Cloud Computing, Edge Computing and Fog Computing, Need for Edge/Fog in IoT, Architectures and real-world applications, Open MPI.	R1,2,3, 4	6*
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Client-Server Communication using RPC or Java RMI
2	Implementation of Multithreading in Distributed System
3	Implementation of Clock Synchronization (logical/physical).
4	Implement Bully and Ring Election Algorithms
5	Implementation of data consistency and replication models
6	Implementation Load Balancing Algorithm.
7	Implementation a basic MapReduce job using Hadoop or Apache Spark
8	Simulate simple fault tolerance with primary-backup replication
9	MPI Collective Communication: Broadcast, Scatter, Gather
10	Parallel Matrix Multiplication using MPI

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Distributed Systems: Principles and Paradigms	2nd Edition	Andrew S. Tanenbaum, Maarten Van Steen	Pearson Education	2007
2	Distributed Operating Systems Concepts and Design	Second Edition	P. K. Sinha	PHI	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Distributed Systems: Concepts and Design	5th Edition	George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair	Pearson	2012
2	Distributed Computing: Principles, Algorithms, and Systems	-	Ajay D. Kshemkalyani, Mukesh Singhal	Cambridge University Press	2008
3	Using MPI: Portable Parallel Programming with the Message-Passing Interface	2nd Edition	William Gropp, Ewing Lusk, Anthony Skjellum	MIT Press	1999
4	Distributed Systems VOD	First Edition	Sudhir D. & Bandu B.M	Research India Publication	2011



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Software Engineering

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Software Engineering	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
CE-302		Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	CE102 :Problem Solving using Object Oriented Programming Lab, CE204: Database Management Systems.
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Course Objective: To understand the best practices in software engineering and gain knowledge to analyze, design, implement and test software project.

Course Outcomes (CO): *At the End of the course students will be able to*

CE-302.1	Illustrates software development lifecycle models.
CE-302.2	Analyze user requirements and specifications to identify functional and non-functional requirements of a software system.
CE-302.3	Design structured and object-oriented system using appropriate design patterns.
CE-302.4	Apply project management principles to schedule tasks, estimate development costs, and manage risks in software system.
CE-302.5	Apply software testing methods to create test cases that validate system functionality

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE-302.1	2	2										
CE-302.2	3	3								1		1
CE-302.3	2		3		3				2			2
CE-302.4	2		2	1	1				2	1	3	2
CE-302.5	2			3	2							2

	PEO1	PEO2	PEO3	PSO1	PSO2
CE-302.1					
CE-302.2					
CE-302.3					
CE-302.4					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction		06
	1.1	Introduction to Software Engineering, The nature of software, the software process, software Engineering Practice.	1,2	
	1.2	Software Methodologies and Related Process Models with applications, Traditional Life Cycle Models, Waterfall, Incremental, Iterative models, Spiral, V-Model, Agile Software Engineering Process Models, SCRUM, Extreme Programming	1,2	
2		Requirements Management and Project Management		10
	2.1	Requirement Gathering and Analysis, Software Requirement Specification, Functional Specifications with Use Cases, Defining User Requirements, Validating Requirements, Achieving Requirements Traceability, Managing Changing Requirements, Agile Requirements Engineering.	1,2	
	2.2	Scheduling, Work Breakdown Structure, Gantt Chart, Pert Chart, Critical Path, Schedule and Cost slippage, Estimation, Decomposition techniques, Empirical estimation models, Software Risk Management: Risk Identification, Risk Projection, Risk Refinement, RMMM Plan.	1,2,3	
3		Software Analysis and Design		10
	3.1	Difference between Structured and Object-Oriented analysis, Structured Analysis, Data Flow Diagrams Structured Design Structure Chart.	4,5	
	3.2	Coupling and Cohesion, Software Architecture, Architecture view, Architecture Styles for Component and connector view: Pipe and Filter, Shared-Data Style, Client-Server Styles	2,3	
	3.3	Object Oriented Analysis and Design, Use Case Diagram, Class diagram, Interaction diagrams, Activity diagram, State Chart diagram, Component and Deployment diagram	5,6	
4		Object Oriented Software Development		06
	4.1	Design Patterns, types of Patterns, Architectural Patterns: MVC, GoF Design Pattern: Singleton, Observer	2,3	
	4.2	GRASP(General Responsibility Assignment Patterns): Low coupling/high cohesion, Controller, Law of Demeter, Expert, Creator.	2,3	
5		Software Testing and Quality Assurance		10
	5.1	Software Testing, Unit Testing, Integration Testing, System Testing Black-Box Testing: Equivalence Class Partitioning, Boundary Value Analysis, White-Box Testing: Statement Coverage, Branch Coverage, Condition Coverage, Condition and Decision Coverage, Multiple Condition Coverage, Multiple Condition Coverage/Decision Coverage (MC/DC), Path Coverage, McCabe's Cyclomatic Complexity Metric, Data Flow-based Testing, Mutation Testing	1,2	
	5.2	Software Metrics, Product Metrics – McCall's Quality Factor,	1,2	

		Metrics for Analysis Model and Design Model, Project Metrics, Process Metrics, Metrics for Source Code		
	5.3	Software Quality Concepts, Quality Assurance, Quality Control, Formal Technical Reviews	1,2	
6	Self Study	Software Engineering with Open Source and GenAI		05
Total				42 5*

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Gather requirements and write a project proposal for case study. Prepare SRS document. (Use IEEE template)
2	Design UML diagram -Use Case
3	Design UML diagram - Class diagram
4	Design UML diagram -Interaction diagrams
5	Design UML diagram -Activity diagram
6	Design Data flow diagram (level 0 and1) for the case study.
7	Create work breakdown structure and schedule the activities
8	Develop Risk Mitigation, Monitoring and Management Plan for the case study.
9	Implement any one Module from chosen case study.
10	Prepare test cases and perform Unit Testing (test scenario, test cases, test data)

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Software Engineering: A Practitioner's Approach	8 th Edition	Roger S. Pressman and Bruce Maxim	McGraw-Hill	2021
2	Fundamentals of Software Engineering	5 th Edition	Rajib Mall	PHI Learning	2018
3	An Integrated Approach to Software Engineering	3 rd Edition	Pankaj Jalote	Narosa Publishing House	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
4	Software Engineering	9 th Edition	Ian Sommerville	Pearson	2023
5	UML for Java Programmers	---	Robert C. Martin	Pearson	2006

6	The Unified Modeling Language User Guide	2 nd Edition	Martin Fowler	Pearson	2010
7	Pankaj Jalote's Software Engineering: With Open Source and GenAI	2 nd Edition	Pankaj Jalote	WILEY	2024



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Artificial Intelligence and Soft Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	Artificial Intelligence and Soft Computing	3	0	2	5	10	2	0	1	4
Examination Scheme										
		Component	ISE			MSE		ESE		Total
CE303		Theory	13			14		40		67
	Laboratory	26			--		7		33	

Pre-requisite Course Codes, if any. Mathematics

Course Objective: The objective of this course is to introduce students to the foundational concepts of Artificial Intelligence (AI) and Soft Computing, which are essential components of modern intelligent systems. The course aims to provide students with both a solid theoretical background and practical understanding necessary to design, analyze, and implement intelligent systems. Emphasis is placed on key AI paradigms and soft computing techniques, including neural networks and fuzzy logic, enabling students to develop systems that can learn, adapt, and make decisions in complex and uncertain environments.

Course Outcomes (CO): At the End of the course students will be able to

CS303.1	Identify the various characteristics of Artificial Intelligence and soft computing techniques in building intelligent machines
CS303.2	Apply the supervised and unsupervised Neural Network Learning algorithm to solve real world engineering problems.
CS303.3	Design an associative memory network for real world problems
CS303.4	Design Fuzzy Logic Controller System
CS303.5	Analysis Working of NN-FL Hybrid System

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS303.1	2	2	--	2	--	--	--	--	--	--	--	--
CS303.2	2	2	2	2	2	--	--	--	1	1	--	--
CS303.3	2	2	2	2	2	--	--	--	1	1	--	--
CS303.4		2	2	2	2	--	--	--	--	--	--	--
CS303.5		2	2	2								

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
CS303.1	2	2	--	--	--	--
CS303.2	3	2	--	--	2	--
CS303.3	3	2	--	--	2	--
CS303.4	3	2	3	--	--	--
CS303.5	3	2	--	--	--	--

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to AI and Soft computing technique	T1,T2, R3	06
	1.1	Definition of AI, History and Future of AI. Intelligent Agents, Agents and Environments ,Rationality, Nature of Environment, Structure of Agent, Problem solving Approach to Typical AI problem, Introduction to Expert System Design		
	1.2	Soft computing Constituents, Difference between Hard Computing and Soft Computing.		
2	Title	Neural Networks	T1,T2 T3,R1	12
	2.1	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks, Models of ANN, terminologies in ANN, Activation functions and its types, McCulloch Pitt model, Linear separability, Hebb Network		
	2.2	Supervised Learning algorithms: Perceptron (Single Layer, Multi layer),, Adaline, Delta learning rule, Back Propagation algorithm.		

	2.3	Un-Supervised Learning algorithms: Hebbian Learning, Winner take all, Self-Organizing Maps KSOFMN , Learning Vector Quantization.		
3	Title	Associative Memory Networks	T2, T3,T4	4
	3.1	Auto associative and Hetero associative Memory Network, BAM, Hopfield network.		
4	Title	Fuzzy Logic, Classical Set and Fuzzy Relations	T2,T3, T4,R1, R3	12
	4.1	Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Functions, Classical and Fuzzy set operations, and properties of classical and Fuzzy sets.		
	4.2	Classical and Fuzzy Relations: Cartesian product of relation, Fuzzy Max-Min and Max-Product Composition, Fuzzy extension principle		
5	Title	Fuzzy control system design and Hybrid Model	T2, T3 T4, R2	8
	5.1	Fuzzy Inference System (FIS), Types of FIS, fuzzification, defuzzification methods, and design of fuzzy controllers. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro-Fuzzy Networks(ANFIS)		
	Self Study	Adaptive Resonance Theory, Genetic Algorithms, CNN, Transfer Learning,	-	5
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To study and write a program using Prolog for simple real time problems like temperature conversion, Monkey banana problem, Fibonacci series etc
2	Implement a simple intelligent agent using Python
3	To implement Transfer/Activation Functions for a given problem statement and design ANN for a given problem statement.
4	To design and implement SLP for a given problem statement. 1. Design a perceptron using Joone Editor. 2. Write a program using Single Layer perceptron
5	To implement the Supervised Learning algorithm.
6	To implement the Unsupervised Learning algorithm
7	To implement Associative Memory Network for a given problem statement
8	To implement Fuzzy Sets and Fuzzy Relations for a given problem statement
9	To design and implement Fuzzy Logic controller for a given problem statement
10	To design and implement ANFIS model for a given problem statement

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
T1	Introduction to Artificial Neural Systems	1st	Jacek M. Zurada	Jaico Publisher	1994
T2	Principles of Soft Computing	3rd	Sivanandan and Deepa	Pearson Edition	2019
T3	Fuzzy logic with engineering applications	3rd	Ross, Timothy J	John Wiley & Sons	2011
T4	Neural Networks, Fuzzy Logic and Genetic Algorithms	Kindle	S.Rajasekaran and G.A.VijayalakshmiPai	PHI Learning	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
R1	Neural Network Design	2nd	Hagan, Demuth, Beale	CENGAGE Learning	2014
R2	Neuro-Fuzzy and Soft Computing	1st	J.-S.R.Jang .	Pearson	1996
R3	Introduction to Soft Computing	1st	Sameer Roy	Pearson	2013



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Theory of Computation

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Theory of Computation	3	0	0	5	8	3	0	0	3
CE304		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Laboratory		--		--		--		

Pre-requisite Course Codes, if any.	CE/CS201: Discrete Structures and Graph Theory
Course Objective: To give an overview of the theoretical foundations of computer science from the perspective of formal languages which provides the mathematical foundation of formal models of computation, and fundamentals of formal grammars and languages that are used in most areas of computer science.	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
CE/CS304.1	Design finite automata for regular expressions and languages.
CE/CS304.2	Understand and apply properties of regular languages.
CE/CS304.3	Design context-free grammar for a language and convert it into normal forms.
CE/CS304.4	Design Pushdown Automata and Turing Machine for a language.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE/CS304.1	3	3	2		1				1	1		
CE/CS304.2	3	2							1	1		
CE/CS304.3	2	3			1				1	1		
CE/CS304.4	2	2	2		1				1	1		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE/CS304.1							
CE/CS304.2							
CE/CS304.3							
CE/CS304.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
✓	✓	✓	✓		

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Sets, Relations and Languages	1,5	3
	1.1	Relations and functions		
	1.2	Alphabets and languages		
	1.3	Types of proof		
2	Title	Finite Automata	1,3,5	7
	2.1	Regular languages and regular expressions		
	2.2	Finite Automata, Nondeterministic Finite Automata, Nondeterministic Finite Automata with ϵ -transitions		
	2.3	Kleene's theorem		
	2.4	NFA to DFA Conversion		
	2.5	Finite Automata with output (Moore and Mealy Machine)		
3	Title	Regular Languages	1,4	6
	3.1	The pumping lemma for regular languages, Applications of the pumping lemma		
	3.2	Closure properties for regular languages		
	3.3	Equivalence and minimization of automata: Testing equivalence of states, Minimization of DFA's		
	3.4	Myhill-Nerode theorem		
4	Title	Context-Free Grammars and Languages	1,5	5
	4.1	Context free grammars: Definition of context free grammars, Derivations using a grammar, The language of a grammar, Sentential forms		
	4.2	Parse trees: Constructing parse trees, From inferences to trees, From trees to derivations, From derivations to recursive inferences		
	4.3	Ambiguity in grammars and languages: Ambiguous grammars, Removing ambiguity from grammars		
5	Title	Pushdown Automata	1,2	6
	5.1	Definition of the pushdown automaton: The formal definition of pushdown automata, A graphical notation for PDA's, Instantaneous descriptions of a PDA		
	5.2	The languages of a PDA: Acceptance by final state, Acceptance by empty stack, From empty stack to final state, From final state to empty stack		
	5.3	Equivalence of PDA's and CFG's: From grammars to pushdown automata, From PDA's to Grammar		

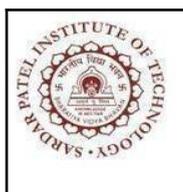
	5.4	Deterministic pushdown automata: Definition of a deterministic PDA, Regular languages and deterministic PDA's, DPDA's and context free languages		
6	Title	Properties of Context-Free Languages	1,2,3	5
	6.1	Eliminating useless symbols, Computing the generating and reachable symbols, Chomsky normal form, Greibach normal form		
	6.2	The Pumping lemma for context free languages: Applications of the pumping lemma for CFL's		
7	Title	Introduction to Turing Machines	1,2,	6
	7.1	Turing machines: Formal definition of a Turing machine, Examples of Turing machines		
	7.2	Halting Problem, Post Correspondence Problem (PCP)		
	7.3	Variants of Turing machines: Multitape Turing Machines		
	7.4	Church-Turing hypothesis		
8	Title	Recursively Enumerable Languages	3	
	8.1	Recursively Enumerable and recursive		4
	8.2	Enumerating a language		
	8.3	Context sensitive languages and the Chomsky hierarchy		
	Self Study	Tractable and Intractable Problems: Tractable and Possibly Intractable Problems: P and NP, Polynomial-Time Reductions and NP-Completeness, Cook's Theorem	3	5*
Total (*Not included)				42

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Automata Theory, Languages, and Computation	Third	John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman	Pearson	2008
2	Introduction to the Theory of computation	Third	Michael Sipser	Cengage	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
3	Introduction to Languages and the Theory of Computation	Fourth	John C. Martin	McGraw-Hill	2010
4	Elements of the Theory of Computation	Second	Harry R. Lewis, Christos H. Papadimitriou	Pearson	2015
5	Automata and Computability	--	Dexter C. Kozen	Springer	1997



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Cryptography and Network Security

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PC	Cryptography and Network Security	3	0	2	5	10	3	0	1	4
		Examination Scheme								
CE305	Cryptography and Network Security	Component		ISE	MSE	ESE	Total			
		Theory		15	15	45	75			
		Laboratory		15	--	10	25			

Pre-requisite Course Codes, if any.	CS207: Computer Communications and Networks
Course Objective: To apply cryptography algorithms and use of different network security protocol/techniques.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE305.1	Understand the fundamental principles of security and cryptography e.g. number theory, finite fields etc.
CE305.2	Make use of classical and modern encryption and decryption algorithms to secure data, ensuring confidentiality, authenticity, and efficiency in cryptographic systems.
CE305.3	Develop a deep understanding of cryptographic data integrity algorithms, including hash functions, message authentication codes (MACs), and digital signatures.
CE305.4	Apply key management, authentication mechanisms, intrusion detection systems (IDS), and firewalls to enhance security, protect data, and mitigate cyber threats.
CE305.5	Understand and implement PGP, SSL, TLS, and IPSec protocols to enhance secure communication, ensure data integrity, and support authentication in networked systems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE305.1	3	-	-	-	-	-	-	-	-	-	-	-
CE305.2	3	1	3	-	-	-	-	-	-	-	-	-
CE305.3	3	2	3	-	2	-	-	-	-	-	-	-
CE305.4	3	2	3	-	2	-	-	-	-	-	-	-
CE305.5	3	-	3	-	-	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO-PEO/PSO	PEO1	PEO2	PEO3	PSO1	PSO2
CE305.1	-	-	-	2	-
CE305.2	-	-	-	2	-
CE305.3	-	-	-	2	-
CE305.4	2	-	-	2	-
CE305.5	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Fundamentals for Security and Cryptography		9
	1.1	Network Security Concepts: OSI Security Architecture, Security Attacks and Malware, Security Services, Security Mechanisms, Network Security Model	1,2	
	1.2	Number Theory: Divisibility and the Division Algorithm, Euclidean Algorithm, Fermat's and Euler's Theorems, Primality Test, Chinese Remainder Algorithm.	1,2	
	1.3	Finite Fields: Groups, Rings, Fields, Finite Fields of the Form $GF(p)$, Polynomial Arithmetic, Finite Fields of the Form $GF(2^n)$	3	
2	Title	Symmetric Ciphers and Asymmetric Ciphers		9
	2.1	Classical Encryption Techniques: Symmetric Cipher Models, Substitution and Transposition Techniques, Rotor Machines, Steganography	1,2	
	2.2	Data Encryption Standard: Traditional Block Cipher Structure, The Data Encryption Standard, Strength of DES. Advanced Encryption Standard: Structure, Transformation Functions, Key Expansion, Implementation, Block Cipher Operation: Multiple Encryption and Triple DES, ECB, CBC, CFB, OFB, CTR	1,2	
	2.3	Asymmetric Ciphers: Public-Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange, Elgamal Cryptographic System, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.	1,2, 3	
3	Title	Cryptographic Data Integrity Algorithms		8
	3.1	Cryptographic Hash Functions: Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA)	1,2	
	3.2	Message Authentication Codes: Requirements, Functions, Security of MACs, MACs Based on Hash Functions: HMAC, MACs Based on Block Ciphers: DAA and CMAC, Authenticated Encryption: CCM and GCM, Pseudorandom Number Generation Using Hash Functions and MACs	1,2	

	3.3	Digital Signatures: Elgamal Digital Signature Scheme, Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm, RSA-PSS Digital Signature Algorithm.	1,2	
4	Title	Key Management and System Security		8
	4.1	Symmetric Key Distribution Using Symmetric Encryption and Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure	1,2,3	
	4.2	User Authentication: Remote User-Authentication Principles, Remote User-Authentication Using Symmetric Encryption and Asymmetric Encryption, Federated Identity Management, Kerberos	1,2,3	
	4.3	IDS and Firewalls: Intrusion Detection System, Types of IDS, Firewalls Characteristics, Types of Firewalls	2,3	
5	Title	Network and Internet Security		8
	5.1	Application Layer Security: Email System Architecture, Pretty Good Privacy (PGP) – Key Rings, PGP Certificates, Key Revocation, PGP Packets, PGP Messages, S/MIME, and Web Application Security.	1,2	
	5.2	Transport Layer Security: Secure Sockets Layer (SSL) – Architecture, Protocols, Message Formats. TLS – Cipher Suite, Protocols.	1,2	
	5.3	Network Layer Security : IPSec – Two Modes, Two Protocols (AH, ESP), Security Associations, Security Policy, Internet Key Exchange, ISAKMP,	1,2	
6	Self Study	ACM, Access Control Mechanisms – MAC, DAC, RBAC, TGP Model, HRU Model, BLP Model, Biba Model, Constraint and State based Models.		
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Experiment on Number Theory
2	Experiment on Symmetric Ciphers
3	Experiment on Symmetric Asymmetric Ciphers
4	Experiment on Cryptographic Hash Functions
5	Experiment on Message Authentication Codes/Digital Signatures
6	Experiment on X.509 Certificates
7	Experiment on Programming Security – Web/Mobile Application
8	Experiment on User/Service Authentication (e.g. Kerberos) /IDS/Firewall
9	Experiment on PGP/S-MIME
10	Experiment on SSL/IPSec
11	Experiment on Access Control Mechanisms - MAC/DAC/RBAC

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Cryptography and Network Security: Principles and Practice	Seventh Edition	William Stallings	Pearson	2017
2	Introduction to Cryptography and Network Security	First Edition	Behrouz A Fourouzan	TMH	2008
3	Computer Security [Art and Science]	Second Edition	Matt Bishop	Addison-Wesley	2019

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Network Security and Cryptography	Second Edition	Bernard Menezes	Cengage Learning	2011
2	Security in Computing	Fifth Edition	Charles P. Pfleeger	Pearson Education	2015
3	Security Engineering	Third Edition	Ross Anderson	Wiley Publication	2021

SEMESTER VI

SEM VI										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Program Core Courses (7credits)	PCC	CE306	System Programming and Compiler Construction	3	0	2	4	9	4
2		PCC	CE307	Machine Learning	2	0	2	5	9	3
3	Multidisciplinary Minor	MDM	MDEC3X	MDM-III	To be defined by others					3
4	Experiential Learning	ELC	PR3-I	Main Project Stage I	0	0	2	4	6	1
5	Program Elective Courses	PEC	CE3X1	PE-I	2	0	2	4	8	3
6	Program Elective Courses	PEC	CE3X2	PE-II	2	0	2	4	8	3
7	Skill Enhancement Course	SEC	CE308	DevOps Lab	0	1	2	2	5	2
Total					9	1	12	23	45	19

- Summer Research Phase II of minimum 2 month and A course on Optimization for the “Honors by Research” for 7(4+3) credits HR31
- For Enrollment to Honors by research, Minimum CGPA must be 8.25



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System Programing and Compiler Construction

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PC)	System Programing and Compiler Construction	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
CE306		Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	
Course Objective: To explore the principles, algorithms, and data structures involved in the design and construction of various System Programs and Compilers.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE306.1	Understand fundamentals of language processing activities and its relationships among all phases of the language processor.
CE306.2	Separate the lexical, syntax and semantic analysis into meaningful phases for a compiler
CE306.3	Apply different techniques of intermediate code and machine code optimization to solve problem.
CE306.4	Analyze the role of memory management as pertaining to run time storage management for compiler.
CE306.5	Understand design and working /concepts of various systems software like assemblers, macro processors, loaders and linkers to increase readability and productivity.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE306.1	-	-	-	-	-	-	-	-	-	-	-	1
CE306.2	2	1	-	-	2	-	-	2	2	-	-	1
CE306.3	2		-	-	-	-	-	2	2	-	-	1
CE306.4	2	2	-	-	-	-	-	2	2	-	-	1
CE306.5	2	-	-	-	-	-	-	2	2	-	-	1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE306.1	-	-	1	-	-	-	-

CE306.2	-	-	2	-	-	-	-
CE306.3	-	-	2	-	-	-	-
CE306.4	-	-	2	-	-	-	-
CE306.5	-	-	1	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Language Processor		04
	1.1	Introduction to Language Processor: Language Processing activities, fundamentals of Language Processing.	1,2	
	1.2	Lexical Analysis: Role of Lexical Analyzer (Scanner), Input buffering, Specification and recognition of tokens, Lexical analyzer generator- LEX, Optimization of DFA-Based Pattern Matchers.	1	
2	Title	Syntax and Semantic Analysis		8
	2.1	Syntax Analysis: Role of Syntax Analyzer (Parser), Top-down parsing- Recursive descent and predictive parsers (LL), Bottom-Up parsing - Operator precedence parsing, LR,SLR and LALR parsers, Parser Generator-YACC	1	
	2.2	Semantic Analysis (Syntax Directed Translation): Syntax directed definitions, Evaluation order for SDDs , Applications of Syntax Directed Translation, Syntax Directed Translation Schemes	1	
3	Title	ICG and Code Generation		09
	3.1	Intermediate Code Generation: Variants of Syntax Trees, Three-Address code, Types and Declarations, Translations of Expressions, Type Checking, Control flow, Backpatching, Switch-statements.	1	
	3.2	Code Generation: Issues in the design of Code Generator , Target language and Addresses, Basic Blocks and Flow graphs, Optimization of Basic Blocks, Simple Code Generator: Register and Address Descriptors, Code Generation Algorithm, Design of Functions	1	
4	Title	Code Optimization and RTE		09
	4.1	Code Optimization: Principal sources of Optimization, Peephole Optimization, Register Allocation and Assignment, Instruction Selection by Tree Rewriting, Optimal Code Generation for Expressions, Loops in Flow Graphs,	1	
	4.2	Run Time Environment: Storage Organization, Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Garbage Collection	1	

	Title	Assembler, Macro-processor, Loaders and Linkers		
5	5.1	Assembler: Elements of Assembly Language Programming, Simple Assembly Scheme, Pass structure of Assemblers, Design of Two-pass Assemblers and one-pass assemblers	2	12
	5.2	Macros and Macro Processors: Macro definition and calls, Macro expansion, nested macro calls, Macro Facilities, Design of Macro Processor	2	
	5.3	Loaders and Linkers: Basic Loader functions, Machine Dependent loader features, Machine-Independent loader Features, loader Design Options, Implementation Example	2	
6	Self-Study	Instruction-Level Parallelism: Processor Architectures, Code-Scheduling Constraints, Basic-Block Scheduling	1	05
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design Lexical analyzer for different programming languages*and implement using lex tool.
2	Write a program to implement optimization of DFA-Based Pattern Matchers.
3	Design syntax analyzer for various grammars and implement using different parsing techniques* (Top-down and Bottom-up).
4	Design SDD and SDT for different grammars* and implement using YACC/BISON utility.
5	Write a program to generate three address code for different types of programming* language constructs
6	Write a program to find Basic blocks and generate flow graph for the given three address code.
7	Write a program to implement Code generation algorithm.
8	Write a program to create optimize code using different code optimization techniques*
9	Design a two-pass assembler.
10	Design a One pass Macro processor
10*	Implementation of various loader/linker schemes

* Instructor should provide distinct programming languages/parsing techniques/optimization techniques/grammars for different batches.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Compilers, Principles, Techniques and Tools	Second	Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman	Pearson Education	2013
2	System Software An Introduction to Systems Programing	Third	Leland L. Beck	Addison Wesley	1997

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Compiler Design and Implementation	First	Steven Muchnik	Morgan Kaufmann Publishers	1997
2	Engineering a Compiler	Second	Cooper & Torczon	Elsevier	2003
3	Compiler Design in C	Second	Allen I. Holub	Prentice Hall India	1992



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Machine Learning

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PCC)	Machine Learning	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE307	Machine Learning	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		7		33

Pre-requisite Course Codes, if any.	
Course Objective: To learn methodology and tools to apply machine learning algorithms to real data and evaluate their performance.	
Course Outcomes (CO): <i>At the End of the course, students will be able to</i>	
CE307.1	Define the fundamental principles of Machine learning.
CE307.2	Apply techniques, mathematical concepts, and algorithms used in machine learning.
CE307.3	Interpret the limitations of various machine learning algorithms and the way to evaluate the performance of machine learning algorithms
CE307.4	Design an application through software implementation of different concepts and algorithms covered in the course.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE307.1	2	2	--	--	--	--	--	--	2	2	2	2
CE307.2	2	2	2	--	2	--	--	--	2	2	2	2

CE307.3	2	2	2	--	2	--	--	--	2	2	2	2
CE307.4	2	2	2	2	2	--	--	--	2	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE307.1	2	2	1	1	1	--	2
CE307.2	2	2	1	1	2	--	2
CE307.3	2	2	1	1	2	--	2
CE307.4	2	2	1	1	2	1	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Machine Learning	T1	04
	1.1	Machine Learning, Key terminology, Key tasks of machine learning, How to choose the right algorithm, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.		
2	Title	Learning with Trees	T1, T2, T3	06
	2.2	Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART)		
	2.3	Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC		

		curve		
3	Title	Learning with Support Vector Machine	T1, T2	05
	3.1	Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as a constrained optimization problem, Quadratic Programming, SVM for linear and nonlinear classification, Basics of Kernel trick.		
	3.2	Support Vector Regression, Multiclass Classification		
4	Title	Ensemble Learning		06
	4.1	Understanding Ensembles, K-fold cross-validation, Boosting, Stumping, XGBoost	T2	
	4.2	Bagging, Subbagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers	T2	
5	Title	Learning with Clustering and Dimensionality Reduction		7
	5.1	Introduction to clustering with an overview of distance metrics and major clustering approaches.	T1, T2	
	5.1	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	T1, T2	
6	Self Study	Graph Based Clustering, Reinforcement Learning	T2	5*
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

All experiments should be performed through PYTHON Language

Sr. No	Title of the Experiment
1	Implement Linear Regression of Prediction/ Classification
2	Implementation on Decision Tree learning
3	Implement SVM for linear data
4	Implement SVM for non-linear data using kernel function
5	Implementation on Ensemble learning: Bagging using Random Forest

6	Implementation on Ensemble learning: Boosting using XGBoost / AdaBoost
7	Implement K-means/ K-Modes Clustering
8	Implement Expectation Maximization(EM) algorithm to Find Natural Patterns in Data
9	Implement PCA/SVD for Dimensionality Reduction
10	Implement LDA for Dimensionality Reduction

Text Books

S.N.	Title	Edition	Authors	Publisher	Year
1	Machine Learning In Action	1st	Peter Harrington	DreamTech Press	2001
2	Introduction to Machine Learning	3rd	Ethem Alpaydın	MIT , PRESS	2012
3	Machine Learning	1st Edition	Tom Mitchell	Mc-Grawhill	1997

Reference Books

S.N.	Title	Edition	Authors	Publisher	Year
1	Pattern Recognition and Machine Learning,	1st Edition	C. M. Bishop	Springer	2013
2	Elements of Statistical Learning	2 nd Edition	Trevor Hastie Robert Tibshirani Jerome Friedman	Springer	2001
3	Machine Learning An Algorithmic Perspective		Stephen Marsland	CRC Press	

Useful Digital Links

1	Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
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2	Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3	Machine Learning from Coursera
4	https://towardsdatascience.com/machine-learning/home
5	https://onlinecourses.nptel.ac.in/noc21_cs85/preview



Main Project Stage I

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PR3-I	Main Project Stage I	0	0	2	4	6	0	0	2	1
		Examination Scheme								
ELC		Component	Phase 1		Phase 2		ESE	Total		
		Major Project	40		40		20	100		

Pre-requisite Course Codes	All courses
Course Objectives	To provide an opportunity for students to apply theoretical knowledge to real-world or research-based problems. It emphasizes project planning, technical implementation, documentation, and evaluation with real-world relevance
Course Outcomes (CO): At the End of the course students will be able to	
PR3-I.1	Identify and analyze real-world problems to define clear, feasible project objectives.
PR3-I.2	Apply knowledge of engineering fundamentals and modern tools to design and develop effective solutions.
PR3-I.3	Manage project activities including teamwork, communication, and time management.
PR3-I.4	Test, validate, and evaluate the developed system.
PR3-I.5	Present the project work through structured documentation and presentation.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PR3-I.1	3	3	2	2	2	2	1	1	2	2	1	2
PR3-I.2	3	3	3	3	3	2	1	1	2	2	2	3
PR3-I.3	2	2	2	2	2	1	1	2	3	3	3	2
PR3-I.4	3	3	3	3	3	2	1	2	2	2	2	2
PR3-I.5	2	2	2	2	2	2	2	3	3	3	2	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
PR3-I.1	3	2	2	2	2
PR3-I.2	3	3	2	3	3
PR3-I.3	2	3	3	2	2
PR3-I.4	3	3	2	3	3
PR3-I.5	2	2	3	2	3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓
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Phase I Evaluation Rubric

P1 (15)	P2 (05)	P3 (07)	P4 (03)	P4 (05)	P5 (05)	Total Marks (Max=40) (Passing=16)
Problem Identification & Literature Survey (Problem Definition/ Idea/Originality/Scope & objectives/ Feasibility/ Application in Society/ Gap identification /Relevance of references/ Adequate references)	Analysis & Design (UML diagrams: Use case, Class, and Sequence diagram/Block diagram/Algorithms)	Prototype and implementation	Technical Competency and Planning (Gantt chart / Work Division)	Presentation (Coverage of topic/use of graphics/Delivery & Speaking skills) and Ethics (Attitude/Deadline/Distribution of Work)	Societal / Industrial Relevance	

Phase II Evaluation Rubric

P1 (05)	P2 (20)	P3 (10)	P4 (05)	Total Marks (Max=40) (Passing=16)
Algorithm / Technique Justification	Work done (Total 50 % Implementation/ Meets project objectives/result analysis/test cases/solution shows originality)	Presentation (Coverage of topic/use of graphics/Delivery & Speaking skills/Presentation length) and Ethics (Attitude/Deadline/Distribution of Work)	Quality of Documentation / Report (in LaTeX)	

ESE Evaluation Rubric-

P1 (02)	P2 (05)	P3 (10)	P4 (03)	Total Marks (Max=20) (Passing=08)
Problem Definition (Idea/Originality/Novelty/ Feasibility/Application in Society)	Presentation (Demo/Oral/Written) and Ethics (Attitude/Deadline/Distribution of Work)	Work Done (Survey/Design/Simulation/Experimentation/Tools Usage/Budget Plan/Execution Plan)	Knowledge (Question-Answer)	



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DevOps Lab

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
CE308	DevOps Lab	0	1	2	2	5	0	1	1	2
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
Skill Enhancement Course		Tutorial		100		-		-		100
		Laboratory		80		-		20		100

Pre-requisite Course Codes, if any.	Fundamentals of Computer and Coding, CCN, OS, PSIPL, PSOOP
Course Objective: To provide hands-on experience with virtualization and containerization while leveraging a range of DevOps technologies for efficient and secure software development, deployment, and automation.	
Learning Outcomes (LO): At the End of the course students will be able to	
CE308.1	Implement virtualization and containerization techniques to optimize development and deployment workflows.
CE308.2	Examine the integration of CI/CD pipelines, infrastructure as code, and monitoring tools to enhance automation and efficiency.
CE308.3	Assess the performance, security, and scalability of various DevOps tools and methodologies in real-world scenarios.
CE308.4	Design and develop a fully automated DevOps workflow incorporating container orchestration, version control, and deployment strategies.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE308.1			1		3				2		1	
CE308.2			1		3				2		1	
CE308.3			1		3				2		1	
CE308.4			1		3				2		1	

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE308.1							
CE308.2							
CE308.3							
CE308.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Virtualization and Containerization	1,2,3,4	4
	1.1	Concept of Virtualization, Types of Virtualization, VirtualBox, VMWare, KVM, QEMU, XEN		
	1.2	Container Technologies: Docker and podman, Minikube and Kubernetes		
2	Title	DevOps Basics: Git, Jenkins, and SonarQube	1,4	4
	2.1	Concept of DevOps, CI/CD Pipeline Introduction to Git: Distributed version control system. Importance in tracking changes, collaboration, and branch management.		
	2.2	Jenkins for Continuous Integration Introduction to Jenkins: Overview of Continuous Integration/Continuous Deployment (CI/CD), Key features and plugins		
	2.3	SonarQube for Code Quality Analysis:SAST and DAST Introduction to SonarQube, Importance of code quality and security Key metrics and issues tracked by SonarQube Implementing DAST in DevOps Pipelines Understanding how DAST works in real-time application security testing Common DAST tools: OWASP ZAP, Burp Suite, Nikto, Arachni Automating DAST in CI/CD pipelines Detecting runtime vulnerabilities (SQL Injection, XSS, etc.) Generating and analyzing DAST security reports		
3	Title	Advanced DevOps: Continuous Deployment and Infrastructure	1,4	6

		as Code		
	3.1	Ansible for Configuration Management: Introduction to Ansible Agentless configuration management tool. Overview of key features and architecture, Ansible Basics, Understanding Playbooks and Roles YAML syntax		
	3.2	Writing basic playbooks, Inventory Management Static and dynamic inventories, Advanced Ansible usage, Ansible Modules and Plugins		
	3.3	Terraform for Infrastructure as Code: Introduction to Terraform Terraform Basics, Understanding Terraform Configuration Files HCL syntax, Writing basic .tf files, Advanced Terraform Usage, Modules and State Management, Creating and using modules Managing state files and remote state,		
	3.4	Terraform in Action, Provisioning Infrastructure, Using providers (AWS, Azure, GCP), Applying and destroying infrastructure		
4	Self Study	Chef Configuration tool, Puppet Configuration tool, Grafana Monitoring tool, Prometheus Monitoring tool, Nagios Configuration tool, OpenVAS, TravisCI tool, CircleCI Tool		*2 per week
Total				14

*Excluding Self Study

Laboratory Component (Minimum 10 Laboratory experiments are expected)- **2 hrs/week**

Sr. No.	Title of the Experiment
1	Installation and configuration of Hypervisors (VirtualBox/VMWare/KVM): Loading the Virtual Machines (VMMs), Network configuration and management
2	Installation and Configuration of Docker (Container) and Docker-compose: Docker usage, docker images, docker containers, docker networking, docker monitoring, Dockerfile, Docker-compose, managing the containers

3	<p>Develop and Manage Multipass and LXD Instances:</p> <ol style="list-style-type: none"> 1. Deploy and manage lightweight Ubuntu VMs using Multipass, leveraging cloud-init for automation. 2. Create and manage LXD containers, utilizing profiles, storage pools, and networking configurations. 3. Understand how to migrate applications between LXD containers and traditional VMs. <p>Implement Advanced Multipass and LXD Features:</p> <ol style="list-style-type: none"> 1. Utilize Multipass cloud-init configurations to automate VM provisioning. 2. Leverage LXD features like profiles, snapshots, clustering, and remote instance management. 3. Configure LXD networking to allow communication between containers and external services. <p>Troubleshoot and Optimize Multipass and LXD Environments:</p> <ol style="list-style-type: none"> 1. Diagnose and resolve common issues in Multipass and LXD environments using logs and debugging tools. 2. Optimize performance by fine-tuning resource allocations, networking, and storage options. 3. Ensure security best practices by implementing access controls, container isolation, and secure configurations.
4	<p>Kubernetes using Minikube: To set up a Kubernetes environment using Minikube with Docker as the driver. Confirm the cluster is up and running with <code>kubectl cluster-info</code> and <code>kubectl get nodes</code>. Deploy a sample application by creating a deployment with <code>kubectl create deployment hello-minikube --image=k8s.gcr.io/echoserver:1.4</code>. Expose this deployment to create a service accessible from outside the cluster with <code>kubectl expose deployment hello-minikube --type=NodePort --port=8080</code>. Obtain the service URL using <code>minikube service hello-minikube --url</code> and access the application through the provided URL. To clean up, delete the deployment and service with <code>kubectl delete deployment hello-minikube</code> and <code>kubectl delete service hello-minikube</code>, and stop the Minikube cluster using <code>minikube stop</code>.</p>
5	<p>Installation and configuration of Git: Basic Git Commands, Basic Operations, Working with Remote Repositories-Connecting to Remote Repos Setting up SSH keys Adding remote repositories: <code>git remote add origin <url></code> Fetching and Pulling from Remotes Understanding <code>git fetch</code> vs. <code>git pull</code>, Collaboration and Workflow, Branching Strategies, Feature branches GitFlow, Handling Merge Conflicts, Rebasing vs. Merging</p>
6	<p>Installing and Configuration of Jenkins: Installation Steps, Using Docker Configuring Jenkins, Initial Setup, Jenkins Dashboard, Creating a Jenkins user, Setting Up Jobs and Pipelines, Freestyle projects, Pipeline projects, Jenkinsfile basics, Declarative vs. Scripted Pipelines Creating a Simple Pipeline, Stages, steps, and post actions, Integrating Jenkins with Git Setting Up Git Repositories in Jenkins, Polling SCM Webhooks, Building and Testing Code Automated builds, Running test suites, Advanced Jenkins Usage Using Plugins Commonly used plugins (Git plugin, Pipeline plugin, etc.) Distributed Builds, Master-slave</p>

	configurations
7	<p>Installation and configuration of SonarQube for Code Quality Analysis:</p> <ul style="list-style-type: none"> Installing SonarQube, Installation Steps, Configuring SonarQube Initial Setup, SonarQube Dashboard Creating a SonarQube user and projects Connecting to Databases, Configuring database settings (PostgreSQL, MySQL, etc.) Running SonarQube Analysis, Setting Up SonarQube Scanners SonarQube Scanner CLI, Integrating with Maven, Gradle, and other build tools Analyzing a Project Configuring sonar-project.properties Running the scanner and interpreting the results Integrating SonarQube with Jenkins Installing SonarQube Plugin in Jenkins Setting Up a Jenkins Job for SonarQube Analysis Configuring analysis parameters Running SonarQube analysis as part of Jenkins pipeline Advanced SonarQube Usage Custom Quality Profiles and Gates Creating and managing quality profiles Setting up quality gates
8	<p>Installation and configuration of Ansible for Configuration Management:</p> <ul style="list-style-type: none"> Agentless configuration management tool. Overview of key features and architecture, Ansible Basics, Understanding Playbooks and Roles, YAML syntax Writing basic playbooks, Inventory Management, Static and dynamic inventories, Advanced Ansible usage, Ansible Modules and Plugins, Continuous Monitoring- Observability Prometheus and Grafana, Elasticsearch, Logstash, Kibana (ELK) and LOKI
9	<p>Terraform for Infrastructure as Code: Installation Steps, Terraform Configuration Files, HCL syntax</p> <ul style="list-style-type: none"> Writing basic .tf files, Advanced Terraform Usage, Modules and State Management Creating and using modules, Managing state files and remote state Applying and destroying infrastructure,
10	Mini Project

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Learning DevOps - Second Edition: A comprehensive guide to accelerating DevOps culture adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins	Second	M. Krief	Packt	2022
2	Practical Linux System Administration: A Guide to	First	Kenneth Hess	O'Reilly	2023

	Installation, Configuration, and Management				
3	Linux For Beginners	Twenty Fourth	Papercut Limited	Papercut Limited	2024
4.	Building Cloud and Virtualization Infrastructure: A Hands-on Approach to Virtualization and Implementation of a Private Cloud Using Real-time Use-cases	First	Mrs.Lavanya S Dr. Venkatachalam K Dr. Saravanakumar N M Dr. Balamurugan S	BPB Publications	2021

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	The DevOps Handbook,	First	Gene Kim, Jez Humble, Patrick Debois, John Willis, Nicole Forsgren	IT Revolution Press	2021

SEMESTER VII

SEM VII									
Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
Multidisciplinary Minor	MDM	MDEC4X	MDM-IV	To be defined others					4
Program Elective Courses	PEC	CE4X3	PE-III	2	0	2	4	8	3
Program Elective Courses	PEC	CE4X4	PE-IV	2	0	2	4	8	3
Open Elective	OE	OE1	OE-I	2	0	2	4	8	3
Experiential Learning	ELC	PR3-II	Main Project Stage II	0	0	6	4	10	3
Total				6	0	12	16	34	16



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Main Project Stage II

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PR3-II	Main Project Stage II	0	0	6	4	10	0	0	6	3
		Examination Scheme								
ELC	Main Project Stage II	Component		Phase 1		Phase 2		ESE	Total	
		Major Project		40		40		20	100	

Pre-requisite Course Codes	All courses
Course Objectives	To provide an opportunity for students to apply theoretical knowledge to real-world or research-based problems. It emphasizes project planning, technical implementation, documentation, and evaluation with real-world relevance
Course Outcomes (CO): At the End of the course students will be able to	
PR3-I.1	Identify and analyze real-world problems to define clear, feasible project objectives.
PR3-I.2	Apply knowledge of engineering fundamentals and modern tools to design and develop effective solutions.
PR3-I.3	Manage project activities including teamwork, communication, and time management.
PR3-I.4	Test, validate, and evaluate the developed system.
PR3-I.5	Present the project work through structured documentation and presentation.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PR3-I.1	3	3	2	2	2	2	1	1	2	2	1	2
PR3-I.2	3	3	3	3	3	2	1	1	2	2	2	3
PR3-I.3	2	2	2	2	2	1	1	2	3	3	3	2
PR3-I.4	3	3	3	3	3	2	1	2	2	2	2	2
PR3-I.5	2	2	2	2	2	2	2	3	3	3	2	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
PR3-I.1	3	2	2	2	2
PR3-I.2	3	3	2	3	3
PR3-I.3	2	3	3	2	2
PR3-I.4	3	3	2	3	3
PR3-I.5	2	2	3	2	3

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓
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Phase III Evaluation Rubric

P1 (02)	P2 (20)	P3 (10)	P4 (05)	Total Marks (Max=40) (Passing=16)
Completion of All Functionalities/objectives	Work done (Total 80 % Implementation/ Meets project objectives/result analysis/test cases/solution shows originality)	Presentation (Coverage of topic/use of graphics/Delivery &; Speaking skills/Presentation length) and Ethics (Attitude/Deadline/Distribution of Work)	Quality of Documentation / Report (in LaTeX)	

Phase IV Evaluation Rubric

P1 (07)	P2 (12)	P3 (06)	P4 (05)	P5 (10)	Total Marks (Max=40) (Passing=16)
User Interface / Usability	Work done (100 % Implementation/ Meets project objectives/result analysis/test cases/solution shows originality)	Presentation (Coverage of topic/use of graphics/Delivery &; Speaking skills/Presentation length) and Ethics (Attitude/Deadline/Distribution of Work)	Report (in LaTeX)	Research paper (in IEEE format with Plagiarism report)	

ESE Evaluation Rubric-

P1 (02)	P2 (05)	P3 (08)	P4 (02)	P4 (03)	Total Marks (Max=20) (Passing=08)
Problem Definition (Idea/Originality/Novelty/Feasibility/Application in Society)	Presentation (Demo/Oral/Written) and Ethics (Attitude/Deadline/Distribution of Work)	Work Done (Survey/Design/Simulation/Experimentation/Tools Usage/Budget Plan/Execution Plan)	Research paper (in IEEE format with Plagiarism report)	Knowledge (Question-Answer)	

SEMESTER VIII

SEM VIII										
Sr. No	Course Category	Abbreviation	Course Code	Course Name	L	T	P	O	E	C
1	Open Elective	OE	OE2	OE-II**	2	0	2	4	8	3
2	Experiential Learning	ELC	INTR	Research/ Industry Internship/ Main	0	0	24	12	36	11
			INTI	Project Stage III***						
Total					2	0	26	16	44	14

- Extended Research Internship of minimum 2 month for the “Honors by Research” for 4 credits HR41
- For Enrollment to Honors by research, Minimum CGPA must be 8.25

** To be completed from MOOCs

***Students neither taking research or industry internships nor willing to extend their project work can earn additional 11 credits from Swayam Platform or NPTEL or registering courses from any peer institution of higher learning., besides open elective program elective courses offered by the institute.

PROGRAM ELECTIVE COURSES

4 Electives are sufficient to specialize in a particular domain.

Track	PE-I CE3X1	PE-II CE3X2	PE-III CE4X3	PE-IV CE4X4
Artificial Intelligence	CE311: Natural Language Processing	CE312: Deep Learning	CE413: Generative AI	CE414: Explainable AI
Network and Security	CE321: Ethical Hacking	CE322: Information and System Security	CE423: Blockchain Technology	CE424: Digital Forensics and Cyber Security
Data Science	CE331: Big Data Analytics	CE332: Information Visualization	CE433: Time-series Data Analysis	CE434: Decision Making and Business Intelligence
General	CE341: Digital Image Processing	CE342: High Performance Computing	CE443: Quantum Computing	CE444: Edge Computing
Generative AI Mastery (by Vizuara)	CE351: Generative AI Fundamentals	CE352: Foundations of Large Language Models	CE453: Large Language Models: Production and Deployment	CE454: Capstone Project in Artificial Intelligence



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Natural Language Processing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Natural Language Processing	2	0	2	5	10	2	0	1	3
		Examination Scheme								
CE311	Natural Language Processing	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any.	Probability & Statistics, Basic knowledge of Python
Course Objective: This course will provide students with the theoretical knowledge and practical skills required to process, analyze and generate human language using computational techniques. The course emphasis on the necessary linguistic intuitions as well as a broad coverage of statistical, sequential processing and deep learning models that enable practical applications in text analysis and AI-driven communication.	
Course Outcomes (CO): At the End of the course students will be able to	
CE311.1	Use Natural language representations and perform language processing tasks.
CE311.2	Evaluate solutions for a range of natural language components using existing algorithms, techniques and frameworks, including part-of-speech tagging, language modeling, parsing and semantic role labeling.
CE311.3	Apply algorithms for text mining and single and multi-class classification problems.
CE311.4	Apply Deep Learning techniques for language generation tasks.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE311.1	3	-	2	-	-	-	-	-	-	-	-	-
CE311.2	-	-	2	-	-	-	-	-	-	-	-	-
CE311.3	3	-	2	-	-	-	-	-	-	-	-	-
CE311.4	3	-	-	-	2	-	-	-	2	-	-	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE311.1	2	-	-	-	-	-	-
CE311.2	2	2	-	-	-	-	-
CE311.3	2	-	-	-	-	-	-
CE311.4	2	2	2	-	2	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to NLP		8
	1.1	A brief history of natural language processing, language challenges, Ambiguity, Applications, classical vs statistical vs deep learning-based AI Ethics: What It Is, Why It Matters Bias, Fairness, Language Technology implications for NLP Basic concepts in linguistic data Structure: Morphology, syntax, semantics, pragmatics, Stemming, Tagging Parts of speech-identify parts of speech, Constituent structure, NLP pipeline	1,2	
	1.2	Regular Expression, Words, Corpora, Text Normalization, Minimum Edit Distance, Words and Vectors, Cosine Similarity, TF-IDF, Bag of words, CBOW, Word embeddings (Word2Vec, GloVe, FastText), Word Sense Disambiguation	1,2	
2	Title	Computational Tools for Text Analysis		6
	2.1	Corpora and other data resources, Uses of corpora: Training and evaluation, Basic corpus analysis: Frequency distribution building and analyzing a corpus. Natural Language Toolkit (NLTK), spaCy for classical NLP Scikit-learn for ML-based NLP, TensorFlow, PyTorch, Hugging Face for deep learning NLP	1,2	
	2.2	Stemming vs Lemmatization in NLP Stemming: Comparing stemmers, Tagging: RE tagging, Trained taggers and backoff, Transformation-based tagging.	1,2	
3	Title	Statistically based techniques for text analysis		8
	3.1	Fundamentals of machine learning: Naive Bayes classifiers, Hidden Markov models; Viterbi decoding, Information and entropy; Decision trees and maximum entropy classifiers, Unigram, Bigram, Trigram, N-gram language models, Advance smoothing for language model	1,2	

	3.2	Machine learning in action: document classification, Information extraction: Types of information extraction, Regular expressions for personal names, Information extraction as sequential classification: chunking and Named Entity Recognition (NER)	1,2	
4	Title	Deep Learning for NLP		6
	4.1	Recurrent Neural Networks, LSTM, GRU Transformer Models(BERT, GPT) Attention and self-attention mechanism	1,2	
	4.2	Application of NLP: Topic modeling, Machine translation, Chatbots & conversational AI, Summarization, Text generation	1,2	
6	Self Study	LLMs and their application, LLM Evaluation methods		5*
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Install NLTK and perform basic Corpus analysis using NLTK such as (i) frequency distribution (ii) learn about morphological features of a word by analysing it.
2	Implement stemming and lemmatization operations for a corpus. (Porter Stemmer, Snowball Stemmer, Lancaster Stemmer, Regexp Stemmer)
3	Use N-gram model to predict the next word.
4	Use HMM model for POS tagging of sentence.
5	Perform POS tagging using Viterbi decoding.
6	Apply Naive Bayes Classifier for document classification.
7	Perform information extraction using Named Entity Recognition.
8	Use CFG to generate parse trees for a given sentence.
9	Build a model for NLP task like Spam detection /Machine translation /Sentiment Analysis / Text Summarization.
10	Create transformer model for NLP task. Evaluate and optimize the model (Translation/Text generation).

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Natural Language Processing with Python	First Edition	Steven Bird, Ewan Klein & Edward Loper	O'Reilly Media, Inc. ISBN: 9780596516 499	2009
2.	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition	Second Edition	Daniel Jurafsky & James H Martin	Pearson Education	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Deep Learning for NLP and Speech Recognition	First Edition	Uday Kamath , John Liu , James Whitaker	Springer	2019
2.	Linguistic Fundamentals for Natural Language Processing	First Edition	Emily M. Bender	Morgan and Claypool	2013
3.	Hands-On Large Language Models: Language Understanding and Generation	First Edition	Jay Alammar Maarten Grootendorst	O'Reilly Media	2024
4.	Neural Network Methods for Natural Language Processing	First Edition	Yoav Goldberg	Morgan and Claypool	2017



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Deep Learning

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-II	Deep Learning	2	0	2	2	5	2	0	1	3
		Examination Scheme								
CE312		Component		ISE		MSE		ESE	Total	
		Theory		13		14		40	67	
		Laboratory		26		--		07	33	

Pre-requisite Course Codes, if any.	Machine Learning
Course Objective: This course introduces Concepts of cloud computing. This course focuses on the architecture of cloud computing along with the application of the same.	
Course Outcomes (CO): At the End of the course students will be able to	
MDCS23.1	Understand the fundamentals of deep learning.
MDCS23.2	Understanding the working of Convolutional Neural Networks and RNN in decision making.
MDCS23.3	Implement, optimize and tune state-of-the-art deep neural network architectures
MDCS23.4	Implement major deep learning algorithms, the problem settings, and their applications to solve real world problems

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDCS23.1	2	-	2	2	-	-	-	-	-	-	-	1
MDCS23.2	2	2	-	-	2	-	-	-	-	-	-	1
MDCS23.3	3	3	3	2	2	-	-	-	-	-	-	2
MDCS23.4	2	2	3	3	2	2	2	2	2	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
MC512.1	1	-	-	2	-
MC512.2	1	2	-	2	-
MC512.3	1	-	-	2	-
MC512.4	1	2	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Theory Component

Module No.	Topics	Ref.	Hrs.
1	Introduction	1,2	5
	Basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method. Neural Networks: Feedforward neural networks, deep networks, regularizing a deep network, model exploration, and hyper parameter tuning.		
2	Introduction to Convolution Neural Networks CNN	1,2	6
	Architecture and Operations, convolutional layer, Pooling layer, Variants of the Convolution Model, Forward and Backward propagation, Training a deep neural network, hyper-parameter tuning, Generalization Gap – Under-fitting Vs Over-fitting – Optimization, Normalization.		
3	Optimization algorithms	1,2	6
	Mini-batch gradient descent, exponentially weighted averages, RMS prop, Learning rate decay, the problem of local optima, Batch norm – Parameter tuning process.		
4	Sequence Modeling: Recurrent Nets	1.2	7
	Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, LSTM networks.		
5	Interactive Applications of Deep Learning	1.2	4
	Generative Adversarial Networks, Deep Reinforcement Learning.		
6	Self Study		
	Deep Learning Research: Autoencoders, Deep Generative Models: Boltzmann Machines Restricted Boltzmann Machines, Deep Belief Networks		
		Total	28

Laboratory Component

Sr. No	Title of the Experiment
1	Study and Implement different classifier for decision tree algorithm eg. J48
2	Working and Implementation of Bayesian Hyperparameter Optimization
3	Implement Single-Layer Feedforward Neural Network
4	Implement Multi-Layer Feedforward Neural Network
5	Learning TensorFlow API and Keras API
6	Implement Optimization technique
7	Build and train RNNs, work with NLP and word embeddings
8	Use LSTMs and GRUs for implementing a real world problem
9	Implement a GAN for a given problem
10	Implement DCGAN for a given problem

Note: Course coordinators can use their own problem statements to solve listed lab sessions.

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Deep Learning	1st Edition	Ian Goodfellow, YoshuaBengi, Aaron Courville	MIT Press	2016
2.	Deep Learning with Python	1st Edition	Francois Chollet	Manning Publications ISBN:9781617294433	2017

References:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals of Deep Learning		Nikhil Buduma	O'Reilly Media	2017
2	Deep Learning and Neural Networks		Jeff Heaton	Heaton Research, Inc.	2015

Additional References:

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Deep Learning	1st	Ian Goodfellow,	MIT Press	2016
2	Deep Learning: Methods and Applications		Li Deng, Dong Yu	Methods and Applications (Foundations and Trend in Signal Processing). Publishers Inc.	2009
3	Deep Learning		Michael L. Hall	VDM Verlag	2011



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Generative AI

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Generative AI	2	0	2	4	8	2	0	1	3
CE413		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		—		07		33

Pre-requisite Course Codes, if any.	CE303: Artificial Intelligence and Soft Computing
Course Objective: To equip students with understanding, design, and implementation of state-of-the-art generative AI models and applications across multiple domains.	
Course Outcomes (CO): At the End of the course students will be able to	
CE413.1	Understand the basic principles of generative models like GANs, VAEs, and Transformers.
CE413.2	Analyze the design principles, performance, and limitations of advanced models like GPT and BERT
CE413.3	Design and implement advanced generative models including GAN,RAG to enhance content generation quality .
CE413.4	Explore ethical, legal, and societal impacts of generative technologies

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE413.1	3		3									3
CE413.2	3		3		3	3						3
CE413.3	3		3		3	3						3
CE413.4						3						3

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE413.1							
CE413.2							
CE413.3							
CE413.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Generative AI	1,2	5
	1.1	Basic principles of generative models and their applications, Discriminative vs. generative models, Use cases and challenges in deploying generative AI models.		
	1.2	Overview of Generative Models: Introduction to GANs (Generative Adversarial Networks) and VAEs (Variational Autoencoders) Diffusion, Transformers for Generation: The role of transformers in generative AI.		
2	Title	Introduction to Transformers and Language Models:	1,2,4	8
	2.1	Overview of Generative AI and Large Language Models. Basics of attention mechanisms and Transformer architecture. Pre-training techniques and transfer learning strategies.		
	2.2	BERT and Advanced Techniques: Understanding BERT architecture and pre-training objectives. Fine-tuning BERT for downstream NLP tasks. Exploration of advanced Transformer architectures and techniques. LangChain: Framework for developing applications using LLMs.		
3	Title	Generative Adversarial Networks (GANs)	1,2,4	6
	3.1	GAN architecture (Generator, Discriminator), Loss functions: Minimax, Wasserstein, Mode collapse and stability issues		
	3.2	Implementing DCGAN / Conditional GAN Retrieval-Augmented Generation (RAG) and its potential.		
4	Title	Image and Text Generation with Generative AI:	1, 2	5
	4.1	Introduction to Image Generation, Implementing GANs for Image Generation Training and Fine-Tuning GANs ,Generating Images with VAEs, Advanced Techniques in Image Generation,		

		and Image and Video Generation Applications.		
	4.2	Introduction to Text Generation, LSTM-based Text Generation, Transformer-based Text Generation, Fine-Tuning Language Models, and Text Generation Applications		
5	Title	Ethical Considerations and Applications in Generative AI	1, 3	4
	5.1	Generative AI Applications: Art and Creativity, Image and Video Generation, Text Generation, Music Composition, Healthcare Finance.		
	5.2	Ethical Considerations: The ethical implications of generative AI, including misuse, deepfakes, and copyright issues, Regulatory frameworks (e.g., EU AI Act)		
	Self Study	Muse GAN, Responsible AI, Reinforcement Learning with Human Feedback		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Application Development

Sr. No	Title of the Experiment
1	Preprocess and clean data sets for GenerativeAI applications using Python libraries such as Pandas and NumPy. Use Matplotlib or Seaborn to visualize data distributions and patterns in GenerativeAI datasets.
2	Implement Generative Image Models such as AutoEncoders, GANs, Diffusion Models, Transformers using Tensor Flow
3	Implement Attention Mechanism.
4	To simulate the process of reward modeling by training a reward predictor using human-preference-style data, and use this model to guide reinforcement learning agents
5	To fine tune a Large Language Model on a domain-specific dataset (e.g., legal, medical, or customer service)
6	To fine-tune a pretrained BERT model on a sentence classification task (e.g., sentiment analysis or spam detection) using Hugging Face Transformers.
7	Implementing a case study using GPT-based chatbot enhancing E-Shop's customer support service
8	To build a RAG system using a retriever and generator model, evaluate its performance on a QA dataset, and analyze the impact of document retrieval on answer accuracy.
9	To develop a facial recognition feature that helps diagnose patients for genetic disorders and their variations.
10	To understand and implement a multimodal generative AI system that can generate text from images (image captioning), or retrieve images from textual queries (text-to-image retrieval).

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
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1	Hands-On Machine Learning with Scikit-Learn and TensorFlow	1st	Aurelien Geron	O'Reilly	2017
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Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Transformer Models for NLP: Building AI Applications with Hugging Face	1st	Denis Rothman	Packt	2021
2	Deep Learning (Adaptive Computation and Machine Learning series)	1st	Ian Goodfellow, Yoshua Bengio	MIT Press	2016
	Generative AI and LLMS	1st	Balasubramaniam, Prasanth and Rajesh Kumar Dhanaraj	De Gruyter	2024



Explainable AI

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-IV	Explainable AI	2	0	2	4	8	2	0	1	3
CE414		Examination Scheme								
		Component	ISE	MSE	ESE	Total				
		Theory	13	14	40	67				
	Laboratory	26	--	7	33					

Pre-requisite Course Codes, if any.	NNFL, ML
Course Objective: This course is designed to provide fundamental concepts of explainable AI. The students should be able to grasp the basic concepts of explainable AI, including its definition, importance, and the challenges involved in developing an AI system that is explainable. The students will be able to understand interpretability, explainability and attribution methods for AI models.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE414.1	Understand the concept and importance of XAI and its applications in various domains.
CE414.2	To explore the various XAI techniques and tools used for tabular, image and text dataset.
CE414.3	To gain practical experience with XAI frameworks..
CE414.4	To evaluate the trade-offs between explainability and accuracy.
CE414.5	To Understand ethical and legal aspects of XAI

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE414.1	3	2	–	2	–	2	–	–	–	–	–	2
CE414.2	3	3	2	2	3	–	–	–	–	–	–	2
CE414.3	–	2	3	3	3	–	–	–	2	–	2	3
CE414.4	3	3	2	2	2	–	–	2	–	–	–	3
CE414.5	–	–	–	–	–	2	2	3	–	–	–	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE414.1							
CE414.2							
CE414.3							
CE414.4							
CE414.5							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Explainable Artificial Intelligence		4
	1.1	Why Explainable AI?, What Is Explainable AI?, Who Needs Explainability?, Challenges in Explainability, Types of explanation,	T1-T3, R1,R2	
2	Title	Explainability for Tabular Data		8
	2.1	Permutation Feature Importance: Permutation Feature Importance from Scratch, Permutation Feature Importance in scikit-learn	T1-T3 R1-R5	
	2.2	Shapley Values: SHAP (Shapley Additive exPlanations), Visualizing Local Feature Attributions, Visualizing Global Feature Attributions, Interpreting Feature Attributions from Shapley Values, Managed Shapley Values		
	2.3	Explaining Tree-Based Models: From Decision Trees to Tree Ensembles, SHAP's TreeExplainer		
	2.4	Partial Dependence Plots and Related Plots: Partial Dependence Plots (PDPs), Individual Conditional Expectation Plots (ICEs)		
3	Title	Explainability for Image Data		8
	3.1	Integrated Gradients (IG), Choosing a Baseline, Accumulating Gradients, Improvements on Integrated Gradients, (Extremal regions with attributions importance) XRAI, How XRAI Works, Implementing XRAI, Grad-CAM, How Grad-CAM Works, Implementing Grad-CAM	T1-T3 R1,R2	
	3.2	LIME: How LIME Works, Implementing LIME, Guided Backpropagation and Guided Grad-CAM, Guided Backprop and DeConvNets, Guided Grad-CAM		
4	Title	Explainability for Text Data		8
	4.1	Overview of Building Models with Text: Tokenization, Word Embeddings and Pretrained Embeddings, LIME, How LIME Works with Text, Gradient x Input, Intuition from Linear Models From Linear to Nonlinear and Text Models	T1-T3, R1,R5	
	4.2	Layer Integrated Gradients: A Variation on Integrated Gradients, Layer-Wise Relevance Propagation (LRP), How LRP Works, Deriving Explanations from Attention, Which Method to Use?, Language Interpretability Tool		
6	Self Study	Building with Explainability in Mind, The ML Life Cycle AI Regulations and Explainability, What to Look Forward To in Explainable AI, Natural and Semantic Explanations, Interrogative Explanations, Targeted Explanations		4
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

No	Title of the Experiment
1	To implement a simple decision tree model for predicting whether a patient has diabetes based on their medical information. Note : students could implement decision trees using a dataset, visualize the decision tree, and explain the results
2	Feature Importance: To implement SHAP algorithm to calculate the feature importance on a given data set. Note:students could analyze a dataset and calculate the feature importance using an algorithm such as permutation importance or SHAP (SHapley Additive exPlanations), and explain the results.
3	Non linear relationship between features and predicted model: Interpretation and explanation of ML models [marginal effect of a single feature on the predicted outcome while holding all other features constant] To implement PDP(partial dependance plot) to calculate the feature importance on a given data set. Note: students could perform sensitivity analysis on a trained model to understand how the output varies with changes in the input features.
4	Non linear relationship between features and predicted model: Interpretation and explanation of ML models To implement ICE (Individual Conditional Expectation Plots) to calculate the feature importance on a given data set.[conditional effect of a single feature on the predicted outcome for each individual sample in a dataset] Note: students could perform sensitivity analysis on a trained model to understand how the output varies with changes in the input features.
5	To implement an IG algorithm for attributions analysis for a given problem statement.
6	To implement the XRAI algorithm for attributions analysis for a given problem statement.
7	To implement a grad-CAM method to generate class activation maps for a given problem statement.
8	Local Interpretable Model-agnostic methods: To implement LIME to explain the predictions of a given problem statement. Note: students could use model-agnostic methods such as LIME (Local Interpretable Model-Agnostic Explanations) or Anchors to explain the predictions of a machine learning model
9	To implement LIME to analyze text data, such as social media posts or customer reviews, and classify them into different categories.
10	To study LRP and demonstrate LIT by Google for interactive visualization, interpretation and understanding NLP models.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Explainable AI for Practitioners: Designing and Implementing Explainable ML Solutions	1st Edition	Michael Munn, David Pitman	O'Reilly Media, Inc	2022
2.	Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning	1st Edition	Uday Kamath , JohnLiu	Springer Link	2021
3.	Explainable AI: Interpreting, Explaining and Visualizing Deep Learning	1st Edition	Wojciech Samek,, Grégoire Montavon, , Andrea Vedaldi, , Lars Kai Hansen, Klaus-Robert Müller	Springer Link	2019

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Interpretable Machine Learning: A Guide for Making Black Box Models Explainable	1st Edition	Christoph Molnar, published	Springer	2019
2.	Explainable AI: Interpreting, Explaining and Visualizing Deep Learning	1st Edition	Konstantinos G. Margaritis and Evangelos N. Daskalakis, published	Wiley	2020
3.	Explainable AI in Healthcare: An Interdisciplinary Approach	1st Edition	Kristin H. Jarman and Julia A. Lane	Springer	2021
4.	XAI - Explainable Artificial Intelligence: Foundations, Methods, and Applications	1st Edition	Fatma Bouali and Sihem Mesnager	Springer	2020
5.	Explainable AI: Interpreting, Explaining and Visualizing Deep Learning	1st Edition	Kalyan Veeramachaneni , published by	O'Reilly Media	2021



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Ethical Hacking

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Ethical Hacking	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE321	Ethical Hacking	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any. –

Course Objective: This course provides fundamental and advanced knowledge of ethical hacking techniques to identify and mitigate cyber security threats. It equips students with hands-on skills in reconnaissance, vulnerability assessment, exploitation, and penetration testing. The course emphasizes legal, ethical, and professional aspects of cyber security to prepare learners for real-world security challenges.

Course Outcomes (CO): At the End of the course students will be able to

CE321.1	Understand ethical hacking principles and cybersecurity fundamentals.
CE321.2	Perform vulnerability assessment and exploit security flaws in networks and systems
CE321.3	Conduct penetration testing, analyze results, and document findings.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE321.1	1					1						
CE321.2		1		1	1							
CE321.3			1				1	1				

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE321.1							
CE321.2							
CE321.3							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Ethical Hacking and Cybersecurity		5
	1.1	Overview of Cybersecurity, Threats, and Attacks. Ethical Hacking vs. Malicious Hacking. Types of Hackers: White Hat, Black Hat, Grey Hat. Cybersecurity Laws, Ethics, and Responsible Disclosure. Phases of Ethical Hacking and Penetration Testing	1,2	
2	Title	Reconnaissance and Scanning Techniques		6
	2.1	Passive vs. Active Reconnaissance Techniques. Information Gathering Tools: WHOIS, Maltego, Google Dorking, Shodan. Network Scanning Techniques: Port Scanning, Service Detection. Vulnerability Scanning with Nessus and OpenVAS. Enumeration Techniques: SNMP, SMB, LDAP, DNS Enumeration	4,5	
3	Title	System Hacking and Exploitation		6
	3.1	Password Cracking: Brute Force, Dictionary Attacks, Rainbow Tables. Privilege Escalation: Linux and Windows Exploits. Malware, Trojans, and Rootkits. Exploiting Vulnerabilities using Metasploit Framework. Case Studies of Real-World System Hacks	1,2,3	
4	Title	Web Application and Wireless Security		5
	4.1	OWASP Top 10 Web Vulnerabilities. SQL Injection, Cross-Site Scripting (XSS), CSRF, Broken Authentication. Web Security Testing Tools: Burp Suite, OWASP ZAP. Wireless Network Hacking: WEP, WPA, WPA2 Attacks. Wireless Hacking Tools: Aircrack-ng, Packet Sniffing & Decryption with Wireshark, Secure Code Review, Evil Twin Attacks (Rogue Access Points)	4	
5	Title	Penetration Testing, Reporting, and Defense Mechanisms		9
	5.1	Conducting a Full Penetration Test: Recon, Exploitation, Reporting. Social Engineering Attacks and Countermeasures. Defensive Cybersecurity Strategies and Hardening Systems. Legal and Ethical Considerations in Cybersecurity. Writing Professional Penetration Testing Reports	2,5	
6	Self Study	Cloud security, IoT vulnerabilities, and mobile application security. Advanced penetration testing tools like Metasploit, Burp Suite, and Wireshark to secure modern infrastructures. Future cybersecurity challenges, including AI-driven threats and the potential impact of quantum computing on encryption.		4
			Total	28

Laboratory Component:

Sr. No	Title of the Experiment
1	Network Penetration Testing using Nmap and Nikto
2	Exploiting Buffer Overflow Vulnerabilities
3	Password Cracking with Hashcat
4	Bypassing Antivirus Software with Metasploit
5	Wireless Network Cracking with Aircrack-ng
6	Advanced SQL Injection with Blind Injection Techniques
7	Web Application Penetration Testing using Burp Suite
8	Man-in-the-Middle Attack using Ettercap
9	Reverse Engineering Malware in a Sandbox Environment
10	Cloud Penetration Testing on AWS Instances

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hacking: The Art of Exploitation	2nd	Jon Erickson	No Starch Press	2008
2	CEH Certified Ethical Hacker Study Guide	3rd	Kimberly Graves	Wiley	2011
3	Metasploit: The Penetration Tester's Guide	1 st	David Kennedy, Jim O'Gorman, Devon Kearns, Mati Aharoni	No Starch Press	2011
4	The Web Application Hacker's Handbook	2nd	Dafydd Stuttard & Marcus Pinto	Wiley	2011
5	Penetration Testing: A Hands-On Introduction to Hacking	1st	Georgia Weidman	No Starch Press	2014



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Information and System Security

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Information and System Security	2	0	2	4	7	2	0	1	3
		Examination Scheme								
CE322	Information and System Security	Component		ISE	MSE	ESE	Total			
		Theory		13	14	40	67			
		Laboratory		26	--	07	33			

Pre-requisite Course Codes, if any.	Operating Systems, Computer Communications and Networks, Discrete Structures and Graph Theory
Course Objective: - To use the fundamental results of information flow and apply security design, assess and evaluation methods for making secure information systems.	
Course Outcomes (CO): At the End of the course students will be able to	
CE322.1	Understand Security Fundamentals – Explain the fundamental principles of security and its limitations through theoretical results.
CE322.2	Analyze Security Policies - Evaluate different types of security policies and its effectiveness in various information systems.
CE322.3	Assess Information Flow and Assurance - Analyze methods for secure information flow and apply assurance techniques to mitigate risks in a computing system.
CE322.4	Evaluate Secure Systems - Assess the security of information systems using evaluation models

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE322.1	3	-	-	-	-	-	-	-	-	-	-	-
CE322.2	3	2	-	1	-	-	1	-	-	-	-	-
CE322.3	3	2	3	1	-	-	1	-	-	-	-	-
CE322.4	3	2	3	2	-	-	1	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
CE322.1	-	-	-	3	-
CE322.2	2	-	-	3	-
CE322.3	3	-	-	3	-
CE322.4	3	-	-	3	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Overview of Information Security	1,2	7
	1.1	Introduction - Basic Components, Threats, Policy and Mechanism, Assumptions and Trust, Assurance, Operational and Human Issues		
	1.2	Access Control Matrix - Protection State, Access Control Matrix Model, Protection State Transitions, Copy and Own Right, Principle of Attenuation of Privilege.		
	1.3	Foundation Results - General Security Question, Take-Grant Protection Model, Schematic Protection Model.		
2	Title	Security Policies - I	1,2	7
	2.1	Security Policy Basics - Types, Role of Trust, Types of Access Control, Policy Languages.		
	2.2	Confidentiality Policies - Goals, The Bell-LaPadula Model, Tranquility.		
	2.3	Integrity Policies – Goals, Biba Integrity Model, Lipner's Integrity Matrix Model, Clark-Wilson Integrity Model.		
3	Title	Security Policies - II	1,2	7
	3.1	Availability Policies – Goals, Deadlock, Denial of Service Models, Availability and Network Flooding Example.		
	3.2	Hybrid Policies - Chinese Wall Model, Clinical Information Systems Security Policy, Originator Controlled Access Control, Role-Based Access Control.		
	3.3	Noninterference and Policy Composition - The Problem, Deterministic Noninterference, Non-deducibility, Generalized Noninterference. Restrictiveness.		
4	Title	System Security	1,2	7
	5.1	Access Control Mechanisms - Eight Secure Design Principles, Access Control Lists, Capabilities, Locks and Keys, Ring-Based Access Control, Propagated Access Control Lists.		

	5.2	Information Flow – Basics, Non-lattice Information Flow Policies, Static Mechanisms, Dynamic Mechanisms, Integrity Mechanisms. Confinement Problem - The Confinement Problem, Isolation, Detection of Covert Channels		
	5.3	Assurance, Verification and Evaluation – Principles of Secure Design, Assurance Requirement Definition and Analysis, Formal Specification and Verification Techniques, TCSEC Evaluation, International Efforts and the ITSEC.		
5	Self Study	Vulnerability Analysis and Classification, Security Auditing, Network Policy Development, Intrusion Detection Modeling, AI-driven Threat Detection		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

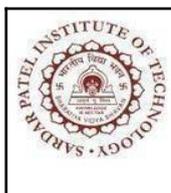
Sr. No.	Title of the Experiment
1	Experiment on Access Control Mechanisms - MAC/DAC/RBAC
2	Experiment on TGP/SPM Model
3	Experiment on Confidentiality Model
4	Experiment on Integrity Model
5	Experiment on Availability Model
6	Experiment on Hybrid Model
7	Experiment on Access Control Mechanisms
8	Experiment on Information Flow
9	Experiment on Confinement Problem
10	Experiment on Assurance Verification and Evaluation of Information System

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Security: Art and Science	SECOND	Matt Bishop, Elisabeth Sullivan & Michelle Ruppel	Addison-Wesley Professional	2019
2	Security Engineering: A Guide to Building Dependable Distributed Systems	FIRST	Ross J. Anderson	Wiley Publishing	2008

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Computer Security: Principles and Practice	FOURTH	William Stallings & Lawrie Brown	Pearson Education	2018
2	Cryptography and Network Security Principles and Practices	FOURTH	William Stallings	Addison-Wesley Professional	2005



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Blockchain Technology

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE-III	Blockchain Technology	2	0	2	5	10	2	0	1	3
		Examination Scheme								
CE423	Blockchain Technology	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		-		07		33

Pre-requisite Course Codes, if any.	Cryptography and Network Security, CCN
<p>Course Overview: This course introduces students to blockchain technology's theoretical foundations and practical applications. Students will gain a comprehensive understanding of blockchain architecture, consensus mechanisms, cryptographic foundations, and the development of decentralized applications. Through a combination of theoretical concepts and practical laboratory exercises, students will explore this transformative technology's technical, economic, and social implications.</p> <p>Course Objectives: Develop a deep understanding of blockchain architecture and its underlying technologies. Gain practical experience in developing and deploying blockchain applications. Understand consensus mechanisms and their role in distributed systems. Explore the cryptographic foundations that secure blockchain networks. Analyze real-world blockchain use cases across various industries. Evaluate the ethical, legal, and regulatory considerations of blockchain implementation</p>	
<p>Course Outcomes (CO): <i>At the End of the course students will be able to</i></p>	
CE423.1	Apply blockchain fundamentals to design a basic cryptocurrency or token system with appropriate features and security considerations.
CE423.2	Analyze various consensus mechanisms to determine their suitability for specific blockchain applications based on performance, security, and scalability requirements. Apply and implement a smart contract on the Ethereum test network
CE423.3	Evaluate the technical and business implications of implementing blockchain solutions for different industry use cases, critically assessing benefits and limitations.
CE423.4	Create a functioning decentralized application (DApp) that incorporates smart contracts and interacts with a blockchain network.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE423.1	2											
CE423.2			2									
CE423.3					2							
CE423.4		2	2		3	2						

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE423.1	2	-	-	-	-	2	-
CE423.2	2	-	-	-	-	2	-
CE423.3	2	-	-	-	-	2	-
CE423.4	2	-	-	-	-	2	-

BLOOM’S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Blockchain Fundamentals		10
	1.1	Introduction – basic ideas behind blockchain, and how it is changing the landscape of digitalization.	1,2,3,4	
	1.2	Introduction to distributed systems and decentralization. History and evolution of blockchain technology. Blockchain architecture and components Cryptographic foundations (hash functions, digital signatures, public/private keys) Types of blockchain networks (public, private, permissioned, consortium) Blockchain data structures and transaction flow.		
	1.3	Consensus Mechanisms and Security: Proof of Work (PoW) and its implementations Alternative consensus mechanisms (PoS, DPoS, PBFT, etc.) Security considerations in blockchain networks Attack vectors and mitigation strategies Scalability challenges and solutions Blockchain governance models Choosing an algorithm- Finality, Scalability, Speed, Performance		
2		Cryptocurrency-Bitcoin and Ethereum Ecosystem		06
	2.1	History of Cryptocurrency, Cryptography in blockchain, SHA hash Function, Merkle Tree, Bitcoin, Monetary Policy, The Halving, Block Frequency, Bitcoin Ecosystem, Bitcoin Network, Bitcoin Mining, Mining Pool, Mining Systems,GPU, FPGA and ASIC, Nonce range, Timestamp, Wallet, UTXOs, SegWit, Wallet Address, Bitcoin Network Payment and API, Bitcoin-core, bitcoind, bitcoin-cli, bitcoin-qt, Bitcoin Improvement Proposal (BIP) introduction, Types of BIP, BIP Lifecycle	1,2,3,4	

	2.2	<p>Ethereum Ecosystem: Introduction to Ethereum, Ethereum Technology Stack, Ethereum Virtual Machine (EVM) - Advantages and Drawbacks of Ethereum.</p> <p>Smart Contract, ether, and solidity Wallets for Ethereum Solidity - Smart Contracts - some attacks on smart contracts. Testing of smart contracts, Blockchain: Enterprise use cases</p> <p>NFTs- Developing smart contracts for tokenization of assets Reviewing the Ethereum improvement proposal process and standards Understanding fungible and non-fungible tokens. Exploring ERC standard tokens ERC20 and ERC721 for fungible and non-fungible assets Designing and developing ERC721-compliant real estate token</p> <p>DeFi- What is DeFi, What you can do with DeFi, How does DeFi work, Ethereum and DeFi,</p> <p>Metaverse- Metaverse and Digital Evolution, Blockchain, and Metaverse, enabling technologies of the metaverse, the motivation behind the integration of blockchain in the metaverse, the use cases of application of blockchain in the metaverse-Financial System, Smart Contract deployment, NFTs, Healthcare, The metaverse projects Decentraland (https://decentraland.org/), SandBox, Axie Infinity, Illuvium</p>		
3		Hyperledger Fabric		06
	3.1	Transaction Flow. Hyperledger Fabric Details, Fabric - Membership and Identity Management, Hyperledger Fabric Network Setup, Fabric Demo on IBM Blockchain Cloud. Hyperledger Composer – Application Development. Hyperledger Composer - Network Administration	1,2,3,4	
	3.2	Blockchain: Enterprise use cases Alternative coins – Ethereum and Smart contracts Alternative coins – Ethereum continued		
4		Applications Blockchain Technology		06
		Uses of Blockchain in E-Governance, Land Registration, Medical Information Systems, and smart cities, smart industries, anomaly detections, FinTech, Shaping the Financial World, IoT	1,2,3,4	
	Self Study	Emerging trends in blockchain technology Layer 2 scaling solutions Zero-knowledge proofs and privacy technologies Tokenomics and cryptoeconomics Quantum computing and its implications for blockchain Regulatory landscape and legal considerations Scaling the blockchain: payment channels and state channels Scaling the blockchain using optimism and using zk-SNARK Privacy in public blockchain: de-anonymizing the blockchain and mixing		04*
				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr.No	Title of the Experiment
1	Track Ethereum transactions using API
2	Ethereum Private Blockchain Part-I
3	Ethereum Private Blockchain Part-II
4	Development of Smart Contract using Solidity and Remix IDE
5	Development of Smart Contract using Solidity and Truffle-Suite
6	Development of Ethereum dApp
7	Tokenization of Asset NFTs
8	Hyperledger Fabric Setup
9	Blockchain and Cybersecurity
10	Testing Smart Contracts

Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Mastering Blockchain	4th Edition	Imran Bashir	Packt Publishing	2023
2	Blockchain in Action	1st Edition	Bina Ramamurthy	Manning Publications	2020
3	Bitcoin and Cryptocurrency Technologies	1st Edition	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder	Princeton University Press	2016
4	Mastering Bitcoin: Unlocking Digital Cryptocurrencies	1st/2nd Edition	Andreas M. Antonopoulos	O'Reilly Media	2014 / 2017
5	Blockchain: Blueprint for a New Economy	1st Edition	Melanie Swan	O'Reilly Media	2015
6	Hyperledger Fabric Documentation	Web Resource	Hyperledger Project Team (The Linux Foundation)	https://www.hyperledger.org	Continuously updated



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Digital Forensics and Cybersecurity

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE) CE424	Digital Forensics and Cybersecurity	2	0	2	4	7	2	0	1	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any.	Computer Communication Network
Course Objective: To enhance the competency and expertise in digital forensics and Cybersecurity skills	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE424.1	Illustrate the science of digital forensic
CE424.2	Categorize the different areas within digital forensics and apply solid foundational grounding for digital investigations and protection of resources from unauthorized activity.
CE424.3	Apply the tools and tactics associated with digital forensics
CE424.4	Identify the requirements of cybersecurity for critical infrastructure and learn to comply with such requirements within a suitable cyber security framework.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE424.1	-	2	-	-	-	-	-	-	-	-	-	-
CE424.2	-	2	-	-	-	-	-	-	-	-	-	-
CE424.3	-	-	-	-	3	-	-	-	-	-	-	-
CE424.4	-	-	-	-	-	2	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CS424.1	2	-	-	-	-	-	-
CS424.2	-	2	-	-	-	-	-
CS424.3	2	-	-	-	-	-	-
CS424.4	-	2	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Digital Forensics Science	1,2	5
	1.1	Introduction to Digital Forensic Science, Planning and development of a Digital Forensic lab, Legal and Regulatory Compliance in Digital Forensics.		
	1.2	The phases of the Digital Forensic investigative process: Identification, Preservation, Collection, Examination, Analysis, Presentation, Decision.		
2	Title	Sub categories of Digital Forensic	1,2	7
	2.1	Media Analysis (Hard drives, RAM, flash memory, PDAs, diskettes etc): Examining physical media for evidence, Chain of Custody (CoC), Powered-on versus powered-off device acquisition, Write blocking, Data imaging and hashing, Mobile and portable Device forensics, Device and data acquisition guidelines and best practices,		
	2.2	Code Analysis: Review of software for malicious signatures, Network Analysis: Scrutinize network traffic and logs to identify and locate.		
3	Title	Incident Response Methodology and Tools	1,2	8
	3.1	Preparation, Detection, Containment, Analysis, Eradication, Recovery and Follow up.		
	3.2	Evidence Acquisition and Preservation, Drive and partition recognition in Linux, Maintaining evidence integrity, Image acquisition using <i>Guymager</i> . File Recovery and Data Carving with <i>Foremost</i> , <i>Scalpel</i> , and <i>Bulk Extractor</i> , Forensic test images used in <i>Foremost</i> and <i>Scalpel</i> , Using <i>Foremost</i> for file recovery and data carving, Using <i>Scalpel</i> for data carving, <i>Bulk_extractor</i> . Memory Forensics with <i>Volatility</i> .		
	3.3	Autopsy – The Sleuth Kit, Kit, Sample, Network and Internet Capture Analysis with Xplico, Packet capture analysis using Xplico		
4	Title	Cybersecurity	3,4	8
	4.1	Introduction to Cybersecurity framework of NIST, Five functions of cybersecurity and critical infrastructure security (Nuclear power plant, smart grid, SCADA, Industrial Control System Security)		
	4.2	Introduction to SOC/SIEM, Advance techniques in Cyber security like Machine learning and Game theory		
5	Self-study	Cloud Forensic, IoT Forensic, Emerging storage technologies like NVMe SSDs		5*
Total(* Not included)				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Scan the network to identify open ports, OS detection, service scanning and vulnerability scanning.
2	Computer Forensic using open source tool (Autopsy, Sleuth kit and TCT)
3	Memory Forensics using open source tool (Volatility)
4	Network Forensics using open source tools (Xplico and Tshark)
5	Email Forensics using online utilities
6	Evaluating commercial Digital forensic tools (EnCase Forensic)
7	Cloud Forensic
8	Implementing SIEM
9	Case Study: IoT Forensic / SolarWinds Supply Chain Attack (2020-2021) / Colonial Pipeline Ransomware Attack (2021) / Log4Shell Vulnerability Exploitation (2021-2022) / MGM Resorts Ransomware Attack (2023).
10	Mini Project on Cybersecurity using advance Technique / Full Digital Forensic Investigation based on a simulated cybercrime

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Forensics with Kali Linux	Second Edition	Shiva V. N. Parasram	Packt	2017
2	Computer Forensics: Incident Response Essentials	--	First Warren G. Kruse II and Jay G. Heiser	Addison-Wesley Professional	2001
3	NIST Cyber Security Framework	--	Alan Calder	NIST online	2018
4	Framework for improving critical infrastructure of Cyber security	--	National Institute of Standards and Technology	NIST Online	2014

Reference Book:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Guide to Computer Forensics and Investigations	Second Edition	Nelson, B, Phillips, A, Enfinger, F, Stuart, C	Thomson Course Technology	2006
2	Computer Forensics, Computer Crime Scene Investigation	First Edition	Vacca, J	Charles River Media,	2005



Big Data Analytics

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Big Data Analytics	2	0	2	4	8	2	0	1	3
Examination Scheme										
CE331		Component	ISE		MSE		ESE		Total	
		Theory	13		14		40		67	
	Laboratory	26		--		7		33		

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): At the End of the course students will be able to	
CE331.1	Understand the building blocks of Big Data Analytics.
CE331.2	Choose appropriate storage structures to make sense out of big data.
CE331.3	Apply scalable algorithms based on Hadoop and Map Reduce to perform Big Data Analytics.
CE331.4	Achieve adequate perspectives of big data analytics in various applications like, recommender systems, social media applications etc.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE331.1			3	3	3							
CE331.2			3	3	3							
CE331.3			3	3	3							
CE331.4			3	3	3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE331.1							
CE331.2							
CE331.3							
CE331.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Big data		
	1.1	Big Data characteristics, types of Big Data, Traditional vs. Big Data, Big data challenges	1	1
2	Title	Memory-efficient data structures		
	2.1	Introduction to data streams, problems related to handling data stream, Mining Data Streams using DGIM algorithm, Need of dimensionality reduction - PCA, SVD - Singular Value Decomposition	3	6
	2.2	Hash functions, universal / perfect hash families, Bloom filters, Sketches for distinct count, Flajolet Martin Sketch, Majority Algorithm, Misra-Gries sketch, Count-Min Sketch, Count Sketch, LSH, MinHash	2	
3	Title	Scaling with Big Data using Hadoop		
	3.1	HDFS - Data in Hadoop, MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, YARN, Details of MapReduce Execution, Coping With Node Failures	1	7
	3.2	Modern Big Data Architecture Data Lake House Architecture: Combining data lakes and data warehouses (Databricks Delta Lake, Apache Iceberg) Modern Data Stack: Introduction to ELT vs ETL pipelines Introduction to Serverless Big Data Computing: Overview of Cloud-native approaches - AWS Lambda, Azure, Google Cloud	1	
4	Title	Frequent Itemsets And Clustering		
	4.1	Handling Larger Data sets in Main Memory Algorithm - Park, Chen and Yu Algorithm, The Multi stage Algorithm, The Multihash Algorithm. The SON Algorithm, BFR clustering algorithm, CURE algorithm	1	4
5	Title	Big Data Analytics Applications		
	5.1	Clustering of Social-Network Graphs - Clique Percolation Method, counting triangles, PageRank, Efficient Computation of PageRank, Topic-Sensitive PageRank, Link Spam, Hubs and Authorities	1	5
	5.2	Scaling with Big Data using Apache SPARK SPARK Ecosystem, SPARK streaming - Flink, and Kafka Streams, Distributed Batch Processing with Spark		
6	Title	Big Data Machine Learning		
	6.1	Decision Trees for Big Data Analytics - fraud detection, Big Data Predictive Analytics, K means using map reduce, Gradient Descent for Large-Scale Learning	1	5
7	Self Study	Recommendation Systems: Introduction, A Model for Recommendation Systems, Content based Recommendation System, Collaborative-Filtering System: Nearest Neighbour Technique	4	4*
		Total		28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Installation of Hadoop and execution of HDFS commands
2	Study of any latest research paper on memory efficient data structure for big data.
3	Demonstrate use of modern tools like Pandas for Exploratory Data Analysis.
4	Implement algorithms in Map-Reduce on Strings and integers
5	Implement algorithms in Map-reduce on Relational Algebra
6	Download a real world dataset and find insights using map reduce. For e.g for a movie dataset list all the movies and the number of ratings, list all the Movie IDs which have been rated (Movie Id with at least one user rating it), list all the Users who have rated the movies (Users who have rated at least one movie), list of all the User with the max, min, average ratings they have given against any movie
7	To use Apache Hbase and implement CRUD operations on database inside HDFS.
8	Extract facts in real world dataset using Hive
9	Extract sessions in real world dataset using Pig
10	Implement wordcount using Apache Spark.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Mining of Massive Dataset	3rd	Anand Raja Raman and Jeff Ullman	Cambridge University	2019
2	Algorithms and models of computation	1st	Jeff Erickson	University of Illinois	2015
3	Introducing Data Science	3rd	Davy Cielen, Meysman, Mohamed Ali	Dreamtech Press	2014
4	Learning Apache Spark 2	2nd	Muhammad Asif Abbasi	Packt Publishing	2017



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Information Visualization

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PEC)	Information Visualization	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE332		Component		ISE		MSE		ESE	Total	
		Theory		13		14		40	67	
		Laboratory		26		--		07	33	

Pre-requisite Course Codes, if any.	
Course Objective: This course will introduce information visualization—visual representations of data through interactive systems. Specific focus will be on the role of visualization in understanding data and understanding how perception, cognition, and good design enhance visualization.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE332.1	Identify and recognize visual perception and representation of data.
CE332.2	Use the various visualization structures (like tables, spatial data, tree and network etc.)
CE332.3	Evaluate information visualization systems and other forms of visual presentation for their effectiveness
CE332.4	Design and build data visualization systems for real world problems

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE332.1	3	-	3	3	3	-	-	-	-	-	-	-
CE332.2	3	-	3	3	3	-	-	-	-	-	-	-
CE332.3	3	-	3	3	3	-	-	-	-	-	-	-
CE332.4	3	-	3	3	3	-	-	-	-	-	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE332.1	2	-	-	-	2	-	-
CE332.2	2	-	-	-	2	-	-
CE332.3	2	-	-	-	2	-	-
CE332.4	2	-	-	-	2	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Visual encodings and data types		
	1.1	Value of Visualization – What is Visualization and Why do it: External representation – Interactivity – Difficulty in Validation. Data Abstraction: Dataset types – Attribute types – Semantics. Task Abstraction – Analyze, Produce, Search, Query. Four levels of validation – Validation approaches – Validation examples. Marks and Channels	1	4
2	Title	Design thinking		
	2.1	Rules of thumb – Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density. Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees: Connections, Matrix views – Containment. Map color: Color theory, Color maps and other channels. Manipulate view: Change view over time – Select elements – Changing viewpoint – Reducing attributes. Facet into multiple views: Juxtapose and Coordinate views – Partition into views – Static and Dynamic layers – Reduce items and attributes: Filter – Aggregate. Focus and context: Elide – Superimpose – Distort – Case studies.	3	6
3	Title	Data simplification techniques		
	3.1	Tools for reducing data complexity as well as visual complexity. On the data side these include filtering & queries, pivoting, aggregation. Visual simplification techniques include visual aggregation, dimensionality reduction, and interaction techniques. Designing multiple coordinated views with brushing and linking, navigation through large datasets (overview + context overview, filter, details on demand).	1	6
4	Title	Applied Visualizations		
	4.1	Basic Plotting : Line plot - Bar plot - Pie Chart - Scatter Plot - Histogram - Stacked Bar Charts - Subplots - Matplotlib, Seaborn, Plotly - Seaborn Styles Advanced Plotting: Box plot - Density Plot - Area Chart - Heat map - Tree map - Graph Networks	1	4
5	Title	Principles of Information Visualization		
	5.1	Interactive Visualizations and Animations Dynamic charts - Dynamic maps - Animation types - 2D, 3D, Motion Animation - Animation Principles - Altair Package - Statistical Visualizations, Visual Perception and Cognition - Gestalt's Principles - Tufte's Principles - Applications of Principles of Information Visualization - Dashboard Design	1	4
6	Title	Visualization Of Volumetric Data And Evaluation Of Visualizations		
	6.1	Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations	1	4
7	Self Study	Visualization Of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization. Various visualization techniques, data structures used in data visualization.	4	
		Total		28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr No	Title of the experiment
1	<p>Create basic charts using Tableau / Power BI / R / Python / D3.js to be performed on the dataset of Ecommerce field</p> <ul style="list-style-type: none"> ● Complete all plots on practice dataset and reproduce on e-commerce dataset. ● Basic - Bar chart, Pie chart, Histogram, Timeline chart, Scatter plot, Bubble plot ● Calculate Product wise sales, region wise sales ● Exploratory data analysis to describe or explain the data ● Write observations from each chart <p>Ref: https://learn.microsoft.com/en-us/power-bi/create-reports/sample-tutorial-connect-to-the-samples Practice dataset: https://learn.microsoft.com/en-us/power-bi/create-reports/desktop-dimensional-model-report?source=recommendations</p>
2	<p>Create advanced charts using Tableau / Power BI / R / Python / D3.js to be performed on the dataset - Socio economic data</p> <ul style="list-style-type: none"> ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter, Line, Area, Waterfall, Donut, Treemap, Funnel ● Write observations from each chart <p>Practice dataset: https://learn.microsoft.com/en-us/power-bi/create-reports/sample-tutorial-decomposition?source=recommendations</p>
3	<p>Design Interactive Dashboards and Storytelling using Tableau / Power BI / R / Python / D3.js to be performed on the dataset - Disease spread / Healthcare</p> <ul style="list-style-type: none"> ● Write observations from each chart <p>References Dashboards in streamlit - https://streamlit.io/gallery?category=data-visualization</p>
	<p>Dashboards in PowerBI - https://learn.microsoft.com/en-us/power-bi/create-reports/sample-covid-19-us</p>
4	<p>Create basic charts using R programming on dataset Crime or Police / Law and Order</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Timeline chart, Scatter plot, Bubble plot ● Write observations from each chart
5	<p>Create advanced charts using R programming on the dataset - Housing data</p> <ul style="list-style-type: none"> ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Write observations from each chart

6	<p>Design Interactive Dashboards and Storytelling using using Power BI on the dataset - Animal / Wildlife / Marine</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Timeline chart, Scatter plot, Bubble plot ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Time series: ARIMA (or any other time series model) prediction for future sales ● Write observations from each chart
+	<p>Power BI DAX Calculations: Create Basic and Advanced DAX Measures to be performed on a Sales dataset. Tasks: 1) Create calculated columns for Profit and Profit Margin. 2) Create measures for Total Sales and Total Profit. 3) Visualize results with bar charts, pie charts, and card visuals. Dataset: Custom or a simple sales dataset. Write observations from each calculation and visualization.</p>
7	<p>Create basic and advanced charts using D3.js on the dataset - Finance / Banking / Insurance / Credit</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Time line chart, Scatter plot, Bubble plot ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Write observations from each chart
8	<p>Design Interactive Dashboards and Storytelling using using D3.js on the dataset - Environment / Forest cover</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Time line chart, Scatter plot, Bubble plot ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Write observations from each chart
9	<p>Design Big Data Dashboards using Tableau on the dataset - Women empowerment / Gender participation</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Time line chart, Scatter plot, Bubble plot ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Write observations from each chart
10	<p>Design Big Data Dashboards using Tableau on the datasets - Education sector</p> <ul style="list-style-type: none"> ● Basic - Bar chart, Pie chart, Histogram, Time line chart, Scatter plot, Bubble plot ● Advanced - Word chart, Box and whisker plot, Violin plot, Regression plot (linear and nonlinear), 3D chart, Jitter ● Write observations from each chart

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Visualization Analysis and Design	-	Tamara Munzner	-	-
2	Visual Thinking for Design	-	Colin Ware	-	-

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Design for Information	-	Isabel Meirelles	-	-
2	The Functional Art: An Introduction to Information Graphics and Visualization Visual Thinking for Design	-	Alberto Cairo	-	-
3	Information Visualization: Perception for Design		Colin Ware		
4	The Visual Display of Quantitative Information		Edward Tufte		



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Time Series Data Analysis

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PEC	Time Series Data Analysis	2	0	2	4	8	2	0	1	3
		Examination Scheme								
Component		ISE		MSE		ESE	Total			
CE433		Theory	13		14		40	67		
	Laboratory	26		--		07	33			

Pre-requisite Course Codes, if any.	CE332
Course Objective: This course helps students learn how to work with time-based data. They will understand patterns like trends and seasonality, clean and visualize data, and use models to make predictions. The course also introduces advanced tools like machine learning to solve real-world problems using time series data.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE433.1	Understand the fundamental concepts, components, and preprocessing techniques of time series data.
CE433.2	Analyze the statistical properties and apply appropriate transformations and smoothing methods for stationarity.
CE433.3	Build and evaluate time series models including ARIMA, VAR, and machine learning-based models for forecasting.
CE433.4	Implement forecasting solutions and anomaly detection for real-world applications using time series data.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE433.1												
CE433.2												
CE433.3												
CE433.4												

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE433.1							
CE433.2							

CE433.3							
CE433.4							

BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	Fundamentals of Time Series Analysis	1,2,3,5	5
	1.1	Introduction to Time Series Definition and importance Types of time series data Key components: trend, seasonality, cyclicity, and irregular variations Applications in finance, economics, and engineering		
	1.2	Data Preprocessing and Visualization Time series data structures Handling missing values and outliers Visualization techniques (heatmap, rolling mean, line plots) Introduction to decomposition methods		
2	Title	Statistical Properties and Transformations	1,2,3,4,5	5
	2.1	Understanding Time Series Properties Stationarity vs. non-stationarity White noise and random walks Autocorrelation and Partial Autocorrelation Functions (ACF & PACF)		
	2.2	Data Transformations and Smoothing Log transformations and differencing techniques Moving averages and exponential smoothing methods Additive and multiplicative decomposition approaches		
3	Title	Time Series Modeling	1,2,3,4	6
	3.1	Autoregressive and Moving Average Models Autoregressive (AR) models Moving Average (MA) models Autoregressive Moving Average (ARMA) models Model selection and parameter estimation		
	3.2	Integrated and Seasonal Models Autoregressive Integrated Moving Average (ARIMA) models Seasonal ARIMA (SARIMA) Exponential Smoothing State Space Models (ETS) Case studies on seasonal forecasting using GARCH and EGARCH		
4	Title	Advanced Topics in Time Series	1,4,5,6	5
	4.1	Multivariate Time Series Models Vector Autoregression (VAR) models Cointegration and Error Correction Models (ECM) Applications in macroeconomics and finance		
	4.2	Machine Learning Approaches		

		Regression-based forecasting models Feature engineering for time series Introduction to Recurrent Neural Networks (RNNs), Gated Recurrent Unit (GRU) and Long Short-Term Memory (LSTM) networks Convolutional Neural Networks (CNNs) for time series analysis		
5	Title	Practical Applications and Case Studies	2,4, 5,6	7
	5.1	Anomaly Detection in Time Series Statistical and machine learning-based methods Case studies in IoT and financial sectors		
	5.2	Real-World Forecasting Applications Energy demand prediction Stock price forecasting Sales and revenue projections Ensemble forecasting techniques		
	5.3	Project Implementation Working with real-world datasets Building and validating forecasting models Interpreting results for business decision-making		
6	Self Study	Hybrid model for time series forecasting, Prophet for time series forecasting, Transfer learning in time series forecasting, Time Series Forecasting in Edge and IoT devices		
			Total	28

Laboratory Component:

Sr. No	Title of the Experiment
1	Time Series Data Visualization and Decomposition - heatmap, line plot, rolling mean
2	Stationarity Testing and Differencing
3	Autocorrelation and Partial Autocorrelation Analysis
4	Building and Evaluating ARIMA Models
5	Seasonal Decomposition of Time Series (STL)
6	Exponential Smoothing Methods
7	Vector Autoregression (VAR) Modeling
8	GARCH Model Implementation for Volatility Forecasting
9	Machine Learning Approaches for Time Series Forecasting using RNN, LSTM, GRU
10	Anomaly Detection in Time Series Data

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Time Series Analysis and Its Applications: With R Examples	Forth	Robert H. Shumway, David S. Stoffer	Springer	2017
2	Forecasting: Principles and Practice	Third	Rob J. Hyndman, George Athanasopoulos	OTexts	2021
3	Introduction to Time Series and Forecasting	Third	Peter J. Brockwell, Richard A. Davis	Springer	2016
4	Applied Time Series Analysis	First	Wayne A. Woodward, Henry L. Gray, Alan C. Elliott	CRC Press	2017

5	Practical Time Series Analysis: Prediction with Statistics and Machine Learning	First	Aileen Nielsen	O'Reilly Media	2019
6	Deep Learning for Time Series Forecasting	First	Jason Brownlee	Machine Learning Mastery	2018



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Decision Making and Business Intelligence

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE-IV)	Decision Making and Business Intelligence	2	0	1	4	7	2	0	1	3
		Examination Scheme								
CE434		Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any.	CS307 Machine Learning
Course Objective: To extract knowledge from data repository for data analysis using frequent pattern, classification, clustering and prediction.	
Course Outcomes (CO): At the End of the course students will be able to	
CS434.1	To design business dashboards using business intelligence tools.
CS434.2	To analyze OLAP and OLTP operations to take strategic decisions.
CS434.3	To develop the understanding of ERP to improve business organizations.
CS434.4	To experiment with the knowledge management system.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CS434.1					3	3		2				3
CS434.2			2	2	3	3		2				3
CS434.3					3	3		2				3
CS434.4			2	2	3	3		2	2	2		3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2
CS433.1					3	
CS433.2					3	
CS433.3					3	
CS433.4					3	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref .	Hrs.
1	Title	Business Intelligence:	1	6
	1.1	Decision-Making Process & Types of Decisions, Role of Business Intelligence (BI) in Decision Making using case studies. Data Ethics, Bias, and Security considerations in BI		
	1.2	Business Intelligence and Decision Support Systems (DSS). BI Process & Architecture, BI applications in different industries. Designing business dashboards and reporting using BI Tools. AI, BI and Business Analytics. AI-driven automation in business decision-making.		
2	Title	Data Warehousing for Decision Support:	1	5
	2.1	Data Warehouse architecture, ETL Process, data mart, data staging area. OLAP and OLTP. Dimensional analysis- data cubes, drill-down, rollup, slice, dice, rotation		
	2.2	OLAP models- ROLAP and MOLAP. Fact and Dimension Tables. Schemas like Star, snowflake and fact constellation.		
3	Title	ERP Solutions and Implementation:	2	10
	3.1	ERP systems, Business processes and IT. Planning Evaluation and selection of ERP systems, Implementation life cycle, ERP implementation, Methodology and Framework, Training, Data Migration. People Organization in implementation-Consultants, Vendors and Employees. Business process reengineering.		
	3.2	Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation. Extended ERP systems and ERP add-ons -CRM, SCM. Future trends in ERP.		
4	Title	Knowledge Management System:	3	7
	4.1	Knowledge management process, lifecycle, Nonaka model, knowledge capturing techniques- Brainstorming, protocol analysis, consensus decision making, repertory grid, concept mapping, blackboarding.		
	4.2	Knowledge codification, tools- knowledge map, decision table, decision tree, frames, production rules, case-based reasoning.		
6	Self Study	Decision making with Machine Learning Techniques using classification, clustering and Association rule mining	1	7
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To design and implement a Star and Snowflake Schema for efficient data storage and retrieval in business intelligence applications.
2	To implement OLAP (Online Analytical Processing) and OLTP (Online Transaction Processing) operations using SQL queries and data warehouse concepts.
3	Designing business Dashboards to facilitate data-driven decision-making by utilizing appropriate visualization techniques.
4	To extract, transform, and visualize business data using Power BI / Tableau and derive insights for decision-making.
5	Identification of different Modules in an open-source ERP system like Odoo etc.
6	Develop a knowledgebase for an organization using wiki, notion, etc.
7	Evaluating the effectiveness of knowledge capturing techniques.
8	To demonstrate Business Process Reengineering.
9	To compare the effectiveness of best practices databases, knowledge maps, case-based repositories, and wikis in codifying and retrieving knowledge.
10	To test whether visual knowledge representation (mind maps, flowcharts, infographics) improves knowledge retention and usability compared to text-based codification (reports, documents).

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Data Warehousing: Fundamentals for IT Professionals	2 nd Edition	Paulraj Ponniah	Wiley India.	2012
2.	Enterprise Resource Planning	3 rd Edition	Alexis Leon	McGraw Hill Education	2017

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Data Mining Concepts and Techniques	4 th Edition	Han, Kamber	Morgan Kaufmann Pub	2022
2.	Strategic Management of Information Systems	5 th Edition	Keri Pearlson and Karal Saunders	Wiley	2012
3.	Knowledge Management	1 st Edition	Elias M. Awad and Hassan Ghaziri	Pearson	2003



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Digital Image Processing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
PE	Digital Image Processing	2	0	2	5	10	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
CE341		Theory	13		14		40		67	
	Laboratory	26		--		07		33		

Pre-requisite Course Codes, if any.

Course Objective: The primary objective of Image Processing Course is to understand and apply image processing tools to process the Digital image

Course Outcomes (CO): At the end of the course students will be able to

CE341.1	apply image enhancement technique
CE341.2	apply image segmentation technique
CE341.3	perform binary image processing Operation
CE341.4	develop fast image transform flowgraph
CE341.5	solve image compression and decompression
CE341.6	develop image processing application

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE341.1	3	3	2	3	3				2			
CE341.2	3	3	2	3	3				2			

CE341.3	3	3	2	3	3				2			
CE341.4	3	3	2	3	3				2			
CE341.5	3	3	2	3	3				2			
CE341.6	3	3	2	3	3				2			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Fundamentals of Digital Image and Video	1,2	2
	1.1	Sampling and Quantization, Digital Image Representation		
	1.2	Introduction of Coordinate representation and Pixel, Neighbors of pixel adjacency connectivity		
2	Title	Image Enhancement	1,2	6
	2.1	Gray Level Transformations, Zero Memory Point Operations		
	2.2	Histogram Processing		
	2.3	Spatial Filtering: Smoothing and Sharpening Filters		
	2.4	Spatial Filtering: Smoothing and Sharpening Filters		
3	Title	Image Segmentation	1,2,4	6
	3.1	Detection of Discontinuities, Point Detection, Line Detection and Edge Detection		

	3.2	Edge Linking using Local processing and Global Processing Hough Transform, Graph Theoretic Method		
	3.3	Region based Segmentation, Image growing by pixel aggregation, Split and Merge Technique		
4	Title	Binary Image Processing	1,2	6
	4.1	Representation and Description, Chain Code, Shape Number, Moments.		
	4.2	Binary Morphological Operators : Dilation, Erosion, Opening and Closing, Boundary Extraction, Region Filling, Hit or Miss Transform, Corner Detection, Thinning and Thickening algorithm		
5	Title	Image Transform and Compression	1,3	4
	5.1	Introduction to Unitary Transform, Discrete Fourier Transform(DFT) and Fast Fourier Transform (FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform, Discrete Cosine Transform (DCT)		
	5.2	Introduction, Redundancy, Fidelity Criteria, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM, Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG		
	5.3	2-D Motion Estimation: Pixel based motion estimation, Block Matching Algorithm, Region based Motion Estimation, Multi resolution Motion Estimation. Block based transform coding, MPEG		
6	Self Study	Connected Component Labeling, Gray Scale Morphology and Colour Image Enhancement, Image restoration		
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Image Enhancement using zero memory point processing
2	Image Enhancement using Histogram Processing
3	Image Enhancement using Spatial Filtering
4	Image Segmentation based on discontinuity property
5	Image Segmentation based on similarity property
6	Morphological Image Processing
7	Thinning and Thickening Algorithm
8	Image representation using Chain code, Shape Number and Moments
9	Fast Image Transform
10	Image Compression using Lossless Compression techniques
11	Image Compression using Lossy Compression techniques
12	Application of Image Processing

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Image Processing	Third Edition	Rafel C. Gonzalez and Richard E. Woods	Pearson Educatio Asia	2009
2	Digital Image Processing	First Edition	S.Jayaraman, E.Esakkirajan and T. Veerkumar	TataMcGraw Hill Education Private Ltd	2009
3	Digital Image Processing	First Edition	S. Sridhar	Oxford	2011
4	Digital Image Processing	First Edition	B. Chanda D. Dutta Majumdar	PHI	2003

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals and Digital Image Processing	Third Edition	Anil K. Jain	Prentice Hall of India Private Ltd	
2.	Digital Image Processing and computer Vision	First Edition	Milan Sonka, Vaclav Hlavac and Roger Boyle	Cengage Learning	2008
3	Multidimensional Signal, Image and Video Processing and Coding	Second Edition	John W Woods	Elsevier	2012
4	Digital Image Processing	Third Edition	William Pratt	John Wiley & Sons	2003

Web References :

NPTEL Courses

1. Digital Image Processing by Prof. Prabir Kumar Biswas, IIT Kharagpur

https://onlinecourses.nptel.ac.in/noc22_ee116/preview

Online Video Course :

1. Digital Image Processing by Prof. Rich Radke ,Rensselaer Polytechnic Institute

<https://sites.ecse.rpi.edu/~rjradke/improccourse.html>



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High Performance Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	High Performance Computing	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE342		Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any.	Operating Systems, Computer and Communication Networks, Computer Architecture and Organization
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Course Objective: To familiarize students with the fundamental concepts, techniques and design of parallel computing and use of parallel computing application area.

Course Outcomes (CO): *At the End of the course students will be able to*

CE342.1	Study fundamental concepts and communication pattern of parallel programming in high performance computing.
CE342.2	Explore MPI and OpenMP message passing paradigm in parallel programs for loosely and tightly coupled parallel systems.
CE342.3	Analyze the performance of parallel programs of high performance computing systems.
CE342.4	Design parallel algorithm for achieving high performance of standard single threaded Algorithm.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE342.1	3	-	-	-	-	-	-	-	-	-	-	-
CE342.2	-	-	-	-	3	-	-	-	-	-	-	-
CE342.3	2	3	-	-	-	-	-	-	-	-	-	-
CE342.4	1	1	3	-	-	-	-	-	-	-	-	3

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE342.1							
CE342.2							
CE342.3							
CE342.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to HPC and Parallel Programming and Platforms		05
	1.1	Implicit Parallelism, Limitations of Memory System Performance, Parallel Computing Platforms, Parallel Platforms Physical Organization	1,2	
	1.2	Parallel Machine Communication Costs, Interconnection Networks Routing, Process-Processor Mapping, Mapping Techniques	1,2	
	1.3	Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, Granularity Effect on Performance, Parallel Systems Scalability	1,2	
2	Title	OpenMP and MPI		07
	2.1	OpenMP – Shared-Memory Model, Critical Sections, Reductions, Data and Functional Parallelism, OpenMP Programming	1,2	
	2.2	MPI – Building Blocks, Communication-Computation Overlapping, Collective Communication, Computation Operations, Groups and Communicators Examples of MPI and – Conjugate Gradient Method, Jacobi Methodology, One-Sided Communication, Dynamic Process Management	1,2	
3	Title	Parallel Algorithm Design		07
	3.1	Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads	1,2	

	3.2	Task/Channel Model, Foster's Design Methodology, Examples of Parallel Programming Design – Sieve of Eratosthenes, Floyd's Algorithm, Matrix Vector Addition, Merge Sort, Quick Sort.	1,2	
4	Title	Communication Operations and Introduction to CUDA		09
	4.1	One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations	1,2	
	4.2	Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Examples of Parallel Programming Communication – Matrix Multiplication	1,2	
	4.3	GPU Programming : Basic Programming Concepts, CUDA Architecture, Threads & Blocks, Memory Hierarchy, Shared Memory, CUDA Optimization Techniques		
6	Self Study	Analytical Modeling of Parallel Programs: Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs, Examples of Analysis of Parallel Programming – Boundary Value Problem, n Body Problem	1,2	4*
Total				28+ 4*

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implement Merge Sort using OpenMP
2	Parallel Prefix-Sum using OpenMP
3	Implement PageRank Algorithm using MPI
4	Parallel Matrix Multiplication using MPI
5	Implement Boundary Value Problem using Foster's Design Methodology
6	One-Sided Communication in MPI
7	Implement Sieve of Eratosthenes with different data decomposition options using Parallel MPI programming

8	Implement Floyd's version of All-Pair Shortest-Paths Problem through all steps of parallel algorithm design namely partitioning, communication, agglomeration and mapping using Parallel MPI programming.
9	Implement Matrix-Vector Multiplication using various Data Decomposition Options using Parallel MPI programming and then analyze the algorithm.
10	Implement Matrix Multiplication algorithm through i) Sequential Algorithm, ii) Parallel Algorithm - a) Rowwise Block-Striped Decomposition and b) Cannon's Algorithm using Parallel MPI programming and then analyze the algorithm.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Parallel Computing	Second Edition	Ananth Grama	Addison Wesley,	2003
2	Parallel programming in C with MPI and Open MP	First Edition	Michael J Quinn	McGraw Hil	2003

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Advanced Computer Architecture: Parallelism, Scalability, Programmability	Second Edition	Kai Hwang, Naresh Jotwani	McGraw Hill	2008
2	Introduction to High Performance Computing for Scientists and Engineers	First Edition	Georg Hager, Gerhard Wellein	CRC Press	2010



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Quantum Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Quantum Computing	2	0	2	5	10	2	0	1	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
CE443		Theory		13		14		40		67
		Laboratory		26		--		07		33

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): <i>At the End of the course, students will be able to</i>	
CE443.1	Understand the computation with Qubits
CE443.2	Explore the Quantum gates and Quantum Circuits
CE443.3	Apply Quantum algorithms and compare effectiveness versus classical algorithms.
CE443.4	Analyze the effectiveness of simple error correction codes and quantum cryptography

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE443.1	3	3	2	2	3	2						
CE443.2	3	3	3	2	3	2						
CE443.3	3	3	3	2	3	2						
CE443.4	3	3	3	2	3	2						

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE443.1							
CE443.2							
CE443.3							
CE443.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyse	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Quantum Computing	T1, T2	05
	1.1	History and Evolution of Quantum Computing. Classical vs. Quantum Computing,		
	1.2	Basic Principles of Quantum Mechanics: Superposition, Entanglement, Quantum Interference, Quantum Bits (Qubits) and Quantum States.		
2	Title	A Quantum Model of Computation	T2	05
	2.1	The Quantum Circuit Model, Quantum Gates: 1-Qubit Gates, Controlled-U Gates, Universal Sets of Quantum Gates		
	2.2	Efficiency of Approximating Unitary Transformations		
	2.3	Implementing Measurements with Quantum Circuits, Construction of the Bell's four states		
3	Title	Quantum Algorithms	T1, T2	07
	3.1	Classical computations on a quantum computer, Quantum parallelism, Deutsch's algorithm, Simon's Algorithm, the Deutsch–Jozsa algorithm.		
	3.2	Grover's Search Algorithm, Shor's Algorithm for Prime Factorisation		
4	Title	Quantum error-correction	T1	05
	4.1	Classical Error Correction, The Classical Three-Bit Code,		
	4.2	Quantum Error Correction, Three- and Nine-Qubit Quantum Codes, Quantum Teleportation.		
5	Title	Quantum cryptography	R1, T1	06
	5.1	Private key cryptography, Privacy amplification and information reconciliation,		

	5.2	Quantum key distribution, Privacy and coherent information. Post-Quantum Cryptography.		
6	Self Study	Applications of Quantum Computing: AI and Machine Learning with Quantum Computing, Quantum Machine Learning (QML) Basics, Real-world Use Cases of Quantum Computing		*5
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Creating Superposition with a Hadamard Gate
2	Flipping a Qubit with a Pauli-X Gate (Quantum NOT Gate)
3	Entangling Qubits Using CNOT Gate
4	Running a Simple Quantum Circuit on IBMQ
5	Measuring Quantum Interference Using Hadamard Gates
6	Implementing the Deutsch Algorithm
7	Implementing Grover's Search Algorithm
8	Implementing Shor's Algorithm for Factoring a Number
9	Quantum Error Correction using Three-Qubit Code
10	Running a Quantum Circuit on IBM Quantum Computer

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Quantum Computation and Quantum Information	10th edition	Nielsen, M. A., & Chuang, I. L.	Cambridge University Press	2010
2	An Introduction to Quantum Computing	First	Phillip Kaye, Raymond Laflamme	Oxford University press	2007

ference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	An Introduction to Quantum Computing Algorithms	First	Pittenger, A. O.	Springer	2000
2	Quantum Computing for Everyone	First	Chris Bernhardt	The MIT Press, Cambridge	2020

3	Quantum Computing Explained	First	David McMahon	Wiley-Interscienc, IEEE Computer Society	2008
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ONLINE RESOURCES

1. MIT OpenCourseWare: Quantum Computation
2. Qiskit Textbook: Quantum Circuits
3. IBM Quantum Experience: [Qiskit Tutorials](#)
4. Google Cirq: Cirq Documentation
5. Quantum Machine Learning: [QML Paper by Google](#)
6. Google Quantum AI: [Quantum Supremacy Paper](#)
7. <https://www.ibm.com/quantum/qiskit>
8. <https://quantumcomputinguk.org/tutorials/introduction-to-bell-states>



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Edge Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Edge Computing	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE444		Component		ISE		MSE		ESE	Total	
		Theory		13		14		40	67	
		Laboratory		26		--		07	33	

Pre-requisite Course Codes, if any.	Network Fundamentals, distributed computing
Course Objective: This subject equips students with the core concepts, technological insights, and analytical capabilities of edge computing in the organisational decision-making journey. Students will explore how edge computing enables organisations to garner, process, and utilise embedded intelligence in generating corporate value	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE 444.1	Describe edge computing concepts and technologies, including infrastructure components, models, services, and their applications.
CE 444.2	Analyse an edge ecosystem demonstrating knowledge of edge-computing architectures and their constituents.
CE 444.3	Conceptualise and model a basic edge-based solution incorporating microservices and security.
CE 444.4	Develop a project AI-driven automation system on an edge device.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE444.1	2	2	2	2	2	-	-	-	-	-	-	-
CE444.2	2	-	2	-	2	-	-	-	-	-	-	-
CE444.3	2	-	2	-	-	-	-	-	-	-	-	-
CE444.4	2	2	2	2	-	-	-	-	-	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE444.1	2	-	-	-	2	-	-
CE444.2	2	-	-	-	2	-	-
CE444.3	2	-	-	-	2	-	-
CE444.4	2	-	-	-	2	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Edge Computing		
	1.1	Introduction to Distributed systems, Design Goals, Models, Middleware, Concepts of distributed systems in edge computing such as time ordering and clock synchronization, distributed snapshot etc. Introduction to Cloud and its limitations to support low latency and RTT. From Cloud to Edge computing: Waves of innovation, Edge computing vs cloud computing vs fog computing, Edge as a service, Cloud as a service,	R1	5
2	Title	Architectures and Applications		
	2.1	Virtualization: Type I and Type II, IOT devices, JIO distributed system, Content Delivery Network Technologies, Edge Computing to support User Applications (5G-Slicing, self-driving cars and more)..	T1	4
3	Title	Edge Data Center		
	3.1	Introduction to Edge Data Center, Lightweight Edge Clouds and its services provided by different service providers. Docker and Kubernetes in edge computing. Design of edge storage systems	R1	5
4	Title	Privacy and Data Security in Edge Computing		
	4.1	Data confidentiality, security and privacy, Identity management in edge computing, Security practice in edge computing, Security and privacy issues in blockchain-enabled fog and edge computing, Differential privacy for edge computing operating over blockchain	R1	5
5	Title	Microservices in Edge Computing		
	5.1	Service centric model, Multiple administrative domains, Deployment of services and applications in an edge environment, Monolithic vs Microservices architecture, Advantage Disadvantages of Microservices	T2	5
6	Title	AI in Edge Computing		
	6.1	Edge AI, Microservices enabled AI, Container based microservices in edge computing, security aspects of Ai-enabled microservices in edge computing	T2, R2	4
7	Self Study	Future Trends and Challenges of Edge Computing: Blockchain-enabled edge supported Internet of Vehicles (IoV), Automation and robotics, Computer vision, Supply chain and Edge Computing	4	
		Total		28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Edge computing in IoT gateways.(Using simulation tool like TinkerCAD).
2	Create Type I /TypeII VM to deploy modules.
3	Deploy application using docker/kubernetes.
4	Use the iFogSim simulator tool to study resource management.

5	Set up an edge computing environment and analyze its performance compared to cloud computing.
6	Implement analysis of health data on edge devices.
7	Set up a Multi broker Kafka cluster.
8,9,10	Develop a project to create an AI-driven automation system on an edge device. Step 1: Identifying the Problem & Defining Goals based on Feasibility, Impact, Data Availability Step 2: Data Collection & Preparation Data Sources and perform Data Cleaning Step 3: Selection of Tools & Platforms based on Scalability, Cost-Effectiveness, Software Compatibility Step 4: Training the Model based on Problem Complexity, Data Volume, Team Expertise Step 5: Evaluating the AI System

Text Books :

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fog Computing: Theory and Practice		Assad Abbas, Samee U. Khan, Albert Y. Zomaya		
2	IoT and Edge Computing for Architects	Second Edition	Perry Lea	Packt Publishing	2020
3	Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge		David Jensen	Microsoft Azure	

Reference Books:

Sr. No	Title	Edition	Authors	Publisher / Conference	Year
1	Fog and Edge Computing: Principles and Paradigms	-	Rajkumar Buyya, Satish Narayana Srirama	Wiley Series on Parallel and Distributed Computing	-
2	Fog Computing and Its Role in the Internet of Things	-	Flavio Bonomi, Rodolfo Milito, Jiang Zhu, Sateesh Addepalli	MCC'12, ACM 978-1-4503-1519-7/12/08... \$15.00	2012
3	A Survey of Fog Computing: Concepts, Applications and Issues	-	Shanhe Yi, Cheng Li, Qun Li	Mobidata'15, ACM:978-1-4503-3524-9/15/06 DOI:10.1145/2757384.2757397	2015



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Generative AI Fundamentals

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Generative AI Fundamentals	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
CE351		Theory	13%		14%		40%		67%	
	Laboratory	26%		--		7%		33%		

Pre-requisite Course Codes, if any.	
Course Objective: Master the fundamentals of Generative AI and LLMs	
Course Outcomes (CO): At the End of the course students will be able to	
CE351.1	Understand the basic principles of generative models like GANs, VAEs, and Transformers.
CE351.2	Explore and apply real-world use cases of generative AI, including art creation and text generation. Understand the role of key industry players like OpenAI, NVIDIA, and PERPLEXITY in AI development.
CE351.3	Execute hands-on projects using generative AI techniques for image, text, and audio generation. Contribute to AI research by converting projects into research papers with a focus on impactful writing.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE351.1	3		3									
CE351.2	3		3									
CE351.3	3		3									

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE351.1	3		3				
CE351.2	3		3				
CE351.3	3		3				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Machine Learning Recap	1,2,3	5
	1.1	Regression, classification and clustering models		
	1.2	Neural networks fundamentals		
	1.3	Difference between traditional ML and Generative AI		
2	Title	Generative AI Introduction	1,2,3	8
	2.1	Introduction to Generative AI: Basic principles of generative models and their applications		
	2.2	Overview of Generative Models: Introduction to GANs (Generative Adversarial Networks) and VAEs (Variational Autoencoders)		
	2.3	Transformers for Generation: The role of transformers in generative AI		
3	Title	Applications of Generative AI	1,2,3	5

	3.1	Real-World Use Cases: Generative AI in text generation, art creation, and synthetic data		
	3.2	Practical Session: Exploring generative AI tools for art or text generation		
4	Title	What are industries in Generative AI doing?	1, 2, 3	6
		Role of Open source and Closed source Generative AI models. Role of industries in advancing Generative AI: OpenAI, NVIDIA, Mistral, Perplexity.		
5	Title	Ethical Considerations in Generative AI	1, 2, 3	4
	5.1	Bias in Generative Models: Understanding how biases manifest in generative AI systems		
	5.2	Ethical Considerations: The ethical implications of generative AI, including misuse, deepfakes, and copyright issues		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Regression, Classification, and Clustering Model Implementation
2	Neural Networks Fundamentals Implementation
3	Comparing Traditional ML and Generative AI
4	Building a Basic Generative Model (GAN or VAE)
5	Exploring GANs for Synthetic Data Generation
6	Exploring VAEs for Data Generation
7	Transformer-based Text Generation
8	Hands-on with Generative AI Tools for Art or Text
9	Evaluating Open-Source vs. Closed-Source Generative AI Models
10	Identifying and Mitigating Bias in Generative AI

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Generative Deep Learning	2	David Foster	O'Reilly	2023

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hands-On Machine Learning with Scikit-Learn and TensorFlow	1st	Aurelien Geron	O'Reilly	2017
2	Transformer Models for NLP: Building AI Applications with Hugging Face	1st	Denis Rothman	Packt	2021



Build your own GPT from Scratch

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Foundations of Large Language Models	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE352		Component		ISE		MSE		ESE	Total	
		Theory		13%		14%		40%	67%	
		Laboratory		26%		--		7%	33%	

Pre-requisite Course Codes, if any.	
Course Objective: Understand how GPT works and build your own GPT	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE352.1	Explore and implement tokenization and embedding techniques like Word2Vec, BERT embeddings, and Byte Pair Encoding (BPE).
CE352.2	Build and train a Transformer model from scratch without using TensorFlow or PyTorch. Execute and evaluate a large language model (LLM) using open-source datasets like WikiText and Common Crawl.
CE352.3	Students will learn how to build their own GPT!

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE352.1	3	3	3									
CE352.2	3	3	3									
CE352.3	3	3	3									

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE352.1	3		3				
CE352.2	3		3				
CE352.3	3		3				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction	1,2	8
	1.1	Introduction to Language Models: Overview of Language Models, History of NLP, Introduction to Pre-trained Models (ELMo, GPT, BERT)		
	1.2	Tokenization Techniques: Byte Pair Encoding (BPE), WordPiece, SentencePiece, Subword Units		
	1.3	Practical Session: Tokenization and Embedding Implementation in Python using Hugging Face library		
2	Title	Language Model Architectures	1,2	12
	2.1	Overview of Language Model Architectures: Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Transformers		
	2.2	Transformer Architecture: Multi-head Attention, Positional Encoding, Feed-Forward Networks, Layer Normalization		
	2.3	Attention Mechanism: Self-Attention, Cross-Attention, Scaled Dot-Product Attention		

3	Title	Training Large Language Models	1,2	8
	3.1	Data Collection: Sourcing Open-source Datasets, Dataset Preprocessing for Language Model Training		
	3.2	Training Techniques: Mini-batch Gradient Descent, Adam Optimizer, Learning Rate Schedulers		
	3.3	Overfitting and Generalization: Regularization Methods, Dropout, Early Stopping		
	3.4	Practical Session: Training a GPT Model from Scratch using Open-source Datasets (WikiText, Common Crawl)		
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

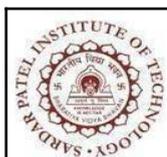
Sr. No	Title of the Experiment
1	Exploring Pre-trained Models (ELMo, GPT, BERT)
2	Implementing Various Tokenization Techniques (BPE, WordPiece, SentencePiece)
3	Embedding Implementation using the Hugging Face Library
4	Comparing RNN, LSTM, and Transformer Architectures
5	Implementing a Simple Transformer Module (Attention, Positional Encoding)
6	Experimenting with Attention Mechanisms (Self-Attention, Cross-Attention)
7	Data Preprocessing for Large Language Model Training
8	Training a Language Model with Different Optimizers and Learning Rate Schedulers
9	Applying Regularization Techniques to Prevent Overfitting in LLMs
10	Training a GPT Model from Scratch on Open-Source Datasets

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hands-On Large Language Models	1st	Jay Alammar	O'Reilly	2024

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building LLMs from Scratch	1st	Sebastian Raschka	Manning	2024



LLM Production and Deployment

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Large Language Models: Production and Deployment	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
CE453		Theory	13%		14%		40%		67%	
	Laboratory	26%		--		7%		33%		

Pre-requisite Course Codes, if any.	
Course Objective: Understanding how LLMs are actually deployed by companies and startups	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE453.1	Fine-tune LLMs for task-specific applications, optimizing for performance and reducing latency through techniques like model compression and quantization.
CE453.2	Apply Retrieval-Augmented Generation (RAG) to enhance LLMs using external knowledge bases, and understand its applications in various industries. Set up workflows for production, including environment setup, versioning, and scaling production systems.
CE453.3	Deploy LLMs in cloud and on-premise environments, exploring best practices and hardware considerations.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE453.1	3		3									
CE453.2	3		3									
CE453.3	3		3									

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE453.1	3		3				
CE453.2	3		3				
CE453.3	3		3				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Fine-Tuning LLMs	1	8
	1.1	Introduction to Fine-Tuning: Importance of fine-tuning LLMs, methods for task-specific optimization		
	1.2	Optimization for Faster Inference: Techniques for reducing latency, using model compression and quantization		
	1.3	Hyperparameter Tuning: Exploring various hyperparameters to improve LLM performance on specific tasks		
2	Title	Retrieval Augmented Generation (RAG) and Applications	1	5
	2.1	Introduction to RAG: How RAG integrates external knowledge bases with LLMs to enhance response accuracy		
	2.2	Real-World Applications of RAG: Enhancing responses in industries like healthcare, finance, and customer support		
	2.3	Practical Session: Implementing RAG in a healthcare or customer support scenario using publicly available knowledge bases		
3	Title	Making LLM applications production ready	1	10

	3.1	Production-Ready LLMs: Overview of transforming a trained model into a production-ready application, best practices for deployment		
	3.2	Workflow for Production: Setting up environments, handling model versioning, scaling up production systems		
4	Title	Deployment Techniques	1	5
	4.1	Cloud Deployment: Deploying LLMs in cloud environments (AWS, GCP, Azure), scaling models in the cloud		
	4.2	Practical Session: Hands-on deployment in both cloud and on-premise environments		
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Setting Up a Fine-Tuning Pipeline for LLMs
2	Implementing Model Compression and Quantization Techniques
3	Hyperparameter Tuning for Task-Specific LLM Performance
4	Integrating External Knowledge Bases for RAG
5	Implementing RAG in a Healthcare Context
6	Implementing RAG for Customer Support Applications
7	Preparing an LLM for Production-Ready Deployment
8	Model Versioning and Continuous Integration/Delivery of LLMs
9	Scaling and Deploying LLMs in the Cloud (AWS/GCP/Azure)
10	On-Premise LLM Deployment and Monitoring

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building LLMs for production	1st	Louis-Francois Bouchard, Louie Peters	O'Reilly	2024

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building LLMs for production	1st	Louis-Francois Bouchard, Louie Peters	O'Reilly	2024



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LLM Capstone Project

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(PE)	Capstone Project in Artificial Intelligence	2	0	2	4	8	2	0	1	3
		Examination Scheme								
CE454		Component		ISE		MSE		ESE	Total	
		Theory		13%		14%		40%	67%	
		Laboratory		26%		--		7%	33%	

Pre-requisite Course Codes, if any.	
Course Objective: Developing a high quality LLM project and converting it into a publication	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
CE454.1	Plan, design, and execute a comprehensive capstone project by defining objectives, sourcing data, and architecting an LLM pipeline.
CE454.2	Select, train, and implement the appropriate LLM architecture for real-world use cases, from model training to deployment. Test and optimize the LLM for scalability, accuracy, and performance using industry-standard techniques like pruning and quantization.
CE454.3	Prepare a detailed project report and submit to a journal for publication.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CE454.1	3	3	3									
CE454.2	3	3	3									
CE454.3	3	3	3									

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
CE454.1	3	3	3				
CE454.2	3	3	3				
CE454.3	3	3	3				

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	LLM Capstone Project Introduction	1, 2	5
	1.1	Project Planning: Defining objectives, timelines, and deliverables based on industry needs		
	1.2	Data Collection: Sourcing and preprocessing data for the project, ensuring data quality		
	1.3	Project Design: Architecting the LLM pipeline, selecting the model, and defining the workflow		
2	Title	Model Implementation	1, 2	12
	2.1	Model Selection: Choosing the appropriate LLM architecture (e.g., GPT, BERT) for the project		
	2.2	Model Training: Implementing the entire LLM training pipeline using open-source datasets		
	2.3	Deployment Setup: Setting up the environment for deploying the LLM in production		
3	Title	Testing and Optimization	1, 2	5
	3.1	Testing LLMs: Creating test cases and evaluating model performance on different datasets		
	3.2	Practical Session: Testing and optimizing the LLM for real-world scalability and performance		
4	Title	Project to Publication	1, 2	6

	4.1	Report Writing: Structure and components of a comprehensive project report (abstract, methodology, results, discussion)		
	4.2	Presentation of Results: Visualizing key findings, creating slides for presenting the project		
	4.3	Practical Session: Submit paper to an appropriate journal or conference		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Defining Project Objectives and Timelines
2	Data Sourcing and Preprocessing for LLMs
3	Architecting the LLM Pipeline and Workflow
4	Selecting the Appropriate LLM Model Architecture
5	Implementing the LLM Training Pipeline
6	Setting Up a Production Deployment Environment
7	Developing Test Cases and Evaluating LLM Performance
8	Optimizing LLM Scalability and Performance
9	Structuring and Writing the Project Report
10	Presenting Findings and Submitting the Final Paper

Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building LLMs for production	1st	Louis-Francois Bouchard, Louie Peters	O'Reilly	2024

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Building LLMs from Scratch	1st	Sebastian Raschka	Manning	2024

LIST OF MULTIDISCIPLINARY MINORS [MDM]

MDM SEQUELS FOR ELECTRONICS & TELECOMMUNICATIONS ENGG. [EXTC]

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Computer Engineering	M051: Database Management Systems	M052: Data Structures and Algorithms	M053: Cloud Computing	M054: Internet and Web Technology
Artificial Intelligence and Machine Learning	M061: Fundamentals of NNFL (NN, Fuzzy)	M062: Machine Learning	M063: Deep Learning	M064: Generative AI and application
Data Science	M071: Fundamentals of Data Science	M072: Data Analytics and Visualization	M073: Decision Making and Business Intelligence	M074: Social Media Analytics
Interface and Experience Design	M081: UI/UX Fundamentals	M082: Fundamentals of Experience Design	M083: Human Machine Interaction	M0844: Prototyping and Interaction Design [Capstone project]

SYLLABUS

MDM Sequels for EXTC

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)
Computer Engineering	M051: Database Management Systems
Artificial Intelligence and Machine Learning	M061: Fundamentals of NNFL (NN, Fuzzy)
Data Science	M071: Fundamentals of Data Science
Interface and Experience Design	M081: UI/UX Fundamentals



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Database Management Systems

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M051 MDM-05	Database Management Systems	2	0	2	4	08	3	0	0	3
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
Laboratory		-		--		-		-		

Pre-requisite Course Codes, if any.		
Course Objective:		
Learning Outcomes (LO): At the End of the course students will be able to		
M051.1	Demonstrate understanding of given system to construct a database model	
M051.2	Apply various Relational and SQL commands on the populated database	
M051.3	Examine the functional dependencies to make a normalized database system and transaction processing techniques on a database	
M051.4	Illustrate query processing and optimization method on a database	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Database Concepts and ER Modeling	1,2	05
	1.1	Introduction to basic concept of Database, File system V/s Database system, Users of Database system, Database Administrator, Data Independence		
	1.2	The Entity-Relationship (ER) Model, Extended Entity-Relationship (EER) Model, Database integrity		
2	Title	Relational Algebra And SQL	1,2	07
	2.1	Relational model, Relational query languages, Relational algebra, Tuple and domain calculus		
	2.2	Structured Query Language: Data Definition Commands, Data Manipulation commands, Data Control commands, Join expressions, views, Triggers		
3	Title	Normalization And Transaction Processing	1,2	05
	3.1	Design guidelines for relational schema, Functional dependencies		
	3.2	Normal Forms- 1NF, 2NF, 3NF, BCNF		
4	Title	Transaction Processing	1,2	06
		Transactions, ACID properties, Concurrency Control, Recovery		

		Serializability, Recoverability, Lock-based, Timestamp-based, Validation-based protocols.		
5	Title	Indexing And Query Optimization:	1,2	05
	4.1	Row-wise and column database, database buffering. Indexing, B+-tree indices		
	4.2	Query Processing, Query Optimization		
6	Self Study	NO SQL-Data type, Database creation, Basic command for creation, updating and querying the database, Mongo dB, Applications of Hyper Graph DB, cloud database		
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Formulate a case study and create an E-R Diagram. Mapping of E-R model to Relational Model.
2	To create a database and populate using SQL commands (With constraints) • Data Definition Language- Create, Alter, Drop, Rename, Truncate • Data Manipulation Language- Insert, Update, Delete, Select Constraints-Not Null, Unique Key, Primary Key, Foreign Key, Check, Dropping a Constraint
3	To perform DCL, TCL commands • Data Control Language: Grant, Revoke, Roles • Transaction Control Language: Commit, Rollback, Save point
4	To perform Date, Time, Arithmetic and Set operation on database.
5	To perform Aggregate function and Group by- Having clause on database
6	To perform Join operations on database. • Equijoins, Non-Equijoins, Self Joins, Outer Join, cross Join
7	To retrieve data using a Subquery.
8	To Create a different view of the database.
9	To examine the integrity of the database using Triggers.
10	To study distributed databases/Normalization

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Database System Concepts	7 th	Korth, Silberchatz, Sudarshan	McGraw – Hill	2019
2	Fundamentals of Database Systems	6 th	Elmasri and Navathe	PEARSON Education	2011

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Database Management Systems	3 rd	Raghu Ramkrishnan and Johannes Gehrke	TMH	2003
2	Database Management Systems	1 st	G. K. Gupta	McGraw – Hill.	2018



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Fundamentals of NNFL

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M061	Fundamentals of NNFL	2	0	2	4	8	2	0	1	3
		Examination Scheme								
MDM-06	Fundamentals of NNFL	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		--		7		33

Pre-requisite Course Basic understanding of mathematics, probability, and programming.

Course Objective: This course focuses on the fundamentals of Neural networks and Fuzzy Logic along with its application. Students will be able to design an expert system using neural networks and Fuzzy logic system for implementation of real-world applications.

Course Outcomes (CO): *At the End of the course students will be able to*

M061.1	Identify the various characteristics of Neural Network techniques in building intelligent machines
M061.2	Apply the supervised and unsupervised Neural Network Learning algorithm to solve real world engineering problems.
M061.3	Design Fuzzy Logic Controller System

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO12	PSO1
M061.1	2	2	--	2	--	--	--
M061.2	2	2	--	2	3	2	1
M061.3	2	2	2	2	3	2	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	<u>Apply</u>	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Neural Networks	T1, T2 T3, R1	12
	1.1	Basics of Neural Networks: Introduction to Neural Networks, Biological Neural Networks, Models of ANN with its terminologies, Activation functions and its types		
	1.2	McCulloch-Pitts Model, Linear separability, Hebb Network		
	1.3	Supervised Learning algorithms: Perceptron (Single-Layer perceptron: Learning Rule and Applications), Multi-Layer Perceptrons (MLPs), Backpropagation Algorithm: Training MLPs Activation Functions Vanishing Gradient Problem and Solutions		
	1.4	Un-Supervised Learning algorithms: Hebbian Learning, Winner takes all, Self-Organizing Maps KSOFMN, Learning Vector Quantization.		
2	Title	Fuzzy Logic, Classical Set and Fuzzy Relations	T2, T3,T4, R1, R3	10
	2.1	Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Functions, Classical and Fuzzy set operations, and properties of classical and Fuzzy sets. Fuzzy Logic Operators: AND, OR, NOT		
	2.2	Classical and Fuzzy Relations: Cartesian product of relation, Fuzzy Max-Min and Max-Product Composition, Fuzzy extension principle		
3	Title	Fuzzy control system design	T2, T3 T4	6
	3.1	Fuzzy Inference System and its types, Fuzzification ,Defuzzification, Designing Fuzzy logic control systems.		
	3.2	Mamdani and Sugeno Fuzzy Inference Systems		
4	Self Study	Associative Memory Network, Architecture of Neuro-Fuzzy Networks(ANFIS and CANFIS), Performance Metrics for Neural Networks and Fuzzy Logic Systems, Model Evaluation Techniques: Cross-Validation, ROC Analysis, Optimization Techniques: Genetic Algorithms, Particle Swarm Optimization	-	5
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To implement Transfer/Activation Functions for a given problem statement.
2	To design ANN to implement logic gates.
3	To implement Hebb Network for a given problem statement.

4	To design and implement ANN (perceptron) for a given problem statement using Joone Editor
5	Write a program using Single Layer perceptron
6	To implement the Supervised Learning algorithm.
7	To implement the Unsupervised Learning algorithm
8	To implement Fuzzy Sets for a given problem statement
9	To implement Fuzzy Relations for a given problem statement
10	To design and implement Fuzzy Logic controller for a given problem statement

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
T1	Introduction to Artificial Neural Systems	1st	Jacek M. Zurada	Jaico Publisher	1994
T2	Principles of Soft Computing	3rd	Sivanandan and Deepa	Pearson Edition	2019
T3	Fuzzy logic with engineering applications	3rd	Ross, Timothy J	John Wiley & Sons	2011
T4	Neural Networks, Fuzzy Logic and Genetic Algorithms	Kindle	S.Rajasekaran and G.A.Vijayalakshmi Pai	PHI Learning	2013

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
R1	Neural Network Design	2nd	Hagan, Demuth, Beale	CENGAGE Learning	2014
R2	Neuro-Fuzzy and Soft Computing	1st	J.-S.R.Jang .	Pearson	1996
R3	Introduction to Soft Computing	1st	Sameer Roy	Pearson	2013



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Fundamentals of Data Science

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-I	Fundamentals of Data Science	2	0	2	5	10	2	0	1	3
		Examination Scheme								
M071	Fundamentals of Data Science	Component		ISE		MSE		ESE		Total
		Theory		13		14		40		67
		Laboratory		26		---		07		33

Pre-requisite Course Codes, if any.	–
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Course Objective: To provide students with a comprehensive understanding of the fundamental concepts, tools, and techniques used in data science and data visualization. This course is designed to introduce students to the basic principles of data science and data visualization, including libraries used for Data Science, data exploration, data preprocessing, EDA, data visualization and basic model building.

Learning Outcomes (LO): *At the End of the course students will be able to*

M071.1	Demonstrate the need of libraries used in Data Science.
M071.2	Make use of different tools and techniques for Data Visualization
M071.3	Analyze the data performance using the EDA process.
M071.4	Develop Linear Regression and Logistic Regression Models for a given case study.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M071.1	-	2	-	2	3	-	-	-	-	-	-	-
M071.2												
M071.3	2	2	2	2	3	-	-	-	-	-	-	-
M071.4	-	2	2	-	3	-	-	-	1	1	-	-

LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M071.1							
M071.2							
M071.3							
M071.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Python for Data Science		06
	1.1	Introduction to Data Science and its roles in Modern Society, Descriptive Statistics		
	1.2	Working with Numpy Basics of Numpy, Creating NumPy Arrays, Mathematical Operations on NumPy Arrays	1,2,3	
	1.3	Working with Pandas Basics of Pandas, Data Frames, Indexing and Slicing, Operations on Data Frames, GroupBy and Aggregate Functions, Merging Data Frames, Pivot Tables	1,2,3	
2	Title	Data Visualization		06
	2.1	Data Visualization using Matplotlib Bar Graphs, Scatter Plots, Line Graphs, Histogram, Box Plots, Sub Plots	1,3,7	
	2.2	Data Visualization using Seaborn Distribution Plots, Pie Charts, Bar Charts, Scatter Plots, Box Plots, Pair Plots, Heat Maps, Line Charts	1,3,8	
4	Title	Data Preprocessing and Exploratory Data Analysis		06
	4.1	Data Sourcing Public Data and Private Data, Web Scraping	5,6	
	4.2	Data Cleaning Fixing the rows and columns, Overfitting and Underfitting, Impute/Remove missing values, Feature Engineering Techniques, Feature Reduction Techniques, Handling Outliers, Standardizing values	5,6	
	4.3	Univariate Analysis Categorical Ordered and Unordered Univariate Analysis	5,6	
	4.4	Bivariate and Multivariate Analysis Numerical-Numerical Analysis, Numerical-Categorical Analysis, Categorical-Categorical Analysis	5,6	
5	Title	Regression		10
	5.1	Linear Regression Simple Linear Regression, Multiple Linear Regression	5,6	
	5.2	Logistic Regression Univariate Logistic Regression, Multivariate Logistic Regression Model Building and Evaluation	5,6	
6	Self Study	Plotly, Different Visualization visualization techniques other than Python and Tableau.	1,2,5	
			Total	28

Laboratory Component:

Sr. No	Title of the Experiment
1	Working with Python Basics
2	Working with Python Data Structures
3	Working with Python Numpy Library
4	Working with Python Pandas Library
5	Working with Python Matplotlib Library
6	Working with Python Seaborn Library
7	Exploratory Data Analysis on the given Case Study
8	Develop a Linear Regression Model on the given Case Study
9	Develop a Logistic Regression Model on the given Case Study
10	Mini Project based on a case study.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Python for Data Science Handbook: Essentials Tools for Working with Data	Second	Jake VanderPlas	O'Reilly	2022
2	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter	Third	Wes McKinney	O'Reilly	2022
3	Python Data Visualization Essentials Guide	First	Kalilur Rahman	BPB	2021
4	Data Visualization Through TABLEAU	First	George Peck	McGraw Hill	2020
5	Hands-On Exploratory Data Analysis with Python	First	Suresh Kumar Mukhiya, Usman Ahmed	Packt	2020
6	Python Data Science Essentials	Third	Alberto Boschetti, Luca Massaron	Packt	2018

Web References:

- 7) <https://matplotlib.org/>
- 8) <https://seaborn.pydata.org/>



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UI/UX Fundamentals

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM I	UI/UX Fundamentals	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE			MSE		ESE		Total
M081		Theory	13			14		40		67
	Laboratory	26			--		07		33	

Pre-requisite Course Codes, if any.	AI305
Course Objective: The aim of the UI/UX course is to provide students with the knowledge of user-centered design, user-centered methods in design, graphic design on screens, simulation and prototyping techniques, usability testing methods, interface technologies and user centered design in corporate perspective. The course is organized around a practical project with iterative design of a graphical user interface to organize information about users into useful summaries with affinity diagrams, to convey user research findings with personas and scenarios and to learn the skill of sketching as a process for user experience design. The students will be given exposure to wireframing and Prototyping software in the various UI/UX Design tools.	
Learning Outcomes (LO): <i>At the End of the course students will be able to</i>	
M081.1	Understand iterative user-centered design of graphical user interfaces
M081.2	Apply the user Interfaces to different devices and requirements
M081.3	Design prototype for the given design problems.

LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation) CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M081.1	2	-	--	2	--	--	--	--	--	--	--	--
M081.2	-	-	2	-	2	--	--	--	--	--	--	--
M081.3	-	-	-	-	2	--	--	--	-	-	--	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to UI and UX	T1-T4	06
	1.1	What is User Interface Design (UI) -The Relationship Between UI and UX , Roles in UI/UX, Menus, Tabs, Bottom tab bar, Buttons (including “Call to action” or CTA) ,Accordion ,Carousel ,Breadcrumbs, Modals Forms ,etc		
	1.2	A Brief Historical Overview of Interface Design, Interface Conventions, Designer vs. developer, Skills to be a top designer.		
2	Title	User Interface Design Elements	T2,T4	06
	2.1	Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design, Spacing and the grid.		
3	Title	Colors, Typography & Fonts	T1-T4	05
	3.1	Display Text (Such as Headings) versus Body Text , Legibility , Type Trends, Typeface Selection & Pairing, Where to Get Web Fonts, Ideal Line Height, Column Width (Line Length), Hyphenation & Justification		
	3.2	Color Harmonies, Creating Contrast with Color, Guidelines for Proper Color Usage		
4	Title	Design Guidelines and Process	T1-T4	06
	4.1	UX Basics- Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience , Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design		
5	Title	Design Tools	T2,T4	03
	5.1	Adobe Photoshop, Illustrator, Figma, AdobeXD, Pencil Project tool.		
	Self Study	Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.		02
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Case Study to understand and know about UI elements for Zomato, Swiggy app.
2	To create logo for restaurant based on given scenario using Adobe XD.
3	To create basic app for creating your own profile using Adobe XD.
4	To create different icons for giving ratings using Pencil tool. Use your own creativity.
5	To customize typography for logo for fitness app in UI design using Pencil tool. Use your own creativity.
6	To evaluate Good and Bad Design of UI elements for IRCTC website
7	To customize typography for logo for selling variations of plants, pots and fertilizers in UI

	design using Illustrator tool.
8	To create GUI for creating feedback form for taking feedback from students and teachers by using only icons which are familiar to users and choose colors based on the scenario and describe the reason for such selection for the same.
9	To create simple Web UI for newly developed Pencil company (like apsara, doms etc.) using different kinds of Menus in an application using Figma tool.
10	To create simple flower selling application in Mobile app layout, laptop screen layout and Desktop layout and compare using Figma tool.

References:

Sr. No	Title	Edition	Authors	Publisher	Year
1	A Project Guide to UX Design: For user experience designers in the field or in the making	2nd Edition	Russ Unger, Carolyn Chandler	New Riders Publishing	2012
2	The Elements of User Experience: User-Centered Design for the Web and Beyond	2nd Edition	Jesse James Garrett	Pearson Education	2011
3	The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques	3rd Edition	Wilbert O. Galitz	Wiley Publishing	2007
4	The UX Book: Process and Guidelines for Ensuring a Quality User Experience		Rex Hartson, Pardha S. Pyla	Elsevier	2012

Course Category of Multidisciplinary Minor	MDM-II (Semester V)
Computer Engineering	M052: Data Structures and Algorithms
Artificial Intelligence and Machine Learning	M062: Machine Learning
Data Science	M072: Data Analytics and Visualization
Interface and Experience Design	M082: Fundamentals of Experience Design



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Data Structures and Algorithms

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M052	Data Structures and Algorithms	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component		ISE		MSE		ESE		Total
MDM-05	Data Structures and Algorithms	Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	Problem-solving using imperative programming
Course Objective: To introduce the fundamentals and abstract concepts of Data Structures for Problem Solving.	
Course Outcomes (CO): At the End of the course students will be able to	
M052.1	Apply various operations of linear and non-linear data structures to given problems.
M052.2	Apply the concepts of Trees and Graphs to a given problem.
M052.3	Analyze the algorithm for given Problem statement
M052.4	Apply the Divide and Conquer, Greedy method, Dynamic Programming strategy to solve given problems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M052.1	1	2	2					2				2
M052.2	1	2	2					2				2
M052.3	1	2	2					2				2
M052.4	1	2	2					2				2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
	EXTC	ETRX	EXTC	ETRX	EXTC	ETRX	EXTC
M052.1	1	1			1	1	
M052.2	1	1			1	1	
M052.3	1	1			1	1	
M052.4	1	1			1	1	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Data Structures		7
	1.1	Concept of Linear and Non-linear Data Structures, Stack: Stack as ADT, operations on the stack, Queue: Queue as ADT, Operations on Queue,	1,2	4
	1.2	Linked List: Linked List as ADT, Operations on Singly Linked List. Types of the linked list- Linear and circular linked lists, Doubly Linked List	1,2	3
2	Title	Trees (use of visualization tools (e.g., Graphviz, VisuAlgo) for better comprehension of tree and graph representations is encouraged)		3
	2.1	Trees as ADT, General tree v/s Binary Tree Terminology, Traversal of Binary Tree, Operations on Binary tree, Binary Search Tree and its operations.	1,2	3
3	Title	Graphs		3
	3.1	Graph as ADT, Introduction To Graph, Representation of Graph-Adjacency Matrix, Adjacency List, Graph Traversal Technique	1,2	3
4	Title	Hashing		4
	4.1	Introduction to Hash Table, Hash functions, Collision Resolution Technique.	1,2	4
5		Introduction to Analysis of algorithm		8
	5.1	Role of Algorithms in Computing, Performance analysis-space and time complexity, Growth of Functions: Asymptotic Notation, Analysis of sorting algorithms such as Selection sort and insertion sort, Master Method	1,2	4
	5.2	Divide and Conquer Approach – General Method, Merge Sort and its Analysis, Quick sort and its Analysis, Binary search algorithm and its analysis	1,2	4
6		Greedy and Dynamic Programming Approach		9
	6.1	Greedy Approach: Basic strategy, Knapsack problem, single-source shortest path-Dijkstra's algorithm. Minimum cost spanning trees-Kruskal algorithm	1,2	4
	6.2	Dynamic Programming: 0/1 knapsack problem, Assembly-line scheduling, Longest common subsequence	1,2	5
7		Backtracking and Branch-and-bound		8
	7.1	Backtracking – General method, 8-queen problem (N-queen problem), Sum of subsets, Graph coloring	1,2	4
	7.2	Branch-and-bound – General method, Travelling Salesman problem, 15 puzzle problem	1,2	4
8	Self Study	AVL Tree, Optimal Binary Search Tree, Approximation and NP-Completeness		5

Total	42
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Laboratory Component, if any (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implement a given problem statement using Stack.
2	Implement a given problem statement using Queue
3	Implement a given problem statement using Linked List.
4	Implement a given problem statement using Binary Trees.
5	Apply Graph Traversal Technique on a given problem statement to solve the problem
6	Implement and analyze insertion sort selection sort
7	Implement and analyze problem based on Divide and Conquer strategy - Merge and Quick sort
8	Implement a given problem statement using Greedy Strategy.
9	Implement a given problem statement using Dynamic Programming.
10	Implement a given problem statement using Backtracking /Branch & bound

Text Books

Sr.No.	Title	Edition	Authors	Publisher	Year
1	Introduction to Algorithms	Third Edition	Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein	MIT Press	2009
2	Fundamentals of Computer Algorithms	Second Edition	Horowitz E, Sahni S and S.Rajasekaran	Galgotia Publications	2010

Reference Books

Sr.No.	Title	Edition	Authors	Publisher	Year
1	Classic Data Structures	Second	Samanta Debasis	PHI	2009
2	Data Structures With C	First	Seymour Lipschutz	Schaum's Outline Series	2010



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Machine Learning

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM	Machine Learning	3	-	2	4	9	3	-	1	4
		Examination Scheme								
M062		Component		ISE		MSE		ESE		Total
		Theory		15		15		45		75
		Laboratory		15		--		10		25

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamentals of Data Structures.	
Course Outcomes (CO): At the End of the course students will be able to	
M062.2	Understanding Machine Learning algorithms with their associated mathematical foundations for appreciating these algorithms.
M062.3	Develop and apply various supervised and unsupervised algorithms using the concept of Dimension reduction techniques
M062.4	Develop and apply reinforcement learning algorithms for learning to control complex systems
M062.2	Enable formulating real world problems to implement basic algorithms using machine learning libraries.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M062.2	2	-	-	-	-	-	-	-	-	-	-	-
M062.3	2	2	2	2	2	-	-	-	1	-	1	-
M062.4	2	2	2	2	2	-	-	-	1	-	1	-
M062.2	-	2	2	-	2	-	-	-	1	-	1	1

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
M062.2	1	-	-	2	-
M062.3	1	2	-	2	-
M062.4	1	-	-	2	-
M062.2	1	2	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Theory Component

Module No.	Topics	Ref.	Hrs.
1	Introduction To Machine Learning	1,2	9
	Need of machine learning, machine learning vs AI, machine learning vs Deep learning ,Learning types : Supervised Learning, Unsupervised learning, Reinforcement learning, What makes Machine Learning tick purpose or objectives, variety of algorithms- learning style, similarity style, Applications of machine learning, General Steps or Process of Machine Learning- SourceX -> Feature Extraction -> Feature Correlation -> Feature TransformX-> Train Model-> Ensemble-> Evaluate Capacity, Overfitting and Underfitting, Hyperparameters and Validation Sets. Estimators, Bias and Variance, likelihood, Stochastic Gradient Descent.		
2	Supervised Learning	1,2	11
	Hypothesis testing, Training versus Testing, Gradient Descent, Over fitting & Regularization ,Regression: Regression fundamentals, Linear Regression, Polynomial regression, Regularization technique (LASSO), Classification: Classification fundamentals, Logistic Regression, Decision trees,-CART,-Random Forest, Naïve Bayes , Support Vector Machine, Time Series, Neural Networks, Types of errors (TYPE I and TYPE II), Case Study(Classification)		
3	Unsupervised Learning	1,2	9
	Clustering basics: K-means clustering, K-Nearest Neighbor ,Association Rule Learning , Hierarchical		
4	Dimensionality Reduction	1,2	7
	Feature Engineering, Feature Selection methods, - Filters; Wrappers, Embedded, PCA, SVD, -tSNE, Case Study (Clustering/Anomaly/Fraud Detection)		
5	Reinforcement Learning	1,2	7
	Markov Decision, Monte Carlo Prediction, Case Study (next best offer, dynamic pricing)		
6	Self-Study Topics		
	Machine Learning Applications across Industries (Healthcare, Retail, Financial Services, Hospitality), Watson, Explore tools used in ML, TensorFlow, Keras, Scikit learn		
Total			42

Laboratory Component

Sr. No	Title of the Experiment
1	Introduction to Python/R Introduction Python/R, Python/R data types and objects, reading and writing data, Python/R Packages
2	Python/R flow control Control structures, scoping rules, dates and times, data manipulation in Python/R
3	Functions and Modules Loop functions, debugging tools, Mathematical Functions, Data Processing and handling
4	Apply Linear regression
5	Apply Logistic regression
6	Apply decision tree for given problems
7	Apply Random Forest for given problems
8	Apply Naïve Bayes for given problems
9	Apply K means clustering for given problem
10	Apply PCA for given problem

Note: Course coordinators can use their own problem statements to solve listed lab sessions.

Text Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Understanding Machine Learning: From Theory to Algorithms	1st Edition	Shai Shalev-Shwartz, Shai Ben-David	Cambridge University Press	2014
2	Foundations of Machine Learning	2nd Edition	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar	The MIT Press	2018

Reference Books:

Sr. No.	Title	Edition	Authors	Publisher	Year
1	An Introduction to Statistical Learning	7th Edition	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani	Springer	2007
2	Machine Learning Yearning	Draft v0.5	Andrew Ng	Deeplearning.ai	2018
3	Machine-learning-using-python	1st Edition	Dr. Dinesh Kumar	WileyIndia	2019

Web References:

[4]<https://www.altexsoft.com/blog/datascience/comparing-machine-learning-as-a-service-amazonmicrosoft-azure-google-cloud-ai-ibm-watson/>

[5] <https://cloud.google.com/products/ai>.



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Data Analytics and Visualization

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM	Data Analytics and Visualization	3	0	2	4	8	3	0	1	3
		Examination Scheme								
		Component	ISE			MSE		ESE		Total
M072		Theory	15			15		45		75
	Laboratory	15			--		10		25	

Pre-requisite Course Codes, if any.	MDCS31
Course Objective: This course aims to provide foundational knowledge and practical skills in data analytics and visualization. Students will learn to analyze, preprocess, and visualize data using tools like Python, SQL, and Power BI. Emphasis is placed on real-world applications, effective storytelling with data, and ethical considerations.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
M072.1	Illustrate the concepts of data analytics, types of data, and preprocessing techniques used in real-world applications.
M072.2	Apply data visualization principles and use libraries/tools like Matplotlib, Seaborn, Plotly, and Power BI to create effective visualizations.
M072.3	Analyze time series and geographic data using appropriate visualization and storytelling techniques.
M072.4	Design and implement a complete data analytics project, integrating machine learning, visualization, and ethical considerations.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M072.1												
M072.2												
M072.3												
M072.4												

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M072.1							
M072.2							
M072.3							
M072.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Data Analytics	1,2,4,5,6	8
	1.1	Overview of Data Analytics Definition and importance of data analytics Real-world applications (business, healthcare, finance, etc.) Data types and sources		
	1.2	Data Collection and Storage Structured vs. unstructured data Data collection techniques Databases and data warehouses		
	1.3	Data Cleaning and Preprocessing Handling missing values and duplicates Data transformation and normalization Exploratory Data Analysis (EDA) basics		
	1.4	Tools and Technologies in Data Analytics Introduction to Excel, SQL, Python, and R Overview of popular libraries (Pandas, NumPy, Matplotlib, Seaborn) Cloud computing and big data platforms		
2	Title	Data Visualization Principles	2,7	10
	2.1	Importance of Data Visualization Why visualization matters in data analysis Types of visualizations and their use cases		
	2.2	Chart Types and Best Practices Bar charts, line graphs, scatter plots, histograms Heatmaps, box plots, and pie charts Best practices for effective visualization		
	2.3	Data Visualization with Matplotlib and Seaborn Creating plots with Matplotlib Enhancing visualizations with Seaborn		

		Customizing charts (colors, labels, annotations)		
	2.4	Interactive Visualizations with Plotly and Power BI Introduction to Plotly for interactive charts Basics of Power BI dashboarding DAX functions		
3	Title	Advanced Data Visualization Techniques	3,7	12
	3.1	Storytelling with Data How to present data insights effectively Common mistakes to avoid		
	3.2	Time Series Analysis and Visualization Time series components (trend, seasonality) Visualizing time series data		
	3.3	Geographic Data Visualization Using maps for data visualization Tools like Folium and Power BI for geospatial analysis		
	3.4	Dashboard Design with Power BI/Tableau Creating interactive dashboards Connecting data sources and filters		
	3.5	Real-World Case Study: Building a Business Dashboard Hands-on project with Power BI or Tableau		
4	Title	Applied Data Analytics & Project	1,4,5,8	12
	4.1	Data Analytics in Different Industries Business, finance, healthcare, e-commerce use cases		
	4.2	Machine Learning for Data Analytics Introduction to classification and clustering Basic models (Logistic Regression, K-Means)		
	4.3	Ethics and Data Privacy Data security, GDPR, and ethical concerns		
	4.4	Final Project Working on a real dataset Presentation of insights and visualization		
5	Self Study	Data Ethics and Bias in Machine Learning, Data Pipeline concepts, Big Data Ecosystem, Google Data Studio		
			Total	28

Laboratory Component:

Sr. No	Title of the Experiment
1	Data Cleaning & Preprocessing
2	Data Exploration & Summary Statistics
3	SQL Data Analysis
4	Data Visualization with Matplotlib & Seaborn
5	Power BI/Tableau Dashboard Creation
6	Time Series Analysis & Forecasting
7	Sentiment Analysis on Text Data
8	Clustering with K-Means
9	A/B Testing for Business Decisions
10	End-to-End Data Analytics Project

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Data Science from Scratch: First Principles with Python	Second	Joel Grus	O'Reilly Media	2019
2	Python for Data Analysis	Third	Wes McKinney	O'Reilly Media	2022
3	Storytelling with Data: A Data Visualization Guide for Business Professionals	First	Cole Nussbaumer Knaflic	Wiley	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Data Analytics Made Accessible	Forth	Anil Maheshwari	Amazon/KDP	2021
2	Practical Statistics for Data Scientists	Second	Peter Bruce, Andrew Bruce, Peter Gedeck	O'Reilly Media	2020
3	Learning SQL	Third	Alan Beaulieu	O'Reilly Media	2020
4	Hands-On Data Visualization	First	Jack Dougherty and Ilya Ilyankou	O'Reilly Media	2021
5	Interactive Data Visualization for the Web	Second	Scott Murray	O'Reilly Media	2017



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Fundamentals of Experience Design

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM	Fundamentals of Experience Design	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE			MSE		ESE	Total	
M082		Theory	15			15		45	75	
	Laboratory	15			--		10	25		

Pre-requisite Course Codes		Software Engineering
At the End of the course students will be able to		
Course Outcomes	M082.1	Analyze UX design life cycle and its process for users.
	M082.2	Apply UX design process for the given scenario
	M082.3	Create real life application with end-to-end understanding of User experience practices.
	M082.4	Evaluate UX design process for best experience.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		UX Design and Life Cycle	1,2	6
	1.1	What is UX (User Experience), Ubiquitous interaction, A UX process lifecycle template, The system complexity space, Meet the user interface team		
2		The UX Design Process – Understand Users	1	12
	2.1	Contextual Inquiry: Introduction, the system concept statement, User work activity gathering, Abridged contextual inquiry process		
	2.2	Contextual analysis: Introduction, Creating and managing work activity notes, Constructing your WAAD (Work Activity Affinity Diagram)		
	2.3	Extracting Design Interaction requirements: Formal Requirements Extraction, Abridged method for requirement extraction		
	2.4	Design Informing Model: User Model (Social Model), Usage Model (Flow Model, Task Interaction Model), Work Environment Model.		
3		The UX Design Process-Design Thinking, Ideation and Sketching	1,3	12
	3.1	Design Paradigm, Design thinking, Design perspective, User personas, Ideation, Sketching		
	3.2	Mental Models and Conceptual Design		
	3.3	Storyboards, Wireframes		
4		The UX Design Process- Prototyping, Evaluation and Agile development	1,3,5	12
	4.1	Fidelity of Prototype, To make effective paper prototype,		

	4.2	UX Evaluation and Improve UX Goals, Metrics and Targets		
	4.3	UX Evaluation Techniques- Formative vs Summative		
	4.4	UX Method for Agile Development: Introduction, Basics of agile SE methods, drawbacks of agile SE methods from UX perspective.		
5		Self-Learning		
	5.1	Affordance, Integration of UX into agile SE methods		
			Total	42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	To Study of open source UX tools (Justinmind Prototype, Pidoco, Marvel Prototype) and create UX design for a given problem definition.
2	Design Mobile/Web UI for your own Travelling agent considering adding map and localization feature along with descriptions if required. (e.g. Make my Trip, Tripadvisor, Thrillophilia etc.)
3	Design a Map based UI (Web User) for Mumbai Dabbawalas with localization feature.
4	Pick a website/app that you use on a daily basis (eg. facebook, gmail, whatsapp, zomato, etc). Evaluate the product based on user experience principles and give suggestions for improvement. Explain usability testing process for the same.
5	Analyze and redesign the (IRCTC/IndianRail) website for better User Experience and create the heuristic report using Nielsen's Heuristic
6	Design UI for student to teach mathematics in rural areas/ to sell the products of farmers directly to consumers.
7	Design UI for student to sell the products of farmers directly to consumers.
8	Design UI/UX Mobile App along with making logo for the same for your own newly opened restaurant. (Consider all the UX Parameters while designing).
9	Design UI for any differently abled users.
10	Design UI for analysis of number of children suffering from juvenile diabetic children in India. The design aims at providing solutions for improving quality treatment and making the treatment affordable.

Note: All the experiments need to be tested for usability.

References:

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	The UX Book	1 st	Rex Hartson and Pardha Pyla	MK Publication	2012
2	A Project Guide to UX Design: For user experience designers in the field or in the making.	2 nd	Russ Unger and Carolyn Chandler	O'reilly, Series Editor	2012
3	UI Design:Key to captivate user understanding	1st	Jain, Kalbande,	SybGen Publications	2021

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
4	Smashing UX Design	1 st	Jesmond Allen and James Chudley	John Wiley & Sons	2012
5	Agile Experience Design	1 st	Brian Fling	, O'Reilly Media Inc.,	2009.

Course Category of Multidisciplinary Minor	MDM-III (Semester VI)
Computer Engineering	M053: Cloud Computing
Artificial Intelligence and Machine Learning	M063: Deep Learning
Data Science	M073: Decision Making and Business Intelligence
Interface and Experience Design	M083: Human Machine Interaction



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Cloud Computing

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M053	Cloud Computing	-	2	2	5	10	-	2	1	3
		Examination Scheme								
		Component		ISE			MSE		ESE	Total
		Tutorial		100			100		--	200
MDM-05		Laboratory		80			--		20	100

Pre-requisite Course Codes, if any.	Machine Learning
Course Objective: This course introduces Concepts of cloud computing. This course focuses on the architecture of cloud computing along with the application of the same.	
Course Outcomes (CO): At the End of the course students will be able to	
M053.1	Demonstrate an understanding of cloud service models, deployment models, and mobile cloud computing through practical applications
M053.2	Differentiate between various virtualization technologies and assess their suitability for different cloud environments.
M053.3	Select and justify appropriate cloud computing services for a given scenario based on performance, cost, and security considerations
M053.4	Design and implement cloud-based solutions using OpenStack, AWS, Google Cloud Platform and Microsoft Azure components for real-world applications.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M053.1	2	-	-	-	-	-	-	-	-	-	-	1
M053.2	2	2	-	-	-	-	-	-	-	-	-	1
M053.3	3	3	3	-	-	-	-	-	-	-	-	2
M053.4	2	2	3	3	2	2	2	2	2	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
M053.1					
M053.2					
M053.3					
M053.4					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Tutorial-Cum-Lab-Based Approach to Cloud Computing

This course adopts a tutorial-cum-lab model to blend conceptual clarity with hands-on skills in cloud computing. It is structured to help students develop as solution architects with a focus on both technology and systems thinking.

Pre-Session: Students engage in pre-readings from curated books, technical papers, and white papers to build foundational knowledge aligned with each topic.

In-Session: Sessions emphasize solving concept-based review questions and real-world use case analysis. Focus areas include cloud service models, virtualization, mobile cloud computing, and platform-specific solutions (CO1–CO3).

Post-Session: Students summarize their learning, reinforcing understanding and connecting concepts to practical implementations (CO4).

This approach supports students in acquiring critical thinking, design, and decision-making skills essential for modern cloud solution development.

Tutorials

Sr. No.	Syllabus	Hrs
1	Introduction to Distributed Computing and Cloud Fundamentals: <ul style="list-style-type: none">● Historical perspective of computing systems● Distributed computing principles● Introduction to cloud computing● Key characteristics of cloud computing● Cloud computing benefits and challenges● Business drivers for cloud adoption	2
2	Virtualization Concepts and Levels <ul style="list-style-type: none">● Virtualization fundamentals● Hypervisors and virtual machines● Levels of virtualization● Hosted virtualization● Type-1 and Type-2 hypervisors● Hardware-assisted virtualization	2
3	Advanced Virtualization Techniques <ul style="list-style-type: none">● Para-virtualization● Full-virtualization● CPU virtualization● Memory virtualization● Disk virtualization● I/O mapping in virtual environments● Network virtualization	2
4	Containerization and Modern Virtualization <ul style="list-style-type: none">● Introduction to containerization● Container architecture● Docker fundamentals	2

	<ul style="list-style-type: none"> ● Container vs. VM comparison ● Container lifecycle management ● Container orchestration concepts ● Container networking and storage 	
5	<p>Cloud Computing Service Models</p> <ul style="list-style-type: none"> ● Infrastructure as a Service (IaaS) ● Platform as a Service (PaaS) ● Software as a Service (SaaS) ● Anything as a Service (XaaS) ● Service model comparison ● Service model selection criteria ● Responsibilities in each service model 	2
6	<p>Cloud Deployment Models and Networking</p> <ul style="list-style-type: none"> ● Public cloud ● Private cloud ● Hybrid cloud ● Community cloud ● Multi-cloud environments ● Cloud networking concepts ● Virtual networks and subnets ● Network security in the cloud 	2
7	<p>Data Center Technology and Cloud Architecture</p> <ul style="list-style-type: none"> ● Data center technologies ● Cloud infrastructure components ● Monolithic architecture ● Microservices architecture ● Multi-tier application design ● Scalability patterns ● High availability in cloud applications 	2
8	<p>Cloud Programming and Optimization</p> <ul style="list-style-type: none"> ● Cloud programming models ● Cloud-native application design principles ● Serverless computing ● Performance optimization in the cloud ● Cost optimization strategies ● Cloud migration approaches ● Refactoring applications for the cloud 	2
9	<p>DevOps for Cloud-Based Software Development</p> <ul style="list-style-type: none"> ● DevOps fundamentals ● Continuous Integration (CI) ● Continuous Delivery/Deployment (CD) ● Infrastructure as Code (IaC) ● Configuration management ● DevOps tools and platforms ● DevOps best practices 	2
10	<p>Cloud Security and DevSecOps</p>	2

	<ul style="list-style-type: none"> ● Cloud security challenges ● Shared responsibility model ● DevSecOps principles ● Security as Code ● Static Application Security Testing (SAST) ● Dynamic Application Security Testing (DAST) ● Vulnerability Assessment and Penetration Testing (VAPT) ● Secure Software Development Lifecycle (SecSDLC) ● Security tools and frameworks 	
11	<p>AWS Cloud Services Fundamentals</p> <ul style="list-style-type: none"> ● AWS Global Infrastructure ● AWS IAM (Identity and Access Management) ● AWS EC2 (Elastic Compute Cloud) ● AWS S3 (Simple Storage Service) ● AWS EBS (Elastic Block Store) ● AWS EFS (Elastic File System) ● AWS VPC (Virtual Private Cloud) ● AWS Security Groups ● AWS Cost Explorer and Calculator 	2
12	<p>AWS Advanced Services and Development</p> <ul style="list-style-type: none"> ● AWS Lambda for serverless computing ● AWS RDS (Relational Database Service) ● AWS CodeCommit, CodeBuild, and CodeDeploy ● AWS CI/CD pipeline ● AWS ECS (Elastic Container Service) ● AWS EKS (Elastic Kubernetes Service) ● AWS SageMaker for ML/AI workloads ● AWS MLOps practices 	2
13	<p>Google Cloud Platform and Microsoft Azure</p> <ul style="list-style-type: none"> ● Google Cloud Platform (GCP) overview ● Google App Engine (GAE) ● Google Compute Engine (GCE) ● Microsoft Azure fundamentals ● Azure core services ● Cross-cloud comparison ● Choosing the right cloud provider ● Transitioning between cloud providers 	2
14	<p>Multi-Cloud Strategy and Future Trends</p> <ul style="list-style-type: none"> ● Multi-cloud architecture design ● Multi-cloud management tools ● Multi-cloud security considerations ● Cloud service brokerage ● XaaS (Anything as a Service) ● Edge computing and cloud ● Quantum computing in the cloud ● AI/ML and cloud convergence ● Future of cloud computing 	2

15	Mini-Project	-
Total		28

Laboratory Component

Sr. No	Title of the Experiment
1	<p>Creating and Running Virtual Machines on Hosted Hypervisors (Virtual Box, KVM, QEMU) Objective: To create and run virtual machines on hosted hypervisors such as KVM, VMware Workstation, and Oracle VirtualBox.</p>
2	<p>Docker and Docker Compose Objective: To provide students with a thorough understanding of Docker and Docker Compose, enabling them to containerize applications, manage multi-container setups, and apply best practices for containerization in real-world scenarios. Participants will learn to build, deploy, and manage containerized applications efficiently.</p>
3	<p>LXD and Multipass Objective: To provide students with a thorough understanding of Multipass and LXD, enabling them to create lightweight virtual machines and manage Linux containers efficiently. Participants will learn to deploy and orchestrate virtualized and containerized workloads, applying best practices for managing scalable and secure environments.</p>
4	<p>Automation using Ansible Objective: Automation in Software Install/Configuration/operations. Description: Set up network applications, apache2, ftp, monitoring and network security devices various security devices (firewalls, IDS/IPS). To use Ansible playbooks for automating routine tasks, such as rule updates and device configuration.</p>
5	<p>Kubernetes using Minikube Objective: 1. Learn basic Kubernetes commands for resource inspection. 2. Understand the process of making deployed applications accessible both internally and externally through service exposure. Learn to deploy servers like NGINX on Kubernetes pods using YAML for effective resource management.</p>
6	<p>Kubernetes using Minikube-Testing Configure Horizontal Pod Autoscaling (HPA):</p> <ol style="list-style-type: none"> 1. Test Case 1: Validate Load Balancing Across Pods 2. Test Case 2: High Load Performance 3. Test Case 3: Pod Failure and Recovery 4. Test Case 4: Service Degradation Under Node Failure 5. Test Case 5: Load Balancing with StatefulSets 6. Test Case 6: Network Latency Simulation

7	<p>OpenStack Implementation</p> <p>Objectives:</p> <ol style="list-style-type: none"> 1. Establish a Stable and Scalable Cloud Infrastructure. 2. Deploy OpenStack on Ubuntu servers 3. Creating a robust cloud infrastructure capable of handling diverse workloads 4. Optimize Resource Utilization and Efficiency
8	<p>Implementing and Managing IAM Roles, EC2 instance and S3 in AWS</p> <p>Objectives:</p> <ol style="list-style-type: none"> 1. Understand the importance and functionality of Identity and Access Management (IAM) roles in AWS. 2. Learn how to create and configure IAM roles to assign granular permissions for different AWS services and resources. 3. Ensure secure and appropriate access control for AWS resources using IAM roles.
9	<p>Building and Deploying Web Applications using AWS Elastic Beanstalk</p> <p>Objective:</p> <ol style="list-style-type: none"> 1. To design a lab on AWS Elastic Beanstalk. 2. The lab will focus on deploying, managing, and scaling web applications using AWS Elastic Beanstalk.
10	<p>Implementing the AWS VPC and hosting multi tier application (public subnet-front-end and Private subnet- back-end)</p>
11	<p>DevOps and DevSecOps in AWS</p> <p>Scenario: A SaaS company wants to implement a CI/CD pipeline with security checks.</p> <p>Problem Statement: Build a secure CI/CD pipeline using AWS CodePipeline, CodeBuild, and security scanning tools.</p> <p>Expected Outcomes:</p> <ul style="list-style-type: none"> • Automated build, test, and deployment. • Security vulnerabilities detected early. <p>Guided Solution:</p> <ol style="list-style-type: none"> 1. Set up AWS CodePipeline. 2. Integrate AWS CodeBuild and AWS Security Hub. 3. Deploy application to AWS Lambda or ECS.
12	<p>Deploying Containerized Applications with Kubernetes & Redshift</p> <p>Scenario: An e-commerce company wants to containerize its application and use AWS Redshift for analytics.</p> <p>Problem Statement: Deploy a containerized app on EKS and set up a Redshift data warehouse.</p> <p>Expected Outcomes:</p> <ul style="list-style-type: none"> • Microservices running on AWS EKS. • Redshift configured for analytics. <p>Guided Solution:</p> <ol style="list-style-type: none"> 1. Create a Kubernetes cluster on AWS EKS. 2. Deploy a sample microservices application. 3. Set up AWS Redshift and load sample data.

13

Scenario-Based Lab

1. Connecting On-Premises Databases to AWS Cloud

Scenario:

A financial company wants to securely connect its on-premises PostgreSQL database to AWS RDS with minimal downtime.

Problem Statement:

Set up a secure connection between an on-premises database and AWS RDS using AWS Direct Connect and AWS VPN.

Expected Outcomes:

Secure connection established between on-premises and AWS RDS

Data transfer with minimal latency

Guided Solution:

1. Configure AWS Site-to-Site VPN.
2. Set up AWS Direct Connect for low-latency connection.
3. Use AWS DMS for database replication.

2. Data Migration from On-Premises to AWS Scenario:

A retail company needs to migrate its large MySQL database to AWS with minimal downtime.

Problem Statement:

Use AWS DMS and Snowball to migrate data efficiently.

Expected Outcomes:

- Data successfully migrated with integrity.
- Reduced downtime during migration.

Guided Solution:

1. Use AWS Schema Conversion Tool for compatibility.
2. Set up AWS DMS for real-time replication.
3. Use AWS Snowball for bulk data transfer.

3. Cloud Automation Using Terraform and Ansible

Scenario:

A startup needs an automated AWS infrastructure setup.

Problem Statement:

Use Terraform to deploy AWS infrastructure and Ansible for configuration management.

Expected Outcomes:

- Infrastructure as Code (IaC) deployed successfully.
- Configuration automated via Ansible.

Guided Solution:

1. Write a Terraform script to provision an EC2 instance.
2. Use Ansible playbook to install required software.
3. Test deployment.

<p>14</p>	<p>Building Data Pipelines from Ingestion to Analytics Scenario: A telecom company needs real-time analytics on customer call data. Problem Statement: Build a data pipeline using AWS Kinesis, Glue, and Redshift. Expected Outcomes:</p> <ul style="list-style-type: none"> ● Real-time data ingestion and processing. ● Insights generated from Redshift queries. <p>Guided Solution:</p> <ol style="list-style-type: none"> 1. Stream data using Amazon Kinesis. 2. Process data with AWS Glue. 3. Store and analyze in Amazon Redshift. <hr/> <p>Multi-Cloud Strategies & Hands-on Scenario: A multinational corporation needs a hybrid cloud setup. Problem Statement: Deploy a multi-cloud environment using AWS and Azure with centralized logging. Expected Outcomes:</p> <ul style="list-style-type: none"> ● Workloads running across AWS and Azure. ● Centralized logging enabled. <p>Guided Solution:</p> <ol style="list-style-type: none"> 1. Deploy Kubernetes clusters on AWS EKS and Azure AKS. 2. Configure a common logging and monitoring solution.
<p>15</p>	<p>Building a Video Streaming Platform for Startup Objectives:</p> <ol style="list-style-type: none"> 1. Design scalable video streaming architecture. 2. Utilize AWS services for storage, transcoding, and delivery. 3. Ensure high availability, scalability, and low latency. <p>Lab Outcomes:</p> <ol style="list-style-type: none"> 1. Deploy an MVP video streaming platform. 2. Configure transcoding and adaptive bitrate streaming. 3. Secure video uploads and delivery using AWS best practices.
<p>16</p>	<p>Unified Platform for Big Data Processing Objective: Setting up and utilizing Apache Hadoop and Apache Spark to process large datasets efficiently. This lab focuses on understanding the integration of Hadoop's distributed storage with Spark's fast computation framework, enabling a unified platform for big data processing.</p>
<p>17</p>	<p>Implementing the USE CASE using Google API & Google App Engine Objectives :</p> <ol style="list-style-type: none"> 1. Authenticate and integrate Google APIs. 2. Deploy applications on Google App Engine. 3. Implement a real-world use case using Google Cloud.

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Cloud Computing: Concepts, Technology & Architecture	1st	Thomas Erl	Prentice Hall	2013
2	Distributed and Cloud Computing	1st	Kai Hwang, Jack Dongarra, Geoffrey C. Fox	Morgan Kaufmann	2011
3	Cloud Computing: A Hands-on Approach	1st	Arshdeep Bahga, Vijay Madisetti	Universities Press	2014
4	AWS Certified Solutions Architect - Associate Study Guide	3rd	Ben Piper, David Clinton	Wiley	2020
5	AWS Certified Solutions Architect - Professional Study Guide	1st	Brett McLaughlin, Jorge Acetozi	Wiley	2020
6	Google Cloud Platform for Architects	1st	Vitthal Srinivasan	Packt Publishing	2020
7	Microsoft Azure: Planning, Deploying, and Managing the Cloud	1st	Marshall Copeland	Apress	2015
8	The Definitive Guide to Container Security	1st	Gareth Baruch, Dave Dukinfield, Mohit Bhasin	Wiley Publishing	2020



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Deep Learning

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM	Deep Learning	2	-	2	2	5	2	-	1	3
		Examination Scheme								
M063	Deep Learning	Component		ISE		MSE		ESE	Total	
		Theory		13		14		40	67	
		Laboratory		26		--		07	33	

Pre-requisite Course Codes, if any.	Machine Learning
Course Objective: This course introduces Concepts of cloud computing. This course focuses on the architecture of cloud computing along with the application of the same.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
M063.1	Understand the fundamentals of deep learning.
M063.2	Understanding the working of Convolutional Neural Networks and RNN in decision making.
M063.3	Implement, optimize and tune state-of-the-art deep neural network architectures
M063.4	Implement major deep learning algorithms, the problem settings, and their applications to solve real world problems

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M063.1	2	-	2	2	-	-	-	-	-	-	-	1
M063.2	2	2	-	-	2	-	-	-	-	-	-	1
M063.3	3	3	3	2	2	-	-	-	-	-	-	2
M063.4	2	2	3	3	2	2	2	2	2	2	2	2

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
M063.1	1	-	-	2	-
M063.2	1	2	-	2	-
M063.3	1	-	-	2	-
M063.4	1	2	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Theory Component

Module No.	Topics	Ref.	Hrs.
1	Introduction	1,2	5
	Basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method. Neural Networks: Feedforward neural networks, deep networks, regularizing a deep network, model exploration, and hyper parameter tuning.		
2	Introduction to Convolution Neural Networks CNN	1,2	6
	Architecture and Operations, convolutional layer, Pooling layer, Variants of the Convolution Model, Forward and Backward propagation, Training a deep neural network, hyper-parameter tuning, Generalization Gap – Under-fitting Vs Over-fitting – Optimization, Normalization.		
3	Optimization algorithms	1,2	6
	Mini-batch gradient descent, exponentially weighted averages, RMS prop, Learning rate decay, the problem of local optima, Batch norm – Parameter tuning process.		
4	Sequence Modeling: Recurrent Nets	1.2	7
	Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, LSTM networks.		
5	Interactive Applications of Deep Learning	1.2	4
	Generative Adversarial Networks, Deep Reinforcement Learning.		
6	Self Study		
	Deep Learning Research: Autoencoders, Deep Generative Models: Boltzmann Machines Restricted Boltzmann Machines, Deep Belief Networks		
Total			28

Laboratory Component

Sr. No	Title of the Experiment
1	Study and Implement different classifier for decision tree algorithm eg. J48
2	Working and Implementation of Bayesian Hyperparameter Optimization
3	Implement Single-Layer Feedforward Neural Network
4	Implement Multi-Layer Feedforward Neural Network
5	Learning TensorFlow API and Keras API
6	Implement Optimization technique
7	Build and train RNNs, work with NLP and word embeddings
8	Use LSTMs and GRUs for implementing a real world problem
9	Implement a GAN for a given problem
10	Implement DCGAN for a given problem

Note: Course coordinators can use their own problem statements to solve listed lab sessions.

Textbooks:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Deep Learning	1st	Ian Goodfellow, Yoshua Bengio, Aaron Courville	MIT Press	2016
2	Deep Learning with Python	1st	François Chollet	Manning Publications ISBN: 9781617294433	2017

References:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals of Deep Learning	1st	N. Bunduma		2017
2	Deep Learning and Neural Networks	1st	J. Heaton	Heaton Research Inc.	2015

Additional References:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Deep Learning	1st	Ian Goodfellow	MIT Press	2016
2	Deep Learning: Methods and Applications	1st	Li Deng, Dong Yu	Now Publishers Inc.	2009
3	Deep Learning	1st	M.L. Hall	VDM Verlag	2011



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Decision Making and Business Intelligence

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
(MDM)	Decision Making and Business Intelligence	2	0	2	4	8	2	0	1	3
		Examination Scheme								
M073		Component		ISE	MSE	ESE	Total			
		Theory		13	14	40	67			
		Laboratory		26	--	7	33			

Pre-requisite Course Codes, if any.	Applied Mathematics, Programming
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Course Objective:

1. Introduce students to the principles and concepts of decision making and business intelligence.
2. Familiarize students with the various types of data and information used in decision making and business intelligence, including structured, semi-structured, and unstructured data.
3. Teach students how to collect, process, and analyze data to support decision making and business intelligence, using tools such as data warehouses, ETL processes, and data modeling.

Course Outcomes (CO): *At the End of the course students will be able to*

1. Understand the principles and concepts of decision making and business intelligence.
2. Collect, process, and analyze data to support decision making and business intelligence, using various business intelligence techniques

M073.1	Identify various decision making methods in industries.
M073.2	Summarize the characteristics of complex business problems.
M073.3	Apply prediction and optimization techniques for decision making.
M073.4	Design expert system for decision making using expert techniques.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M073.1	2										2	
M073.2	2			2	2	2					2	
M073.3	2			2	2	2					2	
M073.4	2			2	2	2					2	

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M073.1							
M073.2							
M073.3							
M073.4							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to Decision Making		4
	1.1	Introduction: Introduction to decision making methods, AHP	1-4	
	1.2	SAW,WPM methods and examples.		
2	Title	Characteristics of Complex Business Problems		5
	2.1	Number of Possible Solutions, Time-Changing Environment , Problem-Specific Constraints	1-4	
	2.2	Multi-objective Problems , Modeling the Problem, A Real-World Example		
3	Title	Prediction Methods and Models		6
	3.1	Data Preparation, Different Prediction Methods, Mathematical Methods, Distance Methods	1-4	
	3.2	Logic Methods, Modern Heuristic Methods, Additional Considerations, Evaluation of Models		
4	Title	Modern Optimization ,Computational Intelligence and Expert Techniques		
	4.1	Local Optimization Techniques, Stochastic Hill Climber, Simulated Annealing, Tabu Search, Constraint Handling	1-4	6
	4.2	Design of an expert system for decision making using Neural network, genetic algorithm and Fuzzy Logic		7
6	Self Study	Applying Business Intelligence : Marketing Campaigns , Manufacturing, Investment Strategies, Emergency Response Services, Credit Card Fraud		4
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To implement SAW method for a given problem.
2	To implement WPM method for a given problem
3	To implement AHP method for a given problem.
4	To implement Business Intelligence using prediction model for a given problem.
5	To implement optimization technique for a given problem.
6	To implement an expert system for decision making using Neural Network.
7	To implement an expert system for decision making using Fuzzy Logic.
8	To implement an expert system for decision making using genetic algorithm.
9	Mini Project on decision making and BI.
10	Mini Project on decision making and BI.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Adaptive Business Intelligence	1 st	Zbigniew Michalewicz, Martin Schmidt, Matthew Michalewicz, Constantin Chiriac	Springer Publication	2006
2	Decision Making in the Manufacturing Environment: Using Graph Theory and Fuzzy Multiple Attribute Decision Making Methods	2 nd	Venkata Rao	Springer publications	2014
3	Computational Intelligence in Complex Decision Systems	1 st	Da Ruan	Atlantis Press, Amsterdam Press, World Scientific.	2010
4	Fuzzy sets, decision making and expert system	1 st	Hans- Jorgen Zimmermann, Kluwer	Academic Publishers, Boston	2011

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Business Intelligence: Data Mining and Optimization for Decision Making	1 st	Carlo Vercellis	Wiley Publications	2009



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Human Machine Interaction (HMI)

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM	Human Machine Interaction (HMI)	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
M083		Theory	13		14		40		67	
	Laboratory	26		--		07		33		

Pre-requisite Course Codes	Software Engineering,
Course Objectives	This course provides an opportunity to learn and apply the design principles of Human-Machine Interaction. Learners will learn the basic human psychology of everyday actions and will be able to design a UI prototype of an application. This course covers the discussion of various interaction design concepts. The laboratory experiments are designed to practice the concepts and to adopt the systematic approach for interface design using various HMI-tools.
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
M083.1	Identify the various design principles used for interacting between humans and machines.
M083.2	Apply human psychology of everyday actions and UI design process for real-world applications.
M083.3	Implement mobile, windows, and web-based application
M083.4	Evaluate and justify UI design
M083.5	Create applications for social and technical tasks.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO5
M083.1	2	-	2	-
M083.2	2	-	2	-
M083.3	2	3	-	2
M083.4	2	-	2	-
M083.5	2	3	-	-

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
M083.1					
M083.2					
M083.3					
M083.4					
M083.5					

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction	T1-T4	06
	1.1	Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields.		
	1.2	The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction		
	1.3	The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction;		
2	Title	Graphical User Interface and Web Interface	T1,T2, T4	06
	2.1	The Graphical User Interface: Popularity of graphics, the concept of direct manipulation, characteristics of GUI,		
	2.2	Web user Interface: Interface popularity, characteristics. Principles of user interface design.		
3	Title	Understanding Goal-Directed Design:	T1,T2, T4	05
	3.1	Goal-directed design; Implementation models and mental models; Beginners, experts, and intermediates – designing for different experience levels;		
	3.2	Understanding users; Modeling users – personas and goals.		
4	Title	Design Guidelines	T1,T2, T3,T4	6
	4.1	perception, Gestalt principles, visual structure		
	4.2	color, vision, memory, six behavioral patterns, recognition and recall.		
5	Title	Interaction Styles and Communication	T2,T4	5
	5.1	Interaction Styles 1: Menus, Windows,		
	5.2	Interaction Styles 2: Device-based and Screen-based Controls.		
	5.3	Communication: Text messages, Feedback, and Guidance.		

6	Self Study	UX tools: Figma, Just In Mind, and any open-source tool for prototype designing, Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To Study open-source UX tools (Justinmind Prototype, Pidoco, Marvel ,Figma Prototype) and create a simple design for a given problem definition.
2	<p>Know your client.</p> <ol style="list-style-type: none"> Design an app that can teach mathematics to children of 4-5 years age in schools in Rural Sector. Design an app that can teach mathematics to children of 4-5 years age in schools in Urban Sector. Design a site that can help people to sell their handmade products in metro cities. Design a site that can connect housewives and keep them engaged. <p>Note : Students should be able to do the following for any given problem statement</p> <ol style="list-style-type: none"> Analysis of user's/client's behavior eg their preferences, interests etc What kind of interfaces will they like and why? Existing apps - analyze and rate them. What will be your choice of screen elements? How will your app/web design be better than the existing one?
3	Goal-oriented design - Design an experience for passengers whose flight /train is delayed.
4	Design Principles - Understand principles of good UI design by heuristic evaluation. Design UI for a given problem statement.
5	Menus & Navigation – Redesign of a user interface (Suggest and implement changes in Existing User Interface) for a given problem statement.
6	<p>Windows & Screen controls – Design UI for a given problem statement.</p> <ol style="list-style-type: none"> Design a navigator for a student new in your Institute. Design a navigator for a person new in tourist city/ village. Motor paralysis for differently able people. Vaccination App design with localization
7	Icons - Design appropriate icons pertaining to a given domain. (Eg. Greeting cards, Travelling, restaurants, Education, Medical, security at Airport, Malls etc)

8	Colors – Design a personal website for any socio-technical problem. Use color guidelines with statistical graphics for better visualization.
9	Design a Map-based UI(Web User) for the given problem statement. Example: Mumbai Dabbawallas with localization feature. Pet Care New Visitors to Hospital
10	To calculate the screen complexity of the existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Human Computer Interaction	3 rd	Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale	Peason,Prentice Hall	2003
2	The Essential Guide to User Interface Design	3 rd	Wilbert O. Galitz,	Wiley publication	2007
3	Design of everyday things	2 nd	Donald A. Normann	Basic Books; Reprint edition	2013
4	Galitz's Human Machine Interaction	1st	Kalbande,Kanade,Iyer	Wiley Publications	2015

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Interaction Design: Beyond Human Computer Interaction	5th	Rogers Sharp Preece	Wiley publications	2019
2	Mobile Design and Development	1 st	Brian Fling	O'Reilly Media Inc.,	2009.

Course Category of Multidisciplinary Minor	MDM-IV (Semester VII)
Computer Engineering	M054: Internet and Web Technology
Artificial Intelligence and Machine Learning	M064: Generative AI and application
Data Science	M074: Social Media Analytics
Interface and Experience Design	M0844: Prototyping and Interaction Design [Capstone project]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-IV	Internet and Web Technology	3	0	2	5	8	3	0	1	4
		Examination Scheme								
M054		Component	ISE		MSE		ESE		Total	
		Theory	--		--		--		--	
		Laboratory	100		--		100		200	

Pre-requisite Course Codes, if any.	CS208
Course Objective:	
Course Outcomes (CO): <i>At the End of the course, students will be able to</i>	
M054.1	Develop a sophisticated web UX
M054.2	Create, integrate, and test REST-based web services
M054.3	Design a secure web application/ web services
M054.4	Demonstrate the behavior of web crawlers and testing of web applications

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M054.1					3							
M054.2					3							
M054.3					3							
M054.4					3							

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M054.1	3	3	3		2	2	
M054.2	3	3	3		2	2	
M054.3	3	3	3		2	2	
M054.4	3	3	3		2	2	

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
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1		Designing UI		6
	1.1	Fundamentals of UX Design, Defining UX Solutions, Design Communication, and Visualizing Ideas	1	
2		Web content management system		4
	2.1	Introduction to Web CMS, different types of Web CMS	2	
3		Web services		5
	3.1	Introduction to web service, REST architecture,	3	
4		Web mashups		4
	4.1	Introduction to web mashups, server-side mashups, client side mashups,	2	
5		Secured Web application		6
	5.1	Introduction to Web Tokens, Auth2.0, OAuth, Access token	2	
6		Integration of web services		6
	6.1	Introduction to Mule ESB, Introduction to Anypoint Studio, Integrating Web Services using Anypoint studio	4	
7		Web crawlers		6
	7.1	Introduction to web crawler, role of crawler in the internet, concept of page ranking	3	
8		Testing web applications		5
	8.1	Introduction to different types of testing, manual testing, and automated testing testing, performance testing, and functional testing, open source tools used for testing, web-specific test	2	
Total				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Design web pages using HTML, CSS and javascript
2	Create a website using web CMS (Node Js/Angular Js/React Js/Flask/Django/Wordpress/Joomla etc.)
3	Design UX for a given problem definition by using open source UX tools
4	Create a Restful service to demonstrate different HTTP methods
5	Testing of restful web service using Postman/ARC
6	Create a web mashup of web services using open source framework
7	Implement a Secure Authentication System – Develop a web application using OAuth 2.0, JWT (JSON Web Tokens), and Multi-Factor Authentication (MFA) for secure user login.
8	Integration of web services using open-source integration tools like Mulesoft
9	Demonstrate the behavior of Web Crawlers/ spiders (use XPATH,CSS PATH),extract information and store it in the database.
10	End to end testing of the web application using open-source testing tools like Selenium, Test runner and Junit
12	Containerizing a Web Application Using Docker Statement: Develop and deploy a web application using Docker by creating a Dockerfile , building a container image, running the container, and exposing the application on a specific port. _ignore the comment as there is no cloud technology prerequisite covered in the course

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Sketching the User experiences	2nd edition	Bill Buxton	Diane Cerra	2010
2	Rich Internet Application AJAX and Beyond	3rd edition	Dana Moore, Raymond Budd, Edward Benson	WROX Publisher	2017
3	Web Technology	2nd Edition	Srinivasan	Pearson	2014
4	API Recipes with Mulesoft(r) Anypoint Platform	1st Edition	WHISHWORK S Editorial Board	White falcon	2017

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	https://nodejs.org				
2	https://angularjs.org/				
3	https://reactjs.org/				
4	Internet Technology And Web Design	1st edition	R. K. JAIN	Khanna Book Publishing Company	2015
5	Understanding the Internet: A Clear Guide to Internet Technologies	1st edition	Keith Sutherland	A Butterworth-H einemann Title	2016
6	RESTful Web APIs: Services for a Changing World	3rd edition	Leonard Richardson, Mike Amundsen, Sam Ruby	O'REILLY	2013



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-IV	Prototyping_ Interaction Design [Capstone Project]	3	0	2	4	9	3	0	1	4
		Examination Scheme								
M084		Component		ISE	MSE	ESE	Total			
		Theory		75	75	150	300			
		Laboratory		50	--	50	100			

Pre-requisite Course Codes		Software Engineering
At the End of the course students will be able to		
Course Outcomes	M084.1	Apply design research and usability principles to real-world problems
	M084.2	Develop low to high-fidelity prototypes using appropriate tools
	M084.3	Work in interdisciplinary teams and deliver a functional design project
	M084.4	Communicate design decisions through documentation and presentations.

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1	Project Framing and Research	1,2	6
		Understand the design challenge, user needs, and context. Capstone project proposal (problem statement, context, significance) Stakeholder mapping Secondary research (literature, trends, existing solutions) Initial user interviews / contextual inquiry		
2	2	Ideation and Concept Development	1	12
		Generate, explore, and select ideas. Design goals & refined “How Might We...” questions” Sketching ideas and interaction flows Storyboarding use scenarios Low-fidelity prototypes, Storyboards, Wireframes		
3	3.1	Low-Fidelity Prototyping and User Feedback	1,3	12
		Create testable low-fidelity interactive prototypes. Wireframes (using tools like Balsamiq, Figma) Click-through interactive prototype, Usability testing plan, Conduct first round of user testing		
		3.2 Explore and plan Gamification and microinteractions		

4		High-Fidelity Prototyping and Design Iteration	1,3,5	12
	4.1	Visual design system (colors, typography, icons, spacing) High-fidelity interactive prototype (Figma, Adobe XD, etc.) Interactive states and transitions, Iteration based on feedback		
	4.2	UX Evaluation techniques and Improve UX Goals, Metrics and Targets		
5		Final Presentation and Reflection		
	5.1	Final prototype with interactive demo Video walkthrough (optional) Reflection journal (what worked, what didn't, what they'd do next), Design documentation & style guide, Accessibility considerations, Pitch deck for evaluation		
			Total	42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Sample Capstone Project : Redesign of a healthcare appointment app. Financial literacy app for teens. Students can be given the freedom to explore and work on the project.
2	Capstone project continue
3	Capstone project continue
4	Capstone project continue
5	Capstone project continue
6	Capstone project continue
7	Develop the capstone project in any software language with full functionality
8	Continue
9	continue
10	Presentation and design documentation with complete testing guide

Text Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	The Essentials of Interaction Design (4th Ed.)	4th	Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel	Wiley	2014
2	A Project Guide to UX Design: For user experience designers in the field or in the making.	2 nd	Russ Unger and Carolyn Chandler	O'reilly, Series Editor	2012
3	Communicating Design: Developing Web Site Documentation for Design and Planning	2 nd	Dan M. Brown	New Riders (Pearson)	2010

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	A Project Guide to UX Design: For User Experience Designers in the Field or in the Making	2 nd	Russ Unger, Carolyn Chandler	Pearson	2012
2	The UX Book: Agile UX Design for a Quality User Experience	2 nd	Rex Hartson, Pardha Pyla	Morgan Kaufmann.	2019

MDM SEQUELS FOR CE/CSE

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Industrial IoT (MDM-01)	M011: Fundamental of Internet of Things	M012: Embedded “C” and Micro Python for IoT	M013: IOT Communication and Network Layer Protocols	M014: IoT Applications and Security
Signal Processing and Communication (MDM-02)	M021: Digital Signal Processing	M022: Principles of Communication & Systems	M023: Digital Image Processing	M024: Wireless Communication and Networks
VLSI (MDM-04)	M041: Hardware Description Language Programming	M042: Digital CMOS VLSI Design	M043: VLSI Physical Design	M044: ASIC Verification

Multidisciplinary Minor -Industrial IoT

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M011	Fundamentals of Internet of Things	3	0	0	4	8	2	0	0	3
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
MDM-01		Laboratory		-		--		-		

Pre-requisite Course Codes, if any.	
Course Objective: This course provides an in-depth understanding of the Internet of Things (IoT), covering its definition, impact, convergence of Information Technology (IT) and Operational Technology (OT), challenges, architecture, data management, and compute stack. It also explores the role of sensors, transducers, smart objects, and computational units in IoT.	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
MDEC11.1	Demonstrate basic concepts, principles, and challenges in IoT
MDEC11.2	Classify various sensing devices and actuator types used in the IoT domain
MDEC11.3	Apply Computation and Communication Technologies for various real-life applications
MDEC11.4	Illustrate IoT infrastructure for various IoT use cases

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC11.1	2	2	2									
MDEC11.2	2	2	2									
MDEC11.3	2	2	2									
MDEC11.4	2	2	2	2								

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze @	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	Introduction to IoT		5

		Definition and fundamentals of IoT, Historical background and evolution, Impact of IoT on various industries, Convergence of IT and OT in IoT	1,2	
2	Title	IoT Challenges and Opportunities		5
		Key challenges in implementing IoT solutions, Security and privacy concerns, Scalability and interoperability issues, Opportunities and potential applications of IoT.	1,2,3	
3	Title	IoT Architectures		5
		Overview of OneM2M IoT architecture, Introduction to IoT World Forum (IoTWF) architecture, Comparison of different IoT architectures Case studies of real-world implementations	1,2	
4	Title	IoT Data Management and Compute Stack		5
		Importance of data management in IoT, Overview of IoT data lifecycle Introduction to compute stack in IoT, Edge computing vs. cloud computing in IoT	1,2	
5	Title	Layer-1 Things in IoT: Sensors and Transducers		9
		Introduction to Signals and Systems. Types of sensors and transducers used in IoT, Working principles and functionalities, Examples of sensor applications in different domains, Challenges and advancements in sensor technology	1,2	
6	Title	Things in IoT: Smart Objects		4
		Definition and characteristics of smart objects, Role of smart objects in IoT ecosystem, Interoperability standards for smart objects, Case studies of smart object deployments	1,2,3	
7	Title	Things in IoT: Computation and Communication Units		9
		Introduction to Computational Units in IoT, Microcontrollers vs. microprocessors, Embedded Systems and their Applications. Need For Communication Interfaces , Serial& Parallel, I2C/ CAN Controller Area Network) – SPI (Serial Peripheral Interface) – Serial UART, MODBUS, HART, SCADA. Introduction to Programming using Microcontrollers Sensors and Actuators.	1,2	
8	Self Study	Practical Applications: Design and implementation of IoT solutions, Solving industry-specific use cases: Manufacturing, Healthcare, Retail, Autonomous vehicles, Supply chain management, Smart Agriculture, Smart City, Tracking and monitoring livestock. Discussion on future trends and directions in IoT.	1,2,3	4*
Total				42

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Internet of Things-A Hands-On Approach	First	Arshdeep Bahga, Vijay Madisetti	University Press	2015
2	Internet of Things: Architecture and Design Principles	First	Raj Kamal	McGraw Hill Education	2017
3	Introduction to Industrial Internet of Things and Industry 4.0	First	Sudip Misra, Chandana Roy, Anadarup Mukherjee	CRC Press	2021

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle	Academic Press	2014
2	The Internet of Things key applications and protocols	First	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	2012
3	Designing the Internet of Things	-	Adrian McEwen	Wiley	2013

Online references:

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://nptel.ac.in/courses/108/108/108108098/>
3. <https://nptel.ac.in/courses/106/105/106105195/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs31/>
5. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
6. <https://nptel.ac.in/courses/108108147>
7. <https://www.mooc-list.com/tags/wearable-technology>

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M012	Embedded "C" and Micro Python for IoT	2	--	2	5	9	2	--	1	3
		Examination Scheme								
MDM-01		Component		ISE		MSE		ESE	Total	
		Theory		20		20		60	100	
		Laboratory		80		--		20	100	

Pre-requisite Course Codes, if any.	CS101: Problem Solving using Imperative Programming EC101: Digital Systems and Microprocessors EC201: Computer Architecture and Organization
Course Objective: To impart students the fundamentals of Embedded "C" programming and Micro Python scripting for building IoT solutions, covering device driver creation, debugging, and optimization.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
MDEC12.1	Demonstrate Proficiency in Embedded "C" Programming and Micro Python
MDEC12.2	Understand Embedded Systems Concepts and Architecture
MDEC12.3	Develop Device Drivers and Hardware Abstraction Layers (HALs)
MDEC12.4	Apply Embedded "C" and Micro Python for IoT Applications
MDEC12.5	Implement Networking Protocols and Communication:

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC12.1	2	2	2	2	2							
MDEC12.2	2	2	2	2								
MDEC12.3	2	2	2	2	2							
MDEC12.4	2	2	2	2	2							
MDEC12.5	2	2	2	2	2							

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	Embedded C Programming:		06
	1.1	C Fundamentals: Data types, variables, operators, expressions, Conditional Compilation, Functions, function calling, parameter passing, arrays, string, pointers, Bit Operations - Packaging data, unpacking data, bit manipulations, storage classes.	1	

	1.2	Memory Management in Embedded Systems: Stack and heap memory, Memory allocation techniques Introduction to Integrated Development Environments (IDEs) for embedded systems, Compilers, debuggers, and simulators for embedded C	1, 2	
2	Title	Input/Output (I/O) Operations:		08
	2.1	Interfacing with peripherals: GPIO (General Purpose Input/Output), UART (Universal Asynchronous Receiver-Transmitter), SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), Analog-to-digital converters (ADC). Digital to Analog converters (DAC).	1,2	
	2.2	Using libraries for device drivers and hardware abstraction.	1,2	
	2.3	Interrupts and Timers: Interrupt handling mechanisms, Timer programming for real-time applications	1,2	
3	Title	Introduction to Micro Python:		06
	3.1	Overview of Micro Python and its features. Syntax, data types, variables, operators, Functions, modules, libraries Lists, tuples, dictionaries, and sets. Control flow: loops, conditionals, and exceptions in Micro Python Setting up Micro Python environment for embedded development.	4	
	3.2	Python for Data Analysis: Introduction to libraries like NumPy and pandas for data manipulation and analysis, Working with sensor data collected from IoT devices	4	
	3.3	Python for Web Development and APIs: Basics of web development using frameworks like Flask or Django (optional)	4	
4	Title	Micro Python for IoT Applications		06
	4.1	Interfacing with peripherals using Micro Python. Writing scripts for sensor data acquisition and control.	3,4	
	4.2	Networking protocols and communication in Micro Python. Implementing MQTT, HTTP, or other IoT protocols in Micro Python.	3,4	
	4.3	Data Processing with Python: Data preprocessing techniques for IoT data. Handling real-time and streaming data in Python. Data Visualization in Python: Introduction to data visualization libraries like Matplotlib and Seaborn. Visualizing IoT data for analysis and insights.	3,4	
5	Title	Case Studies in Embedded Systems and IoT		02
		Exploration of real-world case studies and applications of embedded systems and IoT like Smart Home Automation System, Industrial IoT (IIoT) Monitoring and Control System, Healthcare Monitoring Wearables, Smart Agriculture Solutions, Vehicle Tracking and Fleet Management, Energy Management Systems	3	
			Total	28

Laboratory Component

Sr. No.	Title of the Experiment
1	Blinking LED (Hello World!!! Program): Write a program to blink an LED connected to a GPIO pin of the microcontroller. Experiment with different blinking patterns (e.g., Morse code) by controlling the timing and sequence of GPIO operations.
2	Push Button and LED Interaction: Interface a push button and an LED to the microcontroller. Write a program to toggle the LED state when the button is pressed or released.
3	Serial Communication: Establish serial communication (UART) between the microcontroller and a computer. Write programs to send and receive data packets over UART, such as sending sensor readings or receiving commands.
4	PWM Output: Generate PWM (Pulse Width Modulation) signals using the microcontroller. Control the brightness of an LED or the speed of a motor using PWM output.
5	Analog-to-Digital Conversion (ADC): Interface an analog sensor (e.g., temperature sensor, light sensor) to the microcontroller. Write a program to read analog sensor values using the built-in ADC and display them.
6	Interrupt Handling: Configure external interrupts to detect events (e.g., button press, sensor signal). Write interrupt service routines (ISRs) to handle interrupt events and perform appropriate actions.
7	Timers and Timed Operations: Use timers to generate time delays and schedule periodic tasks. Implement timed operations, such as blinking LEDs at specific intervals or sampling sensors at regular intervals.
8	Communication Protocols: Implement communication protocols such as I2C or SPI to interface with external peripherals (e.g., sensors, displays). Develop projects involving multiple devices communicating over a network using standard protocols (e.g., MQTT for IoT applications).

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Embedded C Programming and the Microchip PIC	-	Richard H. Barnett, Sarah Cox, and Larry O'Cull	Delmar Cengage Learning	2003
2	Embedded System: Real time Operating Systems for the ARM Cortex™M3		Jonathan W. Valvano	Create Space Independent Publishing Platform	2012
3	Programming with MicroPython: Embedded Programming with Microcontrollers and Python		Nicholas H. Tollervey	Shroff / Oreilly Reprints	2017
4	Internet of Things, "A Hands on Approach		Vijay Madiseti, ArshdeepBahga	UniversityPress	2015.

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M013	IOT Communication and Network Layer Protocols	2	--	2	4	6	2	--	1	3
MDM-01		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)		Total
		Theory		20		20		60		100
Laboratory		80		--		20		100		

Pre-requisite Course Codes, if any.	Computer Architecture and Organization Computer Communication and Networks Embedded Systems
Course Objective: To provide the students a comprehensive understanding of communication protocols used in the Internet of Things (IoT) ecosystem. Students will learn about various protocols, their features, advantages, and limitations, along with hands-on experience in implementing and optimizing communication for IoT devices.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
MDEC13.1	Understand the fundamentals of IoT communication and network layer protocols.
MDEC13.2	Compare and contrast different IoT communication and network layer protocols.
MDEC13.3	Implement and configure communication layer protocols for IoT devices.
MDEC31.4	Analyze and optimize data and network layer protocols for efficiency and security.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC13.1	3											
MDEC13.2	3	2										
MDEC13.3		3				2						
MDEC31.4	3						2					

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	Introduction to IoT Communication		06

	1.1	Overview of IoT architecture Importance of communication protocols in IoT Types of IoT communication (Device-to-Device, Device-to-Cloud, etc.)	1,2,4	
	1.2	Wired Communication Protocols Ethernet: Basics, protocols, and standards Power-line Communication (PLC) Industrial Ethernet protocols (MODBUS TCP/IP, EtherNet/IP)	1,2,4	
	1.3	Wireless Communication Protocols Wi-Fi: Standards, security, and IoT applications Bluetooth and Bluetooth Low Energy (BLE) Zigbee and Z-Wave protocols. LoRa WAN.	1,2,4	
2	Title	IOT Data Link Layer Protocols		11
	2.1	Overview: IOT Communications Criteria, Range, Frequency Bands, Power Consumption, Topology Constrained Devices, Constrained-Node Networks, Data Rate and Throughput, Latency and Determinism. Overhead and Payload	3,4	
	2.2	PHY/MAC Layer: 3GPP MTC, LTE-eMTC uplink and downlink layers, Architecture of IEEE 802.11, Architecture of IEEE 802.15- BLE, BLE power class classification and protocol stack	3,4	
	2.3	Data Link Protocols: WirelessHART-Architecture and protocol stack, Z-Wave- Architecture and Protocol stack, DASH7-Communication models, Zigbee Smart Energy-topology and energy features, LoRaWAN Standardization and Alliances Physical Layer MAC Layer Topology Security, Competitive Technologies LoRaWAN, NB-IoT and Other LTE Variations.	3,4	
3	Title	IOT Network Layer Protocols		11
	3.1	Network Layer Routing Protocols: IPv4-Header format with functions, IPv6-Header format with functions, Dynamic IP and DHCP, ICMP, RPL, CORPL, CARP.	4	
	3.2	Network Layer Encapsulation Protocols: 6LoWPAN-IPv6 over Low power Wireless PAN, 6TiSCH, 6Lo, IPv6 over G.9959, IPv6 over BLE, RPL-Routing Protocol for Low Power and Lossy Networks, RPL Routing attributes.	4	
Self Study		Edge Computing and Fog Networking IoT Device Provisioning and Management IoT Interoperability and Standards		4
			Total	28

Laboratory Component

Sr. No.	Title of the Experiment
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<p>1</p>	<p>Setting up a Basic MQTT Communication Network</p> <p>Objective: To understand the basics of MQTT protocol and set up a communication network for IoT devices.</p> <p>Equipment: MQTT broker (e.g., Mosquitto), IoT devices (e.g., Raspberry Pi, ESP8266/ESP32), MQTT client software (e.g., MQTT.fx, Eclipse Paho).</p> <p>Experiment Steps:</p> <p>Install and configure MQTT broker on a server or local machine.</p> <p>Set up IoT devices as MQTT clients and connect them to the broker.</p> <p>Publish and subscribe to MQTT topics to exchange messages between devices.</p>
<p>2</p>	<p>Configuring Ethernet-Based Communication for IoT Devices</p> <p>Objective: To learn about Ethernet protocols and configure wired communication for IoT devices.</p> <p>Equipment: Ethernet switch, Ethernet cables, IoT devices with Ethernet ports (e.g., Raspberry Pi with Ethernet adapter).</p> <p>Experiment Steps:</p> <p>Connect IoT devices to an Ethernet switch using Ethernet cables.</p> <p>Configure IP addresses, subnet masks, and default gateways for devices.</p> <p>Test communication between IoT devices using TCP/IP protocols.</p>
<p>3</p>	<p>Implementing Bluetooth Low Energy (BLE) Communication</p> <p>Objective: To implement BLE communication for IoT sensors and devices.</p> <p>Equipment: BLE-enabled devices (e.g., Raspberry Pi with BLE module, BLE sensors), BLE development tools (e.g., BlueZ library for Linux).</p> <p>Experiment Steps:</p> <p>Set up BLE peripherals and central devices.</p> <p>Develop BLE applications for data transmission between devices.</p> <p>Analyze BLE communication characteristics such as range, data rate, and power consumption.</p>
<p>4</p>	<p>Connecting IoT Devices Using Cellular Communication</p> <p>Objective: To establish cellular communication for IoT devices using GSM, GPRS, or LTE-M/NB-IoT standards.</p> <p>Equipment: IoT devices with cellular modules (e.g., SIM800/SIM900 modules), SIM cards, cellular network access.</p> <p>Experiment Steps:</p> <p>Configure IoT devices with cellular network settings and APNs.</p> <p>Test data transmission over cellular networks using AT commands or APIs.</p> <p>Evaluate cellular communication performance and reliability for IoT applications.</p>

5	<p>Comparing and Analyzing IoT Messaging Protocols</p> <p>Objective: To compare and analyze the performance of different IoT messaging protocols such as MQTT, CoAP, and AMQP.</p> <p>Equipment: IoT devices with support for multiple messaging protocols, MQTT broker, CoAP server, AMQP server.</p> <p>Experiment Steps:</p> <p>Implement message exchange using MQTT, CoAP, and AMQP protocols.</p> <p>Measure message latency, throughput, and overhead for each protocol.</p> <p>Analyze protocol characteristics and suitability for different IoT scenarios.</p>
6	<p>Optimizing IoT Communication Protocols</p> <p>Objective: To optimize IoT communication protocols for resource-constrained devices.</p> <p>Equipment: IoT devices with limited memory and processing capabilities.</p> <p>Experiment Steps:</p> <p>Implement protocol optimization techniques such as message compression, caching, and payload reduction.</p> <p>Measure the impact of optimizations on device performance, power consumption, and network utilization.</p> <p>Evaluate trade-offs between optimization techniques and protocol functionality.</p>
7	<p>IoT Communication Protocol Implementation</p> <p>Objective: To design and implement a communication protocol for a specific IoT application.</p> <p>Equipment: IoT devices relevant to the chosen application, communication protocol libraries or frameworks.</p> <p>Project Steps:</p> <p>Define the communication requirements and constraints for the IoT application.</p> <p>Design a custom communication protocol or adapt existing protocols to meet the requirements.</p> <p>Implement the protocol on IoT devices and test its functionality, efficiency, and security.</p> <p>Present the project findings, including protocol design rationale, implementation details, and performance evaluation.</p>

Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
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1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things		David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry	CISCO press	June 2017
2	Internet of Things: Architectures, Protocols and Standard		Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri	WILEY Publication	2019
3	From Machine-to-Machine to the of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle	Elsevier AP	2014
4	The Internet of Things: Key Applications and Protocols		Hersent, Olivier, David Boswarthick, and Omar Elloumi	Wiely	2011

OnLine References:

1. <https://www.nabto.com/guide-iot-protocols-standards/>
2. <https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols>
3. <https://www.datamation.com/applications/iot-protocols-and-standards/>
4. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
5. <https://archive.nptel.ac.in/courses/108/108/108108098/>

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M014	IOT Applications and Security	3	--	2	4	7	3	--	1	4
MDM-01		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)	Total	
		Theory		20		20		60	100	
Laboratory		80		--		20	100			

Pre-requisite Course Codes, if any.	Computer Architecture and Organization Computer Communication and Networks Embedded Systems
Course Objective: To provide the students a comprehensive understanding of communication protocols used in the Internet of Things (IoT) ecosystem. Students will learn about various protocols, their features, advantages, and limitations, along with hands-on experience in implementing and optimizing communication for IoT devices.	
Course Outcomes (CO): After successful completion of the course, student will be able to	
MDEC14.1	Understand IoT design principles and technology fundamentals
MDEC14.2	Implement secure communication and security mechanisms in IoT systems through various protocols
MDEC14.3	Design and development of typical IoT Applications
MDEC14.4	Implement data analytics with supporting services

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC14.1	3											
MDEC14.2	3	2										
MDEC14.3		3					2					
MDEC14.4	3			2								

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	Title	IoT Technology overview		04

	1.1	Overview of design principles: overview of the architecture for IoT, including the overall design principles and needed capabilities, standards considerations	3	
	1.2	IoT Technology Fundamentals: Devices and Gateways, Local and wide area networking, Data management, Business process in IoT	3	
2	Title	IOT Application Layer Protocols		10
	2.1	HTTP and CoAP protocols for IoT applications, Security mechanisms for HTTP and CoAP (e.g., HTTPS, DTLS)	1,2,4	
	2.2	MQTT Protocol: Architecture, Security considerations, MQTT Deployment, MQTT based IoT Solution	1,2,4	
	2.3	CoAP Protocol: Protocol Architecture, Comparison with MQTT, Secure communication using CoAP, considerations, CoAP based IoT Solution including CoAP client-server interactions and message exchanges.	1,2,4	
3	Title	IoT Security Fundamentals		10
	3.1	Security threats in IoT environments, Introduction to cryptographic techniques (symmetric/asymmetric encryption, hashing, digital signatures), Authentication and access control mechanisms for IoT devices, Secure bootstrapping and provisioning of IoT devices	6	
	3.2	IoT Communication Security Protocols: Overview of TLS/SSL (Transport Layer Security/Secure Sockets Layer) and its relevance in IoT, Introduction to DTLS (Datagram Transport Layer Security) for secure communication over UDP, Securing MQTT communication using TLS, CoAP security considerations and usage of DTLS	5	
4	Title	IoT Applications and Development with Data Analytics		12
	4.1	Design and Development: Design Methodology, Back-end Application Designing Apache for handling HTTP Requests, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development	4,7	
	4.2	Data Analytics and Supporting Services: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.	4,7	
5	Title	Case studies/Industrial Applications		6

		IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth	7,8	
Self Study		Data analytics tools such as Python with libraries like Pandas, NumPy, and Scikit-learn for data analysis and visualization. Learn about applying machine learning algorithms to IoT data for predictive analytics and anomaly detection.		
Total			42	

Laboratory Component

Sr. No.	Title of the Experiment
1	<p>Implementing IoT Data Encryption</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT Devices ● OpenSSL library ● Python IDE <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Generate public and private keys using OpenSSL. 2. Implement encryption and decryption functions in Python using the generated keys. 3. Modify previous IoT application to encrypt sensor data before transmission. 4. Ensure that data is decrypted at the receiving end.
2	<p>Securing IoT Device Boot Process</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● Raspberry Pi or similar IoT device ● Secure Boot software (e.g., U-Boot) ● Computer with Linux OS <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Install U-Boot bootloader on the IoT device. 2. Configure U-Boot to verify the integrity of the boot image. 3. Implement secure boot process using cryptographic signatures.

	4. Test the secure boot process by attempting to boot with a modified image.
3	<p>IoT Network Security Analysis</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● Wireshark or similar network analysis tool ● IoT devices connected to a local network ● Router or network switch <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Capture network traffic using Wireshark. 2. Analyze the captured packets to identify potential security threats. 3. Implement network segmentation to isolate IoT devices from other network segments. 4. Configure firewall rules to restrict unauthorized access to IoT devices.
4	<p>Implementing Secure Firmware Updates</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with firmware update capability ● Digital signatures generation tool ● Firmware update server <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Generate digital signatures for firmware updates using cryptographic algorithms. 2. Implement firmware update mechanism in IoT devices to verify the authenticity of firmware images. 3. Set up a firmware update server to distribute signed firmware updates. 4. Test the firmware update process and verify the integrity of the updated firmware.
5	<p>Implementing Access Control for IoT Devices</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with user authentication capabilities ● Authentication server (e.g., LDAP server) ● Python IDE <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Configure an authentication server (LDAP) to manage user credentials. 2. Implement user authentication mechanism in IoT devices using Python.

	<ol style="list-style-type: none"> 3. Create access control policies to restrict access based on user roles and permissions. 4. Test the access control mechanism by attempting to access IoT devices with different user credentials.
6	<p>IoT Device Hardening</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices (e.g., Raspberry Pi, BeagleBone) ● Secure shell (SSH) client ● Linux OS <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Disable unnecessary services and ports on the IoT device. 2. Configure firewall rules to block incoming and outgoing traffic. 3. Enable secure shell (SSH) access and disable password-based authentication. 4. Install security updates and patches to mitigate known vulnerabilities.
7	<p>Implementing Secure Communication with TLS/SSL</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with network connectivity ● Web server with TLS/SSL support (e.g., Apache, Nginx) ● OpenSSL library <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Generate SSL/TLS certificates for the web server and IoT devices. 2. Configure the web server to enable HTTPS communication with SSL/TLS certificates. 3. Implement SSL/TLS client in IoT devices to establish secure connections with the server. 4. Test the secure communication by exchanging data between IoT devices and the server.
8	<p>IoT Device Monitoring and Intrusion Detection</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with logging capabilities ● Intrusion detection system (e.g., Snort)

	<ul style="list-style-type: none"> ● Monitoring software (e.g., Nagios) <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Configure logging on IoT devices to record system activities and network traffic. 2. Set up an intrusion detection system (IDS) to monitor network traffic for suspicious activities. 3. Configure alerting mechanisms to notify administrators of potential security breaches. 4. Deploy monitoring software to track the health and performance of IoT devices.
9	<p>Collecting and Analyzing IoT Sensor Data</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with sensors (e.g., temperature, humidity) ● Raspberry Pi or similar IoT platform ● Python IDE ● Pandas and Matplotlib libraries for data analysis and visualization <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Connect sensors to the IoT device and collect real-time data. 2. Write Python scripts to read sensor data and store it in a CSV file or a database. 3. Use Pandas library to perform basic data analysis such as mean, median, and standard deviation. 4. Visualize sensor data using Matplotlib library to identify trends and patterns.
10	<p>Anomaly Detection in IoT Sensor Data</p> <p>Equipment/Software Needed:</p> <ul style="list-style-type: none"> ● IoT devices with sensors ● Historical sensor data with known anomalies ● Python IDE ● Statistical libraries such as NumPy and SciPy <p>Experiment Steps:</p> <ol style="list-style-type: none"> 1. Collect historical sensor data containing both normal and anomalous behavior. 2. Calculate statistical measures such as mean, standard deviation, and z-score for the sensor data. 3. Identify thresholds for anomaly detection based on statistical measures. 4. Implement anomaly detection algorithms using Python and NumPy/SciPy libraries.

5. Evaluate the performance of the anomaly detection system using precision, recall, and F1-score metrics.

Reference Books

Sr. No	Title	Edition	Author	Publisher	Year
1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things		David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry	CISCO press	June 2017
2	Internet of Things: Architectures, Protocols and Standard		Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri	WILEY Publication	2019
3	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle	Elsevier AP	2014
4	The Internet of Things: Key Applications and Protocols		Hersent, Olivier, David Boswarthick, and Omar Elloumi	Wiley	2011
5	Implementing SSL / TLS Using Cryptography and PKI		Joshua Davies	Wiley	2010
6	Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations	First	Fei Hu	CRC Press	2016
7	Internet of Things – A hands-on approach		Arshdeep Bahga, Vijay	Universities Press	2017
8	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything	First	Francis daCosta	Apress Publications	2016

Online resources:-https://onlinecourses.nptel.ac.in/noc22_cs52/preview

Introduction to Industry 4.0 and Industrial Internet of Things

OnLine References:

1. <https://www.nabto.com/guide-iot-protocols-standards/>
2. <https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols>
3. <https://www.datamation.com/applications/iot-protocols-and-standards/>
4. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
5. <https://archive.nptel.ac.in/courses/108/108/108108098/>

Multidisciplinary Minor - Signal Processing and Communication

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M021	Digital Signal Processing	2	0	2	5	8	2	0	1	3
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
MDM-02		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	
Course Objective: The primary objective of this course is to provide a thorough understanding and working knowledge of Discrete Time Signal operation and implementation of DSP Algorithms.	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC21.1	Sample and describe Discrete time signals
MDEC21.2	Classify and Perform signal operations
MDEC21.3	Apply DFT properties
MDEC21.4	Illustrate FFT algorithm
MDEC21.5	Design FIR filter
MDEC21.6	Implement DSP Algorithms

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC21.1	3	3							2			
MDEC21.2	3	3		2	2				2			
MDEC21.3	3	3							2			
MDEC21.4	3	3							2			
MDEC21.5	3	3	2	2	2				2			
MDEC21.6	3	3	2	2	3				2			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Discrete-Time Signal	1, 2, 3	8
	1.1	Introduction: Signals and Systems, Continuous Time signal,		

		Discrete - Time signal and representation, Digital signal, The Sampling theorem, Classification of Discrete - Time Signals		
	1.2	Operations on Discrete - Time Signals: Linear Convolution, Circular Convolution, Matrix Representation of Circular Convolution, Linear Convolution using Circular Convolution, Auto and Cross Correlation		
	1.3	Discrete - Time systems: Representation of system using impulse response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) system, Response of the FIR system using convolution		
2	Title	Discrete Fourier Transform	1, 2	6
	2.1	Introduction to DTFT, Relation between DFT and DTFT, DFT of DT signal, Inverse DFT. Computations in DFT		
	2.2	Properties of DFT		
3	Title	Fast Fourier Transform	1,2	6
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm, Flow graph for N=4 and N=8 using Radix-2 DIT-FFT		
	3.2	Inverse FFT algorithm, Computations in FFT		
4	Title	Digital FIR Filter Design	1,2, 3	04
	4.1	Linear Phase Concept		
	4.2	Linear Phase Low Pass/High Pass/Band Pass FIR filter design using Windowing Method		
5	Title	DSP Algorithms	1,2	04
	5.1	Fast Linear and Circular Convolution using FFT		
	5.2	Linear FIR filtering		
	5.3	Signal Matching using Carl's Correlation Algorithm		
6	Self Study	Composite FFT, FFT Flowgraph for N=6 and N=9	1,2	06
		Linear Phase Realization of FIR Filter		
			Total	28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Sampling and Reconstruction
2	Digital Signal Operations
3	Discrete Convolution
4	Discrete Correlation
5	Discrete Fourier Transform

6	Fast Fourier Transform
7	FIR Filter Design
8	Linear Convolution using FFT
9	Circular Convolution using FFT
10	Linear Filtering using Overlap Add Method
11	Linear Filtering using Overlap Save Method
12	Audio Signal Matching using Carl's Correlation Algorithm

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing	Forth Edition	John Proakis and Dimitris Monolakis	Pearson Publication	2007
2	Digital Signal Processing	Second Edition	S.Salivahanan, A Vallavaraj	Tata McGraw Hill	2010
3	Analog and Digital Signal Processing	Second Edition	Ashok Ambardar	Brooks/Cole Publishing	1999

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing	Forth Edition	P. Ramesh Babu	Scitech Publication Pvt Ltd	2011
2.	Digital Signal Processing	First Edition	M. H. Hayes	The McGraw Hill	2007
3	Digital Signal Processing	Second Edition	A. Nagoor Kani	Tata McGraw Hill	2012

Web References :

NPTEL Courses

1. **Digital Signal Processing and Applications by Prof. V. M. Gadre, IIT Bombay**
https://onlinecourses.nptel.ac.in/noc21_ee20/preview

2. **Digital Signal Processing by Prof. S.C.Dutta Roy IIT Delhi**
<https://nptel.ac.in/courses/117102060>

MIT OpenCourseWare

1. **Digital Signal Processing by Prof. Alan V. Oppenheim**
<https://ocw.mit.edu/courses/res-6-008-digital-signal-processing-spring-2011/>

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M022	Principles of Communication & Systems	2	0	2+2	5	10	2	0	1+1	4
		Examination Scheme								
MDM-02		Component	ISE (%)		MSE (%)		ESE (%)		Total	
		Theory	20		20		60		100	
		Laboratory-I	80		--		20		100	
		Laboratory-II	80		--		20		100	

Pre-requisite Course Codes, if any.	MDM-I: Analog Electronics and Circuits
Course Objective: The objective is to equip the students with basic knowledge for analyzing analog and digital communication systems ranging from data networks and internet to mobile data communication systems such as cellular and WiFi systems. Specifically, the students will learn how to manage communication system resources including bandwidth and power by selecting a proper signaling and/or analog/pulse/digital modulation scheme	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC22.1	Explain, compare, and distinguish between the components of analog, pulse, and digital communication systems.
MDEC22.2	Analyze the behavior of modulated signals in time domain, frequency domain, and signal space.
MDEC22.3	Create different source coding and error correction codes.
MDEC22.4	Examine the performance of different analog and digital modulation schemes.
MDEC22.5	Examine and calculate system performance metrics like bit rate and bandwidth for different digital modulation techniques, as well as for source and error correction codes.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC22.1	3				-				-	-		1
MDEC22.2	2	2			3				3	3		
MDEC22.3	2	2			3				3	3		1
MDEC22.4	3	3			3				3	3		1
MDEC22.5	2	2			3				3	3		

CO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PSO1	PSO2
MDEC22.1	2	2			

MDEC22.2	2	2		2	1
MDEC22.3	2	2		2	1
MDEC22.4	2	2		2	1
MDEC22.5	2	2			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Analog and Pulse modulation	7	
	1.1	Introduction to Signals, fourier analysis, Classification of Frequency spectrum,Need for modulation, Block diagram of an analog and digital communication system.		
	1.2	DSB-FC : Principle of working, Waveforms and power relations and power spectrum,Single and multitone, Types of AM FM:Mathematical analysis, Armstrong method of FM generation, Block diagram of Superheterodyne receiver		
	1.3	Sampling theorem, Types of Sampling, Pulse Amplitude modulation, Pulse Width Modulation, Pulse code modulation (PCM)		
	1.4	Delta modulation, Time Division multiplexing		
2	Title	Source coding and Channel Coding	07	
	2.1	Uncertainty, Information, Entropy, Source coding theorem, Huffman encoding, Shannon Fano coding		
	2.2	Channel capacity Theorem, Linear block codes,Cyclic codes-Shift register method and Polynomial division method, Convolutional codes- Shift Register approach, State diagram,Trellis , Viterbi decoding		
3	Title	Digital Modulation Techniques	10	
	3.1	Line coding and Power spectral density (PSD) of line codes		
	3.2	BPSK,8-QAM,16-QAM,BFSK,MSK- Principle of working, PSD and Signal space analysis.WLAN specific		
	3.3	Inter symbol Interference , Eye diagram,		
	3.4	Digital Modulation tradeoffs:Probability of Error evaluations of various modulations		
5	Title	Spread Spectrum and OFDM	04	
	5.1	Direct sequence spread spectrum		
	5.2	Frequency hopping spread spectrum		
	5.3	OFDM		
6	Self Study	Applications and health, safety, and environment aspects of Analog and Digital communication techniques		06

PCS-I Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implementation of double sideband full carrier for various modulation index and demodulation
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Implementation of natural sampling and reconstruction of waveforms
4	Implementation of pulse amplitude modulation.
5	LBC encoder and decoder
6	Implementation of Binary Phase Shift Keying
7	Implementation of Binary Frequency shift keying
8	Signal space analysis of QAM
9	PSD and ISI analysis of BPSK
10	BER analysis of BPSK without and with Convolutional codes

PCS -II Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	<p>Getting Started with ARM Microcontrollers</p> <ul style="list-style-type: none"> ● Objective: Learn the basics of ARM microcontrollers and set up the development environment. ● Experiments: <ul style="list-style-type: none"> ● Install ARM development tools (e.g., Keil, GCC, STM32CubeIDE, or others). ● Write and execute a simple "Hello, World!" program with onboard LED blinking.
2	GPIO and Basic Peripherals

	<ul style="list-style-type: none"> ● Objective: Understand General Purpose Input/Output (GPIO) and basic peripherals. ● Experiments: <ul style="list-style-type: none"> ● Control an LED using a GPIO pin. ● Read input from a push-button or switch. ● Implement Pulse Width Modulation (PWM) to control an LED's brightness.
3	<p>Analog-to-Digital Conversion (ADC)</p> <ul style="list-style-type: none"> ● Objective: Learn to read analog signals with ADC. ● Experiments: <ul style="list-style-type: none"> ● Read a value from a potentiometer. ● Connect a temperature sensor (e.g., LM35, TMP36) and read temperature data.
4	<p>UART/Serial Communication</p> <ul style="list-style-type: none"> ● Objective: Establish communication between the microcontroller and other devices via UART. ● Experiments: <ul style="list-style-type: none"> ● Set up a UART connection and send/receive data to/from a computer. ● Connect a serial-based sensor (e.g., GPS module) and extract information.
5	<p>Interfacing with Digital Sensors</p> <ul style="list-style-type: none"> ● Objective: Learn to connect and read data from digital sensors. ● Experiments: <ul style="list-style-type: none"> ● Connect a digital temperature/humidity sensor (e.g., DHT11/DHT22). ● Connect a motion sensor (e.g., PIR sensor). ● Connect a distance sensor (e.g., ultrasonic HC-SR04).
6	<p>Interfacing with Analog Sensors</p> <ul style="list-style-type: none"> ● Objective: Connect and read data from analog sensors. ● Experiments:

	<ul style="list-style-type: none"> ● Connect an analog temperature sensor (e.g., LM35, TMP36). ● Use a photoresistor (LDR) to measure light intensity. ● Connect an analog accelerometer to measure acceleration.
7	<p>Communication Protocols: I2C and SPI</p> <ul style="list-style-type: none"> ● Objective: Learn to use I2C and SPI for sensor communication. ● Experiments: <ul style="list-style-type: none"> ● Connect and read data from an accelerometer (e.g., MPU6050) using I2C. ● Connect and control an OLED display via SPI.
8	<p>Wi-Fi Communication</p> <ul style="list-style-type: none"> ● Objective: Establish Wi-Fi connectivity for IoT applications. ● Experiments: <ul style="list-style-type: none"> ● Connect an ESP8266 or ESP32 module to the ARM microcontroller for basic Wi-Fi communication. ● Implement a simple HTTP server on the microcontroller to serve data. ● Send data to a cloud platform (e.g., ThingSpeak, AWS IoT, Google Cloud IoT).
9	<p>Bluetooth/BLE Communication</p> <ul style="list-style-type: none"> ● Objective: Explore Bluetooth connectivity for short-range communication. ● Experiments: <ul style="list-style-type: none"> ● Connect a Bluetooth module (e.g., HC-05/HC-06) and send/receive data to/from a smartphone. ● Implement BLE communication with a smartphone or another BLE-capable device.
10	<p>Integration with IoT Platforms</p> <ul style="list-style-type: none"> ● Objective: Connect the microcontroller to an IoT platform for data monitoring and control. ● Experiments: <ul style="list-style-type: none"> ● Send sensor data to an IoT platform and visualize it.

	<ul style="list-style-type: none"> • Set up IoT triggers to control microcontroller outputs (e.g., control an LED from a remote platform).
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Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Principles of Communication Systems	2nd	Taub H. and Schilling D.L	Tata McGraw Hill	2001
2	Communications Systems	4th	Haykin S	John Wiley and Sons	2001

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital and Analog Communication	4th	B.P.Lathi	Oxford	2017
2.	Communication Systems Engineering	4th	Proakis J. G. and Salehi M.	Pearson Education	2002.
3.	Digital Communication	3rd	Haykin S	John Wiley and Sons	2001

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M023	Digital Image and Processing	2	1	2	5	10	3	0	1	4
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
MDM-2		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	
Course Objective: The primary objective of Image Processing Course is to understand and apply image processing tools to process the Digital image	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC23.1	apply image enhancement technique
MDEC23.2	apply image segmentation technique
MDEC23.3	perform binary image processing Operation
MDEC23.4	develop fast image transform flowgraph
MDEC23.5	solve image compression and decompression
MDEC23.6	develop image processing application

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC23.1	3	3	2	3	3				2			
MDEC23.2	3	3	2	3	3				2			
MDEC23.3	3	3	2	3	3				2			
MDEC23.4	3	3	2	3	3				2			
MDEC23.5	3	3	2	3	3				2			
MDEC23.6	3	3	2	3	3				2			

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Fundamentals of Digital Image and Video	1,2	2
	1.1	Sampling and Quantization, Digital Image Representation		
	1.2	Introduction of Coordinate representation and Pixel, Neighbors of pixel adjacency connectivity		
2	Title	Image Enhancement	1,2	6
	2.1	Gray Level Transformations, Zero Memory Point Operations		
	2.2	Histogram Processing		
	2.3	Spatial Filtering: Smoothing and Sharpening Filters		
	2.4	Spatial Filtering: Smoothing and Sharpening Filters		
3	Title	Image Segmentation	1,2,4	6
	3.1	Detection of Discontinuities, Point Detection, Line Detection and Edge Detection		
	3.2	Edge Linking using Local processing and Global Processing Hough Transform, Graph Theoretic Method		
	3.3	Region based Segmentation, Image growing by pixel aggregation, Split and Merge Technique		
4	Title	Binary Image Processing	1,2	6
	4.1	Representation and Description, Chain Code, Shape Number, Moments.		
	4.2	Binary Morphological Operators : Dilation, Erosion, Opening and Closing, Boundary Extraction, Region Filling, Hit or Miss Transform, Corner Detection, Thinning and Thickening algorithm		
5	Title	Image Transform and Compression	1,3	4
	5.1	Introduction to Unitary Transform, Discrete Fourier Transform(DFT) and Fast Fourier Transform (FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform, Discrete Cosine Transform (DCT)		
	5.2	Introduction, Redundancy, Fidelity Criteria, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM, Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG		
	5.3	2-D Motion Estimation: Pixel based motion estimation, Block Matching Algorithm, Region based Motion Estimation, Multi resolution Motion Estimation. Block based transform coding, MPEG		
6	Self Study	Connected Component Labeling, Gray Scale Morphology and Colour Image Enhancement, Image restoration		
Total				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Image Enhancement using zero memory point processing
2	Image Enhancement using Histogram Processing
3	Image Enhancement using Spatial Filtering
4	Image Segmentation based on discontinuity property
5	Image Segmentation based on similarity property
6	Morphological Image Processing
7	Thinning and Thickening Algorithm
8	Image representation using Chain code, Shape Number and Moments
9	Fast Image Transform
10	Image Compression using Lossless Compression techniques
11	Image Compression using Lossy Compression techniques
12	Application of Image Processing

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Image Processing	Third Edition	Rafel C. Gonzalez and Richard E. Woods	Pearson Educatio Asia	2009
2	Digital Image Processing	First Edition	S.Jayaraman, E.Esakkirajan and T. Veerkumar	TataMcGraw Hill Education Private Ltd	2009
3	Digital Image Processing	First Edition	S. Sridhar	Oxford	2011
4	Digital Image Processing	First Edition	B. Chanda D. Dutta Majumdar	PHI	2003

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals and Digital Image Processing	Third Edition	Anil K. Jain	Prentice Hall of India Private Ltd	

2.	Digital Image Processing and computer Vision	First Edition	Milan Sonka, Vaclav Hlavac and Roger Boyle	Cengage Learning	2008
3	Multidimensional Signal, Image and Video Processing and Coding	Second Edition	John W Woods	Elsevier	2012
4	Digital Image Processing	Third Edition	William Pratt	John Wiley & Sons	2003

Web References :

NPTEL Courses

1. **Digital Image Processing by Prof. Prabir Kumar Biswas, IIT Kharagpur**
https://onlinecourses.nptel.ac.in/noc22_ee116/preview

Online Video Course :

1. **Digital Image Processing by Prof. Rich Radke ,Rensselaer Polytechnic Institute**
<https://sites.ecse.rpi.edu/~rjradke/improccourse.html>

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M024	Wireless Communication and Networks	2	0	4	5	7	2	0	2	4
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
case study		50+50		--				100		
MDM-2		Project		80		--		20	100	

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO): At the end of the course students will be able to	
MDEC24.1	Analyze and design wireless systems effectively, understanding RF communication basics, multiple access techniques, and channel coding methods.
MDEC24.2	Comprehend mobile network operation principles and protocols, including cellular network architecture, multiple access techniques, and key technologies such as GSM, LTE, and 5G.
MDEC24.3	Deploy and manage wireless networks securely and efficiently, utilizing protocols such as IEEE 802.11 for WLANs, Bluetooth, WiMAX, and internetworking protocols.
MDEC24.4	Optimize wireless communication system performance by understanding antenna fundamentals, propagation path loss models, and signal reception impacts.
MDEC24.5	Explore wireless sensor networks (WSNs) and Mobile Ad Hoc Networks (MANETs), learning sensor node architecture, network protocols, routing algorithms, and real-world deployment case studies.
MDEC24.6	Gain insights into emerging wireless communication technologies like 5G and 6G, understanding their key features, potential applications, and security challenges, preparing them for contributing to the advancement of wireless communication systems.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC24.1	3	2										
MDEC24.2	2	3	2									
MDEC24.3		2	3	2								
MDEC24.4			2		2	3						
MDEC24.5	2	3	2									
MDEC24.6		2		2	3							

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref	Hrs.
1	Title	Wireless Communication and Networks		4
	1.1	Introduction to wireless communication Basics of radio frequency (RF) communication		
	1.2	Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM.		
	1.3	Channel coding and error correction techniques		
	1.4	Signal propagation and path loss models		
2	Title	Mobile Communication Systems		5
	2.1	Cellular network architecture: Cell structure, handoff, frequency reuse		
	2.2	Multiple access techniques: FDMA, TDMA, CDMA, and their comparisons GSM (Global System for Mobile Communications): Architecture, operation principles, and protocols (e.g., call setup, handover) LTE (Long-Term Evolution): Evolution from GSM, key features, and functionalities (e.g., MIMO, OFDM)		
	2.2	Introduction to 5G technology: Design principles, key features, and potential applications		
3	Title	Wireless Networking Protocols		5
	3.1	IEEE 802.11 standard for Wireless Local Area Networks (WLANs), Network architecture (ad-hoc, infrastructure), access methods (CSMA/CA), and security (WEP, WPA, WPA2)		
	3.2	Bluetooth technology: Architecture, communication protocols, and applications (e.g., wearables, data transfer) WiMAX (Worldwide Interoperability for Microwave Access): Technology overview, comparison to WiFi, and applications Introduction to internetworking protocols for wireless networks (e.g., Mobile IP)		
4	Title	Antennas and Propagation in Wireless Communication		5
	4.1	Antenna fundamentals: Types of antennas (dipole, parabolic, microstrip), radiation patterns, and polarization. Antenna parameters: Gain, directivity, radiation resistance, and efficiency.		
	4.2	Propagation path loss models: Free space, two-ray, and log-distance path loss models. Large-scale path loss and small-scale fading: Impacts on signal reception and mitigation techniques		
5	Title	Applications in Wireless Communication		4

	5.1	Introduction to WSNs: Applications in environmental monitoring, smart agriculture, and industrial automation. Sensor node architecture: Sensing unit, processing unit, and communication module.		
	5.2	Network protocols and routing for WSNs: Energy efficiency considerations , Data aggregation and security challenges in WSNs.		
	5.3	Case studies of WSN deployment in real-world scenarios		
6	Title	Applications: Mobile Ad Hoc Networks (MANETs) and 5G/6G Technologies		5
	6.1	Introduction to MANETs: Characteristics, routing protocols (e.g., AODV, DSR), and applications (e.g., disaster relief, temporary networks) Security challenges and solutions in MANETs Emerging trends in wireless communication: 5G and 6G technologies Key features of 5G (enhanced mobile broadband, ultra-reliable low latency communication, massive machine-type communication) Potential applications of 5G and 6G technologies (e.g., connected vehicles, smart cities, AR/VR)		
Total				28

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Communications & Networks	Second	William Stallings	Pearson Education	2009
2	Fundamentals of Wireless Communication		David Tse and Pramod Viswanath	Cambridge University Press	2005
3	Computer Networks and Internets	Fifth	Douglas E. Comer	Pearson Education	2013
4	Antenna Theory and Design	Third	Constantine A. Balanis	John Wiley & Sons	2016

Additional Resources:

- 5G Americas website: <https://www.5gamericas.org/>
- IMT-2020 (5G) specifications: <https://www.itu.int/en/ITU-R/Documents/ITU-R-FAQ-IMT.pdf>
- International Conference on Wireless Sensor Networks (SECON): <https://conferences.sigcomm.org/sigcomm/2023/>
- National Telecommunications and Information Administration (NTIA): <https://www.ntia.gov/>
- IEEE 802.11 standard: <https://standards.ieee.org/beyond-standards/the-evolution-of-wi-fi-technology-and-standards/>
- Bluetooth website: <https://www.bluetooth.com/>
- WiMAX Forum website: <https://wimaxforum.org/>
- 3GPP website: <https://www.3gpp.org/>
- LTE white paper: <http://lightspeedt.com/wp-content/uploads/2015/10/LTE-Brochure.pdf>

Case Studies and Projects (2 credit)

Case studies on real-world deployments of wireless communication technologies

Group projects on designing and simulating wireless networks using software tools (e.g., ns-3, MATLAB)

Presentation of project findings and discussions on current trends and future directions in wireless communication and networks

- **Case Studies Evaluation:**

- Assessment Criteria:

1. Understanding of real-world deployments of wireless communication technologies
2. Ability to analyze and critique case studies.

- Evaluation Method:

1. Individual or group-based written assignments analyzing assigned case studies.
2. Evaluation rubric assessing comprehension, critical thinking, and analytical skills.

- **Group Project Evaluation:**

- Assessment Criteria:

1. Design and simulation of wireless networks using software tools.
2. Application of theoretical concepts to practical scenarios
3. Collaboration and teamwork within the group

- Evaluation Method:

1. Group project report detailing the design, implementation, and simulation results.
2. Evaluation rubric assessing technical accuracy, creativity, teamwork, and presentation quality.
3. Peer evaluation component to assess individual contributions within the group.

- **Presentation and Discussion Evaluation:**

- Assessment Criteria:

1. Presentation of project findings and analysis
2. Discussion of current trends and future directions in wireless communication and networks
3. Engagement and participation in discussions

- Evaluation Method:

1. Individual or group presentations of project findings
2. Evaluation rubric assessing clarity, depth of analysis, engagement, and contributions to discussions
3. Instructor-led or peer-led discussions assessing understanding of current trends and ability to articulate insights

Multidisciplinary Minor -VLSI

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M041	Hardware Description Language (HDL) Programming	2	0	2	5	9	2	0	1	3
		Examination Scheme								
MDM-4		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

Pre-requisite Course Codes, if any.	Problem Solving using Imperative, Programming, Digital Systems and Microprocessors, Problem Solving using OOPs.
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Course Objective: The course aims to familiarize students with the syntax, semantics, and constructs of Verilog HDL to design, simulate, and verify of digital logic design, including combinational and sequential logic, finite state machines, and synchronous circuits. This includes understanding synthesis process, where HDL descriptions are translated into actual hardware implementations. Students learn about synthesis tools, timing constraints, and optimizing designs for area, power, and performance. The course also aims to provide students with insights into industry practices, standards, and emerging trends in digital hardware and emerging technologies (e.g., hardware accelerators for AI/ML).

Course Outcomes (CO): At the end of the course students will be able to	
MDEC31.1	Demonstrate understanding of basic FPGA design flow and FPGA architecture
MDEC31.2	Write Verilog code for a given digital design using fundamental concepts of Verilog language
MDEC31.3	Construct combinational and sequential circuits in different modelling styles using Verilog HDL.
MDEC31.4	Implement a given digital design problem using Verilog on FPGA platform

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC31.1	3		3		3			1	3	1		1
MDEC31.2	3		3		3			1	3	1		1
MDEC31.3	3		3		3			1	3	1		1
MDEC31.4	3		3		3			1	3	1		1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	FPGA Design Flow	1,2	8
	1.1	India Semiconductor Industry and GoI policies.		
	1.2	Need of HDL, FPGA Design Flow and EDA tools		
	1.3	FPGA Architecture Fundamentals, Different FPGAs available		

		in the market and their applications		
2	Title	Fundamentals of Verilog	1,2	4
	2.1	Verilog Program Structure and concept of testbench		
	2.2	Language constructs, Verilog datatypes, Operators etc.		
3	Title	Design abstractions and Modeling Styles	1,2	8
	3.1	Design Abstractions, Behavioral, Data flow, Gate level and Switch level modelling		
	3.2	Procedural Assignment and Continuous Assignment		
4	Title	Finite State Machines	1,2	8
	4.1	Verilog code for both Mealy & Moore FSM		
5	Self Study	Verilog Models for Memories and Buses: Static RAM Memory, a simplified 486 Bus Model, UART Design, Datapath and Controller Design	Online Resource 2	*5
Total (*Not included)				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design, simulate and synthesize any combinational digital design using structural modelling and carry out physical verification on a given FPGA. a. Logic Gates b. 4-bit Ripple Carry Full Adder by instantiating one-bit full adder c. 2:1 Mux: Using case Statement
2	Design, simulate and synthesis any sequential digital design with behavioral modelling and carry out physical verification on a given FPGA. a. D Flip Flop using gates b. S-R Flip Flop c. 8-Bit Up Counter with Load
3	Create an ALU module capable of performing basic arithmetic and logical operations like addition, subtraction, AND, OR, XOR, etc.
4	Implement a floating-point arithmetic unit capable of performing operations on floating-point numbers following IEEE 754 standards.
5	Design of greatest common divisor using both data-path and control path implementation in Verilog HDL.
6	Design and simulate Round Robin arbiter using behavioral modelling.
7	Design, simulate and synthesis Verilog code using FSM for any one of the following: i. Elevator operation with 4x4 hex key pad input and display the output in LCD. ii. Traffic Light controller using Finite State machine.
8	Develop a Verilog code for any of the concepts of computer organizations like: Implement an I2C controller module for communication with I2C-compatible devices like sensors, EEPROMs, and RTCs. ii. Develop a controller module for interfacing with SPI flash memory chips commonly used for program storage in embedded systems. iii. Design a module to convert UART serial data to Ethernet frames for network communication.

9	Develop a Verilog code for algorithms in the areas like machine learning or cryptography using specialized hardware, such as SoC for faster processing.
10	Mini projects as an application of Verilog programming.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Design and Computer Architecture	1 st	David Money Harris, Sarah L. Harris	Elsevier Science	2013
2	Verilog HDL: A Guide to Digital Design and Synthesis	2 nd	Samir Palnitkar	Pearson Education	2009
3	Advanced Digital Design with Verilog HDL	2 nd	Michel D. Ciletti	PHI	2009

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital System Design with FPGA: Implementation Using Verilog and VHDL	1 st	By Cem Unsalan, Bora Tar	Mc Graw Hill Publication	2017
2	Verilog HDL Primer	3 rd	Bhasker J	BSP	2001
3	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	6 th	Michel D. Ciletti	Pearson Education	2018
4	Design through Verilog HDL	2 nd	Padmanabhan, Tripura Sundari	Wiley	2016

Online Resources:

1. Digital System design with PLDs and FPGAs

Prof. Kuruvilla Varghese, IISc Bangalore

Link: <https://nptel.ac.in/courses/117108040>

2. Hardware modeling using Verilog,

Prof. Indranil Sengupta, IIT Kharagpur

Link: <https://nptel.ac.in/courses/106/105/106105165/>

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M042	Digital CMOS VLSI Design	3	0	2	5	10	3	0	1	4
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
MDM-4		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering, Electronic Devices and Circuits (EDC), Analog Signal Integrated Circuits, Hardware Description Language (HDL) Programming
Course Objective: Today's growth in electronic sector is due to improvements in semiconductor chip design. VLSI course is the foundation course introduced to teach fundamentals of MOSFET based logic circuit design. The primary objective of this course is to impart basic knowledge required to study advanced courses in VLSI domain.	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC32.1	Discuss structure, operation, scaling theory for MOSFET
MDEC32.2	Design MOSFET based inverter circuits with given constraints
MDEC32.3	Analyze MOSFET based combinational and sequential logic circuits
MDEC32.4	Realize MOSFET based logic circuits with different design styles

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC32.1	3			3	3			1	3	1		
MDEC32.2	3	3		3	3			1	3	1		
MDEC32.3	3		3	3	3			1	3	1		
MDEC32.4	3		3	3	3			1	3	1		

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Review of MOSFET Physics	1	8
	1.1	Threshold Voltage Equation, MOSFET Structure and Operation		
	1.2	MOSFET Scaling, Types of scaling and small geometry effects		
2	Title	MOSFET Inverters	1	10
	2.1	Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters		
	2.2	Dynamic Characteristics of inverters, design of CMOS inverters with constraints		
3	Title	Combinational MOS Logic Circuits	1,2	10
	3.1	MOS Logic Circuits with Depletion NMOS Loads and CMOS		

		Logic Circuits		
	3.2	Complex Logic Circuits and Concept of equivalent CMOS inverter		
4	Title	Dynamic Logic Circuits	1	10
	4.1	Static CMOS, pass transistor logic, transmission gate		
	4.2	Pseudo NMOS, Domino, NORA, Zipper, C ² MOS		
5	Title	Sequential MOS Logic Circuits	1,2	4
	5.1	Behavior of Bi-stable Elements		
	5.2	Circuit Realization: SR Latch, JK FF, D FF		
	Title	Semiconductor Memories		
6	Self Study	ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits), Flash (mechanism, NOR flash, NAND flash), Peripheral Circuits: Sense amplifier, decoder	Online Resource 1	5*
Total (*Not included)				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	To develop a program using any programming language to plot the NMOS and PMOS Transistor VI characteristics.
2	To analyze NMOS and PMOS Transistor VI characteristics.
3	To simulate Resistive Load Inverter and CMOS Inverter, verify the VTC. Compare both the topologies. Comment on the Noise Margins.
4	Implement CMOS NAND, NOR, AND, OR using Static CMOS Logic.
5	Design and implement 2:1 Mux using different CMOS Logic styles.
6	Design and implement given Boolean equation using different CMOS Logic styles.
7	Simulate Pseudo NMOS Inverter and comment on the result.
8	Design and implement given equation using Pseudo NMOS, Domino Logic and C ² MOS Logic
9	To design, analyze and simulate the ring oscillator.
10	Simulate Clocked JK and D Flip Flop using Static CMOS Logic.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Electronic circuits: analysis and design	3 rd	Donald Neaman	Tata McGraw Hill	2006
2	CMOS Digital Integrated Circuits Analysis and Design	4 th	Sung-Mo Kang, Yusuf Leblebici	Tata McGraw Hill	2003

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Integrated Circuits: A Design Perspective	2 nd	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson Education	2019
2	Introduction to VLSI Circuits and Systems	Student Edition	John P. Uyemura	Wiley	2013

Online Resource: 1. https://onlinecourses.nptel.ac.in/noc21_ee09

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M043	VLSI Physical Design	2	0	2	5	9	2	0	1	3
		Examination Scheme								
Component		ISE (%)		MSE (%)		ESE (%)		Total		
Theory		20		20		60		100		
MDM-4		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	Basic Electrical Engineering, Electronic Devices and Circuits (EDC), Analog Signal Integrated Circuits, Basic CMOS VLSI Design, Hardware Description Language (HDL) Programming
Course Objective: The objectives of the course to entail a basic understanding of CMOS technology, transistor-level design, and circuit implementation enough to navigate through the physical design flow. It focuses on understanding algorithms used for floorplanning, placement, routing, clock tree synthesis, and final verification using DRC and LVS checks while optimizing performance, power, and area metrics alongside introduction to industry-standard CAD tools for VLSI physical design.	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC33.1	Sketch the layout of CMOS VLSI circuits.
MDEC33.2	Understand physical design techniques, including partitioning, chip planning, placement, and routing to optimize performance, power, and area in VLSI circuits.
MDEC33.3	Understand the principles and techniques of Static Timing Analysis (STA), analyze and ensure that synchronous circuits meet timing requirements, including setup, hold, and clock-to-q delays.
MDEC33.4	Apply optimization algorithms to efficiently partition chips, plan layouts, and place and route VLSI circuits, as well as clock routing algorithms for analyzing performance and area utilization of VLSI design.
MDEC33.5	Effectively utilize Electronic Design Automation (EDA) tool for physical design tasks, static timing analysis, and verification.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC33.1	2		3		3			1	1	1		1
MDEC33.2	2		3		3			1	1	1		1
MDEC33.3	2		3		3			1	1	1		1
MDEC33.4	2		3		3			1	1	1		1
MDEC33.5	2		3		3			1	1	1		1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to VLSI Physical Design & Static Timing Analysis	1	8
	1.1	Introduction, Physical Design flow, Physical Verification, EDA		

		Tools for Physical Design, Data Structures and Algorithms for Physical Design		
	1.2	Necessity of Design rules and Lambda based design rules, Layout of inverters and basic gates.		
	1.3	Introduction (STA, DTA, Behavior of synchronous circuit, Timing Arcs and Unateness, Definitions – Setup, Hold, Latch, Flipflop, STA for Flipflop and Latch		
2	Title	Partitioning, Chip Planning and Placement	1	8
	2.1	Introduction and Optimization goals, KL-Algorithm, Extensions of KL-Algorithm, FM-Algorithm, Multilevel Partitioning		
	2.2	Introduction and Optimization goals, Floor planning Representations, Floor planning Algorithms		
	2.3	Introduction and Optimization goals, Min-cut placement, Analytic Placement, Simulated Annealing, Modern Placement Algorithms		
3	Title	Routing: Global and Detailed	1,2	6
	3.1	Introduction and optimization goals, Single net routing (Rectilinear routing), Global routing in the connectivity graph, finding shortest paths with Dijkstra's Algorithm, Horizontal and vertical constraint graphs, Channel Routing Algorithms, Switch box routing algorithms, Over the cell routing algorithms, Power and Ground routing, Unified Power Format and Special cells used for Power Planning		
4	Title	Routing: Clock Routing	1	6
	4.1	Clocking Schemes and Design Considerations, Clock Routing algorithms – 1 (H-tree based and MMM algorithms), Clock Routing algorithms – 2 (Geometric matching and Weighted center algorithms), Clock Routing algorithms – 3 (Exact zero skew and DME algorithm), Skew, Latency, Uncertainty, and Jitter		
	Self Study	Machine Learning for Physical Design: Machine Learning Models, Predict Path-Based Slack from Graph-Based Timing Analysis, Data collection, Model creation and predicting data	Online Resource 1	5*
Total (*Not included)				28

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Sketch the circuit and Layout for CMOS inverter using CAD tool.
2	Sketch the circuit and Layout for CMOS AND/OR gate using CAD tool.
3	Sketch the circuit and Layout for Flip Flop using CAD tool.
4	Use Electronic Design Automation (EDA) tool for physical design tasks including partitioning, chip planning, placement, and routing to optimize performance, power, and area in any VLSI circuit.
5	Use Electronic Design Automation (EDA) tool to perform Static Timing Analysis for latch and flip-flop using CAD tool.
6	Develop a program for chip partitioning algorithm and simulate VLSI chip partitioning

7	Develop a program for chip planning algorithm and simulate VLSI chip planning
8	Develop a program for placement algorithm and simulate placement of circuit modules
9	Simulate algorithm for global and detailed routing to simulate exact pathways for interconnecting standard cells, macros, and I/O pins.
10	Develop a program for clock routing algorithm to simulate interconnection of multiple clocked cells to a single clock generator.

Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	VLSI Physical Design: From Graph Partitioning to Timing Closure	1 st	Kahng, A.B., Lienig, J., Markov, I.L., Hu, J.	Springer	2014
2	Algorithm for VLSI Physical Design Automation	2 nd	Sherwani, N.A.	Kluwer	2012

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Static Timing Analysis for Nanometer Designs: A Practical Approach	1 st	J. Bhasker and Rakesh Chadha	Springer	2009
2	Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler Physical Compiler and Prime Time	2 nd	Bhatnagar, H.	Kluwer Academic Publishers : New York	2013

Online Resource: 1. https://onlinecourses.nptel.ac.in/noc21_cs12/preview

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
M044	ASIC Verification	3	--	2	5	10	3	--	1	4
		Examination Scheme								
MDM-4		Component	ISE (%)		MSE (%)		ESE (%)		Total	
		Theory	20		20		60		100	
	Laboratory	80		--		20		100		

Pre-requisite Course Codes, if any.	Basic Electrical Engineering, Problem Solving using Imperative, Programming, Problem Solving using OOPs, Hardware Description Language (HDL) Programming, Basic CMOS VLSI Design, VLSI Physical Design
Course Objective: The course aims to familiarize students and select the verification methodology like simulation-based verification, formal verification, and hardware emulation based on their strengths, weaknesses, and when to use each approach. It would lead to build proficiency in hardware description System Verilog, as well as verification languages like System Verilog Assertions (SVA) and Universal Verification Methodology (UVM). Learners will be able to develop comprehensive testbenches that thoroughly exercise the ASIC design under various conditions to identify bugs and ensure functional correctness. Proficiency in using industry-standard verification tool, formal verification tools and debugging tools.	
Course Outcomes (CO): <i>At the end of the course students will be able to</i>	
MDEC34.1	Recognise trends in ASIC verification
MDEC34.2	Apply System Verilog constructs for verification
MDEC34.3	Create testbenches, threads and show interprocess communication
MDEC34.4	Create test cases under constrained environment
MDEC34.5	Validate design with System Verilog assertions and functional coverage

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MDEC34.1	1							1	1	1		2
MDEC34.2	3		3	3	3			1	1	1		1
MDEC34.3	3		3	3	3			1	1	1		1
MDEC34.4	3		3	3	3			1	1	1		1
MDEC34.5	3		3	3	3			1	1	1		1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate√	Create√
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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Basics of System Verilog	1 (T), 5 (R)	4
	1.1	Verification Basics: Technology challenges, Verification methodology, Testbench creation, Verification languages, Verification IP reuse, Verification approaches, Verification plans		
2	Title	Data types, procedural statements and testbench	1 (T), 1 (R), 3 (R)	8
	2.1	Data Types: Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user-defined structures, type conversion, enumerated types, constants, strings, expression width		
	2.2	Procedural Statements and Routines: Procedural statements, tasks, functions and void functions, task and function overview, routine arguments, returning from a routine, local data storage, time values		
	2.3	Connecting the Testbench and Design: Separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, top-level scope, program-module, interactions	1 (T), 1 (R), 3 (R)	
3	Title	OOP and Randomization	1 (T), 1 (R), 3 (R)	10
	3.1	Basic OOP: Class, creating new objects, Object deallocation, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public Vs local, building a testbench		
	3.2	Randomization: Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques, common randomization problems, Iterative and array constraints, Atomic stimulus generation Vs scenario generation, random control, random number generators, random device configuration		
4	Title	IPC and advanced OOP	1 (T), 1 (R), 3 (R)	12
	4.1	Threads and Interprocess Communication: working with threads, disabling threads, interprocess communication, events, semaphores, mailboxes, building a testbench with threads and IPC		
	4.2	Advanced OOP and Testbench Guidelines: Inheritance, Blueprint pattern, downcasting and virtual methods, composition, inheritance and alternatives, copying an object, abstract classes and pure virtual methods, callbacks, parameterized classes		
5	Title	Assertions and Functional Coverage	1 (T),	8
	5.1	System Verilog Assertions: Assertions in verification		

		methodology, understanding sequences and properties, System Verilog Assertions in the Design Process, Formal Verification Using Assertions and System Verilog Assertions Guidelines	1 (R), 2 (R), 4 (R)	
	5.2	Functional Coverage: Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options, analyzing coverage data, measuring coverage statistics during simulation.		
	Self Study	Advanced Interfaces: Virtual interfaces with the ATM router, connecting to multiple design configurations, procedural code in an interface, A complete System Verilog Testbench: Design blocks, testbench blocks, alternate tests, Interfacing with C: Passing simple values, connecting to a simple C routine, connecting to C++, simple array sharing, open arrays, sharing composite types, pure and context imported methods, communicating from C to system Verilog, connecting other languages	1 (T), 1 (R), 2 (R), 4 (R)	5*
Total (*Not included)				42

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design MUX and D-FF modules with parameters to enable students to understand how different parameters influence module behavior and functionality.
2	Familiarization of simulation tool for verification of design using System Verilog. Simulate MUX and D-FF.
3	Complete the given task on literals and data types in System Verilog. Also write the simulation output for the given Procedural Statements
4	Write the simulation output for the given Interprocess Communication
5	Write the simulation output for the given randomization code
6	Write the simulation output for the given Interfaces, Program and Clocking Blocks
7	Write the simulation output for the given Processes
8	Write the simulation output for the given Functional Coverage
9	Write the simulation output for the given Assertions
10	Open-ended problem: Apply System Verilog concepts to any real-life application and its execution/implementation. i. Designing and Verifying Peripheral Interfaces: Design, verify, and simulate interfaces like UART, SPI, I2C, or PCIe using SystemVerilog to ensure compatibility and reliability in ASIC designs. ii. Developing Verification IP (VIP): Create Verification IP (VIP) for popular protocols or interfaces, such as USB, Ethernet, or HDMI, to be used in larger ASIC verification environments.

	<p>iii. Verifying ASIC Components for IoT Devices: Verify ASIC components like sensors, communication modules, or processing units for Internet of Things (IoT) devices, ensuring low power consumption, reliability, and interoperability.</p> <p>iv. ASIC Verification for Automotive Electronics: Verify ASIC components used in automotive electronics, such as engine control units, safety systems, or infotainment systems, to ensure compliance with industry standards and safety requirements.</p> <p>v. ASIC Verification for Consumer Electronics: Verify ASIC components for consumer electronics devices like smartphones, tablets, or gaming consoles, ensuring functionality, performance, and compatibility with diverse hardware and software environments.</p>
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Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	System Verilog for Verification: A guide to learning the testbench language features	2 nd	Chris Spear	Springer	2010

Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	System Verilog for Design: A guide to using system Verilog for hardware design and modeling	2 nd	Stuart Sutherland, Simon Davidmann, and Peter Flake	Springer	2006
2	System Verilog Assertions Handbook	4 th	Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper	VhdlCohen Publishing	2015
3	System Verilog Language Reference manual	--	--	--	--
4	System on Chip Verification Methodologies and Techniques	1 st	S Prakash Rashinkar, Peter Paterson and Leena Singh	Kluwer Academic	2003

Online Resource:

<https://elearn.nptel.ac.in/shop/iit-workshops/completed/workshop-on-soc-verification/?v=c86ee0d9d7ed>

MDM COURSE OFFERED BY INDUSTRY

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
AI (For Non CS Students) (MDM 09) (Vizuara Technologies Pvt Ltd)	M091: Foundations in AI and ML	M092: Machine Learning and Deep Learning Mastery	M093: NLP and CV Mastery	M094: Large Language Models Theory and Deployment, Capstone Project
Financial & Strategic Management (MDM-11) (Six Ladders)	M111: Economics and Strategic Management	M112: Introduction to Financial Analysis	M113: Introduction to Finance	M114: Industry Project (FNSM)
UI/UX Design Programme (MDM-13) (Pearl Academy Pvt. Ltd.)	M131: Foundations of UI/UX Design	M132: Intermediate UI/UX Design	M133: Advanced UI/UX Design and Specializations	M134: Advanced Research and Emerging Practices in
Management (MDM-15) (SPJIMR Management)	M151: Fundamentals of Accounting & Finance	M152: Supply Chain Management	M153: IT for Business	M154: Marketing Management
Barclays Minor in Banking Technology (MDM-16) (Barclays)	M161: BFSI , Data Management & Analytics	M162: Enterprise Risk Management & Applied cyber security	M163: Agile Methodology	M164: Academic-Industry collab Project
Corporate Finance & Investment Banking (MDM -17) (IIT Patna)	M171_P: Data Preparation using MS Excel	M172_P: Corporate Finance & Investment Banking Fundamentals	M173_P: Detailed Investment Banking Operations Activities	M174_P: Performing Diversification in Portfolios and Investments
Business Analytics (MDM-18) (IIT Patna)	M181_P: Python for Data Science	M182_P: SQL for Business Analytics	M183_P: Stats & Machine Learning	M184_P: Data Visualization Tools: Power BI, Excel, Intro to Excel