DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ANNA UNIVERSITY, CHENNAI – 600 025.

Vision of the Department

The vision of the Department is to create computing professionals, researchers and entrepreneurs with high technical competency and communication skills by setting high standards in academic excellence and meeting the future needs of the society.

Mission of the Department

The mission of the Department is to

- Provide motivated faculty and state of the art facilities for education and research, both in foundational aspects and emerging computing trends.
- Develop knowledgeable, industry-ready students with pertinent competencies such as problem solving, leadership, and interpersonal skills.
- Inculcate responsibility through sharing of knowledge and innovative computing solutions that benefit the society-at-large.
- Engage in collaborative research with academia and industry for seamless transfer of knowledge resulting in patents, products and commercialization.
- Generate adequate resources for research activities from sponsored projects and consultancy.

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PROGRAMME EDUCATIONAL OBJECTIVES:

The objectives of the programme can be broadly defined on three counts:

- To comprehend the fundamental concepts in Computer Science and Engineering and apply the interaction between theory and practice for problem solving.
- To critically analyze current systems and trends, and to develop innovative solutions that cater to the dynamic nature of the computer industry, and lead to entrepreneurial initiatives.
- To pursue lifelong multidisciplinary learning as professional engineers, researchers and scientists and effectively communicate technical information, function effectively on teams, and apply computer engineering solutions within a global, societal, and environmental context.

PROGRAMME OUTCOMES:

Students will be able to:

PO1. **Engineering Knowledge:** Apply mathematical foundations, algorithmic principles, and Computer Science theory in the modelling and design of computer based systems of varying complexity .

PO2. **Problem Analysis:** Critically analyze a problem, identify, formulate and solve problems in the field of Computer Science and Engineering, considering current and future trends.

PO3. **Design/Development of Solutions:** Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, and sustainability in the field of computer engineering.

PO4. **Conduct Investigations of Complex Problems:** Perform experiments and organize, analyze, and interpret data.

PO5. **Modern Tool Usage:** Use current techniques, skills, and tools necessary for computing practice.

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PO6. **Engineer and Society:** Apply knowledge and reasoning to assess issues related to social, ethical, legal, economical, health and safety and apply them to professional engineering practice.

PO7. **Environment and Sustainability:** Analyze the local and global impact of computing on individuals, organizations, and society and look at sustained development.

PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO9. **Individual and Team Work:** Function effectively on teams to accomplish a common goal.

PO10. **Communication:** Communicate effectively with a range of audiences and prepare technical documents and make effective oral presentations.

PO11. **Project Management and Finance:** Demonstrate knowledge of engineering and management principles to develop innovative solutions and manage projects effectively, both as a member and a leader in a team.

PO12. **Life-long Learning:** Recognize the need for and possess an ability to engage in life-long learning, leading to continuing professional development.

PROGRAM SPECIFIC OUTCOMES

1. To use mathematical, algorithmic, and theoretical foundations in the study of computing systems.

2. To analyze problem requirements and develop appropriate solutions.

3. To acquire knowledge and skills in emerging technologies.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objectives and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1.	3	3	3	3	3	1	1	1	2	1	2	2	3	3	2
2.	3	3	3	3	3	3	1	1	3	2	3	1	2	3	3
3.	2	2	2	2	2	3	3	3	3	3	3	3	2	3	3

			PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES		
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POI2	1	2	3
YEAR I	SEMESTER I	Technical English I		1.00		1.50	1.00	1.00	1.00	1.00	1.00	2.60	1.00	1.40		1.00	1.00
		Engineering Physics			1.60	1.00		1.00				1.00		1.00		1.20	1.00
		Mathematics I	3.00	3.00	2.00	2.20	2.00	1.40	2.00	2.00			2.00	1.40	3.00	2.20	1.80
		Programming with C	2.00	2.00	1.00	3.00	2.00	1.00						3.00	1.00	2.00	2.00
		Computational Thinking	2.00	2.60	2.40	2.60	1.40	2.60	1.60		1.00	1.40	1.00	2.00	1.00	3.00	

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	SEMESTER II	Technical English II				1.50	1.00	1.00	1.00	1.50	1.20	2.80	1.00	1.80		1.40	1.00
		Engineering Chemistry	1.40	2.40	1.00	2.20	1.40	1.00			1.80		1.00	1.00	1.20	2.40	2.60
		Discrete Mathematics	3.00	3.00	2.00	2.00	2.00	1.20	1.00	1.00			2.00	1.40	3.00	2.20	2.60
		Engineering Graphics	1.00	1.00		2.00	1.00				3.00	3.00		1.00		1.00	
		Application Development Practices	3.00	2.80	1.00	1.00	3.00	1.00					1.00	2.00	2.00	2.00	3.00
YEAR II	SEMESTER III	Data Structures and Algorithms	3.00	3.00	3.00	2.33	1.00	1.67	1.00					3.00	3.00	3.00	3.00
		Digital Fundamentals and Computer Organization	3.00	2.80	2.20	2.40	1.75	1.75	1.00		2.25	1.60	2.00	2.00	2.20	1.80	2.00
		Probability and Statistics	3.00	2.83	2.67	2.67	2.17	2.17	1.50				1.83	1.83	2.83	2.50	1.83
		Basics of Electrical and Electronics Engineering	2.17	1.83	1.67	2.00	2.00	1.00			2.00	1.50			2.83	2.33	1.17
		Open Elective I															
	SEMESTER IV	Database Management Systems	3.00	3.00	3.00	2.67	2.17	2.67	1.00		2.50		1.00	2.33	2.83	2.83	2.00
		Computer Architecture	3.00	3.00	3.00	1.00	1.00	1.00	1.00		1.00			3.00	3.00	3.00	2.33
		Operating Systems	3.00	3.00	3.00	2.20	1.00	1.40	1.00		1.00			3.00	3.00	3.00	3.00
		Mathematics Soft Core I															
		Open Elective II															

YEAR III	SEMESTER V	Compiler Design	3.00	3.00	3.00	3.00	2.80	1.17	1.00		1.00		1.00	2.00	3.00	3.00	2.00
		Object Oriented Analysis and Design	3.00	3.00	3.00	3.00	2.00	2.00	1.00		2.00		2.00	2.00	3.00	3.00	2.00
		Computer Networks	3.00	3.00	2.67	2.50	1.67	1.00	1.00		2.50			1.60	3.00	2.33	1.83
		Mathematics Soft Core II															
		Professional Soft Core I															
	SEMESTER VI	Professional Soft Core II															
		Professional Soft Core III															
		Professional Soft Core IV															
		Professional Elective I															
		Creative and Innovative Project	2.60	2.20	2.00	2.60	1.60	2.00	1.00		3.00	1.00	2.00	1.20	2.60	2.60	2.60
YEAR IV	SEMESTER VII	Professional Elective II															
		Professional Elective III															
		Professional Elective IV															
		Professional Elective V															

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	SEMESTER VIII	Professional Elective VI															
		Professional Elective VII															
		Project Work	3.00	3.00	2.50	2.67	2.17	2.17	2.20	2.00	3.00	3.00	2.33	1.50	2.83	2.67	2.40

ANNA UNIVERSITY, CHENNAI
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I - VIII SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	HS6151	Technical English I	HS	4	4	0	0	3	5
2.	PH6151	Engineering Physics	BS	5	3	0	2	3	5
3.	MA6151	Mathematics I	BS	4	3	1	0	3	5
4.	CS6101	Programming with C	HC	7	2	1	4	3	6
5.	CS6102	Computational Thinking	HC	4	0	0	4	3	3
TOTAL				**24**	**12**	**2**	**10**	**15**	**24**

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	HS6251	Technical English II	HS	4	4	0	0	3	5
2.	CY6251	Engineering Chemistry	BS	5	3	0	2	3	5
3.	MA6251	Discrete Mathematics	BS	4	3	1	0	3	5
4.	GE6251	Engineering Graphics	ES	6	2	0	4	3	5
5.	CS6103	Application Development Practices	HC	5	1	0	4	3	4
TOTAL				**24**	**13**	**1**	**10**	**15**	**24**

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SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6104	Data Structures and Algorithms	HC	8	3	1	4	3	7
2.	CS6105	Digital Fundamentals and Computer Organization	HC	8	3	1	4	3	7
3.	MA6351	Probability and Statistics	BS	4	3	1	0	3	5
4.	EE6351	Basics of Electrical and Electronics Engineering	ES	8	4	0	4	3	7
5.		Open Elective I	OE	3	3	0	0	-	3
TOTAL				**31**	**16**	**3**	**12**	**12**	**29**

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6106	Database Management Systems	HC	7	3	0	4	3	6
2.	CS6107	Computer Architecture	HC	5	3	0	2	3	5
3.	CS6108	Operating Systems	HC	7	3	0	4	3	6
4.		Mathematics Soft Core I	MSC	4/7	3	1/0	0/4	3	5/6
5.		Open Elective II	OE	3	3	0	0	-	3
TOTAL				**26/29**	**15**	**1/0**	**10/14**	**12**	**25/26**

SEMESTER V

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6109	Compiler Design	HC	7	3	0	4	3	6
2.	CS6110	Object Oriented Analysis and Design	HC	7	3	0	4	3	6
3.	CS6111	Computer Networks	HC	7	3	0	4	3	6
4.		Mathematics Soft Core II	MSC	4/7	3	1/0	0/4	3	5/6
5.		Professional Soft Core I	PSC	3/7	3	0	0/4	3	4/6
TOTAL				**28/35**	**15**	**1/0**	**12/20**	**15**	**27/30**

SEMESTER VI

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.		Professional Soft Core II	PSC	3/7	3	0	0/4	3	4/6
2.		Professional Soft Core III	PSC	3/7	3	0	0/4	3	4/6
3.		Professional Soft Core IV	PSC	3/7	3	0	0/4	3	4/6
4.		Professional Elective I	PE	3	3	0	0	3	4
5.	CS6611	Creative and Innovative Project	EEC	4	0	0	4	3	3
TOTAL				**16/28**	**12**	**0**	**12/16**	**15**	**19/25**

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SEMESTER VII

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.		Professional Elective II	PE	3	3	0	0	3	4
2.		Professional Elective III	PE	3	3	0	0	3	4
3.		Professional Elective IV	PE	3	3	0	0	3	4
4.		Professional Elective V	PE	3	3	0	0	3	4
TOTAL				**12**	**12**	**0**	**0**	**12**	**16**

SEMESTER VIII

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.		Professional Elective VI	PE	3	3	0	0	3	4
2.		Professional Elective VII	PE	3	3	0	0	3	4
3.	CS6811	Project Work	EEC	12	0	0	12	9	9
TOTAL				**18**	**6**	**0**	**12**	**15**	**17**

MINIMUM NO OF CREDITS TO BE ACQUIRED:185

HUMANITIES AND SOCIAL SCIENCES (HS)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	HS6151	Technical English I	HS	4	4	0	0	3	5
2.	HS6251	Technical English II	HS	4	4	0	0	3	5

BASIC SCIENCES (BS)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	PH6151	Engineering Physics	BS	5	3	0	2	3	5
2.	MA6151	Mathematics I	BS	4	3	1	0	3	5
3.	MA6251	Discrete Mathematics	BS	4	3	1	0	3	5
4.	CY6251	Engineering Chemistry	BS	5	3	0	2	3	5
5.	MA6351	Probability and Statistics	BS	4	3	1	0	3	5

ENGINEERING SCIENCES (ES)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	GE6251	Engineering Graphics	ES	6	2	0	4	3	5
2.	EE6351	Basics of Electrical and Electronics Engineering	ES	8	4	0	4	3	7

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HARD CORE (HC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6101	Programming with C	HC	7	2	1	4	3	6
2.	CS6102	Computational Thinking	HC	4	0	0	4	3	3
3.	CS6103	Application Development Practices	HC	5	1	0	4	3	4
4.	CS6105	Digital Fundamentals and Computer Organization	HC	8	3	1	4	3	7
5.	CS6104	Data Structures and Algorithms	HC	8	3	1	4	3	7
6.	CS6110	Object Oriented Analysis and Design	HC	7	3	0	4	3	6
7.	CS6109	Compiler Design	HC	7	3	0	4	3	6
8.	CS6108	Operating Systems	HC	7	3	0	4	3	6
9.	CS6106	Data Base Management Systems	HC	7	3	0	4	3	6
10.	CS6111	Computer Networks	HC	7	3	0	4	3	6
11.	CS6107	Computer Architecture	HC	5	3	0	2	3	5

MATHEMATICS SOFTCORE (MSC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	MA6201	Linear Algebra	MSC	4	3	1	0	3	5
2.	CS6201	Graph Theory	MSC	4	3	1	0	3	5
3.	EC6201	Signals and Systems	MSC	7	3	0	4	3	6
4.	CS6202	Theory of Computation	MSC	4	3	1	0	3	5

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PROFESSIONAL SOFTCORES (PSC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6301	Machine Learning	PSC	7	3	0	4	3	6
2.	CS6302	Programming Paradigms	PSC	3	3	0	0	3	4
3.	CS6303	Distributed Systems	PSC	3	3	0	0	3	4
4.	CS6304	Software Engineering	PSC	3	3	0	0	3	4
5.	CS6305	Microprocessors	PSC	7	3	0	4	3	6
6.	CS6306	Parallel Programming	PSC	7	3	0	4	3	6
7.	CS6307	Advanced Algorithms	PSC	7	3	0	4	3	6
8.	CS6308	Java Programming	PSC	7	3	0	4	3	6

PROFESSIONAL ELECTIVES (PE)
TRACK - 1

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6001	Data Mining	PE	3	3	0	0	3	4
2.	CS6002	Soft Computing	PE	3	3	0	0	3	4
3.	CS6003	Big Data Analytics	PE	3	3	0	0	3	4
4.	CS6004	Information Visualization	PE	3	3	0	0	3	4
5.	CS6005	Deep Learning Techniques	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK - 2

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6006	Cloud Computing	PE	3	3	0	0	3	4
2.	CS6007	Information Security	PE	3	3	0	0	3	4
3.	CS6008	Cryptography and Network Security	PE	3	3	0	0	3	4
4.	CS6009	Mobile Networks	PE	3	3	0	0	3	4
5.	CS6010	Wireless and Sensor Networks	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK - 3

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6011	GPU Computing	PE	3	3	0	0	3	4
2.	CS6012	Embedded Systems	PE	3	3	0	0	3	4
3.	CS6013	Unix Internals	PE	3	3	0	0	3	4
4.	CS6014	IoT and Smart Appliances	PE	3	3	0	0	3	4
5.	CS6015	Multicore Architectures	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK - 4

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6016	Graphics and Multimedia	PE	3	3	0	0	3	4
2.	CS6017	Human Computer Interaction							
3.	CS6018	Image Processing	PE	3	3	0	0	3	4
4.	CS6019	Augmented Reality and Virtual Reality	PE	3	3	0	0	3	4
5.	CS6020	Digital Signal Processing	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK - 5

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
1.	CS6021	Software Testing & Quality Assurance	PE	3	3	0	0	3	4
2.	CS6022	Software Project Management	PE	3	3	0	0	3	4
3.	CS6023	Software Test Automation	PE	3	3	0	0	3	4
4.	CS6024	Test Driven Development	PE	3	3	0	0	3	4
5.	CS6025	Supply Chain Management	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK - 6

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
1.	CS6026	Game Development	PE	3	3	0	0	3	4
2.	CS6027	Modeling and Simulation	PE	3	3	0	0	3	4
3.	CS6028	Queuing Theory and Performance Evaluation of Computer Systems	PE	3	3	0	0	3	4
4.	CS6029	Social Network Analysis	PE	3	3	0	0	3	4
5.	CS6030	Natural Language Processing	PE	3	3	0	0	3	4

PROFESSIONAL ELECTIVES (PE)
TRACK – 7

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
1.	CS6031	Database Tuning	PE	3	2	0	0	3	3
2.	CS6032	Software Defined Networks	PE	3	2	0	0	3	3
3.	CS6033	Storage Area Networks	PE	3	2	0	0	3	3
4.	CS6034	Service Oriented Architecture	PE	3	2	0	0	3	3
5.	CS6035	Entrepreneurship Development	PE	3	2	0	0	3	3

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	EL	CREDITS
THEORY									
1.	CS6611	Creative and Innovative Project	EEC	4	0	0	4	3	3
2.	CS6811	Project Work	EEC	12	0	0	12	9	9

SUMMARY

Category of Courses	HS	BS	ES	OE	HC	MSC	PSC	PE	EEC	Total
Minimum Credits to be earned	10	25	12	6	62	10	20	28	12	185

HS6151 **TECHNICAL ENGLISH I** **L T P EL C**
4 0 0 3 5

MODULE	RHETORICAL FUNCTIONS	PRIMARY FOCUS RHETORICAL FUNCTION: INTRODUCING SELF, THE LINGUISTIC ACT OF NARRATING	PRIMARY OUTCOME
MODULE 1	**SELF-INTRODUCTION. THE LINGUISTIC ACT OF NARRATING**	**Oral Fluency**: Introducing oneself-introducing friend/family (connecting campus)- **Reading**: biographies (subject based) reading strategies-skimming-scanning-predicting- **Language Focus**- Use of present and past tense forms of verbs-(Degrees of Comparison) - **Lexical Development**: Adjectives-learning topic related vocabulary (approximately 30)- **Writing**: short biographies with the given details of (related to specific branches of engineering) **Listening:** listening to speeches by specialists from various branches of engineering and completing activities such as answering questions , identifying the main ideas of the listening text, style of the speaker (tone and tenor) and making inferences.	At the end of the module, students should be able to: ▪ Introduce oneself for at least 2 minutes with minimal intrusive errors and breaks. ▪ Write a paragraph by listing information chronologically
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
			12 0 0 9

MODULE 2	**COMPARING AND CONTRASTING**	**Oral Fluency**: Comparing and Contrasting (e.g. Facebook and Whatsapp)- **Language Focus:** verbal phrases-compound nouns(noun strings)-simple present and present perfect , future tense-**Lexical Development**: Discourse Analysis-lexical links- related to the function of comparing and contrasting-lexical items related to the reading texts -**Reading:** texts on comparing and contrasting concepts in engineering and technology (e.g. Computers and Artificial intelligence) **Listening**: gap-filling exercises -**Writing:** Definitions(short and long)-paragraph writing especially comparing and contrasting discourse	At the end of the module, students should be able to: ▪ Compare and contrast products/ concepts both in speech and writing
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
			12 0 0 9

MODULE 3	**STATING PROBLEMS AND EXPRESSING SOLUTIONS**	**Oral Fluency:** Small Group Discussion (e.g. The changing face of the software Industry)-**Language Focus**-sentence level linguistics (construction of function-based sentences)-past continuous and present perfect continuous and future tenses-**Lexical Development**-learning vocabulary related to content and function (approximately 30)-**Reading**: passages discussing problems and solutions (e.g. automation in the software industry and employment opportunities in the next decade)-**Listening**: TED talks & discussions-**Writing:** lengthy paragraphs-(e.g. What does the future hold for the software industry?)-Formal letter writing-highlighting problems and offering solutions.	At the end of the module, students should be able to: • Participate in small group discussions effectively. • Write extended paragraphs • Listen and comprehend long talks
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
MODULE 4	**EXPRESSING CAUSAL RELATIONS**	**Oral Fluency**- speaking skills practice in small groups. (e.g. uses and abuses of the mobile phone) **Language Focus:** use of passive voice forms of verbs – past participle forms (sentence construction for expressing causal relations)-**Lexical Development**: specialized vocabulary to establish causal relations-**Reading**: texts on cause and effect functions- texts on process description-**Listening**:	At the end of the module students should be able to: • Write two paragraphs describing and interpreting visual data (charts, tables etc.) • Read and comprehend texts expressing causal relations

		filling a table, introduction to graphic presentations (pie charts, tables, pictograms) - **Writing:** data interpretation and making inferences	
		Suggested Activities	**Suggested Evaluation Methods**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
			12 0 0 9
MODULE 5	**EXTENDED SPEECH**	**Oral Fluency**: making mini presentations (e.g. the working of an algorithm)- **Language Focus**-passive voice and use of phrases - **Lexical Development**: specialist vocabulary related to theme-cohesive ties related to process description (sequential expressions)- **Reading**- Pie chart/Table /Bar chart interpretation -**Listening** – drawing a flowchart – **Writing**: channel conversion– diagram to written forms	At the end of the module, students should be able to : • Make short presentations • Read and interpret visual data • Write a process description
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work

EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid –Semester Assessment	End Semester
1.	**Theory**	**40**	**20**	**40**

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

- Communicate effectively in group discussion and in oral presentation using visual materials
- Write comparison and contrast paragraphs with emphasis on coherence and cohesion
- Interpret and describe the data presented in the form of charts such as pie chart, bar chart, and table elaborately
- Read short as well as long passages and understand the main ideas of these passages
- Listen to speeches and discussions and comprehend the major points

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	–	–	–	1	–	1	1	–	1	3	1	2	–	1	–
CO2	–	1	–	–	–	1	–	–	1	3	1	2	–	1	–
CO3	–	–	–	2	1	1	–	–	1	2	–	1	–	1	–
CO4	–	–	–	–	–	1	1	–	1	2	–	1	–	1	1
CO5	–	–	–	–	–	1	1	1	–	3	–	1	–	1	1

PH6151	ENGINEERING PHYSICS	L	T	P	EL	CREDITS
		3	0	2	3	5

Prerequisites for the course: None

OBJECTIVES:

- To introduce the basic concepts of physics.
- To develop critical thinking through problem solving related to physics
- To identify, analyze and implement possible applications with the goal of achieving the most efficient and effective usage of conceptual physics.

MODULE I :	L	T	P	EL
	3	0	2	3

Elasticity – Stress-strain diagram – cantilever – bending moment – Young's modulus determination – twisting couple.

SUGGESTED ACTIVITIES:

- In Class activity: Simple harmonic motion
- Practical – Nonuniform bending: Determination of Young's modulus.
- EL: Cantilever, Torsional pendulum, Simple harmonic oscillations

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Torsional pendulum - rigidity modulus - moment of inertia - simple harmonic motion - Wave equation – waves on a string – wave power & intensity – sound waves – decibels.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- In class activity: Derivation and Simplification
- EL – Practical Problems - Waves – Resonance – Doppler effect of sound – standing waves in a string
- **Practical – Torsional Pendulum: Determination of rigidity modulus of wire and moment of inertia of disc.**

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Noise in physical systems – noise mechanisms – ultrasonics: production – magnetostriction and piezoelectric methods – detection of ultrasonic waves– acoustic grating – ultrasonic interferometer.

SUGGESTED ACTIVITIES:

- EL: Piezoelectric effect, acoustic grating
- In class activity: Ultrasonic oscillator construction
- Practical - Ultrasonic interferometer: Determination of velocity of sound and compressibility of liquids.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Thermal expansion – thermal stress – bimetals – heat transfer in solids & thermal conductivity - compound media – Forbe's and Lee's disc method: theory and experiment.

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SUGGESTED ACTIVITIES: • Flipped Class room • EL: Thermal expansion, bimetals, Compound media, Thermal conductivity • Practical – Lee's disc: Determination of thermal conductivity of a bad conductor.
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**
Double and multiple slits interference – diffraction gratings – thin films – antireflection coating – Newton's rings, air-wedge and their applications – Michelson interferometer – The diffraction limit.				
SUGGESTED ACTIVITIES : • Applications in class discussion • EL – Thin films, antireflection coating, Air-wedge, Interferometry • Practical – Air-wedge: Determination of thickness of thin sheet/wire.				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**
Lasers – Principles and applications – Einstein's coefficients – laser resonator - semiconductor laser				
SUGGESTED ACTIVITIES : • Introduction in class • EL: Laser theory, principles, industrial applications, fiber optics • Flipped Classroom for further study • Practical – Compact disc: Determination of width of groove using laser				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

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Optical fibers – propagation of light in optical fibers – acceptance angle – numerical aperture – fiber optical communication system – fiber optic sensors.				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped class rooms • Practical: Optical fiber: Determination of numerical aperture and acceptance angle. • EL: Fiber optics & sensors				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Wave - particle duality - The Schrodinger equation - time dependent and independent equations - expectation values - particle in a box.				
SUGGESTED ACTIVITIES : • Illustration of potential wells and tunneling phenomena in class • Flipped classroom • EL – Wave - particle duality, Schrodinger equation, Particle in a box problem (1D, 2D, 3D)				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**
Crystal structures and packing factor (SC, BCC, FCC, Diamond) – Bragg's law – determination of crystal structures.				
SUGGESTED ACTIVITIES : • Mostly in Class • EL - Mini project for constructing crystal structures using softballs, Crystal structure parameters • Practical: Crystal structures: Classification and packing factor, Modelling of Diamond crystal structure				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation (crystal structures)				
MODULE X:	**L**	**T**	**P**	**EL** Attested

	3	**0**	**4**	**3**
Density of states – Fermi-Dirac statistics – Population of the conduction and valence bands - Fermi level – single crystal growth – epitaxy - process of integrated circuit production.				
SUGGESTED ACTIVITIES : • Combination of in class & Flipped • EL – Crystal growth techniques and IC process • Practical: Post office box: Determination of band gap of a semiconductor • Practical: Solution growth of crystal				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

REFERENCE BOOKS:

1. Richard Wolfson, "Essential University Physics", Second Edition, Addision-Wesley, 2012.
2. Narciso Garcia and Arthur Damask, "Physics for Computer Science Students", Springer-Verlag, 1991.
3. Neil Gershenfeld, "The Physics of Information Technology", Cambridge University Press, 2000.
4. Harris Benson, "University Physics", Wiley India, 2004.
5. P.A. Tipler and G.P. Mosca, "Physics for Scientists and Engineers with Modern Physics, W.H. Freeman, 2007.

EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid – Semester Assessment	End Semester
1.	**Theory Integrated with Practical**	**15(T) + 25 (P)**	**20**	**40**

OUTCOMES:

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

- Apply appropriate concepts of physics to solve problem
- Acquire knowledge on the basics of properties of matter, optics, lasers, crystals.
- Appreciate the importance of physics of materials for various engineering applications.
- The students will gain knowledge on the properties of sound, noise cancellation, and production, detection and applications of ultrasonics
- The students will gain knowledge on interferometers, lasers and fiber optics
-

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	2	1	-	-	-	-	-	-	-	1	-	2	1
CO2	-	-	2	1	-	1	-	-	-	1	-	1	-	1	1
CO3	-	-	1	1	-	-	-	-	-	-	-	1	-	1	1
CO4	-	-	2	1	-	-	-	-	-	-	-	1	-	1	1
CO5	-	-	1	1	-	-	-	-	-	-	-	1	-	1	1

MA6151	MATHEMATICS –I	L	T	P	EL	CREDITS
		3	1	0	3	5

OBJECTIVES:

- To gain proficiency in calculus computations.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To familiarize the student with functions of several variables.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

MODULE I	SINGLE VARIABLE FUNCTIONS	L	T	P	EL
		3	1	0	3

Representation of functions - New functions from old functions - Limit of a function - Limits at infinity -Continuity.

SUGGESTED ACTIVITIES:

- Problem-solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II	DIFFERENTIALCALCULUS	L	T	P	EL
		3	1	0	3

Derivatives - Differentiation rules – intermediate theorem - Rolle's theorem- Maxima and Minima of functions of one variable.

SUGGESTED ACTIVITIES:

- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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MODULE III FUNCTIONS OFSEVERALVARIABLES	L	T	P	EL
	3	1	0	3
Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians				
SUGGESTED ACTIVITIES: • Problem solving sessions • Applications in real life problems				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE IV MULTI VARIABLE DIFFERENTIAL CALCULUS	L	T	P	EL
	3	1	0	3
Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.				
SUGGESTED ACTIVITIES: • Problem solving sessions • Flipped Class room				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE V INTEGRALCALCULUS	L	T	P	EL
	3	1	0	3
Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts				
SUGGESTED ACTIVITIES : • Problem solving sessions				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE VI MORE ON INTEGRAL CALCULUS	L	T	P	EL
	3	1	0	3
Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals				

SUGGESTED ACTIVITIES :

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII MULTIPLEINTEGRALS	L	T	P	EL
	3	1	0	3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves

SUGGESTED ACTIVITIES:

- Problem solving sessions
- Flipped Class room

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII VOLUME INTEGRALS	L	T	P	EL
	3	1	0	3

Triple integrals – Volume of solids – Change of variables in double and triple integrals.

SUGGESTED ACTIVITIES:

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX	L	T	P	EL
	3	1	0	3

Methods of variation of parameters – Method of undetermined coefficients -

SUGGESTED ACTIVITIES:

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:	L	T	P	EL
	3	1	0	3

Homogenous Equation of Euler's And Legendre's Type – System of Simultaneous Linear Differential Equations with Constant Coefficients.

SUGGESTED ACTIVITIES:

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXTBOOKS:

1. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi,2008.
2. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II,S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi,43rdEdition, 2014.

REFERENCES:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint,2010.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9thEdition, New Delhi,2014.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition,2007.
4. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7thEdition,2009.
5. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education, New Delhi, 2ndEdition, 5thReprint,2009.
6. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi,2007.

EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid – Semester Assessment	End Semester
1.	**Theory**	**40**	**20**	**40**

OUTCOMES:

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

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima of functions of two variables.
- Evaluate the integrals both by using Riemann sums and by using the fundamental theorem of calculus.

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- Apply integration to compute multiple integrals, area, volume, integrals in polar co - ordinates in addition to change of order and change of variables.
- Apply various techniques in solving ordinary differential equations.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1	2	2	-	-	2	2	3	2	3
CO2	3	3	1	2	1	1	-	-	-	-	2	1	3	2	2
CO3	3	3	3	2	3	1	-	-	-	-	2	2	3	3	2
CO4	3	3	1	3	1	2	-	-	-	-	2	1	3	2	1
CO5	3	3	3	3	3	2	-	-	-	-	2	1	3	2	1

CS6101 PROGRAMMING WITH C	L	T	P	EL	CREDITS
	2	1	4	3	6

Prerequisites for the course: None

OBJECTIVES:

- To learn programming using a structured programming language.
- To implement programs using basic features of C.
- To learn to use C pointers and dynamically allocated memory techniques.
- To learn advanced features of the C programming language
- To be able to use file operations in C

MODULE I :	L	T	P	EL
	2	1	4	3

Notion of memory, addresses, variables, instructions, execution of instructions. Operating system commands, file editing, compiling, linking, executing a program.

SUGGESTED ACTIVITIES:

- Practical - Use of operating system commands and file editing operations.

SUGGESTED EVALUATION METHODS:

- Exercises on the use of operating system commands and file editing operations.

MODULE II :	L	T	P	EL
	2	1	4	3

Data types - constants, variables - arithmetic operators - expressions - basic input/output. Relational, logical, increment, decrement operators. Bitwise, assignment, conditional operators.

SUGGESTED ACTIVITIES:

- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.

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- Practical - Demonstration of programs using integer type, arithmetic operators and basic input/output.
- Practical - Demonstration of programs using other data types and operators.

SUGGESTED EVALUATION METHODS:

- Programs on integer type, arithmetic operators, basic input output.

MODULE III :	**L**	**T**	**P**	**EL**
	2	**1**	**4**	**3**

Statements and blocks - Selection - if-else construct - iteration - while - for constructs. The constructs else-if, switch, do-while, break, continue, enum. Pseudocode, Programming style.

SUGGESTED ACTIVITIES :

- EL: Programs using if-else, while, for.
- EL: Programs using else-if, switch, do-while, break, continue, enum. Use of pseudocode, programming style.
- Practical: Demonstration of programs using if else, while, for.
- Practical: Use of pseudocode. Demonstration of programs using else-if, switch, do-while, break, continue, enum, programming style.

SUGGESTED EVALUATION METHODS:

- Programs using if else, while, for.

MODULE IV :	**L**	**T**	**P**	**EL**
	4	**2**	**8**	**6**

Array, declaration, initialization. Multi-dimensional arrays. Strings and character arrays, string operations on arrays.

SUGGESTED ACTIVITIES:

- EL - Programs using arrays and operations on arrays.
- Practical - Demonstration of programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- Practical - Demonstration of programs implementing string operations on arrays.

SUGGESTED EVALUATION METHODS:

- Evaluation: Programs using arrays and operations on arrays.
- Evaluation: Programs using strings and use of string library functions.
- Evaluation: Programs implementing string operations on arrays.

MODULE V :	**L**	**T**	**P**	**EL**
	4	**2**	**8**	**6**

Functions, definition, call, arguments, call by value. Call by reference. Recursion. Call stack. Header files, static variables, external variables.

SUGGESTED ACTIVITIES:

- EL - Programs using functions.
- Practical - Demonstration of programs using functions.
- EL - Programs using recursion.
- Practical - Demonstration of programs using recursion.

SUGGESTED EVALUATION METHODS:

- Evaluation: Programs using functions.
- Evaluation: Programs using recursion.

MODULE VI:	L	T	P	EL
	6	3	12	9

Pointers and arrays - address arithmetic. Dynamic Memory Allocation - Two dimensional arrays and pointers. Pointers and strings, string library functions. Pointers to functions.

SUGGESTED ACTIVITIES:

- EL - Programs using pointers and arrays, address arithmetic.
- Practical - Demonstration of programs using pointers and arrays, address arithmetic.
- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- Practical - Demonstration of programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.
- Practical - Demonstration of programs using pointers and strings.

SUGGESTED EVALUATION METHODS:

- Evaluation: Programs on pointers and arrays, address arithmetic.
- Evaluation: Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- Evaluation: Programs using pointers and strings.

MODULE VII:	L	T	P	EL
	4	2	8	6

Structures, Structures and arrays. Pointers to structures, Self-referential structures. Enumeration types, Unions, bit fields, typedefs.

SUGGESTED ACTIVITIES:

- EL - Programs using structures and arrays.
- Practical - Demonstration of programs using Structures and arrays.
- EL - Programs using Pointers to structures, Self-referential structures.
- Practical - Demonstration of programs using pointers to structures, Self-referential structures.

SUGGESTED EVALUATION METHODS:

- Evaluation: Programs using Structures and arrays.
- Evaluation: Programs using pointers to structures, self-referential structures.

MODULE VIII:	L	T	P	EL
	2	1	4	3

Files - binary, text - open, read, write, random access, close. Preprocessor directives. Command line arguments.

SUGGESTED ACTIVITIES:

- EL - Programs using file operations in real-world applications.
- Practical - Demonstration of real-world application using file operations.

SUGGESTED EVALUATION METHODS:

- Evaluation: Demonstration of real-world application.

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TEXT BOOKS:

1. Reema Thareja, "Programming in C", 2nd ed., Oxford University Press, 2016.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education, 1988.
3. Brian W. Kernighan and Rob Pike, "The Practice of Programming" (Chap 1), Pearson Education, 1999.

REFERENCES:

1. Pradip Dey and Manas Ghosh, "Computer Fundamentals and Programming in C", 2nd ed., Oxford University Press, 2013.
2. Yashavant Kanetkar, "Let us C", 15th ed., BPB Publications, 2017.
3. Paul J. Deitel and Harvey Deitel, "C How to Program", 7th ed., Pearson Education, 2013.

EVALUATION METHOD TO BE USED:

Continuous assessment	Mid term	End Semester
40 (P)	20	40

OUTCOMES:

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

- Apply appropriate programming constructs to solve problems.
- Write C programs for simple applications.
- Use C pointers and dynamically allocated memory to solve complex problems.
- Know advanced features of the C programming language.
- Apply file operations to develop solutions for real-world problems.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	3	2	1	-	-	-	-	-	3	1	2	2
CO2	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
CO3	2	2	1	3	2	1	-	-	-	-	-	3	1	2	2
CO4	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
CO5	2	3	1	3	2	1	-	-	-	-	-	3	1	2	2

	L	T	P	EL	CREDITS
CS6102 COMPUTATIONAL THINKING	**0**	**0**	**4**	**3**	**3**

Prerequisites for the course: None

OBJECTIVES:

- To formulate problems in a way that enables the use of a computer to solve them.
- To logically organize and analyze data.
- To automate solutions through algorithmic thinking.
- To identify, analyze and implement possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.

- To generalize and transfer this problem solving process to wide variety of problems.

MODULE I :	L	T	P	EL
	0	0	4	3

Algorithmic thinking - creating oral algorithms for everyday tasks - Data abstraction and representation - Abstraction and translation of everyday data for use on a computer.

SUGGESTED ACTIVITIES:

- Explore algorithm design by creating oral algorithms.
- Abstract the essential details of everyday objects.
- Translate the description of everyday objects into data types and variables.

SUGGESTED EVALUATION METHODS:

- Evaluation of the oral algorithms and computer data.

MODULE II :	L	T	P	EL
	0	0	12	9

Decomposing a complex problem - Strategies for decomposition and algorithm design - Divide and conquer - Simple program implementations.

SUGGESTED ACTIVITIES:

- Decompose a complexproblem into discrete steps,
- Design a simple algorithmfor solving the problem.
- External learning: Study of different strategies for decomposition and algorithm design.
- Examine sample input and expected output and develop strategies to decompose the problem.
- Use decomposition to break the problem into smaller problems and algorithmic design to plan a solution strategy.
- External learning: Simple program implementations.

SUGGESTED EVALUATION METHODS:

- Whiteboard presentations of the decomposition and algorithm.
- Evaluation of the developed strategies.
- Demonstration of the implemented programs.

MODULE III :	L	T	P	EL
	0	0	8	6

Overall data representation, abstraction, analysis and algorithm design. Program implementations.

SUGGESTED ACTIVITIES:

- Examples of Data representation, abstraction, analysis and algorithm design.
- Programming implementation.

SUGGESTED EVALUATION METHODS:

- Whiteboard presentations of the Data analysis and Algorithm design.
- Demonstration of the programming implementations.

MODULE IV:	L	T	P	EL
	0	0	8	6

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Measuring the complexity of an algorithm - sorting algorithms - the notion of unsolvable problems. Programming illustrations.				
SUGGESTED ACTIVITIES: • Develop algorithms for sorting and determine the complexity of the algorithm and how it scales as the number of items to sort increases. • Implement the different algorithms and measure how they scale. • Determine which algorithms are more efficient, whether or not all algorithms are calculable given enough time.				
SUGGESTED EVALUATION METHODS: • Determine complexity of algorithms and how they scale with number of items. • Demonstration using appropriate programs. • Determine which algorithms are computable given enough time.				
MODULE V:	**L**	**T**	**P**	**EL**
	0	**0**	**4**	**3**
Enhancing the clarity of a program - documentation, style, idioms.				
SUGGESTED ACTIVITIES: • External Learning: Study the best practices of documentation, style, idioms, etc that are used to ensure the code can be understood and maintained over a long period. • Use these practices in the documentation of earlier programs.				
SUGGESTED EVALUATION METHODS: • Documentation of given programs.				
MODULE VI:	**L**	**T**	**P**	**EL**
	0	**0**	**9**	**9**
Application of computational thinking to simple real world problems - program implementation of decomposed modules.				
SUGGESTED ACTIVITIES : • Application to simple real-world problems.				
SUGGESTED EVALUATION METHODS: • Evaluation of the solutions to the real world problems				

REFERENCES:

1. Exploring Computational Thinking.
https://edu.google.com/resources/programs/exploring-computational-thinking/

EVALUATION METHOD TO BE USED:

Continuous assessment	Mid term	End Semester

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60	**40**	-

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

- Formulate problems in a way that enables the use of a computer to solve them.
- Logically organize and analyze data.
- Automate solutions through algorithmic thinking.
- Identify, analyze and implement possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.
- Generalize and transfer this problem solving process to wide variety of problems.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	1	3	1	-	1	1	1	2	1	3	-
CO2	2	3	2	3	1	3	1	-	1	1	1	2	1	3	-
CO3	2	3	3	3	1	3	2	-	1	1	1	2	1	3	-
CO4	2	3	3	3	1	3	3	-	1	1	1	2	1	3	-
CO5	2	1	1	1	3	1	1	-	1	3	-	2	1	3	-

HS6251	**TECHNICAL ENGLISH II**	**L**	**T**	**P**	**EL**	**CREDITS**
		4	**0**	**0**	**3**	**5**

	GIVING INSTRUCTIONS AND MAKING RECOMMENDATIONS	**Oral Fluency**: giving oral instructions and recommendations to carry out short processes. (e.g. how to maintain a smart phone)-**Language Focus:** use of imperatives and modal verbs (linguistic acts of instructing and recommending)-**Lexical Development**: learning content-related vocabulary-derivatives-	At the end of the module, students should be able to: • Give instructions and make recommendations

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		functional variations (use of hs61affixes)-stress shift-**Reading Comprehension**: language of advertising-(features)-passages discussing the uses of any particular product-**Listening**- to a product description and listing the uses of the product-**Writing-** designing an advertisement (language component of about 70-100 words)	• Articulate sounds in English with appropriate stress shift in accordance with the meaning and grammar of words
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
			12 0 0 9
MODULE 2	**ASKING AND ANSWERING QUESTIONS**	**Oral Fluency:** short conversations (informal) in academic institutions – Group discussions – Role play Activity -**Language Focus:** speech acts (illocutionary force; making inferences) study of language in context- framing questions (asking & answering questions) - **Lexical Development-**learning specialist vocabulary related to reading texts-**Reading-**dialogues and interviews (e.g. interviews with famous personalities)-**Writing:** dialogue writing-introduction to e-mail writing (personal)	At the end of the module, students should be able to: • Participate in conversations in informal contexts • Learn to use specialist vocabulary in appropriate contexts.
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**

		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Small Group Work
			12 0 0 9
MODULE 3	**ASKING AND ANSWERING QUESTIONS**	**Oral Fluency**: making power point presentations (modus operandi to be given)-debating skills-**Language Focus**- use of adjectival and adverbial forms-**Lexical Development:** content related vocabulary -Use of abbreviations and acronyms-**Reading-**passages on making presentations and making notes - preparation of slides-**Writing** - practice in note making and note taking- **Listening** – watching a presentation and completing a worksheet	At the end of the module, students should be able to: • Make professional Power Point Presentations • Use note making and note taking skills effectively
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Power Point Presentations • Small Group Work
			12 0 0 9
MODULE 4	**ELABORATING ON ONE'S QUALIFICATIONS AND ACHIEVEMENTS**	**Oral Fluency:** Oral Fluency: SWOT analysis- **Role Play:** going abroad for work assignments- **Language Focus**: active voice-use of punctuation marks-simple past and simple present perfect tenses-**Lexical Developmen**t: specialist vocabulary (letter writing)-**Reading** – vision statement-work summary-job application-statement of purpose- **Listening:** listening to a talk and making notes- **Writing-** applying for a job (letter& e-mail) -bio data/resume	At the end of the module, students should be able to: • Write a job application and draw a suitable bio data forms • Read and understand the purposes of different types of writing
		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**

		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Power Point Presentations • Small Group Work
			12 0 0 9
MODULE 5	**WRITING PROJECT REPORTS**	**Oral Fluency**: Asking and answering questions (e.g. discussion on training received in school/imaginary training programme) **Language Focus:** direct and indirect forms of narration-use of simple past and past continuous tense forms of verbs-use of modal verbs- formation of questions (interrogative and yes/no type of questions)-passive voice-**Lexical Development**: factual vs. emotive use of vocabulary-reporting verbs-**Reading:** industry /internship report-**Writing:** report on a training programme (model to be provided)-**Listening:** to a report and completing a worksheet	At the end of the module, students should be able to: • Ask and answer different types of questions • Write a purpose-oriented, factual, report

		SUGGESTED ACTIVITIES	**SUGGESTED EVALUATION METHODS**
		• Lectures on the Communicative aspects of language use. • Practical-Listening, Speaking and Writing	• Quizzes • Assignments • Power Point Presentations • Small Group Work
			12 0 0 9

METHODS TO BE USED DURING CLASSROOM TEACHING

The following methods would be used to achieve programme objectives.

For language skills development:

1. Focus on fluency first for students with limited proficiency. Students would first develop the confidence to express themselves without being inhibited by errors.

2. Guided activities for speaking and writing with vocabulary and information provided as input.
3. Focus on simplicity and clarity than on the use of unnecessarily complex sentences and high- sounding words. Focus on clear organization of any spoken or written message.
4. Adequate preparation time given for demonstration of skills.
5. Sensitivity to issues of shyness and introversion and avoiding coercive methods.
6. Use of relevant techno- social topics on which students have opinion.
7. Use of listening and reading to improve vocabulary.
8. Peer evaluation using feedback templates to allow students to practice in small groups on their own. A session with 30 students needs to allow adequate opportunity to all students.
9. Teacher correction of individual writing scripts with feedback.

FOR COMMUNICATION SKILLS DEVELOPMENT:

1. Focus on essential and time- tested principles of communication that are applicable in most contexts.
2. Avoiding formulae but providing basic templates that can be adapted to situations.
3. Avoiding complex behavioral theories or pop psychology as communication guides.
4. Using situations that students would typically encounter on campus and later at work.
5. Gradual building of confidence by progressing from communication in front of small groups to communication in front of larger groups.

ASSESSMENT

Skills other than speaking would be tested using a paper and pencil test. Speaking skills will be tested using a verbal test.

TEXTBOOK:

1. ENGLISH Today: Technical Communication for Science, Engineering and Technology. Board of Editors, Department of English, Anna University. Orient Black Swan (Volumes 1&2) 2017.

REFERENCES:

1. Learning to Communicate: Dr. V. Chellammal, Allied Publishers, 2002.
2. English for Technical Communication: N.P. Sudharshana, C. Savitha, Cambridge University Press, 2016.

EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid –Semester Assessment	End Semester
1.	**Theory**	**40**	**20**	**40**

OUTCOMES

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

- Make notes properly after reading the given passages
- Participate actively in informal conversations using fixed expressions

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- Understand the meaning of a set of specialized vocabulary and use them in various contexts
- Write reports, application for job and advertisement for products properly
- Use instructions and recommendations in different oral contexts

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	–	–	–	1	–	1	1	–	1	3	1	2	–	1	1
CO2	–	–	–	–	–	1	–	–	1	3	1	2	–	2	–
CO3	–	–	–	2	1	1	–	2	1	3	–	2	–	1	–
CO4	–	–	–	–	–	1	1	–	1	2	–	2	–	2	1
CO5	–	–	–	–	–	1	1	1	2	3	–	1	–	1	1

		L	T	P	EL	CREDITS
CY6251	**ENGINEERING CHEMISTRY**	**3**	**0**	**2**	**3**	**5**

OBJECTIVES:

- To develop an understanding about fundamentals of polymer chemistry, preparation and properties of polymers
- To acquire knowledge in photochemistry and spectroscopy
- To understand the concepts of surface chemistry and catalysis.
- To impart basic knowledge on chemical thermodynamics.
- To get acquainted with the basic concepts of nano chemistry.
- To understand the chemistry of the fabrication of integrated circuits
- To know the types of specialty materials used in the electronics/electrical industry.

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Polymer Chemistry: Introduction: Functionality; Classification of Polymers- Natural and Synthetic, Thermoplastic and Thermosetting. Types and Mechanism of Polymerization: Addition (Free Radical, Cationic, Anionic and Living); Condensation and Copolymerization. Piezo and pyro electric polymers; Photoresists – Positive and negative.

SUGGESTED ACTIVITIES :

- In Class activity for Functionality and Mechanism of polymerisation
- Practical – Thermal free radical polymerisation of styrene/MMA

SUGGESTED EVALUATION METHODS:

- Tutorial : Deduce type of polymer from monomers with different functionalities
- Assignment : Predicting mechanism of polymerization for few important monomers
- Quizzes

Attested

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Properties of Polymers: T_g, Tacticity, Degree of Polymerization & Molecular Weight - Weight Average, Number Average and Polydispersity Index. Techniques of Polymerization: Bulk, Emulsion, Solution and Suspension

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- Proofs and Simplification in class
- Practical – Determination of molecular weight of PVA using Ostwald viscometer

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Photochemistry: Electromagnetic Radiation - Laws of Photochemistry - Grotthuss-Draper Law, Stark-Einstein Law and Lambert-Beer Law. Photo Processes - Internal Conversion, Inter-System Crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-Sensitization.

SUGGESTED ACTIVITIES :

- Evaluate quantum efficiency for different systems
- Photo Processes – in class and EL based on that
- Practical – Estimation of sodium in water sample by flame photometry

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Spectroscopy: Absorption of Radiation-Electronic, Vibrational and Rotational Transitions. Width and Intensities of Spectral Lines. Spectrophotometric Estimation Of Iron. UV-Vis and IR Spectroscopy-Principles, Instrumentation (Block Diagram) and Applications

SUGGESTED ACTIVITIES :

- Flipped Class room
- Types of electronic/vibrational transitions for different molecules – in class and EL based on that
- Practical – Estimation of iron in water sample by spectrophotometry

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

Attested

MODULE V :	L	T	P	EL
	3	0	2	3

Adsorption-Types of Adsorption-Adsorption of Gases on Solids- Adsorption from Solutions- Types of Isotherms – Frendlich Adsorption Isotherm, Langmuir Adsorption Isotherm. Industrial Applications of Adsorption.

SUGGESTED ACTIVITIES :

- Industrial applications in class
- EL – Adsorption of gases on solids
- Practical – Adsorption of acetic acid/oxalic acid on charcoal – verification of Freundlich's adsorption isotherm.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment
- Quizzes

MODULE VI:	L	T	P	EL
	3	0	2	3

Catalysis: Characteristics and Types of Catalysts-Homogeneous and Heterogeneous, Auto Catalysis. Enzyme Catalysis - Factors Affecting Enzyme Catalysis, Michaelis - Menton Equation. Industrial Applications of Catalysts

SUGGESTED ACTIVITIES :

- Introduction in class
- Analysis in Class
- Flipped Classroom for further study
- Practical – Determination of rate constant of acid catalysed hydrolysis of an ester

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment
- Quizzes

MODULE VII:	L	T	P	EL
	3	0	2	3

Second Law: Entropy-Entropy of Phase Transitions; Free Energy- Gibbs-Helmholtz Equation; Clausius Clapeyron Equation; Van't Hoff Isotherm and Isochore. Chemical Potential; Gibbs-Duhem Equation- Variation of Chemical Potential with Temperature and Pressure.

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- Practical – Phase change in a solid.
- EL - HDL descriptions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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MODULE VIII:	L	T	P	EL
	3	0	2	3
Nano chemistry - Basics-Distinction between Molecules, Nanoparticles and Bulk Materials; Size-Dependent Properties. Preparation of Nanoparticles – Sol-Gel and Solvo - thermal. Preparation of Carbon Nanotube by Chemical Vapour Deposition and Laser Ablation. Preparation of Nanowires by Electrochemical Deposition and Electro Spinning. Properties and Uses of Nanoparticles, Nanoclusters, Nanorods, Nanotubes and Nanowires.				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped class rooms • EL – Properties and uses of Nanowires, nanoclusters, nanorods, nanowires • Practical - Preparation of nano wire by electrospinning				
SUGGESTED EVALUATION METHODS: • Tutorial • Assignment • Quizzes				

MODULE IX:	L	T	P	EL
	3	0	2	3
Fabrication of integrated circuits: Introduction – Fabrication – MOS – NMOS, PMOS, CMOS, Ga-As Technologies, Printed circuit boards-Fabrication (Single layer only) – Lamination, printing (photo and screen printing) andmechanical operation.				
SUGGESTED ACTIVITIES : • Mostly in Class • EL - Mini project for Lamination by Hand lay up Technique • Practical – Determination of total, temporary and permanent hardness of water by EDTA method				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				

MODULE X:	L	T	P	EL
	3	0	2	3
Specialty Materials: Dielectrics & insulating materials – Characteristics; Ceramics – Mica and glass; Magnetic materials – basis of magnetism – Soft and hard magnetic materials; Composites : Classification – Particulate, fibrous and laminated composites – Hybrid composites – Application of composites in electrical and electronic components; Semiconductors – Extensive and intensive; Metallic solids –Characteristics.				
SUGGESTED ACTIVITIES : Combination of in class & Flipped				
SUGGESTED EVALUATION METHODS: • Tutorial • Assignment • Quizzes				

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PREREQUISITES FOR THE COURSE:

Laboratory facilities to carry out the experiments mentioned in each of the modules – Thermal free radical polymerisation of styrene/MMA,Determination of molecular weight of PVA using Ostwald viscometer, Estimation of sodium in water sample by flame photometry, Estimation of iron in water sample by spectrophotometry, Adsorption of acetic acid/oxalic acid on charcoal – verification of Freundlich's adsorption isotherm, Determination of rate constant of acid catalysed hydrolysis of an ester, Phase change in solid, Electrospinning, Total and temporary hardness.

TEXT BOOKS:

1. Jain P.C and Monika Jain, "Engineering Chemistry", Dhanpet Rai Publishing Company (P) Ltd.,New Delhi, 2013.
2. Wong M.N., "Polymer for electronics and photonic applications", John Wiley, New York, 2006.

REFERENCES:

1. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012
2. Vairam S., Kalyani P., Suba Ramesh., "Engineering Chemistry", Wiley India Pvt Ltd., New Delhi., 2011.
3. Khanna O.P.," Material Science" NIH Publications, 2007.

EVALUATION METHOD TO BE USED:

Continuous assessment	Mid term	End Semester
15(T) + 25 (P)	20	40

OUTCOMES

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

- To develop an understanding about fundamentals of polymer chemistry, preparation and properties of polymers
- To acquire knowledge in photochemistry and spectroscopy
- To understand the concepts of surface chemistry and catalysis.
- To impart basic knowledge on chemical thermodynamics and to get acquianted with the basic concepts of nanochemistry
- To understand the chemistry of the fabrication of integrated circuits and to know the types of specialty materials used in the electronics/electrical industry.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	3	1	1	-	-	2	-	1	1	1	3	3
CO2	1	2	1	3	2	1	-	-	2	-	1	1	1	2	3
CO3	1	3	1	3	2	1	-	-	3	-	1	1	1	3	3
CO4	2	3	1	1	1	1	-	-	1	-	1	1	2	2	2
CO5	2	1	1	1	1	1	-	-	1	-	1	1	1	2	2

MA6251	**DISCRETE MATHEMATICS**	**L**	**T**	**P**	**EL**	**CREDITS**
		3	**1**	**0**	**3**	**5**

MODULE I	**LOGIC**	**L**	**T**	**P**	**EL**
		3	**1**	**0**	**3**

Propositional Logic – Propositional equivalences - Predicates and Quantifiers – Nested Quantifiers

SUGGESTED ACTIVITIES :

- Problem Solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II	**PROOFS**	**L**	**T**	**P**	**EL**
		3	**1**	**0**	**3**

Rules of inference - Introduction to proofs – Proof methods and strategy.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III	**COMBINATORICS**	**L**	**T**	**P**	**EL**
		3	**1**	**0**	**3**

Mathematical induction – Strong induction and well ordering – The basics of counting - The pigeonhole principle- Permutations and Combinations

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

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- Quizzes

MODULE IV RECURRENCES	L	T	P	EL
	3	1	0	3

Recurrence relations -Solving linear recurrence relations using generating functions – Inclusion - Exclusion Principle and its applications.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V GRAPH THEORY	L	T	P	EL
	3	1	0	3

Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Flipped class room
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI ALGEBRAIC STRUCTURE 1	L	T	P	EL
	3	1	0	3

Algebraic systems – Semi groups and monoids – Groups - Subgroups - Homomorphisms

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII ALGEBRAIC STRUCTURE 2	L	T	P	EL
	3	1	0	3

Normal subgroup and coset - Lagrange"s theorem – Definitions and examples of Rings and Fields

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Flipped Class room

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SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII LATTICES	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Partial ordering – Posets – Lattices as Posets – Properties of lattices - Lattices as algebraic systems – Sub lattices				
SUGGESTED ACTIVITIES : • Problem Solving sessions • Applications in real life problems				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX BOOLEAN ALGEBRA	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Direct product and Homomorphism – Some special lattices – Boolean algebra				
SUGGESTED ACTIVITIES : • Problem Solving sessions • Applications in real life problems				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

OUTCOMES:

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

- Apply Mathematical Logic to validity arguments and programmes
- Apply combinatorial counting principles to solve application problems.
- Apply graph model and graph techniques for solving network connectivity and other problems
- Apply algebraic ideas to understanding in developing cryptograph techniques for solving network security problems
- Apply Boolean laws in developing circuits and its related problems

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TEXT BOOKS:

1. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 7th Edition, Special Indian edition, 2011.
2. Tremblay J.P. and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw Hill Pub. Co. Ltd, New Delhi, 30th Reprint, 2011.
3. Susanna S. Epp, “Discrete Mathematics with Applications” Cengage Learning, New Delhi, 8th Edition, 2016.

REFERENCES:

1. Ralph. P. Grimaldi, “Discrete and Combinatorial Mathematics: An Applied Introduction”, Pearson Education Asia, Delhi, 4th Edition, 2007.
2. Thomas Koshy,” Discrete Mathematics with Applications”, Elsevier Publications, 2006.
3. Seymour Lipschutz and Mark Lipson, ”Discrete Mathematics”, Schaum"s Outlines, Tata McGraw Hill Pub. Co. Ltd., New Delhi, 3rd Edition, 2010.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1	1	1	-	-	2	2	3	2	3
CO2	3	3	1	2	1	1	-	-	-	-	2	1	3	2	2
CO3	3	3	3	2	3	1	-	-	-	-	2	2	3	3	2
CO4	3	3	1	3	1	1	-	-	-	-	2	1	3	2	3
CO5	3	3	3	2	3	2	-	-	-	-	2	1	3	2	3

GE6251	ENGINEERING GRAPHICS	L	T	P	EL	CREDITS
		2	0	4	3	5

OBJECTIVES

• To develop in students, graphic skills for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.

MODULE I :	L	T	P	EL
	2	0	4	3

Importance of Graphics in Engineering Applications – Use of Drafting Instruments – BIS Conventions and Specifications – Size, Layout and Folding of Drawing Sheets – Lettering and Dimensioning.

SUGGESTED ACTIVITIES :

- Demonstration using CAD software to bring out the concepts presented in the subject
- Hands on practicals on open source software

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE II :	L	T	P	EL
	2	0	4	3

Basic Geometrical Constructions, Curves used in Engineering Practices - Conics –Construction of Ellipse,Parabola and Hyperbola by Eccentricity Method – Construction of Cycloid – Construction of Involutes of Square and Circle – Drawing of Tangents and Normal to the above Curves.

SUGGESTED ACTIVITIES :

- Videos of application of Geometric curves in various domains
- Theory and mathematics in class
- EL – Practical Problems
- Practical –Construction of curves

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Visualization Concepts and Free Hand Sketching: Visualization Principles – Representation of Three Dimensional Objects – Layout of Views - Free Hand Sketching of Multiple Views from Pictorial Views of Objects

SUGGESTED ACTIVITIES :

- Building models using various media
- Discussing uses of multiple views in various fields
- Practical - Construction of 3D views

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Orthographic Projection- Principles - Principal Planes - First Angle Projection - Projection of Points. Projection of Straight Lines (only First Angle Projections) Inclined to Both the PrincipalPlanes - Determination of True Lengths and True Inclinations by Rotating Line Method and Trapezoidal Method and Traces

SUGGESTED ACTIVITIES :

- Videos of application of projections in various domains
- Theory and mathematics in class
- EL – Practical Problems in orthographic projection of points
- Practical –Construction of curves

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Projection of Planes (Polygonal and Circular Surfaces) Inclined to both the Principal Planes by Rotating Object Method.

SUGGESTED ACTIVITIES :

- Videos of application of projections in various domains
- Theory and mathematics in class
- EL – Practical Problems in orthographic projection of planes

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Projection of Simple Solids like Prisms, Pyramids, Cylinder, Cone and Truncated Solids when the Axis is Inclined to both the Principal Planes by Rotating Object Method and Auxiliary Plane Method.

SUGGESTED ACTIVITIES :

- Introduction in class
- Models making
- Videos/software demonstrations

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Sectioning of Solids in Simple Vertical Position when the Cutting Plane is Inclined to the one of the Principal Planes and Perpendicular to the other – Obtaining True Shape of Section.

SUGGESTED ACTIVITIES :

- Introduction in class
- Models
- Videos **/**software demonstrations

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**3**

Development of Lateral Surfaces of Simple and Sectioned Solids – Prisms, Pyramids Cylinders and Cones. Development of Lateral Surfaces of Solids with Cut-Outs and Holes.

SUGGESTED ACTIVITIES :

- Development models in cardboard
- Software demonstration

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

Attested

MODULE IX:	L	T	P	EL
	2	0	4	3

Principles of Isometric Projection – Isometric Scale – Isometric Projections of Simple Solids and Truncated Solids - Prisms, Pyramids, Cylinders, Cones - Combination of Two Solid Objects in Simple Vertical Positions and Miscellaneous Problems.

SUGGESTED ACTIVITIES :

- Videos
- Demonstrations using Solid modeling software

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE X	L	T	P	EL
	2	0	4	3

Perspective Projection of Simple Solids - Prisms, Pyramids and Cylinders by Visual Ray Method and Vanishing Point Method.

SUGGESTED ACTIVITIES :

- Videos
- Illustration using Advertisements

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOK:

1. N.D.Bhatt and V.M.Panchal, “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. K.R.Gopalakrishna., “Engineering Drawing” (Vol I&II combined) SubhasStores, Bangalore, 2007
2. Luzzader, Warren.J., and Duff,John M.,”Fundamentals of Engineering Drawingwith an introduction to Interactive Computer Graphics for Design and Production”,Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005
3. M.B.Shah and B.C.Rana, “Engineering Drawing”, Pearson, 2nd Edition, 2009
4. K.Venugopal and V.Prabhu Raja, “Engineering Graphics”, New Age International (P)Limited ,2008.
5. K. V.Natarajan, “A text book of Engineering Graphics”, 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
6. BasantAgarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. N.S Parthasarathy and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

OUTCOMES:

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

- Perform free hand sketching of basic geometrical shapes and multiple views of objects.
- Draw orthographic projections of lines and planes
- Draw orthographic projections of solids.
- Obtain development of surfaces,projection of sections of solids.
- Prepare isometric and perspective views of simple solids.

EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid – Semester Assessment	End Semester
1.	**Theory**	**40**	**20**	**40**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1		2	1				3	3		1		1	
CO2	1	1		2	1				3	3		1		1	
CO3	1	1		2	1				3	3		1		1	
CO4	1	1		2	1				3	3		1		1	
CO5	1	1		2	1				3	3		1		1	

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CS6103 APPLICATION DEVELOPMENT PRACTICES

CS6103 APPLICATION DEVELOPMENT PRACTICES	L	T	P	EL	TOTAL	CREDITS
	1	0	4	3	8	4

OBJECTIVES:

- To introduce students to programming languages and techniques associated with the world wide web and thereby create interest in programming even to students with little programming knowledge
- To introduce tools for creating interactive web pages
- To introduce the client-server architecture
- To introduce databases

MODULE I :	L	T	P	EL
	1	0	4	3

Design of webpages – Use of Cascading style sheets to style the way a webpage looks

SUGGESTED ACTIVITIES :

- EL – Learn to use CSS

SUGGESTED EVALUATION METHODS:

- Demonstration of designed webpages
- Evaluation of the preparation done in learning CSS syntax

MODULE II :	L	T	P	EL
	1	0	4	3

Incorporating multimedia into a webpage (Text / Audio / Image / Video / Animation)

SUGGESTED ACTIVITIES :

- EL – Learn how to read information from a file/array and display on the webpage

SUGGESTED EVALUATION METHODS:

- Demonstration of having incorporated multimedia in a webpage

MODULE III :	L	T	P	EL
	1	0	4	3

Writing client side scripts using Javascript / Angular JS
Client side validation

SUGGESTED ACTIVITIES :

- EL – Learn to use Javascript / Angular JS

SUGGESTED EVALUATION METHODS:

- Demonstration of using client side validation for designed web browsers

MODULE IV:	L	T	P	EL
	1	0	4	3

Designing a static website using content management frameworks

SUGGESTED ACTIVITIES :

- EL – Familiarity with any one content management framework

SUGGESTED EVALUATION METHODS:

- Evaluation of the preparation done in getting familiarized with a content management framework

MODULE V :	L	T	P	EL
	1	0	4	3

Understanding servers – Server login, Database connectivity

SUGGESTED ACTIVITIES : • EL- Overview of databases				
SUGGESTED EVALUATION METHODS: • Quiz on servers and overview of databases				
MODULE VI:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**2**
Use queries for fetching from database Processing the results of queries File upload/download File streaming				
SUGGESTED ACTIVITIES : • EL - SQL queries to create table, select, update and insert				
SUGGESTED EVALUATION METHODS: • Quiz on SQL queries • Demonstration of the use of queries				
MODULE VII:	**L**	**T**	**P**	**EL**
	1	**0**	**4**	**3**
Server side scripts and validation				
SUGGESTED ACTIVITIES : • EL – Learn how to write server side scripts				
SUGGESTED EVALUATION METHODS: • Demonstration of the use server side scripts				
MODULE VIII:	**L**	**T**	**P**	**EL**
	1	**0**	**4**	**3**
Development of web application				
SUGGESTED ACTIVITIES : • EL - Select an application for which webpage has to be developed. List the features to be included.				
SUGGESTED EVALUATION METHODS: • Oral explanation of the web application to be developed				
MODULE iX:	**L**	**T**	**P**	**EL**
	1	**0**	**4**	**3**
Development of web application				
SUGGESTED ACTIVITIES : • EL – Application of what was learnt in the previous weeks and develop the webpage				
SUGGESTED EVALUATION METHODS: • Demonstration of developed web application				

REFERENCES:

1. Scobey, Pawan Lingras, “Web Programming and Internet Technologies An E-Commerce Approach”, Second Edition, Jones & Bartlett Publishers, 2016.

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EVALUATION METHOD TO BE USED:

Sl. no	Category of Courses	Continuous Assessment	Mid – Semester Assessment	End Semester
1.	Practical Integrated with Theory	40(P)	20(T)	40(P)

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

- Use and demonstrate client side technologies including HTML/CSS for Create basic web pages
- Use and demonstrate client side Scripting Language for creating interactive web pages
- Get an understanding of the working of servers and use server side technologies for implementing basic client-server communication.
- Understand the basics of databases and their use
- Implement and Demonstrate complete web application

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	1	-	-	-	-	1	2	2	2	3
CO2	3	3	1	1	3	1	-	-	-	-	1	2	2	2	3
CO3	3	3	1	1	3	1	-	-	-	-	1	2	2	2	3
CO4	3	3	1	1	3	1	-	-	-	-	1	2	2	2	3
CO5	3	3	1	1	3	1	-	-	-	-	1	2	2	2	3

CS6104 DATA STRUCTURES AND ALGORITHMS

Prerequisites for the course: NIL

OBJECTIVES:

- To understand the concepts of linear and non-linear data structures
- To get an idea about suitability of data structure for an application
- To learn some fundamental algorithm design strategies
- To understand how the correctness of an algorithm can be proved
- To learn how to analyze an algorithm
- To understand the concept of NP-Completeness

CS6104 DATA STRUCTURES AND ALGORITHMS	L	T	P	EL	CREDITS
	3	1	4	3	7

MODULE I INTRODUCTION	L	T	P	EL
	4	1	0	4

Abstract Data Types – Algorithm Properties – Overview on Proof of Correctness & Algorithm Analysis – Asymptotic Notations & Properties, Linear Search.

SUGGESTED ACTIVITIES :

- Workout on design of algorithms for some small simple problems, provide proof of correctness, and determine the complexity.
- EL - Study on average case analysis for some standard algorithms.

SUGGESTED EVALUATION METHODS:

- Assignment - Based on design, correctness and efficiency.

MODULE II LINEAR DATA STRUCTURES	L	T	P	EL
	4	1	4	3

Stack - Queue - Linked lists - Some applications based on linear data structures.

SUGGESTED ACTIVITIES :

- EL – Converting an algorithm from recursive to non-recursive using stack.
- Practical - An application based on linear data structure.

SUGGESTED EVALUATION METHODS:

- Programming exercises in the laboratory
- Quizzes

MODULE III NON-LINEAR DATA STRUCTURES	L	T	P	EL
	4	1	4	3

Trees - Graphs - Traversals - Threaded binary trees.

SUGGESTED ACTIVITIES :

- EL - Applications of trees and graphs.
- Practical - Implementing tree and graph traversals.

SUGGESTED EVALUATION METHODS:

- Assignment related to application
- Programming exercises in the laboratory
- Quizzes

MODULE IV DIVIDE & CONQUER	L	T	P	EL
	4	1	4	3

Strassen's Matrix Multiplication - Selection in Linear Time.

SUGGESTED ACTIVITIES :

- EL – Merge Sort & Quick Sort
- Practical – Implementation of Merge Sort & Quick Sort.

SUGGESTED EVALUATION METHODS:

- Programming exercises in the laboratory
- Assignment problems

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● Quizzes				
MODULE V GREEDY METHOD	**L**	**T**	**P**	**EL**
	4	**1**	**4**	**3**
Greedy Strategy – Knapsack Problem - Spanning Trees –Single Source Shortest Path problems				
SUGGESTED ACTIVITIES : ● EL – Tree Vertex Splitting ● Practical – Spanning Tree Implementation				
SUGGESTED EVALUATION METHODS: ● Programming exercises in the laboratory ● Quizzes				
MODULE VI DYNAMIC PROGRAMMING	**L**	**T**	**P**	**EL**
	4	**1**	**4**	**3**
Principles of Optimality - Matrix chain multiplication - Longest common subsequences				
SUGGESTED ACTIVITIES : ● EL – All Pair shortest path. ● Practical - Implementation of All pair shortest path				
SUGGESTED EVALUATION METHODS: ● Programming exercises in the laboratory ● Quizzes				
MODULE VII BACKTRACKING & BRANCH AND BOUND	**L**	**T**	**P**	**EL**
	4	**1**	**4**	**3**
Backtracking:8-Queens & Sum of subsets – Branch & Bound: 0/1 Knapsack				
SUGGESTED ACTIVITIES : ● Flipped class rooms ● Practical - Implementations of sum of subset problem. ● EL –Travelling Salesperson using Branch & Bound				
SUGGESTED EVALUATION METHODS: ● Programming exercises in the laboratory ● Assignment problems ● Quizzes				
MODULE VIII MORE ON SORTING & INDEXING	**L**	**T**	**P**	**EL**
	5	**1**	**4**	**3**
Heap Sort – External sorting – Hashing				
SUGGESTED ACTIVITIES : ● EL – Comparison of internal sorting algorithms ● Practical – Implementation of Hash table				
SUGGESTED EVALUATION METHODS: ● Programming exercises in the laboratory ● Quizzes				
MODULE IX STRING MATCHING	**L**	**T**	**P**	**EL**
	2	**1**	**2**	**2**

Naïve Algorithm – KMP Algorithm				
SUGGESTED ACTIVITIES : ● Tutorial ● Practical – Implementation of KMP algorithm				
SUGGESTED EVALUATION METHODS: ● Programming exercises in the laboratory ● Quizzes				
MODULE X NP-COMPLETENESS	**L**	**T**	**P**	**EL**
	5	**1**	**0**	**5**
Polynomial time verification – Theory of reducibility - NP Completeness proof for Vertex cover &Hamiltonian Cycle.				
SUGGESTED ACTIVITIES : EL – Study of proof for NP completeness on any two problems				
SUGGESTED EVALUATION METHODS: ● Quizzes				

TEXT BOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, Galgotia, 1976.
2. Ellis Horowitz and Sartaj Sahni, “Fundamental of Computer Algorithms”, Galgotia, 1985.
3. Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Third Edition, Prentice Hall, 2010.

REFERENCES:

1. Jean-Paul Tremblay and Paul G Sorenson, “An Introduction to Data Structures with Applications”, Second Edition, Tata McGraw Hill, 1991.
2. Kenneth A. Berman and Jerome L Paul, “Algorithms”, Cengage Learning India, 2010.

Evaluation Pattern:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	**15(T) + 25 (P)**	**20**	**40**

OUTCOMES:

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

- Point out various representations of data structures
- Write functions to implement linear and non–linear data structure operations
- Suggest and use appropriate linear/non–linear data structure operations for solving a given problem
- Apply various algorithm design techniques and analysis
- Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval
- Show how to prove a problem to be NP-Complete

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	3	1	-	-	-	-	3	3	3	3
CO2	3	3	3	2	1	2	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	1	2	1	-	-	-	-	3	3	3	3
CO4	3	3	3	2	1	1	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	1	1	-	-	-	-	-	3	3	3	3
CO6	3	3	3	2	-	1	-	-	-	-	-	3	3	3	3

CS6105 DIGITAL FUNDAMENTALS AND COMPUTER ORGANIZATION

Prerequisites for the course: None

OBJECTIVES:

- To learn Boolean algebra and simplification of Boolean functions
- To learn to design and analyze different combinational circuits
- To study the basics of synchronous sequential logic and analyze and design sequential circuits
- To understand the important components of a computer system and the basic organization
- To learn to write code in hardware description languages for designing larger digital systems

CS6105 DIGITAL FUNDAMENTALS AND COMPUTER ORGANIZATION	L	T	P	EL	CREDITS
	3	1	4	3	7

MODULE I :	L	T	P	EL
	3	1	4	3

Number Systems – Binary, Octal, Hexadecimal – Representation of negative numbers - 1's and 2's Complements - Arithmetic Operations – Binary Codes.

SUGGESTED ACTIVITIES :

- In Class activity for place - value systems
- Practical – Abacus – Counting – Activity

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	1	4	3

Boolean Algebra – Theorems and Postulates - Functions – Truth Table - Logic Gates – Universal gates

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- Proofs and Simplification in class

Attested

- EL – Practical Problems - Introduction to propositional problems using conjunction, disjunction and negation
- Practical - Implementation of simple functions using gates

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**1**	**4**	**3**

Canonical and Standard Forms – Minterms and Maxterms - Sum of Products and Product of Sums - Simplification of Boolean Functions - Karnaugh Map – 2,3,4 variables - NAND / NOR Implementations.

SUGGESTED ACTIVITIES :

- EL - Exclusive OR function
- Practical - Simplification and implementation of Boolean functions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	6	**1**	**8**	**3**

Combinational Circuits – Arithmetic Circuits - Half and Full Adders - Subtractors - Binary Parallel adder – Carry Look-ahead Adder - BCD Adder - Magnitude Comparator - Binary multiplier - Code Converters. Introduction to HDL.

SUGGESTED ACTIVITIES :

- Flipped Class room
- Introduction to HDL – in class and EL based on that
- Practical - Implementation of the arithmetic circuits and getting started with HDL

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**1**	**8**	**3**

Decoder, Encoder, Priority Encoder, Mux/Demux - Applications. HDL for these circuits.

SUGGESTED ACTIVITIES :

- Applications in class
- EL – HDL for these combinational circuits
- Practical - Implementation of these circuits and HDL implementations

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

Attested

MODULE VI:	L	T	P	EL
	5	1	4	3
R –S Latch - D Latch - Flip flops – SR, JK, T, D, Master /Slave FF, HDL for latches and flip flops - Analysis of clocked sequential circuits – Moore /Mealy models - Flip flop excitation tables - Design of clocked sequential circuits.				
SUGGESTED ACTIVITIES : • Introduction in class • Analysis in Class • Flipped Classroom for further study • Practical - Implementation of Flip flops				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**1**	**4**	**3**
Registers – Shift Registers, Universal Shift Register Counters – Ripple Counters, Synchronous Counters, Ring Counter, Johnson Counter - HDL for counters and shift registers				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped class rooms • Practical - Implementations of counters and shift registers • EL - HDL descriptions • EL - Mini project for designing and implementing a digital system using both hardware and software (HDL)				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**1**	**4**	**3**
Practical Problems in Sequential design – Timing diagrams - Problems combining Combinational & Sequential Components – State reduction – State Assignment				
SUGGESTED ACTIVITIES : • Timing diagrams in class • Flipped classroom • Practical - HDL descriptions to be continued				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**1**	**4**	**3**
Memory Systems – RAM, ROM, PLD, PLA and PAL - Design of digital systems				
SUGGESTED ACTIVITIES : • Combination of in class & Flipped • Practical - Project demonstration and presentation				
SUGGESTED EVALUATION METHODS: • Tutorial problems				

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• Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**1**	**4**	**3**
Basic Components of a digital computer - Functions - Organization - Instruction Execution - Data path and control path				
SUGGESTED ACTIVITIES : • Mostly in Class • Practical - Project demonstration and presentation				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", VthEdition, Pearson Education, 2013.
2. Charles H. Roth Jr, "Fundamentals of Logic Design", Fifth Edition, Jaico Publishing House, Mumbai, 2003.

REFERENCES:

1. John F. Wakerly, "Digital Design Principles and Practices", Fourth Edition, Pearson Education, 2007.
2. Donald D. Givone, "Digital Principles and Design", Tata McGraw Hill, 2003.
3. G. K. Kharate, "Digital Electronics", Oxford University Press, 2010.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	**15(T) + 25 (P)**	**20**	**40**

Course Outcomes:

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

- Simplify complex Boolean functions
- Design and analyze digital circuits with combinational and sequential components
- Implement digital circuits using MSI chips and PLDs
- Use HDL to build digital systems
- Point out the basic functionalities of the components of a digital computer and their organization

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	-	-	1	-	1	3	1	-
CO2	3	3	3	3	1	2	1	-	3	2	2	3	3	3	2
CO3	3	3	3	3	2	2	1	-	2	2	2	2	2	1	2
CO4	3	3	3	3	3	2	1	-	2	2	2	3	2	3	2
CO5	3	2	1	2	1	1	-	-	2	1	-	1	1	1	2

MA6351 PROBABILITY AND STATISTICS	L	T	P	EL	TOTAL CREDITS
	3	1	0	3	5

OBJECTIVES:

- To provide students with the basic concepts of probability theory
- To equip the students with essential tools for statistical analyses at the graduate level.
- To Foster understanding through real-world statistical applications.

MODULE I RANDOM VARIABLES	L	T	P	EL
	3	1	0	3

Discrete and continuous random variables – Moments – Moment generating functions

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II DISTRIBUTIONS	L	T	P	EL
	4	2	0	3

Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III TWO - DIMENSIONAL RANDOM VARIABLES	L	T	P	EL
	4	2	0	3

Joint distributions – Marginal and conditional distributions

SUGGESTED ACTIVITIES :

- Problem Solving sessions

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- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV CORRELATION	**L**	**T**	**P**	**EL**
	4	**2**	**0**	**3**

Covariance – Correlation and Linear regression

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V TRANSFORMATION OF RANDOM VARIABLES	**L**	**T**	**P**	**EL**
	6	**2**	**0**	**3**

Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI TESTING OF HYPOTHESIS (Large Samples)	**L**	**T**	**P**	**EL**
	6	**2**	**0**	**3**

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII TESTING OF HYPOTHESIS (Small Samples)	**L**	**T**	**P**	**EL**

	6	**2**	**0**	**3**

Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII DESIGN OF EXPERIMENTS	**L**	**T**	**P**	**EL**
	6	**2**	**0**	**3**

Analysis of variance – One way and two-way classification – Completely Random Design.

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX STATISTICAL QUALITY CONTROL	**L**	**T**	**P**	**EL**
	4	**2**	**0**	**3**

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts)

SUGGESTED ACTIVITIES :

- Problem Solving sessions
- Seminar by students
- Application in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOKS:

1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2. Johnson. R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
3. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.

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REFERENCES:

1. Papoulis. A and Unnikrishnapillai. S., "Probability, Random Variables and Stochastic Processes ", Mc Graw Hill Education India , 4th Edition, New Delhi , 2010.
2. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

Evaluation Pattern:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

Course Outcomes :

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

- Use statistical methodology and tools in the engineering problem-solving process
- Describe the properties of discrete and continuous distribution functions
- Use method of moments and moment generating functions
- Compute point estimation of parameters
- Apply the Central Limit Theorem
- Use statistical tests in testing hypotheses on data

CO -PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	-	-	-	2	2	3	3	2
CO2	3	3	3	3	2	3	1	-	-	-	2	2	3	3	2
CO3	3	2	1	1	0	0	0	-	-	-	1	1	2	1	0
CO4	3	3	3	3	3	3	2	-	-	-	2	2	3	3	2
CO5	3	3	3	3	3	2	1	-	-	-	2	2	3	2	2
CO6	3	3	3	3	3	3	3	-	-	-	2	2	3	3	3

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EE6351 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	EL	TOTAL CREDITS
	4	0	4	3	7

Prerequisites for the course: None

OBJECTIVES :

- To learn the steady state DC and AC characteristics of electric circuits
- To understand the working of DC/AC motors, transformer and generators
- To understand the functionality of basic electronic circuits namely amplifiers, filters, data converters and oscillators
- To learn the design aspects of basic amplifier configurations and concepts of feedback techniques

MODULE I :	L	T	P	EL
	2	0	4	3

DC Electrical circuit - Fundamental laws– Steady State Solution of DC Circuits – Electrical measuring instruments.

SUGGESTED ACTIVITIES :

- Computer simulation of DC circuits problems and solution
- EL- Solving of complex electrical networks using circuit theorems
- Practical – Basic electrical circuit measurements and verification of circuit theorems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	4	0	4	3

Introduction to AC Circuits –Sinusoidal steady state analysis– Power and Power factor – Single Phase and Three Phase Balanced Circuits.

SUGGESTED ACTIVITIES :

- Computer simulation of AC circuits problems and solution
- EL- Solving of other engineering problems as electrical circuit equivalents
- Practical – Three phase power measurements

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	L	T	P	EL
	4	0	4	3

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors

SUGGESTED ACTIVITIES :

- EL- Survey of commonly used DC machines and their applications
- Practical – Load test on DC motor and generator

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**3**

Operating principle of Transformers –Induction Motor – single phase and three phase operation, Stepper motor

SUGGESTED ACTIVITIES:

- Study of utility power grid and the use of transformers
- EL- Survey of commonly used AC machines and their applications
- Practical – Load test on transformer and Induction motor

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**3**

Characteristics of PN Junction Diode, Half wave and Full wave Rectifiers, Zener Diode and its Characteristics – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics.

SUGGESTED ACTIVITIES :

- Practical - V- I characteristics of PN Junction and Voltage regulator characteristic of Zener Diode,
- Demonstration - Half wave and Full wave Rectifiers

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**3**

Elementary Treatment of Small Signal Amplifier – Linear Amplifier, Biasing Requirement – Voltage Divider Biasing, Basic CE amplifier circuit - Small signal equivalent model - Small signal Voltage gain

SUGGESTED ACTIVITIES :

- Practical – CE amplifier Voltage Divider Biasing and verification of operating point, Verification of small signal voltage gain

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII:	L	T	P	EL
	4	0	4	3

Differential amplifier using BJT, Negative feedback amplifier – characteristics – topologies, Opamp - inverting amplifier - non inverting amplifier.

SUGGESTED ACTIVITIES :

- Practical - Opamp characteristics:
  Verification of inverting amplifier gain
  Verification of non inverting amplifier gain

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII:	L	T	P	EL
	4	0	4	3

Opamp based circuit – Summer – Subtractor – Integrator – Differentiator, Opamp based Filters – Low pass, High pass, Band pass, Band reject.

SUGGESTED ACTIVITIES :

- Practical -Verification of opamp based arithmetic circuit
  Verification of frequency response characteristics of opamp based First order lowpass filter,First order highpass filter

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX:	L	T	P	EL
	4	0	4	3

Analog to Digital Converter – Flash ADC- Successive Approximation ADC, Digital to Analog Converter – Binary weighted DAC, Positive feedback – Ring oscillator.

SUGGESTED ACTIVITIES :

- Presentation / Assignment on
  Performance metrics of ADC
  Ring oscillator circuit architecture

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:	L	T	P	EL
	4	0	4	3

MOSFET – V-I characteristics, MOSFET small signal equivalent circuit, Common Source amplifier – Voltage gain – Frequency response characteristic.

SUGGESTED ACTIVITIES :
• Spice simulation - MOSFET V-I characteristic
SUGGESTED EVALUATION METHODS:
• Assignment problems • Quizzes

TEXT BOOKS:

1. J Nagarath and Kothari DP, “Electrical Machines”, Tata McGraw Hill, 2010.
2. Donald .A. Neamen, “Electronic Circuit Analysis and Design”, 3rd Edition, Tata McGraw Hill, 2010.

REFERENCES:

1. P.C. Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2nd Edition, 2007.
2. Leonard S Bobrow, “Foundations of Electrical Engineering”, Oxford University Press, 2013.
3. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’s Outline Series, McGraw Hill, 2002.
4. Del Toro, “Electrical Engineering Fundamentals”, Pearson Education, New Delhi, 2007
5. A.E. Fitzgerald, David E Higginbotham and Arvin Grabel, “Basic Electrical Engineering”, McGraw Hill Education (India) Private Limited, 2009.
6. David A. Bell, “Electronic Devices and Circuits”, Oxford Higher Education Press, 5th Edition, 2010.
7. Adel .S. Sedra, Kenneth C. Smith, “Micro Electronic Circuits”, 7th Edition, Oxford University Press, 2014.
8. Coughlin and Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, Prentice Hall, 1989.

Evaluation Pattern:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

Course Outcomes:

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

- Compute steady state solution of DC and AC electric circuits
- Analyze the characteristics of motors and transformers
- Design and analyze amplifiers
- Characterize the frequency response of BJT based amplifiers
- Realize arithmetic circuits, basic filter configurations using opamp
- Point out the characteristics of data converters

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CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	1	-	-	-	-	-	-	3	2	1
CO2	1	1	1	2	2	1	-	-	2	-	-	-	2	2	1
CO3	3	2	2	2	2	1	-	-	-	1	-	-	3	2	1
CO4	2	2	2	2	2	1	-	-	-	-	-	-	3	2	1
CO5	2	2	2	2	2	1	-	-	-	-	-	-	3	3	1
CO6	3	2	2	2	2	1	-	-	-	2	-	-	3	3	2

CS6106 DATA BASE MANAGEMENT SYSTEMS

Pre-requisites for the course: None

OBJECTIVES:

- To learn the fundamentals of data models and to conceptualize and represent a database system using ER diagram
- To study the principles to be followed to create an effective relational database design and effectively write SQL queries to retrieve/ store data from/to database
- To know the fundamental concepts of transaction processing-concurrency control techniques and recovery procedure
- To have an introductory knowledge about the storage and query processing techniques and the basic concepts of Information retrieval techniques
- To learn about the internal storage structures using different file and indexing techniques which will help in physical DB design

DATABASE MANAGEMENT SYSTEMS	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**4**	**3**	**6**

MODULE I:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**2**

Introduction to Databases- File System Vs Database System - Data Models- Schemas and Instances - DBMS Architecture- Centralized - Client Server - Database Applications

SUGGESTED ACTIVITIES:

- In class activity for various database applications

SUGGESTED EVALUATION METHODS:

- Tutorial: scenarios to analyze the need for DB in various applications
- Practical - Installation of Open Source DBMS software and perform basic DB operations like creating sample tables and populating the instances
- Quizzes

MODULE II:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Entity Relationship (ER) Model - conceptual design of DB Application - ER diagram - Design issues - Relationship types - other notations - Extended Entity-Relationship (EER) Model - ER to Relational Mapping

SUGGESTED ACTIVITIES:

- In class activity: defining the participating entities and their relations for a given scenario
- Practical –Use OSS to draw the ERD depicting the attributes, cardinality and other relationships

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III:	**L**	**T**	**P**	**EL**
	6	**0**	**4**	**6**

Relational Data Model - Operations on Relational Model - Specifying Constraints Relational Algebra - Unary, Binary, Set and other Operations - Tuple and Domain Relational Calculus. SQL - Data Definition - Data Manipulation and Retrieval Queries

SUGGESTED ACTIVITIES:

- In Class - ER Model to Relational Model mapping
- Practical - ER Modeling using open source tools and Schema realization

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV:	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**3**

Database Design - Functional Dependencies - Normal Forms - 1 NF - 2 NF - 3 NF - BCNF - Multivalued Dependency - Join Dependency

SUGGESTED ACTIVITIES:

- In Class - Normalization
- Flipped class room - Database design validation through Normalization, Understanding the functional dependency across the attributes in the relation.
- Practical – Creation of schema using Data Definition language and Instances using the Data Manipulation language commands
- Practical – Simple SQL query construction using keywords

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Complex SQL Queries - Nested Queries - Correlated Nested Queries - Various Types of Joins - Aggregate Functions - Grouping - Triggers – Views – Embedded and Dynamic SQL

SUGGESTED ACTIVITIES:

- In Class - SQL Queries and Joins
- Practical - Implementation of complex SQL Queries (Joins, Sub queries, inbuilt functions) and Triggers
- EL – Understand the features in other commercial or open-source DBMS

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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MODULE VI:	L	T	P	EL
	5	0	4	3
Transaction processing concepts -Need for concurrency control and recovery- ACID Properties - Recoverability - Serializability				
SUGGESTED ACTIVITIES: • In Class –examples to understanding the real-world scenarios like concurrency in transactions • Practical - Implementation of complex procedures (PL/SQL Procedures) and transactions involving shared variables				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Concurrency Control - Two phase locking Techniques - Timestamp Ordering - Granularity - Recovery - Deferred Update - Immediate Update - Deadlocks				
• In Class – examples to understanding the real-world scenarios like concurrency, deadlock and recovery in transactions • Practical - Implementation of complex procedures (PL/SQL functions) and transactions involving shared variables				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Query Processing - SQL Query Translation - Pipelining - Query Optimization - Cost Estimation - Semantic Query Optimization				
SUGGESTED ACTIVITIES: • EL – Methods for optimizing the query in terms of space and time complexity • In Class - Query Translation and Optimization • Flipped classroom - cost-based query optimization for complex SQL queries • Practical – Cost estimation for a query using OSS				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Indexing - Single-Level and Multilevel Index - Multiple Key Index - Indexing Issues. Hashing				
SUGGESTED ACTIVITIES: • EL – efficient methods for storage and retrieval • In Class - Selecting the Index types for a scenario and discuss the efficiency • Flipped Classroom – Issues on selection of attribute in a relation for Indexing / Hashing • Practical – Use OSS to compare the efficiency of the various available methods of storage and retrieval				

SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Introduction to Database Tuning - Data Warehousing and Mining – Spatial and Temporal Databases – OO Databases, NoSQL				
SUGGESTED ACTIVITIES: • EL – Applications that use Spatial and temporal data • In Class – Analyzing the tuning parameters that corresponds to high performance. • Flipped Classroom – Demonstrate the operations on Data in Data warehouse & mine specific patterns • Practical – Use OSS to perform the operations in DW & M				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				

TEXT BOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Seventh Edition, Tata McGraw Hill, 2019.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson/Addison - Wesley, 2016.

REFERENCES:

1. C.J. Date, A. Kannan and S. Swamynathan, “An Introduction to Database Systems”, Pearson Education, Eighth Edition, 2006.
2. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Third Edition, McGraw Hill, 2014.
3. Narain Gehani and Melliyal Annamalai, “The Database Book: Principles and Practice Using the Oracle Database System”, Universities Press, 2012.
4. Pramod J. Sadalage and Martin Fowler, “NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence”, Addison-Wesley, 2012.

EVALUATION METHOD TO BE USED:

Continuous assessment	Mid term	End Semester
15(T) + 25 (P)	**20**	**40**

OUTCOMES:

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

- Model an application’s data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model
- Formulate solutions to a broad range of query problems using relational algebra/ SQL

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- Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database
- Run transactions and estimate the procedures for controlling the consequences of concurrent data access
- Discuss the basic database storage structures and access techniques: file and page organizations, indexing methods including B-tree, and hashing
- Point out the basics of query evaluation techniques and query optimization

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	1	-	2	-	1	2	3	3	2
CO2	3	3	3	3	3	3	1	-	3	-	1	3	3	3	2
CO3	3	3	3	3	1	3	-	-	2	-	1	3	3	3	2
CO4	3	3	3	2	3	3	-	-	3	-	1	2	3	3	2
CO5	3	3	3	2	1	3	-	-	3	-	1	2	3	3	2
CO6	3	3	3	3	2	1	1	-	2	-	-	2	2	2	2

CS6107 **COMPUTER ARCHITECTURE**

Prerequisites for the course: None

OBJECTIVES:

- To identify the requirements of different types of computer systems
- To understand the evaluation of computer systems based on various performance metrics
- To study the characteristics of the ISA and the hardware software co-design
- To trace the execution sequence of an instruction through the processor
- To compare different approaches used for implementing a functional unit
- To understand the fundamentals of memory and I/O systems and their interaction with the processor

	L	T	P	EL	CREDITS
COMPUTER ARCHITECTURE	**3**	**0**	**2**	**3**	**5**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Introduction - Classes of computer systems - Performance - Amdahl's law - The Power wall - Switch from uniprocessors to multiprocessors – Benchmarks.

SUGGESTED ACTIVITIES :

- In Class activity for performance evaluation
- EL - Evolution of computer systems, identification of benchmarks
- Practical – Demonstration - Opening up a computer system and studying the components

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Hardware Software Interface - ISA - Operations of the computer hardware - Operands - Representing instructions - Instructions for making decisions - Supporting procedures in computer hardware.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Writing simple assembly language programs from high level code
- Practical – Study of an existing standard architectural simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Addressing modes - Translating and starting a program - Arrays versus pointers - MIPS instruction formats - Assembly language programming.

SUGGESTED ACTIVITIES :

- EL - Familiarising with assembly language programming
- Practical - Study of an existing standard architectural simulator

Attested

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Integer arithmetic - Binary Parallel adder – Carry Look-ahead Adder - Carry save adder - Binary multiplier - Booth's multiplier - Bit-pair recoding - Binary division.

SUGGESTED ACTIVITIES :

- Flipped Class room
- Some arithmetic algorithms in class and some as EL
- Practical : Study of addressing modes with examples, Tracing the execution sequences, Identifying the timing constraints

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Floating point arithmetic- Representation - Arithmetic operations on floating point numbers - Parallelism and computer arithmetic.

SUGGESTED ACTIVITIES :

- Flipped class room
- EL – Simulation of the floating point operations
- Practical - Study of the ISA supported by the architectural simulator and running simple programs on the simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes
- Demonstrate decode and execute for a subset of instructions on the simulator

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Datapath design - Implementation of the basic MIPS ISA - Building the datapath - A simple implementation scheme - Drawbacks.

SUGGESTED ACTIVITIES :

- Introduction in class
- Flipped Classroom for building of datapath for additional instructions
- Practical - Analysing the datapath on the standard simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quiz in Class or automatic Quizzes for the flipped classroom content

MODULE VII:	**L**	**T**	**P**	**EL**
	6	**0**	**2**	**6**

Instruction Level Parallelism - Pipelining - Overview of pipelining - Performance - Pipeline hazards - Pipelined datapath and control - Handling data hazards and control hazards - Exceptions - Introduction to advanced ILP.

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- Practical - Study of the pipelined implementation and analysis of various hazards on the standard simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems involving instruction sequences and real-time scenarios
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	6	**0**	**4**	**6**

Need for a hierarchical memory system - The basics of caches - Measuring and improving cache performance. Virtual memory - Paging and segmentation - TLB - Implementing protection with virtual memory. A common framework for memory hierarchies, Associative memories, Introduction to virtual machines.

SUGGESTED ACTIVITIES :

- Flipped classroom
- Practical - Implement a simple functional model of a set-associative cache in C/C++. Study hit/miss rates for various access patterns. Experiment with different replacement policies.
- EL - Writing simple programs to study the behaviour of the memory hierarchy of your own laptop/ PC
  - Analyzing the performance of the memory hierarchy by varying different parameters

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes
- Practical component evaluation

MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**2**	**3**

Storage and I/O - Dependability, reliability and availability - Disk storage - Flash storage - Connecting processors, memory and I/O devices - Interfacing I/O devices to the processor, memory and the operating system, Designing an I/O system, Parallelism and I/O, RAID.

SUGGESTED ACTIVITIES :

- EL - Survey of storage devices (NAS/SAN/RAID etc.) on different classes of systems
- Practical – Continue with the exercises on memory hierarchy

SUGGESTED EVALUATION METHODS:

- Survey evaluation – mindmap

TEXT BOOKS:

1. David A. Patterson and John L. Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Fifth Edition, Morgan Kaufmann / Elsevier, 2013.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, “Computer Organization and Embedded Systems”, Sixth Edition, Tata McGraw Hill, 2012.

REFERENCE BOOKS:

1. William Stallings, “Computer Organization and Architecture – Designing for Performance”, Sixth Edition, Pearson Education, 2003.

2. John P. Hayes, “Computer Architecture and Organization”, Third Edition, Tata McGraw Hill, 1998.
3. V.P. Heuring, H.F. Jordan, “Computer Systems Design and Architecture”, Second Edition, Pearson Education, 2004.
4. Behrooz Parhami, “Computer Architecture”, Oxford University Press, 2007.

EVALUATION METHOD TO BE USED:

Continuous assessment	Mid term	End Semester
15(T) + 25 (P)	20	40

Course Ourcomes:

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

- Evaluate the performance of computer systems
- Design a simple instruction execution unit
- Point out the hazards present in a pipeline and suggest remedies
- Explain the data path and control path implementation of a processor
- Modify some features of an architectural simulator
- Critically analyse the various characteristics of the hierarchical memory and I/O devices and their interface to the processor

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	1	-	-	-	-	3	3	3	3
CO2	3	3	3	1	1	1	1	-	1	-	-	3	3	3	3
CO3	3	3	3	1	1	1	1	-	-	-	-	3	3	3	1
CO4	3	3	3	1	1	1	1	-	1	-	-	3	3	3	1
CO5	3	3	3	1	1	1	1	-	1	-	-	3	3	3	3
CO6	3	3	3	1	1	1	1	-	-	-	-	3	3	3	3

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CS6108 **OPERATING SYSTEMS**

Prerequisites for the course: None

OBJECTIVES:

- To learn the basic concepts and functions of operating systems
- To learn the mechanisms of operating systems to handle processes and threads and their communication
- To know the components and management aspects of concurrency management
- To study the basic components of scheduling mechanism
- To learn the mechanisms involved in memory management in contemporary OS
- To appreciate the emerging trends in Operating Systems
- To learn programmatically to implement simple OS mechanisms

	L	T	P	EL	TOTAL	CREDITS
OPERATING SYSTEMS	**3**	**0**	**4**	**3**		**6**

MODULE I INTRODUCTION TO OPERATING SYSTEMS	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**4**

Introduction to OS – Operating System Services – Operating System Operations – Virtualization –User and Operating System Interface – System Calls – Operating System Structures - Building and Booting an Operating System

SUGGESTED ACTIVITIES:

PRACTICAL:

I - Shell programming assignments

EL

1. Shell programming
2. Read the history of Unix/Linux/Windows
3. Know the operating system in your phone/laptop
4. System boot up process of Windows / Linux

SUGGESTED EVALUATION METHODS:

- Quiz on understanding of Linux and shell programming

MODULE II **INTRODUCTION TO PROCESSES**	**L**	**T**	**P**	**EL**
	6	**0**	**8**	**6**

Process Concept – Process Scheduling – Context Switch – Operations on Processes – Inter-process Communication – IPC in Shared-Memory Systems – IPC in Message-Passing Systems Examples of IPC Systems – POSIX shared memory

SUGGESTED ACTIVITIES :

Practical:

1. Use of ps, ps lx, ps tree, ps –aux commands
2. Use of top command to display resource usage statistics of processes
3. Use of the fork, clone, exec, wait, exit system calls
4. Inter-process communication using pipes, shared memory

EL: Learn to write a makefile, to use gdb and to use grep

SUGGESTED EVALUATION METHODS:

- Implementation evaluation
- EL assignment to be appropriately evaluated

MODULE III THREADS	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Threads – Overview – Multithreading models – Pthreads

SUGGESTED ACTIVITIES :

Practical:

Implement multi-threading using the Pthread library

EL: Java threads

SUGGESTED EVALUATION METHODS:

- Evaluation of the implementation of multi-threading

MODULE IV CPU SCHEDULING	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Basic Concepts of CPU Scheduling – Scheduling Criteria – Scheduling Algorithms

SUGGESTED ACTIVITIES :

Practical:

Simulation of CPU scheduling algorithms

EL:

Assignment problems on CPU scheduling algorithms

SUGGESTED EVALUATION METHODS:

- Assignments to be appropriately evaluated.

MODULE V PROCESS SYNCHRONIZATION	**L**	**T**	**P**	**EL**
	6	**0**	**8**	**6**

The Critical-Section Problem - Peterson's Solution – Hardware Support for Synchronization – Mutex Locks – Semaphores – Monitors – Deadlocks.

SUGGESTED ACTIVITIES:

Practical:

1. Solutions to Syncronization problems using semaphores
2. Introduction to xv6: download and build
3. Run the kernel inside QEMU gdb

EL:

Reading details about xv6 operating system

SUGGESTED EVALUATION METHODS:

- Implementation evaluation
- Quiz on the understanding of the different concepts in this module

MODULE VI STORAGE MANAGEMENT	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**4**

File Concept – Access Methods – Directory Structure – Protection – Directory Implementation – Allocation Methods – Free-Space Management – Disk Structure – Disk Scheduling

SUGGESTED ACTIVITIES:

Practical:

1. Use of system calls like creat, open, read, write, close, dup, readdir and scandir

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2. Read the file xv6/fs.h to understand how a directory entry, a superblock and the contents of an inode are implemented in xv6
3. Read the file xv6/fs.c to understand how a new entry is added to a directory and explain the functions involved.

EL:
Read about the contents of a superblock, a directory entry, and an inode in UNIX-like operating systems

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE VII MEMORY MANAGEMENT	**L**	**T**	**P**	**EL**
Contiguous Memory Allocation – Paging – Structure of the Page Table – Segmentation – Paging with segmentation	**6**	**0**	**8**	**6**

SUGGESTED ACTIVITIES :
Practical:

1. Read and understand appropriate files in xv6 related to process scheduling and memory management

EL:
Assignment problems on memory management

SUGGESTED EVALUATION METHODS:

- Quiz on xv6 study files

MODULE VIII VIRTUAL MEMORY MANAGEMENT	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Demand Paging – Page Replacement – Allocation of Frames – Thrashing

SUGGESTED ACTIVITIES
Practical:

- Implementation of at least one of the page replacement policies
- Implementation of a new system call in xv6

EL:

- Assignments on page replacement algorithms

SUGGESTED EVALUATION METHODS

- Evaluation of the coding assignments
- Quiz on the different parts of the module

TEXT BOOK:

1. Abraham Silberschatz, Greg Gagne and Peter B. Galvin. "Operating System Concepts", 10th Edition, Wiley, 2018.

REFERENCES:

1. Andrew S. Tanenbaum. "Modern Operating Systems", Addison Wesley, Fourth Edition, 2014.
2. D. M. Dhamdhere. "Operating Systems: A Concept-Based Approach", 3rd. Edition, Tata McGraw-Hill, 2017.
3. William Stallings. "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2013.

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4. Russ Cox, Frans Kaashoek and Robert Morris. "xv6: A Simple, Unix-like Teaching Operating System", Revision 8. (Free and can be downloaded)

SOURCE CODE

The xv6 source code is available via : *git clone git://pdos.csail.mit.edu/xv6/xv6.git*

EVALUATION METHOD TO BE USED:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

Course Outcomes:

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

- Articulate the main concepts, key ideas, strengths and limitations of Operating Systems
- Analyze the structure and basic architectural components of OS
- Elaborate and design various scheduling algorithms
- Discuss various memory management schemes and design them
- Point out the various aspects of storage management

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	2	1	-	-	-	-	3	3	3	3
CO2	3	3	3	1	1	2	1	-	1	-	-	3	3	3	3
CO3	3	3	3	3	1	1	1	-	1	-	-	3	3	3	3
CO4	3	3	3	3	1	1	1	-	1	-	-	3	3	3	3
CO5	3	3	3	3	1	1	1	-	-	-	-	3	3	3	3

CS6109 **COMPILER DESIGN**

OBJECTIVES:

- To know about the various transformations in the different phases of the compiler, error handling and means of implementing the phases
- To learn about the techniques for tokenization and parsing
- To understand the ways of converting a source language to intermediate representation
- To have an idea about the different ways of generating assembly code
- To have a brief understanding about the various code optimization techniques

COMPILER DESIGN	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**4**	**3**	**6**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Phases of the compiler – compiler construction tools – role of assemblers, macroprocessors, loaders, linkers.

SUGGESTED ACTIVITIES :

- EL – Constructs of programming languages - C, C++, Java
- LEX tool tutorial

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Role of a lexical analyzer – Recognition of Tokens – Specification of Tokens - Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Finite Automata with Epsilon Transitions – NFA to DFA conversion - Minimization of Automata.

SUGGESTED ACTIVITIES :

- EL –LEX tool for tokenization
- Problems based on conversion from NFA to DFA, Epsilon NFA to DFA
- Practical – Programs using LEX for tokenization

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Error handling – Error Detection and Recovery – Lexical phase error management – Syntax phase error management -Error recovery routines.

SUGGESTED ACTIVITIES :

- Flipped Class room – LEX programs
- Problems based on obtaining automata for error routines.
- EL – Implementation of error recovery procedures using LEX/FLEX tool

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Context-Free Grammar (CFG) – Derivation Trees – Ambiguity in Grammars and Languages – Need and Role of the parser

SUGGESTED ACTIVITIES :

- EL - CFG for C language constructs
- Problems to check for ambiguity

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Recursive Descent Parsers – LL(1) Parsers – Shift Reduce Parser – LR(0) items - Simple LR parser

SUGGESTED ACTIVITIES :

- EL – Push down automata for Parsing, YACC tutorial.
- Problems based on simplification of CFG

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

LALR Parser – CALR Parser – Parser Generators – Design of a parser generator

SUGGESTED ACTIVITIES :

- EL – YACC tutorial for parsing particular language syntaxes
- Practical – programs using YACC for parsing

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Syntax directed Definitions – Inherited and Synthesized Attributes - Syntax Directed Translation - Construction of Syntax Tree-Type Systems-Specification of a simple type checker

SUGGESTED ACTIVITIES :

- EL – Type checking semantic rules for a programming language like C.
- Programs for validating C-lite constructs using YACC

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Three address code – Types of Three address code – Quadruples, Triples, Three-address code for Declarations, Arrays, Loops, Backpatching

SUGGESTED ACTIVITIES :

- Flipped classroom – semantic rules for three-address code a programming language like C.
- Practical – implementation of three-address code generation for a programming language like C.
- EL – Three-address code for Switch-case statements
- Assignment on generating three-address code for arrays, looping constructs with and without backpatching

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Run Time Environment: Source Language Issues- Symbol Tables - Storage Organization-Stack Allocation- Access to nonlocal data on stack – Heap management - Parameter Passing

SUGGESTED ACTIVITIES :

- Flipped classroom – suggested parameter passing techniques for a programming language like C.
- Practical – Symbol table implementation

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Practical demo / evaluation

MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Basic blocks – Next use – Register allocation – DAG construction – Loops

SUGGESTED ACTIVITIES :

- Combination of in class & Flipped
- EL – Basic block, next-use applications,
- EL – alternate register allocation techniques
- Practical – Implementation of Register allocation using Graph colouring

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE XI:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Code Generator Issues – Simple Code generator – Data Structures for simple code generator, Labelling algorithm - Code generator using DAG – Dynamic programming based code generation

SUGGESTED ACTIVITIES :

- Combination of in class & Flipped
- EL – Template based code generation
  - Practical – simple code generator for a programming language like C.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

MODULE XII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Principle sources of optimization - Optimization in Basic blocks – DAG – Structure Preserving transformation – functional transformation – loop optimization – Peep hole optimization

SUGGESTED ACTIVITIES :

- Combination of in class & Flipped
- Practical – Combining and integrating all the implemented features for a programming language like C

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical demo / evaluation

TEXT BOOK:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, Second Edition, Pearson Education Limited, 2014.

REFERENCES:

1. Randy Allen, Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence-based Approach”, Morgan Kaufmann Publishers, 2002.
2. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint, 2003.
3. Keith D Cooper and Linda Torczon, “Engineering a Compiler”, Morgan Kaufmann Publishers, Elsevier Science, 2004.
4. V. Raghavan, “Principles of Compiler Design”, Tata McGraw Hill Education Publishers, 2010.
5. Allen I. Holub, “Compiler Design in C”, Prentice-Hall Software Series, 1993.

EVALUATION METHOD TO BE USED:

Category of Course	**Continuous Assessment**	**Mid – Semester Assessment**	**End Semester**
Theory Integrated with Practical	**15(T) + 25 (P)**	**20**	**40**

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

- Comprehensively identify the issues in every phase of the compiler
- Analyse the design issues in the different phases of the compiler and design the phases by integrating appropriate tools
- Articulate the front end in the design of a compiler with, Lexical, Syntactic and Semantic phases and its processes for any given source language
- Analyse and understand the various code optimizations that are necessary for any given intermediate code or assembly level code for sequential algorithms
- Apply and design code optimization techniques for any input code with error recovery
- Design a compiler by incorporating the various phases of the compiler for any new source language

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3		1	1	-				2	3	3	2
CO2	3	3	3	3	3	1	1	-			1	2	3	3	2
CO3	3	3	3	3	3	1	1	-			1	2	3	3	2
CO4	3	3	3	3	3	1	1	-			1	2	3	3	2
CO5	3	3	3	3	3	1	1	-	1		1	2	3	3	2
CO6	3	3	3	3	2	2	1	-	1		1	2	3	3	2

CS6110 OBJECT ORIENTED ANALYSIS AND DESIGN

Prerequisites for the course: None

OBJECTIVES:

- To capture the requirement specifications of an intended software system
- To design software with static and dynamic UML diagrams
- To map the design properly to code
- To improve the software design with design patterns
- To test the software against its requirements specifications

	L	T	P	EL	CREDITS
OBJECT ORIENTED ANALYSIS AND DESIGN	**3**	**0**	**4**	**3**	**6**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Introduction to OOAD with OO Basics - Unified Process – UML diagrams				
SUGGESTED ACTIVITIES : • EL - Identifying a suitable case study to work on for a complete end-end implementation • EL – Document the Software Requirement Specifications(SRS) for the identified case study • Practical – Getting familiar with the case tool				

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	0	4	3

Use Cases –Case study – the Next Gen Point of Sale(POS) system, Inception Use case Modelling

SUGGESTED ACTIVITIES :

- EL – Identify use cases for the chosen case study and develop the Use Case model.
- Practical – Presenting the SRS for the chosen case study and obtaining approval

SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE III :	L	T	P	EL
	3	0	4	3

Use case modeling - Relating Use cases – include, extend and generalization - Class Diagram— Elaboration – Domain Model – Finding conceptual classes and description classes – Associations – Attributes

SUGGESTED ACTIVITIES :

1. EL - Identify the conceptual classes to develop a DomainModel and Class Diagram.
2. Practical – Presenting the use case model (for the chosen case study) along with use case diagrams.

SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE IV :	L	T	P	EL
	3	0	4	3

Domain Modeling using class diagrams - Domain model refinement – Finding conceptual class Hierarchies – Aggregation and Composition

SUGGESTED ACTIVITIES :

- EL – Expand the domain model by identifying the hierarchies, association, aggregation and composition
- Practical – Present the refined use case model and the basic domain model

SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE V :	L	T	P	EL
	3	0	4	3

Dynamic Diagrams - UML interaction diagrams - System sequence diagram – Collaboration diagram - Communication diagram

SUGGESTED ACTIVITIES :

- EL – Develop sequence diagrams for the scenarios identified in the use case model
- Practical – Presenting the complete domain model(after refinement) and class diagrams for the chosen case study

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SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

State machine diagram and Modelling – State Diagram - Activity diagram

SUGGESTED ACTIVITIES :

- EL - Develop state and activity diagrams for the chosen case study
- Practical – Presenting the dynamic model with sequence diagrams

SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Implementation Diagram - UML package diagram - Component and Deployment Diagrams

SUGGESTED ACTIVITIES :

- EL –Finalize the environment and initiate implementation
- Practical – Presenting the complete dynamic model with state and activity diagrams and refined sequence diagrams

SUGGESTED EVALUATION METHODS:

- Presentations
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Designing objects with responsibilities – Creator – Information expert – Low Coupling – High Cohesion – Controller. Design Patterns – Creational – Factory method – Structural – Bridge – Adapter – Behavioural– Strategy – Observer

SUGGESTED ACTIVITIES :

- EL– Continue with the implementation
- Practical – Demonstrate partial implementation

SUGGESTED EVALUATION METHODS:

- Practical demonstration
- Quizzes

MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Applying Gang of Four design patterns – Mapping design to code

SUGGESTED ACTIVITIES :

- EL – Identifying suitable design patterns to improve the design and documenting the rationale behind their selection. Proceed with the refined implementation by applying them,
- Practical **–** Demonstrate complete implementation without the design patterns

SUGGESTED EVALUATION METHODS:

- Practical demonstration
- Quizzes

MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

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Object Oriented Methodologies – Software Quality Assurance – Impact of object orientation on Testing – Develop Test Cases and Test Plans				
SUGGESTED ACTIVITIES : • EL – Developing a Test plan with all test cases • Practical – Present the modified design with appropriate design patterns. Demonstrate the implementation after incorporating the implementation of suitable design patterns				
SUGGESTED EVALUATION METHODS: • Presentations • Quizzes				
MODULE XI	**L**	**T**	**P**	**EL**
	2	**0**	**4**	**0**
Revisiting and consolidating all salient points and key insights based on the team projects				
Suggested Activities: • Practical – Demonstrating the test plan and the various test cases				
Suggested Evaluation: • Presentations				

TEXT BOOK:

1. Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", 3rd. Edition, Pearson Education, 2005.

REFERENCES:

1. Martin Fowler, "UML Distilled: A Brief Guide to the Standard Object Modeling Language", Third Edition, Addison Wesley, 2003.
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Pearson, 2015.

EVALUATION METHOD TO BE USED:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	**15(T) + 25 (P)**	**20**	**40**

OUTCOMES:

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

- Identify and map basic software system requirements in UML
- Express software design with UML diagrams
- Design and implement software systems using OO methodology
- Improve software design using design patterns
- Test the software system developed against the intended requirements

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CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	1	-	2	-	2	2	3	3	2
CO2	3	3	3	3	2	2	1	-	2	-	2	2	3	3	2
CO3	3	3	3	3	2	2	1	-	2	-	2	2	3	3	2
CO4	3	3	3	3	2	2	1	-	2	-	2	2	3	3	2
CO5	3	3	3	3	2	2	1	-	2	-	2	2	3	3	2

CS6111 COMPUTER NETWORKS

CS6111 COMPUTER NETWORKS	L	T	P	EL	CREDITS
	3	0	4	3	6

OBJECTIVES

- To understand the division of network functionality into layers
- To familiarize the functions and protocols of each layer of the TCP/IP protocol suite
- To visualize the end-to-end flow of information
- To understand the components required to build different types of networks
- To learn concepts related to network addressing and routing

MODULE I :	L	T	P	EL
	3	0	8	3

Building a network - Network edge and core – Layered Architecture – ISO/OSI Model – Internet Architecture (TCP/IP) - Performance Metrics – Introduction to Sockets.

SUGGESTED ACTIVITIES :

- Performance Metrics – In class
- EL - Socket Programming
- Practical – Socket Programming

SUGGESTED EVALUATION METHODS:

- Problems on Performance Metrics

MODULE II :	L	T	P	EL
	4	0	8	3

Application Layer protocols – HTTP- FTP – Email – DNS

SUGGESTED ACTIVITIES :

- EL - HTTP/DNS format using Wireshark
- Practical – Implementation of HTTP, Web Caching, FTP using socket programming

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quiz on Wireshark

MODULE III :	L	T	P	EL
	3	0	4	3

Transport Layer: End to End Protocols – Connectionless Transport: User Datagram Protocol – UDP Applications.

SUGGESTED ACTIVITIES :

- EL - Wireshark for UDP, TCP packet formats
- Practical – Socket Programming on UDP**,** Implementation of DNS using UDP

SUGGESTED EVALUATION METHODS:

- Quiz on UDP applications

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MODULE IV :	L	T	P	EL
	6	0	4	3

Connection Oriented Transport: Transmission Control Protocol – Flow Control - Retransmission strategies - Transport layer for Real Time Applications - Congestion Control

SUGGESTED ACTIVITIES :

- EL – Transport layer for Real Time Applications
- Analysis in Class – Flow Control
- Practical – Flow Control

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quiz on Real time transport protocols

MODULE V :	L	T	P	EL
	3	0	4	2

Network Layer: Introduction- Internet Protocol – IPV4 - IP Addressing

SUGGESTED ACTIVITIES :

- EL- IPV6
- Practical – Basic network construction using simulator

SUGGESTED EVALUATION METHODS:

- Assignment Problems
- Quizzes

MODULE VI	L	T	P	EL
	3	0	0	3

Subnetting – Variable Length Subnet Mask (VLSM) - Classless Inter Domain Routing (CIDR) - DHCP – ICMP

SUGGESTED ACTIVITIES :

- In class – Problems on Subnetting,
- EL – Problems on CIDR

SUGGESTED EVALUATION METHODS:

- Assignment Problems

MODULE VII:	L	T	P	EL
	3	0	8	4

Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – SDN Control Plane

SUGGESTED ACTIVITIES :

- In Class – Problems in Distance Vector Routing , Link State Routing
- EL - RIP, OSPF
- Practical – Performance analysis of different network topologies and routing protocols using suitable simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VIII:	L	T	P	EL
	3	0	0	3

BGP- Introduction to Quality of Services (QoS). Data Link Layer: Link Layer – Framing – Addressing – Error Detection/ Correction

SUGGESTED ACTIVITIES

- In class: Error Detection and Correction
  EL – Problems on QoS

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IX:	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**3**

Medium Access Control – Address Resolution Protocol (ARP) – Network Address Translation (NAT) - Ethernet Basics - CSMA/CD - Virtual LAN – Wireless LAN (802.11) – WAN Technologies

SUGGESTED ACTIVITIES :

- EL – RARP

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE X:	**L**	**T**	**P**	**EL**
	5	**0**	**4**	**3**

Physical layer: signals - Bandwidth and data rate - Encoding - Multiplexing - Transmission media - Networking devices: Hubs, Bridges, Switches, Routers, Gateways.

SUGGESTED ACTIVITIES :

- In class – Encoding techniques problems
- EL – Recent developments in transmission media
- Practical – Topology setup using Hubs, Switches and Bridges using simulator.

SUGGESTED EVALUATION METHODS:

- Quizzes

TEXT BOOKS:

1. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”, Seventh Edition, Pearson Education, 2016.
2. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.

REFERENCES:

1. William Stallings, “Data and Computer Communications”, Eighth Edition, Pearson Education, 2011.
2. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, " Computer Networks: An Open Source Approach", 1st Edition, McGraw Hill, 2011.

EVALUATION METHOD

Category of Course	**Continuous Assessment**	**Mid – Semester Assessment**	**End Semester**
Theory Integrated with Practical	**15(T) + 25 (P)**	**20**	**40**

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Course Outcomes:

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

- Highlight the significance of the functions of each layer in the network
- Identify the devices and protocols to design a network and implement it
- Build network applications using the right set of protocols and estimate their performance
- Trace packet flows and interpret packet formats
- Apply addressing principles such as subnetting and VLSM for efficient routing
- Explain media access and communication techniques

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	1	-		-	-	-	3	2	2
CO2	3	3	3	3	2	1	1	-	3	-	-	2	3	3	2
CO3	3	3	3	3	2	1	1	-	3	-	-	2	3	3	3
CO4	3	3	1	3	3	1	1	-	3	-	-	1	3	2	2
CO5	3	3	3	2	1	1	1	-		-	-	2	3	3	1
CO6	3	3	3	2	1	1	1	-	1	-	-	1	3	1	1

CS6611	CREATIVE AND INNOVATIVE PROJECT	L	T	P	EL	C
		0	0	4	3	3

OBJECTIVES:

- To identify the problem based on societal needs
- To interview people on societal problems that require computerization
- To suggest creative solutions to societal problems
- To explore possible alternative solutions
- To estimate risk and develop a prototype

The aim of this course is to encourage the students to identify projects that help in exploring variables that promote creativity and innovation. Each student is expected to choose a real life or socially relevant problem. At the end of the project, students should be familiar with the state of art in their respective fields. They would be able to apply the concepts learnt to relevant research problems or practical applications. This course is to motivate them to learn concepts, models, frameworks, and tools that engineering graduates' need in a world where creativity and innovation is fast becoming a pre-condition for competitive advantage.

OUTCOMES:

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

- Convert user requirements to a software architecture diagram
- Identify and specify the pre-processing necessary to solve a problem
- Suggest optimum solutions by comparing the different solutions from an algorithmic perspective
- Discover the research implications in any societal problem
- Design and use performance metrics to evaluate a designed system
- Perform SWOT and PESTEL Analysis

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1. Internals

a. First Review
   i. Block Diagram of the proposed solution for a societal / creative problem
   ii. New Contribution in terms of modifications to existing algorithm or suggestion of new ones
   iii. Detailed Design of each module
   iv. Evaluation Metrics
   v. Test Cases

b. Second Review
   i. Implementation - Justifying pros and Cons
   ii. Coding - highlighting what has been reused and what is being written

c. Third Review
   i. Test Runs
   ii. Performance Evaluation based on Metrics
   iii. Project Documentation

2. Externals
   - Presentation, Viva-Voce, Report submission.

Course Outcomes:

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

- Convert user requirements to a software architecture diagram
- Identify and specify the pre-processing necessary to solve a problem
- Suggest optimum solutions by comparing the different solutions from an algorithmic perspective
- Discover the research implications in any societal problem
- Design and use performance metrics to evaluate a designed system

.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	-	-	3	1	2	1	3	3	2
CO2	3	2	2	2	2	2	1	-	3	1	2	1	2	2	2
CO3	3	2	3	3	1	2	1	-	3	1	2	1	2	3	3
CO4	2	3	2	3	1	2	1	-	3	1	2	2	3	3	3
CO5	2	1	1	3	2	2	1	-	3	1	2	1	3	2	3

MA6201 LINEAR ALGEBRA	L	T	P	EL	TOTAL	CREDITS
	3	1	0	3		5

OBJECTIVES:

- To learn to analyze a linear system of equations
- To study the properties of a linear transformation
- To understand the process of orthogonalization
- To learn to solve linear equations using different methods
- To understand the applications of linear algebra in engineering

MODULE I	L	T	P	EL
	5	1	-	3

Vector spaces – Subspaces – Linear combinations and linear system of equations

SUGGESTED ACTIVITIES :

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II	L	T	P	EL
	5	1	-	3

Linear independence and Linear dependence – Basis and Dimension

SUGGESTED ACTIVITIES :

- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III	L	T	P	EL
	5	1	-	3

Linear Transformation – Null space, Range space - Dimension theorem - Matrix representations of Linear Transformations

SUGGESTED ACTIVITIES:

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV	L	T	P	EL
	5	1	-	3

Eigenvalues and Eigenvectors of a linear transformation – Diagonalization of linear transformations – Application of diagonalization in a linear system of differential equations

SUGGESTED ACTIVITIES:

- Problem solving sessions

- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V	**L**	**T**	**P**	**EL**
	6	**2**	**-**	**6**

Inner Product Spaces –Norms - Orthogonal vectors – Gram Schmidt orthogonalization process - Least Square Approximations

SUGGESTED ACTIVITIES :

- Problem solving sessions

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI	**L**	**T**	**P**	**EL**
	3	**1**	**-**	**3**

Solution of linear system of equations – Direct method: Gauss elimination method – Pivoting – Gauss Jordan method -LU decomposition method – Cholesky decomposition method

SUGGESTED ACTIVITIES :

- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII	**L**	**T**	**P**	**EL**
	3	**1**	**-**	**3**

Iterative methods: Gauss-Jacobi and Gauss-Seidel – SOR Method

SUGGESTED ACTIVITIES :

- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII	**L**	**T**	**P**	**EL**
	3	**1**	**-**	**3**

Eigenvalue Problems: Power method – Inverse Power method - Jacobi's rotation method

- **SUGGESTED ACTIVITIES :**
- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX GENERALISED INVERSES	**L**	**T**	**P**	**EL**
	3	**1**	**-**	**3**

QR decomposition - Singular Value Decomposition method

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SUGGESTED ACTIVITIES :

- Problem solving sessions
- Applications in real life problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXT BOOKS:

1. Stephen H. Friedberg, Insel A.J. and Spence L.E., "Linear Algebra", 4th. Edition, Prentice - Hall of India, New Delhi, 2003.
2. M.K.Jain, S.R.K.Iyengar, R.K.Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International (P) Limited, New Delhi, 2003.
3. Richard Bronson, "Matrix Operations", Schaum's Outline Series, 1989.

REFERENCES:

1. Strang G., "Linear Algebra and its Applications", Thomson (Brooks/Cole), New Delhi, 2005.
2. Kumaresan. S., "Linear Algebra – A Geometric Approach", PHI, New Delhi, 2010.
3. Faires J.D. and Burden R., "Numerical Methods", Brooks/Cole (Thomson Publications), New Delhi, 2002.
4. Gerald C.F., Wheatly P.O., "Applied Numerical Analysis", Pearson Education India, New Delhi, 2002.

EVALUATION METHOD TO BE USED:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

Course Outcomes:

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

- Perform linear transformations and write down the matrix representing a linear transformation
- Find the Gram-Schmidt orthogonalization of a matrix
- Determine the rank, determinant, eigenvalues and eigenvectors, diagonalization, and different factorizations of a matrix
- Solve a linear system of equations using direct and iterative methods
- Solve Eigen value problems
- Formulate linear equations for real life problems and solve them

CO – PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	1	-	-	-	1	1	3	3	2
CO2	3	3	2	2	2	2	2	-	-	-	2	1	3	2	1
CO3	3	3	3	3	3	2	2	-	-	-	2	2	3	3	3
CO4	3	3	3	3	3	3	3	-	-	-	2	2	3	3	3
CO5	3	3	3	3	3	2	2	-	-	-	2	2	3	2	2
CO6	3	3	3	3	3	2	2	-	-	-	2	2	3	3	2

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CS6201	GRAPH THEORY	L	T	P	EL	CREDITS
		3	1	0	3	5

Prerequisites for the course: Discrete Mathematics

OBJECTIVES:

- To understand the fundamentals of graph theory
- To study the proofs related to various concepts in graphs
- To study about the different types of graphs and their properties
- To learn about the distinguishing features of various graph algorithms
- To study the applications of graphs in solving engineering problems

MODULE I INTRODUCTION	L	T	P	EL
	4	1	0	3

Introduction - Graph Terminologies - Types of Graphs - Isomorphism - Isomorphic Graphs - Operations on graphs - Degree sequences - Euler graph - Hamiltonian Graph - Related theorems.

SUGGESTED ACTIVITIES :

- EL: Graphs and tournaments, Graphs in real world applications

SUGGESTED EVALUATION METHODS:

- Assignment on graphs in real world applications

MODULE II EDGE GRAPH	L	T	P	EL
	3	1	0	3

Edge Graphs and Traversability - Eccentricity Sequences and Sets – Isometry.

SUGGESTED ACTIVITIES :

- Graph Isometry Problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Quizzes

MODULE III TREES	L	T	P	EL
	3	1	0	3

Trees -Properties- Distance and Centres - Types - Rooted and Binary Tree- Tree Enumeration- Labeled Tree - Unlabeled Tree

SUGGESTED ACTIVITIES :

- EL: Binary trees and signed trees

SUGGESTED EVALUATION METHODS:

- Tutorial problems and assignment problems on generating trees with specified properties

MODULE IV SPANNING TRE	L	T	P	EL
	4	1	0	3

Spanning Tree - Fundamental Circuits- Cut Sets - Properties - Connectivity- Separability – Network Flows - 1-isomorphism, 2-isomorphism - Related Theorems

SUGGESTED ACTIVITIES :

- Concept maps to relate spanning trees with other topics

SUGGESTED EVALUATION METHODS:

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- Tutorial problems on proof techniques
- Assignment problems on graph connectivity

MODULE V PLANARITY	L	T	P	EL
	3	2	0	3

Planar Graph - Representation - Detection of planarity - Dual Graph - Related Theorems.

SUGGESTED ACTIVITIES :

- Identification of planar and non-planar graphs

SUGGESTED EVALUATION METHODS:

- Tutorial problems on proving related theorems

MODULE VI DIGRAPH	L	T	P	EL
	3	1	0	3

Digraph - Properties -Euler Digraph – Tournament graph - Applications.

SUGGESTED ACTIVITIES :

- EL: Application of Digraph

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VII GRAPH REPRESENTATION	L	T	P	EL
	3	1	0	3

Matrix Representation- Adjacency matrix- Incidence matrix- Circuit matrix - Cut-set matrix - Path Matrix- Properties - Related Theorems - Correlations.

SUGGESTED ACTIVITIES :

- Graph representation for different types of graphs

SUGGESTED EVALUATION METHODS:

- Tutorial problems on comparative analysis on representation methods
- Assignment problems

MODULE VIII COLORING AND COVERING	L	T	P	EL
	4	2	0	3

Graph Coloring - Chromatic Polynomial - Chromatic Partitioning - Matching - Covering - Related Theorems

SUGGESTED ACTIVITIES :

- EL: Edge coloring and example problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems to find chromatic number of special graphs
- Assignment problems on applications using matching and covering

MODULE IX GRAPH ALGORITHMS -1	L	T	P	EL
	3	0	0	3

Graph Algorithms- Connectedness and Components- Spanning Tree - Fundamental Circuits – Cut Vertices.

SUGGESTED ACTIVITIES :

- Programming on related algorithms

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SUGGESTED EVALUATION METHODS: • Demo on the programs for small applications				
MODULE X GRAPH ALGORITHMS -2	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
Directed Circuits- Shortest Path – Planarity Testing – Isomorphism – Any two applications overview.				
SUGGESTED ACTIVITIES : • Project based learning to apply suitable concepts for a small application				
SUGGESTED EVALUATION METHODS: • Mini Project demo and evaluation				
OUTCOMES: **Upon completion of the course, the students will be able to:** • Point out the basic concepts of graphs, and different types of graphs • Discuss the properties, theorems and be able to prove theorems • Apply suitable graph models and algorithms for solving engineering problems • Analyse various representations of graphs • Analyse graph algorithms and discuss their suitability for applications				

TEXT BOOKS:

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science",Prentice-Hall of India Pvt. Ltd, 2003.
2. S. Pirzada, “An Introduction to Graph theory”, University Press, 2012.

REFERENCES:

1. Frank Harary, “Graph Theory”, Narosa Publishing House, 2001.
2. West D. B., “Introduction to Graph Theory”, 2nd Edition, Pearson Education, 2001.
3. Diestel R, "Graph Theory", 5th Edition, Springer, 2017.

EVALUATION METHOD TO BE USED:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO – PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	-	-	-	-	-	-	-	3	3	3
CO2	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3

EC6201 **SIGNALS AND SYSTEMS**

OBJECTIVES:

- To understand the types of signals and systems
- To gain knowledge about understanding continuous time and discrete time signals.
- To learn time domain and frequency domain analysis of signals
- To learn the transformations from time domain to frequency domain
- To gain knowledge about the various functionalities available in signal processing software to support signal processing applications

SIGNALS AND SYSTEMS	**L**	**T**	**P**	**EL**	**TOTAL CREDITS**
	3	**0**	**4**	**3**	**6**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Classification of Signals - Useful Signal models – periodic and a periodic signals, random signals, Energy & Power signals -Systems – Classification of systems

SUGGESTED ACTIVITIES :

- In Class activity – expressing signals as a function of step, ramp.
- Practical – Plotting of Continuous signals and operations on them using either Open CV, MATLAB, OCTAVE
- EL – Study of any one Open CV, MATLAB, OCTAVE

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Time Domain analysis of continuous-time systems – unit impulse response – Convolution Integral – System response

SUGGESTED ACTIVITIES :

- EL – Visualizing signals of practical day to day activities like traffic light, count of vehicles, temperature of the day, stock market changes
- Practical - Implementation of continuous signals and understanding

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE III	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Fourier Series – Periodic representation by trigonometric Fourier series – Role of amplitude and phase spectra - LTI continuous system response to periodic inputs – Signals as vectors

SUGGESTED ACTIVITIES :

- EL – Flipped Class-room – Signal representation by orthogonal signal set
- Practical – Fourier series application using Open CV, MATLAB or OCTAVE

SUGGESTED EVALUATION METHODS:

- Tutorial problems

- Assignment problems
- Quizzes
- Practical exercises demo

MODULE IV	L	T	P	EL
	3	0	4	3

Fourier Transform – Aperiodic representation by Fourier integral – Properties of Fourier transform – Fourier transform in the analysis of Continuous time systems

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL – Application of Fourier transform
- Practical –Properties of Fourier transform implementation using Open CV, MATLAB, or OCTAVE

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE V	L	T	P	EL
	3	0	4	3

Classification of Discrete time systems – Sampling theorem – signal reconstruction – Discrete-time signal models

SUGGESTED ACTIVITIES :

- EL – Signal operations
- Practical - Open CV, MATLAB, or OCTAVE – implementation and visualization of discrete time systems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE VI	L	T	P	EL
	3	0	4	3

Impulse response – Convolution sum – Discrete time systems response – Differential equation – Block diagram representation of Discrete time systems

SUGGESTED ACTIVITIES :

- EL – Impulse response for special cases, Correlation
- Practical –Convolution Implementation using MATLAB, OCTAVE or Open CV

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE VII	L	T	P	EL
	3	0	4	3

Z-transform – Properties of Z-transform – Inverse Z-transform – Pole-Zero location

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SUGGESTED ACTIVITIES :

- Practical –Implementation of Z-transform using Open CV, MATLAB, or OCTAVE
- EL – Bilateral Z-transform, Inverse Z-transform using alternate methods

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE VIII	L	T	P	EL
	3	0	4	3

Discrete Time Fourier transform – Properties – Inverse Discrete Time Fourier Transform

SUGGESTED ACTIVITIES :

- EL – DTFS, relationship between DTFT and Z-transform
- Practical – Implementation DFT, properties using MATLAB, OCTAVE or Open CV

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE IX	L	T	P	EL
	3	0	4	3

Discrete Fourier Transform – Properties – Circular Convolution – Inverse Discrete Fourier transform

SUGGESTED ACTIVITIES :

- EL – DTFS, relationship between DTFT and Z-transform
- Practical – Implementation DFT, properties using MATLAB, OCTAVE or Open CV

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Practical exercises demo

MODULE X	L	T	P	EL
	3	0	4	3

Fast Fourier Transform –Divide and Conquer – Decimation in Time – Radix-2 algorithm - Complexity

SUGGESTED ACTIVITIES :

- EL – Radix – n implementation of Fast Fourier Transform
- Practical – Analyzing the FFT of signals and their interpretation

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Practical exercises demo

MODULE XI	L	T	P	EL
	3	0	4	3

Fast Fourier transform – Decimation in frequency – Radix-2 algorithm - Inverse DFT using one FFT technique

SUGGESTED ACTIVITIES :

- EL – Derivation of Radix-n FFT for DIF algorithms

SUGGESTED EVALUATION METHODS:

- Tutorial problems

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- Quizzes

OUTCOMES:

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

- Analyze and classify any given signal and system
- Propose appropriate time domain and frequency domain analysis for a signal to satisfy anapplication
- Suggest appropriate frequency transformation to convert an analog signal to a digital signal
- Convert any input data to a signal and analyse it mathematically
- Code and represent a signal and analyse using a signal processing software

TEXT BOOKS:

1. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”, Pearson Education, Second Edition, 2014.
2. B. P. Lathi, “Principles of Linear Systems and Signals”, Oxford University Press, Second Edition, 2009.

REFERENCES:

1. M.J. Roberts, “Signals & Systems, Analysis using Transform Methods & MATLAB”, Tata McGraw Hill (India), Third Edition, 2019.
2. P. Ramakrishna Rao, “Signals and Systems”, Second Edition, Tata McGraw Hill Publications, 2017.
3. H P Hsu, “Signals and Systems”, Schaum‘s Outline Series, Third Edition, Tata McGraw Hill, 2013.
4. S. Haykin and B. Van Veen, "Signals and Systems", Second Edition, Wiley, 2007.
5. Edward W. Kamen and Bonnie S. Heck, “Fundamentals of Signals and Systems Using the Web and MATLAB”, Pearson, Third Edition, 2006.
6. John Alan Stuller, “An Introduction to Signals and Systems”, Cengage Learning, 2007

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-		3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3		-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	2	-	2	2	2	1	3	3	3	3

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CS6202	THEORY OF COMPUTATION	L	T	P	EL	CREDITS
		3	1	0	3	5

OBJECTIVES:

- To understand the Chomsky language hierarchy
- To construct automata for any given pattern and find its equivalent regular expressions
- To design CFG for any given language and prove its equivalence
- To understand the need for Turing machines and their capability
- To understand undecidable problems

MODULE I :	L	T	P	EL
	3	1	0	3

Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Finite Automata with Epsilon Transitions – NFA to DFA conversion – Epsilon NFA to DFA conversion

SUGGESTED ACTIVITIES :

- Defining automata for different types of patterns
- EL – Epsilon NFA to DFA direct conversion

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	1	0	3

Regular Expression – FA and Regular Expressions – Pumping Lemma for Regular Languages

SUGGESTED ACTIVITIES :

- Proofs in class
- EL – Regular expression for practical patterns

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	L	T	P	EL
	3	1	0	3

Properties of Regular languages - Equivalence and Minimization of Automata

SUGGESTED ACTIVITIES :

- Flipped Class room – Moore and Mealy machines
- Problems based on properties – in-class and EL

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	L	T	P	EL
	2	1	0	3

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Context-Free Grammar (CFG) – Derivation Trees – Ambiguity in Grammars and Languages – Equivalence of Parse Trees and Derivation				
SUGGESTED ACTIVITIES : • EL - CFG for practical programming constructs • EL – Alternate theorems and proofs				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE V :	**L**	**T**	**P**	**EL**
	4	**1**	**0**	**3**
Simplification of Context-free Grammar – Chomsky Normal Form – Greibach Normal Form				
SUGGESTED ACTIVITIES : • EL – Problems based on context-free grammar • Proofs of all the grammar equivalence – in-class				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VI:	**L**	**T**	**P**	**EL**
	6	**2**	**0**	**6**
Definition of the Pushdown Automata – Language of a Pushdown Automata – Equivalence of Acceptance by Empty-stack and final state - Equivalence of Pushdown Automata and CFG – Pumping Lemma for CFL – Ogden's lemma for CFL - Closure Properties - Deterministic Pushdown Automata.				
SUGGESTED ACTIVITIES : • Proofs – in-class • EL – String acceptance using the converted PDA from CFG and CFG from PDA • EL - Problems based on properties of CFL				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Turing Machines – Language of a Turing Machine – Turing Machine as a Computing Device				
SUGGESTED ACTIVITIES : • EL – problems on Turing machines as language acceptors, computing device • In-class and EL – Turing machines as computing functions in both unary and binary representation				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**

Attested

Techniques for TM – Modifications of Turing Machines – Two-way Infinite Tape, Equivalence of One Way Infinite Tape and Two-way Infinite Tape Turing Machines – Multi Tape Turing Machines				
SUGGESTED ACTIVITIES : • Flipped Class room – Non-deterministic Turing machines, multi-dimensional Turing machine				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	6	**1**	**0**	**6**
Chomsky hierarchy - A Language that is not Recursively Enumerable (RE) – An Undecidable Problem that is RE – Undecidable Problems about Turing Machine – Universal language – L_r, L_{nr}, L_e, L_{ne}, - Rice Theorem for Recursive and Recursively Enumerable Languages				
SUGGESTED ACTIVITIES : • EL – Halting problem and other undecidable problems and their proofs				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Undecidable nature of Post Correspondence Problem and Modified Post Correspondence problem				
SUGGESTED ACTIVITIES : • EL – Problems based on PCP, MPCP and conversions				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

OUTCOMES:

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

- Classify languages based on Chomsky hierarchy
- Identify the class of language and design automata or Type x grammar
- Prove equivalence of the different language representations within a class of the Chomsky hierarchy
- Identify the undecidable problems and their class of languages
- Apply and prove a given language is decidable or undecidable

TEXT BOOK:

1. John E Hopcroft and Jeffery D Ullman, “Introduction to Automata Theory, Languages and Computations”, Narosa Publishing House, 2002.

REFERENCES:

1. J. Martin, “Introduction to Languages and the Theory of Computation”, Third Edition, Tata McGraw Hill, 2003.
2. Micheal Sipser, “Introduction of the Theory and Computation”, Thomson Brokecole, 1997.
3. H.R. Lewis and C.H. Papadimitriou, “Elements of the Theory of Computation”, Second Edition, Pearson Education, 2003.

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EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	-	-	-	-	-	-	1	2	3	3	1
CO2	3	3	1	2	-	2	-	-	-	-	2	2	3	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	3	1
CO4	3	3	1	2	-	1	1	-	-	-	2	2	3	3	2
CO5	3	2	2	1	-	-	-	-	-	-	2	2	3	3	1

CS 6301 MACHINE LEARNING

OBJECTIVES:

- To understand the need for machine learning for various types of problem solving
- To know the mathematics involved in various machine learning algorithms
- To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
- To learn about probabilistic models in machine learning
- To have a glimpse of the latest developments in machine learning

CS6301 MACHINE LEARNING	L	T	P	EL	TOTAL CREDITS
	3	0	4	3	6

MODULE I :	L	T	P	EL
	6	0	4	3

Learning – Types of Machine Learning – Supervised Learning - The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning- Concept Learning task – Concept Learning as Search - Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm

SUGGESTED ACTIVITIES :

- EL – Fundamentals of Predictive Analytics, Study of tools for data mining like WEKA, KNIME, Rapidminer, etc
- Practical – Study of tools like WEKA, KNIME and the UCI repository datasets

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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MODULE II :	L	T	P	EL
	3	0	4	3

Neural Networks – Perceptron – Linear Separability – Linear Regression

SUGGESTED ACTIVITIES :

- In-class activity – practical problems and the need for machine learning algorithms
- EL – Working with tools and standard data sets
- Practical - Implementation of the Candidate Elimination Algorithm

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE III :	L	T	P	EL
	3	0	4	3

The Multi-Layer Perceptron – Back Propagation of Error-Multi-layer Perceptron in Practice – Deriving Back Propagation – Applications of MLP

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Applications of MLP
- Practical – Implementation of the Neural Network perceptron algorithm and enhancing it to other variations
- Proposal for Mini Project

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Approval of Mini project based on the reference papers, abstract and design

MODULE IV :	L	T	P	EL
	3	0	4	3

Radial Basis Function Network - Concepts –Training - Interpolation and Basis Functions – Solutions using RBF

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL –Applications of RBF Networks
- Practical – Implementation of Multi-layer Perceptron

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE V :	L	T	P	EL
	3	0	4	3

Dimensionality Reduction –Linear Discriminant Analysis-Principal Component Analysis-Factor Analysis-Independent Component Analysis-Locally Linear Embedding-Isomap

SUGGESTED ACTIVITIES :

- EL – Probabilistic PCA and Factor analysis concepts

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- Practical –Implementation of Independent Component Analysis(ICA) algorithm
- Practical – Mini-project design completion

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE VI:	L	T	P	EL
	6	0	4	3

Probabilistic Learning-Gaussian Mixture Models-Nearest Neighbor Models-Support Vector Machines-Optimal Separation-Kernels-The Support Vector Machine Algorithm-Extensions to the SVM

SUGGESTED ACTIVITIES :

- EL – Application of SVM, Nearest Neighbor concepts and other regression models on various datasets
- Practical –Implementation of Support Vector Machines with various kernel models, Nearest Neighbor models
- Continuation of mini project, minimum 40% implementation

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstration of algorithms and mini project

MODULE VII:	L	T	P	EL
	3	0	4	3

Evolutionary Learning-The Genetic Algorithm-Genetic Operators-Using Genetic Algorithms-Genetic Programming - Applications

SUGGESTED ACTIVITIES :

- Flipped Classroom for applications
- EL – Applications of Evolutionary algorithms
- Practical – Implementation of GA, Continuation of mini-project

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE VIII	L	T	P	EL
	3	0	4	3

Reinforcement Learning – Markov Decision Processes - Values-The difference between SARSA and Q-Learning

SUGGESTED ACTIVITIES :

- Flipped Classroom for applications
- EL – Applications of Evolutionary algorithms
- Practical – Continuation of mini-project

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Learning with Trees-Using Decision trees-Constructing Decision Trees-Classification and regression trees-Classification example-Decision by committee: Ensemble Learning-Boosting-Bagging-Random Forests-Different ways to combine classifiers

SUGGESTED ACTIVITIES :

- EL – Applications of Decision tree, CART
- Practical –Implementation of Decision Trees, Bagging, Boosting and EM algorithms Continuation of mini-project

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations, Mini project 80% completion

MODULE X	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Unsupervised Learning-The K-Means Algorithm-Vector Quantization-The self-organizing feature map

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- EL –K-Means algorithm applications
- Practical - Implementations of K-Means algorithm

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical demonstrations

MODULE XI	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Deep learning introduction – CNN – RNN

SUGGESTED ACTIVITIES :

- EL – Survey of deep learning network models
- Practical – Mini-project demonstration

SUGGESTED EVALUATION METHODS:

- Mini project final evaluation

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OUTCOMES:

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

- Differentiate between supervised, unsupervised, semi-supervised machine learning approaches
- Choose and implement classification or regression algorithms for an application using an open source tool
- Implement probabilistic, discriminative and generative algorithms for an application and analyze the results
- Use a tool to implement typical clustering algorithms for different types of applications
- Create potential solutions for real time applications using machine learning techniques

TEXT BOOKS

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.

REFERENCES:

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014.
3. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014.

EVALUATION METHOD:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	1	-	-	-	2	2	3	3	3
CO2	3	3	3	3	3	2	1	-	2	-	2	2	3	3	3
CO3	3	3	3	3	3	2	1	-	2	-	2	2	3	3	3
CO4	3	3	3	3	3	2	1	-	2	-	2	2	3	3	3
CO5	3	3	3	3	3	2	1	-	2	-	2	2	3	3	3

CS6302 PROGRAMMING PARADIGMS

Prerequisites for the course: Data Structures and Algorithms

OBJECTIVES:

- To introduce the major programming paradigms with the principles and the techniques involved in the design and implementation of modern programming languages
- To introduce the framework for specifying and reasoning about programming languages
- To analyse a given program from the perspective of good programming practices
- To compare and contrast the range of programming paradigms
- To evaluate programming language features critically with respect to the way they support good software engineering practices
- To discuss the appropriateness of the use of a given programming paradigm within a given environment

CS6302 PROGRAMMING PARADIGMS	L	T	P	EL	CREDITS
	3	0	0	3	4

OBJECTIVES:

MODULE I :	L	T	P	EL
	3	0	0	5

The art of Language design – Programming language spectrum - Compilation and Interpretation– Evaluation of Programming languages

SUGGESTED ACTIVITIES :

- Activity based learning - brain storming quizzes and puzzles of programming languages

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE II :	L	T	P	EL
	4	0	0	5

Languages – Syntax and Semantics of language C-lite - Names – Types – Type Systems - Binding – Scope – Static – Dynamic – Abstract Data types

SUGGESTED ACTIVITIES :

- Using peer learning- Interaction and group discussion about data types

SUGGESTED EVALUATION METHODS:

- Quizzes
- Assignment problems

MODULE III :	L	T	P	EL
	4	0	0	5

Expression – Assignment - Control flow – Input/output – exception handling - exception hierarchy-throwing and catching exception

SUGGESTED ACTIVITIES :

- Problem based learning for solving problems using various exception handling techniques in the module.

Attested

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**6**

Introduction to semantics -state transformation – partial functions – semantics with dynamic typing – Formal treatment of semantics

SUGGESTED ACTIVITIES :

- Outcome based learning- various assessment tests for the above four modules.

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**6**

Functions - Call and Return – Parameter passing – function declaration – semantics of call and return

SUGGESTED ACTIVITIES :

Activity based learning - quizzes and puzzles related to using functions

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**5**

Formal treatment of types and semantics – memory management – dynamic arrays – garbage collection

SUGGESTED ACTIVITIES :

- Problem based learning - Solving problems using dynamic arrays

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VII	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**5**

Programming techniques-Imperative programming – C – ADA – Perl

SUGGESTED ACTIVITIES :

- Based on project learning, develop a mini project based on C or Perl

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VIII	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**5**

Object Oriented Programming -grouping of data and operations-constructs for program structuring-information hiding-program design with modules - Object Oriented Programming – Small Talk- Java– Python

Attested

SUGGESTED ACTIVITIES : • Case study to understand OOPs concepts of Java and Python				
SUGGESTED EVALUATION METHODS: • Assignment problems				
MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**5**
Functional Programming – Introduction to Scheme and Haskell- Expressions-types and functions				
SUGGESTED ACTIVITIES : • Problem solving paradigms in Functional programming				
SUGGESTED EVALUATION METHODS: • Assignment problems				
MODULE X	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**5**
Logic programming – Prolog – Event-Driven programming – Concurrent Programming – Concepts – Synchronization strategies – Language level mechanism - Interprocess communication – Scripting languages.				
SUGGESTED ACTIVITIES : • Project based learning to apply suitable concepts for a small application.				
SUGGESTED EVALUATION METHODS: • Mini Project evaluation				

TEXT BOOKS:

1. Michael L Scott, "Programming Language Pragmatics", Third Edition, Morgan Kauffman, 2009.
2. Allen B. Tucker and Robert E. Noonan, "Programming Languages - Principles and Paradigms", Second Edition, Tata McGraw Hill, 2009.

REFERENCES

1. Daniel P. Friedman and Mitchell Wand, "Essentials of Programming Languages", Third Edition, The MIT Press, 2008.
2. Robert W. Sebesta, "Concepts of Programming Languages", Sixth Edition, Addison Wesley, 2003.
3. Terrence W. Pratt, Marvin V. Zelkowitz, "Programming Languages: Design and Implementation ", 4th Edition, Pearson, 2000.

OUTCOMES:

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

- Write programs related to syntax and semantics
- Compare programs between C, Perl and Small Talk
- Write programs using scripting languages
- Demonstrate event-driven and concurrent programming using Prolog
- Apply Prolog for developing distributed systems

EVALUATION METHOD:

Category of Course	Continuous Assessment	Mid –Semester Assessment	End Semester
Theory	40	20	40

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	-	-	-	-	-	1	2	3	1	1
CO2	3	3	3	3	3	1	-	-	-	-	2	2	3	3	2
CO3	3	3	3	3	3	1	1	-	1	-	2	3	3	3	2
CO4	3	3	3	3	2	1	1	-	2	-	-	2	2	3	2
CO5	3	3	3	3	2	1	-	-	2	-	2	2	2	3	2

CS6303 DISTRIBUTED SYSTEMS	L	T	P	EL	CREDITS
	3	0	0	3	4

Prerequisites for the course: NONE

OBJECTIVES:

- To understand the foundations of distributed systems
- To learn issues related to clock Synchronization and the need for global state in distributed systems
- To learn distributed mutual exclusion and deadlock detection algorithms
- To understand the significance of agreement, fault tolerance and recovery protocols in distributed systems
- To learn the characteristics of peer-to-peer and distributed shared memory systems

MODULE I INTRODUCTION	L	T	P	EL
	4	0	0	3

Definition –Relation to computer system components –Motivation –Relation to parallel systems – Message-passing systems versus shared memory systems –Primitives for distributed communication –Synchronous versus asynchronous executions –Design issues and challenges.

SUGGESTED ACTIVITIES :

- EL – Fundamentals of Distributed Systems
- Flipped classroom and activity

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II A MODEL OF DISTRIBUTED COMPUTATIONS AND LOGICAL TIME	L	T	P	EL
	6	0	0	3

A distributed program –A model of distributed executions –Models of communication networks –Global state –Cuts –Past and future cones of an event –Models of process communications –A framework for a system of logical clocks –Scalar time –Vector time –Physical clock synchronization: NTP.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Basics of Communication Networks

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SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE III MESSAGE ORDERING AND GROUP COMMUNICATION	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**
Message ordering paradigms –Asynchronous execution with synchronous communication – Synchronous program order on an asynchronous system –Group communication – Causal order (CO) - Total order.				
SUGGESTED ACTIVITIES : • EL- Basic concepts on Group Communication • In class Activity on Message Ordering				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IV GLOBAL STATE AND SNAPSHOT RECORDING ALGORITHMS	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
Introduction –System model and definitions –Snapshot algorithms for FIFO channels.				
SUGGESTED ACTIVITIES : • Flipped Class room • EL - Introduction to Snapshot Algorithm				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE V DISTRIBUTED MUTUAL EXCLUSION ALGORITHMS	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**
Introduction – Preliminaries – Lamport's algorithm – Ricart - Agrawala algorithm – Maekawa's algorithm – Suzuki–Kasami's broadcast algorithm.				
SUGGESTED ACTIVITIES : • EL – Introduction to Mutual Exclusion • In class activity on problem solving in Distributed Mutual Exclusion Algorithms				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VI DEADLOCK DETECTION IN DISTRIBUTED SYSTEMS	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
Introduction – System model – Preliminaries – Models of deadlocks – Knapp's classification– Algorithms for the single resource model, the AND model and the OR model.				

SUGGESTED ACTIVITIES :

- EL – Introduction to Deadlock Detection.
- Flipped classroom and activity

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VII CHECKPOINTING AND ROLLBACK RECOVERY	L	T	P	EL
	5	0	0	3

Introduction – Background and definitions – Issues in failure recovery – Checkpoint-based recovery – Log-based rollback recovery –Coordinated check pointing algorithm –Algorithm for asynchronous checkpointing and recovery.

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- EL – Applications for Rollback Recovery

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VIII CONSENSUS AND AGREEMENT ALGORITHMS	L	T	P	EL
	4	0	0	3

Problem definition – Overview of results – Agreement in a failure –free system – Agreement in synchronous systems with failures.

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Basics concepts of Agreement Algorithms

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IX PEER-TO-PEER COMPUTING AND OVERLAY GRAPHS	L	T	P	EL
	4	0	0	3

Introduction – Data indexing and overlays –Chord – Content addressable networks –Tapestry.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Introduction to peer to peer computing

MODULE X DISTRIBUTED SHARED MEMORY	L	T	P	EL
	4	0	0	3

Abstraction and advantages – Memory consistency models –Shared memory Mutual Exclusion.

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Introduction to Memory Consistency Models

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OUTCOMES:

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

- Elucidate the foundations and issues of distributed systems
- Point out the various synchronization issues and global state for distributed systems
- Demonstrate the mutual exclusion and deadlock detection in distributed systems
- Demonstrate the agreement protocols and fault tolerance mechanisms in distributed systems
- Describe the features of peer-to-peer and distributed shared memory systems

TEXT BOOK:

1. Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011.

REFERENCES:

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education, 2012.
2. Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.
3. Mukesh Singhal and Niranjan G. Shivaratri, “Advanced Concepts in Operating Systems, McGraw Hill, 2001.
4. Tanenbaum A.S., Van Steen M., “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007.
5. Liu M.L., “Distributed Computing, Principles and Applications”, Pearson Education, 2004.
6. Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufmann Publishers, USA, 2003.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1	-	1	-	-	3	3	3	3
CO2	3	3	3	3	-	1	-	-	1	-	-	2	3	3	3
CO3	3	3	3	3	1	1	-	-	1	-	-	2	3	3	3
CO4	3	3	3	3	-	1	-	-	1	-	-	3	3	3	3
CO5	3	3	3	3	-	1	-	-	1	-	-	3	3	2	2

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CS6304 SOFTWARE ENGINEERING	L	T	P	EL	TOTAL CREDITS
	3	0	0	3	4

Prerequisites for the course: None

OBJECTIVES:

- To gain knowledge about various software development lifecycle (SDLC) models
- To appreciate the importance of requirements engineering in SDLC
- To be aware of designing a software, considering the various perspectives of the end user
- To learn to develop a software component using coding standards and facilitate code reuse
- To analyze the software using metrics and measurements and predict the complexity and the risk associated
- To appreciate appropriate software documentations across various SDLC stages

MODULE I:	L	T	P	EL
	4	0	0	3

Introduction –Product and Process –Software Development Lifecycle –Waterfall Model – Incremental Models – Evolutionary Models - Spiral Model – Unified model. Software Project Planning

SUGGESTED ACTIVITIES:

- In-class activity on Application specific Product and Process view
- External Learning on impact of unified process models on Quality Software Development and JIT software

SUGGESTED EVALUATION METHODS:

- Assignments: Selection of suitable software process models for a given software specification
- Tutorial problems: Identification of Sample Application for each process model and justify the same stating reasons.

MODULE II:	L	T	P	EL
	3	0	0	3

CMM – CMMI – PSP – TSP – ISO 12207 (Software Lifecycle), ISO 29148 (Requirements), ISO 15026 (Risk & Integrity), ISO 29119 (Testing), ISO 14764 (Maintenance), ISO 15939 (Measurement)

SUGGESTED ACTIVITIES:

- Need for organization wide standards adoption

SUGGESTED EVALUATION METHODS:

- Recalling the KPAs to be adhered for each level in CMM.
- Assignment on selection of appropriate standards for each phase in software development.

MODULE III:	L	T	P	EL
	3	0	0	3

Requirements Elicitation – Analysis & Negotiation – Requirements Modeling & Specification – Requirements Validation & Management

SUGGESTED ACTIVITIES:

- External Learning: Using open-source tools for RE to understand the requirements traceability and interdependency among the functionalities provided by the software project.

SUGGESTED EVALUATION METHODS:

- Tutorial on various Requirements elicitation mechanisms and selection of an appropriate strategy.
- Assignment on Requirements categorization (considering contradicting, omission, commission of requirements) in a software project

MODULE IV:	L	T	P	EL

	2	**0**	**0**	**3**
Data Modeling– Scenario Based Modeling				
SUGGESTED ACTIVITIES: • External Learning: Using open-source tools for Conceptual Data modeling of a Sample application • External Learning: Using open-source tools for Scenario based modelling of a problem statement.				
SUGGESTED EVALUATION METHODS: • Assignment Data Modeling of sample application • Assignment: Designing use case diagram and activity diagram to analyze the requirements obtained from the customer and segregate them as use cases and determine the possible set of activities from the end user.				
MODULE V:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Flow Oriented Modeling – Class Based Modeling – User Interface Design				
SUGGESTED ACTIVITIES: • External Learning: Use open source tools to perform Class Based Modeling for a given software requirements.				
SUGGESTED EVALUATION METHODS: • Assignment: Determine the flow of data/events among the processes in the application under consideration • Assignment: Designing UI of Sample application • Assignment: Design-to-code of Sample application involving coding standards				
MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Testing strategies – Unit testing, Integration testing, OO testing – Smoke testing – Validation testing – System testing - Alpha/Beta testing – Recovery Testing – Security Testing – Stress Testing – Performance Testing				
SUGGESTED ACTIVITIES: • External Learning: Understanding the requirements (SRS) and designing a suitable test suite. • External Learning: Determine valid interfaces for integration testing and design necessary stub and driver modules • External Learning on ideas of testing a simple online application on selected test cases • Tutorial on using Automation software for testing				
SUGGESTED EVALUATION METHODS: • Assignment on obtaining a mind-map on testing strategies • Assignment: Testing of Sample application using any OSS on Software Test Automation				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Debugging Process - Testing Tactics – Black-box approaches – Graph based testing Methods – Equivalence class partitioning – Boundary value analysis – Orthogonal array testing				
SUGGESTED ACTIVITIES: • In-class activity on Equivalence class partitioning • In-class activity on Boundary value analysis • External Learning on Software Test Documentation				
SUGGESTED EVALUATION METHODS: • Assignment: Testing Sample application using Black-box approaches and understand the differences in selecting of test cases from the test suite.				

MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Testing Tactics – White-box approaches– Basis Path testing – Control Structure Testing				
SUGGESTED ACTIVITIES: • In-class activity on Basis Path testing • In-class activity on Control-structure testing				
SUGGESTED EVALUATION METHODS: • Assignment: Testing Sample application for White-box approaches and understand how it differ from black box testing approaches.				

MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Software Maintenance –Software Project Management - Software Cost Estimation - Risk Management& Mitigation – Configuration Management – Software Documentation standards				
SUGGESTED ACTIVITIES: • External Learning on using tools for estimating Software Cost				
SUGGESTED EVALUATION METHODS: • Tutorial: Identification of potential risks for a software project during development/ maintenance and tabulate. • Assignment: Using a Software Configuration Management template for a software project				

MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Software Metrics – Process, Project and Product Metrics – OO Metrics - Test Metrics: Test effort, effectiveness, efficiency metrics – Test coverage, Test execution & Defect Distribution Metrics				
SUGGESTED ACTIVITIES: • External Learning on Software Quality Models • In-class activity on FP metrics & Variants • External Learning on Software Test Lifecycle				
SUGGESTED EVALUATION METHODS: • Assignment: Calculation of test metrics for sample application				

OUTCOMES:

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

- Point out the role and impact of software engineering in contemporary business, and global, economic, environmental and societal context
- Analyze and resolve information technology problems through the application of systematic approaches and diagnostic tools
- Analyze, design and manage the development of a computing-based system, component or process to meet the desired needs within realistic constraints in one or more application domains
- Use knowledge, techniques, skills and modern tools necessary for software engineering practice
- Engineer tools to analyze, evaluate, select and synthesize information sources for the purpose of developing a software system

TEXTBOOKS:

1. Roger S. Pressman, “Software Engineering: A Practitioner‘s Approach”, McGraw Hill, Seventh Edition, 2009.
2. Ian Sommerville, “Software Engineering”, Ninth Edition, Pearson Education, 2008.

REFERENCES:

1. Jalote Pankaj, “An Integrated Approach to Software Engineering”, Third Edition, Springer, 2010.
2. Shari Lawrence Pfleeger and Joanne M. Atlee, “Software Engineering: Theory and Practice”, Fourth Edition, Prentice Hall, 2010.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	40	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	3	3	1	3	1	3	2	2	3	3
CO2	3	3	3	3	3	3	2	1	3	1	2	2	3	3	2
CO3	3	3	3	3	3	2	2	-	3	1	2	2	3	3	2
CO4	3	3	3	3	3	2	1	-	3	1	2	2	3	3	3
CO5	3	3	3	3	3	2	2	-	3	-	2	2	3	3	2

CS6305	MICROPROCESSORS	L	T	P	EL	CREDITS
		3	0	4	3	6

Prerequisites: None

OBJECTIVES:

- To learn the architecture of the Intel 8086 microprocessor
- To familiarize with assembly language programming and learn to write programs in 8086 assembly
- To discuss the various multiprocessor configurations
- To understand the functionality and working of different peripheral chips and their interfacing to the processor
- To understand the architecture and the salient features of the x86 family of processors
- To familiarize with tools for program analysis and performance analysis

MODULE I :	L	T	P	EL
	3	-	8	3

Intel 8086 Microprocessors – Architecture – Internal operation - Instruction set – Assembler directives and operators – Addressing modes

SUGGESTED ACTIVITIES :

- In Class activity for 8086 instructions and addressing modes
- EL - Familiarising with the assembler
- Practical – 8086 simple programs on the assembler.

SUGGESTED EVALUATION METHODS:

- Assignment problems on basic arithmetic operations
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**-**	**8**	**3**

8086- Assembly language programming- Stacks - Procedures – Macros – Interrupts and Interrupt service routines – Byte and String manipulation instructions

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Study of BIOS calls for keyboard and video services
- Practical – 8086 programs using procedures, macros and string manipulation instructions
  - Use of BIOS calls for video and keyboard services

SUGGESTED EVALUATION METHODS:

- Assignment problems for using the various string primitives
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**-**	**4**	**3**

8086 Signals – Basic Configurations – Minimum mode- Maximum mode – Queue status and Lock Facility - System Bus Timing

SUGGESTED ACTIVITIES :

- EL - Minimum mode signals, some timing diagrams
- Practical – To continue with 8086 assembly language programming.

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**

System design using 8086: Multiprocessor configurations – Coprocessor – Closely coupled and Loosely coupled configurations

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL- Basics of Loosely Coupled Configurations

SUGGESTED EVALUATION METHODS:

- Assignment problems on different types of configurations
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**-**	**4**	**3**

Memory interfacing and I/O interfacing – Parallel communication Interface – Programming and Applications.

SUGGESTED ACTIVITIES :

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- EL – Applications using 8255
- Practical - Implementation of various modes of operations of 8255 and applications

SUGGESTED EVALUATION METHODS:

- Assignment problems on memory interfacing and I/O interfacing in different configurations, System design using the 8086
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**-**	**4**	**3**

Serial communication interface – Interrupt controller – DMA controller – programming and applications

SUGGESTED ACTIVITIES :

- EL – System design using these devices, Applications
- Practical - Implementation of various modes of operations of these devices

SUGGESTED EVALUATION METHODS:

- Assignment problems on applications and interfacing
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**-**	**4**	**3**

IA 32 and IA 64 architectures - Evolution and salient features - Basic execution environment - System architecture overview - Modes of operation - Protected mode memory management.

SUGGESTED ACTIVITIES

- Flipped Classroom
- EL - evolution of the Intel processors
- Practical - Study of a typical program debugging tool
  - Create dis-assembly of a simple C program and identify the stack frame and its contents

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes
- Report on the execution trace

MODULE VIII:	**L**	**T**	**P**	**EL**
	6	**-**	**4**	**3**

Paging - Address translation - Protection - Paging MMU cache - Demand paging and virtual memory management - Using segmentation and paging together. Privilege levels - Protection - Defining and changing privilege levels.

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL - Further explorations with the debugging tool
- Practical - Instrumentation and analysis with the tool

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes
- Report based on the additional features

MODULE IX:	**L**	**T**	**P**	**EL**
	6	**-**	**4**	**3**

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Multitasking - Task state segments - Scheduling - Changing privilege levels within a task - Communicating among tasks, Handling faults and interrupts.				
SUGGESTED ACTIVITIES : • EL – Different types of exceptions and their handling • Practical – Study of a performance analysis tool				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**-**	**4**	**3**
Performance issues - Power and thermal management - Performance monitoring.				
SUGGESTED ACTIVITIES : • Flipped Classroom • Practical - Performance monitoring with the tool and reporting the various parameters like the number of instructions, cache misses, context switches, etc.				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • Report on the findings of the performance tool for various scenarios				

OUTCOMES:

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

- Discuss the architecture of the 8086 processor in detail
- Write assembly language programs in 8086 assembly
- Show how multiple processors can be connected with an 8086 processor
- Show how the various peripheral chips can be interfaced to the processor
- Point out the salient features of the other processors in the x86 family and discuss the various modes of operation of these processors
- Generate CFGs for simple C programs using the dynamic instrumentation tools and generate performance statistics

TEXT BOOKS:

1. Yu – Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086/8088 Family – Architecture, Programming and Design “, Second Edition, Prentice Hall of India, 2007.
2. Barry B. Brey, “The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit Extensions : Architecture, Programming, and Interfacing”, Eighth edition, Pearson Prentice Hall, 2009.

REFERENCES:

1. Peter Abel, “IBM PC Assembly Language and Programming”,Fifth edition, Prentice Hall, 2000.
2. James L. Turley, “Advanced 80386 Programming Techniques”, Osborne McGraw Hill, 1988.
3. Intel® 64 and IA-32 Architectures Software Developer’s Manual, Volume 3B: System Programming Guide, Part 2.

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EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	-	-	-	-	-	3	3		
CO2	2	2	3	3	3	1	1	2	2	-	3	3	3	3	2
CO3	3	2	3	2	1	1	1	-	-	-	2	3	3	2	2
CO4	3	2	3	2	2	1	1	-	-	-	2	3	3	2	2
CO5	3	1	2	1	1	-	-	-	-	-	2	3	3	1	2
CO6	3	3	3	3	2	-	-	-	-	-	-	3	3	2	2

CS6306 PARALLEL PROGRAMMING	L	T	P	EL	CREDITS
	3	0	4	3	6

Prerequisites for the course: NONE

OBJECTIVES:

- To identify the scope available for parallel programming over different models
- To identify the challenges in parallel programming
- To develop parallel programs using OpenMP in shared memory
- To develop parallel programs in distributed memory using MPI
- To program heterogeneous processors using CUDA and OPENCL

MODULE I :	L	T	P	EL
	3	0	0	3

Introduction to Parallel Computing –Need for Parallel Computing – Concurrent, Parallel and Distributed Systems – The Von Neumann Architecture – Flynn's Taxonomy

SUGGESTED ACTIVITIES :

- EL – Fundamentals of Parallel Computing.
- In Class activity for Conversion of Simple Serial Problem to Parallel Problem

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	0	4	3

Parallel Computing Models - ILP, TLP and Data Parallelism – Parallel Programming Overview: Processes, Tasks and Threads - Parallel Programming Models: Shared Memory Programming – Distributed Programming.

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SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL - Basics of Inter Process Communication (IPC)
- Practical - Programs on Interprocess Communication (Shared memory, Message Queue, Pipes)

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Interconnection Networks : Shared Memory Interconnects - Distributed Memory Interconnects – Parallel Software – Identifying Potential Parallelism – Techniques for Parallelizing Programs

SUGGESTED ACTIVITIES :

- EL – Basics of Interconnection Networks
- In class activity to identify techniques for parallelizing the program

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Performance: Speedup and Efficiency – Amdahl's Law – Scalability – Parallel Program Design – Writing and Running Parallel Programs.

SUGGESTED ACTIVITIES :

- EL- Writing simple parallel programs
- In class activity for speed and efficiency calculation
- Practical - Analyzing and comparing the speedups on serial and parallel programs

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Challenges of Parallel Programming: Cache Coherence Issues - Memory Consistency Models – Maintaining Memory Consistency – Synchronization Issues.

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL – Basics of cache principles

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	6	**0**	**8**	**3**

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Shared Memory Model: OpenMP Execution Model – Parallel regions – Work Sharing – Data Environment – Synchronization – Reductions – Data Parallelism – Functional Parallelism – Runtime Library Routines– Environment Variables–Performance Improvements.

SUGGESTED ACTIVITIES :

- EL – Introduction to OpenMP
- Practical - Programs on OpenMP and Applications on OpenMP

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

The MPI Programming Model – MPI Basics – Circuit Satisfiability – Global Operations – Collective Operations.

SUGGESTED ACTIVITIES :

- EL – Introduction to MPI
- Practical - Programs on MPI

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

Other MPI Features – Asynchronous Communication – Performance Issues – Combining OpenMP and MPI.

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- EL – Applications of OpenMP and MPI
- Practical - Applications on MPI

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

GPU Architecture – Basics of CUDA – CUDA Threads – CUDA Memories – Synchronization Handling – - Performance Issues - Application Development using CUDA.

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Basics of GPU and Applications of CUDA
- Practical - Programs on CUDA

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**

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Introduction to OpenCL – Benefits of OpenCL- Anatomy of OpenCL – OpenCL Architecture – Application development using OpenCL
SUGGESTED ACTIVITIES : • Mostly in Class • EL – Applications of OpenCL. • Practical - Programs on OpenCL.
SUGGESTED EVALUATION METHODS: • Assignment problems • Tutorial problems

OUTCOMES:

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

- Point out the fundamental concepts of parallelism
- Discuss the challenges in parallel programming
- Parallelize a serial program and point out the advantages and overheads
- Implement parallel programs with OpenMP and MPI
- Develop parallel programs in a heterogeneous processor using OpenCL and CUDA

TEXT BOOKS

1. Peter S. Pacheco, “An Introduction to Parallel Programming”, Morgan Kaufmann, 2011.
2. Michael J Quinn, “Parallel Programming in C with MPI and OpenMP”, Tata McGraw Hill, 2003.
3. David B. Kirk and Wen-mei W. Hwu, “Programming Massively Parallel Processors”, Morgan Kaufmann, 2010.

REFERENCES:

1. Ananth Grama, George Karypis, Vipin Kumar and Anshul Gupta, “Introduction to Parallel Computing”, Second Edition, Pearson Education Limited, 2003.
2. John L. Hennessy and David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann / Elsevier Publishers, 5th. Edition, 2012.
3. Ian Foster, “Designing and Building Parallel Programs: Concepts and Tools for Parallel Software Engineering”, Addison Wesley Longman Publishing Co., USA, 1995.
4. David E. Culler, Jaswinder Pal Singh, Anoop Gupta, “Parallel Computing Architecture: A Hardware/Software Approach”, Morgan Kaufmann / Elsevier Publishers, 1999.
5. OpenMP Programmer’s Manual.
6. MPI Programmer’s Manual
7. “Introduction to OpenCL Programming”, AMD, 2010.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	-	1	1	-	-	-	-	2	3	3	-
CO2	3	3	3	3	-	1	1	-	-	-	-	2	3	3	2

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CO3	3	2	3	3	2	1	1	-	1	-	-	2	3	3	-
CO4	3	3	3	3	3	1	1	-	1	-	-	2	3	2	2
CO5	3	3	3	3	3	1	1	-	1	-	-	2	3	2	2

CS6307 ADVANCED ALGORITHMS

Prerequisites for the course: Data Structures & Algorithms

OBJECTIVES:

- To familiarize with the main thrust areas in algorithms that will be sufficient for formulating and seeking known solutions to an algorithmic problem
- To understand how to formulate an approximation algorithm for an NP-complete problem
- To introduce the key concepts, problems, techniques and data structures within Computational Geometry
- To understand and analyze multithreading and parallel algorithms
- To learn linear programming models

	L	T	P	EL	CREDITS
CS6307ADVANCED ALGORITHMS	**3**	**0**	**4**	**3**	**6**

MODULE I	**L**	**T**	**P**	**EL**
	3	**0**	**8**	**3**

PRAM Models–List Ranking - Prefix sum - Sorting - Sum - Bitonic sort.

SUGGESTED ACTIVITIES :

- EL - Study of one or two problems having parallel solutions
- Practicals – Implementation of list ranking, prefix sum and bitonic sort using C with MPI
- Analysis of suitable PRAM models

SUGGESTED EVALUATION METHODS:

- Assignment - Based on EL
- Demonstration of programs

MODULE II	**L**	**T**	**P**	**EL**
	4	**0**	**4**	**3**

Sorting on: Butterfly - 2D Mesh. Matrix multiplication on: 2D Mesh - Hypercube.

SUGGESTED ACTIVITIES :

- EL – Study atleast two problems on any of the DCM
- Practicals – Implementation of sorting and matrix multiplication on 2D mesh using C with MPI

SUGGESTED EVALUATION METHODS:

- Assignment - Based on EL

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- Demonstration of programs

MODULE III	L	T	P	EL
	3	0	4	3

Prefix sum on: 2D Mesh - Butterfly. Sum on: 2D Mesh - Butterfly.

SUGGESTED ACTIVITIES :

- EL - Based on suggested reading by the course instructor
- Practical – Implementation of prefix sum and sum on 2D mesh using C with MPI

SUGGESTED EVALUATION METHODS:

- Assignment: Based on EL
- Quizzes: Based on first three modules
- Demonstration of programs

MODULE IV	L	T	P	EL
	6	0	4	3

Geometric Algorithms: Segment trees - kd-trees - 1D and 2D Range Search.

SUGGESTED ACTIVITIES :

- EL: Problems on segment trees and range search
- Practical – Implementation of segment trees

SUGGESTED EVALUATION METHODS:

- Based on EL
- Demonstration of programs

MODULE V	L	T	P	EL
	4	0	4	3

Line Segment Intersection - Closest Pair of Points - Range Trees – Voronoi diagram.

SUGGESTED ACTIVITIES :

- EL – Study of Voronoi diagram
- Practical – Implementation of line segment intersection and Voronoi diagram

SUGGESTED EVALUATION METHODS:

- Demonstration of programs

MODULE VI	L	T	P	EL
	5	0	4	3

Randomized Algorithms: Introduction - Randomized Selection - Randomized sorting.

SUGGESTED ACTIVITIES :

- Flipped Classroom – Types of Randomized Algorithms and analysis
- Practical – Implementation of randomized selection and quick sort

SUGGESTED EVALUATION METHODS:

- Quizzes: Based on Modules IV, V and VI
- Demonstration of programs

MODULE VII	L	T	P	EL
	5	0	0	3

Approximation Algorithms: Vertex cover - Metric TSP- Set Covering Problem

SUGGESTED ACTIVITIES :

- Assignment

Attested

SUGGESTED EVALUATION METHODS: • Assignment problems				
MODULE VIII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
NP Complete: Clique Problem - Subset Sum Problem				
SUGGESTED ACTIVITIES : • EL – Studying proof for atleast one NP complete problem				
SUGGESTED EVALUATION METHODS: • Based on EL				
MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Multithreaded Algorithms: Matrix Multiplication - Merge sort.				
SUGGESTED ACTIVITIES : • Quiz • Practical – Implementation of multithreaded algorithms				
SUGGESTED EVALUATION METHODS: • Quizzes: Based on Modules VII, VIII and IX • Demonstration of programs				
MODULE X	**L**	**T**	**P**	**EL**
	3	**0**	**4**	**3**
Solving system of linear equations - Simplex algorithm – Duality.				
SUGGESTED ACTIVITIES : • Assignments • Practical – Implementation of simplex algorithm				
SUGGESTED EVALUATION METHODS: • Assignments • Demonstration of programs				

OUTCOMES:

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

- Comprehend and propose algorithms for any given problem
- Construct and implement algorithms for simple geometrical problems
- Perform the design of parallel and multithreading algorithms
- Find approximate solution to a hard problem
- Formulate a linear programming model for a given problem

TEXTBOOKS:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Second Edition, University Press, 2007.
2. Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Cliford Stein, “Introduction to Algorithms”, Third Edition, Prentice Hall, 2010.
3. Mark de Berg, Otfred Vheong, Marc van Kreveld and Mark Overmars, “Computational Geometry Algorithms and Applications”, Third Edition, Springer, 2008.

REFERENCES:

1. Gilles Brassard, Paul Bratley,” Algorithmics: Theory and Practice”, Prentice Hall,1998
2. J.A.Storer, “An Introduction to Data Structures and Algorithms”, Birkhauser Boston, 2002.

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3. Michael Quinn, "Parallel Programming in C with MPI and OpenMP", Indian Edition, Tata McGraw Hill, 2017.

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid –Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	1	1	-	1	3	2	-
CO2	3	3	2	1	1	-	-	-	1	1	2	1	3	2	-
CO3	3	3	3	1	-	-	-	-	1	1	2	1	3	2	-
CO4	3	3	3	2	-	-	-	-	1	1	2	1	3	2	-
CO5	3	3	1	1	2	-	-	-	1	1	2	1	3	2	-

CS6308 JAVA PROGRAMMING

Pre-requisites: None

OBJECTIVES:

- To learn about the fundamentals of Java language constructs
- To familiarize the student with Object Oriented Programming in Java
- To expose the student to creating UI
- To understand the concepts of parallel programming
- To develop web applications with Java

CS6308 JAVA PROGRAMMING	L	T	P	EL	CREDITS
	3	0	4	3	6

MODULE I FUNDAMENTALS OF JAVA LANGUAGE	L	T	P	EL
	3	0	4	3

Introduction to Java, Java basics – Variables, Operators, Expressions, Control flow Statements, Methods, Arrays

SUGGESTED ACTIVITIES :

- Practical-Implementation of simple Java programs Using Java Basic Constructs and Arrays using any standard IDE like NETBEANS / ECLIPSE
- EL – Understanding JVM

SUGGESTED EVALUATION METHODS:

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- Assignment problems
- Quizzes

MODULE II JAVA OBJECTS -1	L	T	P	EL
	3	0	4	3

Classes and Objects, Constructor, Destructor, Static instances, this, constants, Thinking in Objects, String class, Text I/O

SUGGESTED ACTIVITIES :

- Flipped classroom
- Practical - Implementation of Java programs – using String class, Creating Classes and objects
- EL – Thinking in Objects

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III JAVA OBJECTS – 2	L	T	P	EL
	3	0	4	3

Inheritance and Polymorphism – Super classes and sub classes, overriding, object class and its methods, casting, instance of, Array list, Abstract Classes, Interfaces, Packages, Exception Handling

SUGGESTED ACTIVITIES :

- flipped classroom
- Practical - implementation of Java programs – use Inheritance, polymorphism, abstract classes and interfaces, creating user defined exceptions
- EL – dynamic binding, need for inheritance, polymorphism, abstract classes and interfaces

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV GUI	L	T	P	EL
	3	0	4	3

Creating UI, Frames, layout manager, Panels, components, Event Driven Programming

SUGGESTED ACTIVITIES :

- flipped classroom
- Practical – Mouse, key events, creating interactive forms using AWT/Swing and adding functionality
- EL – Understand AWT and SWING

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE V I/O STREAMS	L	T	P	EL
	3	0	4	3

I/O Streams, binary I/O

SUGGESTED ACTIVITIES :

- Practical - binary streams, file streams
- EL – Lambdas and Streams

SUGGESTED EVALUATION METHODS:

- Assignment problems

• Quizzes					
MODULE VI	**MULTITHREADING**	**L**	**T**	**P**	**EL**
		3	**0**	**4**	**3**
Multithreading – states, synchronization, avoiding deadlocks					
SUGGESTED ACTIVITIES : • Practical – implementing threads • Flipped Classroom, • EL – Parallel Programming					
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes					
MODULE VII	**NETWORKING AND DATABASE CONNECTIVITY**	**L**	**T**	**P**	**EL**
		3	**0**	**4**	**3**
Java Networking – Inet address class, Sockets, JDBC					
SUGGESTED ACTIVITIES : • Flipped class room • Practical – Using Socket, Developing simple applications using JDBC • EL – Internationalization					
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes					
MODULE VIII	**FRAMEWORKS**	**L**	**T**	**P**	**EL**
		3	**0**	**4**	**3**
Collections Frameworks – lists, vector and stack classes, Generics,					
SUGGESTED ACTIVITIES : • Flipped classroom • Practical - Using Generic classes and Collections framework, Using Comparative interface, list, stack • EL - Code Annotations					
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes					
MODULE IX	**WEB DEVELOPMENT - 1**	**L**	**T**	**P**	**EL**
		3	**0**	**4**	**3**
Applets, Servlets / JSP					
SUGGESTED ACTIVITIES : • Flipped class room • Practical - Implementations of Java programs – Creating applets, servlets, JSP • EL – Java based web servers					
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes					
MODULE X	**WEB DEVELOPMENT - 2**	**L**	**T**	**P**	**EL**
		3	**0**	**4**	**3**
JSF, RMI, Web services					
SUGGESTED ACTIVITIES : • Flipped class room • Practical - Implementations of Java programs – Creating UI with JSF, Implementing RMI					

- EL – creating UI with JSF

SUGGESTED EVALUATION METHODS:

- Quizzes

OUTCOMES:

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

- Use NETBEANS or equivalent open source editors for Java programming
- Create and use Java Objects for applications related to object oriented concepts
- Demonstrate networked Java Applications using Java Sockets and JDBC
- Implement Multithreading and create rich UI
- Implement and deploy web applications using Java

TEXT BOOKS:

1. Y. Daniel Liang, "Introduction to Java Programming and Data Structures, Comprehensive Version", 11th Edition, Pearson Education, 2018.
2. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw-Hill Education, 2018.

REFERENCES:

1. Paul Dietel and Harvey Deitel, "Java - How to Program Early Objects", 11th Edition, Pearson Education, 2017.
2. Sachin Malhotra, Sourabh Choudhary, "Programming in Java", Revised 2nd Edition, Oxford University Press, 2018.
3. Cay S. Horstmann, "Core Java - Vol. 1, Fundamentals", 11th Edition, Pearson Education, 2018.

Web references:

1. NPTEL
2. MIT OCW

EVALUATION PATTERN:

Category of Course	Continuous Assessment	Mid –Semester Assessment	End Semester
Theory Integrated with Practical	15(T) + 25 (P)	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	1	-	2	-	2	2	3	3	3
CO2	3	3	3	3	3	3	1	-	2	-	2	2	3	3	3
CO3	3	3	3	3	2	3	1	-	3	-	2	2	3	3	3
CO4	3	3	3	3	2	3	1	-	2	-	2	2	3	3	3
CO5	3	3	3	3	3	3	1	-	2	-	2	2	3	3	3

CS6001 DATA MINING

Prerequisites for the course: None

OBJECTIVES:

- To understand and interpret the contribution of data mining to decision support invarious organizations.

- To categorize and carefully differentiate between situations for applying different data-mining techniques: frequent pattern mining, association, correlation, classification, prediction, and cluster and outlier analysis.
- To provide an overview of the developing areas - Graph mining, Multi-relational analysis, and Social Network mining.
- To propose data-mining solutions for different applications.
- To highlight the importance of applying data mining techniques compared to thetraditional methods

	L	T	P	EL	CREDITS
CS6001 DATA MINING	**3**	**0**	**0**	**3**	**4**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Introduction to Data Mining: Data Mining –Roots – Process – Large Datasets – DW for Data Mining, Stages of the Data Mining Process- Task Primitives, Data Mining Techniques - Data Mining Knowledge Representation – Data Mining Query Languages, Business Aspects of Data Mining

SUGGESTED ACTIVITIES :

- Discussion: Issues& Challenges

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Data preprocessing: Data Cleaning, Data Transformation, Feature Selection, Dimensionality Reduction, Regression, Multiple Regression & Model building, Discretization and Generating Concept Hierarchies – UCI repository of Dataset

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Practical Problems
- Practical - Implementation of data preprocessing techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
127	**3**	**0**	**0**	**3**

Mining Frequent Patterns, Associations and Correlation: Market-Basket Analysis – Apriori Algorithm, Frequent Itemset Mining Methods, Frequent Itemsets to Association Rules, From Association Mining to Correlation Analysis, Constraint-Based Association Mining – Multidimensional Association

SUGGESTED ACTIVITIES :

- EL - Frequent-Pattern Mining in Data Streams
- Practical –Implementation of Frequent Pattern Mining Techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Attested

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Classification: Classification, Issues, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Back Propagation, Support Vector Machines, Association Classification, Lazy Learners, Ensemble Methods, Performance Measures

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL -Classification of Dynamic Data Streams
- Practical - Implementation of Classification Techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Prediction:Prediction, Issues, Linear Regression, Non-Linear Regression, Generalized Linear Models, Regression Trees, Performance Measures

SUGGESTED ACTIVITIES :

- Applications in class
- EL – Performance Measures
- Practical - Implementation of Prediction Techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Clustering Concepts, Similarity Methods : Partitioning Methods: k-means, Hierarchical Methods: Distance-based Agglomerative and Divisible Clustering, Density-Based Methods, Model-Based Methods: Expectation Maximization, Grid Based Methods, Constraint-Based Cluster Analysis, Outlier Analysis, Clustering large database

SUGGESTED ACTIVITIES :

- Flipped Classroom for further study
- Practical - Implementation of Clustering Techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**5**

Learning Process – Learning Task using ANN – MLP – SOM – Ensemble Learning – Methodologies –Combination Schemes – Bagging – Boosting - AdaBoost

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- Seminars on Applications
- Practical - Implementations of Social Network Analysis

EL – Mining Frequent Subgraphs

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

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MODULE VIII:	L	T	P	EL
	4	0	0	3
Graph Mining and Social Network Analysis: Methods for Mining Frequent Subgraphs, Mining Variant and Constrained Substructure Patterns, Social Network Analysis, Multi-relational Data Mining: Multi-relational Classification using Inductive Logic Programming, Multi-relational Classification using Tuple ID Propagation, Multi-relational Clustering with User Guidance				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped classroom • Practical				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Mining Complex data objects: Spatial Data Mining, Multimedia Data Mining, Distributed Data MiningText Data Mining, Mining the World Wide Web				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped classroom • EL – Mining the Web				
SUGGESTED EVALUATION METHODS: • Assignments • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Applications and Trends in Data mining : Applications-Decisions involving judgments, Screening Images, Load forecasting, Diagnosis, Marketing, Sales & financial domains, Bio-medical ; Trends in Data Mining				
SUGGESTED ACTIVITIES : • Combination of in class & Flipped • Seminars • Demos EL – Mini project				
SUGGESTED EVALUATION METHODS: Project demonstration and presentation				
• Quizzes				

TEXT BOOK

1. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, Third Edition, 2011.

REFERENCES:

1. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Eastern Economy Edition, Prentice Hall of India, 2006.

2. Mehmed Kantardzic, “Data mining Concepts, Models, Methods, and Algorithms” Wiley 2011.
3. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining and OLAP” Tata McGraw Hill Edition, Tenth Reprint 2007.
4. Ian.H.Witten, Eibe Frank and Mark.A.Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann, Third edition, 2011.
5. Bruce Ratner, “Statistical and Machine - Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data”, CRC Press, Second Edition, 2012.

COURSE OUTCOMES:

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

- Demonstrate the knowledge of the ethical considerations involved in Data Mining.
- Examine data and select suitable methods for data analysis.
- Integrate various Classification, Clustering, Association rule mining techniques on real world data.
- Synthesize the different algorithms and analyze it with the support of tools.
- Interpret the concept of Spatial, Multimedia and Distributed, text and web mining and able to retrieve the data, analyze and make decision.

EVALUATION PATTERN:

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	-	1	1	3	-	-	1	2	1	2	-
CO2	3	3	3	3	3	3	2	1	3	-	1	2	3	3	1
CO3	3	3	3	3	3	3	2	1	3	-	1	2	3	3	2
CO4	3	3	3	3	3	3	2	1	2	-	-	3	3	3	3
CO5	3	3	3	3	3	3	2	-	1	-	1	2	3	3	2

CS6002 SOFT COMPUTING

Prerequisites for the Course: None

OBJECTIVES:

- To learn different soft computing approaches
- To learn the fundamental concepts of Fuzzy logic and apply them to different domains
- To learn the fundamental concepts of Genetic Algorithms and apply them to different domains
- To learn the fundamental concepts of Neural Networks
- To learn the different types of Neural Networks and apply them to different domains

CS6002 SOFT COMPUTING	L	T	P	EL	TOTAL	CREDITS
	3	0	0	3	6	4

MODULE I :	L	T	P	EL
	3	0	0	3

Introduction to soft computing - Fuzzy Logic - Genetic Algorithms - Neural Networks

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL - Classification, clustering, optimization in real world
- In class activity - Mapping classification, clustering and optimization to soft computing techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Quiz
- Reflection journal

MODULE II :	L	T	P	EL
	3	0	0	3

Introduction to Fuzzy logic - Fuzzy membership functions - Operations on Fuzzy sets - Fuzzy relations - Fuzzy propositions - Fuzzy implications

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL - Solving real world problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	L	T	P	EL
	4	0	0	3

Fuzzy inferences - Defuzzification techniques -Fuzzy logic controller- - Decision making - Fuzzy pattern recognition - Optimization problems

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- In class activity - Numerical example problem solving
- Practical - Simulation of optimization and pattern recognition problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical simulation problems
- Quizzes
- Reflection journal

MODULE IV :	L	T	P	EL

	3	**0**	**0**	**3**

Fuzzy logic controller- Fuzzy logic applications in Computer Science - Decision making - Fuzzy pattern recognition - Optimization problems

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- In class activity - Numerical example problem solving
- Practical - Simulation of optimization and pattern recognition problems

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Practical simulation problems

MODULE V	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Genetic Algorithm - Operators - Selection - Mutation - Optimization Techniques

SUGGESTED ACTIVITIES :

- Flipped Class room
- Inclass activity - Solving Numerical Real world problems with GA opearators
- Practical - Programming exercises

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

MODULE VI	**L**	**T**	**P**	**EL**
	3	**0**	**0**	3

Kinematics - Particle swarm optimization - Artificial Life - Genetic Fuzzy model

SUGGESTED ACTIVITIES :

- Applications in class
- Practical - Simulation of optimization techniques

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**

Artificial Neural Networks - Neuron model - Basic learning rules - Multilayer neural networks and backpropagation

SUGGESTED ACTIVITIES :

- Flipped classroom
- In class activity - Numerical problem solving
- Practical - Simulation of learning

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes
- Reflection journal

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MODULE VIII	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**6**
Associative memory - Self organizing neural network - RBF neural network - Neuro Fuzzy models				
SUGGESTED ACTIVITIES : ● Flipped classroom ● Inclass - Solving numerical examples ● Practical - Implementation of auto associative memory model and Self-organizing maps				
SUGGESTED EVALUATION METHODS: ● Tutorial problems ● Assignment problems ● Quizzes ● Reflection journal				

TEXTBOOKS:

1. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice hall, 1995
2. Goldberg, Genetic Algorithms, Pearson, 2008
3. Jacek M Zurada, Introduction to Artificial Neural Systems, PWS Publishing Company, 1992

REFERENCES:

1. Timothy Ross, Fuzzy Logic with Engineering Applications, Wiley Publications, 2016
2. SimonHaykin, Neural Networks and Learning Machines, Prentice Hall of India, 1999.
3. J.S.R. Jang, C.T. Sun and E. Mizutani, Neuro-Fuzzy and Soft Computing, Pearson Education, 2004.

OUTCOMES:

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

- Dsicuss the theoretical background of Fuzzy Logic
- Analyse the optimization and clustering problems with Fuzzy Logic
- Present the theoretical background of Genetic Algorithm
- Apply Genetic Algorithms for optimization problems
- Present the theoretical background of Artificial Neural Networks
- Implement the algorithms on Artificial Neural Networks for Classification and Clustering problems.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	2	1	-	2	-	-	2	3	3	2
CO2	3	3	3	3	2	2	2	-	3	-	2	3	3	3	2
CO3	3	3	3	3	-	2	1	-	2	-	-	2	3	3	2
CO4	3	3	3	3	2	2	2	-	3	-	2	3	3	3	2
CO5	3	3	3	3	-	2	1	-	2	-	-	2	3	3	2
CO6	3	3	3	3	2	2	2	-	3	-	2	3	3	3	2

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CS6003 **BIG DATA ANALYTICS**

Prerequisites for the course: None

OBJECTIVES:

- To know the fundamental concepts of big data and analytics.
- To explore tools and practices for working with big data
- To learn about stream computing.
- To know about the research that requires the integration of large amounts of data.

BIG DATA ANALYTICS	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I INTRODUCTION TO BIG DATA	L	T	P	EL
	3	0	0	3

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating - The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value

SUGGESTED ACTIVITIES :

- EL- Big Data Usecases

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE II UNDERSTANDING BIG DATA STORAGE	L	T	P	EL
	3	0	0	3

A General Overview of High-Performance Architecture - HDFS - MapReduce and YARN - Map Reduce Programming Model

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- Practical on MapReduce application for word counting on Hadoop cluster
- Introduction to YARN and EL based on that

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III CLUSTERING	L	T	P	EL
	3	0	0	3

Overview of Clustering - K-means - Use Cases - Overview of the Method - Determining the Number of Clusters - Diagnostics - Reasons to Choose and Cautions

SUGGESTED ACTIVITIES :

- Practical on K-means clustering using map reduce in Hadoop

SUGGESTED EVALUATION METHODS:

- Tutorial problems

Attested

- Assignment problems

MODULE IV CLASSIFICATION	L	T	P	EL
	3	0	0	3

Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Naïve Bayes - Bayes‘ Theorem - Naïve Bayes Classifier.

SUGGESTED ACTIVITIES :

- Flipped Class room
- EL-Basics of R programming

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

MODULE V ASSOCIATION	L	T	P	EL
	3	0	0	3

Advanced Analytical Theory and Methods: Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association& finding similarity

SUGGESTED ACTIVITIES :

- Applications in class
- Flipped Class room

SUGGESTED EVALUATION METHODS:

- Tutorial problems on Apriori algorithm
- Assignment problems

MODULE VI: RECOMMENDATION SYSTEM	L	T	P	EL
	3	0	0	3

Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation- Hybrid Recommendation Approaches.

SUGGESTED ACTIVITIES :

- Mini project on Recommendation Systems using Hadoop libraries
- Flipped Classroom for further study

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Project demonstration and presentation

MODULE VII GRAPH MEMORY	L	T	P	EL
	3	0	0	3

Using Graph Analytics for Big Data: Graph Analytics - The Graph Model- Representation as Triples- Graphs and Network Organization- Choosing Graph Analytics-Graph Analytics Use Cases- Graph Analytics Algorithms and Solution Approaches-Technical Complexity of Analyzing Graphs-Features of a Graph Analytics Platform-Considerations: Dedicated Appliances for Graph

SUGGESTED ACTIVITIES :

- Combinations of in Class & Flipped class rooms
- EL on Graph Analytics Use Cases

Attested

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII STREAM MEMORY	L	T	P	EL
	3	0	0	3

Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window – Real time Analytics Platform(RTAP) applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL-Case study on Real time Analytics Platform(RTAP)

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IX NOSQL DATA MANAGEMENT FOR BIG DATA	L	T	P	EL
	3	0	0	3

NoSQL Databases : Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases-Hive - Sharding – - Hbase

SUGGESTED ACTIVITIES :

- Introduction to Hive and EL based on that
- Practical -Unstructured data into NoSQL data and do all operations such as NoSQL query with API.

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE X VISUALIZATION AND TRENDS	L	T	P	EL
	3	0	0	3

Visual data analysis techniques-Interaction Techniques-Systems and applications -Analyzing big data with twitter-Big data for E-Commerce-Big data for blogs-Review of Basic Data Analytic Methods using R.

SUGGESTED ACTIVITIES :

- Combination of in class & Flipped
- EL- Big data for blogs
- Practical- Data analytics in R

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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TEXT BOOKS:

1. Jure Leskovec, Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.

REFERENCES:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2014.
3. DietmarJannach, Markus Zanker,Alexander Felfernig, and Gerhard Friedrich, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
4. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.
5. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.

OUTCOMES:

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

- Work with big data tools and its analysis techniques
- Analyze data by utilizing clustering and classification algorithms
- Learn and apply different mining algorithms and recommendation systems for large volumes of data
- Perform analytics on data streams
- Work with NoSQL databases and management

EVALUATION PATTERN

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	1	-	-	-	1	3	2	2	3
CO2	3	3	3	2	2	3	1	-	1	-	1	3	3	2	1
CO3	2	3	3	3	2	2	1	-	3	-	1	3	3	2	2
CO4	3	3	3	1	2	2	-	-	-	-	1	3	2	1	3
CO5	2	2	2	1	2	2	1	-	1	-	1	2	1	-	3

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CS6004 INFORMATION VISUALIZATION

Prerequisites for the course: None

OBJECTIVES:

- To understand data collection and representation
- To analyze real-time problems and identify tasks
- To study the levels of validation
- To learn to define and use, marks and channels
- To understand the various techniques of visualization

	L	T	P	EL	CREDITS
CS6004 INFORMATION VISUALIZATION	**3**	**0**	**0**	**3**	**4**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Visualization – The Big Picture – Human in the Loop – Computer in the loop – External Representation – Data in detail –Use Interactivity – Vis Idiom Design space huge – Focus on Tasks – Focus on Effectiveness – Data Abstraction – Data Semantics – Data Types – Dataset Types – Attribute Types – Semantics

SUGGESTED ACTIVITIES :

- El – Case study for visualization
- Objects that can be used for visualization
- Data Collection for any one domain – Societal, Technical domains

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Task Abstraction – Analyze tasks abstractly –Designer or User – Actions – Targets –Analyzing and Deriving : examples

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Practical Problems –Task identification for real-time problems or any one problem for which data collection has been done

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**

	3	**0**	**0**	**3**

Four Levels for Validation – Validate – Four Levels of Design – Angles of Attack – Threats and Validation approaches- Examples

SUGGESTED ACTIVITIES :

- Practical activity – Data validation approaches for any one domain
- Group activity – discussion on methods of data validation – their pros and cons

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Data Abstraction – Semantics vs Types – Attribute types – Dataset types – Attribute Semantics – Dataset Semantics – Derived and Transformed Data - Marks and Channels – Defining Marks and Channels – Using Marks and Channels

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- Visualization aspects
- Group activity – Data type identification

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Channel Effectiveness – Relative vs Absolute Judgments - Dynamic Design Principles – Classes of Change – Latency and Feedback – Interactivity Costs – Memory and Attention – Spatial Cognition

SUGGESTED ACTIVITIES :

- Group activity – day to day objects for visualization – Kolams, traffic light, etc.,
- Practical activity – Real life examples for Classes of change
- Group activity – using dynamic design principles

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE VI :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Rules of Thumb – Unjustified 3D – Unjustified 2D – Eyes beat Memory – Resolution over Immersion – Zoom and Filter, Details on Demand – Responsiveness is required- Get it right in Black and White – Function first, Form next

SUGGESTED ACTIVITIES :

- Flipped classroom – Project selection
- Project discussion – Group activity

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity

Attested

- Quizzes

MODULE VII :	L	T	P	EL
	3	0	0	4

Arrange Tables – Arrange – Classifying arrangements by keys and values – Express: Quantitative values – Separate, order, align: Categorical Regions – Spatial Axis Orientation – Spatial Layout Density – Geometry – Scalar Fields – Vector Fields – Tensor Fields

SUGGESTED ACTIVITIES :

- Project Discussion
- Real-time objects and their orientation methods – group activity

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE VIII:	L	T	P	EL
	3	0	0	3

Arrange Networks and Trees – Link Marks – Matrix Views – Costs and Benefits: Connection vs Matrix – Containment : Hierarchy – Map color and other Channels – The Big Picture – Color Theory – Colormaps – Other Channels

SUGGESTED ACTIVITIES :

- Trees and linking to the project activity
- Color theory – Practical applications

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE IX:	L	T	P	EL
	3	0	0	3

Manipulate View – Change – Change view over time – Select elements – Changing Viewpoint – Reducing Attributes – Facet into Multiple views – The Big Picture – facet – Juxtapose and Coordinate views – Partition into views – Superimpose views

SUGGESTED ACTIVITIES :

- Sample views for real world problems
- EL – group activity – real-world problem identification and their activity
- Case studies – Graph, VisDB, Hierarchical Clustering

SUGGESTED EVALUATION METHODS:

- Assignment activity
- Group activity
- Quizzes

MODULE X:	L	T	P	EL
	3	0	0	3

Reduce Items and Attributes – Reduce – Filter – Aggregate – Embed: Focus+ Context – Embed – Elide – Superimpose – Distort – Costs and benefits

SUGGESTED ACTIVITIES :

- Project progress
- Case studies – Pivot Graph, Interring, Constellation

Attested

- Combination of in class & Flipped
- EL – Other Applications
- Practical – Mini Project

SUGGESTED EVALUATION METHODS:

- Project documentation and demo

TEXT BOOK:

1. Tamara Muzner, “Visualization Analysis and Design”, CRC Press, First Edition, 2014

REFERENCES:

1. Colin Ware, “Information Visualization: Perception for Design (Interactive Technologies)”, Morgan Kauffman Publishers, 2012
2. Andy Kirk, “Data Visualisation: A Handbook for Data Driven Design“, Sage Publications, First Edition, 2016

OUTCOMES:

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

- Perform data collection and representation
- Identify the task and analyze the real time problems
- Study the levels of validation
- Define and use, marks and channels
- Perform various techniques of visualization

EVALUATION PATTERN:

Continuous Assessment	Mid –Semester Assessment	End Semester
40	20	40

CO - PO MAPPING:

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

Attested

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CS6005 DEEP LEARNING TECHNIQUES

Prerequisites for the course: Machine Learning

OBJECTIVES:

- To learn the basic principles of supervised and unsupervised learning
- To provide basic understanding of the concepts involved in deep learning
- To understand the difference and similarities between the various forms of deep neural networks
- To have knowledge about deep generative models.
- To know about the applications of deep learning techniques in various real-time problems

CS6005 DEEP LEARNING TECHNIQUES	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I :	L	T	P	EL
	3	0	0	3

Machine Learning Basics – Learning Algorithms – Maximum Likelihood Estimation – Bayesian Statistics – Basics of Supervised Learning Algorithms and Unsupervised Learning Algorithms – Building a Machine Learning Algorithm – Challenges Motivating Deep Learning.

SUGGESTED ACTIVITIES :

- EL – Fundamentals of Linear Algebra
- In Class activity for linear algebra
- EL – Learn to implement machine learning algorithms

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	0	0	3

Neural Networks – The Biological Neuron – The Perceptron – Multilayer Feed-Forward Networks - Training Neural Networks – Activation Functions – Loss Functions – Hyperparameters

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Practical Problems –Bias, Variance and Maximum likelihood estimation

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	L	T	P	EL
	3	0	0	3

Deep learning - Deep feed forward networks – Architecture design - Gradient based learning – Back propagation and other differentiation algorithms -				
SUGGESTED ACTIVITIES : • Neural Networks - EL				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Regularization – Regularization and Under constrained problem – Semi-supervised learning – multitask learning – Early stopping – Tangent distance, prop and Tangent classifier				
SUGGESTED ACTIVITIES : • Flipped Class room • Introduction to Deep Learning – in class and EL based on that				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Unsupervised Pretrained Networks - Deep Belief Networks - Generative Adversarial Networks – Convolutional Neural Networks(CNNs) - CNN Architecture Overview - Other Applications of CNNs.				
SUGGESTED ACTIVITIES : • EL – Belief Networks • Applications of CNN in class				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Recurrent Neural Networks (RNN) - General RNN Architecture - LSTM Networks – Recursive Neural Networks - Architecture - Applications.				
SUGGESTED ACTIVITIES : • Introduction in class • Flipped Classroom for applications				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VII:	**L**	**T**	**P**	**EL**

	3	**0**	**0**	**3**
Linear Factor Models – Probabilistic PCA and Factor Analysis – Independent Component Analysis (ICA) – Slow Feature Analysis – Sparse Coding – Manifold Interpretation of PCA.				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped class rooms • EL - Probabilistic PCA and Factor Analysis				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Under complete and Regularized auto encoders – Contradictive auto encoders – Transfer learning and domain adaptation				
SUGGESTED ACTIVITIES : • Flipped classroom • EL on Sampling • Practical – Mini Project				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Deep Generative Models – Boltzmann Machines – Restricted Boltzmann Machines – Deep Belief Networks – Deep Boltzmann Machines – Boltzmann Machines for Real Valued Data – Convolution Boltzmann Machines.				
SUGGESTED ACTIVITIES : • Mostly in Class • EL –Deep Generative Models • Practical – Mini Project				
SUGGESTED EVALUATION METHODS: • Assignment problems • Tutorial problems				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Large Scale Deep Learning – Computer Vision – Speech Recognition – Natural Language Processing – Other Applications				
SUGGESTED ACTIVITIES : • Combination of in class & Flipped • EL – Other Applications • Practical – Mini Project				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O'Reilly Media, Inc,2017.

REFERENCES:

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
2. Raúl Rojas, “Neural Networks: A Systematic Introduction”, Springer Science & Business Media 2013.

OUTCOMES:

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

- Differentiate the various deep neural network models
- Design systems by applying appropriate deep neural networks concepts
- Analyse and provide modification to deep learning principles to suit any application
- Justify the need for Boltzmann machine principles for a target application
- Apply deep learning concepts for any target application

EVALUATION PATTERN:

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	3	2	-	1	-	1	2	3	3	1
CO2	3	3	3	3	3	3	2	1	2	-	1	2	3	3	3
CO3	3	3	3	3	3	3	2	2	3	-	1	3	3	3	3
CO4	3	2	2	2	2	-	1	1	1	-	-	1	3	2	1
CO5	3	3	3	3	3	3	2	2	3	2	2	3	3	3	3

CS6006 CLOUD COMPUTING

Prerequisites for the course: None

OBJECTIVES:

- To learn the concepts of cloud computing
- To provide an in-depth knowledge of the cloud computing fundamentals, technologies, applications and implementations.
- To expose the students to the cloud working methodology through virtualization, and networking techniques including SDN and NFV
- To motivate students to do programming and experiment with the various cloud computing environments and platforms.
- To shed light on the security issues in cloud computing.
- To appreciate the emergence of the next generation computing paradigm based on cloud.

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CLOUD COMPUTING	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I	L	T	P	EL
INTRODUCTION TO CLOUD COMPUTING	**3**	**0**	**0**	**3**

Introduction to Cloud Computing- Roots of Cloud Computing -;System Models for Distributed and Cloud Computing-Layers and Types of Clouds -Desired Features of a Cloud -Cloud Infrastructure Management -Infrastructure as a Service Providers -Platform as a Service Providers -Challenges and Risks-Architectural Design of Compute and Storage Clouds

SUGGESTED ACTIVITIES :

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

SUGGESTED EVALUATION METHODS:

- Quiz
- Report Submission – Comparison of various services provided by different Cloud Service Provider (Configuration of VM, Cost, Network Bandwidth etc…)

MODULE II	L	T	P	EL
SERVICE-ORIENTED ARCHITECTURE FOR CLOUD	**3**	**0**	**0**	**3**

Introduction to Services and Service Oriented Architecture -SOAP, REST and Systems of Systems - Services and Web Services-Event Driven SOA -SOA Communication

SUGGESTED ACTIVITIES :

- Create a simple Web Service using Python Flask /Java [Web Service: Client-server model should be implemented using socket/http]

SUGGESTED EVALUATION METHODS:

- Quiz on various concepts of the Module
- Flipped classroom
- Reviewofthe Web Service Implementation – Proper Connection should be established between the client and server to make use of the service offered by the Server.

MODULE III	L	T	P	EL
Virtualization	**3**	**0**	**0**	**3**

Implementation Levels of Virtualization -Virtualization Structures and Mechanisms – Full Virtualization, Para-Virtualization and Hardware-assisted Virtualization -Virtualization of CPU, Memory and I/O Devices-Understanding Hypervisors

SUGGESTED ACTIVITIES :

- Install Oracle Virtual Box/VMware Workstation and Create a Blackboard Application

[Hint: One VM should act as a master and other VMs acts as a listeners, when any content is written by the master VM, the content should be displayed in all the Listener VMs]

- Install KVM / Xen and create VM using image templates

SUGGESTED EVALUATION METHODS:

- Quiz on various concepts of the Module
- Flipped classroom
- Assessing of the working of installed Virtualization Tools.

Attested

• Review of the working of Blackboard Application in virtual environment [Implemented using basic echo and chat concepts]				
MODULE IV	**L**	**T**	**P**	**EL**
Open Source Cloud Platforms	**3**	**0**	**0**	**6**
Features of Cloud platforms- Overview of various open-source platforms –Eucalyptus and OpenNebula- Insight into OpenStack Architecture and Components				
SUGGESTED ACTIVITIES: • Learn architecture and features of Eucalyptus and OpenNebula • Install and configure OpenStack all-in-one using Devstack/Packstack • Launch VMs in OpenStack through dashboard				
SUGGESTED EVALUATION METHODS: • Quizon various concepts of the Module • Flipped classroom • OpenStack Dashboard should be accessible through web browser and the working of instance must be verified by logging in to it /pinging the instance.				
MODULE V	**L**	**T**	**P**	**EL**
Cloud Storage and Containers	**3**	**0**	**0**	**3**
Introduction to Cloud Storage, Definition, Provisioning -Unmanaged and Managed cloud storage - Creating cloud storage systems --Cloud Backup types, Features -Cloud attached backup -Cloud Storage Interoperability, CDMI, OCCI-Introduction to containers -Overview of Dockers				
SUGGESTED ACTIVITIES: • Explore volumes and its functions in OpenStack – creating volume, snapshots and other activities. • Install Docker and run “hello world” docker instance				
SUGGESTED EVALUATION METHODS • Quizon various concepts of the Module • Flipped classroom • OpenStack activity is to be appropriately verified • Working of Docker must be tested by running the simple command “docker run hello-world”.				
MODULE VI	**L**	**T**	**P**	**EL**
Cloud Security	**3**	**0**	**0**	**3**
Cloud Security Defense Strategies-Securing the Cloud & Data-Distributed Intrusion and Anomaly Detection-Data and Software Protection Techniques-Data Security in the Cloud -The Current State of Data Security in the Cloud -Cloud Computing and Data Security Risk -The Cloud, Digital Identity, and Data Security -Establishing Identity in Cloud.				
SUGGESTED ACTIVITIES: • Secure the OpenStack cloud instances by adding one’s own rule to security groups. • Use any free security tools (e.g., ACUNETIX, ETTERCAP) to scan web applications on the cloud, cloud networks for finding vulnerabilities, verifying leakage of information to an unauthorized third party.				
SUGGESTED EVALUATION METHODS: • Quiz on various concepts of the Module • Flipped classroom • Report Submission – Take the screenshot of the list of rules added in the security groups and justify the necessity of the each and every added rule. • Report Submission - Generate a detailed report describing vulnerabilities along with the suitable action that can be taken to remedy the loopholes.				
MODULE VII	**L**	**T**	**P**	**EL**

Cloud Platforms in Industry	**3**	**0**	**0**	**3**
Parallel Programming Paradigm -Apache Hadoop and Map-Reduce -MapReduce Programming Model -Major MapReduce Implementations for the Cloud -Public Cloud Platforms: GAE, AWS, and Azure-Programming Google App Engine-Programming on EC2, S3 -Best Practices in Architecting Cloud Applications in the AWS Cloud				
SUGGESTED ACTIVITIES: ● Install and configure Apache Hadoop (single node) and run a simple problem (e.g., word count) ● Install GAE ● Build and deploy a simple web application /host a static website on Google App Engine/Heroku				
SUGGESTED EVALUATION METHODS: ● Quiz on various concepts of the Module ● Flipped classroom ● Hadoop installation must be checked by running the simple problem with appropriate inputs ● Working of web application must be tested in browser by entering the unique URL assigned by Google App Engine / Heroku to the web app.				
MODULE VIII	**L**	**T**	**P**	**EL**
Cloud Management	**3**	**0**	**0**	**3**
Administrating the Clouds – Management Responsibilities & lifecycle Management-Distributed Management of Virtual Infrastructures -SLA – An Inspiration-Traditional Approaches to SLO Management -Types of SLA -Life Cycle of SLA -SLA Management in Cloud -Automated Policy-based Management -Cloud Management Standards				
SUGGESTED ACTIVITIES: • Explore Amazon CloudWatch, Nagios, Hyperic Management and Monitoring Tools and use on an application				
SUGGESTED EVALUATION METHODS: ● Quiz on various concepts of the Module • Report Submission - Detailed Report should be given with the details of the available resources and used resources (CPU,RAM,N/W bandwidth and storage) of the application.				
MODULE IX	**L**	**T**	**P**	**EL**
Cloud and Advanced Technologies	3	0	0	3
Use of Clouds for HPC/HTC and Ubiquitous Computing -Performance Metrics for HPC/HTC Systems-Quality of Service in Cloud Computing				
SUGGESTED ACTIVITIES : Mini Project ● Build your own Docker Web Application Image and push it into docker hub image repository ● Setup a private cloud for device monitoring and control using OpenStack. ● Create a private cloud and take automatic snapshot/backup of machines/virtual machines based on predefined conditions(e.g., timely backup, event-based backup etc.) ● Create a Hadoop application and extract important and relevant information (like max/min recorded temperature in particular year or number of patients in a year) in large weather/medical datasets.				
SUGGESTED EVALUATION METHODS: ● Quiz on various concepts of the Module ● Mini project demonstration				
MODULE X	**L**	**T**	**P**	**EL**
Cloud and Advanced Technologies	3	0	0	3
An Architecture for Federated Cloud (Inter-Cloud) Computing -Inter-Cloud Resource Management -Introduction to Fog Computing				

SUGGESTED ACTIVITIES :

Mini Project

- Create a private cloud and take automatic snapshot/backup of machines/virtual machines based on predefined conditions(e.g., timely backup, event-based backup etc.)
- Create a Hadoop application and extract important and relevant information (like max/min recorded temperature in particular year or number of patients in a year) in large weather/medical datasets.

SUGGESTED EVALUATION METHODS:

- Quiz on various concepts of the Module
- Mini project demonstration

TEXT BOOKS:

1. Kai Hwang, Geoffrey C Fox and Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Barrie Sosinky,"Cloud Computing Bible", Wiley Publishing Inc,2011
3. Buyya R., Broberg J.and Goscinski A., "Cloud Computing: Principles and Paradigm", First Edition, John Wiley & Sons, 2011.

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi,"Mastering the Cloud Computing", Morgan Kaufmann,2013
2. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation "Management, and Security", CRC Press, 2016.
3. David Bernstein,"Containers and Cloud: From LXC to Docker to Kubernetes", IEEE Cloud Computing,Volume: 1 , Issue: 3 , 2014.
4. VMware (white paper),"Understanding Full Virtualization, Paravirtualization, and Hardware Assist ":www.vmware.com/files/pdf/VMware_paravirtualization.pdf.

OUTCOMES:

Upon Completion of the course, the students will be able to:

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Discuss the core issues of cloud computing such as resource management and security.
- Install and use current cloud technologies.
- Establish their own cloud environment using OpenStack and work on it.

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	20	40

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CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	1	1	1	-	-	1	1	1	3	2
CO2	3	2	3	3	1	2	1	1	-	-	1	1	1	3	2
CO3	3	2	3	3	1	2	1	1	-	-	1	1	1	3	2
CO4	3	2	3	3	-	2	1	1	-	-	1	1	1	3	2
CO5	3	3	3	3	3	2	1	1	-	-	1	1	1	3	3
CO6	3	3	3	3	3	2	1	1	-	-	1	1	1	3	3

CS6007 INFORMATION SECURITY

Prerequisites for the course: None

CS6007 INFORMATION SECURITY	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**

OBJECTIVES:

- To know the various forms of attacks
- To understand the risk management and framing of various security models.
- To learn, to protect using physical secure design and cryptographic techniques
- To know the standard algorithms used to provide authentication and authorization
- To understand real world security protocols

MODULE I: INFORMATION SYSTEM	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Introduction to Information Systems - Trustworthiness of information systems - Security and Access - Security SDLC - Ethical and Professional Issues.

SUGGESTED ACTIVITIES :

- EL - Prepare an information system for any organization. Consider an organization, prepare table consisting of functional components of the organization, purpose of the components and Hardware & software supporting for the functional component.
- Draw an overall information model consisting of all the functional component of an organization.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :SOFTWARE ATTACKS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Use of Malware - Virus- Worm - Trojon Horse - Logic Bomb - Rootkit - Spyware - Adware - Password Cracking - DoS and DDoS - Spoofing - Sniffing - Man-in-Middle Attack - Phishing - Pharming.

SUGGESTED ACTIVITIES :

- Consider each functional component and prepare a table consisting of possible vulnerabilities list of malware, adware and attacks and appropriate solution to prevent the attacks.

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- A discussion wall may be created and ask the student to discuss the different attacks of information system
- Ask the student group to identity the kind of threat and attack for a case where security breach occurred in the fraudulent transactions (Collaborative Learning)
- EL – DoS and DDoS

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III : RISK MANAGEMENT	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Importance of risk Management - Integration of Risk Management in SDLC - Risk Assessment - System Characterisation - Threat Identification - Vulnerability Identification - Control Analysis - Impact Analysis - Risk Determination - Risk Level Matrix - Control Recommendations.

SUGGESTED ACTIVITIES :

- EL to identify the Risk Determination.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV : SECURITY MODELS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Bell-LaPadula model - Biba model - Clark-Wilson model - Information flow model - Noninterference model - Brewer and Nash model - Graham-Denning model - Harrison-Ruzzo-Ullman model

SUGGESTED ACTIVITIES :

- Prepare a table, to list the uniqueness of each security model.
- EL - Harrison-Ruzzo-Ullman model

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V : Physical Security Design	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Security Technology - Digital certificate - Digital Signatures - Firewall – Firewall Configuration Strategies - Packet Filtering– IDS

SUGGESTED ACTIVITIES :

- EL – Digital Signature
- Consider that you are owning an insurance company, list the preparations and procedure to issue digital certificate for your customers.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI: NETWORK SECURITY	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Cryptography and Network Security - Symmetric Key Encipherment - Asymmetric Key- Encipherment - Integrity, Authentication, and Key Management				
SUGGESTED ACTIVITIES : • Exemplify a scenario where symmetric key algorithms / asymmetric key algorithms is more suitable • EL – Key Management				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VII: AUTHENTICATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction – Authentication methods – Passwords – Key versus Password – Attacking systems via passwords – Password verification – Biometrics – types of error – Biometric error rates				
SUGGESTED ACTIVITIES: • EL - Biometrics • Many websites require users to register before they can access information or services. Suppose that you register at such a website, but when you return later you've forgotten your password. The website then asks you to enter your email address, which you do. Later, you receive your original password via email. Discuss several security concerns with this approach to dealing with forgotten passwords.				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII: AUTHORIZATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction – Access control matrix – Compartments – Convert Channel – Inference Control – CAPTCHA				
SUGGESTED ACTIVITIES: • EL - Design and implement your own visual CAPTCHA. Outline possible attacks on your CAPTCHA. How secure is your CAPTCHA? • EL - Design and implement your own audio CAPTCHA. Outline possible attacks on your CAPTCHA. How secure is your CAPTCHA?				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX: CERTIFICATION, ACCREDITATION, AND SECURITY ASSESSMENTS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Certification, Accreditation, and Security Assessments Roles and Responsibilities - Delegation of Roles - The Security Certification and Accreditation Process - Security Certification Documentation - Accreditation Decisions - Continuous Monitoring				
SUGGESTED ACTIVITIES : • Consider that you are assigning a duty of chief information security officer (CISO) to one of your employee. Define the roles and responsibilities of the CISO and his/her team				

• EL - security polices for an organization				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE X: Real world Security Protocols	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction – SSH – SSL -IPSec – Kerbose – WEP				
SUGGESTED ACTIVITIES : • EL - WEP				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

TEXT BOOK

1. Cryptography and Network Security by Behrouz A. Forouzan, McGraw-Hill Education, 2007.

REFERENCES:

1. Information Security Handbook: A Guide for Managers, National Institute of Standards and Technology, 2006.
2. Information Security Principles and Practices by Mark Stamp, John Wiley & Sons, 2011.

COURSE OUTCOMES

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

- Explain software security development life cycle, list of attacks in Network, Host and Information and write the consequences of the attack
- Analyze risks in a given activity and write the impact of risk.
- Differentiate security models and suggest best model for the given institution
- Differentiate the functions of IDS and Firewall
- Explain the features of digital certificate
- Document security policies and management activities for an organization.

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	**20**	**40**

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	2	2	1	-	-	2	3	3	2
CO2	3	2	3	2	2	3	2	1	1	-	2	3	2	3	1
CO3	3	3	3	2	1	2	1	1	1	-	1	2	3	3	1
CO4	3	3	2	2	1	2	1	-	2	-	1	2	2	3	2

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CO5	3	2	2	1	1	2	1	-	1	-	1	1	2	2	2
CO6	3	2	2	1	1	2	1	-	1	-	1	1	2	2	2

CS6008 CRYPTOGRAPHY AND NETWORK SECURITY

Prerequisites for the course: Computer Networks

	L	T	P	EL	TOTAL CREDITS
CRYPTOGRAPHY AND NETWORK SECURITY	**3**	**0**	**0**	**3**	**4**

OBJECTIVES:

- To know the various art of the security exploitation
- To learn secure programming techniques
- To understand the mathematics behind cryptography
- To know the standard algorithms used to provide confidentiality, integrity and authenticity
- To learn the public key infrastructure that will be used for security practices

MODULE I : FUNDAMENTALS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Syllabus Review - Memory Management Basics - Review of Assembly - Recognizing C and C++ Code Constructs in Assembly - Using GDB to reverse engineer code

SUGGESTED ACTIVITIES :

- Flipped Classroom
- EL - Finding passwords in executables using GDB

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quiz on Memory Management - understanding where different memory is allocated in memory

MODULE II : MEMORY CORRUPTION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Buffer Overflows - Understanding system calls in Linux - Shellcode - Global Offset Tables - Format Strings

SUGGESTED ACTIVITIES :

- Walk through of syscalls using ltrace and ptrace
- Going through shellshock, heartbleed exploits
- EL - Implementing simple buffer overflows
- EL - Implementing simple format string attacks

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

MODULE III : EXPLOIT TECHNIQUES	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

ELF Executable Format - SQL and SQL Injection - Data Execution Prevention - Return Oriented Programming

SUGGESTED ACTIVITIES :

- EL - Implementing Return Oriented Programming

● EL - Implement SQL injection in PHP based websites				
SUGGESTED EVALUATION METHODS: ● Assignment - Exploit a web server based on PHP to make it print all records, delete all records, drop tables ● Quizzes - Demonstrate understanding of ELF, DEP and ROP				
MODULE IV : NETWORK EXPLOITS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Port Scanning - Fuzzing - ARP Poisoning				
SUGGESTED ACTIVITIES : ● Using shodan.io for finding protocols in the Internet based on countries ● EL - Using libfuzzer and AFL to fuzz your own C/C++ implementations ● EL - Using arpspoof to poison network and detect using Wireshark				
SUGGESTED EVALUATION METHODS: ● Assignment problems				
MODULE V : INTRODUCTION TO CRYPTOGRAPHY	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction to Cryptology - Discrete Logarithms - Security Levels - Basics of Number Theory - Fermat and Euler's Theory				
SUGGESTED ACTIVITIES : ● Flipped Classroom ● Activity - Implementing Simple Caesar Ciphers and breaking it using frequency analysis				
SUGGESTED EVALUATION METHODS: ● Quizzes				
MODULE VI : NUMBER THEORY	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Euclidian's Algorithm - Primality Testing – Chinese Reminder Theorem – Finite Fields of the form GF(P)				
SUGGESTED ACTIVITIES : ● Flipped Classroom ● Assignment Problems				
MODULE VII: BLOCK CIPHERS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Block Ciphers - AES - DES - Block Cipher Modes - Padding				
SUGGESTED ACTIVITIES : ● EL - Implementing block ciphers using openssl in C/C++.				
SUGGESTED EVALUATION METHODS: ● Assignment problems ● Quizzes				
MODULE VIII: HASHES	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Hashing - MD5 - SHA1 - SHA256 - Message Authentication Codes - Hashed Message Authentication Codes – Weaknesses				

SUGGESTED ACTIVITIES : ● Activity - Demonstrate two different Certificates producing the same MD5 hash http://www.win.tue.nl/~bdeweger/CollidingCertificates/ ● EL - Computing MACs, Hashes and HMACs for messages				
SUGGESTED EVALUATION METHODS: ● Assignment problems ● Quizzes				
MODULE IX: PUBLIC KEY CRYPTOGRAPHY	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Diffie-Hellman - RSA - Elliptic Curve Cryptography - Digital Signatures – Certificates				
SUGGESTED ACTIVITIES : ● Flipped Classroom ● Demonstration - Effectiveness of Elliptic Curves over RSA				
SUGGESTED EVALUATION METHODS: ● Assignment problems				
MODULE X: PUBLIC KEY INFRASTRUCTURE	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Dream of PKI - PKI Examples - PKI Reality - Key Revocation - PKI Practicalities - Lifetime of Keys				
SUGGESTED ACTIVITIES : ● Flipped classroom				
SUGGESTED EVALUATION METHODS: ● Security Practices				

COURSE OUTCOMES:

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

- Present the exploitation present in the security.
- Discuss various types of attacks and their characteristics.
- Illustrate the basic concept of encryption and decryption for secure data transmission.
- Develop solutions for security problems.
- Analyze various cryptography techniques and its applications.

TEXTBOOKS:

1. Jon Erickson, “Hacking: The Art of Exploitation”, 2nd Edition, Starch Press, 2008.
2. William Stallings, “Cryptography and Network Security: Principles and Practices”, Sixth Edition, Pearson Education, 2014.

REFERENCES:

1. “The Shellcoder's Handbook: Discovering and Exploiting Security Holes”, 2nd Edition by Chris Anley et al.

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2. N. Ferguson, B. Schneier, and T. Kohno. “Cryptography Engineering: Design Principles and Practical Applications”. Wiley, 2010.
3. Neil Daswani, Christoph Kern, and Anita Kesavan, “Foundations of Security: What Every Programmer Needs to Know”, Frist Edition, Apress, 2007.
4. www.shodan.io
5. https://github.com/robertdavidgraham/masscan
6. https://zmap.io/
7. https://cs.dartmouth.edu/~sergey/cs60/wireshark-exercises.txt
8. https://cs.dartmouth.edu/~sergey/cs60/arp/arp-poisoning.txt

EVALUATION PATTERN

	Category of Courses	Continuous Assessment	Mid – Semester Assessment	End Semester
	Theory	40(T)	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	2	2	1	1	-	-	2	2	2	3
CO2	3	3	2	2	2	3	2	1	1	-	-	2	2	3	2
CO3	3	2	2	1	1	2	2	-	1	-	-	2	3	1	1
CO4	3	3	3	1	2	3	2	1	1	-	-	2	3	3	3
CO5	3	3	3	1	2	3	2	1	1	-	-	2	3	3	3

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CS6009 MOBILE NETWORKS

Prerequisites for the course: Computer Networks

OBJECTIVES:

- To provide the fundamentals of the wireless communications systems, the wireless network architectures, protocols, and applications.
- To provide guidelines, design principles and experience in developing applications for small, mobile devices, including an appreciation of context and location aware services
- To develop an appreciation of interaction modalities with small, mobile devices through the implementation of simple applications and use cases.
- To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.
- To understand the use of transaction and e-commerce principles over such devices to support mobile business concepts
- To appreciate the social and ethical issues of mobile computing, including privacy

CS6009 MOBILE NETWORKS	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**

MODULE I :	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**

Introduction – Applications – Signals – Signal Propagation (including effects)– Multiplexing (SDM, FDM, TDM, CDM) – Spread spectrum (FHSS, DSSS)

SUGGESTED ACTIVITIES:

- Analyze the problem definition and select a suitable multiplexing strategy
- Case study on Multi propagation effects
- Debate on mobile applications – Need, Quality of living.
- Depict the evolvement in the techniques using timelines

SUGGESTED EVALUATION METHODS:

- Tutorial/ Assignments
- Quiz

MODULE II :	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**

MAC – SDMA – FDMA – TDMA – CDMA

SUGGESTED ACTIVITIES:

- Target evaluation – given a solution attempt to check for correctness.
- Given a scenario, identify and debate on the suitability in multiple access schemes.
- Practical – Devise an orthogonal code and simulate the data transfer across end points using CDMA.
- Survey on any two MAC algorithms used in wireless networks

SUGGESTED EVALUATION METHODS:

- Report writing – How efficiency enhances on usage of the TDMA scheme in a real time application.

• Effect of combined TDMA, FDMA in terms of measuring parameters like cost, transmitter power etc. • Focus groups				
MODULE III :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**
IEEE 802.11 - System Architecture and Protocol Architecture of IEEE 802.11 (Infrastructure based WLAN and Ad-hoc Networks) – Physical and MAC layer (Distributed Coordinated Function, Point Coordinated Function with various variants of CSMA CA) – MAC management (Synchronization, Power Management and Roaming in both types of WLAN)				
SUGGESTED ACTIVITIES: • Flipped Classroom • Simulate the multiple access of the channel by the various mobile stations using all CSMA CA variants • Debate on the modifications required for Ad-hoc networks in comparison with infrastructure-based WLAN.				
SUGGESTED EVALUATION METHODS: • Quiz • Written Evaluation				
MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
802.11b – 802.11a – HIPERLAN 1 – Bluetooth				
SUGGESTED ACTIVITIES: • Flipped classroom • Comparison across the various standards. • Selection of appropriate standards for a problem description				
SUGGESTED EVALUATION METHODS: • Target evaluation – Checking the appropriate selection of standards • Convincing the selection of the standard by stating reasons.				
MODULE V :	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
GSM – DECT – UMTS				
SUGGESTED ACTIVITIES: • Understanding the elements, its function and signals of GSM required to establish a call • Need of different techniques for sending voice and data.				
SUGGESTED EVALUATION METHODS: • Written Assignment – Components in respective systems • Question generation				
MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Mobile AD HOC Networks - AD HOC Routing Protocols – DSDV - DSR and AODV Routing Techniques - Quality of service in Mobile Ad hoc Networks				
SUGGESTED ACTIVITIES: • Practical - Implementation Routing protocols and discuss the efficiency • Flipped Classroom • Application wide QoS requirements				
SUGGESTED EVALUATION METHODS: • Assignments • Quiz				

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MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Mobile Internet Protocol - IP Packet Delivery - Tunneling and Encapsulation - Reverse Tunneling – DHCP				
SUGGESTED ACTIVITIES: • Comparison of wired and wireless networks in IP layer • Learn by analogy – Postal system • Simulate the working of DHCP				
SUGGESTED EVALUATION METHODS: • Learn by visualization – Preparing placards, Storyboarding • Problem sets to understand the encapsulation				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
IPv6 - Security Concerns – Mobile IPv6 – Overview – Basic Operation – Header Extension – Alignment Requirements – Home Address Option – Type 2 Routing Header – Mobility Header – Mobility Options – Neighbor Discovery Messages – Procedure of Mobile IPv6 – Route Optimization – Movement Detection – Dynamic Home Agent Address Discovery – Mobile Prefix Solicitation / Advertisement – Relationship with IPsec				
SUGGESTED ACTIVITIES: • Flipped Classroom • Internet search – to understand the need of Security				
SUGGESTED EVALUATION METHODS: • Assignment • Learn by visualization – Preparing placards, Storyboarding				
MODULE IX:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
Traditional TCP – TCP improvements for mobile devices				
SUGGESTED ACTIVITIES: • Debate – Will traditional TCP work for wireless? • Internet Search – Compare the available TCP methods for mobility				
SUGGESTED EVALUATION METHODS: • Assignment • Quiz • Flipped Classroom				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
History of mobile application frameworks, Application models of mobile application frameworks, Challenges in Developing Mobile Apps (Resource constraints, security, mobility), Context Aware Computing, Service Discovery Middleware, Protocols (Auto configuration, Energy efficient communication, Mobility requirements)				
SUGGESTED ACTIVITIES : • Review of Mobile Applications • Special additions to mobile applications				
SUGGESTED EVALUATION METHODS: • Mini Project – context aware mobile solutions • Devising algorithms foe service discovery • Develop energy efficient mobile applications				

TEXT BOOKS:

1. Jochen Schiller, “Mobile Communications”, Second Edition, Pearson Education, 2003.
2. Asoke K Talukder,Roopa R Yavagal, “Mobile Computing , Technology, Application and Service Creation. Tata Mc Graw Hill, 2005.

REFERENCES:

1. Pei Zhang, Feng Zhao, David Tipper, JinmeiTatuya, Keiichi Shima, Yi Qian, Larry L. Peterson, Lionel M. Ni, Manjunath D, Qing Li, Joy Kuri, Anurag Kumar, Prashant Krishnamurthy, Leonidas Guibas, Vijay K. Garg, Adrian Farrel, Bruce S. Davie, “Wireless Networking Complete”, Elsevier, 2010.
2. Jon W.Mark,Weihua Zhuang, “ Wireless Communication and Networking”, PHI, 2002
3. C D M Cordeiro, D. P. Agarwal, “Adhoc and Sensor Networks: Theory and applications”, World Scientific, 2006.

EVALUATION PATTERN

Continuous assessment	Mid term	End Semester
40	20	40

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to:

- Develop the concept of systems thinking in the context of mobile and wireless systems
- Develop knowledge of the interplay of concepts and multiple sub-disciplines in mobile and wireless systems
- Develop knowledge and experience in mobile interface and applications design, and development techniques and methodologies set in the context of a research project addressing a real-world application
- Apply various computation methods and algorithms as a part of mobile application development
- Evaluate mobile computing applications, computation methods and algorithms through experiments and simulations

.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	1						1	3	3	3
CO2	3	2	2	2	2								3	3	3
CO3	3	3	3	3	3	2			2			1	3	3	3
CO4	3	3	3	3	3	1			2			1	2	3	3
CO5	2	2	2	3	3				2				2	1	3

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CS6010 WIRELESS AND SENSOR NETWORKS

Prerequisites for the course: Computer Networks

OBJECTIVES:

- To learn the fundamental technologies that help in the networking of wireless devices.
- To learn about different wireless technologies.
- To understand about sensor networks and the challenges involved in managing a sensor network.
- To study the various protocols at various layers and its differences with traditional protocols.
- To evaluate the performance of sensor networks and identify bottlenecks.

CS6010 WIRELESS AND SENSOR NETWORKS	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**

MODULE I INTRODUCTION	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**2**

Frequency Spectrum – Signal Propagation – Modulation – Multiplexing – Spread Spectrum – IEEE 802.11 Wireless LANs – Wireless LAN Equipment – WLAN Topologies – WLAN Technologies - Architecture and Protocols – Data Link Layer – Beacon Frame – Joining an Existing Basic Service Set

SUGGESTED ACTIVITIES:

- Survey on various wireless technologies

SUGGESTED EVALUATION METHODS:

- Quizzes
- Assignment

MODULE II WIRELESS LANS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**2**

Roaming in a Wireless LAN – Security in Wireless LANs – Power Management – Other WLAN Standards – Bluetooth – Overview – Architecture – Radio and Baseband – L2CAP and Frame Format – RFCOMM – SDP .

SUGGESTED ACTIVITIES:

- Survey on various wireless technologies

SUGGESTED EVALUATION METHODS:

- Quizzes
- Assignment

MODULE III WIRELESS NETWORKS I	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Performance of a Bluetooth- Piconet in the Presence of IEEE 802.11WLANs-Ultra-Wideband Standard and Applications – Radio-Frequency Identification – System – Applications – Wireless Metropolitan Area Networks.

SUGGESTED ACTIVITIES:

- Assign papers to read and present in class.

SUGGESTED EVALUATION METHODS:

- Evaluation of the presentation

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MODULE IV WIRELESS NETWORKS II	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Wireless Broadband: IEEE 802.16 – WiMAX – PHY – MAC – Spectrum Allocation – Satellite – Communication – Systems – Self-Organized Networks – ZigBee.				
SUGGESTED ACTIVITIES: • Comparison of different wireless technologies				
SUGGESTED EVALUATION METHODS: • Assignments				
MODULE V OVERVIEW OF WIRELESS SENSOR NETWORKS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Characteristicsof Wireless Sensor Networks -Challenges for WSN - mobile ad-hoc vs sensor networks –Sensor node Architecture - Physical layer and transceiver design considerations in WSNs				
SUGGESTED ACTIVITIES: • Understanding of commercial sensor products				
SUGGESTED EVALUATION METHODS: • Class presentations and discussions				
MODULE VI MAC LAYER FOR WSN	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Fundamentals of wireless MAC protocols-low duty cycle protocols and wakeup concepts, contention-based protocols- Schedule-based protocols				
SUGGESTED ACTIVITIES: • Survey on various MAC protocols				
SUGGESTED EVALUATION METHODS: • Class presentations and discussions				
MODULE VII ROUTING FOR WSN	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Routing Challenges and Design Issues in Wireless Sensor Networks-Gossiping and agent-based unicast forwarding-Energy-efficient unicast-Broadcast and multicast-geographic routing-mobile nodes-Data centric and content-based networking-Data aggregation.				
SUGGESTED ACTIVITIES: • Study of latest network simulation tools				
SUGGESTED EVALUATION METHODS: • Basic network demonstrations.				
MODULE VIII LOCALIZATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction-Elements of Localization-Sensor Localization with multidimensional scaling-Localization in wireless sensor networks.				
SUGGESTED ACTIVITIES: • Study on WSN data gathering methods and tools				
SUGGESTED EVALUATION METHODS: • Demo				

MODULE IX DATA AGGREGATION	L	T	P	EL
	3	0	0	3
On the security of WSN Localization-Time synchronization in wireless sensor network- Aggregate Queries in Sensor Networks - Aggregation Techniques.				
SUGGESTED ACTIVITIES • Study on various localization and data aggregation techniques				
SUGGESTED EVALUATION METHODS: • Group Discussions				
MODULE X IoT AND WSN	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Internet of Things-Wireless sensor and Actor networks-underwater sensor networks-video Sensor networks- Wireless Sensor Networks OS-Tiny Operating System-Contiki				
SUGGESTED ACTIVITIES: • Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot-Techniques for Protocol Programming. • Explore to the latest applications of commercial sensors.				
SUGGESTED EVALUATION METHODS: • Simple application using anyone of the commercial sensor node				

TEXT BOOKS:

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-Technology, Protocols and Applications”, John Wiley Publication, 2015.
2. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley and Sons, 2005.
3. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks - An Information Processing Approach”, Elsevier, 2007.

REFERENCES:

1. Robert Faludi, “Building Wireless Sensor Networks", O‘Reilly Media, 2011.
2. Pei Zheng, Feng Zhao, David Tipper, Jinmei Tatuya, Keiichi Shima, Yi Qian, larry L. Peterson, Lionel M. Ni, Manjunath D, Qing Li, Joy Kuri, Anurag Kumar, Prashant Krishnamurthy, Leonidas Guibas, Vijay K. Garg, Adrian Farrel, Bruce S. Davie, “Wireless Networking Complete”, Elsevier, 2010.
3. Fei Hu and Xiaojun Cao, “Wireless Sensor Networks Principles and Practice”, CRC Press, 2010.
4. Sitharama Iyengar S, Nandan Parmeshwaran, Balkrishnan N and Chuka D, “Fundaments of Sensor Network Programming, Applications and Technology”, John Wiley & Sons, 2011.
5. Jean Philippe Vasseur and Adam Dunkels, “Interconnecting Smart Objects with IP, The Next Internet”, Morgan Kaufmann, Elsevier, 2010.

EVALUATION PATTERN:

Continuous assessment	Mid term	End Semester
40	20	40

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OUTCOMES:

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

- Design MAC and Routing protocols for wireless and sensor network
- Prototype sensor networks using commercial components
- Apply knowledge of wireless sensor networks (WSN) to various application areas.
- Formulate and solve problems creatively in the areas of WSN and IoT
- Evaluate the performance of sensor networks and identify bottlenecks.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1								3	3	3
CO2	3	3	3	3	2								3	3	3
CO3	3	3	3	3	3				2			1	3	3	3
CO4	3	3	3	3	3				2			1	3	3	3
CO5	2	2	1	3	3				2				2	1	3

CS6011 GPU COMPUTING

Prerequisites for the course:

Programming with C, Computer Architecture

OBJECTIVES:

- To acquire a basic knowledge of GPU
- To understand the programming for heterogeneous architectures
- To know programming for massively parallel processors
- To understand the issues in mapping algorithms for GPUs

CS6011 GPU COMPUTING	L	T	P	EL	CREDITS
	3	0	0	3	4
MODULE I :		L	T	P	EL
		5	0	0	3
Understanding Parallelism with GPU - CUDA Hardware Overview, Threads, Blocks, Grids, Warps, Scheduling					
SUGGESTED ACTIVITIES : • Compare and Contrast Multicore and GPUs • Scheduling given problem with its input size into blocks and grids • Experimenting different block sizes					
SUGGESTED EVALUATION METHODS: • Assignment on GPU Applications • Evaluation of simple problems with no data parallelism using GPU • Evaluation of the ability to map a data parallel problem into GPU processor space					
MODULE II :		L	T	P	EL
		3	0	0	3
Memory Handling with CUDA : Shared memory, Global memory, Constant memory, Texture memory					

SUGGESTED ACTIVITIES :

- Exploring different memory types
- Finding optimal memory based on data size and reuse
- Using textures for Graphics

SUGGESTED EVALUATION METHODS:

- Assignment on data representation on different memories
- Evaluation of programs that manages data among different blocks and different memories
- Evaluation of data transfers in between host and device using programs

MODULE III :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

CUDA - Multi GPU - Multi GPU Solutions

SUGGESTED ACTIVITIES :

- Mapping large problem into GPU and executing
- Handling synchronization across different GPUs

SUGGESTED EVALUATION METHODS:

- Evaluating different ways to partition problems for different SMs and different GPUs
- Assignment on data distribution among different GPUs
- Assignment on handling larger problem space into different GPUs

MODULE IV :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Optimizing CUDA Applications : Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource contentions, Self-tuning Applications

SUGGESTED ACTIVITIES :

- Problem decomposition
- Memory selection for different data sizes
- Pinned memory usage
- Zero copy memory usage

SUGGESTED EVALUATION METHODS:

- Identify the resource requirement for the given problem and input size
- Quiz on Memory, Data transfer, Threads and optimization

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Common problems - CUDA error handling

SUGGESTED ACTIVITIES :

- Dealing with memory allocation errors
- Dealing with memory transfer errors
- Dealing with pitched memory

SUGGESTED EVALUATION METHODS:

- Assignment on pitched memory allocation
- Evaluating programs that process multi-dimensional arrays using pitched memory

MODULE VI :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Parallel programming issues, Synchronization, Algorithmic Issues, Finding and avoiding errors

SUGGESTED ACTIVITIES :

- Synchronization of threads within thread blocks
- Synchronization threads among thread blocks
- Explicit synchronization

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SUGGESTED EVALUATION METHODS:

- Evaluation of handling programs with data parallelism and dependence across neighbors
- Assignment on synchronization and errors

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Parallel Patterns : Convolution, Prefix Sum

SUGGESTED ACTIVITIES :

- Computing prefix sum
- Sparse matrix computations

SUGGESTED EVALUATION METHODS:

- Programming assignment for Computing prefix sum
- Programming assignment for Convolution

MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Parallel Patterns : Sparse matrix - Matrix Multiplication

SUGGESTED ACTIVITIES :

- Computing prefix sum
- Sparse matrix computations

SUGGESTED EVALUATION METHODS:

- Programming assignment for Computing matrix addition
- Programming assignment for Computing matrix multiplication using shared memory

MODULE IX :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Programming heterogeneous cluster - CUDA Dynamic Parallelism

SUGGESTED ACTIVITIES :

- Experimenting different GPUs
- Creating cluster of GPUs for problem solving
- Experimenting recursive algorithms

SUGGESTED EVALUATION METHODS:

- Programming assignment on graph traversal
- Programming assignment on tree traversal
- Programming assignment on binary search

MODULE X :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**3**

Introducing OpenCL, OpenACC, Thrust.

SUGGESTED ACTIVITIES :

- Application development using OpenCL
- Application development using OpenACC
- Application development using Thrust

SUGGESTED EVALUATION METHODS:

- Programming assignment for rendering
- Programming assignment for stencils
- Programming assignment for sort, scan scatter skeletons

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TEXT BOOKS:

1. Shane Cook, CUDA Programming: “A Developer's Guide to Parallel Computing with GPUs” (Applications of GPU Computing), I Edition, Morgan Kaufmann, 2012.
2. David B. Kirk, Wen-mei W. Hw, “Programming Massively Parallel Processors - A Hands-on Approach”, II Edition, Morgan Kaufmann, 2012

REFERENCES:

1. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison - Wesley, 2013.
2. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison - Wesley, 2010.
3. http://www.nvidia.com/object/cuda_home_new.html

OUTCOMES:

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

- Write programs for CUDA architecture
- Implement algorithms in GPUs to get maximum occupancy and throughput
- Program in any heterogeneous programming model
- Create a cluster of GPU’s
- To develop application using parallel programming standards

EVALUATION PATTERN

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping:

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

CS6012 EMBEDDED SYSTEMS

Prerequisites for the course: None

OBJECTIVES:

- To learn the architecture and programming of ARM processor
- To learn the architecture and programming of 8051 Microcontroller
- To familiarize with the embedded computing platform design and analysis
- To get exposed to the basic concepts of real time operating systems
- To design an embedded processor based system for a real-time application.

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EMBEDDED SYSTEMS	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I :	L	T	P	EL
	3	0	0	3

Introduction – Complex Systems and Microprocessors - System Design Process – ARM Architecture – Instruction Set

SUGGESTED ACTIVITIES :

- EL – Study of ARM Simulator Software, Mapping of Embedded Design Process to a simple Embedded Application
- Flipped Classroom
- Practical - ARM basic instruction set

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	L	T	P	EL
	3	0	0	3

CPUs – Programming Input and Output - Supervisor Mode, Exceptions, Traps – Co-processors – Memory System Mechanisms

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Study of applications using ARM processor
- Practical - combination of C and assembly language programming for interrupt handling, serial communication

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	L	T	P	EL
	3	0	0	3

CPU Bus – Memory Devices – I/O devices – Component Interfacing - Embedded Software Development Tools – Emulators and Debuggers

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Study of applications using ARM processor interfacing
- Practical - combination of C and assembly language programming for applications using memory, I/O interface, real-time clock and simple digital LED interface
- EL – Study of EDK Toolkit, Emulators and Debuggers
- Flipped Classroom
- Practical – Implement a Simple Embedded Application in any EDK toolkit

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV:	L	T	P	EL

	3	**0**	**0**	**3**
8051 Microcontroller – Architecture – Assembly Language Programming –Instruction Set — Addressing Modes - Input/output Port, Timers and Serial Port – Interrupt Handling				
SUGGESTED ACTIVITIES : • Flipped classroom • EL – Study of Keil 8051 Microcontroller Development tool, Introduction to Embedded C • Practical – Implementation of Software development using Keil compiler, 8051 assembly programming, Data transfer and Branch instructions, Arithmetic and Logical instructions • C Flipped Class room • EL – Programming in Embedded C Practical - Implementation of 8051 timers/ counters, serial port and Interrupts programming in assembly and Embedded				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE V:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
8051 Microcontroller - IO Interfacing – Memory Mechanisms – Memory Interfacing - Processes and Operating Systems–Preemptive Real-Time Operating Systems - Priority Based Scheduling				
SUGGESTED ACTIVITIES : • Flipped Classroom • EL- 8051 Interfacing like LED seven segment, keyboard interfacings • Practical – Implementation of 8051 Interfacing - ADC, Stepper Motor in assembly and Embedded C • Discussion of various RTOs • Flipped Classroom for further study • EL – Comparison of the different RTOs • Practical – Implementation of Real Time Scheduling of Tasks				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VI:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
Inter-Process Communication Mechanisms– basic functions – System Level, Task, mailbox and Queue related Functions				
SUGGESTED ACTIVITIES : • Flipped Classroom • EL – study of functions related scheduling and inter-process communications with respect to any specific RTOs • Practical –Implementation of Inter-task communications- Semaphores, Events, mailboxes, pipes in any RTOs				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

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MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Design Methodologies – Complete Design of Example Embedded Systems				
SUGGESTED ACTIVITIES : • Flipped Classroom • EL –Apply the design methodology to the chosen application • Practical – Mini project Implementation – an Embedded Application Development on any EDK				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation • Quizzes • Tutorial problems • Project design methods • Project demo • Mini project design and implementation				
MODULE VIII:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**3**
Program Design – Assembly, linking and loading – Basic Compilation Techniques -Program Optimization				
SUGGESTED ACTIVITIES : • Flipped Classroom • EL – study of the working of assemblers and linkers for Embedded Systems • Practical – Compilation, assembly and linking of the Mini Project				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
System and Program Level – Performance and Power - Analysis and Optimisation – Program Validation and Testing				
SUGGESTED ACTIVITIES : • Flipped Classroom • EL – Study of the Embedded Testing tools • Practical – Program validation and testing and performance analysis for the Mini project Implementation				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Multiprocessors in Embedded Systems – CPUs and Accelerators – System Architecture Framework - Networks for Embedded Systems				

SUGGESTED ACTIVITIES :

- Flipped Classroom
- EL – Study of practical applications using multiprocessors

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXTBOOKS:

1. Wayne Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition, Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay , “The 8051 Microcontroller & Embedded Systems”, Pearson Education, Second edition, 2008.

REFERENCES:

1. David. E. Simon, "An Embedded Software Primer", First Edition, Fifth Impression, Addison-Wesley Professional, 2007.
2. Andrew N Sloss, D. Symes, C. Wright, “ARM System Developer's Guide”, First Edition, Morgan Kaufmann/Elsevier,2006.
3. Steve Heath, “Embedded Systems Design”, Second Edition, Elsevier, 2008.
4. Michael J. Pont, “Embedded C”, Pearson Education , 2007

OUTCOMES:

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

- Describe the architecture and programming of ARM processor and Microcontroller.
- Outline the concepts of embedded systems.
- Explain the basic concepts of real time Operating system design.
- Use the system design techniques to develop software for embedded systems.
- Differentiate between the general purpose operating system and the real time operating System.
- Model real-time applications using embedded-system concepts.

EVALUATION PATTERN:

Continuous assessment	Mid term	End Semester
40	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	-	-	-	-	-	-	3	2	2	2
CO2	2	-	2	1	-	-	-	-	-	-	-	3	2	-	2
CO3	2	-	2	1	-	-	-	-	-	-	-	3	2	-	2
CO4	2	3	3	3	3	3	1	-	3	3	3	2	2	3	2
CO5	2	-	2	1	-	-	-	-	-	-	-	3	2	-	2
CO6	2	3	3	3	3	2	-	-	3	3	3	3	2	3	3

CS6013 UNIX INTERNALS

Prerequisites for the course: Operating Systems

	L	T	P	EL	TOTAL	CREDITS
CS6013 UNIX INTERNALS	**3**	**0**	**0**	**3**		**4**

OBJECTIVES

1. To learn the fundamentals and design principles of the UNIX operating system.
2. To learn the design of the internal algorithms of the UNIX operating system.
3. To know and understand the data structures used in the implementation of the UNIX operating system.
4. To understand the implementation of various system calls of the UNIX operating system.
5. To understand the use and working of the shell

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

General Overview: History - System structure - User perspective - Operating system services - Assumptions about hardware. Introduction to kernel: Architecture of UNIX operating system - Introduction to system concepts

SUGGESTED ACTIVITIES :

- Explore UNIX commands
- Assignment on processor support for kernel/user mode and interrupts/exceptions

SUGGESTED EVALUATION METHODS:

- Quizzes for UNIX Commands
- Assignments

MODULE II :	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**4**

The Buffer Cache - Buffer headers – Structure of the Buffer Pool – Scenarios for Retrieval of a Buffer– Reading and Writing Disk Blocks – Advantages and Disadvantages of the Buffer Cache.

SUGGESTED ACTIVITIES :

- EL- Implementation of buffer free list and hash queue

SUGGESTED EVALUATION METHODS:

- Assignment

MODULE III :	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**4**

Internal Representation of Files: Inodes – Structure of a Regular File – Directories –Conversion of a Path Name to an Inode – Super Block – Inode Assignment to a New File – Allocation of Disk Blocks

SUGGESTED ACTIVITIES :

- EL - Use stat command, system call to get inode information
- EL - Implementation of linked list of free disk blocks
- Flipped classroom for ‘Allocation of Disk Blocks’

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	5	**0**	**0**	**5**

Open – Read – Write – File And Record Locking – Adjusting the Position of File I/O –lseek – close – File Creation – Changing Directory – Root – Owner – Mode – stat and fstat – Pipes – dup – Mounting And Unmounting File Systems – link – unlink.

SUGGESTED ACTIVITIES :

- EL - Use system calls creat, open, read, write, lseek, dup in programs
- EL - Programs using pipes, use mount/umount commands

SUGGESTED EVALUATION METHODS:

- Assignments
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**4**

Process States and Transitions – Layout of System Memory – The Context of a Process

SUGGESTED ACTIVITIES :

- EL- View process layout using readelf, /proc/mem

SUGGESTED EVALUATION METHODS:

- Assignments
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**4**

Manipulation of the Process Address Space

SUGGESTED ACTIVITIES :

- Flipped classroom for free region, detach region

SUGGESTED EVALUATION METHODS:

- Assignments
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**5**

Process Control – Process Creation – Signals – Process Termination – Awaiting Process Termination – Invoking other Programs – Changing the size of a Process

SUGGESTED ACTIVITIES :

- EL - Use fork, exec, kill, signal, brk
- Flipped classroom for 'wait' system call

SUGGESTED EVALUATION METHODS:

- Assignments
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**5**

Shell – System Boot and the INIT Process– Process Scheduling

SUGGESTED ACTIVITIES :

- EL- implementation of a basic shell
- Assignment on system boot in other Linux distributions (rc, upstart)

SUGGESTED EVALUATION METHODS:

- Assignments

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• Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**2**
Swapping – Demand Paging				
SUGGESTED ACTIVITIES : • Tutorial on working sets				
SUGGESTED EVALUATION METHODS: • Tutorial problems				
MODULE X:	**L**	**T**	**P**	**EL**
	4	**0**	**0**	**4**
Inter process communication - Messages - Shared memory – Semaphores				
SUGGESTED ACTIVITIES : • EL – Programs for messaging, shared memory, semaphores				
SUGGESTED EVALUATION METHODS: • Assignment • Quizzes				

OUTCOMES:

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

- Design and implement the subsystems of the kernel
- Understand the implementation of Unix-like operating systems
- Create and rebuild the system calls of an open source operating system
- Create and modify the data structures of Unix-like operating systems
- Optimize open source operating systems by creating/modifying the internal files and scripts

TEXT BOOK:

1. Maurice J. Bach, “The Design of the Unix Operating System”, First Edition, Pearson Education, 1999.

REFERENCES:

1. B. Goodheart, J. Cox, “The Magic Garden Explained”, Prentice Hall of India,1986.
2. S. J. Leffler, M. K. Mckusick, M. J. .Karels and J. S. Quarterman., “The Design and Implementation of the 4.3 BSD Unix Operating System”, Addison Wesley, 1998.

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	**20**	**40**

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CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	-	-	-	-	1	3	3	3	2
CO2	3	2	2	2	1	1	-	-	-	-	1	3	3	3	2
CO3	3	2	2	2	2	1	-	-	1	-	1	2	3	3	3
CO4	3	2	2	2	1	1	-	-	1	-	1	2	3	3	3
CO5	3	2	2	2	1	1	-	-	1	-	1	2	3	3	3

CS6014 IOT AND SMART APPLIANCES

Prerequisites for the course: None

OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for smart applications

CS6014 IOT AND SMART APPLIANCES	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**
MODULE I : IoT fundamentals		**L**	**T**	**P**	**EL**
		3	**0**	**0**	**3**
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT					
SUGGESTED ACTIVITIES : • EL: Do a survey of different real-world IoT applications • EL : Survey the open hardware platforms available for IoT and compare their characteristics					
SUGGESTED EVALUATION METHODS: • Check survey for breadth and depth – pairwise comparison • Quiz					
MODULE II : Things in IoT		**L**	**T**	**P**	**EL**
		3	**0**	**0**	**3**
Sensors, Actuators and Smart Objects – IoT Hardware platforms – Arduino/Raspberry Pi					
SUGGESTED ACTIVITIES : • Assignment on operational principles of sensors and actuators • Miniproject on building a smart system – Identify the sensors required for the system, connect sensors (such as temperature, pressure, light) to a suitable IoT hardware platform and take measurements					
SUGGESTED EVALUATION METHODS: • Quiz on sensors and actuators • Demonstration of practical setup on connecting sensors					

MODULE III : IoT connectivity Technologies	L	T	P	EL
	3	0	0	3

Connecting Smart Objects - IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 1901.2a, 802.11ah and LoRaWAN

SUGGESTED ACTIVITIES :

- Assignment on access technologies – (Use simulator)
- Flipped classroom for 802.11
- EL : Alternatives to LoRaWAN
- Miniproject on building a smart system – Choose appropriate access technology and connect the hardware to the Internet

SUGGESTED EVALUATION METHODS:

- Quiz on access technologies
- Quiz on LoRaWAN
- Demonstration of practical setup on connecting to the internet

MODULE IV : Network Layer	L	T	P	EL
	3	0	0	3

Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo- Routing over Low Power and Lossy Networks (RPL)

SUGGESTED ACTIVITIES :

- Find the RFCs related to Layer 2 and layer 3 IoT protocols

SUGGESTED EVALUATION METHODS:

- Quiz

MODULE V : Transport Layer	L	T	P	EL
	3	0	0	3

Application Transport Methods: Application Layer Not Present, Supervisory Control and Data Acquisition (SCADA)

SUGGESTED ACTIVITIES :

- Assignment on RPL – (simulator could be used)
- Flipped classroom

SUGGESTED EVALUATION METHODS:

- Quiz
- Demonstration of practical setup

MODULE VI: Application Layer and Cloud Services	L	T	P	EL
	3	0	0	3

Application Layer Protocols: CoAP and MQTT – Service discovery – mDNS - Cloud and Fog Topologies – Cloud services model – Fog Computing

SUGGESTED ACTIVITIES :

- Miniproject on building a smart system – Choose appropriate application protocol and connect to the cloud using available open platforms (such as IBM Bluemix)
- Use a simulator such as Fogsim to study the characteristics of fog computing

SUGGESTED EVALUATION METHODS: • Quiz • Cloud SIM and Fogsim Demonstration				
MODULE VII: Data Analytics for IoT	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Data analytics: Structured Vs Unstructured data and Data in Motion Vs Data in Rest – Role of machine learning – No SQL databases				
SUGGESTED ACTIVITIES : • Miniproject on building a smart system – Choose appropriate analytics mechanisms to analyze the data collected, and build the application				
SUGGESTED EVALUATION METHODS: • Demo of project				
MODULE VIII: Bigdata Analytics tool and IoT Security	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Frameworks: Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics –				
SUGGESTED ACTIVITIES : • EL : Explore data analytics on any open/academic license framework				
SUGGESTED EVALUATION METHODS: • Quiz				
MODULE IX: IoT Security	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Security in IoT - Cisco IoT system - IBM Watson IoT platform				
SUGGESTED ACTIVITIES : EL : Review of security in various IoT platforms				
SUGGESTED EVALUATION METHODS: Quiz				
MODULE X: Applications in IoT	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Smart appliances and applications: Autonomous cars – Connected cars – Smart Home appliances– Smart speakers –Smart energy.				
SUGGESTED ACTIVITIES : • Design the architecture and use cases for various smart systems – (eg., agriculture, home automation, smart campus, smart hostel) • Miniproject on building a smart system – Enhance the system with additional smart features				
SUGGESTED EVALUATION METHODS: • Report and Presentation of architecture solutions • Demonstration of complete smart system				

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TEXTBOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.

REFERENCES:

1. Perry Lea,” Internet of things for architects”, Packt Publishing, 1st Edition,2018
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier Science Publishers, 1st Edition ,2014.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key applications and Protocols”, Wiley, 2nd Edition, 2012.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011 Edition.
5. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on-Approach”, Universities Press, 1st Edition ,2015
6. https://www.arduino.cc/

https://www.ibm.com/smarterplanet/us/en

OUTCOMES :

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

1. Explain the concept and architecture of IoT.
2. Choose the right sensors and actuators for an application.
3. Analyze various protocols for IoT.
4. Apply data analytics and use cloud/fog offerings related to IoT.
5. Analyze applications of IoT in real time scenario
6. Design an IoT based smart system using open hardware platforms and open cloud offerings.

Evaluation Pattern:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	1	-	1	-	-	1	2	3	3
CO2	3	3	3	3	3	2	1	-	1	-	-	1	2	3	3
CO3	3	3	3	3	3	2	1	-	1	-	-	2	3	3	3
CO4	3	3	3	3	3	2	1	-	1	-	-	2	3	3	3
CO5	3	3	3	3	2	2	1	-	1	-	-	2	3	3	3
CO6	3	2	3	1	3	2	3	1	1	3	3	3	2	2	2

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CS6015 **MULTI CORE ARCHITECTURES**

Prerequisites for the course: Computer Architecture

OBJECTIVES:

- To introduce the students to the recent trends in the field of Computer Architecture and identify performance related parameters
- To learn to exploit ILP using various techniques
- To study about the various types of multiprocessor systems and their challenges
- To understand the various types of optimizations performed in a hierarchical memory system
- To explore the exploitation of data level parallelism, thread level parallelism and request level parallelism in different types of computer systems
- To understand the need for domain specific architectures and learn their characteristics

MULTI CORE ARCHITECTURES	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**

Introduction - Defining Computer Architecture - Trends in Technology - Trends in Power and Energy in Integrated Circuits - Trends in Cost – Dependability - Measuring, Reporting and Summarizing Performance - Quantitative Principles of Computer Design

SUGGESTED ACTIVITIES :

- EL - Review of the fundamental concepts of Computer Architecture
- Study of Existing Multicore architecture Simulator

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	6	**-**	**-**	**6**

Instruction-Level Parallelism - Basic Compiler Techniques for Exposing ILP-Reducing Branch Costs with Advanced Branch Prediction - Overcoming Data Hazards with Dynamic Scheduling - Dynamic Scheduling Algorithm

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- EL – Dynamic scheduling - Loop based example
- Simulation of ILP exploitation on simulator – Experiment with timing model for a 5-stage single-issue processor pipeline

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes
- Report of work done on simulator

MODULE III :	**L**	**T**	**P**	**EL**
	5	**-**	**-**	**3**

Hardware - Based Speculation - Exploiting ILP Using Multiple Issue and Static Scheduling - Exploiting ILP Using Dynamic Scheduling, Multiple Issue and Speculation - Advanced Techniques for Instruction Delivery and Speculation - Studies of the Limitations of ILP - ILP Approaches and the Memory System - Multithreading - Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput				
SUGGESTED ACTIVITIES : • Flipped class room • EL - Simulation of the concepts for ILP exploitation				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • Report of work done on simulator				
MODULE IV :	**L**	**T**	**P**	**EL**
	6	**-**	**-**	**6**
Multiprocessors - Classes - Issues - Centralized Shared-Memory Architectures - Cache Coherence Snooping Coherence Protocols - Limitations - Performance of Symmetric Shared-Memory Multiprocessors - Distributed Shared-Memory Architectures - Directory-Based Coherence				
SUGGESTED ACTIVITIES : • Flipped Class room • EL - In a standalone framework (shell provided by instructor) or simulator, implement directory or snoopy coherence protocol.				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • Evaluation of EL				
MODULE V :	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**
Synchronization Issues - Basic Hardware Primitives - Implementing Locks using Coherence. Introduction to Models of Memory Consistency. Interconnection Networks				
SUGGESTED ACTIVITIES : • EL – Write and run benchmarks on the simulator to demonstrate synchronization issues and solutions				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • Report on EL				
MODULE VI:	**L**	**T**	**P**	**EL**
	4	**-**	**-**	**3**
Memory Hierarchy Design - Cache Memory - Performance Issues - Advanced Optimizations of Cache Performance - Memory Technology and Optimizations - Protection Aspects of Virtual Memory and Virtual Machines				
SUGGESTED ACTIVITIES : • EL - Model cache optimization – eg. a lockup-free data cache in C/C++ (support miss-under-misses, hit-under-misses) • Flipped Classroom				

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SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • Report on EL				
MODULE VII:	**L**	**T**	**P**	**EL**
	4	**-**	**-**	**3**
Exploiting Data-level Parallelism - Vector Architectures - Vector Execution Time - Vector Instructions - Optimizations in Vector Architectures. SIMD Instruction Set Extensions for Multimedia, Detecting and Enhancing Loop-Level Parallelism				
SUGGESTED ACTIVITIES : • Combinations of in Class & Flipped class rooms • EL – Project : Implement an idea from a research paper (to be given/approved by the instructor) and attempt to reproduce the paper's results on a standard simulator				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**
Graphics Processing Units - Salient Features - Example Architectures - GPU Computational Structures - Comparison with Vector Architectures				
SUGGESTED ACTIVITIES : • Flipped classroom • EL – continue on project implementation				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**
Warehouse-Scale Computers - Introduction - Programming Models and Workloads for Warehouse-Scale Computers - Computer Architecture of Warehouse-Scale Computers - Physical Infrastructure and Costs of Warehouse-Scale Computers - Cloud Computing				
SUGGESTED ACTIVITIES : • EL - Case Study of a Typical WSC				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**-**	**-**	**3**
Domain Specific Architectures - Introduction - Guidelines for DSA - Example DSAs like Google's TPU, Intel Crest, Microsoft Catapult and Pixel Visual Core.				
SUGGESTED ACTIVITIES : Combination of in class & Flipped				

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Survey of Intel/AMD/ARM processors – categorize and classify
SUGGESTED EVALUATION METHODS: • Quizzes • Project demonstration and presentation

OUTCOMES:

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

- Demonstrate how ILP is exploited with static and dynamic approaches
- Discuss the different types of multiple issue processors and instruction scheduling
- Critically examine the various cache coherence protocols
- Discuss the support provided by the architecture for providing synchronization
- Point out optimization techniques for improving the performance of the memory hierarchy design
- Critically analyse the characteristics of the various types of multicore architectures and how they exploit different types of parallelism

TEXT BOOKS:

1. John L. Hennessey and David A. Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann / Elsevier, 5th edition, 2012.
2. Recent papers as applicable from the internet for case studies.

REFERENCE BOOKS:

1. William Stallings, “Computer Organization and Architecture - Designing for Performance”, Tenth edition, Pearson Education Limited, 2016.
2. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors”, Morgan Kauffman, 2010.
3. Wen - Mei W. Hwu, “GPU Computing Gems”, Morgan Kaufmann / Elsevier, 2011.

Evaluation method to be used:

Continuous assessment	Mid term	End Semester
40	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	-	1	2	-	1	3	2	-
CO2	3	2	2	2	3	1	1	-	1	2	-	1	3	2	-
CO3	3	2	2	2	3	1	1	-	1	2	-	1	3	2	-
CO4	3	3	2	2	3	1	1	-	1	2	-	1	3	2	-
CO5	3	2	3	2	3	1	1	-	1	2	-	1	3	2	-
CO6	3	3	3	2	3	1	1	-	1	2	-	1	3	2	-

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CS6016 **GRAPHICS AND MULTIMEDIA**

Prerequisites: None

Objectives:

- To Understand and apply the 2D viewing pipeline
- To learn the 3D Object representations and the 3D viewing pipeline
- Focus on advanced Graphics for visual realism, with add on exposure to OpenGL programming.
- Introduce Multimedia elements, file formats, data structures, data compression
- To learn authoring multimedia content.

	L	T	P	EL	CREDITS
GRAPHICS AND MULTIMEDIA	**3**	**0**	**0**	**3**	**3**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Computer Graphics terminology – Hardware – Software APIs – Coordinate Systems

SUGGESTED ACTIVITIES :

- In Class activity – simple exercises on display device configuration
- Graphics cards, display devices, Installation of APIs
- EL – Graphics cards, display devices, APIs

SUGGESTED EVALUATION METHODS:

- Assignments
- Quizzes

MODULE II : 2D Graphics	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

2D Transformations – Viewing - Clipping

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- Solving exercise problems on Transformations, clipping
- performing transformations on 2D shapes, clipping
- EL – 2D Transformations, Viewing, clipping

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III : 3D Object Representations	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Mesh Modeling, splines, coordinate systems

SUGGESTED ACTIVITIES :

- Using software like 3D Studio Max / Unity or equivalent for understanding coordinate systems
- EL – Splines, Understanding Mesh modeling for standard objects – cube, sphere

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV : 3D Transformations, Viewing in 3D	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

3D Transformations, Viewing – Projections

Attested

SUGGESTED ACTIVITIES :

- Simple classroom exercises on 3D Transformations, Projections Implementation of 3D transformations on 3D objects
- EL – Implementation of 3D transformations on 3D objects, Quaternions, Projections

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE V : Visual Realism and Rendering-1	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Color Models, Visible Surface Detection

SUGGESTED ACTIVITIES :

- Simple exercise problems on VSD
- removing Hidden surfaces
- EL –Hidden surface removal, Shaders, Rendering

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VI : Visual Realism and Rendering-2	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Shading, Textures, Ray Tracing.

SUGGESTED ACTIVITIES :

- Applying shading, shadows, textures, Rendering.
- EL – Shaders, shadows, textures, Rendering

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VII: Multimedia Introduction	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Definitions – Applications – Elements – File formats - Animation Techniques

SUGGESTED ACTIVITIES :

- Implementing simple animations using any 2D or 3D software tools
- EL- simple animations, file formats

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE VIII: Multimedia data compression	**L**	**T**	**P**	**EL**
– Data Compression (Text, Audio, Image, Video), Multimedia Data Structures	**3**	**0**	**0**	**3**

SUGGESTED ACTIVITIES :

- Exercise problems on Text compression, Image compression
- EL-Latest compression standards and formats, Text Compression, Image compression, 2D Animation using software like Flash or equivalent.

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IX: Multimedia Authoring	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Authoring metaphors – Tools – Scripting - Creating interactive presentations				
SUGGESTED ACTIVITIES : • Creating Interactive multimedia presentations using Authoring tools / software, • EL – Latest authoring tools / frameworks, Creating Interactive multimedia presentations using Authoring tools / software, Creating Animations in 2D and 3D				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE X: Applications of Multimedia	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Creating simple Games - virtual learning – simulations, Virtual Reality, Augmented Reality – Creating Multimedia rich websites using Web Authoring tools like Dreamweaver.				
SUGGESTED ACTIVITIES : • Flipped classroom • Creating simple games, Virtual Reality, Web authoring • EL- Designing presentations, Creating simple games, interactive simulations, learning, Virtual Reality, Web authoring				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

Outcomes:

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

- Implement 2D transformations and viewing algorithms
- Solve problems in 3D transformations and viewing
- Demonstrate visual realism by adding textures, lights shadows etc using tools/software
- Critically examine file formats, compression of media elements
- Author multimedia presentations using 2D and 3D authoring tools in addition to advanced VR and AR applications

Continuous assessment	Mid term	End Semester
40	20	40

TEXT BOOKS:

1. Donald D. Hearn,M. Pauline Baker, Warren Carithers, “Computer Graphics with OpenGL”, Pearson Education, Fourth Edition, 2011.
2. Li, ,”Ze – Nian, “Fundamentals of Multimedia Prentice Hall, 2005.

REFERENCE BOOKS:

1. Donald D. Hearn,M. Pauline Baker, Warren Carithers, “Computer Graphics with OpenGL”, Pearson Education, Fourth Edition, 2011.

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2. Francis S Hill Jr.,Stephen M Kelley, ”Computer Graphics with OpenGL”, Pearson Educati on, Third Edition, 2006.
3. Edward Angel, “Interactive Computer Graphics a Top Down Approach using OpenGL”, Fifth Edition, Pearson Education, 2012.
4. Prabhat K.Andleigh, Kiran Thakrar, “Multimedia System Design”, Pearson Education, First Edition, 2015.

CO-PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO3	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO4	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3

CS6017 HUMAN COMPUTER INTERACTION

Pre-requisites: None

OBJECTIVES:

- To determine the necessity of user interaction by understanding usability engineering and user modeling
- To learn the methodologies for designing interactive systems
- To investigate the core and complex design issues for interaction
- To examine the evaluation methodologies of design
- To understand design issues for web and mobile platforms

CS6017 HUMAN COMPUTER INTERACTION	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I : INTRODUCTION	L	T	P	EL
	3	0	0	3
Context of Interaction –Ergonomics - Designing Interactive systems – Understanding Users-cognition and cognitive frame works, User Centre approaches				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE II : USABILITY	L	T	P	EL
	3	0	0	3
Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

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MODULE III : INTERACTION DESIGN - 1	L	T	P	EL
	3	0	0	3
Universal design principles, guidelines, heuristics, HCI patterns, design frame works, design methods, prototyping				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IV : INTERACTION DESIGN -2	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE V : DESIGN ISSUES	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Advancing the user experience, Timely user Experience, Information search, Data Visualization				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VI: EVALUATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models.				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VII: MODELS AND THEORIES - 1	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Cognitive models, Socio-organizational issues and stake holder requirements, Communication and collaboration models				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VIII: MODELS AND THEORIES - 2	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IX: DESIGNING INTERACTION FOR THE WEB	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup patterns-Feedback patterns				
SUGGESTED EVALUATION METHODS: • Assignment problems				

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• Project demonstration and presentation				
MODULE X: DESIGNING INTERACTION FOR THE MOBILE	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Mobile apps, Mobile navigation, content and control idioms, Multi-touch gestures, Inter-app integration, Mobile web.				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

TEXT BOOKS:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen,Steven Jacobs,NiklasElmqvist"Designing the User Interface: Strategies for Effective Human-Computer Interaction", Sixth Edition, Pearson Education, 2016.
2. Jenny Preece, Helen Sharp, Yvonne Rogers, "Interaction Design: Beyond Human Computer Interaction", Wiley Student Edition, 4th Edition, Wiley, 2015.

REFERENCES:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", Third Edition, Pearson Education, 2004.
2. Alan Cooper,RobertReimann, David Cronin, Christopher Noessel,"About Face: The Essentials of Interaction Design", 4th Edition, Wiley, 2014.
3. Donald A. Norman, "Design of Everyday Things", MIT Press, 2013.
4. Cameron Banga, Josh Weinhold, "Essential Mobile Interaction Design: Perfecting Interface Design in Mobile Apps", Addison-Wesley Professional, 1 edition, 2014.
5. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O"Reilly, 2009.
6. StevenHoober, Eric Berkman, "Designing Mobile InterfacesPatterns for Interaction Design", O'Reilly, 2011.
7. http://hcibib.org/
8. http://debaleena.com/HCI-CS-522.html#schedule

OUTCOMES:

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

- Understand the basics of human computer interactions via usability engineering and cognitive modeling.
- Understand the basic design paradigms, complex interaction styles.
- Understand the fundamental design issues.
- Examine the evaluation of interaction designs and implementations.
- Understand the models and theories for user interaction
- Elaborate the above issues for web and mobile applications.

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	20	40

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CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	-	-	-	-	-	-	3	3	3
CO2	3	3	2	2	2	2	-	-	-	-	-	-	3	3	3
CO3	3	3	2	2	2	2	-	-	-	-	-	-	3	3	3
CO4	3	3	2	2	2	2	-	-	-	-	-	-	3	3	3
CO5	3	3	2	2	2	2	-	-	-	-	-	-	3	3	3
CO6	3	3	2	2	3	2	-	-	-	-	-	-	3	3	3

CS6018 **IMAGE PROCESSING**

Pre-requisites: None

OBJECTIVES:

- To learn about the basic concepts of digital image processing and various image transforms.
- To familiarize the student with the image enhancement techniques
- To expose the student to a broad range of image processing techniques and their applications.
- To appreciate the use of current technologies those are specific to image processing systems.
- To expose the students to real-world applications of image processing.

	L	T	P	EL	CREDITS
IMAGE PROCESSING	**3**	**0**	**0**	**3**	**4**

MODULE I : FUNDAMENTALS OF IMAGE PROCESSING	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction – Applications of Image Processing - Steps in image processing Applications - Digital imaging system- Sampling and Quantization				
SUGGESTED ACTIVITIES : • Introduction in class • EL – Applications of Image Processing				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE II :FUNDAMENTALS OF IMAGE PROCESSING	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Pixel connectivity – Distance measures - Color fundamentals and models - File Formats, Image operations.				
SUGGESTED ACTIVITIES : • Flipped classroom • EL – Image operations				
SUGGESTED EVALUATION METHODS: • Assignment problems				

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• Quizzes				
MODULE III : IMAGE ENHANCEMENT	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Image Transforms: Fast Fourier Transform and Discrete Fourier Transform. Image Enhancement in Spatial and Frequency domain - Gray level transformations - Histogram processing - Spatial filtering - Smoothing and sharpening				
SUGGESTED ACTIVITIES : • flipped classroom • EL – Image enhancement in the frequency domain				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IV : IMAGE RESTORATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Frequency domain: Filtering in frequency domain. Image Restoration - Image degradation model - Noise modeling – Blur – Order statistic filters – Image restoration algorithms.				
SUGGESTED ACTIVITIES : • flipped classroom • Analysis in class • EL – Image Restoration algorithms				
SUGGESTED EVALUATION METHODS: • Quizzes				
MODULE V : MULTI RESOLUTION ANALYSIS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Multi Resolution analysis: Image pyramids - Multi resolution expansion - Wavelet transforms				
SUGGESTED ACTIVITIES : • Introduction in class				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes • EL – Wavelet Transforms				
MODULE VI: IMAGE COMPRESSION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Image compression : Fundamentals - Models - Elements of information theory - Error free compression - Lossy compression - Compression standards				
SUGGESTED ACTIVITIES : • Introduction in class • Analysis in Class • Flipped Classroom • EL – Lossy Compression standards				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VII: IMAGE SEGMENTATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Image Segmentation - Detection of discontinuities - Edge operators - Edge linking and boundary Detection - Thresholding - Region based segmentation				
SUGGESTED ACTIVITIES : • Flipped class room				

• EL – Region Based Segmentation				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VIII: FEATURE EXTRACTION	**L**	**T**	**P**	**EL**
	3	**0**	**3**	**3**
Image Features and Extraction – Image Features – Types of Features – Feature extraction - Texture - Feature reduction algorithms – PCA – Feature Description.				
SUGGESTED ACTIVITIES : • Flipped classroom • EL – Feature extraction and engineering				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IX: IMAGE CLASSIFICATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Image classifiers – Bayesian Classification, nearest neighborhood algorithms - Support Vector Machines - Image Clustering Algorithms – Hierarchical and Partitional clustering algorithms.				
SUGGESTED ACTIVITIES : • Flipped class room • EL – SVM				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				
MODULE X: APPLICATIONS OF IMAGE PROCESSING	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Case Studies in Image Security - Steganography and Digital watermarking - Visual effects and Digital compositing - Case studies in Medical Imaging and remote sensing.				
SUGGESTED ACTIVITIES : • Applications in class • EL - Mini project for designing and implementing a digital image processing system				
SUGGESTED EVALUATION METHODS: • Quizzes				

Outcomes:

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

- Implement basic image processing algorithms.
- Design an application that uses different concepts of Image Processing.
- Apply and develop new techniques in the areas of image enhancement- restoration- segmentation- compression-wavelet processing and image morphology.
- Critically analyze different approaches to different modules of Image Processing.
- Build and use any simple Image Classifier using standard approaches

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40(T)	**20**	**40**

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Text Books:

1. S.Sridhar, “Digital Image Processing”, Second Edition, Oxford University Press, 2016.
2. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018.

Reference Books:

1. Alasdair McAndrew, “Introduction to Digital Image Processing with MATLAB”, Cengage Learning 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, —Image Processing, Analysis and Machine Vision, Fourth Edition, Cengage India, 2017.
3. Anil K.Jain, Fundamentals of Digital Image Processing, First Edition, Pearson Education, 2015.

CO-PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	2	-	2	-	1	2	3	2	3
CO2	3	3	3	2	1	2	2	-	2	-	1	2	3	3	3
CO3	3	3	3	2	3	3	2	-	2	-	1	2	3	3	3
CO4	3	3	3	3	3	1	2	-	2	-	1	2	3	3	3
CO5	3	2	2	2	3	2	2	-	2	-	1	2	3	2	3

CS6019 AUGMENTED REALITY AND VIRTUAL REALITY

Prerequisites: None

Objectives:

- To understand Virtual Reality
- To Familiarize with hardware and software for AR and VR
- To understand Augmented Reality
- To develop Augmented Virtuality
- To develop Mixed Reality applications

AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I : Introduction	L	T	P	EL
	3	0	0	3

Fundamental Concepts and Components of Virtual Reality.
Primary Features and Present Development on Virtual Reality

SUGGESTED ACTIVITIES:

- EL - Knowingthe head mounted display optics and unity tool.

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

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MODULE II : Multiple Modals of Input and Output Interface in Virtual Reality	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual / Auditory / Haptic Devices				
SUGGESTED ACTIVITIES:				
• EL – Interfaces and Device types				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE III : Environment Modeling in Virtual Reality	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Geometric Modeling; Behavior Simulation; Physically Based Simulation				
SUGGESTED ACTIVITIES:				
• EL **-** Generating graphical models				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE IV : Haptic & Force Interaction in Virtual Reality -1	**L**	**T**	**P**	**EL**
Concept of haptic interaction; Principles of touch feedback and force feedback;	**3**	**0**	**0**	**3**
SUGGESTED ACTIVITIES:				
• EL **-** Adding physical components				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE V : Haptic & Force Interaction in Virtual Reality -2	**L**	**T**	**P**	**EL**
Typical structure and principles of touch/force feedback Facilities in applications.	**3**	**0**	**0**	**3**
SUGGESTED ACTIVITIES:				
• EL –Adding Haptics using Arduino VR				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

MODULE VI: Augmented Reality -1	**L**	**T**	**P**	**EL**
Introduction System Structure of Augmented Reality; Key Technology in AR, AR hardware, AR software, AR content, Interaction	**3**	**0**	**0**	**3**
SUGGESTED ACTIVITIES:				
• EL – AR hardware and software				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

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MODULE VII: Augmented Reality -2	L	T	P	EL
General solution for calculating geometric & illumination Consistency in the augmented environment. Tracking, Calibration and registration, Computer vision	3	0	0	3
SUGGESTED ACTIVITIES:				
• EL – Lighting, Tracking in AR				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VIII: Augmented Virtuality and Mixed Reality	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
visual coherence, situated visualization, modeling and annotation Authoring AR, navigation, Mobile AR, Augmented Virtuality, Mixed Reality				
SUGGESTED ACTIVITIES:				
EL – Annotation authoring AR, navigation				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IX: Mixed Reality Development Tools	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Frameworks of Software Development Tools in VR; Modeling Tools for VR, Planning, creating content for VR and AR projects				
SUGGESTED ACTIVITIES:				
EL– ModelingAR using ARCore, ARKit, Vuforia, etc - Simple Game				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				
MODULE X: Mixed Reality application development	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Gaming and entertainment, Education, Science and Engineering, Information control and bigdata visualization				
SUGGESTED ACTIVITIES:				
EL – Build mobile app using AR technologies (using ARCore, ARKit, Vuforia, etc) • Simple Game • Combine VR and AR Game				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

Continuous assessment	Mid term	End Semester
40(T)	20	40

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Outcomes:

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

- Point out the various user interaction modes
- Design and Create user environment
- Demonstrate VR through simple applications
- Familiarity with Augmented Reality and Mixed Reality Development platforms
- Use techniques to combine AR and VR to generate Augmented Virtuality
- Implement simple mixed reality applications

Text Books:

1. Virtual Reality by Steve Lavalle, Cambridge University Press, 2016.
2. Steve Aukstakalnis , Practical Augmented Reality, A guide to technologies applications and human factors for AR and VR (usability), Addison-Wesley Professional, 1st Edition, 2016.

Reference Books:

1. Paul Mealy, Virtual and Augmented Reality for Dummies, For Dummies, 1st Edition, 2018.
2. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
3. Schmalstieg/Hollerer, Augmented Reality: Principles & Practice, Pearson Education India, 1st Edition, 2016.
4. Alan B. Craig, Understanding Augmented Reality: Concepts and Applications, Morgan Kaufmann, 1st Edition, 2013.
5. George Mather, Foundations of Sensation and Perception: Psychology Press; 2 edition, 2009.
6. Kelly S. Hale, Kay M. Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, September 10, 2014 by CRC Press.

Web References:

1. *https://nptel.ac.in/courses/106106138/*
2. *https://www.evl.uic.edu/aej/491/*
3. *http://www.quivervision.com/*
4. *https://vr.google.com/cardboard/*

Laboratory Requirements:

Hardware: VR/AR headset, Mobile Phones, ArduinoVR and Tablets
PC based - Oculus Rift, HTC Vive, HoloLens, Windows Mixed Reality Ultra
PC – GPU with I7 PROCESSOR,
Smart Gloves, Intel RealSense Depth Camera, Kinect

Software (VR): Three.js, Unity3D, Blender, Vuforia

Software (AR): A-Frame, ARToolKit, ARKit, Wikitude, Vupohoria, ARCore, AR.js

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CO-PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	3	3	1	-	-	1	-	1	1	1	1	1
CO2	2	2	3	1	2	-	-	-	-	-		1	2	2	2
CO3	2	2	3	2	3	1	-	-	2	-	2	2	1	2	3
CO4	1	2	3	2	3	-	-	-	-	-	1	1	1	2	2
CO5	2	3	3	3	3	1	-	-	-	-	2	2	1	2	2
CO6	2	3	3	3	3	1	-	-	2		2	2	1	2	2

CS6020 DIGITAL SIGNAL PROCESSING

Prerequisites for the course: None

CS6020 DIGITAL SIGNAL PROCESSING	L	T	P	EL	TOTAL CREDITS
	3	0	0	3	4

OBJECTIVES:

- To understand the concepts involved in designing analog and digital filters.
- To learn the design of infinite and finite impulse response filters for filtering undesired signals.
- To acquire knowledge on the various errors encountered in a DSP system.
- To understand signal processing concepts in systems having multiple sampling rate.
- To gain knowledge about adaptive filters.

MODULE I:	L	T	P	EL
	3	1	0	3

Signals - Classification of signals, Conversion of analog to digital signal, digital signal processing, Discrete Time Signals: Preliminary signals – Representation – Manipulations – Classification, Digital Systems: Classification, LTIS: Response – Correlation

SUGGESTED ACTIVITIES :

- EL– Classifying signals and systems
- In Class activity – Problems on Response and Correlation.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II:	L	T	P	EL
	3	1	0	3

Review of Z-transform, Fourier Transform – Fast Fourier transform– FFT applications – Overlap add and overlap save methods

SUGGESTED ACTIVITIES :

- In Class activity – Problems based on FFT, overlap add, overlap save methods.
- EL – Circular and linear convolution review

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

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MODULE III:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Analog filters –Butterworth filters, Chebyshev Type I filters				
SUGGESTED ACTIVITIES : • EL – Visualizing signals of practical day to day activities like traffic light, count of vehicles, temperature of the day, stock market changes • Tutorial – Analog filter design using Butterworth and Chebyshev approximation				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE IV:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Transformation of prototype LPF to BPF /BSF/ HPF – Transformation of analog filters to digital using Impulse invariance method and bilinear transformation				
SUGGESTED ACTIVITIES : • EL – Flipped Class-room – Approximation of derivatives and its mathematical representation • In-class activity – Derivation of Impulse invariance method and bilinear transformation				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE V:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
IIR Filter Structures – Realization - Direct Forms – Cascade and Parallel Realization				
SUGGESTED ACTIVITIES : • EL – Lattice structures - Flipped Class room • Tutorial on filter structures				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

MODULE VI :	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Linear phase FIR filter design –Fourier Series method - Window method – Rectangular, Hamming, Hanning windows				
SUGGESTED ACTIVITIES : • EL – Proof that FIR filters conserve phase • EL – Other windows like Bartlett, triangular windows for FIL filter design • **Mini project**				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems				

Attested

• Quizzes				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
FIR Filter design – frequency sampling method – Structures of IIR systems – Transversal and linear phase structures – IIR & FIR comparison				
SUGGESTED ACTIVITIES : • EL – Flipped class room – Comparison of FIR and IIR and applications • Mini project topic review				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Representation of numbers-ADC Quantization noise-Coefficient Quantization error, Product Quantization error				
SUGGESTED ACTIVITIES : • EL –Circular integral computation • Mini project review				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Truncation & rounding errors -Limit cycle due to product round-off error – Round-off noise power				
SUGGESTED ACTIVITIES : • EL – Noise power derivation • Mini project review / demo				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Multi-rate signal processing – Decimation, Interpolation, Fractional decimation – Properties of Decimator and Interpolator				
SUGGESTED ACTIVITIES : • EL – application of Multi-rate signal processing • EL – Flipped class room Noble identities and their application • Mini project demo				
SUGGESTED EVALUATION METHODS: • Assignment problems • Tutorial problems • **Mini project evaluation**				

MODULE XI:	**L**	**T**	**P**	**EL**
	3	**1**	**0**	**3**
Adaptive filters – Echo Cancellation – Channel Equalization				
SUGGESTED ACTIVITIES : • EL – Other areas of adaptive filter applications • Mini project demo				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Quizzes • Mini project evaluation				

TEXT BOOKS:

1. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson, Fourth Edition, 2007.
2. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, 2004.

REFERENCES:

1. I.C.Ifeachor and B.W. Jervis, Digital Signal Processing-A practical approach, Pearson, 2002.
2. D.J. De Fatta, J.G.Lucas and W.S. Hodgkiss, Digital Signal Processing-A system Design Approach, John Wiley & sons, Singapore, 1988.
3. M. H. Hayes, Digital Signal Processing, Schaum s outlines, Tata McGraw Hill, 2007.
4. Sanjit K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4th Edition, The McGraw-Hill Companies, Inc, 2011.

OUTCOMES:

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

- Analyze and apply appropriate frequency transformations for any class of signal
- Analyse and design filters for a given signal processing application
- Identify and compute the errors encountered in a digital signal processing systems
- Design applications that involves signal and image processing by adopting appropriate transformation and filtering techniques
- Justify and apply possible extensions to digital filters for a given application.

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	**20**	**40**

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CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO3	3	2	3	3	3	-	1	-	-	-	-	-	3	3	
CO4	3	2	3	3	3	2	-	2	2	2	1	3	3	3	3
CO5	3	3	3	3	3	2	1	-	-	-	-	-	3	3	3

CS6021 SOFTWARE TESTING AND QUALITY ASSURANCE

Prerequisites for the course: Software Engineering

OBJECTIVES:

- To understand the basics of software quality
- To learn and apply the metrics related to software quality
- To emphasize the importance of testing in SDLC
- To differentiate the test case view for functional and structural testing
- To gain insight into automation

CS6021 SOFTWARE TESTING AND QUALITY ASSURANCE	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I	L	T	P	EL
	3	0	0	3

Software Quality – Errors, Faults and Failure – Software Quality Factors – Development Plan and Quality Plan

SUGGESTED ACTIVITIES :

- Flipped Classroom on Software Project Lifecycle
- External Learning on Designing the Software Development Plan and Software Quality Plan for Sample Application

SUGGESTED EVALUATION METHODS:

- Assignments on Software Project Lifecycle for sample application

MODULE II	L	T	P	EL
	3	0	0	3

SQA components – Reviews: Formal Design Review, Peer Review, Expert Opinion – Software Configuration Management

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SUGGESTED ACTIVITIES :

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• External Learning on Comparison of Review Methodologies • External Learning on developing Software Review Documentation for Sample Application				
SUGGESTED EVALUATION METHODS: • Assignment : Preparing SCM document for sample application				
MODULE III	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Software Quality Metrics – Process Metrics : Quality Metrics, Timetable Metrics, Error removal efficiency metrics, process productivity metrics– Product Metrics: HD Quality Metrics, Productivity and effectiveness measures, corrective maintenance metrics - Size Metrics: LOC, Cyclomatic complexity & FP Metrics				
SUGGESTED ACTIVITIES : • Flipped Classroom: Assessing Software Quality for Sample application using Software Size Metrics				
SUGGESTED EVALUATION METHODS: • Assignment problems on calculation of software quality metrics for sample application				
MODULE IV	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Object Oriented Metrics: coupling, cohesion, inheritance and size metrics–Test Metrics: Time, Quality of Source Code, Source Code Coverage, Test case defect density, Review Efficiency				
SUGGESTED ACTIVITIES : • Flipped Classroom: Assessing OO Software Metrics for sample application				
SUGGESTED EVALUATION METHODS: • Assignment on assessing software test metrics for sample application				
MODULE V	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Testing Lifecycle – Defect Life Cycle - Defect Management: Defect Reporting & Classification – Taxonomy of Bugs				
SUGGESTED ACTIVITIES : • Flipped Classroom on Bug Reporting for any Bug related to Sample Application				
SUGGESTED EVALUATION METHODS: • Quiz on Open Source tools on Bug Tracking				
MODULE VI	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
SDLC – Levels of Testing- Functional Testing – Structural Testing				
SUGGESTED ACTIVITIES : • Flipped Classroom on Comparison of SDLC from various perspectives				
SUGGESTED EVALUATION METHODS: • Quiz on Open source Tools for Unit Testing				
MODULE VII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Test Automation Frameworks – Types – Types of Automation Tools				
SUGGESTED ACTIVITIES : • Flipped Classroom: Testing the Sample Application using Robotium				
SUGGESTED EVALUATION METHODS: • Assignments: Testing the Sample Application using JUnit				
MODULE VIII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Test Management: Test planning, Cost Benefit Analysis, Test Organization, Monitoring & Control				

SUGGESTED ACTIVITIES : • Assignments on Test Planning for Sample Application				
SUGGESTED EVALUATION METHODS: • Assignments on Cost Benefit Analysis for Sample Application				
MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Creating Test Cases from Requirements and Use Cases – Selection, minimization and prioritization of test cases for Regression Testing				
SUGGESTED ACTIVITIES : • Assignment on High Level Use Cases, Detailed Use Cases and Use case Scenarios for Sample Application				
SUGGESTED EVALUATION METHODS: • Assignment on generating Test Cases from Use Cases for Sample Application				
MODULE X	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Object oriented Testing – Testing Web Applications				
SUGGESTED ACTIVITIES : • Flipped Classroom: Testing a sample web application • Tutorial: Security Testing of Web Application				
SUGGESTED EVALUATION METHODS: • Assignment: Designing test cases for a sample web application using form based testing • Quiz on Security Testing of Web Application				

TEXT BOOKS:

1. Yogesh Singh, “Software Testing” Cambridge University Press, 2012.
2. Daniel Galin, “Software Quality Assurance” From theory to Implementation, Pearson Education, 2008.

REFERENCES:

1. Sandeep Desai & Abhishek Srivatsava, “Software Testing : A Practical Approach”, PHI Learning Pvt. Ltd, 2016, Second Edition
2. Arunkumar Khannur, “Software testing: Techniques & Applications”, Pearson Education India, 2011

OUTCOMES:

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

- Create and Analyze software documentation for SDLC phases
- Assess software quality using Software Quality Metrics
- Differentiate between Functional and Structural Testing practices
- Test a given application using Automated Testing Tools
- Develop test cases to remove bugs

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	**20**	**40**

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1	1	1	3	3	3	2	1	3	3
CO2	3	2	3	3	2	-	-	-	-	1	1	1	3	2	1
CO3	3	3	1	3	1	-	-	-	-	3	1	1	1	3	1
CO4	3	3	3	3	3	-	-	-	-	1	1	3	1	1	3
CO5	3	3	3	3	3	-	-	-	1	2	2	3	3	3	3

CS6022 SOFTWARE PROJECT MANAGEMENT

Prerequisites for the course: Software Engineering

OBJECTIVES:

- To understand the fundamental principle of software project management
- To be familiar with the different methods & techniques used for project management
- To learn project activity sequencing and scheduling
- To learn to evaluate risks and estimate cost of the project
- To study the impact of risks on project schedules

CS6022 SOFTWARE PROJECT MANAGEMENT	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I :	L	T	P	EL
	3	0	0	3

Activities covered by Software Project Management - Overview of stepwise project planning

SUGGESTED ACTIVITIES :

- External Learning: Creating products related to stepwise project planning for the sample project application

SUGGESTED EVALUATION METHODS:

- Assignments: Identifying different activity / stages for a sample project application

MODULE II :	L	T	P	EL
	3	0	0	3

Project evaluation: Strategic assessment, Technical assessment, Cost-Benefit Analysis, Cash-flow forecasting, Cost-Benefit Evaluation Techniques, Risk Evaluation

SUGGESTED ACTIVITIES :

- External Learning: Identify major risks & rank them in order of importance for the sample project application

SUGGESTED EVALUATION METHODS:

- Assignment : Cost-Benefit analysis on sample project application

MODULE III :	L	T	P	EL
	3	0	0	3

Effort Estimation: Problems with over and under estimation, Software effort estimation techniques

SUGGESTED ACTIVITIES :

- External Learning: Metrics for Effort Estimation

SUGGESTED EVALUATION METHODS:

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Assignment: Identify tasks/activities and respective effort estimates in duration (weeks) for the sample project application				
MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Albrecht Function Point Analysis, Function Points Mark II, Object Points, COCOMO model				
SUGGESTED ACTIVITIES : • External Learning: For the sample project application, identify each instances of each external user type				
SUGGESTED EVALUATION METHODS: • Assignment: Classify the complexity of Sample Application and use them to calculate Function Points				
MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Activity Planning: Projects and activities, Sequencing and Scheduling activities, Network Planning Models				
SUGGESTED ACTIVITIES : • External Learning: Draw a project schedule chart by considering the nature of software development process and the available resources ordered in sequence				
SUGGESTED EVALUATION METHODS: • Assignment: Draw an activity network using CPM or precedence network conventions for the sample project application				
MODULE VI :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Risk Management: Nature of risks, Managing risks, Risk identification, Risk Analysis, Reducing Risks, Evaluating risks to schedule				
SUGGESTED ACTIVITIES : • External Learning: For the sample project application, identify hazards and analyse the risk exposure				
SUGGESTED EVALUATION METHODS: • Assignment: Using PERT evaluate the effects of uncertainty including expected duration of activity and standard deviation for the sample project application				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Monitoring and control: creating the framework, collecting the data, visualizing progress				
SUGGESTED ACTIVITIES : • External Learning: For the identified activities, describe project monitoring using visualization approaches, for the sample application.				
SUGGESTED EVALUATION METHODS: • Assignment: Project Monitoring Visualization for sample application				
MODULE VIII:	**L**	**T**	**P**	**EL**
Monitoring and control: cost monitoring, earned value analysis	**3**	**0**	**0**	**3**
SUGGESTED ACTIVITIES : • External Learning: Tools for budgeting				
SUGGESTED EVALUATION METHODS: • Assignment : Create a baseline budget and perform earned value analysis				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

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Managing people and organizing team: understanding behavior, organizational behavior, selecting the right person, motivation, working in groups, becoming a team, decision making, leadership				
SUGGESTED ACTIVITIES : • External Learning: Forming the right team and Work Delegation				
SUGGESTED EVALUATION METHODS: • Assignment: Deciding the qualities of team member for sample application				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Seven core project metrics, quality indicators, pragmatic software metrics, metrics automation				
SUGGESTED ACTIVITIES : • External Learning: Automation tools for obtaining relevant software project metrics				
SUGGESTED EVALUATION METHODS: • Assignment: Assessing the software metrics for the sample application				

TEXT BOOKS:

1. Bob Hughes, Mike Cotterell, "Software Project Management", Fourth Edition, Tata McGraw Hill, 2006.
2. Royce Walker,"Software Project Management", Pearson Education, 1999.

REFERENCES:

1. Adolfo Villafiorita," Introduction to Software Project Management",Auerbach publication First Edition, 2016.
2. Ashfaque Ahmed, "Software Project Management: A Process-Driven Approach", First Edition, CRC Press, 2012.

OUTCOMES:

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

- Perform stepwise project planning
- Perform cost-benefit analysis and cash-flow forecasting techniques
- Apply function point analysis
- Model project scheduling using CPM or precedence networks
- Perform risk analysis and risk reduction

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	20	40

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	2	-	2	2	3	2	2	2	3
CO2	3	3	3	3	2	2	3	-	2	2	3	3	1	3	3
CO3	3	3	3	2	1	2	2	-	2	2	3	2	1	3	3
CO4	3	3	3	3	3	2	2	-	2	2	3	1	1	3	3
CO5	3	3	3	1	2	2	3	-	2	3	3	3	1	3	3

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CS6023 SOFTWARE TEST AUTOMATION

Prerequisites for the course: Software Engineering

OBJECTIVES:

- To gain insight into test automation
- To learn tools for web testing
- To learn web driver scripting
- To handle exceptions in test automation
- To understand the procedure of automating software tests

CS6023 SOFTWARE TEST AUTOMATION	L	T	P	EL	CREDITS
	3	0	0	3	4

MODULE I :	L	T	P	EL
	3	0	0	3

Automation lifecycle and Automation goals - Test Automation Frameworks – Types – Types of Automation Tools

SUGGESTED ACTIVITIES :

- External Learning on Test Automation Tools like JMeter
- Tutorial: Installation of Selenium and Selenium IDE

SUGGESTED EVALUATION METHODS:

- Quiz on JMeter

MODULE II :	L	T	P	EL
	3	0	0	3

Selenium IDE – Selenium versions and their capabilities - Selenium Test scripting – Cucumber Behavior Driven Development

SUGGESTED ACTIVITIES :

- External Learning on using Cucumber
- In-class Activity: Installation of Java, Eclipse, Cucumber

SUGGESTED EVALUATION METHODS:

- Assignment: Quiz on Using Cucumber

MODULE III :	L	T	P	EL
	3	0	0	3

Selenium Web Driver – Web Elements – Interactions and Features of Web Driver – Web Driver Events – Remote Web Driver

SUGGESTED ACTIVITIES :

- External Learning on open-source test automation projects from GitHub
- External Learning on using WebDriver with various browsers like Firefox, IE, Chrome, Safari and Opera

SUGGESTED EVALUATION METHODS:

- Assignments: Demo and Programming Assignments on Actions of Web Elements
- Assignments: Using Selenium Web Driver for a sample project

MODULE IV :	L	T	P	EL
	3	0	0	3

Functional web testing : using Twill, using Selenium - Testing simple web applications with Twill and Selenium

SUGGESTED ACTIVITIES :

- External Learning on Twill installation

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• External Learning on testing a web application using Twill				
SUGGESTED EVALUATION METHODS: • Assignment: Testing a web application using Selenium				
MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Selenium web driver based test automation frameworks – selenium WebDriver scripting				
SUGGESTED ACTIVITIES : • Assignments on Data-driven Tests using Excel files with Selenium WebDriver • External Learning on capturing screenshots using Selenium WebDriver				
SUGGESTED EVALUATION METHODS: • Quiz on Selenium WebDriver Scripting				
MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Test NG scripting – Test Automation Results Management – Selenium Exceptions Guide				
SUGGESTED ACTIVITIES : • External Learning on installation and using TestNG • Assignments on handling selenium exceptions				
SUGGESTED EVALUATION METHODS: • Quiz on Working with Selenium Exceptions				
MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Selenium Grid - Selenium IDE				
SUGGESTED ACTIVITIES : • External Learning on Performance Testing Basics				
SUGGESTED EVALUATION METHODS: • Quiz on Working with Selenium Grid				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Selenium IDE scripting – Advanced Selenium IDE				
SUGGESTED ACTIVITIES : • External Learning on Compatibility testing using Selenium Grid				
SUGGESTED EVALUATION METHODS: • Quiz on Selenium IDE Scripting				
MODULE XI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Selenium Web Driver Page Object Model – Selenium Automation Framework in Agile Projects				
SUGGESTED ACTIVITIES : • External Learning: Automating CRM Applications using Selenium POM				
SUGGESTED EVALUATION METHODS: • Quiz and Programming Assignments on Selenium POM				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Testing iOS and Android Apps				
SUGGESTED ACTIVITIES : • External Learning on automating iOS and Android tests using Appium				
SUGGESTED EVALUATION METHODS: • Quiz on App Development using Selenium				

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TEXT BOOKS:

1. Sandeep Desai & Abhishek Srivatsava, “Software Testing : A Practical Approach”, PHI Learning Pvt. Ltd, 2016, Second Edition
2. Satya Avasarala, “Selenium WebDriver Practical Guide”, Packt Publishing Ltd, 2014
3. Narayanan Palani, “Software Automation Testing Secrets Revealed” Revised Edition Part 1, Educreation Publishing, 2017 Edition.

REFERENCES:

1. Narayanan Palani, “Selenium Webdriver: Software Automation Testing Secrets Revealed”, Part 2, Educreation Publishing, 2016 Edition.
2. Ashish Bhargava, Designing and Implementing Test Automation Frameworks with QTP, Packt Publishing Ltd, 2013
3. Titus Brown C., Gheorghe Gheorghiu, Jason Huggins, “An Introduction to Testing Web Applications with twill and Selenium”, O'Reilly Media, Inc., 2007

OUTCOMES:

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

- Conduct automated software testing
- Test a web application using Selenium
- Test a web application using Twill
- Understand selenium POM
- Learn testing iOS and Android applications

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	20	40

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	1	1	1	1	1	2	1	2	3	1
CO2	2	2	3	2	3	1	1	1	1	1	2	1	3	1	2
CO3	2	2	3	2	3	1	1	1	1	1	2	1	3	1	2
CO4	3	1	2	1	3	1	1	1	1	1	3	1	2	1	3
CO5	3	1	3	1	3	1	1	1	1	1	3	1	2	1	3

CS6024 **TEST DRIVEN DEVELOPMENT**

Prerequisites for the course: Software Engineering

OBJECTIVES:

- To get insight into test driven development
- To learn to use tools for unit testing in TDD
- To identify potential regions for refactoring in a software application
- To understand pattern based TDD
- To gather ideas on TDD tools and frameworks

	L	T	P	EL	CREDITS
CS6024 TEST DRIVEN DEVELOPMENT	**3**	**0**	**0**	**3**	**4**

MODULE I	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Test Driven Development: Basics, Techniques in TDD, Importance of Test cases

SUGGESTED ACTIVITIES :

- External Learning on Agile & TDD
- External Learning on Building a Test Case in Java

SUGGESTED EVALUATION METHODS:

- Assignment: Importing a suitable sample application in Java from GitHub

MODULE II	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

The Money Example –xUnit - Refactoring by Example

SUGGESTED ACTIVITIES :

- External Learning on working with Junit

SUGGESTED EVALUATION METHODS:

- Assignments Programming Problems on Refactoring

MODULE III	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Principles of Refactoring – Bad smells in code – Building tests – catalog of refactoring

SUGGESTED ACTIVITIES :

- Flipped Classroom on finding bad smells in code for sample application

SUGGESTED EVALUATION METHODS:

- Assignments Programming Problems on Refactoring

MODULE IV	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

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Composing methods - moving features between objects – organizing data – simplifying conditional expressions – making method calls simpler – dealing with generalization				
SUGGESTED ACTIVITIES : • Assignments: Programming Problems on Generalisation for sample application				
SUGGESTED EVALUATION METHODS: • Quiz on Simplifying Method Calls				
MODULE V	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Big refactoring – refactoring, reuse and reality – refactoring tools				
SUGGESTED ACTIVITIES : • External Learning on refactoring tools				
SUGGESTED EVALUATION METHODS: • Assignments: Finding potential locations for Big Refactoring for sample application				
MODULE VI	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Patterns for TDD: TDD patterns – Red Bar patterns, testing patterns, green bar patterns				
SUGGESTED ACTIVITIES : • External Learning on TDD patterns				
SUGGESTED EVALUATION METHODS: • Assignment: Using Red-green TDD patterns in sample application				
MODULE VII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Patterns for TDD: TDD patterns –xUnit Patterns, Design Patterns				
SUGGESTED ACTIVITIES : • External Learning on GoF patterns and their usage in TDD				
SUGGESTED EVALUATION METHODS: • Quiz on Abstract Factory Pattern in TDD				
MODULE VIII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
TDD Tools, Frameworks and Environments: Virtual Machines, IDE, Unit Testing Frameworks				
SUGGESTED ACTIVITIES : • External Learning on Open Source TDD Unit Testing tools – JUnit, HtmlUnit				
SUGGESTED EVALUATION METHODS: • Quiz on JUnit, HtmlUnit				
MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
TDD Tools, Frameworks and Environments: Hamcrest and AssertJ, Code coverage tools, Mocking frameworks				

SUGGESTED ACTIVITIES : • External Learning on Open Source TDD code coverage tools – CodeCover, Coverage.py				
SUGGESTED EVALUATION METHODS: • Quiz on CodeCover, Coverage.py				
MODULE X	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
TDD Tools, Frameworks and Environments: User-Interface testing, Behavior-driven development (BDD)				
SUGGESTED ACTIVITIES : • Flipped Classroom: UI testing for sample application				
SUGGESTED EVALUATION METHODS: • Quiz on Open Source tools on Behavior Driven Development (BDD) – Cucumber				

TEXT BOOKS:

1. BalaParanj, "Test Driven Development in Ruby: A Practical Introduction to TDD Using Problem and Solution Domain Analysis", Apress, 2017.
2. Fowler, Martin, "Refactoring: improving the design of existing code", Pearson Education India, 2002.

REFERENCE BOOKS:

1. Kent Beck, "Test-driven development: by example" Addison-Wesley Professional, 2003
2. Viktor Farcic& Alex Garcia, "Test-Driven Java Development", Packt Publishing Ltd, 2015

OUTCOMES:

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

- To learn working with JUnit
- To identify bad smells in code
- To understand and apply refactoring tools
- To apply Red-green TDD patterns
- To learn to use various code-coverage tools

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	**20**	**40**

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	3	1	1	1	1	1	3	1	2	1	3
CO2	2	3	1	3	1	1	1	1	1	1	1	1	2	3	1
CO3	3	1	3	1	3	1	1	1	1	1	3	1	2	2	3
CO4	3	1	3	1	3	1	1	1	1	1	3	1	3	2	1
CO5	3	1	3	1	3	1	1	1	1	1	3	1	2	1	3

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CS6025 SUPPLY CHAIN MANAGEMENT

Prerequisites for the course: Software Engineering

OBJECTIVES:

- To understand the role and value of Customers and Stakeholders in a Business Enterprise
- To provide better Quality-of-Service to Customer using state-of-art Supply Chain Practices
- To interpret global Supply Chain Practices and the significance of logistics
- To identify best storage model suitable for Supply Chain Applications
- To create, protect and grow long term environmental, social and economic value for all stakeholders involved in bringing products and services to market.

CS6025 SUPPLY CHAIN MANAGEMENT	**L**	**T**	**P**	**EL**	**CREDITS**
	3	**0**	**0**	**3**	**4**

MODULE I	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Foundations of Supply Chain Management - Defining Supply Chain Management – Drivers of Supply Chain Change - Five SCM Tasks

SUGGESTED ACTIVITIES :

- External Learning: Exploring Supply Chain Management and Supply chain Drivers for Sample Application

SUGGESTED EVALUATION METHODS:

- Assignmenton Supply Chain Drivers for Sample Application

MODULE II	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Project Management and SCM: Levels of Project Management Maturity, Project Management Standards, Project Management Knowledge Areas - Supply Chain Process Standards and Reference Models – IT projects: Lessons for SCM

SUGGESTED ACTIVITIES :

- External Learning: Studying Sample Application for SCM standards

SUGGESTED EVALUATION METHODS:

- Quiz on Supply Chain Project Management & Process Standards

MODULE III	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

SCM Maturity Models – Executing SCM Processes - Developing a Supply Chain Strategy

SUGGESTED ACTIVITIES :

- External Learning: Studying Sample Application for Supply Chain Strategy

SUGGESTED EVALUATION METHODS:

- Quiz on Supply Chain Maturity Models
- Quiz on Supply Chain Strategy

MODULE IV	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Concepts of Logistics and Distribution: Introduction - Integrated Logistics & Supply Chain – Customer Service & Logistics – Channels of Distribution – Key Issues & Challenges

SUGGESTED ACTIVITIES :

- External Learning: Studying Value Addition Aspects of Logistics for Sample Application

SUGGESTED EVALUATION METHODS:

- Quiz on Value Addition in Logistics

MODULE V	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Planning for logistics: Planning framework for logistics – Logistics processes – Supply Chain Segmentation – Logistics Network Planning – Logistics Management &Organization – Manufacturing & Materials Management

SUGGESTED ACTIVITIES :

- External Learning: Choosing the cost-effective Supply Chain Segments for Sample Application

SUGGESTED EVALUATION METHODS:

- Quiz on Configuration management for reduction of Supply Chain Costs

MODULE VI	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Procurement and inventory decisions: Basic inventory planning & Management – Inventory & supply chain – Purchasing & supply

SUGGESTED ACTIVITIES :

- External Learning: Demand forecasting for Sample Application
- External Learning: Alternate Inventory and Procurement strategies

SUGGESTED EVALUATION METHODS:

- Quiz on Procurement Logistics Management
- Quiz on Distribution Logistics Management

MODULE VII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Warehousing and storage: Principles – Storage & Handling systems – Order picking & replenishment – Receiving & dispatch – Warehouse Design – Warehouse Management & Information

SUGGESTED ACTIVITIES :

- External Learning: Designing Innovative Storage Systems

SUGGESTED EVALUATION METHODS:

- Quiz on Global Storage Systems

MODULE VIII	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Freight transport: International Logistics & Modal Choice – Maritime Transport – Air Transport – Rail & Inter Modal Transport - Road freight transport: vehicle selection – vehicle costing – planning & resourcing

SUGGESTED ACTIVITIES :

- External Learning: Logistics for Sample Application

SUGGESTED EVALUATION METHODS:

- Quiz on Logistics and Distribution

MODULE IX	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Operational management: Cost & performance monitoring – Benchmarking – ICT in supply chain – Outsourcing: services, decision criteria, selection process – security & safety in distribution - Logistics & environment

SUGGESTED ACTIVITIES :

- External Learning: Transportation in Value Chains

SUGGESTED EVALUATION METHODS:

- Assignmenton Eco-friendly Logistics
- Quiz on Supply Chain Operations Management

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TEXT BOOKS:

1. James B. Ayers, “Supply Chain Project Management – A Structured Collaborative and Measurable Approach”, Second Edition, CRC Press, 2010.
2. Alan Rushton, Phil Croucher, Peter Baker, “The Handbook of Logistics and Distribution Management”, Fourth Edition, Kogan Page Limited, 2010.

REFERENCES:

1. Dawei Lu, “Fundamentals of Supply Chain Management”, Ventus Publishing, 2011.
2. Alan Harrison, Remko van Hoek,”Logistics Management and Strategy Competing through the supply chain”, Pearson Education, 2008.

OUTCOMES:

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

- To develop comprehensive strategic and tactical plans for an organization.
- Integrate appropriate technologies in developing dynamic solutions to business opportunities and challenges.
- Correlate the key responsibilities and interrelationships of all stakeholders in an organization’s supply chain.
- Apply and use analytical techniques for logistics management
- Identify storage, maintenance and handling systems across various modes of logistics

EVALUATION PATTERN:

Continuous Assessment	Mid-Semester Assessment	End Semester
40	20	40

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1	3	3	2	3	3	3	2	3	3	2
CO2	3	2	3	2	3	3	2	1	2	2	3	2	3	3	3
CO3	2	2	3	2	1	2	2	1	1	2	3	2	1	1	2
CO4	2	2	2	2	2	3	1	1	2	2	2	1	3	3	3
CO5	2	1	2	3	2	2	2	2	2	3	2	2	1	1	1

CS6026 GAME DEVELOPMENT

Pre-requisites: None

OBJECTIVES:

- To realize the importance of 3D Graphics for game design
- To familiarize with the process of game design
- To learn the processes, mechanics, issues in game design
- To understand the architecture of game engines and gaming platforms
- To develop simple interactive games

	L	T	P	EL	CREDITS

GAME DEVELOPMENT	3	0	0	3	4

MODULE I : 3D GRAPHICS FOR GAME DEVELOPMENT-1	L	T	P	EL
	3	0	0	3

Coordinate systems, 3D Graphics, Modeling, Curves and Surfaces

SUGGESTED ACTIVITIES :

- Flipped Classroom
- EL – Basics of 3D Graphics

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE II : 3D GRAPHICS FOR GAME DEVELOPMENT-2	L	T	P	EL
	3	0	0	3

Vertex Processing, Rasterization, Fragment Processing, Output merging, Image Texturing

SUGGESTED ACTIVITIES :

- Flipped classroom
- EL – Rasterization

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE III : 3D GRAPHICS FOR GAME DEVELOPMENT-3	L	T	P	EL
	3	0	0	3

Illumination and shaders, Rendering techniques

SUGGESTED ACTIVITIES :

- flipped classroom
- EL – Shading languages, Applying textures to 3D shapes

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

MODULE IV : GAME DESIGN PRINCIPLES -1	L	T	P	EL
	3	0	0	3

Games, Genres, Game worlds, Character Development, storytelling, creating user experience, Game Play

SUGGESTED ACTIVITIES :

- flipped classroom
- EL – Game terminologies

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE V : GAME DESIGN PRINCIPLES -2	L	T	P	EL
	3	0	0	3

Core Mechanics, Game Balancing, Level Design

SUGGESTED ACTIVITIES :

- Flipped Classroom
- EL – Game Mechanics design

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Quizzes

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MODULE VI: GAME DESIGN PRINCIPLES -3	L	T	P	EL
	3	0	0	3
Collision Detection, Physics based Simulation, Game AI				
SUGGESTED ACTIVITIES : • EL – Game AI • Flipped Classroom				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VII: GAME ENGINE ARCHITECTURE AND ANIMATION	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Game Engine Architecture, scene graphs, sorting, level of detail, Animation				
SUGGESTED ACTIVITIES : • Flipped class room • EL – Animation and rendering techniques				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE VIII: GAME DEVELOPMENT - 1	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Understanding UNITY environment, scripting, sprite animations				
SUGGESTED ACTIVITIES : • Flipped classroom • EL - UNITY				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE IX: GAME DEVELOPMENT - 2	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
More on understanding UNITY for character development, collision detection, physics, level design and fine tuning				
SUGGESTED ACTIVITIES : • Flipped class room • EL – UNITY				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				
MODULE X:DEMONSTRATION OF GAME PROJECTS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Implementing and demonstrating Games designed and developed by students using standard tools				
SUGGESTED ACTIVITIES : • Flipped class room • EL - UNITY				
SUGGESTED EVALUATION METHODS: • Assignment problems • Quizzes				

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Outcomes:

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

- Implement simple 3D Graphics applications for Game development
- Use core Game design principles for Game Design
- Analyze Game Engine Architecture and rendering
- Design simple animations
- Use tools like UNITY for Game design and development

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	20	40

Text Books:

1. Jung Hyun Han, “3D Graphics for Game Programming”, Delmar Cengage Learning, 2011.
2. Ernest Adams, “Fundamentals of Game Design”, 3rd Edition, Pearson Education, 2015.

Reference Books:

1. David H. Eberly, “3D Game Engine Architecture”, A Practical Approach to Real-Time Computer Graphics” Morgan Kaufmann, 2 Edition, 2006.
2. Jason Gregory, “Game Engine Architecture”, CRC Press, Third Edition, 2018.
3. https://unity3d.com/
4. https://www.pygame.org/

CO-PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	3	1	3	3	-	-	-	-	-	-	-	3	2	3
CO3	3	3	1	2	3	-	-	-	-	-	-	-	3	2	3
CO4	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	1	3	3	-	-	-	-	-	-	-	3	3	3

CS6027 MODELING AND SIMULATION

Attested

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Pre-requisites for the course: None

CS6027 MODELING AND SIMULATION	L	T	P	EL	CREDITS
	3	0	0	3	4

OBJECTIVES:

- To obtain knowledge and make decisions of any given system.
- To simulate the modeled system for performance study of an actual system.
- To reflect the continuing evolution of simulation software.
- To understand the statistical models in simulation.
- To acquire skills on analysis of simulation data.

MODULE I INTRODUCTION TO MODELING AND SIMULATION	L	T	P	EL
	3	0	0	3

System modeling - Simulation examples - Types and concepts

SUGGESTED ACTIVITIES:

- EL –Single server and multi server exercises

SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment exercises
- Quizzes

MODULE II MODELING APPROACHES	L	T	P	EL
	3	0	0	3

Modeling concurrent systems ,Finite State Automata and Regular expressions

SUGGESTED ACTIVITIES:

- EL – Regular sets analysis and model checking

SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment exercises
- Quizzes

MODULE III STATISTICAL MODELS IN SIMULATION	L	T	P	EL
	3	0	0	3

Terminology and concepts – Useful statistical models – Discrete distributions – Continuous distributions

SUGGESTED ACTIVITIES:

- EL –Poisson process – Empirical distributions

SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment exercises
- Quizzes

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MODULE IV SIMULATION SOFTWARE	L	T	P	EL
	3	0	0	3
Selection of simulation software – Simulation in C++ - Simulation in GPSS – Simulation packages				
SUGGESTED ACTIVITIES: • EL –Experimental and statistical analysis tools – Trends in simulation software				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				

MODULE V QUEUEING MODELS	L	T	P	EL
	3	0	0	3
Characteristics of queueing systems – Notations – Long run measures of performance of queueing systems - Markovian models				
SUGGESTED ACTIVITIES: • EL – Networks of Queues – Applications of queueing systems				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				

MODULE VI RANDOM NUMBER GENERATION	L	T	P	EL
	3	0	0	3
Random number properties - Generation of pseudo random numbers - Techniques for generating random Numbers				
SUGGESTED ACTIVITIES: • EL –Tests for random numbers – Frequency tests –Tests for autocorrelation				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				

MODULE VII RANDOM VARIATE GENERATION	L	T	P	EL
	3	0	0	3
Inverse transform techniques – Exponential distribution – Uniform distribution – Weibull distribution – Triangular distribution				
SUGGESTED ACTIVITIES: • EL – Acceptance – Rejection techniques - Direct transformation for the normal and lognormal distributions – Convolution method				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises				

• Quizzes				
MODULE VIII ANALYSIS OF SIMULATION DATA	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**3**
Problem formulation – Input modeling – Verification and validation of simulation models				
SUGGESTED ACTIVITIES: • EL –Output analysis for a single model – Comparison of alternative system designs				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				
MODULE IX SIMULATION OF MANUFACTURING AND MATERIAL HANDLING SYSTEMS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
• Models of manufacturing systems – Models of material handling - Goals and performance measures – Issues in manufacturing and material handling systems				
SUGGESTED ACTIVITIES: • EL – Manufacturing examples				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				
MODULE X SIMULATION OF COMPUTER SYSTEMS	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Simulation tools – Model input – High level computer system simulation				
SUGGESTED ACTIVITIES: • EL –CPU simulation – Memory simulation				
SUGGESTED EVALUATION METHODS • Tutorial problems • Assignment exercises • Quizzes				

TEXT BOOKS

1. Hopcroft, John E, Motwani, Rajeev, Ullman, Seffrey D, “Introduction to automata theory, languages and computation”, Pearson Education Limited, 3rd Edition, 2013.
2. Donald Gross and Carl M. Harris, Fundamentals of Queueing theory, John Wiley and Sons, 2nd edition, 1985.
3. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol, “Discrete-event system simulation”, Pearson Education, 5th Edition, 2009.
4. Hamdy A Taha, “Operations Research: An Introduction”, Prentice Hall, 8th Edition, 2006
5. GeoFfrey Gordon “System Simulation”, Prentice Hall of India, 2nd Edition, 2009.

REFERENCES:

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1. Fitzgerald, Jhon, Larsen,PeterGorm, “Modelling Systems; Practical Tools and Techniques in software development”, Cambridge University Press, 2nd Edition, 2009.
2. Law A.M, Simulation Modelling and Analysis, Tata Mc Graw Hill, 4th Edition, 2007
3. Thomas J. Schriber, Simulation using GPSS, John Wiley,2nd Edition, 1991.

OUTCOMES:

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

- Model any given system with rationality
- Predict the behavior through fine grained analysis
- Identify the important aspects of discrete event simulation
- Apply the modeling and simulation concepts to manufacturing, services and computing
- Verify and validate simulation models.

Evaluation Pattern:

Category of Course	Continuous Assessment	Mid – Semester Assessment	End Semester
Theory	**40**	**20**	**40**

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	1	2	-	-	-	-	1	3	2	-
CO2	2	3	3	3	3	1	2	-	-	-	-	1	3	2	-
CO3	2	3	3	3	3	1	2	-	-	-	-	1	3	2	-
CO4	2	3	3	3	3	1	2	-	-	-	-	1	3	2	-
CO5	2	3	3	3	3	1	2	-	-	-	-	1	3	2	-

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CS6028 QUEUING THEORY AND PERFORMANCE EVALUATION OF COMPUTER SYSTEMS

Prerequisites for the course: None

CS6028 QUEUING THEORY AND PERFORMANCE EVALUATION OF COMPUTER SYSTEMS	L	T	P	EL	TOTAL CREDITS
	3	0	0	3	4

OBJECTIVES

- To learn the foundations for probabilistic analysis
- To learn the queues used in modeling computer systems
- To learn the metrics used to analyze and evaluate computer systems
- To gain better knowledge and understanding of the workloads on computer systems
- To learn the techniques needed to represent data

MODULE I:	L	T	P	EL
	6	0	0	6

Random variables – Stochastic processes – Operational laws: Utilization law, Forced flow law, Little's law, General Response Time Law, Interactive Response Time Law

SUGGESTED ACTIVITIES :

- Explore the different types of random variables, their moments and moment generating functions
- Explore how the operational laws can be used to represent any system

SUGGESTED EVALUATION METHODS:

- Tutorial problems on random variables
- Quizzes

MODULE II:	L	T	P	EL
	3	0	0	3

Performance Bounds: Asymptotic Bounds, Balanced System Bounds.

SUGGESTED ACTIVITIES :

- Assignment on the usage of performance bounds to evaluate computer systems

SUGGESTED EVALUATION METHODS:

- Tutorial problems on random variables
- Quizzes

MODULE III:	L	T	P	EL
	4	0	0	4

Markovian queues – Birth & Death processes – Single and multiple server queueing models – Little's formula – Queues with finite waiting rooms

SUGGESTED ACTIVITIES :

- Assignment on the application of each queueing model in computer systems

SUGGESTED EVALUATION METHODS:

- Tutorial problems

MODULE IV:	L	T	P	EL
	4	0	0	4

Finite source models – Machine Interference Model – Steady State analysis – Self Service Queue.

SUGGESTED ACTIVITIES :

- Assignment on the application of each queuing model in computer systems

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SUGGESTED EVALUATION METHODS: • Tutorial problems				
MODULE V:	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**6**
Non-markovian queues – Pollaczek-Khinchin formula – Queues in series – Open queuing networks – Closed queuing networks.				
SUGGESTED ACTIVITIES : • Assignment on the application of each queuing model in computer systems				
SUGGESTED EVALUATION METHODS: • Tutorial problems				
MODULE VI:	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**6**
Performance metrics and types – Cost-performance ratio – Types of Workload – Workload Selection – Workload Characterisation – Workload Forecasting.				
SUGGESTED ACTIVITIES : • Explore the usage of different performance metrics • Assignment on workload				
SUGGESTED EVALUATION METHODS: • Assignments • Quizzes				
MODULE VII :	**L**	**T**	**P**	**EL**
	6	**0**	**0**	**6**
Instrumentation – Representation of Measurement Data: Gantt Charts, Kiviat Graphs – Amdahl's Law – Average Parallelism – Speedup and Efficiency – Application Models – Scalability of Parallel Algorithms – Gustafson's Law – Memory-Bounded Speedup.				
SUGGESTED ACTIVITIES : • Consider a project which is in progress or is about to be started, and identify suitable techniques to evaluate it and represent the results				
SUGGESTED EVALUATION METHODS: • Assignments • Quizzes				

TEXT BOOKS:

1. Gross, D. and Harris, C.M., "Fundamentals of Queuing Theory", Wiley Student, 3rd Edition, New Jersey, 2004.
2. Jain, R., "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling", John-Wiley, 1991.

REFERENCES:

1. Lazowska, E.D. et al., "Quantitative System Performance", Prentice-Hall, 1984.
2. Lilja, D.J., "Measuring Computer Performance - A Practitioner's Guide", Cambridge University Press, 2000.
3. Robertazzi. T.G. "Computer Networks and Systems – Queuing Theory and Performance Evaluation", Third Edition, Springer, 2002 Reprint.
4. Ross. S.M., "Probability Models for Computer Science", Academic Press, 2002.

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5. Johnson, R.A. Miller and Freund's, "Probability and Statistical for Engineers", Prentice Hall of India Pvt., Ltd., New Delhi, Seventh Edition, 2005.
6. Jay L. Devore," Probability and Statistics for Engineering and the Sciences", Cengage Learning, Seventh Edition, 2009.
7. Ross. S.M., "Probability Models for Computer Science", Academic Press, 2002.
8. J.Medhi, "Stochastic models of Queuing Theory", Academic Press, Elsevier, Amsterdam, 2003.

OUTCOMES:

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

- Use and apply the foundations of probabilistic analysis in various applications
- Represent and model the behaviour of any system.
- Analyse and design service processes that use shared resources.
- Apply different types of workload to test a system.
- Precisely represent data.

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	2	3	1	1	1	-	-	-	1	1	3	2	-
CO2	1	3	2	3	1	1	1	-	-	-	1	1	3	2	-
CO3	1	3	2	3	1	1	1	-	-	-	1	1	3	2	-
CO4	1	3	2	3	1	1	1	-	-	-	1	1	3	2	-
CO5	1	3	2	3	1	1	1	-	-	-	1	1	3	2	-

CS6029 SOCIAL NETWORK ANALYSIS

Prerequisites for the course: None

	L	T	P	EL	TOTAL CREDITS
SOCIAL NETWORK ANALYSIS	**3**	**0**	**0**	**3**	**4**

OBJECTIVES:

- To understand the concept of semantic web and related applications
- To represent knowledge using ontology
- To understand human behavior insights in social networks
- To learn about the extraction and mining tools for social networks
- To visualize social networks

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Introduction to Social Network Analysis –Graph Essentials –Graph Basics – Graph Representation- Types of Graphs – Connectivity in Graphs – Special Graphs – Graph Algorithms.

SUGGESTED ACTIVITIES :

- Create a social network with yourself as the central node and minimum of 50 friend nodes using Facebook entries using tools like Protégé / Vizter / Touchgraph
- Calculate the graph parameters

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Network Measures – Network Models: Properties of Real-World Networks – Random Graphs – Small-World Model – Preferential Attachment Model

SUGGESTED ACTIVITIES :

- Finding the network related properties such as Degree Distribution, Path length, Centrality of random nodes.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web

SUGGESTED ACTIVITIES :

- Understand the XML document format for Ontologies

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language.

SUGGESTED ACTIVITIES :

- Creating an ontology using protégé tool
- Creating a sample RDF document for the ontology created
- Checking the validity of the RDF documents using any validator tool

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Modelling and aggregating social network data, Ontological representation of social individuals - Ontological representation of social relationships, Aggregating and reasoning with social network data -Advanced representations

SUGGESTED ACTIVITIES :

- Create an OWL file which incorporates all the constraints and obtain inferences

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Community Detection-Community Evolution-Community Evaluation-Information Diffusion in Social Media-Herd Behavior-Information Cascades-Diffusion of Innovations-Epidemics.

SUGGESTED ACTIVITIES :

- Try to detect communities from FOAF Profiles/ Social networking sites
- Mine the community using any one of the community mining algorithm and find patterns

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Challenges-Classical Recommendation Algorithms-Recommendation Using Social Context-Evaluating Recommendations Behavior Analytics: Individual Behavior- Collective Behavior

SUGGESTED ACTIVITIES : • Mine the FOAF network and recommend interests of users to other people in the network • Predict the behavior of community based on human behavior prediction algorithm				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Understanding and predicting human behavior for social communities - User data management - Inference and Distribution - Enabling new human experiences – Reality mining - Context – Awareness				
SUGGESTED ACTIVITIES : • Predict the behavior of a person from online social networks				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Introduction: Hacking on Twitter Data-Twitter: Friends, Followers, and Set wise Operations-Analyzing Tweets-Visualizing tons of tweets.				
SUGGESTED ACTIVITIES : • Use tweepy to extract tweets and perform set wise operations				
SUGGESTED EVALUATION METHODS: • Assignment problems • Project demonstration and presentation				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations -Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.				
SUGGESTED ACTIVITIES : • Visualize the social networks using tools like Vizter, Touch graph • Visualize the bibliography network for coauthorship networks				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

TEXT BOOKS

1. R. Zafarani, M. Abbasi, and H. Liu,"Social Media Mining: An Introduction", Cambridge University Press, 2014.
2. Peter Mika, "Social networks and the Semantic Web", Springer, 1st edition 2007.

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3. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 1st edition, 2010.
4. Matthew A. Russell, “Mining the Social Web”, O“Reilly Media,2nd edition, 2013.

REFERENCES:

1. Colleen McCue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Elsevier,2nd edition, 2015.
2. Guandong Xu,Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, Springer, 1st edition, 2011.
3. Dion Goh and Schubert Foo, “Social information retrieval systems: emerging technologies and applications for searching the Web effectively”, IGI Global, 2007.

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

- Understand and appreciate the concept of semantic web
- Represent knowledge using ontology
- Design extraction and mining tools for social networks
- Visualize social networks and infer social parameters from the same
- Apply the analytics concept on Online Social networks

Evaluation method to be used:

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	-	-	-	1	2	3	3	1
CO2	3	2	3	2	2	2	1	-	-	-	1	2	3	3	1
CO3	3	3	3	2	3	3	1	-	1	-	1	3	3	3	3
CO4	2	2	3	2	2	2	3	-	1	-	1	3	3	3	3
CO5	3	3	2	3	2	2	2	-	1	-	1	2	3	3	3

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CS6030 NATURAL LANGUAGE PROCESSING

Prerequisites for the course: None

OBJECTIVES:

- To understand basics of linguistics and probability and statistics
- To study concept of morphology, syntax, semantics and pragmatics
- To learn various machine learning techniques used in NLP
- To understand statistical approaches to machine translation
- To understand deep learning for NLP

CS6030 NATURAL LANGUAGE PROCESSING	**L**	**T**	**P**	**EL**	**TOTAL CREDITS**
	3	**0**	**0**	**3**	**4**

MODULE I :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Introduction to Natural Language Processing, Basics of Linguistics and Probability and Statistics

SUGGESTED ACTIVITIES :

- Flipped classroom and activity
- In Class Activity – Linguistic Tagging
- Tutorials – Probability and Statistics for NLP Problems
- Practical – Use of Standard NLP tools for Simple analysis

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE II :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Words, Tokenization, Morphology, Finite State Automata, Spelling Correction

SUGGESTED ACTIVITIES :

- In Class Activity - Morphological Tagging
- Tutorial – Finite State Automata – Adjectives
- Assignment Problems – Finite State Automata – Other Grammatical Categories
- Practical- Programming Exercises - Build your Own Morphological Analyzer & Spell Checker

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE III :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Introduction to Statistical NLP - N-grams and Language models -Text classification, Naive Bayes, Vector space model

SUGGESTED ACTIVITIES :

- In Class – Vector Space Model
- Flipped Classroom and Activity
- Project Design

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SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE IV :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Sequence labeling - Part of speech tags, Hidden Markov models

SUGGESTED ACTIVITIES :

- Flipped Class room
- In Class Activity – Part of Speech Tagging
- Tutorial – Hidden Markov Models
- Practical - Implementation of a Simple POS Tagger

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Syntax Analysis - CYK algorithm, Earley's algorithm, Treebanks and PCFGs

SUGGESTED ACTIVITIES :

- Flipped Classroom and Activities
- In Class Activity – Simulation of Earley's algorithm
- Project Review

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Word Sense Disambiguation, WordNet, Dependency Parsing, Semantic Role Labeling and Semantic Parsing

SUGGESTED ACTIVITIES :

- In Class Activity – Semantic Exercises
- Use of WordNet
- Flipped Classroom for further study
- Practical - Implementation of Word Sense Ambiguation and Semantic Role labelling

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**

Statistical Machine Translation

SUGGESTED ACTIVITIES :

- In Class Activity – Step by Step Statistical Machine Translation
- Practical - Implementation of one Component of Machine Translation

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SUGGESTED EVALUATION METHODS: • Tutorial problems • Quizzes				
MODULE VIII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**
Deep learning for NLP, Word Embedding				
SUGGESTED ACTIVITIES : • In Class Activity – Word Embedding • **Project Submission**				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Quizzes • Project demonstration and presentation				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**4**
Information extraction, question answering, Sentiment Analysis				
SUGGESTED ACTIVITIES : • Combination of in class & Flipped Classroom • Project Submission				
SUGGESTED EVALUATION METHODS: • Tutorial problems • Assignment problems • Quizzes				

TEXT BOOKS:

1. Daniel Jurafsky and James H.Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, Second Edition, Pearson Education India,2013
2. Christopher Manning, “Foundations of Statistical Natural Language Processing”, MIT Press, 2009.

REFERENCE BOOKS:

1. Nitin Indurkhya,Fred J. Damerau, “Handbook of Natural Language Processing”, Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover,2010
2. Yoav Goldberg,Graeme Hirst, “Neural Network Methods for Natural Language Processing (Synthesis Lectures on Human Language Technologies)”, Morgan and Claypool Life Sciences, 2017
3. Deepti Chopra,Nisheeth Joshi, “Mastering Natural Language Processing with Python”, Packt Publishing Limited, 2016
4. Mohamed Zakaria Kurdi “Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax (Cognitive Science)”, ISTE Ltd., 2016
5. Atefeh Farzindar,Diana Inkpen, “Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)”, Morgan and Claypool Life Sciences, 2015

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OUTCOMES:

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

- Understand basics of linguistics and probability and statistics
- Understand morphology, syntax, semantics and pragmatics
- Discuss various machine learning techniques used in NLP
- Understand statistical machine translation
- Understand deep learning for NLP

EVALUATION METHOD:

Continuous Assessment	Mid –Semester Assessment	End Semester
40	20	40

CO - PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	3	1	-	-	-	1	-	3	3	3
CO2	3	3	3	2	-	3	1	-	-	-	1	-	3	3	2
CO3	3	3	3	2	1	3	1	-	1	-	1	3	3	3	3
CO4	3	3	3	2	2	3	1	-	1	-	1	1	3	3	3
CO5	3	3	3	2	1	3	1	-	1	-	1	3	3	3	3

CS6031 **DATABASE TUNING**

Prerequisites for the course: Database Management Systems

OBJECTIVES

- To comprehend the basic principles of database tuning
- To understand the basics of backup and recovery techniques
- To comprehend the principles of query optimization
- To understand the principles of E-commerce application tuning

	L	T	P	EL	Credits
CS6031 DATABASE TUNING	**2**	**0**	**0**	**3**	**3**
MODULE 1		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**
Review of Relational databases-Relational Algebra -Transaction Management- Locking and concurrency control- Lock Tuning					
SUGGESTED ACTIVITIES • Flipped Class Room • Study of Concurrency Control technique in any three relational databases					
SUGGESTED EVALUATION METHODS • Tutorial Problems • Assignment Problems • Quizzes					
MODULE 2		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**
Structured Query Language-Types of Queries-Procedures-Functions-Triggers					
SUGGESTED ACTIVITIES • Flipped Class Room • Executing different triggers					
SUGGESTED EVALUATION METHODS • Tutorial Problems • Assignment Problems • Quizzes					
MODULE 3		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**
Recovery Subsystem – Principles of Backup and Recovery – Tuning the Recovery Subsystem – Operating Systems Considerations – Hardware Tuning					
SUGGESTED ACTIVITIES • Flipped Class Room • NPTEL videos					

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SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment Problems
- Quizzes

MODULE 4		L	T	P	EL
		2	0	0	3

B tree – B + Tree – Examples-Hash Structures – Bit Map Indexes –Clustering Indexes – Non Clustering Indexes – Composite Indexes – Hot Tables – Comparison of Indexing and Hashing Techniques.

SUGGESTED ACTIVITIES

- Flipped Class Room
- Constructing B Tree B+ tree from given set of data

SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment Problems
- Quizzes

MODULE 5		L	T	P	EL
		2	0	0	3

Tuning Relational Systems – Normalization –Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Tuning

SUGGESTED ACTIVITIES

- Flipped Class Room
- Mooc Classes

SUGGESTED EVALUATION METHODS

- **Tutorial Problems**
- **Assignment Problems**
- **Quizzes**

MODULE 6		L	T	P	EL
		2	0	0	3

Client Server Mechanisms – Objects - Application Tools and Performance – Tuning the Application Interface – Bulk Loading Data – Accessing Multiple Databases.

SUGGESTED ACTIVITIES

- Flipped Class Room
- Exercises on Triggers

SUGGESTED EVALUATION METHODS

- **Tutorial Problems**
- **Assignment Problems**
- **Quizzes**

MODULE 7		L	T	P	EL
		2	0	0	3

Query Plan Explainers – Performance Monitors – Event Monitors – Finding Suspicious Queries

SUGGESTED ACTIVITIES

- Flipped Class Room
- Mooc Classes

SUGGESTED EVALUATION METHODS

- **Tutorial Problems**
- **Assignment Problems**
- **Quizzes**

MODULE 8		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**

Analyzing a Query's Access Plan – Profiling a Query Execution – DBMS Subsystems – Data Warehousing Tuning.

SUGGESTED ACTIVITIES

- Flipped Class Room
- Mooc Classes

SUGGESTED EVALUATION METHODS

- **Tutorial Problems**
- **Assignment Problems**
- **Quizzes**

MODULE 9		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**

Tuning E-Commerce Applications – E-Commerce Architecture – Tuning E-Commerce Architecture -Transaction Chopping

SUGGESTED ACTIVITIES

- Flipped Class Room
- Mooc Classes
- Casestudy

SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment Problems
- Quizzes

MODULE 10		**L**	**T**	**P**	**EL**
		2	**0**	**0**	**3**

Time Series Databases – Understanding Access Plans – Configuration Parameters –Distributed DB Implementation.

SUGGESTED ACTIVITIES

- Flipped Class Room
- Case study

SUGGESTED EVALUATION METHODS

- Tutorial Problems
- Assignment Problems
- Quizzes

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TEXT BOOKS

1. Dennis Shasha and Philippe Bonnet, “Database Tuning, Principles, Experiments, and Troubleshooting Techniques”, Morgan Kaufmann, An Imprint of Elsevier, 2003.
2. Thomas Connoly and Carlolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education, 2003.

REFERENCES:

1. Database Systems, C.J. Date Addison Wesley 2004
2. Oracle9i Performance Tuning BPB 2002
3. M.TamerOzsu, Patrick Valduriez and S.Sridhar, “Principles of Distributed Database Systems”,
   Pearson Education, 2007.
4. Hector Garcia – Molina, Jeffrey D. Ullman, Jennifer Widom, “Database Systems: The Complete Book”, Prentice Hall, 2008

OUTCOMES:

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

- Point out the significance of database tuning
- Identify suitable backup and recovery techniques
- Optimize queries for tuning databases
- Tune E-Commerce applications
- Point out the significance of time series databases

Evaluation Pattern

Continuous Assessment	Mid – Semester Assessment	End Semester
40	20	40

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	1	3	1	-
CO2	3	3	3	2	3	2	-	-	-	-	-	2	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	2	3	-	-	-	3	-	-	3	3	3	3
CO5	3	3	3	2	3	1	-	-	-	-	-	3	3	3	3

CS6032 SOFTWARE DEFINED NETWORKS

Prerequisites for the course: Computer Networks

OBJECTIVES:

- To learn the basic concepts related to software defined networks.
- To demonstrate knowledge of software defined networking and its principles and applications
- To describe the concepts behind Networks Function Virtualization
- To understand SDN deployment models
- To gain knowledge about the languages and tools used for SDN.

CS6032 SOFTWARE DEFINED NETWORKS	L	T	P	EL	CREDITS
	2	0	0	3	3

MODULE I :	L	T	P	EL
	2	0	0	3

History and Evolution of Software Defined Networking (SDN):Traditional Switch Architecture - Separation of Control Plane and Data Plane.

SUGGESTED ACTIVITIES :

- Presentation and Discussion on SDN standards

SUGGESTED EVALUATION METHODS:

- Quizzes

MODULE II :	L	T	P	EL
	3	0	0	33

OpenFlow protocol Specification -Drawbacks of Open SDN,SDN Via APIs-SDN via Hypervisor-based overlays.

SUGGESTED ACTIVITIES :

- Learning Openflow for practical implementation of SDN
- Peer learning for In depth analysis of Openflow protocol components and its architecture

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE III :	L	T	P	EL
	3	0	0	3

Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework (VMWare and others), Mini Net based examples.

SUGGESTED ACTIVITIES :

- Installation of MiniNet
- Mini project or practice problems using MiniNet

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SUGGESTED EVALUATION METHODS:

- Mini Project Demonstration

MODULE IV :	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**

Control Plane: Overview, Existing SDN Controllers including Floodlight and OpenDaylight projects.

SUGGESTED ACTIVITIES :

- Comparison of SDN Controllers.
- Group discussion on Floodlight and Opendaylight controller project

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE V :	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts.

SUGGESTED ACTIVITIES :

- Analysis of firewall implementations
- Case study on SDN switch

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VI:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**

Data Plane: Software-based and Hardware-based; Programmable Network Hardware.

SUGGESTED ACTIVITIES :

- Activity based Learning on software-based data planes

SUGGESTED EVALUATION METHODS:

- Assignment problems

MODULE VII:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**

Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs.

SUGGESTED ACTIVITIES :

- Case study of various tools used for SDN deployment
- Programming a SDN for a given task

SUGGESTED EVALUATION METHODS:

- Assignment problem
- Quizzes

MODULE VIII:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**

Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

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SUGGESTED ACTIVITIES : • Peer Learning-Discussion on Network Functions Virtualization • Implementation of NVF				
SUGGESTED EVALUATION METHODS: • Assignment problems				
MODULE IX:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network				
SUGGESTED ACTIVITIES : • Peer Learning - Discussion on the need for data centers • Integration of Topologies and SDN				
SUGGESTED EVALUATION METHODS: • Assignment problems				
MODULE X:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
VLANs – EVPN – VxLAN – NVGRE -Juniper SDN Framework – IETF SDN Framework				
SUGGESTED ACTIVITIES : • Activity based learning-Quizzes on SDN Frameworks.				
SUGGESTED EVALUATION METHODS: • Assignment problems				

TEXT BOOKS:

1. Thomas D. Nadeau, Ken Gray,"SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", First Edition, O'Reilly Media, 2013.
2. Paul Goransson and Chuck Black,"Software Defined Networks: A Comprehensive Approach", Second Edition, Morgan Kaufmann, 2016.

REFERENCES:

1. VivekTiwari,"SDN and OpenFlow for Beginners",Amazon Digital Services, Inc., ASIN: , 2013.
2. FeiHu,"Network Innovation through OpenFlow and SDN: Principles and Design", First Edition, CRC Press, ISBN-10: 1466572094, 2014.

OUTCOMES:

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

- Understand decoupling of data and control planes in SDN
- Configure an SDN-friendly network emulator
- Program a sample SDN for a given task
- Understand and appreciate network virtualization

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- Apply concepts of software defined network principles for the design of new generation of networks.

Evaluation Pattern:

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1								3	3	2
CO2	3	2	2	3	3				2				1	1	2
CO3	3	3	3	3	3				3				3	3	3
CO4	3	3	2	2	3							3	2	1	2
CO5	3	3	3	3	3				3			3	3	3	3

CS6033 STORAGE AREA NETWORKS

Prerequisites for the course: None

STORAGE AREA NETWORKS	L	T	P	EL	CREDITS
	2	0	0	3	3

Prerequisites for the course: Computer Networks, Computer Architecture and DBMS.

OBJECTIVES:

- To gain proficiency in Storage Area Networks architecture, characteristics and components.
- To make the student acquire sound knowledge of SAN techniques in solving real-time client / server model.
- To familiarize the student with functions and management of SAN.
- To acquaint the need to overcome challenges of SAN using modern technologies.
- To learn Fibre channel protocols and communication of various components in SAN.

MODULEI	L	T	P	EL
Introduction to Storage and Networking concepts	2	0	0	3

Networking in front of the server- SCSI Bus Architecture - Network-Attached Storage- Networking behind the server.

SUGGESTED ACTIVITIES :

- Survey on various storage technologies.

SUGGESTED EVALUATION METHODS:
Class Presentation

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MODULEII	L	T	P	EL
Fiber Channel Internal	**3**	**0**	**0**	**3**

Layers- Data Encoding- Framing Protocol- Class of Service-Flow Control- Naming and Addressing Conventions.

SUGGESTED ACTIVITIES :

- Implement Framing protocols and flow control mechanisms.

SUGGESTED EVALUATION METHODS:

- Discussion.

MODULEIII	L	T	P	EL
Fibre Channel SAN Topologies	**2**	**0**	**0**	**3**

Point-to-Point-Arbitrated Loop: Loop Addressing - Port Login- Loop Port State Machine- Design Considerations for Arbitrated Loop.

SUGGESTED ACTIVITIES :

- Discussion of different SAN topologies.

SUGGESTED EVALUATION METHODS:

- Group discussion.

MODULEIV	L	T	P	EL
Fabrics overview	**2**	**0**	**0**	**3**

Simple Name Server- State Change Notification- Private Loop Support- Fabric Zoning- Building Extended Fabrics.

SUGGESTED ACTIVITIES :

- Byte encoding Schemes in Fabrics.

SUGGESTED EVALUATION METHODS:

- Assignment
- Quiz

MODULEV	L	T	P	EL
Fibre Channel Products I	**2**	**0**	**0**	**3**

Gigabit Interface Converters (GBICs) - Host Bus Adapters - Fibre channel RAID- Fibre channel JBODs - Arbitrated Loop Hubs: Hub Architecture-Unmanaged Hubs- Managed Hubs- Switching Hubs.

SUGGESTED ACTIVITIES :

- Characterization of fibre channels and its specification

SUGGESTED EVALUATION METHODS:

- Presentation

MODULEVI	L	T	P	EL
Fibre Channel Products II	**2**	**0**	**0**	**3**

Fibre Channel-to-SCSI Bridges- SAN software Products - Problem isolation in SANs: Isolation Techniques - Fibre channel Analyzers.				
SUGGESTED ACTIVITIES : Analyze SCSI bridges and SAN isolation techniques.				
SUGGESTED EVALUATION METHODS: Assignment.				
MODULEVII	**L**	**T**	**P**	**EL**
Management of SAN I	**2**	**0**	**0**	**3**
Storage Network Management: In-Band management- Out-of-Band Management- SNMP- HTTP- TELNET-				
SUGGESTED ACTIVITIES : • Going the Distance with Storage Data				
SUGGESTED EVALUATION METHODS: • Discussion.				
MODULEVIII	**L**	**T**	**P**	**EL**
Management of SAN II	**2**	**0**	**0**	**3**
Storage Resource Management- -Integration of Storage, Systems and Enterprise Management.				
SUGGESTED ACTIVITIES : • Comparison of Network and Resource management.				
SUGGESTED EVALUATION METHODS: • Assignment.				
MODULE IX	**L**	**T**	**P**	**EL**
Application Studies	**2**	**0**	**0**	**3**
Application Studies-Video Editing–-Backup-Server Clustering- Campus Storage Networks-Disaster Recovery.				
SUGGESTED ACTIVITIES: • Disaster Recovery in an Uncertain World.				
SUGGESTED EVALUATION METHODS: • Discussion. • Quizzes.				
MODULE X	**L**	**T**	**P**	**EL**
Future of SAN	**2**	**0**	**0**	**3**
Integration of SAN into Mainstream Networking- Shared Storage- Virtualization – Contributing Technologies.				
SUGGESTED ACTIVITIES : • Contributing Technologies for SAN.				

SUGGESTED EVALUATION METHODS:

- Presentation and demo.

TEXT BOOKS:

1. Tom Clark, “Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs", Second Edition, Addison-Wesley Professional, 2003.
2. Meeta Gupta, "Storage Area Network Fundamentals", First Edition, Pearson Education Limited, 2002.
3. Alex Goldman, “Storage Area Networks Fundamentals”, Cisco Press 2002.

REFERENCES :

1. G. Somasundaram, AlokShrivastava, "Information Storage and Management: Storing, Managing & Protecting Digital Information in Classic, Virtualized and Cloud Environments", Second edition, EMC Education Services, WileyIndia, 2012.
2. Rebert Spalding: Storage Networks, The Complete Reference, First Edition, Tata McGraw Hill, 2003.
3. Richard Barker and Paul Massiglia, "Storage Area Networks Essentials A Complete Guide to Understanding and Implementing SANs", First Edition, Wiley India, 2002.

OUTCOMES

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

- Understand standards compliance versus interoperability.
- Provide mechanisms for backup/recovery.
- Identify different storage resource management methods.
- Discuss different applications of SAN.
- Illustrate the storage infrastructure and management activities

Evaluation pattern

Continuous Assessment	Mid – Semester Assessment	End Semester
40	20	40

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1		2	2	2			2	3	3	2	3
CO2	3	2	3	2	3	2	1	2			2	3	3	2	3
CO3	3	2	3	2	3	1	1	1			2	3	3	2	3
CO4	3	2	2	2	3	2	1				2	3	2	2	3
CO5	3	2	3	2	3	1		1			1	3	2	2	3

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CS6034 SERVICE ORIENTED ARCHITECTURE

Prerequisites for the course: None

OBJECTIVES:

- To learn the fundamentals of XML to realize a web service
- To learn the basics of web services and its associated features
- To understand the basic principles of service orientation and various WS-* specification standards
- To apply the SOA principles for creating web services
- To analyze the steps involved in designing services using SOA building blocks
- To develop enterprise solutions using advanced concepts such as service composition, orchestration and Choreography

CS6034 SERVICE ORIENTED ARCHITECTURE	L	T	P	EL	CREDITS
	2	0	0	3	3

MODULE I :	L	T	P	EL
	2	0	0	2

Hierarchical Data: XML and JSON, Constraining Hierarchical Data: XML DTDs, XML Schema and JSON Schema Processing Hierarchical Data: XSLT, DOM, JAXP and JSON-P

SUGGESTED ACTIVITIES :

- In class activity for authoring XML/JSON document, parsing XML/JSON and using with style sheet

SUGGESTED EVALUATION METHODS:

- Practical Markup languages like MathML, ChemML
- Familiarization with XML authoring and validation tools
- Quizzes

MODULE II :	L	T	P	EL
	3	0	0	3

Roots of SOA–Characteristics of SOA-Comparing SOA to client-server anddistributed internet architectures–Anatomy of SOA-How components in an SOAinterrelate-Principles of service orientation.

SUGGESTED ACTIVITIES :

- Practical - Understanding RMI, CORBA and DCOM
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures

SUGGESTED EVALUATION METHODS:

- Case Study: Inter-Enterprise applications like Insurance Claim processing
- Quizzes

MODULE III :	L	T	P	EL
	3	0	0	3

SOA and service orientation - principles of SOA - service layers - configuration scenarios

SUGGESTED ACTIVITIES :

- In Class - Comparing service with object orientation principles
- Service layer identification for specific domain

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems

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- Quizzes

MODULE IV :	L	T	P	EL
	3	0	0	3

Building SOA - Delivery strategies - life cycle phases - service oriented analysis - service modeling

SUGGESTED ACTIVITIES :

- In class - Relate business insights and behavioral, legal, and societal expertise in modern information systems and services.
- Practical - Domain specific SOA application analysis

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE V:	L	T	P	EL
	3	0	0	3

Building SOA - service oriented design - composition guidelines - service design - business process design

SUGGESTED ACTIVITIES :

- In Class - Domain specific SOA design
- Practical -Integration of information systems and development of service-oriented architecture

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VI:	L	T	P	EL
	3	0	0	3

Web Services Basis - Web Services versus SOA - Web services framework, Services (Web services: Definition, Architecture and standards)– Messaging – Service Description – Service Discovery –Service Transport – Security

SUGGESTED ACTIVITIES :

- In class -

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VII:	L	T	P	EL
	3	0	0	3

SOAP Based Web Services -SOAP Protocol - WSDL – UDDI –Web Service Clients and Service Invocation

SUGGESTED ACTIVITIES :

- In class activity for identifying web services in specific domains
- Understanding the structure of SOAP, WSDL and UDDI
- Practical knowledge about web services using Apache Tomcat, Axis2 and Derby as well as the Eclipse Development Environment

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE VIII:	L	T	P	EL
	3	0	0	3

WS-* Standards - WS-Addressing – WS-ReliableMessaging – WS-Policy – WS-Coordination – WS -Transactions – WS Evolution, Management, Monitoring, and Testing- WS-Security – Examples

SUGGESTED ACTIVITIES :

- Mostly in Class
- Flipped classroom - Analyze different service-oriented computing approaches and open standards.

SUGGESTED EVALUATION METHODS:

- Assignment problems
- Project demonstration and presentation

MODULE XI:	L	T	P	EL
	3	0	0	3

REST Based Web Services- Principles - Comparison with SOAP - XML Based Web Services– Design and Implementation of REST Services - Resource Oriented Architecture – best practices

SUGGESTED ACTIVITIES :

- In class - Compare SOAP with REST WS
- Practical - Create RESTFul web services Service which accepts integer ID of the student Service and it should return XML document which represents student and Perform CRUD operations
- EL - Direct to Home Services.

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

MODULE X:	L	T	P	EL
	4	0	0	3

WS Development- Properties of a service development methodology. Qualities of service development methodology. Web services development lifecycle. - Basic Business process management Concepts- Business process reengineering and management

SUGGESTED ACTIVITIES:

- In class - Identify and master appropriate software technologies, architectures and systems related to service-oriented computing.
- Case Study - SOA and Web services in J2EE and .Net Platform

SUGGESTED EVALUATION METHODS:

- Tutorial problems
- Assignment problems
- Quizzes

TEXTBOOKS:

1. Richardson L and Ruby S, “Restful Web Services”, First Edition, O'Reilly, USA, 2007.
2. Robert Daigneau, "Service design patterns: fundamental design solutions for SOAP/WSDL and RESTful Web services", First Edition, Addison-Wesley, cop. 2012. ISBN: 9780321544209

REFERENCES :

1. Raj Balasubramanian, Benjamin Carlyle, Thomas Erl and Cesare Pautasso, "SOA with REST: Principles, Patterns & Constraints for Building Enterprise Solutions with REST (The Prentice Hall Service Technology Series from Thomas Erl)", First Edition, Prentice Hall, 2012, ISBN: 9780137012510.
2. M. Papazoglou, "Web services: principles and technology", First Edition, Pearson, cop. 2008, ISBN: 978-0-321-15555-9.
3. Shankar Kambhampaty, “Service-oriented Architecture & Microservice Architecture: For Enterprise, Cloud, Big Data and Mobile”, Third Edition, Wiley, 2018.

OUTCOMES:

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

- Create basic web services
- Analyze and design SOA based solutions
- Analyze and implement a web service based application
- Discuss the technology underlying service design
- Classify and make reasoned decision about the adoption of different SOA platforms

Continuous assessment	Mid term	End Semester
40	20	40

CO - PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2	3	2		1			2	2	3	3	3
CO2	3	2	3	2	2	1		1	1		2	2	2	3	3
CO3	2	3	3	2	2	1		1	2		2	2	2	3	3
CO4	2	2	3	2	1	1		1	2		2	2	2	2	2
CO5	2	2	2	2	1	1		1	1		2	2	1	2	2

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CS6035 ENTREPRENEURSHIP DEVELOPMENT

Prerequisites for the course: None

OBJECTIVES:

- To learn to create a startup business plan
- To gain an introduction to the key elements of creating an entrepreneurial venture, such as figuring out the market potential and viability, crafting the right business model, determining go-to market strategy, creating a financial model to estimate funding needs, etc.
- To learn the regulatory basics of starting a company in India
- To learn about funding sources and government programs available to support budding entrepreneurs
- To learn the various paths to entrepreneurship by studying real-life entrepreneurial success stories in the Indian context

CS6035 ENTREPRENEURSHIP DEVELOPMENT	L	T	P	EL	CREDITS
	2	0	0	3	3

MODULE I :	L	T	P	EL
	2	0	0	3

Introduction to Entrepreneurship- need -Types of entrepreneurship.

SUGGESTED ACTIVITIES :

- Video (Steve Jobs Commencement Address)
- Class discussion on the mind of an entrepreneur and what it takes to be one
- Students asked to form teams and choose startup ideas to develop into a business plan over the course

SUGGESTED EVALUATION METHODS:

- Seminar /assignments

MODULE II :	L	T	P	EL
	2	0	0	3

The Business Plan: need - The elements of a Business Plan- Sample Business Plan.

SUGGESTED ACTIVITIES :

- Video ("Art of the Start" by Guy Kawasaki)
- "Story of an Entrepreneur" Presentation by student/student-team.
- Discuss a sample business plan

SUGGESTED EVALUATION METHODS:

Seminar /assignments

MODULE III :	L	T	P	EL
	2	0	0	3

Defining the product/Service. Determine viability and unique competitive advantage. Defining Target Market. Estimating Market Size. Building The Startup Team

SUGGESTED ACTIVITIES :

- "Story of an Entrepreneur" Presentation by student/student-team.

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SUGGESTED EVALUATION METHODS: Seminar /assignments				
MODULE IV :	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
Business Model. Types of Biz Model. Who is the customer. Why will they purchase.				
SUGGESTED ACTIVITIES : • "Story of an Entrepreneur" Presentation by student/student-team				
SUGGESTED EVALUATION METHODS: Seminar /assignments				
MODULE V :	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
Market and Competitive Analysis, Sources of Market Data, Common Techniques for Competitive Analysis. Go-to Market Strategy. Sales & Marketing.				
SUGGESTED ACTIVITIES : • "Story of an Entrepreneur" Presentation by student/student-team				
SUGGESTED EVALUATION METHODS: Seminar /assignments				
MODULE VI:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
Project plan. Determining Resource needs (People, Equipment, Vendors, etc.). Financial Modeling to determine investment needs.				
SUGGESTED ACTIVITIES : • "Story of an Entrepreneur" Presentation by student/student-team • Project Plan and Financial model for a sample startup is created in class to demonstrate				
SUGGESTED EVALUATION METHODS: . Seminar /assignments				
MODULE VII:	**L**	**T**	**P**	**EL**
	2	**0**	**0**	**3**
Executive Summary & the 30-second pitch. Fundraising, The fundraising process, Sources of Capital, Incubators. Government programs for Startups				
SUGGESTED ACTIVITIES : • "Story of an Entrepreneur" Presentation by student/student-team				
SUGGESTED EVALUATION METHODS: • Seminar /assignments.				
MODULE VIII:	**L**	**T**	**P**	**EL**

	2	**0**	**0**	**3**
Business Structures in India. Legal and Regulatory Aspects. Taxes. Intellectual Property Protection. Trademarks, Copyrights, Patents				
SUGGESTED ACTIVITIES : • "Story of an Entrepreneur" Presentation by student/student-team				
SUGGESTED EVALUATION METHODS: Seminar /assignments				
MODULE X:	**L**	**T**	**P**	**EL**
	3	**0**	**0**	**3**
o Business Plan case study 2				
SUGGESTED ACTIVITIES : • Business Plan presentations				
SUGGESTED EVALUATION METHODS: • Review of presentation				

TEXT BOOKS:

1. Elliot J Smith, "How to write a Business Plan", CreateSpace Independent Publishing Platform, 2017.
2. Guy Kawasaki, "Art of The Start 2.0", Portfolio, 2015.
3. Vijaya Kumar Ivaturi, Meena Ganesh, "The Manual for Indian Start-ups: Tools to Start and Scale-up Your New Venture", Penguin Random House India, 2017.
4. Nanda Kumar, "Startup Fundamentals", Kindle edition, 2017.

REFERENCES:

1. Jessica Livingstone, "Founders at Work: Stories of Startups' Early Days", Apress, 2009. (To be used for "Story of an entrepreneur" presentations.)
2. Ganesh V, "The Underage CEOs: Fascinating Stories of Young Indians Who Became CEOs in their Twenties", Collins Business India, 2015. (To be used for "Story of an entrepreneur" presentations.)
3. RashmiBansal , "Arise, Awake: The Inspiring Stories of Young Entrepreneurs Who Graduated From College Into A Business of Their Own", Westland Books Private Limited, 2015. (To be used for "Story of an entrepreneur" presentations.)
4. RashmiBansal, "Take me Home – Inspiring Stories of 20 Entrepreneurs from Small-Town India with Big-Time Dreams", Westland Books Private Limited, 2014. (To be used for "Story of an entrepreneur" presentations.)

OUTCOMES:

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

- Outline the basics of creating a startup in India.
- Discuss the legal and regulatory aspects of starting a business.
- Gain an understanding of the elements of a business.
- Comprehend in more holistic terms,to become industry ready

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- Create real business plans that can potentially compete in national level startup competitions and lead to funding.

EVALUATION PATTERN

Continuous assessment	Mid term	End Semester
40	20	40

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-					2	3		3	3	3	3		3	3
CO2	-	-		2		3		3	3	1	3	3		3	3
CO3	-	2		2		1	3	3	3	1	3	3	1	3	3
CO4	1	2	2	2	2	1	2	3	3	3	3	3	2	3	3
CO5	1	2	3	2	3	3	3	3	3	3	3	3	2	3	3