Department of Computer Science Engineering

M.Tech. Integrated Computer Science and Engineering
Curriculum and Syllabus

(Applicable to the students admitted from AY: 2024 onwards)

School of Engineering and Sciences

SRM University *AP*, Andhra Pradesh

Department Vision

To create technology innovators and leaders who can shape the future of society through technical, research, and entrepreneurial skills with a strong emphasis on interdisciplinary learning and collaborations.

Department Mission

1. Use effective teaching and learning pedagogies to enhance technical competency with a focus on computer science and engineering fundamentals.
2. Encourage interdisciplinary education and research by promoting the exchange of ideas among a varied community of researchers, educators, and learners.
3. Develop a substantial body of knowledge for industrial applications.
4. Create an outstanding interdisciplinary research atmosphere.
5. Instil students with effective managerial skills, fostering their development into competitive and visionary entrepreneurs.

Program Educational Objectives (PEO)

1. Inculcate strong foundations in basic Computer Science and Engineering concepts by implementing innovative teaching-learning methods with a strong emphasis on practice-oriented learning and thus to improve applicability in students.
2. Make the students highly employable to meet the needs of various national and global industries by imparting the ability to adapt themselves to the rapidly changing requirements of the Computer Science and Engineering field.
3. Promote a strongly interdisciplinary approach that integrates the study of multiple academic disciplines which can develop skills required to build careers in various emerging fields of Science and Technology.
4. Educate the students to emerge as intellectually capable leaders and entrepreneurs respecting human values and to become more responsive to environmental and social issues.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3	PEO 4
Mission Statement 1	3	1	1	-
Mission Statement 2	-	2	3	-
Mission Statement 3	-	3	2	-
Mission Statement 4	-	2	3	-
Mission Statement 5	1	1	1	3

Program Specific Outcomes (PSO)

1. Demonstrate proficiency in analysis, design, and development of competent solutions by applying algorithmic techniques, software modelling, mathematical foundations and theory of computation.
2. Design and develop solutions for computer hardware, system software and application software.
3. Conduct world-class research activities in the emerging areas such as Data Science, Artificial Intelligence, Machine Learning, Cyber Security, Internet of Things, and Distributed and Cloud computing which helps in developing solutions needed for the society.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

PEOs	Program Learning Outcomes (PLO)														
	POs												PSOs		
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1	3	3	3	3	2	-	-	-	-	-	-	-	3	2	2
PEO 2	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
PEO 3	2	3	3	3	2	-	-	-	-	-	-	-	-	-	-
PEO 4	-	-	-	-	-	-	2	3	2	3	3	3	-	1	1

Category Wise Credit Distribution			
Course Sub-Category	**Subcategory Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		8	240
University AEC	4		
School AEC	4		
Value Added Courses (VAC)		8	240
University VAC	8		
School VAC	-		
Skill Enhancement Courses (SEC)		24	720
School SEC	5		
Department SEC	4		
SEC Elective	15		
Foundation / Interdisciplinary Courses (FIC)		17	510
School FIC	14		
Department FIC	3		
Core + Core Elective Including Specialization (CC)		74	2220
Core	63		
Core Elective (Inc Specialization)	11		
Minor (MC) + Open Elective (OE)	12	12	360
Research / Design / Internship / Project (RDIP)		-	-
Internship / Design Project / Startup / NGO	-		
Internship / Research / Thesis	-		
Total		**143**	**4290**

Semester wise Course Credit Distribution Under Various Categories								
Category	**Semesters**							
	I	**II**	**III**	**IV**	**V**	**VI**	**Total**	**%**
Ability Enhancement Courses - AEC	2	2	2	2	0	0	8	7
Value Added Courses - VAC	2	2	0	0	0	4	8	7
Skill Enhancement Courses - SEC	3	2	2	2	3	3	15	12
Foundation / Interdisciplinary Courses - FIC	8	9	0	0	0	0	17	14
CC / ES / SE / CE / TE / DE / HSS	4	4	13	15	19	19	74	61
Minor / Open Elective - OE	0	0	0	0	0	0	0	0
(Research / Design / Industrial Practice / Project / Thesis / Internship) - RDIP	0	0	0	0	0	0	0	0
Grand Total	**19**	**19**	**17**	**19**	**22**	**26**	**122**	**100**

Note: L-T/D-P/Pr and the class allocation is as follows.

a) Learning Hours : 30 learning hours are equal to 1 credit.

b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.

c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.

e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	U AEC	AEC 101	Art of Listening, Speaking and Reading Skills	1	0	1	2
2	VAC	U VAC	VAC 101	Environmental Science	2	0	0	2
3	SEC	S SEC	SEC 101	Analytical Reasoning and Aptitude Skills	1	1	1	3
4	FIC	S FIC	FIC 101	Emerging Technologies	2	0	0	2
5	FIC	S FIC	FIC 102	Engineering Physics	2	0	1	3
6	FIC	S FIC	FIC 103	Calculus For Engineers	3	0	0	3
7	Core	CC	CSE 101	Fundamentals of Computing and Programming in C	3	0	1	4
				Semester Total	**14**	**1**	**4**	**19**

SEMESTER - II								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	AEC	U AEC	AEC 107	Effective Writing and Presentation Skills	1	0	1	2
2	VAC	U VAC	VAC 102	Universal Human Values and Ethics	2	0	0	2
3	SEC	S SEC	SEC 103	Entrepreneurial Mindset	2	0	0	2
4	FIC	S FIC	FIC 105	Principles of Economics and Management	2	0	1	3
5	FIC	S FIC	FIC 117	Linear Algebra and Differential Equations	3	0	0	3
6	FIC	D FIC	FIC 120	Foundations of Electrical and Electronics Engineering	2	0	1	3
7	Core	CC	CSE 102	Data Structures	3	0	1	4
				Semester Total	**15**	**0**	**4**	**19**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	SAEC	AEC 108	Problem Solving Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
4	SEC	D SEC	CSE 201	Coding Skills - I	2	0	0	2
5	Core	CC	CSE 202	OOPS with C++	3	0	1	4
6	Core	CC	CSE 203	Discrete Mathematics	3	0	0	3
7	Core	CC	CSE 204	Design and Analysis of Algorithms	3	0	1	4
8	Core	CC	CSE 205	Hands on with Python	0	0	2	2
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**15**	**0**	**4**	**20**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 104	Creativity and Critical thinking Skills	1	0	1	2
2	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
4	SEC	D SEC	CSE 206	Coding Skills - II	2	0	0	2
5	Core	CC	CSE 207	Digital Electronics	3	0	1	4
6	Core	CC	CSE 208	Probability and Statistics	3	0	0	3
7	Core	CC	CSE 209	Database Management Systems	3	0	1	4
8	Core	CC	CSE 210	Web Technology	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**18**	**0**	**8**	**22**

SEMESTER - V								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2*
3	SEC	E SEC		Career Skills - I	3	0	0	3
4	Core	CC	CSE 301	Computer Networks	3	0	1	4
5	Core	CC	CSE 302	Operating Systems	3	0	1	4
6	Core	CC	CSE 303	Machine Learning	3	0	1	4
7	Core	CC	CSE 304	Automata and Compilers Design	3	0	0	3
8	Core	CC	CSE 305	Computer Organization and Architecture	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**21**	**0**	**8**	**25**

SEMESTER - VI								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2
2	VAC	U VAC	VAC 104	Community Service and Social Responsibility	0	0	2	2
3	SEC	E SEC		Career Skills - II	3	0	0	3
4	Core	CC	CSE 306	Software Engineering and Project Management	3	0	1	4
5	Core	CC	CSE 307	Mobile Application Development with Java	3	0	1	4
6	Elective	CE		Core Elective - I	3	0	0	3
7	Elective	CE		Stream Elective - I	3	0	1	4
8	Elective	CE		Stream Elective - II	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**21**	**0**	**8**	**30**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1								
2								
3								
4								
5								
				Semester Total				

SEMESTER - VIII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1								
				Semester Total				

Specialization: Artificial Intelligence and Machine Learning								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1								
2								
3								
4								

Specialization: Data Science								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1								
2								
3								
4								

Technical Electives								
S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	Elective	TE	CSE 421	Human Computer Interaction	3	0	0	3
2	Elective	TE	CSE 422	Advanced Computer Architecture	3	0	0	3
3	Elective	TE	CSE 423	Natural Language Processing	3	0	0	3
4	Elective	TE	CSE 424	Computer Graphics	3	0	0	3
5	Elective	TE	CSE 425	Advanced Data Structures and Algorithms	3	0	0	3
6	Elective	TE	CSE 426	Distributed Operating Systems	3	0	0	3
7	Elective	TE	CSE 427	Data and Web Mining	3	0	0	3
8	Elective	TE	CSE 428	Complexity Theory	3	0	0	3
9	Elective	TE	CSE 429	Software Project Management	3	0	0	3
10	Elective	TE	CSE 430	Multimedia	3	0	0	3
11	Elective	TE	CSE 457	Deep Learning	3	0	0	3
12	Elective	TE	CSE 432	Advanced Database Management Systems	3	0	0	3
13	Elective	TE	CSE 433	Fog Computing	3	0	0	3
14	Elective	TE	CSE 434	Parallel Algorithms	3	0	0	3
15	Elective	TE	CSE 435	Web Services	3	0	0	3
16	Elective	TE	CSE 436	Advances in Data Mining	3	0	0	3
17	Elective	TE	CSE 437	Social Network Analysis	3	0	0	3
18	Elective	TE	CSE 438	Recommender Systems	3	0	0	3
19	Elective	TE	CSE 439	Computational and Complexity Theory	3	0	0	3
20	Elective	TE	CSE 459	Cryptography and Network Security	3	0	0	3

21	Elective	TE	CSE 455	Artificial Intelligence	3	0	0	3
22	Elective	TE	CSE 442	Machine Learning on Edge Computing	3	0	0	3
23	Elective	TE	CSE 443	Mobile and wireless security	3	0	0	3
24	Elective	TE	CSE 444	Internet protocols and networking	3	0	0	3
25	Elective	TE	CSE 445	Mobile application security testing	3	0	0	3
26	Elective	TE	CSE 446	IoT security	3	0	0	3
27	Elective	TE	CSE 447	Biometric Security	3	0	0	3
28	Elective	TE	CSE 448	Cyber Law	3	0	0	3
29	Elective	TE	CSE 449	Ethical Hacking	3	0	0	3
30	Elective	TE	CSE 450	Security audit and Risk Assessment	3	0	0	3
31	Elective	TE	CSE 451	Digital Forensics and Incident Response	3	0	0	3
32	Elective	TE	CSE 452	Security Analytics	3	0	0	3
33	Elective	TE	CSE 453	Multiview Geometry	3	0	0	3
34	Elective	TE	CSE 454	Quantum Computation	3	0	0	3

List of Carrer Skill Courses

S. No	Category	Sub-Category	Course Code	Course Title	L	T/D	P/Pr	C
1	SEC	E SEC	SEC 123	Advanced Data Structures and Algorithms	3	0	0	3
2	SEC	E SEC	SEC 124	Cloud Computing	3	0	0	3
3	SEC	E SEC	SEC 125	Full Stack Development Using Mern Stack	3	0	0	3

Art of Listening, Speaking and Reading Skills

Course Code	AEC 101	**Course Category**	AEC		**L**	**T**	**P**	**C**
					1	0	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Literature and Languages	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To develop the students' ability to comprehend spoken language in various contexts and help them build confidence and fluency in speaking through structured activities, discussions, and presentations as well as enhance their reading skills by engaging with a variety of texts, including literary works, informational articles, and academic writings.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Demonstrate effective listening strategies by accurately summarizing and responding to spoken content in various contexts	2	70%	65%
Outcome 2	Students will be able to critically analyze spoken and written texts to identify underlying themes, arguments, and perspectives.	3, 4	75%	70%
Outcome 3	Students will construct and deliver coherent and engaging oral presentations and written responses that integrate information from multiple sources.	5, 6	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1		2	2	3					3					
Outcome 2		3	3	3			1	3	3	3	2			
Outcome 3			2	3	2			3	3	3	2			
Average		**2**	**2**	**3**	**1**			**2**	**3**	**2**	**1**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Augmenting Listening skills**	**9**		
	Course introduction and objectives: Importance of LSRW	1	1	1 a
	Listening - Barriers to active listening and steps to Overcome	2	1	1 b
	Listening Comprehension How to take/ make notes (different ways)	2	1	1b, 2a, 2c
	Listening practice: Identifying main ideas, supporting details, and inferences and summarizing key points	2	1	1b, 2a, 2c
	Practice sessions: memory games, Chinese whisper	2	1	NA
Unit 2	**Developing Speaking Skills**	**9**		
	Strategies for good speech, Basics of grammatically correct speech	1	2	1a, 2 a, b, c
	Basics of phonetics and intonation	2	2	1a
	Oral presentations: do's and don'ts	1	2	1a
	Speaking Practice: Just a minute/ Impromptu, Story-telling/ Story starters Group discussions,	5	2	NA
Unit 3	**Communication and Persuasion**	**9**		
	Verbal Communication and Nonverbal Communication	2	2, 3	1a
	The art of persuasive communication (Ethos, pathos, Logos)	2	2, 3	1a
	Practice sessions (Convince the other Role plays, Self-introduction, Pitching, extempore, public speaking)	5	2, 3	NA
Unit 4	**Reading**	**9**		
	Reading strategies (Skimming and scanning, extensive and intensive)	2	2	1c
	Reading and analyzing various texts, including articles, essays, and academic papers	3	2	1c
	Reading Comprehension Practice	4	2	1c, 2a
Unit 5	**Integrated Skills and Real-World Application**	**9**		
	Engaging in discussions and debates on current issues	2	3	NA
	Real-world application of language skills (e.g., job interviews, social interactions)	2	3	NA
	Pitching Presentation	5	3	NA

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)			End Semester Exam (40%)
		CLA-1 20%	Mid-1 20%	CLA-2 20%	
Level 1	Remember	20%		40%	30%
	Understand				
Level 2	Apply	60%	40%	40%	30%
	Analyse				
Level 3	Evaluate	20%	60%	20%	40%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Shoba, L. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Leonardo, N. (2020) Active Listening Techniques: 30 Practical Tools to Hone Your Communication Skills. Rockridge Press
3. Williams, A.J. (2014) Reading Comprehension: How To Drastically Improve Your Reading Comprehension and Speed Reading Fast! (Reading Skills, Speed Reading)

Other Resources

1. https://learnenglishteens.britishcouncil.org/
2. https://www.bbc.co.uk/learningenglish/
3. https://www.ted.com/?geo=hi

Environmental Science

Course Code	VAC 101	**Course Category**	VAC		**L**	**T**	**P**	**C**
					2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Environmental Science and Engineering	**Professional / Licensing Standards**						

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. To describe the environmental concepts from ecology and earth science to address real-world problems.
2. To interpret the complex interactions within and between environmental systems and to evaluate evolving environmental problems.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Comprehend the environmental challenges that need attention.	1	80%	70%
Outcome 2	Summarize the types of environmental pollutions and possible effects to society	2	80%	70%
Outcome 3	Classify the natural environmental resources, present state, rate of depletion and future perspectives	2	80%	70%
Outcome 4	Articulate a project-based learning on existing local to global environmental issues	2	80%	70%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	-	-	-	-	1	1	2	-	2	1	-	1	-	-	-
Outcome 2	-	1	-	1	1	1	2	-	2	1	-	1	-	-	-
Outcome 3	-	1	-	1	1	1	3	-	2	1	-	1	-	-	-
Outcome 4	1	1	1	2	1	2	3	2	2	2	2	2	-	-	-
Average	1	1	1	1.33	1	1.25	2.5	2	2	1.25	2	1.25	-	-	-

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Human, Environmental Issues, and Climate Change**	**6**	1	1,2,3
	The man-environment interaction	1	1	1,2,3
	Environmental issues and scales	1	1	1,2,3
	Land use and Land cover change	2	1	1,2,3
	Ozone layer depletion	1	1	1,2,3
	Understanding climate change and adaptation	1	1	1,2,3
Unit 2	**Environmental Pollution and Health**	**7**	2	1,2,3
	Understanding pollution; Definitions, sources, impacts on human health and ecosystem	2	2	1,2,3
	Air pollution	1	2	1,2,3
	Water pollution	1.5	2	1,2,3
	Soil pollution	1	2	1,2,3
	Solid waste	1.5	2	1,2,3
Unit 3	**Ecosystems, Biodiversity Conservation, and Sustainable Development**	**9**	3	1,2,3
	Ecosystems and ecosystem services	1	3	1,2,3
	Biodiversity and its distribution	1	3	1,2,3
	Threats to biodiversity and ecosystems	1	3	1,2,3
	Overview of natural resources	1	3	1,2,3
	Biotic resources	1	3	1,2,3
	Water resources; Soil and Energy resources	2	3	1,2,3
	Introduction to Sustainable Development Goals (SDGs)-targets and indicators	2	3	1,2,3
Unit 4	**Environmental Management, Treaties and Legislation**	**8**	4	1,2,3
	Introduction to environmental laws and regulation	2	4	1,2,3
	Environmental management system	2	4	1,2,3
	Pollution control and management	2	4	1,2,3
	Major International Environmental Agreements; Major Indian Environmental Legislations	2	4	1,2,3
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (70%)				End Semester Exam (30%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (15%)	CLA-3 (15%)	
Level 1	Remember Understand	60%	60%	60%	60%	40%
Level 2	Apply Analyse	40%	40%	40%	40%	60%
Level 3	Evaluate Create	-	-	-	-	-
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rajagopalan, R. (2016) Environmental Studies (3rd edition), Oxford University Press.
2. Sharma, P. D. (2018) Ecology and environment. Rastogi Publications.
3. Anil K. Dey. (2016). Environmental Chemistry. New Age Publisher International Pvt Ltd. ISBN: 9789385923890, 9385923897

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

ANALYTICAL REASONING AND APTITUDE SKILLS - I

					L	T	P	C
Course Code	**SEC 101**	**Course Category**	**SEC**		**1**	**0**	**1**	**2**
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**	**SEC 102**			
Course Offering Department	**Mathematics**	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	80%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	70%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	90%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1					1			2		2		1			
Outcome 2		2			3			3	3						
Outcome 3		3							2			2			
Outcome 4								2	3			2			
Average		**3**			**2**			**4**	**4**			**3**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quantitative Aptitude**	**7**		
	Time, speed and distance	3	1,4	1,4
	Time and work, Pipes and cisterns	4	1,4	1,4
Unit II	Numbers, LCM and HCF.	2	1,4	1,4
	P and C	2	1,4	1,4
	Probability, progressions	4	1,4	1,4
Unit III	Geometry, Mensuration	3	1,2	2,3
	Clocks and calendars	2	1,3	1,4
Unit IV	Linear equation and special equations	3	1,2	1,2
	Quadratic equations	2	1,2	1,2
	Inequalities	2	2,3	2,3
	Sets and Venn diagrams	3	1,2	2,4
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		50%		40%		50%		50%	
	Understand										
Level 2	Apply	60%		50%		60%		50%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

Other Resources

Course Designers

Emerging Technologies

Course Code	FIC 101	Course Category	FIC		L	T	P	C
					2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department		Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Foster a comprehensive grasp of diverse emerging technologies and their transformative impacts on society and industries.
2. Cultivate critical thinking skills to analyze challenges, opportunities, and applications within each technological domain.
3. Develop practical skills through hands-on experiences and assignments, translating theoretical concepts into real-world applications.
4. Raise awareness of ethical considerations, particularly in the context of Artificial Intelligence, encouraging responsible and informed decision-making.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Exhibit a thorough understanding of quantum computing principles, including superposition, entanglement, and interference.	1	80	90
Outcome 2	Illustrate understanding by explaining the history, synthesis, and applications of nanomaterial and green hydrogen.	1	80	90
Outcome 3	Understand and classify 3D printing technologies.	2	75	85
Outcome 4	Demonstrate understanding of the evolution, classification, and applications of UAVs.	2	75	85
Outcome 5	Apply knowledge of Artificial Intelligence and Machine Learning to address classification, regression, clustering, and decision-making problems.	2	75	85

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	2	1	1	3	1	1	2	1	3	1	2	1	1	1
Outcome 2	1	2	1	2	1	1	2	2	2	1	1	2	1	1	1
Outcome 3	2	1	2	1	2	2	1	1	1	2	2	1	1	2	2
Outcome 4	3	3	3	2	1	3	2	3	2	1	3	3	2	2	1
Outcome 5	2	3	2	1	1	2	1	3	1	1	2	3	2	2	1
Average	2	2	2	1	2	2	2	2	2	2	2	3	2	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Quantum Computing and Quantum Communications**	**7**		
1.1	Quantum Computer and early ideas, classical and quantum computing approaches, superposition, entanglement, and interference in quantum computing.	1	1	1
1.2	QUBITS and their types; representation of data in quantum mechanics.	1	1	1
1.3	Shor's Algorithm, Grover's search algorithm.	1	1	1
1.4	Quantum programming languages; Obstacles in building quantum computers.	1	1	1
1.5	Applications of quantum computers; Opportunities in the field of quantum computing.	1	1	1
1.6	Introduction of quantum communication pillers, quantum network, Heisenberg's uncertainty principle and QKD.	1	1	1
1.7	Challenges in QKD, National Quantum Mission, Future perspectives.	1	1	1
Unit 2	**Unit 2: Nanotechnology and Green Hydrogen**	**6**		
2.1	Introduction to the nanometer scale. history of nanomaterials	1	2	2
2.2	Synthesis of nanomaterials: Bottom-up and Top-down approach	1	2	2
2.3	tools & techniques to characterize nanomaterials. Applications of nanomaterials.	1	2	2
2.4	Green Technology: Definition, types of Green Technologies, Green Hydrogen production.	1	2	2
2.5	Challenges involved in the storage of Green Hydrogen produced from PEM based electrolysis.	1	2	2
2.6	Applications of Green Hydrogen.	1	2	2
Unit 3	**3D Printing and Applications**	**5**		
3.1	Introduction to 3D printing and additive manufacturing	1	3	3
3.2	Capabilities of 3D printing	1	3	3
3.3	Applications of 3D printing	1	3	3
3.4	Classification based on ASTM	1	3	3
3.5	Working principles of 3D printing technologies	1	3	3
Unit 4	**UAVs, Drones and Applications**	**6**		
4.1	Introduction to the evolution of drones	1	4	4
4.2	Classification of drones	1	4	4
4.3	Basic components of drones	1	4	4
4.4	Principles of flight	1	4	4
4.5	Applications of drones	1	4	4
4.6	Drones rules in India, Challenges and future scope.	1	4	4
Unit 5	**Introduction to Artificial Intelligence and Machine Learning**	**6**		
5.1	Introduction to Artificial Intelligence, Machine Learning and Deep learning	1	5	5
5.2	Supervised (Classification and regression) learning	1	5	5
5.3	Unsupervised (Clustering) learning	1	5	5
5.4	Reinforcement learning (Decision making)	1	5	5
5.5	Features and Applications of AI and ML	1	5	5
5.6	Threats of AI: Lack of Regulation.	1	5	5
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		CLA-1 (20%)	CLA-2 (20%)	CLA-3 (20%)	CLA-4 (20%)	CLA-5 (20%)
Level 1	Remember	100 %	100 %	100 %	100 %	100 %
	Understand					
Level 2	Apply	0 %	0 %	0 %	0 %	0 %
	Analyse					
Level 3	Evaluate	0 %	0 %	0 %	0 %	0 %
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Nielsen, M. A., & Chuang, I. L. (2001). Quantum computation and quantum information (Vol. 2). Cambridge: Cambridge university press.
2. Fiiipponi, L., & Sutherland, D. (Eds.). (2012). Nanotechnologies: principles, applications, implications and hands-on activities: A compendium for educators. European Union, Directorate General for Research and Innovation.
3. Paul, C. P. and Jinoop, A. N. (2021) Additive manufacturing: Principles, Technologies and applications. McGraw Hill
4. Kilby, T., & Kilby, B. (2015). Getting Started with Drones: Build and Customize Your Own Quadcopter. Maker Media, Inc.
5. Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson.

Other Resources

Course Designers

1. Dr. Sunil Chinnadurai, Assistant Professor, ECE Department.
2. Dr. Pardha Saradhi Maram, Associate Professor, Chemistry Department.
3. Dr. Sangjukta Devi, Assistant Professor, Mechanical Department.
4. Dr. Harish Puppala Assistant Professor, Civil Department.
5. Dr. Ravi Kumar, Assistant Professor, Physics Department.

Engineering Physics

Course Code	**FIC 102**	**Course Category**	FIC		L T P C		2 0 1 3
Pre-Requisite Course(s)	NA	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**	NA		
Course Offering Department	Physics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamental concepts of physics and their application in engineering.
2. To develop problem-solving skills through physics-based problems.
3. To enhance practical knowledge through laboratory experiments and real-world applications.
4. To foster analytical and critical thinking skills.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate understanding of core physics principles in mechanics, waves, modern physics, and electromagnetism	2	**75**	**70**
Outcome 2	Apply physics principles to analyse and solve engineering physics problems	3	**70**	**65**
Outcome 3	Demonstrate problem-solving skills using mathematical tools	3	**70**	**65**
Outcome 4	Evaluate experimental data to interpret and explain the underlying physics concepts	3	**75**	**70**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	1	1	1			1	2			2	1	1	1
Outcome 2	2	3	2	2	2			2	2			2	2	1	1
Outcome 3	2	3	2	2	2			2	2			2	2	1	1
Outcome 4	2	3	2	2	3			2	3			2	2	1	2
Average	**2.0**	**2.8**	**1.8**	**1.8**	**2.0**			**1.8**	**2.3**			**2.0**	**1.8**	**1.0**	**1.3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Introduction	1	1	1, 3
	Newton's laws of mechanics, Free body force diagram	1	1, 2, 3	1, 3
	Momentum and Impulse, Conservation of linear momentum	1	1, 2, 3	1, 3
	Work-Kinetic Energy Theorem and related problems	1	1, 2, 3	1, 3
	Conservation of mechanical energy: Worked out problems	1	1, 2, 3	1, 3
	Elastic properties of solids, Stress-strain relationship, elastic constants, and their significance	1	1	1, 2
Unit No. 2	Concept of Electromagnetic waves & EMW Spectra	1	1	1, 2
	Geometrical & Wave Optics: Laws of reflection and refraction	1	1, 2, 3	1, 2
	Concept of Interference	1	1, 2, 3	1, 2
	Phase Difference and Path Difference	1	1	1, 2
	Double-Slit Interference	1	1	1, 2
	Diffraction: types and single slit	1	1, 2, 3	1, 2
Unit No. 3	Black Body Radiation; Wien's displacement law	1	1	1, 2
	Discussion on failure of classical laws to explain Black Body Radiation, and concept of Planck's Hypothesis	1	1, 2, 3	1, 2
	What is Light? Photon and Overview on Planck Constant	1	1	1, 2
	Photoelectric effect – Concept and Experimental Setup	1	1, 2, 3	1, 2
	Photoelectric effect – Intensity vs Current, Frequency vs Kinetic Energy, the drawback of Wave theory to explain Photoelectric effect	1	1	1, 2
	Wave properties of particle: De Broglie wave	1	1	1, 2
Unit No. 4	**Focus on Maxwell's Equation I**: Discuss lines of force and Electrostatic flux, Introduce Gauss's law (differential and integral form)	1	1	1, 4
	Application of Gauss Law: ES field due to infinite wire and sheet.	1	1	1, 4
	Electrostatic field due to conducting and insulating sphere.	1	1	1, 4
	Concept of Electrostatic Potential and Potential Energy. Inter-relation with electrostatic field.	1	1	1, 4
	Capacitor and Capacitance:	1	1, 2	1, 4
	Capacitance of a parallel plate capacitor.	1	1, 2, 3	1, 4
Unit No. 5	Introduce Biot-Savart Law as an alternative approach to calculate magnetic field.	1	1	1, 4
	Calculate Magnetic field due to finite current element using Biot Savart Law.	1	1	1, 4
	Focus on Maxwell's Equation IV: Discuss Ampere's circuital law.	1	1	1, 4
	Calculate Magnetic field due to Infinite wire and Solenoid using Ampere's Law.	1	1, 2, 3	1, 4
	Focus on Maxwell's Equation III: Lenz's Law and Faraday's law: Induced EMF and Current	1	1, 2, 3	1, 4
	Describe Maxwell Equations as the foundation of electro-magnetism. Derive differential forms starting from Integral forms. Discuss Physical Significance.	1	1	1, 4

Course Unitization Plan: Laboratory

Exp No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
1	Hooke's law and determination of spring constant for a given spring	4	1, 4	5
2	Michelson interferometer kit with diode laser	4	1, 4	5
3	He-Ne laser kit: Optical Interference and Diffraction	4	1, 4	5
4	Diffraction by Grating and Particle size measurement	4	1, 4	5
5	Dielectric constant of air using dielectric constant kit.	4	1, 4	5
6	Verification of Stefan's Law	4	1, 4	5
7	Biot-savart law: To study the dependence of magnetic field on the current and magnetic field along the axis of a current carrying circular loop	4	1, 4	5
8	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	4	1, 4	5
9	Practice and model exam	8	1, 4	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)								End Semester Exam (50 %)	
		CLA-1 (15 %)		CLA-2 (15 %)		CLA-3 (__%)		Mid Term (20 %)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	10%	5%	10%	5%			20%		10%	5%
	Understand	10%	5%	10%	5%			20%		10%	5%
Level 2	Apply	30%	10%	30%	10%			40%		30%	10%
	Analyse	10%	20%	10%	20%			20%		10%	20%
Level 3	Evaluate										
	Create										
Total		**60%**	**40%**	**60%**	**40%**			**100%**		**60%**	**40 %**

Recommended Resources

1. Serway, R. A., & Jewett, J. W. (2017). Physics for Scientists and Engineers with Modern Physics (9th ed.). Cengage India Private Limited.
2. Young, H. D., Freedman, R. A., & Ford, L. C. (2018). University Physics with Modern Physics with Mastering Physics (12th ed.). Pearson.

Recommended Online Resources

1. Massachusetts Institute of Technology: OpenCourseWare. (2023). Physics I: Classical Mechanics. Retrieved from Massachusetts Institute of Technology: MIT OpenCourseWare https://ocw.mit.edu/courses/physics/8-01x-classical-mechanics-fall-2023/
2. Massachusetts Institute of Technology: OpenCourseWare. (2023). Physics II: Electricity and Magnetism. Retrieved from Massachusetts Institute of Technology: MIT OpenCourseWare https://ocw.mit.edu/courses/physics/8-02x-electricity-and-magnetism-fall-2023/
3. Department of Physics, SRM University AP. Engineering Physics lab manuals. Retrieved from Engineering Physics Lab (FIC102) https://srmap.edu.in/seas/physics-teaching-lab/

Other Resources

Course Designers

1. Dr. Jatis Kumar Dash, Associate Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
2. Dr. Pranab Mandal, Associate Professor & Head. Dept. Of Physics. SRM University – AP, Andhra Pradesh.
3. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras.

4. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad, Hyderabad

Calculus For Engineers

Course Code	FIC 103	Course Category	FIC		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)	NA	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**				
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Develop a comprehensive understanding of the fundamental concepts of calculus, including limits, derivatives, and integrals. Apply calculus techniques to solve a wide range of mathematical problems.
2. Utilize calculus to find extreme values of functions and understand the Mean Value Theorem.
3. Apply calculus to analyze monotonic functions, identify inflection points, and sketch curves.
4. Apply Lagrange multipliers to solve optimization problems with single constraints.
5. Calculate double and iterated integrals over various regions and in polar form. Utilize triple integrals in rectangular coordinates and apply them to real-world scenarios to find volumes, masses, and more.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe functions and their graphs to identify key characteristics such as domain, range, and behaviour.	2	75%	80%
Outcome 2	Compute derivatives of d-variable functions at specific points and apply various differentiation rules.	3	70%	75%
Outcome 3	Determine definite and indefinite integrals of functions and their applications.	3	75%	80%
Outcome 4	Apply calculus techniques to solve practical problems, including finding extreme values of functions. Utilize the Mean Value Theorem to understand rate of change in real-world applications.	4	72%	75%
Outcome 5	Analyse double and triple integrals over various regions and apply calculus to real-world problems such as finding volumes, masses, and areas.	4	70%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3		2					3						
Outcome 2	3	2		1					3						
Outcome 3	2	3		1					3						
Outcome 4	3	3		2					3						
Outcome 5	3	2		2					3						
Average	2	3		2					2						

Course Unitization Plan

Unit No.	Description of Topic	Contact Hours Required	CLOs Addressed	References Used
Unit I	**Unit I: Limit, Continuity, Derivative, and Integrals of Single Variable**	**10 Hours**		
	Functions and Their Graphs,	1	**CO 1**	1
	Limit of a function at a point and limit laws,	2	**CO 1**	1
	Continuity of a function,	1	**CO 1**	1
	Derivative of a function at a point,	2	**CO 2**	1
	Various rules of Derivative,	1	**CO 2**	1
	Definite and indefinite integral,	2	**CO 3**	1
	Fundamental Theorem of Calculus.	1	**CO 3**	1
Unit II	**Unit II: Applications of Calculus (Single Variable)**	**9 Hours**		
	Extreme Values of Functions	2	**CO 4**	1
	The Mean Value Theorem, Monotonic Functions	2	**CO 4**	1
	Concavity and curve sketching	2	**CO 4**	1
	Newton's Method to find roots	1	**CO 4**	1
	Area between curves	1	**CO 4**	1
	Arc length.	1	**CO 4**	1
Unit III	**Unit III: Limit, Continuity, Partial Derivatives of Multi-Variables Function**	**10 Hours**		
	Three-dimensional rectangular coordinate systems	1	**CO 1**	1
	Functions of several variables	2	**CO 1**	1
	Limits and continuity	2	**CO 2**	1
	Partial Derivatives	1	**CO 3**	1
	The Chain Rule, Directional Derivatives,	2	**CO 3**	1
	Gradient.	2	**CO 3**	1
Unit IV	**Unit IV: Extrema of Multi-Variables Function**	**6 Hours**		
	Extreme values	1	**CO 4**	1
	Saddle points	1	**CO 4**	1
	Absolute Maxima and Minima on Closed Bounded Regions,	2	**CO 4**	1
	Lagrange multipliers (Single Constraints).	2	**CO 4**	1
Unit V	**Unit V: Multiple Integrals**	**10 Hours**		
	Double and Iterated Integrals over Rectangles	2	**CO 5**	1
	Double Integrals over General Regions.	2	**CO 5**	1
	Area by Double Integration,	1	**CO 5**	1
	Double Integrals in Polar Form	1	**CO 5**	1
	Triple Integrals in Rectangular Coordinates	2	**CO 5**	1
	Applications.	2	**CO 5**	1
Total		45		

Learning Assessment (Macro)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (ds60%)				End Semester Assessments (40%)
		CLA-1 (15%)	**Mid-1 (25%)**	**CLA-2 (10%)**	**CLA-3 (10%)**	
Level 1	Remember	30%	20%	25%	25%	20%
	Understand	20%	30%	30%	25%	30%
Level 2	Apply	25%	30%	25%	25%	25%
	Analyse	25%	20%	20%	25%	25%
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Hass, J. (2008). Thomas' calculus. Pearson Education India.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Fundamentals of Computing and Programming in C

Course Code	CSE 101	Course Category	Core Course (CC)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Gain basic knowledge in C programming language.
2. Acquire knowledge on Decision making and functions in C.
3. Learn arrays, strings and pointers concept in C.
4. Understand the basics concepts of Structures, Union and File handling techniques using C Programming.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe C structures, enumerators, keywords, header files and operators	2	75 %	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70 %	65%
Outcome 5	Solve given projects based on C concepts	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1									2	2	3
Outcome 2	3	3	2	1									3	2	3
Outcome 3	3	3	2	2									3	2	3
Outcome 4	3	3	2	2									3	2	3
Outcome 5	3	3	2	2								2	3	2	2
Average	**3**	**3**	**2**	**2**								**2**	**3**	**2**	**3**

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	**INTRODUCTION TO COMPUTER SCIENCE**	**9**	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer: ALU, input-output units, memory, program counter - variables and addresses - instructions: store, arithmetic, input and output	2	1	1,2
	Problem solving: Algorithm / Pseudo code, flowchart, program development steps	1	1	1,2
	Computer languages: Machine, symbolic and high-level language Level languages	1	1	1,2
	Creating and Running Programs: Writing, editing (any editor), compiling (gcc)	1	1	1,2
	linking, and executing in Linux environment	2	1	1,2
UNIT 2	**C PROGRAMMING BASICS**	**9**		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	2	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	2	1	1,2
	Conditional operator, assignment operator, expressions Type conversi Type	1	1	1,2
	Conditional Expressions Precedence and order of evaluation, Sample Programs.	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested if, examples, multi-way selection: switch, else-if, examples.	1	1	1,2
	ITERATION: Loops - while, do-while and for, break, continue,	1	1	1,2
	initialization and updating, event and counter controlled loops and examples.	1	1,2	1,2
UNIT 3	**FUNCTIONS AND ARRAYS**	**9**		
	User defined functions, standard library functions	1	2,3	1,2
	Passing 1-D arrays, 2-D arrays to functions.	1	2,3	1,2
	Recursive functions - Recursive solutions for Fibonacci series, towers of Hanoi.	1	2,3	1,2
	C Pre-processor and header files	1	2,3	1,2
	Concepts, declaration, definition, storing and accessing elements	2	2,3	1,2
	one dimensional, two dimensional and multidimensional arrays	2	2,3	1,2
	array operations and examples, Character arrays and string manipulations	1	2,3	1,2
UNIT 4	**POINTERS**	**9**		
	Concepts, initialization of pointer variables	1	3,4	1,2
	pointers as function arguments, passing by address, dangling memory, address arithmetic	2	3,4	1,2
	character pointers and functions, pointers to pointers	1	3,4	1,2
	pointers and multi-dimensional arrays, dynamic memory management functions	3	3,4	1,2
	command line arguments	2	3,4	1,2
UNIT 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**9**		
	Structures - Declaration, definition, and initialization of structures, accessing structures	1	5	2, 3, 4
	nested structures, arrays of structures, structures and functions, pointers to structures,	2	5	2, 3, 4
	self-referential structures. Unions, typedef, bit-fields, program applications	2	5	2, 3, 4
	Bit-wise operators: logical, shift, rotation, masks.	1	5	2, 3, 4

	FILE HANDLING: Concept of a file, text files and binary files, formatted I/O, file I/O operations and example programs.	3	5	2, 3, 4
Total Hours		**45**		

Course Utilization Plan- (Lab)

Exp. No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	GCC Compiler using Linux, various Linux commands used to edit, compile and executing	2	1	1,2
2	a) Calculation of the area of the triangle. b) Swap two numbers without using a temporary variable. c) Find the roots of a quadratic equation	2	1	1,2
3	a) Find the sum of individual digits of a positive integer and find the reverse of the given number. b) Generate the first n terms of Fibonacci sequence. c) Generate all the prime numbers between 1 and n, where n is a value supplied by the user.	1	1, 2	1,2
4	a) Print the multiplication table of a given number n up to a given value, where n is entered by the user. b) Decimal number to binary conversion. c) Check whether a given number is the Armstrong number or not.	2	1, 2	1,2
5	Triangle star patterns I: * II: * * * * * * * * * * * * * * * *	2	1, 2	1,2
6	**a)** (nCr) and (nPr) of the given numbers 1+x+x^2\2+x^3\3!+x^4\4!+………..X^n\n!	1	2,3	1,2
7	Interchange the largest and smallest numbers in the array. Searching an element in an array Sorting array elements.	1	2,3	1,2
8	Transpose of a matrix. Addition and multiplication of 2 matrices.	1	2,3	1,2
9	Function to find both the largest and smallest number of an array of integers. Liner search. Replace a character of string either from beginning or ending or at a specified location.	1	2,3	1,2
10	Pre-processor directives . If Def . Undef Pragma	1	2,3	1,2
11	Illustrate call by value and call by reference. Reverse a string using pointers Compare two arrays using pointers	2	3, 4	1,2,3
12	Array of Int and Char Pointers. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
13	To find the factorial of a given integer.	2	3, 4	1,2,3

	To find the GCD (greatest common divisor) of two given integers. Towers of Hanoi			
14	Reading a complex number Writing a complex number. Addition of two complex numbers Multiplication of two complex numbers	2	5	2, 3, 4
15	File copy Word, line and character count in a file.	2	5	2, 3, 4
	Total Contact Hours	30		

Learning Assessment- (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)				End Semester Exam (40%)
		CLA-1 (10%)	Mid-1 (10%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember Understand	70%	60%	30%	30%	50%
Level 2	Apply Analyse	30%	40%	70%	70%	50%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment- (Lab)

Bloom's Level of Cognitive Task		Lab Performance (10%)	End Semester Exam (10%)
Level 1	Remember Understand	50%	50%
Level 2	Apply Analyse	50%	50%
Level 3	Evaluate Create		
Total		**100%**	**100%**

Recommended Resources

1. Kernighan, B. W., & Ritchie, D. M. (2002). The C programming language.
2. Dey, P., & Ghosh, M. (2011). Programming in C.
3. Hanly, J. R., & Koffman, E. B. (2007). Problem solving and program design in C. Pearson Education India.
4. Bichkar, R. S. Programming with C. (2012) Universities Press.

Other Resources

1. Gottfried B. (2016) Programming with C. Mcgraw hill Education, Fourteenth reprint.

Course Designers

Effective Writing and Presentation Skills

					L	T	P	C
Course Code	AEC 107	**Course Category**	AEC		1	0	1	2
Pre-Requisite Course(s)	AEC 101	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Literature and Languages	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Demonstrate proficiency in written communication, including the ability to compose clear, grammatically structured writing and critically analyse information from various sources, conduct research effectively, and use evidence to support their arguments in both written assignments and oral presentations.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop coherent and well-structured written communication by generating clear and concise written content with logical organization, appropriate grammar, vocabulary, and sentence structure.	1, 2	70%	60%
Outcome 2	Recognize and analyze the expectations of specific target audiences by adjusting tone, language and style to suit the intended purpose of the message and tailoring written content to various formats such as reports, essays, emails, and professional correspondence.	3, 4	70%	60%
Outcome 3	Increased Confidence in Public Speaking with the ability to deliver structured, well-organized, and persuasive presentations by employing visual and interactive aids, storytelling techniques.	5, 6	70%	70%
Outcome 4	Develop strong critical thinking and research skills, enabling students to evaluate information critically, synthesize sources effectively, and provide well-reasoned arguments in their written work and presentations.	3, 4, 5, 6,	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1									3	3	1	2	2	2	2
Outcome 2		2				1			3	3	2	2	2	2	2
Outcome 3		2				2			3	3	3	2	2	2	2
Outcome 4		2				3									
Average		**2**				**2**			**3**	**3**	**2**	**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basics of Grammatically correct writing**	**9**		
	SVO	1	1	1a, 2a,b
	Punctuation	3	1	1a, 2a,b
	Articles and Preposition	2	1	1a, 2a, b
	Tense and Apostrophe	1	1	1a, 2a, b
	Subject-Verb-Agreement	2	1	1a, 2a, b
Unit 2	**Categories of Writing**	**9**		
	Emails – different types (Official mails : Requesting Leave/ Enquiring vacancy/ Resigning from job/ requesting internship etc.)	3	1, 2	1b, c
	Notice and Agenda,	2	1, 2	1b, c
	Minutes of Meeting	2	1, 2	1b, c
	Paragraph writing	2	1, 2	1b, c
Unit 3	**Advanced Writing**	**9**		
	Writing Cover Letters	3	1, 2	1e
	Resume writing	2	1, 2	1d
	SOP, Abstract	2	1, 2	1g
	Project Report Writing	2	1, 2	2, d
Unit 4	**Effective Presentation Techniques**	**9**		
	Understanding the elements of successful presentations – Non-verbal communication in presentaions	3	2,3, 4	1f, 2c
	Creating engaging PPTs	2	2,3, 4	1f, 2c
	Structuring presentations for clarity and impact - Logical flow of topics and connected writing in line with storyboard	2	2, 3, 4	1f, 2c
	Handling Questions and Answers	2	2, 3, 4	1f, 2c
Unit 5	**Project Based Learning**	**15**		
	Community Based Project	15	1, 2, 3, 4	NA

Learning Assessment

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="3">Continuous Learning Assessments (60%)</th><th rowspan="2">End Semester Exam (40%)</th></tr>
<tr><th>CLA-1 20%</th><th>CLA-2 20%</th><th>CLA-3 20%</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">20%</td><td rowspan="2">20%</td><td rowspan="2"></td><td rowspan="2">50%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td><td rowspan="2">50%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. Swan, M. (2005). Practical English usage (Vol. 688). Oxford: Oxford university press.
2. Fenning, C. (2023). Effective Emails: The secret to straightforward communication at work: 1 (Business Communication Skills): Sanage Publishing
3. University Press.
4. Talbot, F. (2009). How to Write Effective Business English: The Essential Toolkit for Composing Powerful Letters, Emails and More, for Today's Business Needs. Kogan Page Publishers
5. Yate, M. (2016). Knock'em Dead Resumes: A Killer Resume Gets More Job Interviews! Simon and Schuster.
6. Yate, M. J. (2018). Ultimate Cover Letters: Master the Art of Writing the Perfect Cover Letter to Boost Your Employability (Vol. 5). Kogan Page Publishers.
7. Carnegie, D. (2013). The Art of Public Speaking. Wyatt North Publishing, LLC.
8. Yakhontova, T. V. (2003). English academic writing for students and researchers. Lviv: PAIS.

Online Resources

1. https://learnenglishteens.britishcouncil.org/
2. https://www.bbc.co.uk/learningenglish/
3. https://www.ted.com/?geo=hi
4. https://www.tifr.res.in/~cccf/data/InternDocs/How_to_write_a_structured_Project_Report.pdf

Universal Human Values and Ethics

Course Code	VAC 102	**Course Category**	VAC		L: 1	T: 1	P: 0, C: 2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Psychology	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To cultivate deep understanding of human values by teaching students the core principles of universal human values and their significance.
2. To promote ethical decision-making skills by equipping the students with the ability to make ethical choices in life, work, and society.
3. To foster a diverse and inclusive ethical perspective by sensitizing the students to diversity, equity, inclusion, gender, and cultural differences.
4. To highlight the relevance of ethics in society and professions by showcasing the practical importance of ethics in personal, societal, and professional contexts.
5. To address common challenges by preparing the students to overcome obstacles to ethical behaviour, fostering a commitment to universal values.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession	3	70%	80%
Outcome 2	Students will foster diverse and inclusive perspectives, contributing to more equitable and harmonious communities and workplaces	2	70%	70%
Outcome 3	Students will be able to apply ethical principles effectively in their personal and professional lives, leading to improved relationships and ethical practices in society	3	60%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	3				2	3	3	1	1	3			
Outcome 2		2	3				1	3	3	1		3			
Outcome 3	2	3	3					3	3	1	1	3			
Average	**2**	**2**	**3**				1	3	3	1	1	3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamentals of Human Values and Ethics**	**7**	1	1, 2, 3, 4, 5
	Introduction to human values and ethics.	1		
	Theory of wellbeing	2		
	Purpose and relevance of human values	4		
Unit 2	**Culture and Ethical Principles**	**5**	**2**	
	Culture and ethics.	2		
	Ethics in the community and society	3		
Unit 3	**Ethics and Inclusivity**	**6**	**2**	
	Ethics and diversity & inclusion	3		
	Equity, equality, and addressing violence	3		
Unit 4	**Ethics in various life spheres**	**6**	**3**	
	Ethics in family, society, and workplace	4		
	Ethics in IPR and plagiarism	2		
Unit 5	**Overcoming ethical challenges**	**6**	**3**	
	Identifying common challenges	3		
	Strategies to overcome challenges	3		
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		
		CLA-1 (10%)	**CLA 2 (20%)**	**CLA-3 (20%)**
		Theory	**Theory**	**Theory**
Level 1	Remember Understand	50%	50%	50%
Level 2	Apply Analyse	50%	50%	50%
Level 3	Evaluate Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Landau, RS. Living Ethics. New York: Oxford University Press, 2019.
2. Nagarazan, R.S. Ethics and Human Values, New Delhi: New Age International
3. Limited.
4. Rachels, J. The Elements of Moral Philosophy. New York: McGraw Hill. 2003.
5. Singer, P. Applied Ethics. Oxford: Oxford University Press, 1986.
6. Ethics: Contemporary Readings. Edited by Harry Gensler, Earl Spurgin, James Swindle. New York, Routledge. 2004

Other Resources

Entrepreneurial Mindset

Course Code	SEC 103	**Course Category**	SEC		**L**	**T**	**P**	**C**
					2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Management	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To develop the Entrepreneurial Mindset of Students.
- To provide tools and techniques for navigating the uncertain path of entrepreneurship

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the key entrepreneurship and innovation concepts	1	80%	80%
Outcome 2	Explain concepts of Startup Funding and Pitching	1	80%	80%
Outcome 3	Identify Entrepreneurial Opportunity and ideate solutions	2	80%	70%
Outcome 4	Articulate innovative business plans with sound entrepreneurial concepts.	3	70%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1			2				1								
Outcome 2			2						3		3				
Outcome 3		3	3		2				3	2	3	3			
Outcome 4		3	3		2				3		3	3			
Average		**1.5**	**2.5**		**1**		**0.25**		**2.25**	**0.5**	**2.25**	**1.5**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT-1	**Introduction to Entrepreneurship**	2		
	What and Why of Entrepreneurship		1	1,2
	Need of Entrepreneurship		1	1,2
	Entrepreneurship at SRM-AP		1	1,2
UNIT-2	**Entrepreneurial Orientation**	4		
	Characteristics of successful entrepreneurs		1,2	1,2
	Mindset shifts: from an employee to an entrepreneur		1,2	1,2
	Overcoming challenges and dealing with failures		1,2	1,2
UNIT-3	**Entrepreneurial Skills**	4		
	Skillsets of an Entrepreneur		1,2	1,2
	Design Thinking, Growth Mindset		1,2	1,2
	Design Thinking		1,2	1,2
UNIT-4	**Entrepreneurial Opportunity & Ideation**	2		
	Difference between idea and opportunity		1,2	1,2
	Opportunities in Vibrant Indian Entrepreneurial Ecosystem		1,2	1,2
	Opportunity Recognition (Sources of Opportunity)		1,2	1,2
	Idea Generation		1,2	1,2
UNIT-5	**Business Model Canvas**	2		
	Why BMC		3	1,2
	Value Proposition		3	1,2
	Customer Discovery		3	1,2
	Customer Relationship		3	1,2
	Channels		3	1,2
	Key Partners		3	1,2
	Key Activities		3	1,2
	Key Resources		3	1,2
	Revenue Structure		3	1,2
	Cost Structure		3	1,2
UNIT-6	**Startup Financing & Pitching**	2		
	Stages of Fundraising		4	1,2
	Mode of Investment		4	1,2
	Startup Valuation		4	1,2
	From Pitch to Hitch (Pitch Deck)		4	1,2
UNIT-7	**Growth Mindset and Sales Ability**	2		
	Importance of Sales skill for Entrepreneur		3	1,2
	Sales Techniques		3	1,2
	Developing Growth Mindset		3	1,2
UNIT-8	**Developing the Business Plan**	12	3,4	1,2
	Total Hours	30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (100%)			End Semester Exam (40%)
		CLA-1 (10%)	CLA-2 (20%)	CLA-3 (30%)	
Level 1	Remember		20%	20%	100%
	Understand				
Level 2	Apply	100%	80%	80%	
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Bruce R. Barringer, R. Duane Ireland. Entrepreneurship Successfully Launching New Ventures, Pearson; 2020

2. Robert D. Hasrich, Dean A. Shepherd, Michael P. Peters, Entrepreneurship, McGraw Hill, 2021

Other Resources

1. Best business courses online (n.d.). Coursera. https://www.coursera.org/browse/business/entrepreneurship

Course Designers

1. Dr Aftab Alam, Assistant Professor, Paari School of Business, SRM University-AP
2. Mr Udayan Bakshi, Associate Director, Directorate of Entrepreneurship, SRM University-AP

Principles of Economics and Management

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">FIC 105</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">FIC</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td></td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>Economics</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. This course will provide the basic understanding of concept of economics. Its analysis the choice and decision to manage the scare resources.
2. To understand consumer behaviour; how the demand and supply works in market.
3. To understand producer behaviour. How producer will behave with limited resources. How cost can be minimised
4. To understand the nature of market. How to identify the market and how different markets works.
5. To understand the concepts of macroeconomics and how economy as a whole works.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe and explain how microeconomic models can be used to consider fundamental economic choices of households and firms.	2	70%	65%
Outcome 2	Describe and explain how macroeconomic models can be used to analyse the economy as a whole.	2	70%	65%
Outcome 3	Describe and explain how government policy influences microeconomic choices and macroeconomic outcomes.	3	70%	65%
Outcome 4	Interpret and economic models, diagrams and tables and use them to analyse economic situations.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							2			
Outcome 2	3	3	3	3	2	1			2			2			
Outcome 3	3	3	3	3	2				2			2			
Outcome 4	3	3	3	3	2	1			3			2			
Average	**3**	**3**	**3**	**3**	**2**	**1**			**2**			**2**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	COs Addressed	References Used
Unit I	**Exploring the subject matter of Economics:**	**5**		
1	Definition; Scope and method of economics; the economic problem	2	1	1
2	Science of economics; the basic competitive model; prices,	1	1	1
3	Opportunity cost; economic systems; reading and working with graphs	2	1	1
Unit II	**Supply and Demand**	**14**		
4	How Markets Work, Markets and Welfare	1	1,4	1
5	Markets and competition;	1	1,4	1
6	Concept of Demand and supply	2	1,4	1
7	Equilibrium of market	2	1,4	1
8	The concept of elasticity	2	1,4	1
9	Controls on prices; taxes and the costs of taxation;	1	1,4	1
10	Consumer Surplus	2	1,4	1
11	Utility Analysis: Ordinal and cardinal utility analysis	2	1,4	1
Unit III	**The Households**	**6**		
12	The consumption decision: budget constraint	1	1,4	1, 2
13	Consumption and income/price changes	1	1,4	1, 2
14	Demand for all other goods and price changes	1	1,4	1, 2
15	Description of preferences	1	1,4	
16	Properties of indifference curves	1	1,4	1, 2
17	Consumer ‘s optimum choice	1	1,4	1, 2
Unit IV	**Theory of production, cost & market**	**10**		
18	Theory of production: short and long run	2	1,4	1, 2
19	Theory of cost	1	1,4	1, 2
20	Types of cost, short run and long run	2	1,4	1, 2
21	The Firm and Perfect Market Structure	1	1,4	1, 2
22	Behaviour of profit maximizing firms and the production process	2	1,4	1, 2
23	Monopoly	2	1,4	1, 2
Unit V	**Macroeconomics**	**10**		
24	GDP- definition and concepts	2	2, 3	1, 3
25	Measurement of National Income: Different methods	2	2, 3	1, 3
26	Consumption function	1	2, 3	1, 3
27	Investment	1	2, 3	1, 3
28	Demand for money	1	2, 3	1, 3
29	Supply of Money	1	2, 3	1, 3
30	Inflation	1	2, 3	1, 3
31	Unemployment	1	2, 3	1, 3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		90%		40%		80%		70%	
	Understand										
Level 2	Apply	60%		10%		60%		20%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Mankiw, N. G. (1998). Principles of microeconomics (Vol. 1). Elsevier.
2. Taussig, F. W. (2013). Principles of economics (Vol. 2). Cosimo, Inc..
3. Samuelson, P. A. and Nordhus, W. D. (2018) Economics. Publisher: McGraw-Hill

Other Resources

Course Designers

1. Dr. Ghanshyam Pandey. Asst. Professor. Dept. Of Economics. SRM University - AP

Linear Algebra and Differential Equations

						L	T	P	C
Course Code	FIC 117	**Course Category**	FIC			3	0	0	3
Pre-Requisite Course(s)	FIC103	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**					
Course Offering Department	Mathematics	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. Develop a comprehensive set of skills and knowledge to solve complex systems of linear equations and utilizing matrix operations by introducing determinants, vector spaces, and their applications in real-world scenarios.
2. To gain proficiency in understanding and manipulating linear transformations, eigenvalues, and eigenvectors, enabling them to analyse and interpret diverse mathematical models.
3. To develop practical techniques for solving first and higher-order differential equations, employing methods like reduction of order and variation of parameters to tackle real-world problems involving dynamic systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Proficiently solve linear equations and perform matrix operations. Understand special matrix types, determinants, and vector spaces.	2	75%	80%
Outcome 2	Define and analyze linear transformations. Apply eigenvalue concepts and understand diagonalization.	3	70%	65%
Outcome 3	Establish the existence, uniqueness, and classification of solutions. Solve various types of first-order differential equations, including separable and linear.	3	75%	70%
Outcome 4	Explore homogeneous equations with constant coefficients and Euler-Cauchy equations with solution methods like undetermined coefficients and variation of parameters.	3	70%	65%
Outcome 5	Transform higher-order equations into systems, emphasizing critical points and stability. Address nonhomogeneous linear systems using methods like undetermined coefficients and variation of parameters.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2											
Outcome 2	2	3	2	2											
Outcome 3	2	3	2	2											
Outcome 4	2	3	3	2											
Outcome 5	2	3	3	3											
Average	**2**	**3**	**2**	**2**											

Course Unitization Plan

Unit No.	Description of Topic	Contact Hours Required	CLOs Addressed	References Used
Unit I	**Unit I: Linear Equations, Matrices, Determinants and Vector Spaces**	**9 Hours**		
	Systems of Linear Equations, Algebraic Properties of Matrix Operations	1	**CO 1**	1
	Special Types of Matrices, Echelon Form of a Matrix, Rank of a matrix	2	**CO 1**	1
	Solving Linear Systems, Elementary Matrices, Finding A-1.	1	**CO 1**	1
	Determinants, Properties of Determinants	2	**CO 1**	1,3
	Vectors in the Plane and in 3-Space, Vector Spaces	1	**CO 1**	1,3
	Subspaces, Span, Linear Independence, Basis and Dimensions	2	**CO 1**	1,3
	Unit II: Linear Transformations, Eigenvalues and Eigenvectors	**9 Hours**		
Unit II	Definition and Examples of Linear Transformations,	1	**CO 2**	1,3
	Kernel and Range of a Linear Transformation,	2	**CO 2**	1,3
	Matrix of a Linear Transformation,	1	**CO 2**	1,3
	Eigenvalues and Eigenvectors, Diagonalization and Similar Matrices,	2	**CO 2**	1,3
	Diagonalization of Symmetric Matrices	1	**CO 2**	1,3
	Spectral Decomposition and Singular Value Decomposition.	2	**CO 2**	1,3
	Unit III: First order differential equations	**9 Hours**		
Unit III	Geometrical meaning of first order differential equations,	1	**CO 3**	2
	Existence and uniqueness of solution,	2	**CO 3**	2
	Classification of ODEs,	1	**CO 3**	2
	Separable differential equations, Exact differential equations,	2	**CO 3**	2
	Linear differential equations,	1	**CO 3**	2
	Bernoulli differential equations, Initial value problems.	2	**CO 3**	2
	Unit IV: Second or higher order linear differential equations	**9 Hours**		
Unit IV	Method of reduction of order (when one solution is known)	1	**CO 4**	2
	Wronskian	2	**CO 4**	2
	Homogeneous differential equations with constant coefficients	1	**CO 4**	2
	Homogeneous Euler-Cauchy differential equations	2	**CO 4**	2
	Method of undetermined coefficients	1	**CO 4**	2
Unit V	Method of variation of parameters.	2	**CO 4**	2
	Unit V: System of first order differential equations	**9 Hours**		
	Solution of homogeneous constant coefficient system of differential equations	2	**CO 5**	2
	Converting higher order differential equations into system of equations	1	**CO 5**	2
	Critical points and stability	1	**CO 5**	2
	Nonhomogeneous Linear Systems of ODEs.	1	**CO 5**	2
	Method of undetermined coefficients	1	**CO 5**	2,4
	Method of variation of parameters	2	**CO 5**	2
	Linearization of Nonlinear Systems.	1	**CO 5**	2,4
Total		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	25%	10%	20%	25%
	Understand	30%	30%	30%	30%	30%
Level 2	Apply	20%	25%	30%	30%	25%
	Analyse	20%	20%	30%	20%	20%
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Strang, G. (2005). Linear algebra and its applications. Cengage India Private Limited
2. Kreyszig, E. (2010). Advanced engineering mathematics. Willey
3. Kolman, B. Hill, D. (2007). Elementary linear algebra with applications. Pearson
4. Boyce, W. E., DiPrima, R. C., & Meade, D. B. (2021). Elementary differential equations and boundary value problems. John Wiley & Sons.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Foundations of Electrical and Electronics Engineering

						L	T	P	C
Course Code	FIC 120	**Course Category**	FIC			2	0	1	3
Pre-Requisite Course(s)	Engineering Physics	**Co-Requisite Course(s)**	NIL	**Progressive Course(s)**					
Course Offering Department	EEE	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. To impart fundamental knowledge and understanding of electrical and electronic circuits/components.
2. To inculcate analytical and reasoning skills pertaining to operations of DC and AC systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Infer essential electrical engineering applications in daily life.	2	70%	60%
Outcome 2	Apply the fundamentals laws and concepts to solve the electrical circuits.	3	70%	60%
Outcome 3	Apply the concept of network theorems to find the response electrical circuits with DC excitation.	3	70%	60%
Outcome 4	Find the steady state response of pure R, L, C circuits, RL, RC and RLC circuits under single-phase AC excitation.	3	70%	60%
Outcome 5	Understand the basics of semiconductor devices and their applications.	2	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3		1		2				1	1		2	2	1	
Outcome 2	3	3	1		2				1	1		2	2	1	
Outcome 3	3	3	1		2				1	1		2	2	1	
Outcome 4	3	3	1		2				1	1		2	1	1	
Outcome 5	3	3	1		2				1	1		2	2	1	
Average	**3**	**2**	**1**		**2**				**1**	**1**		**2**	**2**	**1**	

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Essence of electrical and electronics engineering in daily life;**	**2**		
	DC/AC Power Generation	1	1	1
	AI/ML/IoT/Robotics in Electrical Engineering	1	1	3
Unit 2	**Basic Circuit Analysis**	**6**		
	DC Source (battery), AC Sources, Ohm's law, Kirchhoff's laws, Concept of Node, Path, Loop, Branch, Mesh	1	2	1, 2
	Voltage and Current Division, Ideal and Practical Voltage and Current Source, Source transformations	1	2	1, 2
	Nodal Analysis and Supernode - Presence of independent voltage and current sources.	2	2	1, 2
	Mesh Analysis and Super mesh - Presence of independent voltage and current sources.	2	2	1, 2
Unit 3	**Network Theorems**	**6**		
	Introduction to Network Theorems and Techniques, Superposition Theorem	1	3	1, 2
	Thevenin's Theorem	2	3	1, 2
	Norton's Theorem	1	3	1, 2
	Maximum Power Transfer Theorem	2	3	1, 2
Unit 4	**Single-Phase AC Circuits**	**9**		
	Basic Concepts Related to Generation of Sinusoidal AC Voltage. Definition and Numerical values of Average Value, Root Mean Square Value, Form Factor and Peak Factor for sinusoidal varying quantities	1	4	1, 2
	Steady State Analysis of Pure R, L, C Circuits.	2	4	1, 2
	Steady State Analysis of RL, RC and RLC Series Circuits with Phasor Diagrams	2	4	1, 2
	Definitions of Real Power, Reactive Power, Apparent Power, and Power Factor. Concepts of Resonance	2	4	1, 2
	Basics of Magnetic Circuits, Motor, Transformer	2	4	1, 2
Unit 5	**Semiconductor Devices and Circuits**	**7**		
	PN junction diode structure	2	5	1, 2
	Forward and reverse bias operation and characteristics of PN junction diode	1	5	1, 2
	Half-wave, full wave, bridge rectifiers, clipping circuits using PN junction diode	2	5	1, 2
	Bipolar junction transistors (BJTs) structure and operation	2	5	1, 2
Total Contact Hours		**30**		

Course Unitization Plan - Lab

Exp. No.	Name of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Study of Wind energy system	1	2	3
2	Study of solar photovoltaic energy system	1	2	3
3	Introduction to electrical lab to know different components	1	1	3
4	Affirmation of Ohm's Law	1	2	1-2
5	Affirmation of Kirchhoff's Voltage Law	1	2	1-2
6	Affirmation of Kirchhoff's Current Law	1	2	1-2
7	Affirmation of Superposition theorem	1	3,4	1-2
8	Affirmation of Thevenin's theorem	1	3,4	1-2
9	Introduction to electronics laboratory to know different components	1	5	3
10	P-N junction diode I-V characteristics	1	5	1
11	Half rectifier experiments	1	5	1
12	Full wave rectifier experiments	1	5	1
13	Application of P-N junction diode	1	5	1
14	BJT I-V characteristics (I/P and O/P)	1	5	1
15	Study of oscilloscope	1	5	1
Total Contact Hours		**15**		

Learning Assessment (Theory)

Question Difficulty	Bloom's Level of Cognitive Task	Continuous Learning Assessments (25%)				End Semester Exam (25%)
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	70%	60%	50%	50%	60%
Level 2	Apply Analyse	30%	40%	50%	50%	40%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment - Lab

Bloom's Level of Cognitive Task		Continuous Learning Assessments (25%)			End Semester Exam (25%)
		Experiments (10%)	Record/ Observation Note (5%)	Viva Voce + Model examination (10%)	
Level 1	Remember Understand	30%	60%	30%	30%
Level 2	Apply Analyse	70%	40%	70%	70%
Level 3	Evaluate Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William, H. Kemmerly, J. E. and Steven, M. D. (2011) Engineering Circuit Analysis. McGraw Hill, 8th Edition.
2. Chakrabarti, A. (2017). Circuit Theory Analysis and Synthesis. Dhanpat Rai & Co. 7th Edition.
3. Online Sources

Other Resources

1. Del Toro, V. (1986). Electrical engineering fundamentals. Second Edition, PHI
2. Bobrow, L. S. (1996). Fundamentals of electrical engineering. Oxford University press.
3. Svoboda, J. A., & Dorf, R. C. (2013). Introduction to electric circuits. John Wiley & Sons.
4. Alexander, C. K., Sadiku, M. N., & Sadiku, M. (2007). Fundamentals of electric circuits. McGraw-Hill Higher Education.
5. Boylestad, R. L. (2003). Introductory circuit analysis. Pearson Education India. Charles K. Alexander and Matthew, N.O. (2005). Fundamentals of Electric Circuits. McGraw Hill Higher Education, Third Edition.

Course Designers

1. Dr. Tarkeshwar, Asst Professor, Department of EEE, SRM University - AP
2. Dr. Somesh Vinayak Tewari, Asst Professor, Department of EEE, SRM University - AP

Data Structures

Course Code	CSE 102	**Course Category**	Core Course (CC)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE101	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the basic concepts such as abstract data types, linear and non-linear data structures.
2. To understand the behaviour of data structures such as arrays, linked lists, stacks, queues, trees, hash tables, search trees, graphs, and their representations.
3. To provide an independent view of data structures, including its representation and operations performed on them, which are then linked to sorting, searching and indexing methods to increase the knowledge of usage of data structures in an algorithmic perspective.
4. To choose an appropriate data structure for a specified application.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Compare and contrast the algorithms for linked list, stack and queue operations.	4	77%	70%
Outcome 2	Illustrate algorithms for Binary Search Trees and AVL Trees.	4	75%	70%
Outcome 3	Analyze Graph traversal and minimum cost spanning tree algorithms.	4	72%	70%
Outcome 4	Distinguish searching and sorting techniques.	2	78%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	2	-	-	-	-	-	-	-	-	1	3	3	3
Outcome 2	3	3	2	1	-	-	-	-	-	-	-	1	3	3	3
Outcome 3	3	3	2	1	-	-	-	-	-	-	-	1	3	3	3
Outcome 4	3	3	1	-	-	-	-	-	-	-	-	1	3	3	3
Average	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Data Structures**	**9**		
	Abstract Data Type (ADT), Time and space requirements of algorithms	1	1	1
	Array ADT, Representing polynomials	1	1	1,2
	Sparse matrix using arrays and its operations	1	1	1
	Stacks: representation and application, implementation of stack operations using C.	2	1	1
	Example applications on Stacks	2	1	
	Queues: representation and application, implementation of queue operations using C.	1	1	1,2
	Example applications on Queues	1	1	1,2
Unit 2	**Linked lists**	9		
	Linked lists: Single linked lists representation	1	1	1,2
	Implementation of linked list various operation using C	3	1	1
	Doubly linked list representation and Implementation of doubly linked list various operation using C	2	1	5
	Implementation of Circular linked list various operation using C	2	1	4,5
Unit 3	**Trees**	**9**		
	Tree terminology	1	2	1
	Binary tree, Representation of Binary Trees using Arrays and Linked lists	1	2	1
	Binary search tree	2	2	1
	Binary Search Trees- Basic Concepts, BST Operations: Insertion, Deletion	1	2	1
	Tree Traversals, Construction of tree using traversals	1	2	
	Applications, Expression tree	1	2	1
	General tree	1	2	1
	Heap Sort, Balanced Binary Trees, AVL Trees, Insertion, Deletion and Rotations.	1	2	1
Unit 4	**Graphs**	**9**		
	Graph terminology, Representation of graphs, path matrix	1	3	3
	BFS (breadth first search)	2	3	3
	DFS (depth first search)	1	3	3
	Topological sorting	1	3	3
	Priority Queues: Heap structures	1	3	5
	Binomial heaps, leftist heaps	1	3	2
	Shortest path algorithms.	1	3	2
	Implementation of shortest path algorithm using C	1	3	2
Unit 5	**Sorting and Searching techniques**	**9**		
	Bubble sort,selection sort and their algorithm analysis	1	4	2
	Insertion sort and its algorithm analysis	2	4	2
	Quick sort and its algorithm analysis	1	4	2,3
	Merge sort and its algorithm analysis	1	4	3
	Heap sort and its algorithm analysis	1	4	3
	Radix sort and its algorithm analysis	1	4	5
	Linear and binary search methods and its algorithm analysis.	1	4	5
	Hashing techniques and hash functions	1	4	5
Total Contact Hours		**45**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)	
Level 1	Remember	70%	60%	30%	30%	60%
	Understand					
Level 2	Apply	30%	40%	70%	70%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (20%)	End Semester Exam (20%)
Level 1	Remember	50%	60%
	Understand		
Level 2	Apply	50%	40%
	Analyse		
Level 3	Evaluate		
	Create		
Total		**100%**	**100%**

Recommended Resources

1. Tenenbaum, A. M. (1990). Data structures using C. Pearson Education India.
2. Mark, A. W. (1992). Data structures and algorithm analysis in C.
3. Anderson-Freed, S., Horowitz, E., & Sahni, S. (2007). Fundamentals of Data Structures in C.
4. Lipschutz, (2002) “Data Structures”, Schaum's outline series, Tata McGraw Hill Edition
5. Pai, G. V. (2008). Data Structures and Algorithms. Tata McGraw-Hill.
6. Kruse, R., & Tondo, C. L. (2007). Data structures and program design in C. Pearson Education India.

Other Resources

1. Gottfried, B. (2016) Programming with C Mcgraw hill Education, Fourteenth reprint
2. Dey, P. and Ghosh, M. (2012) Programming in C Second Edition, Oxford University Press.

Course Designers

Problem Solving Skills

Course Code	AEC 108	**Course Category**	AEC		**L**	**T**	**P**	**C**
					1	0	1	2
Pre-Requisite Course(s)	SEC 101	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To categorize, apply and use thought process to distinguish between concepts of quantitative methods.
2. To prepare and explain the fundamentals related to various possibilities.
3. To critically evaluate numerous possibilities related to puzzles.
4. Explore and apply key concepts in logical thinking to business problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Use logical thinking and analytical abilities to solve quantitative aptitude questions from company specific and other competitive tests.	1	70%	60%
Outcome 2	Solve questions related to Time and Distance and Time and work from company specific and other competitive tests.	3	65%	70%
Outcome 3	Understand and solve puzzle questions from specific and other competitive tests	1	60%	60%
Outcome 4	Make sound arguments based on mathematical reasoning and careful analysis of data.	1	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		2	2	2	1				1						
Outcome 2		2	1	2	1										
Outcome 3		3	2	2					1						
Outcome 4		3	1	2											
Average		**3**	**2**	**2**	**1**				**1**						

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Clocks, Calendars	**2**	1,4	2,3
	Logical Reasoning Basics, Linear Arrangements, Circular Arrangements	**3**	**1,4**	**2,3**
	Logical Reasoning – Selections, Distributions, Selection decision table, Circular / Tabular arrangements	**6**	**1,4**	**2,4**
	Direction Sence, Blood Relations, Directions, Blood Relations, Problems based on dice and cubes	**5**	**1,4**	**2,3**
Unit No. 2	Data interpretation – Introduction, Line Graph	**3**	1,4	1,3
	Data interpretation – Bar Graph, Pie-Charts	3	1,4	1,3
	Data Interpretation – Tables, Case lets	3	1,4	1,3
Unit No. 3	Statistics: Basics, Concept Review Questions	**2**	**1,2**	**4**
	Mean, Median, Mode, QD, MD, SD, Advanced Problems.	**3**	**1,2**	**4**
	Functions Basics, Graphs Basics, Functions and Graphs-Advanced.	**3**	**1,2**	**5**
Unit No. 4	**Geometry and Mensuration**	**3**	1,2	**1**
	Venn diagram with two variables and three variables ,logical deductions	**3**	1,2	**2,3**
Unit No. 5	**Coding Maths – problems based on Number System** **Coding Maths - Pigeon Hole Principle**	**3**	2,3	1,5
	Coding Maths - Discrete Math Graph Theory	**3**	1,2	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (_50%)	
		CLA-1 (10%)		CLA-2 (15%)		CLA-3 (10%)		Mid Term (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%		25%		20%		25%		25%	
	Understand	20%		25%		20%		25%		25%	
Level 2	Apply	30%		25%		30%		25%		25%	
	Analyse	30%		25%		30%		25%		25%	
Level 3	Evaluate										
	Create										
	Total	**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata McGraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Logical Reasoning and Data Interpretation for CAT, By Nishit K. Sinha
4. Basic Statistics - B.L. Agarwal.
5. Graph Theory and Its Applications – Jonathan L. Gross

Other Resources

1. Geeks for Geeks
2. Indiabix.
3. M4maths.com

Course Designers

1. Mr. Naresh Adapa – Quantitative Aptitude Trainer, Department of CR&CS SRM University AP.
2. Mr. Shaik Mohammed Musa Kaleemullah, Verbal Ability Trainer, Department of CR&CS, SRM University AP.
3. Dr. Fouzul Atik – Assistant Professor, Department of Mathematics, SRM University AP.

Coding Skills-I

Course Code	CSE 201	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Analyze and evaluate code complexity to understand the efficiency and performance of algorithms.
2. Master the implementation of linear data structures, including arrays and linked lists, for solving diverse computational problems.
3. Learn to work with abstract data structures, including stacks and queues, to solve real-world problems.
4. Apply divide and conquer strategies in problem-solving and become proficient in algorithms like Quick Sort and Merge Sort
5. Develop a strong foundation in non-linear data structures, particularly binary trees, and analyze their properties and applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Compute code complexity and understand the computational efficiency of algorithms.	2, 3	80%	75%
Outcome 2	Implement linear data structures, including arrays and linked lists, to solve problems involving data manipulation and storage.	2, 3	75%	70%
Outcome 3	Apply abstract data structures, including stacks and queues to solve complex, real-world computational problems.	2, 3	75%	70%
Outcome 4	Apply divide and conquer strategies to solve complex problems, with a focus on algorithms like Quick Sort and Merge Sort.	2, 3	75%	70%
Outcome 5	Solve problems related to non-linear data structures, particularly binary trees, and understand their applications in real-world scenarios.	3	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3		2				1	1			3	2	
Outcome 2	2	3	3		2				1	1			3	2	
Outcome 3	2	3	3		2				1	1			3	2	
Outcome 4	2	3	3		2				1	1			3	2	
Outcome 5	2	3	3		2				1	1			3	2	
Average	**2**	**3**	**3**		**2**				**1**	**1**			**3**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Code Complexity Analysis & Linear List data Problem solving through Coding, Compare and contrast coding and competitive coding, Various approaches for problem solving, techniques for competitive coding, Orientation on Competitive coding on coding platforms like Codechef/ Codeforces/ Leetcode/ Hackerrank etc. Precise coding techniques implementing the evaluation of the language supported expressions, code complexity analysis, Linear/ Logarithmic/ Super linear/ Polynomial/ Exponential/ Recursion Algorithm analysis, Problem Solving using Linear list data, Subscripts, 2D Array Subscript, RMO & CMO Representation, Matrix Problems. Company Specific Examples & Competitive Programming Practice Problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc	**9**	**1**	
Unit 2	Memory Manipulation Methods and Problem Solving on String data Pointer Variable, Pointer Arithmetic, Memory Layout, Runtime memory allocation, Problem Solving on String Data, String handling methods, Examples, Practice Problems. Problem Solving using Linked List data: Implementing a Structure member pointer reference, Coding solutions for Linked list manipulation, Solutions for order statistic problems on linked lists: Comparison/ Cycle Detection/ Merge Point Detection/ Merging the lists, Coding solution for the circular linked data and Double linked data, coding problems, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	2	
Unit 3	Problem Solving using Abstract data structures: Stacks Problem solving using Stacks, Coding solutions for the implementation of stack using an array, Coding solutions for the implementation of stack using a linked list. Problem solving on expression conversion and evaluation, Examples, Practice problems. Problem Solving through Queues & Search-Sort Algorithms: Problem solving using Queues, Coding solutions for the implementation of queue using an array/ linked list, Divide & Conquer Strategies: Linear Vs Binary Search Analysis, Bubble sort and Selection Sort Analysis, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	3	
Unit 4	Problem Solving through Divide & Conquer Strategies: Divide & Conquer Strategies: Quick sort Analysis, Merge Sort Analysis, Min/Power functions, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	4	
Unit 5	Problem Solving through Non-Linear Data structures – Trees	**9**	5	

	Problem solving approaches using Non-linear data structures, Coding problems on the height of a binary tree, Size of a binary tree, Tree order traversals, Problem Solving on Binary Trees, Time comparison and analysis on Binary Search Trees & Coding problems, Search/probe sequence validation, Significance of height balancing the tree, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.			
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)								End Semester Exam (60%)	
		CLA-1 (20%)		Mid-1 (20%)							
		Th	Prac	Th	Prac					Th	Prac
Level 1	Remember		50%		50%						50%
	Understand										
Level 2	Apply		50%		50%						50%
	Analyse										
Level 3	Evaluate										
	Create										
Total			**100%**		**100%**						**100%**

Recommended Resources

Other Resources

Course Designers

Object Oriented Programming using C++

Course Code	CSE 202	**Course Category**	Core Course (CC)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	NIL	**Progressive Course(s)**	NIL			
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the concepts of Object-Oriented Programming using C++ programming.
2. Apply the Object-Oriented Concepts such as Class and Object in solving real-world problems.
3. Demonstrate the principles of inheritance and polymorphism to the design of abstract classes.
4. Apply exception handling and template creation using STL and interfaces.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Utilize the Object-Oriented Concepts in solving real word problems through C++.	2, 3	70%	65%
Outcome 2	Use Object Oriented Concepts such as Class and Object in solving real-world problems through C++.	3	70%	65%
Outcome 3	Use the principles of Inheritance and Polymorphism through C++.	3	70%	65%
Outcome 4	Use exception handling and template creation using STL and interfaces.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	
Outcome 2	2	2	3	3	2								2	2	
Outcome 3	2	3	3	2	2								2	2	
Outcome 4	3	3	3	3	2								2	3	
Average	2	3	3	3	2								2	2	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	Ref. Used
Unit 1	**INTRODUCTION**	**9**		
	Understanding the Object-Oriented World View, A way of viewing world – Agents and Communities, messages and methods, Responsibilities, Classes, Objects, and Methods.	2	1	1
	OOP principles	1	1	1,2
	An overview of C++, basic program construction - data types, variables, constants - type conversion, operators.	1	1	2
	Decision making and looping constructs	1	1	1,2
	Arrays, strings and pointers		1	1,2
	Functions, passing arguments, Returning values, Reference Arguments	2	1	1,2
	Storage Classes	1	1	1,2
	Dynamic memory management in C++	1	1	1,2
Unit 2	**FEATURES OF OBJECT-ORIENTED PROGRAMMING**	**9**		
	Concept of classes and objects with real world examples	1	1,2	2
	Encapsulation, data hiding using storage classifier	2	1,2	2
	Polymorphism, Types of polymorphism, Use-cases		1,2	2
	Method overloading, Method overriding	2	1,2	2
	Virtual functions		1,2	2
	Interfaces	2	1,2	2
	Constructors and destructors		1,2	2
	Methods, Method calling, Method with object parameters	1	1,2	2
	Summary, Putting it all together with hands-on	1	1,2	2
Unit 3	**POLYMORPHISM**	**9**		
	Concept of Polymorphism	2	1,2	1,2
	Function overloading and its advantages		1,2	2
	Pitfalls of function overloading	3	1,2	2
	Operator overloading		1,2	2
	Overloading unary operations	2	1,2	2
	Overloading binary operators		1,2	2
	Data Conversion	2	1,2	2
	Pitfalls of operators overloading and conversions		1,2	2
Unit 4	**INHERITANCE**	**9**		
	Inheritance in real world, definition and applications	2	1,2	2
	Derived and Base Classes		1,2	2
	Derived class constructor, Overriding member functions	2	1,2	2
	Inheritance in the English distance class		1,2	2
	Class hierarchies	2	1,2	2
	Inheritance and graphics shapes		1,2	2
	Public and private inheritance, Levels of Inheritance	2	1,2	2
	Multiple Inheritance, Ambiguity in Multiple Inheritance with Example		1,2	2
	Aggregation: Classes within classes	1	1,2	2
Unit 5	**TEMPLATES AND EXCEPTIONS**	**9**		
	Templates: Function templates	2	1,2	2
	Class templates		1,2	2
	Exceptions: Need of Exceptions, keywords,	2	1,2	2
	Simple and Multiple Exceptions		1,2	2
	Re-throwing Exception and Exception Specifications, Custom Exception.	2	1,2	2
	Standard Template Library: Containers, Algorithms, iterators - potential problems with STL	1	1,2	2
	Algorithms: find (), count (), sort (), search (), merge ()	1	1,2	2

	Function Objects: for each (), transform ()		1,2	2
	Sequence Containers: vectors, Lists, Dequeues - Iterators and specialized.	1	1,2	2
	Total Hours	45		

Exp No.	**Unit Name**	**Required Contact Hours**	**CLOs Addressed**	**Ref. Used**
1	1. Takes two integer operands and one operator form the user, performs the operation and then prints the result. 2. Generate all the prime numbers between 1 and n, where n is a value supplied by the user.	2	1	1
2	1. Write a program to demonstrate the Inline functions. 2. Programs to understand different function call mechanism. a. call by reference b. call by value	2	1	1
3	1. Write a Program to design a class having static member function Named showcount() which has the property of displaying the number of objects created of the class. 2. Write a Program using class to process Shopping List for a Departmental Store. The list includes details such as the Code No and Price of each item and perform the operations like Adding, Deleting Items to the list and Printing the Total value of a Order.	2	2	2
4	1. Write a Program which creates & uses array of object of a class. (foreg. implementing the list of Managers of a Company having details such as Name, Age, etc..). 2. Write a Program to find Maximum out of Two Numbers using friend function. Note: Here one number is a member of one class and the other number is member of some other class.	2	2	2
5	1. Write a Program to swap private data members of classes Named as class_1, class_2 using friend function. 2. Write a Program to design a class complex to represent complex numbers. The complex class should use an external function (use it as a friend function) to add two complex numbers. The function should return an object of type complex representing the sum of two complex numbers.	2	2	2
6	1. Write a Program using copy constructor to copy data of an object to another object. 2. Write a Program to allocate memory dynamically for an object of a given class using class's constructor.	2	2	2
7	1.Write a program to design a class representing complex numbers and having the functionality of performing addition & multiplication of two complex numbers using operator overloading. 2. Write a Program to overload operators like *, <<, >> using friend function. The following overloaded operators should work for a class vector.	2	2	2
8	1.Write a Program to design a class to represent a matrix. The class should have the functionality to insert and retrieve the elements of the matrix. 2.Write a program to overload new/delete operators in a class.	2	2	2
9	1.Write a Program to design a class to represent a matrix. The class should have the functionality to insert and retrieve the elements of the matrix. 2.Write a program for developing a matrix class which can handle integer matrices of different dimensions. Also overload the operator for addition, multiplication & comparison of matrices.	2	2	2
10	1. Write a Program illustrating how the constructors are implemented and the order in which they are called when the classes are inherited. Use three classes	2	2	2

	Named alpha, beta, gamma such that alpha, beta are base class and gamma is derived class inheriting alpha & beta. 2. Write a Program to design a student class representing student roll no. and a test class (derived class of student) representing the scores of the student in various subjects and sports class representing the score in sports. The sports and test class should be inherited by a result class having the functionality to add the scores and display the final result for a student.			
11	1. Write a program to maintain the records of person with details (Name and Age) and find the eldest among them. The program must use this pointer to return the result. 2. Write a Program to illustrate the use of pointers to objects which are related by inheritance.	2	2	2
12	1. Write a program illustrating the use of virtual functions in class. 2. Write a program to design a class representing the information regarding digital library (books, tape: book & tape should be separate classes having the base class as media). The class should have the functionality for adding new item, issuing, deposit etc. the program should use the runtime polymorphism.	2	2	2
13	1. Write a program to show conversion from string to int and vice-versa. 2. Write a program showing data conversion between objects of different classes.	2	2	2
14	1. Write a program showing data conversion between objects of different classes and conversion routine should reside in destination class. 2. Write a program to copy the contents of one file to another.	2	2	2
15	1. Write a program to implement the exception handling. 2. Write a program to maintain the elementary database of employee using file concepts.	2	2	2
	Total Hours	**30**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	70%	60%	50%	50%	30%
Level 2	Apply Analyse	30%	40%	50%	50%	70%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Lab Performance (20%)	End Semester Exam (20%)
Level 1	Remember Understand	40%	30%
Level 2	Apply Analyse	60%	70%
Level 3	Evaluate Create		
Total		**100%**	**100%**

Recommended Resources

1. Stanley B. Lippman, Josée Lajoie, Barbara E. Moo. (2012) C++ Primer, Addison-Wesley
2. Schildt, H. (1998). C++ Complete Reference. Osborne McGraw-Hill, 1997.

Other Resources

1. Eckel, B. (2000). Thinking in C++ Vol-1. Pearson
2. Lafore, R. (2001) Object-oriented programming in C++ Sams Publishing, Fourth edition.
3. Lischner, R. (2003). STL Pocket Reference: Containers, Iterators, and Algorithms. " O'Reilly Media, Inc."

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Discrete Mathematics

Course Code	CSE 203	Course Category	Core Course (CC)		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)	NA	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**	NA			
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. The objective is to equip the students with mathematical definitions, proofs, and applicable methods.
2. Use mathematically correct terminology and notation. Constructs correct direct and indirect proofs.
3. Use foundational concepts in number theory and algorithms and developing problem-solving skills through the application of mathematical reasoning and induction principles.
4. Familiar about graphs and graph models, terminology, and special types is to understand the fundamental concepts and applications of graphs in various domains.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Express an argument using predicates, quantifiers and logic connectives and determine if the argument is valid.	2	80%	80%
Outcome 2	Apply the rules of inferences and methods of proofs including direct and indirect proofs, proof by contradiction and mathematical induction.	3	70%	60%
Outcome 3	Describe set properties, set operations, set identities, and representing relationship between the sets.	2	80%	70%
Outcome 4	Discover whether a given function is one-one, onto and invertible.	4	70%	60%
Outcome 5	Define the concept of divisibility, congruence, greatest common divisor, prime numbers, and prime factorization of numbers.	1	80%	80%
Outcome 6	Apply counting principles to determine probabilities and solving problems using recurrence relations.	3	70%	60%
Outcome 7	Explain graphs, their representations and determine the Euler circuits, Hamilton circuits, Euler paths and Hamilton paths in a graph.	3	80%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	**2**	**3**	**2**	-	-	-	-	-	-	-	-				
Outcome 2	**2**	3	2	**-**	**-**	-	-	-	-	-	-				
Outcome 3	2	3	2			-	-	-	-	-	-				
Outcome 4	3	**2**	3			-	-	-	-	-	-				
Outcome 5	2	3	2			-	-	-	-	-	-				
Outcome 6	3	3	3			-	-	-	-	-	-				
Outcome 7	3	3	3			-	-	-	-	-	-				
Average	**3**	**3**	**2**												

Course Unitization Plan

Unit No.	Description of Topic	Contact hours	CLo's Addressed	Reference
Unit 1	**The Foundations: Logic and Proofs**	**10**		
	Propositional Logic, Applications of Propositional Logic,	1	**CO 1**	1
	Propositional Equivalences	1	**CO 1**	1
	Predicates and Quantifiers	2	**CO 1**	1
	Nested Quantifiers, Rules of Inference	2	**CO 2**	1
	Introduction to Proofs	2	**CO 2**	1
	Proof Methods and Strategy.	2	**CO 2**	1
Unit 2	**Set Theory**	**8**		
	Laws of set theory	1	**CO 3**	1
	Set Operations	1	**CO 3**	1
	Functions	2	**CO 4**	1
	Sequences and Summations	2	**CO 4**	1
	Matrices	2	**CO 4**	1
Unit 3	**Elementary number theory, Induction and Recursion**	**9**		
	Divisibility and Modular Arithmetic	2	**CO 5**	1
	nteger Representations and Algorithms	2	**CO 5**	1
	Primes and Greatest Common Divisors, Solving Congruence	2	**CO 5**	1
	Mathematical Induction, Strong Induction and Well-Ordering	2	**CO 2**	1
	Recursive Definitions and Structural Induction.	1	**CO 5**	1
Unit 4	**Counting principles**	**9**		
	The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations	2	**CO 6**	1
	Binomial Coefficients and Identities	2	**CO 6**	1
	Applications of Recurrence Relations, Solving Linear Recurrence Relations	2	**CO 6**	1
	Divide-and-Conquer Algorithms	2	**CO 6**	1
	Recurrence Relations	1	**CO 6**	1
Unit 5	**Introduction to Graph Theory**	**9**		
	Graphs and Graph Models, Graph Terminology and Special Types of Graphs	3	**CO 7**	1
	Trees, Spanning trees, Minimal spanning trees	2	**CO 7**	1
	Representing Graphs and Graph Isomorphism	2	**CO 7**	1
	Connectivity, Euler and Hamilton Paths	1	**CO 7**	1
	Shortest-Path Problems	1	**CO 7**	1
	Total contact Hours	45		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	**Mid-1 (25%)**	**CLA-2 (10%)**	**CLA-3 (10%)**	
Level 1	Remember Understand	50%	50%	40%	40%	50%
Level 2	Apply Analyse	50%	50%	60%	60%	50%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Kenneth, H. R. (2012). Discrete Mathematics and Applications, Seventh edition,
2. Tata McGraw-Hill.

Other Resources

Course Designers

1. Dr. Ranjana Mehta, Dr. Fouzul Atik, Prof. Kannan

Design and Analysis of Algorithms

Course Code	CSE 204	Course Category	Core Course (CC)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)	CSE 107	Co-Requisite Course(s)	CSE202	Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To impart basic skills to analyse the performance of algorithms.
2. To train the students to choose appropriate algorithm design techniques for solving problems.
3. To make aware how the choice of data structures and algorithm design methods impact the performance of programs.
4. To impart basic proficiency to deal with NP problems and to develop approximate algorithms wherever required
5. To create an understanding of the basic issues of complex and efficient algorithms.
6. To introduce advanced topics of Backtracking and Branch and bound algorithms required in state space search.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
CO 1	Express an argument using predicates, quantifiers and logic connectives and determine if the argument is valid.	2	80%	80%
CO 2	Apply the rules of inferences and methods of proofs including direct and indirect proofs, proof by contradiction and mathematical induction.	3	70%	60%
CO 3	Describe set properties, set operations, set identities, and representing relationship between the sets.	2	80%	70%
CO 4	Discover whether a given function is one-one, onto and invertible.	4	70%	60%
CO 5	Define the concept of divisibility, congruence, greatest common divisor, prime numbers, and prime factorization of numbers.	1	80%	80%
CO 6	Apply counting principles to determine probabilities and solving problems using recurrence relations.	3	70%	60%
CO 7	Explain graphs, their representations and determine the Euler circuits, Hamilton circuits, Euler paths and Hamilton paths in a graph.	3	80%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	**2**	**3**	**2**	-	-	-	-	-	-	-	-				
Outcome 2	**2**	3	2	**-**	**-**	-	-	-	-	-	-				
Outcome 3	2	3	2			-	-	-	-	-	-				
Outcome 4	3	**2**	3			-	-	-	-	-	-				

Outcome 5	2	3	2			-	-	-	-	-	-				
Outcome 6	3	3	3			-	-	-	-	-	-				
Outcome 7	3	3	3			-	-	-	-	-	-				
Course Average	**3**	**3**	**2**												

Course Unitization Plan

Unit No.	Description of Topic	Contact hours	CLo's Addressed	Reference
Unit 1	**The Foundations: Logic and Proofs**	**10**		
	Propositional Logic, Applications of Propositional Logic,	1	**CO 1**	1
	Propositional Equivalences	1	**CO 1**	1
	Predicates and Quantifiers	2	**CO 1**	1
	Nested Quantifiers, Rules of Inference	2	**CO 2**	1
	Introduction to Proofs	2	**CO 2**	1
	Proof Methods and Strategy.	2	**CO 2**	1
Unit 2	**Set Theory**	**8**		
	Laws of set theory	1	**CO 3**	1
	Set Operations	1	**CO 3**	1
	Functions	2	**CO 4**	1
	Sequences and Summations	2	**CO 4**	1
	Matrices	2	**CO 4**	1
Unit 3	**Elementary number theory, Induction and Recursion**	**9**		
	Divisibility and Modular Arithmetic	2	**CO 5**	1
	Integer Representations and Algorithms	2	**CO 5**	1
	Primes and Greatest Common Divisors, Solving Congruence	2	**CO 5**	1
	Mathematical Induction, Strong Induction and Well-Ordering	2	**CO 2**	1
	Recursive Definitions and Structural Induction.	1	**CO 5**	1
Unit 4	**Counting principles**	**9**		
	The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations	2	**CO 6**	1
	Binomial Coefficients and Identities	2	**CO 6**	1
	Applications of Recurrence Relations, Solving Linear Recurrence Relations	2	**CO 6**	1
	Divide-and-Conquer Algorithms	2	**CO 6**	1
	Recurrence Relations	1	**CO 6**	1
Unit 5	**Introduction to Graph Theory**	**9**		
	Graphs and Graph Models, Graph Terminology and Special Types of Graphs	3	**CO 7**	1
	Trees, Spanning trees, Minimal spanning trees	2	**CO 7**	1
	Representing Graphs and Graph Isomorphism	2	**CO 7**	1
	Connectivity, Euler and Hamilton Paths	1	**CO 7**	1
	Shortest-Path Problems	1	**CO 7**	1
	Total contact Hours	45		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="4">Continuous Learning Assessments (60%)</th><th rowspan="2">End Semester Assessments (40%)</th></tr>
<tr><th>CLA-1 (15%)</th><th>Mid-1 (25%)</th><th>CLA-2 (10%)</th><th>CLA-3 (10%)</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">50%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. Kenneth, H. R. (2012). Discrete Mathematics and Applications, Seventh edition,
2. Tata McGraw-Hill.

Other Resources

Course Designers

1. Dr. Ranjana Mehta, Dr. Fouzul Atik, Prof. Kannan

Hands on with Python

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 205</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Core Course (CC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td></td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. To understand python programming concepts clearly.
2. To make students able to write python programs clearly.
3. To apply these concepts to write programs in different domains.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate efficient data management by selecting appropriate data structures for mutable and immutable types.	2	85%	80%
Outcome 2	Demonstrate clear code logic and improved readability through proficient use of data type operations.	1,2	85%	80%
Outcome 3	Design programs with robust control flow and modular code structures based on flow control statements and functions	4	85%	80%
Outcome 4	Develop skills to design resilient software capable of handling errors gracefully.	4	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	3		2							3	1	1	3
Outcome 2	1	1		2	2				2			3	1	1	3
Outcome 3	1	1		2	2				2			3	1	1	3
Outcome 4	3	3	3	3	2				3			3	1	1	3
Average	**2**	**2**	**3**	**3**	**2**				**2**			**3**	**1**	**1**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction: Language Fundamentals**	**6**		
	Features, Limitations, advantages, and applications of python	2	1	1,2
	Identifiers and Reserved words	1	1	1,2
	Data types: Fundamental data types (int, float, complex, bool, string), Mutable vs Immutable	1	1	1,2
	Derived Data types: Byte, Byte array, List, tuple, set, frozenset, range, dictionary, None	2	1	1,2
Unit 2	**Python Operators**	**6**		
	Arithmetic Operators	1	2	1,2
	Relational operators, chaining of relational operators	1	2	1,2
	Logical Operators, Bitwise operators	2	2	1,2
	Module, Input & Output statements	2	2	1,2
Unit 3	**Python: Flow control statements**	**6**		
	Conditional/selection statements	2	3	1,2
	Iterative Statements: For, while, For-else	2	3	1,2
	Transfer statements: break, continue,pass	2	3	1,2
Unit 4	**Python: Functions**	**6**		
	Inbuilt functions and user defined functions	2	3	1,2
	Filter, Map and reduce	2	3	1,2
	Global and local variables	2	3	1,2
Unit 5	**Python advanced topics**	**6**		
	Object oriented programming	3	4	1,2
	Try-except block	3	4	1,2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	60%	40%	50%	40%	40%	40%	50%	40%	40%	40%
Level 2	Apply Analyze	40%	60%	50%	60%	60%	60%	50%	60%	60%	60%
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Learn complete python in simple way, Durgsoft Learning material (online available)
2. PYTHON PROGRAMMING EXERCISES, GENTLY EXPLAINED by Al Sweigart, Inventwithpython.com.

Other Resources

1. The Joy of Computing using Python by Prof.Sudarshan Iyengar, IIT Ropar (nptel course)

Course Designers

1. Dr. V. Udaya Sankar, Asst Professor, Dept of ECE, SRM University – AP

Creativity and Critical thinking Skills

Course Code	AEC 104	**Course Category**	Ability Enhancement Course (AEC)		**L**	**T**	**P**	**C**
					1	0	1	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Literature & Languages	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Identify key concepts associated with creative problem-solving and critical analysis.
2. Interpret and summarize various models and frameworks used in fostering creative and critical thinking skills.
3. Apply divergent thinking methods to generate innovative solutions to multifaceted problems.
4. Assess and compare the strengths and weaknesses of various critical thinking approaches in decision-making.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Define and describe fundamental concepts and theories related to creativity and critical thinking.	1	80%	80%
Outcome 2	Explain the significance of creativity and critical thinking in problem-solving and decision-making processes.	2	80%	60%
Outcome 3	Implement critical thinking strategies to analyse and evaluate information and arguments effectively.	3	80%	70%
Outcome 4	Analyse and assess the effectiveness of specific creative thinking methods in addressing real-world problems.	4	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	3	3	3			3		3		3			
Outcome 2	3	3	3	3	3			3		3		3			
Outcome 3	3	3	3	3	3			3		3		3			
Outcome 4	3	3	3	3	3			3		3		3			
Average	3	3	3	3	3			3		3		3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Creativity and Critical Thinking**	**10**		
	Introduction to key concepts	3	1,3	1
	Importance in personal and professional contexts	3	1,3	1,2
	Understanding the differences	2	2,3	1,4
	Real-world applications	2	1,3	1,3
Unit 2	**Overcoming Mental Blocks**	**5**		
	Identifying and addressing barriers	3	1	14
	Exercises for mental flexibility	2	4	1,2
Unit 3	**Critical Thinking Skills**	**5**		
	Recognizing common pitfalls	1	1,3	1,2
	Examples and group discussion	1	2,3	1,2
	Techniques for assessing information credibility	2	1,3	1
	Case studies and research exercises	1	1,3	3
Unit 4	**Application of Creative Solutions**	**5**		
	Practical problem-solving exercises	1	1,3	1,4
	Group projects and case studies	1	2,3	2,3
	Integrating ethics into creative and critical thinking	2	1,3	1
	Discussions on ethical dilemmas and decision-making	1	1,3	3
Unit 5	**Application of Creative Solutions**	**5**		
	Quizzes on concepts and techniques	1	1,3	1,2
	Individual and group assignments	1	2,3	1,2
	Applying creativity and critical thinking to a real-world scenario	2	1,3	1
	Presentation and peer evaluation	1	1,3	3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (75%)			
		CLA-1 (20%)	**CLA-2 (20%)**	**CLA-3 (20%)**	**Project Work (45%)**
Level 1	Remember	30%		10%	
	Understand				
Level 2	Apply	70%	100%	90%	100
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Kelley, T., & Kelley, D. (2013). Creative confidence: Unleashing the creative potential within us all. Crown Currency.
2. Fisher, A. (2011). Critical thinking: An introduction.
3. Dubner, S. D. L. S. J. (2014). Think Like a Freak: The Authors of Freakonomics Offer to Retrain Your Brain. Harper Collins.
4. Nussbaum, B. (2013). Creative intelligence: Harnessing the power to create, connect, and inspire.

Other Resources

Course Designers

1. Dr. Sayantan Thakur

Coding Skill - II

Course Code	CSE 206	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand and apply problem-solving techniques using greedy methods, including algorithmic thinking and selection as a greedy strategy, in various problem domains.
2. Develop proficiency in solving problems through dynamic programming, including recognizing and solving overlapping sub-problems, and understanding the trade-off between exponential and polynomial time complexity.
3. Master the principles of backtracking algorithms and their applications in solving complex problems, such as the N-Queens and maze problems.
4. Acquire a comprehensive understanding of graph algorithms, including graph terminology, storage and retrieval of graph data, traversal techniques like Breadth-First Search and Depth-First Search, and graph-related problems like minimum sum path matrices and spanning trees.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Design and analyze algorithms using greedy methods, such as greedy coin change and fractional knapsack, and apply them to real-world problem-solving scenarios.	4	80%	75%
Outcome 2	Employ dynamic programming techniques to optimize solutions for various problems, including calculating the longest increasing subsequence and solving grid-related problems like 0/1 knapsack.	2, 3	75%	70%
Outcome 3	Master the art of backtracking and be able to apply it to problems such as N-Queens and maze problems, effectively finding solutions by exploring and eliminating possibilities	2, 3	75%	70%
Outcome 4	Possess a strong foundation in graph algorithms, including the ability to represent and traverse graphs, find spanning trees, and identify strongly connected components in directed graphs, making them well-prepared for a wide range of graph-related challenges.	2, 3	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	3	3		2				1	1			3	2	
Outcome 2	2	3	3		2				1	1			3	2	
Outcome 3	2	3	3		2				1	1			3	2	
Outcome 4	2	3	3		2				1	1			3	2	
Outcome 5	2	3	3		2				1	1			3	2	
Average	**2**	**3**	**3**		**2**				**1**	**1**			**3**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Problem Solving implementing Algorithms - Greedy Methods Algorithmic Thinking, Selection as Greedy Strategy, Heaps Min and Max, Priority Queues, Greedy Coin change solution, Fractional Knapsack, Sequencing jobs with deadlines, Activity selection, Examples, Practice problems. Problem Solving with Algorithms – Dynamic Programming 1 Dynamic programming features, the overlapping sub-problems, Exponential time Vs Polynomial Time, Exponential time illustration using staircase example, Formation of the substructure, Substructure using greedy coin change, Substructure for cloth cutting problem, Ways to translate, Longest Increasing Sub-sequence, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	**1**	
Unit 2	Problem Solving with Algorithms – Dynamic Programming II Problem solving on grids: 0/1 Knapsack, Trip Organization, Longest Common Sub-string, Longest Common Sub-sequence, Minimum Edit Distance, Examples, Sum of max sub square on a binary grid, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	2	
Unit 3	Problem Solving implementing Backtracking Algorithms The backtrack view, Applications of the backtracking, Iterative approach Vs Loop free approach, State Space tree illustration using 3-bit number problem, finding triplets exactly equal to a given sum, finding triplets less than or equal to a given sum, Grid Solution: N-Queens/Maze problems, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	3	
Unit 4	Problem Solving using Graph Algorithms I Graph Terminology, types of graphs, Storage and retrieval of graph data, adjacency matrix, incidence matrix, Handshaking Lemma, Algorithm to find a simple graph for a given input sequence, Graph Traversal Algorithms: Breadth First Search - Traversal – Examples, Graph Algorithms: Depth First Search - Traversal – Examples, Min Sum Path Matrix, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	4	
Unit 5	Problem Solving implementing Graph Algorithms II Spanning Trees, Minimum cost spanning trees, Connected Components in the graph, strongly connected points, Directed Acyclic Graphs, Kahn's Algorithm, Examples, Practice problems. Problem Solving implementing String Algorithms Problem Solving implementing TRIE Data structure, Pattern matching algorithm, KMP algorithm, Examples, Practice problems. Contextual implementation using Competitive Coding using global coding platforms: Code chef/ Leet code / Codeforces / Hackerrank etc.	**9**	4	

Total contact hours	45

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)								End Semester Exam (60%)	
		CLA-1 (20%)		Mid-1 (20%)							
		Th	Prac	Th	Prac					Th	Prac
Level 1	Remember		50%		50%						50%
	Understand										
Level 2	Apply		50%		50%						50%
	Analyse										
Level 3	Evaluate										
	Create										
Total			100%		100%						100%

Recommended Resources

Other Resources

Course Designers

Digital Electronics

Course Code	CSE 207	**Course Category**	Professional Core (C)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Basic Mathematics and Science, Basics of Electrical	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire the basic knowledge of digital logic levels and its application to understand the digital electronic circuits.
2. To impart how to design Digital Circuits both theoretically and practically.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand various number system and its application in digital electronics and compare different types of logic families.	2	85 %	80 %
Outcome 2	Apply mapping, mathematical methods and logical tools to design digital circuits.	3	85 %	80 %
Outcome 3	Designing of various combinational, synchronous, and asynchronous sequential circuits.	4	75 %	65 %
Outcome 4	Explain the functioning of various memory devices.	3	80 %	70 %

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	-	-	-	-	-	3	3	2	1	2
Outcome 2	3	3	3	3	2	3	1	-	3	2	3	3	3	3	3
Outcome 3	3	2	1	1	1	-	-	-	1	-	2	3	1	1	1
Outcome 4	3	2	1	2	2	-	-	-	1	-	2	3	1	1	3
Average	**3**	**2.25**	**2**	**2.25**	**1.75**	**3**	**1**	**-**	**1.67**	**2**	**2.5**	**3**	**1.75**	**1.5**	**2.25**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Digital Fundamentals**	**15**		
	4 and 5 variable K-maps	2	1,2	1,2
	1's and 2's complements	2	1	1
	Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes (*Active Learning*)	2	1,2	1
	Sum of products and product of sums, Minterms and Maxterms	1	1	1
	Quine-McCluskey method of minimization	2	1,2	1,3
	Lab Experiment 1: Realization of Basic Logic Gates.	3	2	1,2
	Lab Experiment 2: Design of Code Converters (Binary to Gray) & (Gray to Binary).	3	2	1
Unit 2	**Combinational Circuit Design**	**18**		
	4 bit Adder and Subtractor	1	1	1,2,3
	Binary Parallel Adder – Carry look ahead adder, BCD Adder	2	1,2	2,3
	Multiplexer, Demultiplexer	2	1,2	1
	Magnitude Comparator	2	1,2	1,3
	Decoder, Encoder, Priority Encoder (*Active Learning*)	2	1,2	2,3
	Lab Experiment 3: Design of Half-Adder/Subtractor, Full-Adder/Subtractor, Multiplexers/De Multiplexers.	3	3	1,2
	Lab Experiment 4: Design of Decoder and Encoder/ BCD 7SSD.	3	3	2,3
	Lab Experiment 5: Design of Magnitude Comparator (2-bit).	3	3	1,3
Unit 3	**Synchronous Sequential Circuits**	**21**		
	Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF	2	1,2	3,4
	Analysis and design of clocked sequential circuits – Design – Moore/Mealy models	2	1	4
	State minimization, State assignment	1	1	4
	Circuit implementation – Design of Counters – Ripple Counters, Ring Counters	2	1,2	4
	Shift Registers, Universal Shift Register	2	1,2	3,4
	Lab Experiment 6: Design and Verification of Flip-Flops using IC.	3	3	3,4
	Lab Experiment 7: Design of Asynchronous Counter (Any Mod, Up and Down, Jhonson and Ring).	3	3	4
	Lab Experiment 8: Design of Synchronous Counter (Any Mod, Decade counter 74ls90).	3	3	4
	Lab Experiment 9: Design of Universal Shift Register (Serial to Parallel, Parallel to Serial, Serial to Serial and Parallel to Parallel Converters).	3	3	3,4
Unit 4	**Asynchronous Sequential Circuits**	**9**		
	Stable and unstable states, output specifications	3	1,2,3	2,3
	Cycles and races, state reduction, race free assignments	2	3	1,3
	Hazards, Essential Hazards	2	2,3	1,3
	Pulse mode sequential circuits, Design of Hazard free circuits	2	1,2,3	1,3
Unit 5	**Memory Devices**	**12**		
	Classification of memories – ROM – ROM organization – PROM – EPROM – EEPROM –EAPROM	2	4	1,5
	RAM – RAM organization – Write operation – Read operation	1	4	2,5

	Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL)	2	4	5
	Field Programmable Gate Arrays (FPGA)	1	4	5
	Implementation of combinational logic circuits using ROM, PLA, PAL.	3	4	3,5
	Lab Experiment 10: Design & Verification of Memory (SRAM)	3	4	2,5
Total Contact Hours (Theory + Lab)		**75**		

Learning Assessment Theory

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (40%)**				**End Semester Exam (30%)**
		CLA-1 (10%)	**CLA-2 (10%)**	**CLA-3 (10%)**	**Mid Sem (10%)**	
Level 1	Remember	55%	40%	40%	40%	46%
	Understand					
Level 2	Apply	45%	60%	60%	60%	46%
	Analyse					
Level 3	Evaluate					8%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment Practical

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (20%)**			**End Semester Exam (10%)**
		Lab Performance (10%)	**Observation Note (5%)**	**Model Exam (5%)**	
Level 1	Remember	30%	80 %	30%	30%
	Understand				
Level 2	Apply	70%	20%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Ciletti, M. D., & Mano, M. M. (2007). Digital design. Hoboken: Prentice-Hall.
2. Wakerly, F. J. (2008). Digital Design. Fourth Edition, Pearson/PHI.
3. Yarbrough, J. M. (2006). Digital Logic Applications and Design. Thomson Learning.
4. Roth, C. H. (2013). Fundamentals of Logic Design. 6th Edition, Thomson Learning.
5. Maini, A. K. (2014). Digital Electronics. Wiley.

Other Resources

1. Floyd, T. L. (2011). Digital Fundamentals. 10th Edition, Pearson Education Inc.
2. Givone. D. D. (2003). Digital Principles and Design", TMH.

Course Designers

Probability and Statistics

Course Code	CSE 208	**Course Category**	Core Course (CC)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	ECE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. After this course, students should be able to understand the compute basic probabilities, formulate a problem using random variables, analyze sample data for possible conclusions about population.
2. After taking this course, students will be able to use calculators and tables to perform simple statistical analyses for small samples and use popular statistics packages, such as SAS, SPSS, S-Plus, R or Matlab, to perform simple and sophisticated analyses for large samples.
3. Students who are interested in becoming statisticians themselves can build a solid foundation in probability and statistics through this course but should plan on additional coursework for thorough and comprehensive preparation.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the basic knowledge on fundamental probability concepts, including random variable, probability of an event, additive rules and conditional probability Bayes' theorem S understand the basic statistical concepts and measures	2	70%	75%
Outcome 2	Demonstrate the concept of the central limit theorem understand several well-known distributions, including, Geometrical, Negative Binomial, Pascal, Normal and Exponential Distribution	4	70%	73%
Outcome 3	Apply the central limit theorem to sampling distribution use estimation technique to determine point estimates confidence interval and sample size.	3	75%	80%
Outcome 4	Interpret and Analyses in SAS, S-PLUS, R or MATLAB	4	70%	70%
Outcome 5	Apply central limit theorem and hypothesis testing	3	70%	72%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3		2					2						
Outcome 2	3	2		1					2						
Outcome 3	2	3		1					2						
Outcome 4	2	3		2					3						
Outcome 5	3	2		2					3						
Average	2	3		2					3						

<u>Course Unitization Plan</u>

Unit No.	Description of Topic	Contact hours	CLOs Addressed	Reference
	<u>Unit I – Introduction to Probability</u>	**7**		
	Basic principle of counting, multinomial coefficients	1	1	1
	Axioms of probability, computing probabilities - unions, intersections, and Inclusion-exclusion principle	2	1	1
Unit I	Conditional probability, Independent events	2	1	1
	In Bayes' theorem, law of total probability	2	1	1
	<u>Unit II- Random variables and distributions</u>	**12**		
	Random variables, cumulative distribution function	1	1	1
	Discrete random variables	1	1	1
	Cumulative distribution function and its properties	1	1	1
	Expectation, variance and standard deviation of discrete random variables, conditional expectation	1	1	1
	Bernoulli and binomial distributions, their expectations and variances	1	1	1
Unit II	Poisson, geometric and negative binomial distributions, their expectati variances	1	1	1
	Continuous random variables	1	1	1
	Expectation and variance, Conditional expectation	2	1	1
	Uniform and exponential distributions	1	1	1
	Normal distribution , Student's t-distribution	2	1	1
	<u>Unit III – Joint probability distributions and CLT</u>	**8**		
	Joint distribution of two random variables - discrete and continuous	2	2	1
Unit III	Change of variables under integration (Determinant of Jacobian), Independent random variables and their sum,	3	2	1
	Central limit theorem	1	2	1
	Covariance and correlation between random variables	2	2	1
	<u>Unit IV – Descriptive statistics and linear regression</u>	**8**		
	Graphical representation of data -Histograms, scatter plots & time plots	1	3,4	1
	Descriptive statistics	2	1	2,3
Unit IV	Correlation – Pearson's correlation coefficient	2	3	2,3
	Linear regression, Goodness of fit, Normal equations for least-squares regression,	3	3,5	2,3
	<u>Unit V – Introduction to statistical inference</u>	**10**		
	Population, sample and statistics	2	3	2,3
	Point estimation of population parameters	1	3	2,3
	Confidence intervals for population mean, and population proportion	2	3	2,3
	P-values, Significance level, Tests of significance for population mean, population proportion.	3	3,4	2,3
	Types of errors, contingency table, sensitivity, specificity, power of a test.	2	3	2,3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	25%	10%	20%	25%
	Understand	30%	30%	30%	30%	30%
Level 2	Apply	20%	25%	30%	30%	25%
	Analyse	20%	20%	30%	20%	20%
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Ross, S. M. (2012). A first course in probability (9th Edition). Pearson Education

2. Baron, M. (2019). Probability and statistics for computer scientists. Chapman and Hall/CRC.

3. Montgomery, D. C., & Runger, G. C. (2010). Applied statistics and probability for engineers. John wiley & sons.

Other Resources

Course Designers

Database Management Systems

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 209</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Core Course (C)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td>Data Structures</td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the advantages of DBMS over traditional file systems and characteristics of DBMS.
2. Design ER-models to represent data of the organization.
3. Design relational databases and execute various queries on the database using SQL.
4. Gain knowledge of various anomalies that can occur in the database and overcome those with the help of normal forms.
5. comprehend the purpose of transaction processing and concurrency control protocols.
6. Learn indexing schemes used in DBMS for the fast retrieval of data from the database.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify and design database structure for a system.	4	70%	65%
Outcome 2	Design relational databases and execute queries on the database using SQL.	3	70%	65%
Outcome 3	Implement concurrency control protocols for transaction processing systems.	3	70%	65%
Outcome 4	Use indexing schemes for fast retrieval of data from the database.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1						1		3	3	1
Outcome 2	3	3	3	2	1						1	1	3	3	1
Outcome 3	3	2	3	2	1							1	3	3	1
Outcome 4	3	2	2	2	1						1	1	3	3	1
Average	**3**	**3**	**3**	**2**	**1**						**1**	**1**	**3**	**3**	**1**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	Introduction to DBMS and Relational model	8		
	File Processing System, Advantages of DBMS over File Processing System, Database System Applications.	1	1	1,3
	BMS Architecture: The three-schema architecture Data Independence: Logical and Physical.	2	1	1,3
	Data Models: Hierarchical, network and relational models.	1	1	1,3
	Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values.	2	1	1,3
	Database constraints (Domain, Key constraints, integrity constraints) and their importance.	2	1	1,3
Unit II	Query processing	10		
	Relational Algebra.	2	2	1,3
	Relational Calculus.	1	2	1,3
	Introduction to SQL: Database Objects- DDL Schema definitions.	1	2	1,3
	DML- Insert, select, update, delete.	1	2	1,3
	Views, exercise on SQL queries.	1	2	1,3
	Transaction support in SQL.	1	2	1,3
	Aggregate Functions, Null Values, Views.	1	2	1,3
	Complex Integrity Constraints in SQL.	1	2	1,3
	Assertions, Triggers	1	2	1,3
Unit III	Conceptual model and database design	9		
	Entity Relationship model Entity types, Entity Sets, Attributes, and Keys Relationships, Relationship types and constraints, Weak Entity types.	3	2	1,2
	Enhanced ER (EER) Modeling: Super/Sub Classes Specialization and Generalization. Constraints and characteristics of Specialization and Generalization.	2	2	1,2
	Example EER Schema.	1	2	
	Basics of Normalization, Normal Forms: First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF)	2	2	1,2
	BCNF, 4NF	1	2	1,2
Unit IV	Transaction Processing, Concurrency Control and Recovery	10		
	ıtroduction of transaction processing, advantages and disadvantages of transaction processing system.	2	3	1,3
	Serializability and Recoverability of transaction.	2	3	1,3
	Concurrency Control Lock based Protocols.	2	3	1,3
	Timestamp Based Protocols – Validation based Protocols - Multiple Granularity Locking.	2	3	1,3
	Recovery techniques.	2	3	1,3
Unit V	Overview of Storage and Indexing	8		
	Data on External Storage, File Organization and Indexing - Clustered Indexes, Primary and Secondary Indexes.	2	4	1,3
	Indexed Sequential Access Methods (ISAM) B+ Trees: Tree Structure, Search, Insert, Delete.	3	4	1,3
	Hash Based Indexing: Static Hashing, Extendible hashing, Linear Hashing, Extendible vs. Linear Hashing.	3	4	1,3

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Implementation of data storage and indexing methods using files.	4	4	1,2,3
2.	DML queries on a single table.	2	2	1,4
3.	Queries on Joining tables and Aggregate Functions.	4	2	1,3
4.	Nested queries, Queries on creation of views, indexes, sequences and access privileges.	4	2	1,3
5.	Triggers, Assertions.	4	2	1,3
6.	SQL Transactions.	4	3	1,3
7.	PL/SQL, Stored Procedures.	4	4	4
8.	Design and Develop Applications.	4	1,2	1,3
Total contact hours		30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (35%)				End Semester Exam (35%)
		CLA-1 (5%)	Mid-1 (20%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember					
	Understand					
Level 2	Apply	100%	100%	100%	100%	100%
	Analyze					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Lab Performance (15%)	End Semester Exam (15%)
Level 1	Remember		
	Understand		
Level 2	Apply	100%	100%
	Analyze		
Level 3	Evaluate		
	Create		
Total		**100%**	**100%**

Recommended Resources

1. Elmasri, R., Navathe, S. B. (2016). Fundamentals of Database Systems. India: Pearson India.
2. Ramakrishnan, R., & Gehrke, J. (2002). Database management systems. McGraw-Hill, Inc.
3. Silberschatz, A., Korth, H. F., & Sudarshan, S. (2011). Database system concepts. 6th Edition, McGraw Hill, 2011.
4. Garcia-Molina, H., Ullman, J. D., & Widom, J. (2000). Database system implementation (Vol. 672). Upper Saddle River: Prentice Hall.

Other Resources

1. Date. C. J. (2003). An Introduction to Database Systems (8 ed.). Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.

Course Designers

Web Technology

Course Code	CSE 210	**Course Category**	Core Course (CC)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. To familiarize the concepts of HTML and CSS.
2. To gain knowledge on Javascript for creating Dynamic Websites.
3. To gain knowledge about the ReactJS.
4. To comprehend server-side programming using PHP and the basics web services.
5. To make the students understand the Web hosting services.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe internet and world wide web	2	70%	65%
Outcome 2	Implement web pages using HTML, CSS and JavaScript	3	70%	65%
Outcome 3	Design Front-end Applications using ReactJS Framework Components.	4	70%	65%
Outcome 4	Create Web Services, server-side programming using PHP and the methods to access DBMS.	4	70%	65%
Outcome 5	Design backend programming by using MongoDB, Spring boot Framework-ORM and Hibernate-REST API	5	70%	65%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2												1	1	1
Outcome 2	3	3	3	2	3							1	1	2	1
Outcome 3	3	3	3	2	3							1	1	1	2
Outcome 4	3	2	2	2	3							1	2	2	2
Outcome 5	3	2	2	2	3							1	2	3	3
Average	**3**	**3**	**3**	**2**	**3**							**1**	**2**	**2**	**2**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	Introduction to WWW and Web development using HTML	10		
	Introduction to world wide web	1	1	3
	Introduction to HTML5	1	1	3
	Basic tags in HTML5 for text styling-Tags for linking images, videos and audio on a Web page.	1	1	3
	Special characters and line breaks in XHTML	1	1	3
	Various lists (Ordered and Unordered lists)	1	1	3
	Tables and Forms in HTML	1	1	3
	Introduction to CSS	1	1	3
	CSS for background	1	1	3
	Manipulation of texts, fonts, borders etc. using CSS	1	1	3
	Padding lists, positioning elements using CSS	1	1	3
UNIT II	JavaScript	8		
	Introduction to JavaScript	1	2	1, 2
	JavaScript Datatypes, Operators and Expressions	1	2	1
	String Manipulation	0.5	2	1, 2
	Conditional Statements and loops	0.5	2	1, 2
	Arrays and Objects in JS	1	2	1
	Functions in JS, modules in JS	1	2	1
	Recursion in JS	1	2	1
	Constructors in JavaScript	1	2	1, 2
	Pattern matching using Regular expressions in JavaScript	1	2	1,2
UNIT III	jQuery and ReactJS	10		
	Introduction to ReactJS& Setting up React Environment	1	3	1
	React DOM	1	3	1, 2
	Built-in components	1	3	1, 2
	User Defined Components	0.5	3	1, 2
	Internal component state(setState()).	0.5	3	1, 2
	ReactJS Lists	1	3	1, 2
	ReactJS forms and Keys	1	3	1
	React Events	1	3	1,2
	ES6 object Initializer	1	3	1
	Lifecycle methods in ReactJS	1	3	1
	Fetching data from API	1	3	1
UNIT IV	Server-side Programming -PHP	9		
	Introduction to Server-side scripting, Features of PHP.	1	4	1
	Datatypes, Operations and expressions.	1	4	1
	Control statements and arrays in PHP.	1	4	1
	Functions and Pattern matching in PHP	1	4	1
	Cookies and Sessions in PHP	1	4	1
	Filters in PHP	1	4	1
	Object Oriented Programming using PHP	1	4	1, 2
	Introduction to MySQL, features of MySQL	1	4	1
	MySQL and PHP Queries.	1	4	1,2
UNIT V	MongoDB	8		
	Introduction to NoSQL and Features of MongoDB	1	5	1, 2
	Operations on MongoDB databases	1	5	1
	Web hosting services	1	5	1
	Introduction to Node.js	1	5	1
	MVC Architecture	1	5	1
	Introduction to web services, REST and SOAP	1	5	1

	Backend Development Using Springboot Framework-ORM	1	5	1
	Hibernate-REST APIs	1	5	1
Total Contact Hours		Theory: 45		

Course Utilization Plan - Lab

Experiment No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Familiarize all the basic HTML tags for ● Heading styles ● Ordered and unordered lists ● Image ● Tables ● Forms ● Hyperlinks	2	1	3
2	Practice CSS for web page development ● The CSS element Selector ● CSS backgrounds and borders ● CSS fonts ● CSS effects, etc.	2	1	3
3	Create a static personal web page using hyperlinks, tables, images, etc.	2	1	3
4	Practice JavaScript coding: ● Find the sum of all elements/numbers of a given array ● Reverse a given string ● Generate the first N prime numbers. ● Create an HTML page to change the background color for every click of a button using Java script. ● Read the age of a person through a textbox and display his age group (Child/Teenage/Young/Senior citizen) ● Create a simple calculator with HTML and JavaScript functions. Read the inputs through text boxes and keep four different buttons to perform the operations such as add, div, sub, mul, etc. ● Develop a webpage with HTML and JavaScript to read name and marks of five subjects obtained for that particular student using forms. Further, it should compute the Grade and output the user.	2	2	1,2
5	Implement the following using HTML, CSS and JavaScript ● Create a registration form (Name, Age, Email ID, PIN code, Password, etc.) using HTML, CSS and perform the client validation of the details using JavaScript. The constraints on the user inputs are given below: o Name should contain alphabets or spaces. No other characters are allowed. o Age should be an integer between 18 and 60. o The email ID should be valid. o The PIN code should contain 6 digits (spaces or any other characters are not allowed) o Password should have a minimum length of 8 characters, at least one lower case letter and one upper case letter must be there. In addition, at least one special character and one digit must be present.	2	2	1,2
6	Create an interactive web user interface using ReactJS (Example: A simple version of a Social media application, messaging application, or E-commerce application).	4	3	1

7	Practice Server-side scripting using PHP. ● Write a PHP function that checks whether a string is all lowercase or not. ● Write a PHP script that checks whether a given string *S1* presents another string *S2*. ● Write a PHP script to remove non-numeric characters from the given string (Retain digits, comma and dot) ● Write a PHP script to remove all characters from a string except a-z A-Z 0-9 or " " ● Calculate the difference between two dates using object-oriented concept in PHP ● Create a Calculator class in PHP with required data and functions in such a way that it will accept two values as arguments, then add them, subtract them, multiply them together, or divide them on request.	2	4	1,2
8	Database connectivity using PHP, Operations on MySQL database using a structured query language (SQL) and PHP.	2	4	1,2
9	Connect MySQL with PHP. Create a simple webpage to store and retrieve details from a database. Example: A web application to handle billing process at super market. (Project Work).	2	4	1,2
10-14	Project Work on a full-stack project using HTML,CSS, Javascript React JS,PHP with Database (MySQL/MongoDB).	10	5	1,2
Total Contact Hours		Practical: 30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (35%)				End Semester Exam (35%)
		CLA-1 (5%)	Mid-1 (20%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	50%	40%	40%	20%	30%
Level 2	Apply Analyse	50%	60%	40%	40%	70%
Level 3	Evaluate Create	-	-	-	40%	-
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment - Lab

Bloom's Level of Cognitive Task		Continuous Learning Assessments (15%)		End Semester Exam (15%)
		Lab Record (5%)	Lab Performance (10%)	
Level 1	Remember Understand	20%	20%	40%
Level 2	Apply Analyse	40%	40%	20%
Level 3	Evaluate Create	40%	40%	40%
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Robin Nixon. (2021). Learning PHP, MySQL & JavaScript: A Step-by-Step Guide to Creating Dynamic Websites, 6th ed. O'Reilly Publication.
2. RobinWieruch. The Road to React. Zaccheus Entertainment
3. Robert W. Sebesta. (2020). Programming World Wide Web, 8th ed. Pearson Publishers

Other Resources

1. Bruno Joseph D'mello, Mithun Satheesh, and Jason Krol. (2017). Web Development with MongoDB and Node, 3rd ed. Packt Publishing Limited

Course Designers

Computer Networks

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 301</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Core Course (CC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td></td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the computer networking fundamentals with data communication system, TCP/IP and OSI reference mode.
2. Analyse the requirements for a given organizational structure and selection of appropriate network architecture and topology.
3. Specify and identify working limitation in existing protocols of networking layers and try to formulate new and better protocols.
4. Gain knowledge of services and design issues of Transport layer. Also compare and contrast TCP and UDP protocol.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe computer networking fundamentals based on data communication system, TCP/IP and OSI reference model	2	70 %	65%
Outcome 2	Demonstrate error control and flow control techniques at data link layer	3	70 %	65%
Outcome 3	Select the routing protocols for wired and wireless networks	3	70 %	65%
Outcome 4	Implement ECN congestion and flow control transport layer protocols	3	70 %	65%
Outcome 5	Compare and Contrast application layer protocols -FTP, HTTP, SMTP	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	
Outcome 2	2	2	3	3	2								2	2	
Outcome 3	2	3	3	2	2								2	2	
Outcome 4	3	3	3	3	2								2	3	
Outcome 5	2	3	3	3	2								2	2	
Average	**2**	**3**	**3**	**3**	**2**								**2**	**2**	

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	9		
	Basic Computer Network concepts, Protocol, Layering Scenario.	1	1	1,2
	Layer Architecture: OSI Model, TCP/IP model.	1	1	1
	Internet history standards and administration; Comparison of the OSI and TCP/IP reference model.	1	1	1,2
	Guided transmission media, wireless transmission media.	1	1	1
	Different LAN topologies: BUS, RING and STAR topology.	1	1	1
	Data Link layer design issues: Error detection techniques.	1	1	1
	Error Correction Techniques, Flow control.	1	1	1,2
	Sliding Window protocols. Go back N and selective Repeat protocols.	1	1	1,2
	Difference between single bit sliding window and n-bit sliding window protocols.	1	1	1,2
Unit 2	Medium Access Control	9		
	Static and Dynamic channel Allocations.	1	2	1,2
	Shared channel Access: Pure ALOHA and slotted ALOHA.	1	2	1,2
	Persistent CSMA protocols: 1,P and Non-persistent CSMA protocols.	1	2	1,2
	CSMA with collision detection. Comparison of different CSMA protocols.	1	2	1,2
	Collision free protocols: Bit-map protocol, Token Ring and Binary Count down protocols.	1	2	1,2
	Limited Contention protocols: Adaptive tree walk protocol.	1	2	1,2
	Shared medium for wireless networks: CSMA/CA or MACA.	1	2	1,2
	Interconnecting LANs: HUBS, Repeaters and Switches and bridges.	1	2	1,2
	Spanning tree algorithm for bridges.	1	2	1,2
Unit 3	Network Layer	9		
	Overview: Connection oriented and connection less services.	1	3	1,2
	Comparison of packet switched, and circuit switched networks.	1	3	1,2
	Routing: proactive routing and reactive routing protocols, static and dynamic routing protocols.	1	3	1,2
	Dijkstra Algorithm, Distance vector routing and Link state routing protocols.	1	3	1,2
	Routing in wireless networks: AODV and DSR routing protocols.	1	3	1,2
	Overview of IP header and IP addressing.	1	3	1,2
	Classful IP addressing: Class A, B,C,D and E.	1	3	1,2
	Limitations of classful Addressing, Introduction to Subnet.	1	3	1,2
	Overview of Congestion: Warning Bit, Choke packets, Load Shedding, RED (Random Early Detection)	1	3	1,2
Unit 4	Internetworking and Transport layer	7		
	IP Encapsulation and Tunnelling.	1	4	1
	IP packet fragmentation, ICMP, ARP.	1	4	1
	ICMP, DHCP, Introduction to Transport layer.	1	4	1
	Different end-to-end transport layer protocols: TCP and UDP.	1	4	1
	Brief explanation of TCP protocol.	1	4	1
	Brief explanation of UDP protocol.	1	4	1
	Packet formats for TCP and UDP protocol.	1	4	1
Unit 5	Transport and Application protocols	11		
	TCP Connection Management Modelling.	1	5	1
	TCP Sliding Window.	1	5	1
	TCP congestion control.	1	5	1
	Introduction to application layer paradigms.	1	5	1
	Client Server model.	1	5	1
	Introduction and overview of HTTP protocol.	1	5	1

	Overview of FTP protocol.	1	5	1
	Operation of Electronic Mail.	1	5	1
	Introduction to peer-to-peer communication models.	1	5	1
	Introduction and overview of TELNET.	1	5	1
	Importance of Security in computer Networks.	1	5	1
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Using Wireshark, for sniffing network traffic in real-time and analyse the packet contents--traffic analysis.	2	3	2
2	Simulate error detection technique using CRC Algorithm.	2	2	2
3	Write a program to implement error correction technique using Hamming code.	2	2	2
4	Write a program to implement 1-bit Stop and Wait Protocol at data link layer.	2	3	2
5	Simulate N-bit Sliding Window protocol, at data link layer.	2	3	2
6	Write a program to implement Dijkstra Shortest path routing protocol	2	3	2
7	Write a program to implement Distance Vector Routing.	2	3	2
8	Demonstrate TCP Client Server paradigm through simulation	2	1	2
9	Demonstrate UDP Client Server paradigm through simulation.	2	1	2
10	Write a program to implement echo command in client server socket programming.	2	3	2
11	Write a program to simulate Trace-route command.	2	3	2
12	Demonstrate the implementation of Ping command	2	3	2
13	Write a code to display the class of IP address, network mask and generate the subnet IP address based on the subnet bits entered from the keyboard	2	3	2
14	Write a code to implement sliding window protocol at the transport layer	2	3	2
15	Simulate transfer file operation using TCP	2	3	2
Total Contact Hours		30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (30%)**				**End Semester Exam (30%)**
		CLA-1 (10%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**CLA-3 (5%)**	
Level 1	Remember	70%	60%	30%	30%	60%
	Understand					
Level 2	Apply	30%	40%	70%	70%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (20%)**		**End Semester Exam (20%)**
		Lab Record (5%)	**Lab Performance (15%)**	
Level 1	Remember	50%	50%	50%
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Tanenbaum, A. S. (2011). Computer Networks , 5th Edition, Pearson Education.
2. Forouzan, B. A. (2013). Data Communications and Networking, 5th Edition TMH.

Other Resources

1. Kurose, J. K., & Ross, K. W. (2017). Computer Networking: A Top-Down Approach Featuring the Internet, 7th Edition, Pearson Education.
2. Shay, W. A. (2003). Understanding communications and Networks, 3rd Edition, Cengage Learning

Course Designers

Operating Systems

Course Code	CSE 302	**Course Category**	Core Course (CC)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	CSE 101, CSE 235	**Co-Requisite Course(s)**		**Progressive Course(s)**	CSE 326		
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To familiarize the main components of an OS & their functions
2. To study the process management and scheduling
3. To attain knowledge on various issues in Inter Process Communication (IPC) and the role of OS in IPC.
4. To familiarize the concepts and implementation Memory management policies and virtual memory.
5. To gain knowledge on the working of an OS as a resource manager, file system manager, process manager, memory manager and I/O manager and methods used to implement the different parts of OS.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Discuss the structure and functions of operating systems	2	70%	70%
Outcome 2	Implement shell script for basic programming skills	3	70%	70%
Outcome 3	Analyse process states and implement process scheduling algorithms.	3	70%	70%
Outcome 4	Apply process synchronization techniques.	3	70%	65%
Outcome 5	Implement memory management techniques.	3	70%	65%
Outcome 6	Demonstrate input, output and file management functions of operating system.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	1	2							2	2	2	2
Outcome 2	3	2	1	1	2							2	2	2	2
Outcome 3	2	3	3	3	2							1	3	3	3
Outcome 4	2	3	3	3	2							1	3	3	3
Outcome 5	2	3	3	3	2							1	3	3	3
Outcome 6	2	3	3	3	2							1	3	3	3
Average	**2**	**3**	**3**	**3**	**2**							**1**	**3**	**3**	**3**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	6		
	Operating system overview-objectives and functions	1	1	1,2
	Evolution of Operating System	1	1	1,2
	Computer System Organization	1	1	1,2
	Operating System Structure and Operations	1	1	1,2
	System Programs	1	1	1,2
	Generation and System Boot	1	1	1,2
UNIT 2	Process Management	9		
	Process Concepts	1	3	1,2
	Various types of scheduling	1	3	1,2
	Operations on Processes	1	3	1,2
	Inter process Communication	2	3	1,2
	CPU Scheduling Algorithms	3	3	1,2
	OS – examples	1	3	1,2
UNIT 3	Process Synchronization and Deadlocks	9		
	Threads- Overview.	1	4	1,3
	Multithreading Models.	1	4	1,3
	Process Synchronization: Critical section problem and mutual exclusion.	1	4	1,3
	Mutex Locks.	1	4	1,3
	Semaphores.	1	4	1,3
	Monitors	1	4	1,3
	Deadlocks	2	4	1,3
	OS examples.	1	4	1,3
UNIT 4	Storage Management	10		
	Main Memory Management.	1	5	1,2
	Contiguous Memory Allocation.	1	5	1,2
	Segmentation	1	5	1,2
	Virtual Memory	1	5	1,2
	Paging	1	5	1,2
	Demand Paging.	1	5	1,2
	Page Replacement Algorithms.	1	5	1,2
	Frame Allocation Techniques	1	5	1,2
	Thrashing	1	5	1,2
	OS examples.	1	5	1,3
UNIT 5	I/O Systems and File Management	11		
	Mass Storage Structure- Overview.	1	6	1,3
	Disk Scheduling and Management.	1	6	1,3
	File System Storage.	1	6	1,3
	File Concepts.	1	6	1,3
	Directory and Disk Structure.	1	6	1,3
	Sharing and Protection.	1	6	1,3
	File System Implementation.	1	6	1,3
	File System Structure, Directory Structure.	1	6	1,3
	Allocation Methods.	1	6	1,3
	Free Space Management.	1	6	1,3
	OS examples.	1	6	1,3
Total Contact Hours		45		

Course Utilization Plan – Lab

Experiment No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Shell Programming exercises	4	1, 2	5
2	Implementing Linux system commands using system calls.	4	1, 2	6
3	CPU Scheduling Algorithms.	4	3	1
4	Implement producer, consumer problem using semaphores. Computing page faults for various page replacement algorithms.	4	4	1
5	Implement deadlock avoidance and detections algorithms.	4	4	1
6	Computing page faults for various page replacement algorithms.	4	5	1
7	Simulation of Demand Paging System.	4	5	1
8	Project Development.	2	6	Internet resources
Total Contact Hours		30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (10%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	50%	40%	50%	40%	40%
Level 2	Apply Analyse	50%	60%	50%	60%	60%
Level 3	Evaluate Create					
Total		100%	100%	100%	100%	100%

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (20%)		End Semester Exam (20%)
		Lab Record (5%)	Lab Performance (15%)	
Level 1	Remember Understand	40%	40%	40%
Level 2	Apply Analyse	60%	60%	60%
Level 3	Evaluate Create			
Total		100%	100%	100%

Recommended Resources

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne. (2012). Operating System Concepts, 9th ed. John Wiley and Sons Inc.
2. Harvey M. Dietel, Paul J. Deitel and David R. Choffnes. (2012). Operating Systems, 3rd ed. Pearson Publications.
3. William Stallings, (2018). Operating Systems – Internals and Design Principles, 9th ed. Pearson Publications.

Other Resources

1. Andrew S. Tanenbaum. (2007). Modern Operating Systems, 4th ed. Pearson Publications.
2. Randal K. Michael. (2008). Mastering Unix Shell scripting, 2nd ed. Wiley Publications.
3. Robert Love. (2007). Linux system programming, 2nd ed. O'Reily Publications.

Course Designers

Machine Learning

Course Code	CSE 303	**Course Category**	Speciality Stream Courses (C)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce Machine Learning and various tasks involved in the pipeline of machine learning application development.
2. Understand a wide variety of regression, classification and clustering algorithms.
3. Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
4. Learn the rapid advances in Machine Learning and be able to understand the research articles.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate the phases of machine learning application development.	2	75%	75%
Outcome 2	Describe the learning algorithms.	2	75%	70%
Outcome 3	Explain the techniques to deal with data and its dimension.	2	70%	65%
Outcome 4	Develop speech recognition, object recognition and classification models using machine learning algorithms	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	-	-	-	-	-	-	-	-	-	3	2	
Outcome 2	3	3	3		2	-	-	-	-	-	-	-	3	3	
Outcome 3	3	3	2	-	-	-	-	-	-	-	-	-	3	2	
Outcome 4	3	3	2	-	-	-	-	-	-	-	-	-	3	3	
Average	**3**	**3**	**3**		**2**								**3**	**3**	

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I		12		
	Introduction: Introduction to Machine Learning	1	1	1
	Different types of learning	1	1	1
	Different models and Learning algorithm	1	1	1
	Hypothesis space and inductive bias	1	1	1
	Training, Testing, validation of models	1	3	2
	Evaluation of the model: Train data, Test data	1	3	2
	Evaluation of the model: Cross Validation, Overfitting and Underfitting	1	3	2
	Regression: Introduction	1	2	3
	Linear Regression: Simple	1	2,4	3
	Linear Regression: Multiple	1	2,4	3
	Polynomial regression	1	2,4	3
	Evaluating regression fit	1	2,4	3
UNIT II		13		
	Decision tree learning: Introduction, Decision tree representation	1	2,4	1
	appropriate problems for decision tree learning, the basic decision tree algorithm	1	2,4	1
	hypothesis space search in decision tree learning, inductive bias in decision tree learning,	1	2,4	1
	issues in decision tree learning	1	2,4	1
	Decision tree learning (ID3) Algorithm and numerical	1	2,4	1
	Instance based Learning: K nearest neighbor, numerical problem	1	2,4	1
	the Curse of Dimensionality, Feature selection	1	2,4	1
	Univariate and Multivariate feature selection approaches	1	2,4	1
	Feature selection techniques	1	2,4	1
	Feature reduction: Principal Component Analysis	1	2,4	1
	Feature reduction: Principal Component Analysis	1	2,4	1
	Feature reduction: Linear Discriminant Analysis	1	2,4	1
	Recommender System: Content based system, Collaborative filtering based	1	2,4	4
UNIT III		4		
	Probability and Bayes Learning: Probability and classification, Bayesian Learning,	1	2	1
	Bayes optimal decisions, Naïve Bayes	1	2,4	1
	Support Vector Machine: Introduction, the Dual formulation,	1	2,4	1
	Maximum margin with noise, nonlinear SVM and Kernel function, solution to dual problem, python exercise on SVM	1	2,4	1
UNIT IV		11		
	Artificial Neural Networks: Introduction, , Biological motivation, ANN representation	1	2,4	2
	appropriate problem for ANN learning, McCulloh-Pitts neuron	1	2,4	2
	Perceptron, Perceptron learning, implementation of logic gates using perceptron	1	2,4	2
	Problem with perceptron, Gradient descent algorithm	1	2,4	2
	ADALINE and delta rule, implementation of logic gates using ADALINE	1	2,4	2
	Problem with ADALINE, Nonlinear classification using ADALINE: Polynomial discriminant function, MADALINE	1	2,4	2

	multilayer networks and the back propagation algorithm	1	2,4	2
	Radial Basis Function Neural Network	1	2,4	2
	Radial Basis Function Neural Network	1	2,4	2
	Introduction to Computational Learning Theory: Introduction	1	2	1
	sample complexity, finite hypothesis space, VC dimension	1	2	1
UNIT V		5		
	Ensembles: Introduction, Bagging and boosting, Random Forest	1	2,4	3
	Fixed rule fusion techniques, Trained rule fusion techniques	1	2,4	3
	Trained rule fusion techniques	1	2,4	3
	Clustering: Introduction, K-mean clustering	1	2,4	3
	Hierarchical clustering	1	2,4	3
	Total contact hours	45		

Course Utilization Plan- Lab

Exp. No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Introduction to Python basics	2	4	4
2	Machine Learning packages in Python	2	4	4
3	Implement different types of regression using python	2	4	4
4	Write a program that provides an option to compute different distance measures between two points in the N dimensional feature space. Consider some sample datasets for computing distances among sample points	2	4	4
5	Implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.	2	4	4
6	Implement ID3 algorithm to construct a decision tree. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample	2	4	4
7	Given a dataset. Write a program to compute the Covariance, Correlation between a pair of attributes. Extend the program to compute the Covariance Matrix and Correlation Matrix	2	4	4
8	Write a program to implement feature reduction using Principal Component Analysis	2	4	4
9	Write a program to implement the naïve Bayesian classifier for a sample training data set. Compute the accuracy of the classifier, considering few test data sets.	2	4	4
10	Given a dataset for classification task. Write a program to implement Support Vector Machine and estimate its test performance.	2	4	4
11	Write a program to implement perceptron for different learning tasks.	2	4	2
12	Write programs to implement ADALINE and MADALINE for a given learning task.	2	4	2
13	Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets	2	4	2
14	Write a program to implement the K-means clustering algorithm. Select your own dataset to test the program. Demonstrate the nature of output with varying value of K	2	4	4
15	Implementation of hierarchical clustering using python	2	4	5
		30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)	
Level 1	Remember Understand	70%	50%	40%	40%	40%
Level 2	Apply Analyse	30%	50%	60%	60%	60%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment Lab

Bloom's Level of Cognitive Task		Lab Performance (20%)	End Semester Exam (20%)
Level 1	Remember Understand	20%	30%
Level 2	Apply Analyse	80%	70%
Level 3	Evaluate Create		
Total		**100%**	**100%**

Recommended Resources

1. Mitchell, T.M. and Tom, M. (1997) Machine Learning. McGraw-Hill, New York.
2. Deepa, S. N., & Sivanandam, S. N. (2011). Principles of soft computing. Delhi, India: Wiley India Pvt. Ltd
3. Alpaydin, E. (2020). Introduction to machine learning. MIT press.
4. Swamynathan, M. (2017). Mastering machine learning with python in six steps: A practical implementation guide to predictive data analytics using python. Manohar Swamynathan.

Other Resources

1. Bishop, C. M., & Nasrabadi, N. M. (2006). Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: springer.

Course Designers

Automata and Compilers Design

				L	T	P	C
Course Code	CSE 304	**Course Category**	Core Course (CC)	3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. To comprehend the formal connection between algorithmic problem solving and the theory of languages and automata and develop them into a mathematical (and less magical) view towards algorithmic design and, in general, computation itself.
2. To understand different formal language classes and their relationships and learn the decidability and intractability of computational problems.
3. To clarify the practical view towards the applications of these ideas in the engineering part of computer science.
4. To provide an understanding of the fundamental principles in language translation and compiler design. Also, create an awareness of the function and complexity of compilers.
5. To gain knowledge of theory and practice required to design and implement compilers for programming languages. To familiarise some compiler construction tools.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Design the finite state machines for modelling and examine their power to recognise the regular languages	2	75%	65%
Outcome 2	Analyse the concept of Context-Free Languages and Top-Down parsers	2	75%	65%
Outcome 3	Construct Bottom-up Parsers and implement YACC programs	3	75%	65%
Outcome 4	Apply the semantic analysis and generate the intermediate Code.	3	75%	65%
Outcome 5	Analyse the code optimization techniques and generate the machine code	2	75%	65%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	3	2	2	1								3	2	
Outcome 2	2	2	3	3	1								2	2	
Outcome 3	2	3	2	3	1								3	2	
Outcome 4	2	3	2	3	1								3	2	
Outcome 5	2	3	1	3	1								2	1	
Average	**2**	**3**	**2**	**3**	**1**								**3**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Finite Automata: NFA, DFA and LEX**	**9**		
	Introduction to Formal Languages, Chomsky Hierarchy	1	1	1, 3, 5, 6
	Structure of Compiler	1	1	1, 3, 5, 6
	Finite Automata – DFA	1	1	1, 3, 5, 6
	Design of NFA, Conversion of NFA to DFA.	1	1	1, 3, 5, 6
	Regular expression	1	1	1, 3, 5, 6
	Conversion of regular expression to NFA	1	1	1, 3, 5, 6
	Minimization of DFA	1	1	1, 3, 5, 6
	Applications of Finite Automata to lexical analysis	1	1	1, 3, 5, 6
	Lex tool	1	1	2, 4
Unit 2	**Context-Free Grammar and Top down Parsing**	**9**		
	Context free grammars	1	2	1, 3, 5, 6
	Design of Context free grammars	1	2	1, 3, 5, 6
	derivation, parse trees, ambiguity	1	2	1, 3, 5, 6
	Applications of CFG to parsing	1	2	1, 3, 5, 6
	Left Recursion, Left Factorization	1	2	1,2, 4
	Recursive Descent parsing	1	2	2, 4
	Computation of FIRST	1	2	2, 4
	Computation of FOLLOW	1	2	2, 4
	LL(1) parsing	1	2	2, 4
Unit 3	**Bottom Up Parsers and YACC**	**9**		
	Bottom up parsing: Handle pruning, Shift reduce parsing	1	3	2, 4
	LR parsing algorithm	1	3	2, 4
	Construction of LR(0) items	1	3	2, 4
	SLR	1	3	2, 4
	SLR table construction	1	3	2, 4
	Construction of LR(1) items	1	3	2, 4
	CLR	1	3	2, 4
	LALR	1	3	2, 4
	Introduction to YACC	1	3	2, 4
Unit 4	**Semantic Analysis and Intermediate Code Generation**	**9**		
	Semantic Analysis: Syntax directed translation	1	4	2, 4
	S-attributed and L-attributed grammars	1	4	2, 4
	Type system: Type expression of Array, Record, product, Pointer and function.	1	4	2, 4
	Type checking, type conversions, equivalence of type expressions,	1	4	2, 4
	overloading of functions and operations.	1	4	2, 4
	Intermediate code generation	1	4	2, 4
	Three address code for statements	1	4	2, 4
	Three address code for control flow statements	1	4	2, 4
	Run time storage management	1	4	2, 4
Unit 5	**Code Optimization and Code Generation**	**9**		
	Code Optimization, Principal sources of optimization	1	5	2
	optimization of basic blocks.	1	5	2
	Construction of flow graphs	1	5	2
	Common sub expression elimination, Copy propagation,	1	5	2
	dead code elimination, constant folding, operator strength reduction	1	5	2
	Data flow analysis of flow graphs	1	5	2
	Code generation	1	5	2

	A simple code generation algorithm	1	5	2
	Register allocation and assignment	1	5	2
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%) Theory				External Evaluation (50%)
		CLA-1	**Mid-1**	**CLA-2**	**CLA-3**	
Level-1	Remember	40%	40%	40%	40%	40%
	Understand					
Level-2	Apply	60%	60%	60%	60%	60%
	Analyse					
Level-3	Evaluate					
	Create					

Recommended Resources

1. Hopcroft, J. E., Motwani, R., & Ullman, J. D. (2001). Introduction to automata theory, languages, and computation. Acm Sigact News, 32(1), 60-65.
2. Alfred, V. A., Monica, S. L., & Jeffrey, D. U. (2007). Compilers principles, techniques & tools. pearson Education.

Other Resources

1. Peter, L. (2001). An introduction to formal languages and automata. 6th Edition, Jones & Bartlett
2. Raghavan, V. (2010). Principles of Compiler Design. Tata McGraw-Hill Education..
3. Mishra, K. L. P., & Chandrasekaran, N. (2006). Theory of computer science: automata, languages and computation. PHI Learning Pvt. Ltd..
4. Sunitha, K. V. N. (2010). Formal languages and automata theory. Pearson Education India.

Course Designers

Computer Organization and Architecture

Course Code	CSE 305	**Course Category**	Core Course (CC)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Learn basic organization of a typical computing system.
2. Understand working of a basic data path and control unit of a processor.
3. Gain knowledge of how a memory is organized and how it interacts with a processor.
4. Learn how an Input/Output device can interact/communicate with a processor and memory.
5. Apply knowledge of 8086 Architecture to program 8086 microprocessor using Simulator.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain the basic organization of a typical computing system	2	75%	65%
Outcome 2	Illustrate the working of a basic data path and control unit of a processor	2	75%	65%
Outcome 3	Demonstrate memory organization and its interaction with a processor	3	75%	65%
Outcome 4	Illustrate the interaction/communication of an Input/Output device with a processor and memory	3	75%	65%
Outcome 5	Program 8086 microprocessor using Simulator.	3	75%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	2	1	1	1								3	1	1
Outcome 2	2	2	2	2	2							3	2	3	2
Outcome 3	2	2	2	3	2							3	1	3	3
Outcome 4	2	2	2	3	2							3	1	3	3
Outcome 5	2	2	2	2	2							3	3	3	2
Average	**2**	**2**	**2**	**2**	**2**							**3**	**2**	**3**	**2**

Course Unitization Plan

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Practical: 8086 Programming	16	1,2	1
2	Practical: Design of Hardwired control unit for a hypothetical CPU	6	2	
3	Practical: Design of Microprogrammed control unit for a hypothetical CPU	8	2	
	Total Hours	30		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)				End Semester Exam (35%)
		CLA-1 (10%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	40%	40%	40%	40%	40%
Level 2	Apply Analyse	60%	60%	60%	60%	60%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (10%)		End Semester Exam (15%)
		Weekly Evaluation (5%)	Internal Exam (5%)	
Level 1	Remember Understand	50%	20%	20%
Level 2	Apply Analyse	50%	80%	80%
Level 3	Evaluate Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Mano, M. M. (1993). Computer system architecture. Prentice-Hall, Inc..
2. Hamacher, V. C., Vranesic, Z. G., Zaky, S. G., Vransic, Z., & Zakay, S. (1996). Computer organization McGraw-Hill publications

Other Resources

1. Stallings, W. (2003). Computer organization and architecture: designing for performance. Pearson Education India.
2. Tanenbaum, A. S. (2016). Structured computer organization. Pearson Education India.
3. Patterson, D. A., & Hennessy, J. L. (2016). Computer organization and design ARM edition: the hardware software interface. Morgan kaufmann.
4. Hayes, J. P. (2002). Computer architecture and organization. McGraw-Hill, Inc..
5. Savaliya, M. T. 8086 Programming and Advance Processor Architecture, First Edition, Wiley India

Course Designers

CO-CURRICULAR ACTIVITIES

Course Code	VAC 103	**Course Category**	VAC		**L**	**T**	**P**	**C**
					0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	SA	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Develop essential skills, including leadership, communication, and teamwork, among students.
2. Offer opportunities for students to apply academic concepts in practical, real-world scenarios.
3. Promote self-exploration, confidence-building, and social responsibility.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate confidence in leading group activities, communicate clearly, and collaborate effectively with diverse teams.	2	80%	75%
Outcome 2	Apply theories to practical tasks by solving problems and adapting concepts to real-life situations through cocurricular activities	2	80%	70%
Outcome 3	Develop new experiences with an open approach through guided reflection to assess personal growth, skills, and learning for holistic development.	3	80%	70%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 100%			
		CLA-1 25%	**CLA-2 25%**	**CLA-3 25%**	**CLA-4 25%**
Level 1	Remember Understand				
Level 2	Apply Analyse	15%	15%	15%	15%
Level 3	Evaluate Create	10%	10%	10%	10%
Total		**25%**	**25%**	**25%**	**25%**

COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 104	**Course Category**	VAC		**L**	**T**	**P**	**C**
					0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CEL	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments 50%**				**End Semester Exam 50%**
		CLA-1 20%	**Mid-1 20%**	**CLA-2 20%**	**CLA-3 20%**	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		**10%**	**20%**	**10%**	**10%**	**50%**

Software Engineering and Project Management

Course Code	CSE 306	**Course Category**	Professional Core (C)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	CSE 101, CSE 236	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**	IEEE				

Course Objectives / Course Learning Rationales (CLRs)

1. To comprehend software development life cycle.
2. To gain knowledge of requirement engineering and SRS documents.
3. To understand software architecture styles.
4. To learn various software testing techniques and their applicability.
5. To apply and analyze project management life cycle.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the principles of software engineering, life cycle models	2	75%	70%
Outcome 2	Analyze the computing requirements to solve a given problem	3	75%	70%
Outcome 3	Demonstrate the importance of software modeling and modeling languages	3	70%	65%
Outcome 4	Illustrate the necessity of software testing and design test cases for a software	3	75%	70%
Outcome 5	Interpret Software maintenance and state the concepts of project management.	3	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1	2	2	2						2	3	2	3	1
Outcome 2	2	3	2	3	3							3	3	3	2
Outcome 3	2	3	3	2	3							3	3	3	2
Outcome 4	2	3	3	2	3						3	3	3	3	2
Outcome 5	2	3	2	2	3						3	3	3	3	2
Average	**2**	**3**	**2**	**2**	**3**						**1**	**3**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Software Product and Software Process**	**8**		
	Software Product and Process Characteristics	1	1	1
	Software Process Models	2	1	1
	Perspective and Specialized Process Models	2	1	1
	Introduction to Agility	1	1	1
	Agile process	1	1	1,2
	Software Process customization and improvement	1	1	1
Unit 2	**Requirements Analysis and Specification**	**8**		
	Software Requirements: Functional and Non-Functional	1	2	1,2
	Requirement Sources and Elicitation Techniques	1	2	1,2
	Software Requirements Document	1	2	1,3
	Requirement Engineering Process: Feasibility Studies	1	2	1,3
	Requirements elicitation and analysis	1	2	1,2
	requirements validation, requirements management	1	2	1,2
	Classical analysis: Structured system Analysis	1	2	1,2
	Petri Nets- Data Dictionary.	1	2	1,3
Unit 3	**Software Design**	**8**		
	Design process and Design Concepts	1	3	1,4
	Design Model– Design Heuristic	1	3	2,3
	Architectural Design - Architectural styles,	1	3	1,5
	Architectural Design, Architectural Mapping using Data Flow- User Interface	2	3	1,2
	Design: Interface analysis, Interface Design	1	3	1,3
	Component level Design: Designing Class based components, traditional Components	2	3	1,4
Unit 4	**Testing and Maintenance**	**11**		
	Software testing fundamentals	1	4	1,2
	Internal and external views of Testing	1	4	1,3,4
	white box testing : Basis path testing-control structure testing	2	4	1,4
	black box testing- Regression Testing	2	4	1,5
	Unit Testing – Integration Testing – Validation Testing	1	4	1,3
	System Testing And Debugging	1	4	1,2
	Software Implementation Techniques: Coding practices- Refactoring	1	4	1,5
	Maintenance and Reengineering-BPR model	1	4	1,3
	Reengineering process model-Reverse and Forward Engineering.	1	4	1,2
Unit 5	**Software Maintenance & Software Project Measurement**	**10**		
	Software Configuration Management (SCM)	2	5	2,3
	Software Change Management	2	5	2,5
	Version Control, Change control and Reporting	2	5	1,3
	Re-engineering, Reverse Engineering	1	5	1,4
	Project Management Concepts	1	5	1,5
	Project Scheduling and Tracking	1	5	3
	Software Quality Assurance (SQA)	1	5	1
Total Contact Hours		**45**		

Course Utilization Plan- (Lab)

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Develop requirements specification for a given problem	2	2	1,2,3
2	Develop DFD Model (Level 0, Level 1 DFD and data dictionary) of the sample problem	2	2	1,2,3
3	To perform the function oriented diagram : DFD and Structured chart	2	2	1,2,4
4	To perform the user's view analysis : Use case diagram	2	2	1,2,4
5	To perform the user's view analysis : Use case diagram Scenario's	2	2	1,2,4
6	To draw the structural view diagram : Class diagram	2	3	1,4,5
7	To draw the structural view diagram : Object diagram	2	3	1,4,5
8	To draw the structural view diagram : Package diagram	2	3	1,4,5
9	To draw the behavioral view diagram: Sequence diagram	2	3	1,4,5
10	To draw the behavioral view diagram: Collaboration diagram	2	3	1,4,5
11	To draw the behavioral view diagram: State-chart diagram	2	3	1,4,5
12	To draw the behavioral view diagram: Activity diagram	2	3	1,4,5
13	To draw the implementation view diagram: Component diagram	2	3	1,4,5
14	To draw the environmental view diagram : Deployment diagram	2	3	1,4,5
15	To perform various testing using the testing tool unit testing, integration testing	2	4	1,4
	Total Hours	**30**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)	
Level 1	Remember Understand	70%	60%	50%	40%	30%
Level 2	Apply Analyse	30%	40%	50%	60%	70%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Lab Performance (20%)	End Semester Exam (20%)
Level 1	Remember Understand	50%	30%
Level 2	Apply Analyse	50%	70%
Level 3	Evaluate Create		
Total		**100%**	**100%**

Recommended Resources

1. Pressman, R. S. (2010). Software Engineering (A Practitioner's Approach). New York, EUA: McGraw-Hill.
2. Sommerville, I. (2011). Software engineering 9th Edition. ISBN-10, 137035152, 18.
3. Mall, R. (2015). Fundamentals of Software Engineering. PHI Learning Pvt. Ltd
4. Jalote, P. (2010). Pankaj Jalote's Software Engineering: A Precise Approach. John Wiley & Sons.
5. Kelkar, S. A. (2007). Software Engineering: A Concise Study. PHI Learning Pvt. Ltd.
6. Cotterell, M., & Hughes, B. (1995). Software project management. International Thomson Computer Press.

Other Resources

Course Designers

Mobile Application Development with Java

Course Code	CSE 307	**Course Category**	Core Course (CC)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To introduce the concepts of Object Oriented Programming using JAVA programming.
2. To demonstrate the introduction and characteristics of mobile applications.
3. To understand the design of user interfaces in mobile devices.
4. To develop mobile applications and deploy in play store.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Utilize the Object-Oriented Concepts in solving real word problems through Java.	2, 3	75%	75%
Outcome 2	Install and configure Android application development tools.	3	77%	70%
Outcome 3	Design and develop user Interfaces for the Android platform.	3	75%	70%
Outcome 4	Apply Java programming concepts to Android application development	2, 3	72%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Outcome 4															
Average															

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTRODUCTION TO JAVA**	**10**		
	An Overview of Java - Data types, Variables and Arrays, operators, expressions, Control statements	**2**	**1**	**8**
	Classes, Objects, Constructor, Methods, this reference, static keyword, and final keyword;.	**2**	**1**	**8**
	String handling, Compiling using command line argument	**2**	**1**	**8**
	Inheritance - Concept, Member access, Abstract Class, Interface, Creating Multilevel hierarchy- super uses, Packages-access specifiers, using final with inheritance	**2**	**1**	**8**
	Polymorphism - Compile time Polymorphism, Method overloading, Constructor overloading	**1**	**1**	**8**
	Run time polymorphism, Method overriding, Dynamic method dispatch	**1**	**1**	**8**
Unit 2	**EXCEPTION HANDLING & MULTITHREADING**	**8**		
	Fundamentals of exception handling, Uncaught exceptions, using try and catch, multiple catch blocks	**2**	**1**	**8**
	Exception types - Introduction to Object class, Exception class hierarchy, Termination or presumptive models, Built-in exceptions, User defined exceptions	**2**	**1**	**8**
	Nested try statements, Throw, Throws, and Finally. Multithreading- Differences between thread-based multitasking and process based multitasking	**2**	**1**	**8**
	Java thread model, Thread life cycle, Creating threads – Thread class,	**1**	**1**	**8**
	Runnable interface, Thread priorities, Synchronizing threads, Inter-thread communication.	**1**	**1**	**8**
UNIT-3	**UI Components and Layout, Design User Interface with View**	**7**		
	Control Flow, Directory Structure, Components of a Screen, Fundamental UI Design, Linear Layout, Absolute Layout, Frame Layout, Table Layout, Relative Layout.	**3**	**3**	**2**
	Text View, Edit Text, Button, Image Button, Toggle Button, Radio Button and Radio Group, Checkbox	**2**	**3**	**2**
	Progress Bar, List View, Grid View, Image View, Scroll View, Custom Toast Alert, Time and Date Picker.	**2**	**3**	**2**
UNIT-4	**Activity and Multimedia with databases**	**12**		
	Intent, Intent Filter, Activity Lifecycle, Broadcast Lifecycle, Content Provider, Fragments, Service: Features Of service, Android platform service, Defining new service	**3**	**3**	**1,2**
	Service Lifecycle, Permission, example of service Multimedia framework, Play Audio and Video, Text to speech, Sensors,	**3**	**3**	**1**
	Async task, Android System Architecture, Audio Capture, Camera, Bluetooth, Animation, SQLite Database, Defining a Schema, Building Your Initial database	**3**	**3**	**1**
	Creation and connection of the Database, extracting value from cursors, Transactions.	**3**	**3**	**1**
UNIT-5	**Security and Application Deployment**	**8**		
	SMS Messaging: Sending SMS Messages Programmatically , Getting Feedback after Sending a Message	**2**	**4**	**2**
	Sending SMS Messages Using Intent, Receiving SMS Messages,Caveats and Warnings, Sending E-mail.	**2**	**4**	**2**

	Location Based Services: Creating the project, Getting the maps API key, Displaying the map, Displaying the zoom control, Navigating to a specific location, Adding markers	**2**	**4**	**2**
	Getting location, Geocoding and reverse Geocoding. Getting Location data, Monitoring Location, Android Security Model, Declaring and Using Permissions, Using Custom Permission.	**2**	**4**	**2**
	Application Deployment: Creating Small Application, Signing of application, Deploying app on Google Play Store, Publishing Android Applications, Developer Console.	**2**	**4**	**2**
Total Contact Hours		**45**		

<u>Course Utilization Plan – (Lab)</u>

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Install and configure java development kit (JDK), android studio and android SDK. Configure android development tools (ADT) plug-in and create android virtual device.	**1**	**2**	**2**
2	Declare two classes Student and Teacher. The classes will have the data members and constructors as per your convenience. Write a JAVA program, (i) where the Teacher will enter the marks of the all the students in the database. (ii) Once the marks are entered, the student can view the marks.	**1**	**2**	**8**
3	Define a package named gradepack. The gradepack consists of a class named operations. The operations class consists of the methods to compute the average, minimum, maximum, median and standard deviation. Create a class named GradesStatistics, which reads in n grades (of int between 0 and 100, inclusive) and displays the average, minimum, maximum, median and standard deviation by importing the gradepack package. (Pass the grades information to the methods in the operations class.) Display the floating-point values upto 2 decimal places.	**1**	**1**	**8**
4	Create three classes named Student, Teacher, Parents. Student and Teacher class inherits Thread class and Parent class implements Runnable interface. These three classes have run methods with statements. The task of the teacher class of the first assignment has to be synchronized. Similarly, the other two classes should have run methods with few valid statements under synchronized.	**1**	**1**	**8**
5	a. Develop a program to implement linear layout and absolute layout. b. Develop a program to implement frame layout, table layout and relative layout.	**2**	**3**	**2**
6	a Develop a program to implement Text View and Edit Text. b Develop a program to implement Auto Complete Text View. c Develop a program to implement Button, Image Button and Toggle Button.	**2**	**3**	**2**
7	a Develop a program to implement login window using above UI controls. **b**. Develop a program to implement Checkbox, Radio Button and Radio Group, Progress Bar. **c** Develop a program to implement List View, Grid View, Image View and Scroll View.	**2**	**3**	**2**
8	**a** .Develop a program to implement Date and Time Picker. **b**. Develop a program to implement Custom Toast Alert.	**2**	**3**	**2**
9	**a:** Develop a program to create an activity. **b:** Develop a program to implement new activity using explicit intent and implicit intent. **c:** Develop a program to implement content provider	**4**	**3**	**1**

	d: Develop a program to implement service.			
10	**a:** Develop a program to implement broadcast receiver. **b:** Develop a program to implement sensors. **c:** Develop a program to build Camera.	**4**	**3**	**1**
11	**a:** Develop a program for providing Bluetooth connectivity **b:** Develop a program for animation **c:** Perform Async task using SQLite.	**2**	**3**	**1,9,10**
12	**a.** Create sample application with login module. (Check username and password) On successful login, Change text view "Login Successful" And on login fail, alert user using Toast "Login fail" **b:** Create login application where you will have to validate username and password till the username and password is not validated, login button should remain disabled.	**4**	**4**	**3,4,5**
13	**a:** Develop a program to: a) Send SMS b) Receive SMS **b:** Develop a program to send and receive e-mail **c:** Deploy map based application.	**2**	**4**	6,7,8
	Total Hours	30		

Learning Assessment Theory

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (30%)**				**End Semester Exam (30%)**
		CLA-1 (10%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**CLA-3 (5%)**	
Level 1	Remember Understand	70%	60%	30%	30%	60%
Level 2	Apply Analyse	30%	40%	70%	70%	40%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (20%)**		**End Semester Exam (20%)**
		Lab Record (5%)	**Lab Performance (15%)**	
Level 1	Remember Understand	50%	50%	50%
Level 2	Apply Analyse	50%	50%	50%
Level 3	Evaluate Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Phillips, B., & Hardy, B. (2013). Android programming: the big nerd ranch guide. Pearson Education.
2. Lee, W. M. (2012). Beginning android 4 application Development. John Wiley & Sons.
3. Lee, V., Schneider, H., & Schell, R. (2004). Mobile applications: architecture, design, and development. Prentice Hall PTR.
4. Meier, R. (2012). Professional Android 4 application development. John Wiley & Sons.
5. Sheusi, J. C. (2012). Android Application development for Java programmers. Cengage Learning
6. Griffiths, D., & Griffiths, D. (2021). Head First Android Development. " O'Reilly Media, Inc.".
7. Schildt, H. (2014). Java: the complete reference. McGraw-Hill Education Group.
8. McWherter, J., & Gowell, S. (2012). Professional mobile application development. John Wiley & Sons.

Other Resources

1. Nurkiewicz, T., & Christensen, B. (2016). Reactive programming with RxJava: creating asynchronous, event-based applications. " O'Reilly Media, Inc.".
2. Fling, B. (2009). Mobile design and development: Practical concepts and techniques for creating mobile sites and Web apps. " O'Reilly Media, Inc."
3. Firtman, M. (2010). Programming the mobile web. " O'Reilly Media, Inc."
4. Crumlish, C., & Malone, E. (2009). Designing social interfaces: Principles, patterns, and practices for improving the user experience. " O'Reilly Media, Inc.".
5. Ginsburg, S. (2010). Designing the iPhone user experience: a user-centered approach to sketching and prototyping iPhone apps. Pearson Education.

Course Designers

Summer Internship

Course Code	CSE 401	**Course Category**		**L**	**T**	**P**	**C**
				0	0	4	4
Pre-Requisite Course(s)	None	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	**Civil, Mechanical, ECE, EEE and CSE – All B.Tech/M.Tech**	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the application of academic knowledge to practical (Social, Environmental, Industrial and Scientific) problems	**2**	**70**	**80**
Outcome 2	Demonstrate essential soft skills and relevant technical abilities in managing practical tasks and projects within the internship setting.	**3**	**70**	**80**
Outcome 3	Understand and adhere to standard operating procedures and interpret quality control measures specific to the industry or organization.	**2**	**70**	**80**
Outcome 4	Build effective professional relationships by networking with supervisors, team members, and other departments.	**3**	**70**	**80**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	1	1	2	2	2	1	2	1	0	3			
Outcome 2	3	3	1	3	2	2	1	1	3	3	2	3			
Outcome 3	3	3	2	2	2	1	2	1	2	2	2	2			
Outcome 4	1	1	1	1	1	3	1	1	3	3	0	2			
Average	2.5	2.25	1.25	1.75	1.75	2	1.5	1	2.5	2.25	1	2.5			

Course Unitization Plan

Unit No.	Unit Name	Required Weeks	CLOs Addressed
Unit 1	**Definition of Problem** This unit focuses on clearly articulating the problem that the project aims to solve. Interns will describe the current situation, analyze gaps or challenges, and explain why a solution is necessary. Establishing a clear problem statement is essential to set a precise project direction.	**2**	1
Unit 2	**Method** Interns will explore and apply various methods and approaches critical to the successful execution of the project. This unit includes planning, selecting suitable methods, and implementing best practices to achieve project objectives efficiently.	**2**	1,2
Unit 3	**Description of results** This unit requires interns to interpret the results obtained from their project using appropriate software, tools, and analytical techniques. Emphasis is on accuracy, relevance, and coherence in presenting findings that support the project objectives.	**1**	3
Unit 4	**Strategy Evaluation** Students assess and critique the effectiveness of strategies and methodologies employed that support the project objectives.	**1**	3
Unit 5	**Project Presentation and thesis report** Interns will prepare and deliver a scientific presentation of their results, providing well-supported reasoning. Additionally, they will compile their work into a thesis, manuscript, or report that summarizes the project, including methodology, results, and conclusions, adhering to academic or industry standards.	**1**	4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		Diary 10%	Mid Sem 20%	Synopsis 10%	Report 10%	
Level 1	Remember Understand	100%	40%	50%	20%	20%
Level 2	Apply Analyse		60%	50%	60%	60%
Level 3	Evaluate Create				20%	20%
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Mini Project

Course Code	CSE 402	**Course Category**			**L**	**T**	**P**	**C**
					0	0	4	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department		**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1				
Outcome 2				
Outcome 3				

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1															
Outcome 2															
Outcome 3															
Average															

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember					
	Understand					
Level 2	Apply					
	Analyse					
Level 3	Evaluate					
	Create					
Total						

Recommended Resources

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Research Project

Course Code	CSE 403	**Course Category**		**L**	**T**	**P**	**C**
				0	0	2	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department		**Professional / Licensing Standards**					

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1				
Outcome 2				
Outcome 3				

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Average															

<u>Course Unitization Plan</u>

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				

Learning Assessment

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="4">Continuous Learning Assessments (50%)</th><th rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th>CLA-1 20%</th><th>Mid-1 20%</th><th>CLA-2 20%</th><th>CLA-3 20%</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Recommended Resources

Other Resources

Course Designers

Major Project

				L	T	P	C
Course Code	CSE 404	**Course Category**	RDIP	0	0	12	12
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To widen the understanding of doing research.
2. To facilitate the ideation of a thought.
3. To devise and plan ways to execute an idea.
4. To learn how to avoid plagiarism and publish one's contribution in the research community.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Conceptualize an idea	2	75%	70%
Outcome 2	Devise a plan to do the literature survey on the idea	4	75%	70%
Outcome 3	Formulate the mathematical model for the problem.	3	75%	70%
Outcome 4	Assess the relevance and societal impact of the work	5	70%	65%
Outcome 5	Write a technical paper and report the findings.	6	75%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	1			2		1	2	3	2	1	3	2	2	2
Outcome 2	3	2	2	3	3	1	1	3	3	3	2	3	2	2	2
Outcome 3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
Outcome 4	1	2				3	3	3			3	3	2	1	2
Outcome 5	3	1	1	3	3			3	3	3	2	3	2	2	3
Average	**2.4**	**1.8**	**2**	**3**	**2.75**	**2**	**1.75**	**2.8**	**3**	**2.75**	**2.2**	**3**	**2.2**	**2**	**2.4**

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
Unit 1	**Conception of Idea**	**45 hours**		
	Based on interest conceive an idea	35 hours	1,4	1
	Do a feasibility check of the project	10 hours	1,4	1
Unit 2	**Submission of Abstract of the idea**	**90 hours**		
	Literature survey of the related works	70 hours	2	1,2,3,4,5
	Write an abstract of the proposed idea	20 hours	2	1
Unit 3	**Formulate the Mathematical model**	**45 hours**		
	Formulate the mathematical model for the considered problem	35 hours	3	1
	Creating timeline for execution of various module of the project.	10 hours	3	1,6
Unit 4	**Conducting Simulations and Publish results**	**180 hours**		
	Execution of the various modules of the project and intermediate report submission.	120 hours	3	1
	Initiation of the process for a possible publication.	60 hours	5	2,3,4,5
Total		**360 Hours**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			External (50%)
		CLA - 1 (10%)	CLA - 2 (15%)	CLA - 3 (25%)	
Level 1	Remember				
	Understand				
Level 2	Apply	70%	70%	70%	30%
	Analyse				
Level 3	Evaluate	30%	30%	30%	70%
	Create				
Total		100%	100%	100%	100%

Recommended Resources

1. As recommended by Advisor pertaining to student research interest.
2. https://ieeexplore.ieee.org/Xplore/home.jsp
3. https://www.sciencedirect.com/
4. www.springer.com
5. https://onlinelibrary.wiley.com/
6. Research Methodology

Other Resources

Course Designers

Artificial Intelligence

				L	T	P	C
Course Code	CSE 455	**Course Category**	Stream Electives (SE)	3	0	1	4

Pre-Requisite Course(s)	CSE 201	**Co-Requisite Course(s)**		**Progressive Course(s)**	
Course Offering Department	CSE	**Professional / Licensing Standards**			

Course Objectives / Course Learning Rationales (CLRs)

1. To enhance comprehension of both the theory that underpins and the accomplishments of artificial intelligence.
2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems.
3. To review the different stages of development of the AI field from human like behaviour to Rational Agents.
4. To impart basic proficiency in representing difficult real-life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
5. to develop an awareness of the fundamental problems with knowledge representation, logic, blind and heuristic search, and other subjects like minimum, resolution, etc. that are crucial to AI systems.
6. To introduce advanced topics of AI such as planning, Bayes networks, natural language processing and Cognitive Computing.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the Intelligent systems and Approaches.	1	75%	65%
Outcome 2	Discuss the building blocks of AI as presented in terms of intelligent agents.	2	75%	65%
Outcome 3	Formalize the problem as a state space, graph, design heuristics and select amongst search or game-based techniques to solve them.	4	75%	65%
Outcome 4	Develop intelligent algorithms for constraint satisfaction problems and intelligent systems for Game Playing.	5	75%	65%
Outcome 5	Implement application-specific intelligent systems	3	75%	65%
Outcome 6	Represent logic-based techniques to perform inference and planning in given problems.	6	75%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	3	3	3	1			2		2	2	2	2	2
Outcome 2	3	2	3	2	2	1			2		2	3	2	2	2
Outcome 3	3	3	3	3	2	1			2		2	2	2	2	2
Outcome 4	3	3	3	2	3	1			2		3	3	3	2	3
Outcome 5	3	3	3	3	2	1			2		2	3	2	2	2
Outcome 6	3	3	3	3	2	1			2		2	2	3	3	2
Average	**3**	**3**	**3**	**3**	**2**	**1**			**2**		**2**	**3**	**2**	**2**	**3**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	What is Intelligence.	1	1	1, 2
	Foundations and History of Artificial Intelligence.	1	1	1, 2
	Applications of Artificial Intelligence.	1	2	1, 2
	Types of Different Intelligent system.	1	2	1, 2
	Intelligent Agents, Structure of Intelligent Agents.	1	1, 2	1, 2
	Introduction to Machine Learning and categorization.	1	1, 2	1, 2
	Introduction to Reinforcement Learning.	1	1, 2	1, 2
	Introduction to Deep Learning.	1	1, 2	1, 2
	Introduction to Agents	1	1	1, 2
Unit 2	**Search Mechanisms & Constraint Satisfaction problems.**	**9**		
	Introduction to Search (Single Agent).	1	1	1, 2
	Introduction to Search (Two Agents).	1	1	1, 2
	Introduction to State space.	1	1	1, 2
	Searching for solutions.	1	2, 3	1, 2
	Uniformed search strategies.	1	3, 4	1, 2
	Informed search strategies.	1	3, 4	1, 2
	Local search algorithms and optimistic problems Adversarial Search.	1	3, 4	1, 2
	Least commitment search.	1	3	1, 2
	Constraint satisfaction problems.	1	2	1, 2
Unit 3	**Knowledge Representation and Reasoning**	**9**		
	Propositional Logic and Inference rules.	1	2	1, 2, 3, 4
	Predicate Logic (first order logic).	1	2, 3	1, 2, 3, 4
	Inference in FOL.	1	2, 3	1, 2, 3, 4
	Rule-based system, Logical Reasoning.	1	2, 3	1, 2, 3, 4
	Forward &Backward Chaining.	1	2, 3	1, 2, 3, 4
	Knowledge Resolution.	1	3, 4	1, 2, 3, 4
	AI languages and tools – Lisp.	1	5	1, 2, 3, 4
	AI languages and tools –Prolog.	1	5	1, 2, 3, 4
	AI languages and tools –CLIPS.	1	5	1, 2, 3, 4
Unit 4	**Problem Solving and planning**	**9**		
	Formulating problems.	1	1, 2	1, 2, 3, 4
	Problem types	1	2	1, 2, 3, 4
	Solving Problems by Searching.	1	3, 4	1, 2, 3, 4
	Heuristic search techniques.	2	2, 3	1, 2, 3, 4
	Constraint satisfaction problems.	1	3, 4	1, 2, 3, 4
	Plan space, partial order planning, planning algorithms	1	3, 4	1, 2, 3, 4
	Stochastic search methods.	1	4	1, 2, 3, 4
	Tabu search, best first search.	1	4	1, 2, 3, 4
Unit 5	**Learning**	**9**		
	Overview of different forms of learning, Inductive tree	1	1	1, 2
	Decision trees, rule- Game playing	1	2, 3	1, 2
	Perfect decision game-based learning.	1	2, 3	1, 2
	Neural networks.	1	3, 4, 5	1, 2
	Reinforcement learning.	1	2, 4, 5	1, 2
	Game playing: Perfect decision game.	1	3, 4	1, 2
	Imperfect decision game.	1	3, 4	1, 2
	Evaluation function.	1	3, 4	1, 2
	Minimax, Alpha-beta pruning.	1	4, 6	1, 2
Total Theory Contact Hours		**45**		

<u>Course Unitization Plan Lab</u>

No.	Lab Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Artificial Intelligence Problem identification, PEAS description, and Introduction to PROLOG	2	1	1, 2, 3
2	Study of facts, objects, predicates, variables, arithmetic operators, simple input/output, and compound goals in PROLOG	4	2	1, 2
3	Study of string operations in PROLOG. Implement string operations like substring, string position, palindrome, and implement all set operations (Union, intersection, complement).	4	1, 2	1, 2, 4
4	Write a program for Usage of rules in Prolog. Create a family tree program to include following rules 1. M is the mother of P if she is a parent of P and is female 2. F is the father of P if he is a parent of P and is male 3. X is a sibling of Y if they both have the same parent. 4. Then add rules for grand-parents, uncle-aunt, sister and brother.	4	2, 3	1, 2
5	Write programs for studying Usage of arithmetic operators in Prolog. a) Accept name of the student, roll no, his/her subject name, maximum marks and obtained marks in the subject. (Take marks of atleast 6 subjects). Compute the percentage of a student. Display his result with other information. b) Accept department, designation, name, age, basic salary, house rent allowance (HRA) of an employee. Compute dearness allowance (DA) which is 15% of basic salary. Determine the gross salary (basic salary + HRA + DA) of the employee. Display all information of the employee (Generate Payslip).	4	4	1, 2, 3
6	Implement a program for recursion and list in PROLOG	4	4, 5	1, 2, 4, 5
7	Write a program for studying usage of compound object and list in Prolog. a) Write a program to maintain inventory items using a compound object: i. Accept from user the details of at least 10 objects. ii. Display from user the details of objects entered by user b) Find and display odd and even numbers from a given input list.	4	5	3, 4, 5
8	Write a program to solve the following problems. 1. Write a prolog program to solve “Water Jug Problem”. 2. Write a program to implement a monkey banana problem. 3. Write a program to implement 8 Queens Problem. 4. Write a program to solve traveling salesman problem. 5. Write a program to solve water jug problem using LISP.	4	5, 6	4, 5
Total Lab Contact Hours		**30**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (10%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	
Level 1	Remember Understand	40%	50%	40%	50%	30%
Level 2	Apply Analyse	40%	40%	40%	30%	50%
Level 3	Evaluate Create	20%	10%	20%	20%	20%
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (20%)		End Semester Exam (20%)
		Lab Record (5%)	Lab Performance (15%)	
Level 1	Remember Understand	10%	50%	30%
Level 2	Apply Analyse	50%	30%	50%
Level 3	Evaluate Create	40%	20%	20%
Total		**100%**	**100%**	**100%**

<u>Recommended Resources</u>

1. Russell, S., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach (4th ed.). Prentice Hall.
2. Charniak, E., & McDermott, D. (2002). Introduction to Artificial Intelligence. Pearson Education.
3. Nilsson, N. J. (2002). Artificial Intelligence: A New Synthesis. Morgan Kaufmann.
4. Pearl, J. (2009). Causality: Models, Reasoning and Inference (2nd ed.). Cambridge University Press.
5. Rich, E., Knight, K., & Nair, S. B. (2017). Artificial Intelligence (3rd ed.). McGraw Hill Education.

<u>Other Resources</u>

<u>Course Designers</u>

Digital Image Processing

Course Code	CSE 456	**Course Category**	**Stream Elective (SE)**		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	CSE 336	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**	MathWorks License for MATLAB software					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the overview of the field of image processing.
2. Gain knowledge of the fundamental algorithms and how to implement them.
3. Prepare to read the current image processing research literature.
4. Gain experience in applying image processing algorithms to real problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Describe the process of image processing and techniques involved in image processing pipeline.	2	75%	75%
Outcome 2	Identify image enhancement techniques.	2	75%	70%
Outcome 3	Illustrate the causes for image degradation and overview of image restoration techniques.	3	70%	65%
Outcome 4	Apply spatial and frequency domain techniques for image compression.	3	70%	65%
Outcome 5	Demonstrate extraction techniques for image analysis and recognition.	3	75%	70%
Outcome 6	Develop an image processing application using feature extraction and representation	5	65%	60%
Outcome 7	Recognize the rapid advances in Machine vision.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	3	-	-	-	-	-	-	-	-	-	3	2	
Outcome 2	3	3	3		2	-	-	-	-	-	-	-	3	3	
Outcome 3	3	3	2	-	-	-	-	-	-	-	-	-	3	2	
Outcome 4	3	3	2	-	-	-	-	-	-	-	-	-	3	3	
Outcome 5	3	3	2	-	2	-	-	-	-	-	-	-	3	3	
Outcome 6	2	2	3	3	3	-	-	-	-	-	-	-	2	3	
Outcome 7	3	3	1	-	-	-	-	-	-	-	-	-	3	3	
Average	**3**	**3**	**2**	**3**	**2**								**3**	**3**	

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	Introduction: What is digital image and DIP? History, Applications of DIP	1	1,7	1
	Key stages of Digital Image processing, Advances in machine vision application domain		1,7	1, 4
	Image sampling and quantization, spatial resolution, intensity resolution	1	1	1
	Relationship between pixels: neighbourhood, adjacency and connectivity, Path, region boundary		1	1
	Connected component labelling, Distance measure: Euclidian, chess board, city block.	1	1	1
	Image acquisition and Pre-processing, Intensity transformations, spatial filtering		2	1
	Image enhancement: Introduction, Point Processing- image negative, log transform, dynamic range compression.	1	2, 6	1
	Power law or gamma Transformation, gamma correction	1	2, 6	1
	Piecewise linear transformation: contrast stretching, threshold, bit-plane slicing		2, 6	1
	Histogram processing: image histogram, histogram equalization	1	2, 6	1
	Numerical on histogram equalization, histogram specification, numerical on histogram specification		2	1
	Spatial filters for smoothing operations: linear filters (average and weighted average), order statistics (nonlinear) filters: median, min, max filters.	1	2, 6, 7	1
	Spatial filters for sharpening operations: Convolution vs. correlation, objective (integration, differentiation, application of sharpening),	1	2, 6	1
	First order and second order derivative operators and their response, Laplacian operator, unsharp masking,	1	2	1
Unit 2	**Filtering in the Frequency Domain, Image Restoration**	**9**		
	Frequency domain approach: low pass filtering, high pass filtering, Laplacian, high boost filtering.	1	2	1, 2, 3
	Image transform and its importance, Fourier transform, 1D FT, 1D Discrete Fourier Transform (DFT)	1	2	1, 2, 3
	2D DFT and its property, Holomorphic filtering	1	2	1, 2, 3
	Image restoration: Fundamentals,	1	3	1, 2, 3
	Noise models, example images affected with noise	1	3	1, 2, 3
	Estimation of noise parameters models	1	3	1, 2
	Restoration in presence of noise (Spatial domain techniques): mean filters, order statistics filters	1	3	1, 2
	Adaptive local noise filter, adaptive median filter	1	3	1, 2
	Estimation of degradation function: (i) by observation, (ii) by experimentation (iii) mathematical modelling	1	3	1, 2
Unit 3	**Image Segmentation**	**9**		
	Image segmentation: Fundamentals, point, line detection,	1	5, 6	1
	Basic edge detection techniques, Hough transform	1	5, 6	1
	Thresholding: Bi-modal and Multi-model Histogram,	1	5	1
	Noise effect on thresholding, Illumination effect on image thresholding	1	5	1

	Basic global thresholding, Optimal thresholding using Otsu's method	1	5	1, 2
	Multi-spectral thresholding, Region based segmentation.	2	5	1, 2
	Region growing, Region splitting and Merging.	2	5	1, 2
Unit 4	**Color Image Processing, Image Compression**	**9**		
	Colour image processing: Fundamentals, motivation, full and pseudo colour image processing	2	5	1
	Components of colour, primary and secondary colours, tristimulus, chromaticity diagram,	1	5	1
	Colour models: RGB, CMY, CMYK, HSI	1	5	1, 3
	Colour conversion, numerical on colour conversion	1	5	1, 3
	Image compression: Motivation, Applications, Compression ratio	1	4	1, 2
	Data redundancy- Coding, Inter-pixel and Psycho-visual redundancy,	1	4	1, 2
	JPEG Coding, Huffman Coding	1	4	1, 2
	LPZ coding, arithmetic coding, lossless and lossy predictive coding	1	4	1, 2
Unit 5	**Image representation and Object Recognition**	**9**		
	Image presentation and description- Introduction, Motivations	2	5	3
	Shape features (Region-based shape representation and descriptors) Area, Euler's number, eccentricity, Elongatedness, rectangularity, direction, compactness. moments, covex hull.	2	5	3
	Texture features, Color features	1	5	3
	Object and Pattern Recognition: Pattern and pattern classes.	1	5	3
	Matching, classifier role minimum distance or nearest neighbor classifier.	1	5	1, 4
	Matching by correlation, Optimum statistical classifier	1	5	1, 4
	Neural network classifier	1	5	1, 4
	Total Contact Hours	45		

Course Unitization Plan - Lab

S. No.	Experiment Name	Required Contact Hours 30	CLOs Addressed	References Used
1.	**Lab Experiment 1:** Perform the following operations using library functions a. Read, Display and write any color image in other formats. b. Find RED, GREEN and BLUE plane of the color image. c. Convert color image to grayscale image and binary image d. Resize the image by one half and one quarter. i.e. Image rotates by 45, 90 and 180 degrees.	2	1	1
2.	**Lab Experiment 2:** Create black and white images (A) of size 1024x1024. Which consists of alternative horizontal lines of black and white? Each line is of size 128. Create black and white images (B) of size 1024x1024. Which consists of alternative vertical lines of black and white? Each line is of size128. Perform the following operations on Image A and Image B. a. Image addition of A and B b. Subtraction of A and B c. Multiplying Images of A and B d. Create a grayscale image of size 256 x 1024. Intensity of image should vary sinusoidally. e. Create a white image of size 256x256, with black box of size 58x58 at centre.	2	1	1
3.	**Lab Experiment 3:**	3	2,3	1

	Develop programs for following intensity transformation operation on a grayscale image. Collect any gray scale image from any source. Process that image using these operations. a. Image negative b. Log transformation and inverse log transform: s = c log (1+r), c is a const, r ≥ 0. s is pixel intensity of output image, r is the pixel intensity of input image. Study the effect of constant c on the quality of output image. c. Power law transformation: Study the effect of different values of Gamma used in this transformation. d. Contrast stretching e. Gray level slicing			
4.	**Lab Experiment 4:** Develop programs for following spatial filtering operations on a grayscale image. a. Averaging: Implement averaging filtering operations for different window sizes and study their effect on the quality of output image. Write your observations on output image quality. b. Weighted averaging: Implement weighted averaging filtering operations for different window sizes and study their effect on the quality of output image. Write your observations on output image quality. c. Median filtering: Implement weighted averaging filtering operations for different window sizes and study their effect on the quality of output image. Write your observations on output image quality. d. Max filtering e. Min filtering	3	4,5	4
5.	**Lab Experiment 5:** Take a grayscale image and add salt and pepper noise. Write programs for following operations and observe their outputs a. Linear smoothing or Image averaging b. Weighted averaging c. Median filtering. Compare the output quality among Image averaging and median filtering. d. Max filtering e. Min filtering	4	2,6	1
6.	**Lab Experiment 6:** Write programs to perform following sharpening operations on a grayscale image a. Laplacian filter b. Filtering using composite mask c. Unsharp masking d. High boost filtering e. Filtering using first order derivative operators such as sobel and prewitt mask.	4	2,6	1
7.	**Lab Experiment 7:** Write a program to improve contrast of an image using histogram equalization. The prototype of the function is as below: histogram_equalisation(input_Image, no_of_bins); The function should return the enhanced image. Consider two low contrast input images. Study the nature of the output image quality in each case by varying the number of bins.	3	2	1
8.	**Lab Experiment 8:** Take a low contrast grayscale image (A) and a high contrast gray scale image (B). Write a program to improve the contrast of A with the help of image B using histogram specification or matching. The prototype of the function is as below: Histogram_sp(input_Image,	3	2	1

	specified_Iage, no_of_bins); The function should return the enhanced image.			
9.	**Lab Experiment 9:** Develop programs to implement frequency domain smoothing filters (Ideal, Butterworth and Gaussian) and apply these filters on a grayscale image. a. Compare/comment on the output of Ideal, Butterworth and Gaussian Low pass Filters having the same radii (cutoff frequency) value. b. Consider a suitable gray scale image and demonstrate the ringing effect on the output of Ideal low pass frequency domain filter. c. Compare the output of Butterworth low pass filters (order n=2) for different cutoff frequencies (5, 15, 30, 90, 120). d. Compare the output of Gaussian low pass filters for different cut-off frequencies (5, 15, 30, 90, and 120).	3	2	1,2,3
10.	**Lab Experiment 10:** Develop programs to implement frequency domain sharpening/High pass filters (Ideal, Butterworth and Gaussian) and apply these filters on a grayscale image. a. Compare/comment on the output of Ideal, Butterworth and Gaussian High pass Filters having the same radii (cutoff frequency) value. b. Consider a suitable gray scale image and demonstrate the ringing effect on the output of Ideal high pass frequency domain filter. c. Compare the output of Butterworth high pass filters (order n=2) for different cut-off frequencies (5, 15, 30, 90, 120). d. Compare the output of Gaussian high pass filters for different cut-off frequencies (5, 15, 30, 90, and 120).	3	2	1,2,3
Total Contact Hours		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		CLA-1 (5%)	**CLA2 (5%)**	**CLA-3 (5%)**	**Mid (15%)**	**Practical (20%)**	**Th (30%)**	**Prac (20%)**
Level 1	Remember Understand	70%	50%	40%	40%	20%	40%	30%
Level 2	Apply Analyse	30%	50%	60%	40%	30%	40%	30%
Level 3	Evaluate Create				20%	50%	20%	40%
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Gonzalez, R. C. (2009). Digital image processing. Pearson education India.
2. Sridhar, S. (2016) Digital Image Processing, Oxford University Press.
3. Sonka, M., Hlavac, V., & Boyle, R. (2013). Image processing, analysis and machine vision. Springer.
4. Forsyth, D. A., & Ponce, J. (2002). Computer vision: a modern approach. prentice hall professional technical reference.

Other Resources

Course Designers

Deep Learning

Course Code	CSE 457	**Course Category**	Stream Elective (SE)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	NIL	**Progressive Course(s)**	NIL			
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental concepts of ML/DL, tensor flow, and keras
2. Study of different activation functions and ANN.
3. Study and application of CNN, and RNN models
4. Application of different deep learning concepts.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Illustrate the concepts of ML/DL	1	70	68
Outcome 2	Design and implement CNN model	2	70	65
Outcome 3	Design and implement RNN model	2	70	65
Outcome 4	Apply deep learning models to given problems.	3	70	60

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	1	2								2	2	
Outcome 2	2	2	3	2	3								3	2	
Outcome 3	2	2	3	2	3								2	3	
Outcome 4	2	2	3	3	3								2	3	
Average	**2**	**2**	**3**	**2**	**3**								**2**	**3**	

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction:**	**11**		
	Overview of machine learning	2	1	1
	History of Deep Learning	1	1	1
	Introduction to TensorFlow:	1	1	1
	Computational Graph, Key highlights, Creating a Graph	1	1	1
	Linear classifiers, loss functions , Regression example	1	1	1
	Gradient Descent	1	1	1
	TensorBoard	2	1	1
	Modularity, Sharing Variables	1	1	1
	Keras	1	4	3
Unit 2	**ACTIVATION FUNCTIONS , PERCEPTRON, ANN**	**9**		
	Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Softmax	2	1	1,2
	Perceptrons: What is a Perceptron, XOR Gate	1	1	1
	Artificial Neural Networks: Introduction	1	1	2
	Perceptron Training Rule	2	1	2
	Gradient Descent Rule	2	1	2
	Vanishing gradient problem and solution	1	1	2
Unit 3	**Convolutional Neural Networks**	**8**		
	Introduction to CNNs	2	1,2	3
	Kernel filter	1	1,2	3
	Principles behind CNNs	1	1,2	3
	Long Short-Term Memory (LSTM)	2	1,2	3
	Problem and solution of under fitting and overfitting	2	1,2	3
Unit 4	**Recurrent Neural Networks**	**8**		
	Introduction to RNNs	2	1,3	2
	Unfolded RNNs	1	1,3	2
	Seq2Seq RNNs	1	1,3	2
	LSTM	1	1,3	2
	GRU	1	1,3	2
	Encoder Decoder architectures	2	1,3	2
Unit 5	**Deep Learning applications**	**9**		
	Image segmentation	1	4	3
	Self-Driving Cars	1	4	3
	News Aggregation and Fraud News Detection	1	4	3
	Natural Language Processing	1	4	3
	Virtual Assistants	1	4	3
	Entertainment	1	4	3
	Visual Recognition	1	4	3
	Fraud Detection, Healthcare	2	4	3
	Total Contact Hours	**45**		

Course Unitization Plan Lab

Unit Name	Required Contact Hours	CLOs Addressed	References Used
Lab 1: To implement a Multilayer Perceptron (MLP) using Keras with TensorFlow, and fine-tune neural network hyperparameters for regression problem (house price prediction).	3	1,2	1
Lab 2: To implement a MLP using Keras with TensorFlow for classification problem (heart disease prediction).	3	1,2,3	1
Lab 3: To implement a Convolution Neural Network (CNN) for dog/cat classification problem using TensorFlow/Keras.	3	2,3	1
Lab 4: To implement a CNN for handwritten digit recognition.	2	1,2,3	1
Lab 5: To Implement a CNN for object detection in the given image.	3	2,3	1
Lab 6: To implement a Long Short-Term Memory (LSTM) for predicting time series data.	3	3,4	
Lab 7: To implement a Seq2Seq Model for Neural Machine Translation.	3	3,4	1
Lab 8: To implement a Recurrent Neural Network (RNN) for predicting time series data.	3	3,4	1
Lab 9: To implement an Encoder-Decoder Recurrent neural network model for Neural Machine Translation.	3	2,3,4	1
Lab 10: Case Study 1: Object detection for Self-Driving Cars	3	1,2,3,4	1,2
Lab 11: Case Study 2: Object detection for Healthcare images	3	1,2,3,4	1,2
Total	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1		Mid-1 (15%)		CLA-2		CLA-3			
		Th (5%)	Prac	Th	Prac	Th (5%)	Prac	Th (10%)	Prac (15%)	Th (35%)	Prac (15%)
Level 1	Remember	40%		40%		20%		10%	10%	10%	10%
	Understand										
Level 2	Apply	30%		30%		40%		50%	40%	40%	40%
	Analyse										
Level 3	Evaluate	30%		30%		40%		40%	50%	50%	50%
	Create										
Total		**100%**		**100%**		**100%**		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Buduma, N., Buduma, N., & Papa, J. (2022). Fundamentals of deep learning, 2nd ed. O'Reilly Media, Inc."
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning, 2nd ed. MIT press.

Other Resources

1. https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT
2. https://www.coursera.org/professional-certificates/tensorflow

Course Designers

Principles of Soft Computing

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 458</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Stream Electives (SE)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td>CSE 201, CSE 336</td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations.
2. Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications.
3. Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
4. Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
5. Understand the Genetic Algorithm and able to identify the application area.
6. Understand soft computing techniques and their role in problem solving.Reveal different applications of these models to solve engineering and other problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate neural network model	3	90%	75%
Outcome 2	Describe neural network architectures, algorithms, applications and their limitations	2	70%	65%
Outcome 3	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems	3	80%	75%
Outcome 4	Apply genetic algorithms to combinatorial optimization problems	3	80%	75%
Outcome 5	Evaluate and compare solutions by genetic algorithms with traditional approaches for a given problem.	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	2	1	2	1	1	2	3	2	1	3	3	2	1
Outcome 2	3	2	1	2	2	2	2	2	3	3	2	3	3	2	1
Outcome 3	3	3	3	2	2	2	2	2	3	3	2	3	3	2	2
Outcome 4	3	3	3	2	3	2	2	2	3	3	2	3	3	3	2
Outcome 5	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
Average	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**2**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction to Soft Computing, ANN**	**9**		
	Introduction to Soft Computing, Artificial Neural Network (ANN)	1	1	1
	Fundamentals of ANN, Basic Models of an artificial Neuron, Neural Network Architecture	1	1,2	1
	Learning methods, Terminologies of ANN	1	1	1,3
	Hebb network	1	2	1,3
	Supervised Learning Networks: Perceptron, Adaline, Madaline	1	1	1
	Multi-Layer Perceptron	1	1,2	1
	Feed forward Back propagation Network	1	1,2	1
	Back propagation learning	1	1,2	1
	Learning Effect of Tuning parameters of the Back propagation	1	2,5	1
Unit II	**Advanced Neural Network**	**9**		
	RBF Network, Associative memory:	1	2	1,3
	Auto, hetero and linear associative memory network	1	2	1,3
	Adaptive Resonance Theory: ART1	1	2	1,3
	ART2	1	2	1,3
	Introduction to Computer vision	1	2	1,3
	Introduction to Convolutional Neural Network	1	2	1,3
	Popular architectures: AlexNet	1	2,5	1,3
	GoogleNet	1	2,5	1,3
	VGG Net	1	2,5	1,3
Unit III	**Fuzzy Logic**	**9**		
	FUZZY LOGIC : Fuzzy set theory:	1	3	2
	Crisp sets, fuzzy sets	1	3	2
	Crisp relations, fuzzy relations	1	3	2
	Fuzzy Systems	1	3	2,3
	Crisp logic, predicate logic	1	3	2,3
	Fuzzy logic	1	3	2,3
	fuzzy Rule based system	1	3,5	2,3
	Defuzzification Methods	1	3	2,3
	Fuzzy rule-based reasoning	1	3,5	2,3
Unit IV	**Genetic Algorithms**	**9**		
	Genetic Algorithms: Fundamentals of genetic algorithms:	1	4	3
	Encoding, Fitness functions, Reproduction.	1	4	3
	Genetic Modeling : Cross cover, Inversion and deletion	1	4	3
	Mutation operator, Bit-wise operators, Bitwise operators used in GA.	1	4	3
	Convergence of Genetic algorithm.	1	4	3
	Applications of Genetic Algorithms	1	4,5	3
	Real life Problems of Genetic Algorithms	1	5	3
	Particle Swarm Optimization	1	4,5	3
	Variants of PSO	1	4	3
Unit V	**Advanced Soft Computing**	**9**		
	Hybrid Soft Computing Techniques Hybrid system	1	4	2,3
	Advanced neural Networks	1	2	1,3
	Fuzzy logic and Genetic algorithms hybrids.	1	3,4	2,3
	Genetic Algorithm based Back propagation Networks	1	1,4	2,3
	GA based weight determination applications	1	4,5	2,3
	Fuzzy logic controlled genetic Algorithms	1	3,4	2,3
	Soft computing tools	1	5	3
	Soft computing Applications	2	5	3

	Total contact hours	45

Course Unitization Plan - Lab

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
	Introduction to Soft Computing and ANN			
Unit I	Write a Python Program to implement a perceptron. The input is your semester marks.	1	1	1,3
	Write a python program to extend the exercise given above to implement Feed Forward Network. The inbuilt function should not be used.	2	1,2	1,3
	Write a python program to implement Hebb Network. The inbuilt function should not be used.	2	1,2	1,3
	Write a python program to implement Multilayer Perceptron. The inbuilt function should not be used.	2	2	1,3
	Write a python program to implement any ANN with back propagation learning Algorithm.	2	1,2	1,3
Unit II	**Advanced Neural Network**			
	Write a Python Program to implement ART1 and ART 2.	2	2	1,3
	Write a python program to implement CNN.	2	2	1,3
	Write a python Programming to realize the working principles of popular architectures such as AlexNet, GoogleNet and VGG Net.	2	2	1,3
Unit III	**Fuzzy Logic**			
	Write python Program to realize Fuzzy Sets arithmetic.	2	2	2,3
	Write a python Program to realize fuzzy relations.	1	2	2,3
	Write a python program to realize a fuzzy rule of any popular problem (s).	2	3	2,3
	Write a python program to realize a defuzzification scheme for the above exercise.	2	3	2,3
	Write a python Program to reason the fuzzy rules in exercises 12 and 13.	2	3	2,3
Unit IV	**Genetic Algorithms**			
	Write a python program to realize various steps of Genetic Algorithms.	2	4	3
	Write a Python Program to realize GA based back propagation Networks.	2	4,5	3
Unit V	**Advanced Soft Computing**			
	Write a Python Program to realize Fuzzy Controlled Genetic Algorithms.	2	4,5	1,3
	Total contact hours	**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		CLA-1 (5%)	CLA2 (5%)	CLA-3 (5%)	Mid (15%)	Practical (20%)	Th (30%)	Prac (20%)
Level 1	Remember Understand	70%	50%	40%	40%	20%	40%	30%
Level 2	Apply Analyse	30%	50%	60%	40%	30%	40%	30%
Level 3	Evaluate Create				20%	50%	20%	40%
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Sivanandan, S. N. and Deepa, S. N. (2011). Principles of Soft Computing Willey India, 2nd Edition.
2. Jang, J. S. R. (1997). Neuro-Fuzzy and Soft Computing/J.-SR Jang, C.-T. Sun, E. Mizutani. A Compute. Approach to Learn. Mach. Intell. Saddle River, NJ Prentice Hall, Inc.
3. Rajasekaran, S., & Pai, G. V. (2003). Neural networks, fuzzy logic and genetic algorithm: synthesis and applications (with cd). PHI Learning Pvt. Ltd..

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Cryptography and Network Security

				L	T	P	C
Course Code	CSE 459	**Course Category**	Stream Elective (SE)	3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce cryptographic principles, methods, and algorithms for data protection.
2. Understand network vulnerabilities and apply security measures to counter threats.
3. Explore authentication techniques, key management, and digital signatures for communication.
4. Analyse security protocols, access controls, and secure communication in networks.
5. Develop skills to assess risks, design secure systems, and ensure data integrity.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand cryptographic algorithms, their principles, and applications in data protection	2	70 %	65%
Outcome 2	Analyze network vulnerabilities and apply measures to safeguard against attacks.	3	70 %	65%
Outcome 3	Implement secure communication protocols ensuring data integrity and confidentiality.	3	70 %	65%
Outcome 4	Evaluate and deploy encryption techniques for data privacy and non-repudiation.	3	70 %	65%
Outcome 5	Develop skills to manage network access, authentication, and intrusion detection.	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	
Outcome 2	2	2	3	3	2								2	2	
Outcome 3	2	3	3	2	2								2	2	
Outcome 4	3	3	3	3	2								2	3	
Outcome 5	2	3	3	3	2								2	2	
Average	**2**	**3**	**3**	**3**	**2**								**2**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	16		
	Introduction, Traditional Cipher structure	1	1	1,2
	Substitution Techniques: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher	1	1	1
	Hill Cipher, Poly Alphabetic Cipher, One TimePad	1	1	1,2
	Transposition Cipher: Rail Fence Cipher, Simple Columnar or Row Transposition	1	1	1
	Motivation for the feistel Cipher structure, Stream Ciphers and block Ciphers	1	1	1
	The data encryption Techniques, Finite Fields	1	1	1
	Advanced Encryption Standard, AES encryption, AES decryption, AES example, results	1	1	1,2
	The avalanche effect, the strength of AES	1	1	1,2
	Stream Ciphers, RC1, RC4	1	1	1,2
	Lab Experiment 1: Write a encryption program: Input: computerscienceengineeringsrmuniversity Output: gsqtyxivwgmirgiirkmriivmrkwvqyrmzivwmxc Hint: key =4 (play with ascii value)	1	3	2
	Lab Experiment 2: Raju send encrypted message "ZICVTWQNGKZEIIGASXSTSLVVWLA" to Rani. Can you build decryption process and find out what is the message send to Rani. Hint: try all keys for each character	1	3	2
	Lab Experiment 3: Raju want to build encrypted and decryption algorithms of Playfair Cipher. Help him to build a key matrix using the key "srmapuniversity"	1	3	2
	Lab Experiment 4: Implement AES Key Expansion	1	3	2
	Lab Experiment 5:Implementation of AES encryption and decryption	1	3	2
	Lab Experiment 6:Implementation of Simplified DES Encryption and decryption	1	3	2
	Lab Experiment 7: Implementation of RC4	1	3	2
UNIT 2	Public-Key Cryptosystems	13		
	Fermat's and Euler's Theorems	1	2	1,2
	Public-Key Cryptography and RSA, Principles of public-key cryptosystems	1	2	1,2
	Applications for public-key cryptosystems, requirements for public-key cryptosystems	1	2	1,2
	public-key cryptanalysis. The RSA algorithm, description of the algorithm computational aspects	1	2	1,2
	the security of RSA, Diffie-hellman key exchange	1	2	1,2
	Elliptic Curve Cryptography systems, key exchange protocols	1	2	1,2
	man in the middle attack	1	2	1,2
	Elgamal Cryptographic systems	1	2	1,2
	Lab Experiment 8: Implementation of RSA algorithm.	1	3	2
	Lab Experiment 9: Implementation of Diffie-Helman key exchanges	1	3	2
	Lab Experiment 10: Implementation of elliptic-curve cryptography	1	3	2
	Lab Experiment 12: Write a program for session Key establishment using RSA	1	3	2
	Lab Experiment 13: Write a program to implement Diffie-Hellman Algorithm	1	3	2
UNIT 3	Cryptographic Hash Functions and MAC	12		
	Introduction to Cryptographic Hash Functions	1	3	1,2
	Hash Functions Based on Cipher Block Chaining	1	3	1,2
	Secure Hash Algorithm (SHA), SHA1	1	3	1,2
	SHA-3, Application of Cryptographic Hash Functions	1	3	1,2

	Message Authentication Codes (MAC): Message Authentication Requirements	1	3	1,2
	Message Authentication Functions	1	3	1,2
	Security of MACs	1	3	1,2
	MACs Based on Hash Functions: HMAC	1	3	1,2
	Lab Experiment 11: Implementation of Hash functions	2	3	2
	Lab Experiment 13: Setup and configure a certificate authority using Easy-RSA, distribute Certificate Authority's public certificate in a LAN (/ NAT) network, create certificate signing request, and revoke certificates	2	3	2
UNIT 4	Authentication	13		
	Digital Signature: Digital Signatures, Elgamal Digital Signature Scheme	1	4	1
	Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm	1	4	1
	RSA-PSS Digital Signature Algorithm	1	4	1
	Overview of Authentication Systems: Password-Based Authentication, Address-Based Authentication, Cryptographic Authentication Protocols	1	4	1
	KDCs, Certification Authorities (CAs), Session Key Establishment	1	4	1
	Security Handshake Pitfalls: Login, Mutual Authentication, Integrity/Encryption for Data	1	4	1
	Two-Way Public Key Based Authentication, One-Way Public Key Based Authentication	1	4	1
	Mediated Authentication (with KDC), Needham-Schroeder, Expanded Needham-Schroeder	1	4	1
	Otway-Rees, Nonce Types. Strong Password Protocols: Lamport's Hash,	1	4	2
	Strong Password Protocols, Strong Password Credentials Download Protocols	1	4	2
	Lab Experiment 15: Write a program to demonstrate Authentication using symmetric/asymmitric key	2	3	2
	Lab Experiment 16: Write a program to implement the Digital Signature	1	3	2
UNIT 5	Internet Security	16		
	IPSec: Overview of IP Security (IPSec), IP Security Architecture, Modes of Operation	1	5	1
	Security Associations (SA), Authentication Header (AH), Encapsulating Security Payload (ESP)	1	5	1
	Comparison of Encodings	1	5	1
	Comparison of Encodings, Phase 1 IKE - Aggressive Mode and Main Mode	1	5	1
	Phase 2/Quick Mode, Traffic Selectors, The IKE Phase 1 Protocols	1	5	1
	Phase-2 IKE: Setting up IPsec SAs, ISAKMP/IKE Encoding	1	5	1
	Fixed Header, Payload Portion of ISAKMP Messages, SA Payload, SA Payload Fields	1	5	1
	Web Security Requirements: Web Security threats	1	5	1
	Web traffic Security Approaches. SSL/TLS: Secure Socket Layer (SSL)	1	5	1
	Transport Layer Security (TLS), TLS Architecture, TLS record protocol	1	5	1
	change cipher spec protocol, Alert Protocol, Handshake Protocol, Https	1	5	1
	SSH. Secure Electronic Transaction (SET): SET functionalities	2	3	2
	Dual Signature, Roles & Operations, Purchase Request Generation	2	3	2
	Purchase Request Validation, Payment Authorization and Payment Capture.	1	3	2
	Total contact hours	70		

Learning Assessment Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (15%)	
Level 1	Remember Understand	70%	60%	30%	30%	60%
Level 2	Apply Analyse	30%	40%	70%	70%	40%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment Lab

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	
Level 1	Remember Understand	50%	50%	50%	50%
Level 2	Apply Analyse	50%	50%	50%	50%
Level 3	Evaluate Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Perlman, R., Kaufman, C., & Speciner, M. (2016). Network Security: Private Communication in a Public World. Pearson Education India.
2. Stallings, W. (2013). Cryptography and Network Security: Principles and Practice (6th ed.). Pearson Education.

Other Resources

1. Menezes, B. (2010) Network Security and Cryptography. Cengage Learning.
2. Krawetz, N. (2007). Introduction to Network Security. Cengage Learning.
3. Kahate, A. (2017). Cryptography and Network Security (3rd ed.). McGraw Hill.

Course Designers

Web Application Penetration Testing

Course Code	CSE 460	**Course Category**	Stream Elective (SE)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Develop proficiency in identifying web vulnerabilities and understanding attack methodologies.
2. Acquire hands-on skills in using security tools to assess web application risks.
3. Master techniques to secure web services, databases, and authentication mechanisms.
4. Gain practical knowledge of exploiting and mitigating XSS, SQL injection, and other attacks.
5. Demonstrate the ability to apply cryptographic principles for web application security.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate comprehensive knowledge of web application vulnerabilities and their exploitation techniques.	3	70%	65%
Outcome 2	Apply cryptographic principles and security measures to protect web applications from threats.	3	70%	65%
Outcome 3	Perform effective penetration testing using tools like Burp Suite and OWASP ZAP.	3	70%	65%
Outcome 4	Analyse and secure web services, preventing attacks on SOAP, REST, and other protocols.	4	70%	65%
Outcome 5	Proficiently identify and mitigate SQL injection, XSS, session hijacking, and other common web threats.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	2	3	2								3	3	
Outcome 2	2	3	3	3	3	3							3	2	
Outcome 3	2	3	2	3	3								2	2	
Outcome 4	2	3	3	3	3								2	2	
Outcome 5	2	3	3	3	3								2	2	
Average	2	3	3	3	3	3							2	2	

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Introduction- A web security forensic lesson, Web languages	1	1	1,2
	Introduction to different web attacks. Overview of N-tier web applications	1	1	1
	Web Servers: Apache, IIS, Database Servers	1	1	1,2
	Review of computer security, Public Key cryptography, RSA	1	1	1
	RSA, Review of Cryptography Basics	1	1	1
	Review of Cryptography Basics, Network security Basics	1	1	1
	On-line Shopping, Payment Gateways	1	1	1,2
	Gathering information on your target, Fingerprinting the web server and applications	1	1	1,2
	Enumerating subdomains and resources	1	1	1,2
UNIT2	Unit-II	9		
	Web Hacking Basics HTTP & HTTPS URL	1	2	1
	Web Under the Cover Overview of Java security Reading the HTML source, Encoding	1	2	1
	Cookies, Sessions, Applet Security Servlets Security Symmetric and Asymmetric Encryption	1	2	1,2
	Firewalls & IDS	1	2	1, 2
	Cross-Site Scripting: Anatomy of an XSS Exploitation	1	2	1
	Types of XSS, Finding XSS	1	2	1
	XSS Exploitation, Mitigation	1	2	2
	HTML5: Cross-Origin Resource Sharing, Cross-Windows Messaging	1	2	1,2
	Web Storage, WebSocket, Sandboxed frames	1	2	1,2
UNIT3	Unit Name 3	9		
	Digital Certificates, Hashing	1	3	1
	Hashing, Message Digest, & Digital Signatures	1	3	1,2
	Message Digest, & Digital Signatures	1	3	1,2
	Authentication and Authorization	1	3	1
	Authorization, Common Vulnerabilities	1	3	1
	Common Vulnerabilities, Bypassing Authorization	1	3	1,2
	Bypassing Authorization	1	3	1
	Session Security: Weaknesses of the session identifier, Session Fixation, Cross-Site Request Forgeries	2	3	1,2
UNIT4	Unit Name 4	9		
	Web Services: Web Services Implementations	1	4	1,2
	The WSDL Language, Attacks on SOAP and REST	1	4	1
	XPath Injection: XML Documents and Databases	1	4	1
	XPath, Detecting XPath Injection	1	4	1
	Exploitation, Best Defensive Techniques	1	4	1,2
	File and Resource Attacks: Path Traversal	1	4	1,2
	Path Traversal, File Inclusion Vulnerabilities	1	4	2
	File Inclusion Vulnerabilities, Unrestricted File Upload	1	4	2
	Clickjacking, HTTP Response Splitting	1	4	1,2
UNIT5	Unit Name 5	9		
	Basics, Securing databases	1	5	1,2
	Secure JDBC, Securing Large Applications	1	5	1
	Cyber Graffiti. Introduction to SQL Injections	1	5	1,2
	Finding SQL Injections, Exploiting In-band SQL Injections	1	5	1
	Exploiting In-band SQL Injections, Exploiting Error-based SQL Injections	1	5	1

	Exploiting Error-based SQL Injections	1	5	1
	Exploiting blind SQLi	1	5	1,2
	SQLMap, Mitigation Strategies	1	5	1,2
	NoSQL Fundamentals & Security, NoSQL Exploitation	1	5	2
Total Contact Hours		45 Hours		

Course Unitization Plan – Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Lab Experiment 1: Securing Web applications using Keytool & OpenSSL	2	3	2
2	Lab Experiment 2: Implement a one-way SSL to a web app	2	3	2
3	Lab Experiment 3: System Fingerprinting using nmap, Fingerprinting the web server Netcat, WhatWeb, Wappalyzer	2	3	2
4	Lab Experiment 4: Inspecting the Cookie Protocol, login, cookie installation, Correct cookie installation, Incorrect cookie installation	2	3	2
5	Lab Experiment 5: Burp Suite	2	3	2
6	Lab Experiment 6: OWASP ZAP	2	3	2
7	Lab Experiment 7: XSS Attacks, Cookie Stealing through XSS, Defacement, XSS for advanced phishing attacks, BeEF	2	3	2
8	Lab Experiment 8:Simple SQL Injection scenario, SQL errors in web applications	2	3	2
9	Lab Experiment 9: Finding the DBMS version, Dumping the database data, Finding the current username, finding readable databases, Enumerating database tables, Enumerating columns	2	3	2
10	Lab Experiment 10: Defending from inadequate password policy Strong password policy Storing hashes Lockout/Blocking requests	2	3	2
11	Lab Experiment 11: Session Hijacking via Packet Sniffing, Session Hijacking via access to the web server	2	3	2
12	Lab Experiment 12: Local File Inclusion (LFI), Remote File Inclusion (RFI)	2	3	2
13	Lab Experiment 13: WSDL Scanning, Attack in ction, SOAPAction Spoofing	2	3	2
Total Contact Hours		26 Hours		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (15%)	
Level 1	Remember	70%	60%	30%	30%	60%
	Understand					
Level 2	Apply	30%	40%	70%	70%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="3">Continuous Learning Assessments (50%)</th><th rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th>Experiments (20%)</th><th>Record / Observation Note (10%)</th><th>Viva + Model (20%)</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">50%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">50%</td><td rowspan="2">50%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. McClure, Stuart, Saumil Shah, and Shreeraj Shah.(2003), Web Hacking:attacks and defense. Addison Wesley.
2. Garms, Jess and Daniel Somerfield. (2001) Professional Java Security. Wrox.

Other Resources

Course Designers

Vulnerability Analysis and Cyber Forensics

Course Code	CSE 461	**Course Category**	Stream Elective (SE)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Develop proficiency in identifying web vulnerabilities and understanding attack methodologies.
2. Acquire hands-on skills in using security tools to assess web application risks.
3. Master techniques to secure web services, databases, and authentication mechanisms.
4. Gain practical knowledge of exploiting and mitigating XSS, SQL injection, and other attacks
5. Demonstrate the ability to apply cryptographic principles for web application security

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate comprehensive knowledge of web application vulnerabilities and their exploitation techniques	2	70 %	65%
Outcome 2	Apply cryptographic principles and security measures to protect web applications from threats.	3	70 %	65%
Outcome 3	Perform effective penetration testing using tools like Burp Suite and OWASP ZAP.	3	70 %	65%
Outcome 4	Analyze and secure web services, preventing attacks on SOAP, REST, and other protocols.	3	70 %	65%
Outcome 5	Proficiently identify and mitigate SQL injection, XSS, session hijacking, and other common web threats.	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	3	3	3	2								3	2	
Outcome 2	2	2	3	3	2								2	2	
Outcome 3	2	3	3	2	2								2	2	
Outcome 4	3	3	3	3	2								2	3	
Outcome 5	2	3	3	3	2								2	2	
Average	**2**	**3**	**3**	**3**	**2**								**2**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	11		
	Introduction- A web security forensic lesson, Web languages	1	1	1,2
	Introduction to different web attacks. Overview of N-tier web applications	1	1	1
	Web Servers: Apache, IIS, Database Servers	1	1	1,2
	Review of computer security, Public Key cryptography	1	1	1
	RSA. Review of Cryptography Basics	1	1	1
	Network security Basics, On-line Shopping, Payment Gateways	1	1	1
	Gathering information on your target, Fingerprinting the web server and applications	1	1	1,2
	Enumerating subdomains and resources	1	1	1,2
	Example problems	1	1	1,2
	Lab Experiment 1: Securing Web applications using Keytool& OpenSSL	1	3	2
	Lab Experiment 2: Implement a one-way SSL to a web app	1	3	2
UNIT 2	Web Hacking	12		
	Basics HTTP & HTTPS URL	1	2	1,2
	Web Under the Cover Overview of Java security Reading the HTML source	1	2	1,2
	Encoding, Cookies, Sessions	1	2	1,2
	Applet Security Servlets Security Symmetric and Asymmetric Encryptions	1	2	1,2
	Firewalls & IDS	1	2	1,2
	Cross-Site Scripting: Anatomy of an XSS Exploitation	1	2	1,2
	Types of XSS, Finding XSS, XSS Exploitation, Mitigation	1	2	1,2
	HTML5: Cross-Origin Resource Sharing, Cross-Windows Messaging, Web Sto[illegible] frames	2	2	1,2
	Lab Experiment 3: System Fingerprinting using nmap, . Fingerprinting the web server Netcat, WhatWeb, Wappalyzer	1	3	2
	Lab Experiment 4: Inspecting the Cookie Protocol, login, coockie installation, Correct cookie installation, Incorrect cookie installation	1	3	2
	Lab Experiment 5: Burp Suite	1	3	2
UNIT 3	Digital Certificates	12		
	Hashing, Message Digest, & Digital Signatures	2	3	1,2
	Authentication and Authorization:	1	3	1,2
	Common Vulnerabilities, Bypassing Authorization	1	3	1,2
	Session Security:	1	3	1,2
	Weaknesses of the session identifier	1	3	1,2
	Session Fixation	1	3	1,2
	Cross-Site Request Forgeries	1	3	1,2
	Lab Experiment 6: OWASP ZAP	2	3	2
	Lab Experiment 7: XSS Attacks, Cookie Stealing through XSS, Defacement, XSS for advanced phishing attacks, BeEF	2	3	2
UNIT 4	Web Services	13		
	Web Services Implementations	1	4	1
	The WSDL Language	1	4	1
	Attacks on SOAP and REST.	1	4	1
	XPath Injection: XML Documents and Databases	1	4	1
	XPath, Detecting XPath Injection	1	4	1
	Exploitation, Best Defensive Techniques	1	4	1
	File and Resource Attacks	1	4	1
	Path Traversal, File Inclusion Vulnerabilities	1	4	1

	Unrestricted File Upload. Clickjacking,	1	4	2
	HTTP Response Splitting	1	4	2
	Lab Experiment 8: Simple SQL Injection scenario, SQL errors in web applications	2	3	2
	Lab Experiment 9: Finding the DBMS version, Dumping the database data, Finding the current username, Finding readable databases, Enumerating database tables, Enumerating columns	1	3	2
UNIT 5	SQL	16		
	Basics, Securing databases	1	5	1
	Secure JDBC, Securing Large Applications	1	5	1
	Cyber Graffiti	1	5	1
	Introduction to SQL Injections, Finding SQL Injections	1	5	1
	Exploiting In-band SQL Injections	1	5	1
	Exploiting Error-based SQL Injections	1	5	1
	Exploiting blind SQLi	1	5	1
	SQLMap, Mitigation Strategies	1	5	1
	NoSQL Fundamentals & Security	1	5	1
	NoSQL Exploitation	1	5	1
	Lab Experiment 10: Defending from inadequate password policy Strong password policy Storing hashes Lockout/Blocking requests	1	5	1
	Lab Experiment 11: Session Hijacking via Packet Sniffing, Session Hijacking via access to the web server	2	3	2
	Lab Experiment 12: Local File Inclusion (LFI), Remote File Inclusion (RFI)	2	3	2
	Lab Experiment 13: WSDL Scanning, Attack in action, SOAPAction Spoofing	1	3	2

Learning Assessment Theory

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**				**End Semester Exam (50%)**
		CLA-1 (10%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (15%)**	
Level 1	Remember Understand	70%	60%	30%	30%	60%
Level 2	Apply Analyse	30%	40%	70%	70%	40%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Exam (50%)**
		Experiments (20%)	**Record / Observation Note (10%)**	**Viva + Model (20%)**	
Level 1	Remember Understand	50%	50%	50%	50%
Level 2	Apply Analyse	50%	50%	50%	50%
Level 3	Evaluate Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. McClure, Stuart, Saumil Shah, and Shreeraj Shah. (2003), Web Hacking:attacks and defense. Addison Wesley.
2. Garms, Jess and Daniel Somerfield. (2001), Professional Java Security. Wrox.

Other Resources

Course Designers

Blockchain Technology

Course Code	CSE 462	**Course Category**	Stream Elective (SE)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Cryptography	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department		**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To Understand the types, benefits and limitation of block chain
2. To Explore the block chain decentralization and cryptography concepts.
3. To Enumerate the Bitcoin features and its alternative options
4. To Describe and deploy the smart contracts and summarize the block chain features outside of currencies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Describe block chain technology and its applications	2	70%	65%
Outcome 2	Explain Cryptocurrency and its applications	2	70%	65%
Outcome 3	Develop and deploy Smart contract	3	70%	65%
Outcome 4	Develop block chain-based solutions and write smart contract using Ethereum Framework.	3	70%	65%
Outcome 5	Analyse and apply Deploy Decentralized Application	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2												1	3	
Outcome 2	2	2	3	2	3							1	3	3	
Outcome 3	2	2	3	2	3							1	3	3	
Outcome 4	1	2	2	2	3							1	3	3	
Outcome 5	1	2	2	2	3							1	3	3	
Average	**2**	**2**	**3**	**2**	**3**							**1**	**3**	**3**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**16**		
	Need for Distributed Record Keeping, Modeling faults and adversaries.	2	2	1
	Byzantine Generals problem, Consensus algorithms and their scalability problems	2	2	1
	Blockchain based cryptocurrency, hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash etc	3	2	1
	Distributed Computing, Atomic Broadcast, Consensus, Byzantine Models of fault tolerance	2	2	1
	Basic Crypto primitives, Hash functions, Puzzle friendly Hash, Collison resistant hash, Hash pointer and Merkle tree,	3	2	1
	digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems	2	2	1
	Lab Experiment: Use of MetaMask, Ethereum and Blocks representation	2	2	1
Unit 2	**Blockchain 1.0**	**15**		
	Creation of coins, Bitcoin Scripts, Bitcoin P2P Network	1	2	1,2
	Transaction in Bitcoin Network, Block Mining, Block propagation and block relay	1	2	1,2
	Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW): basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem	3	2	1,3
	Payments and double spending, Proof of Stake, Proof of Burn and Proof of Elapsed Time	1	2	1,3
	The life of a Bitcoin Miner, Mining Difficulty, Mining Pool. Bitcoin scripting language and their use	1	2	1,3
	Lab Experiment: Implementation of Hashcash PoW Algorithm with varying difficulty level	2	2	1,3
	Lab Experiment: Use of Timestamp in Block	2	2	1,3
	Lab Experiment: Use of Transaction value in Block	2	2	1,3
	Lab assignment: Working on different wallet	2	2	1,3
Unit 3	**Blockchain 2.0**	**19**		
	Ethereum and Smart Contracts	1	3	1,4
	The Turing Completeness of Smart Contract Languages and verification challenges	1	3	2,3
	Using smart contracts to enforce legal contracts	1	3	1,5
	comparing Bitcoin scripting vs. Ethereum Smart Contracts,	2	3	1,2
	Dapps development	4	3	1,3
	Lab Experiment: Introduction to remix and its working	2	3	1,5
	Lab Experiment: Introduction to Solidity compiler and its different version	2	3	1,2
	Lab Experiment: Development of smart contracts	2	3	1,2
	Lab Experiment: Introduction to various testnetworks	2	3	1,3
	Lab Experiment: Deployment of smart contracts over different blockchain network	2	3	1,3,4
Unit 4	**Blockchain 3.0**	**9**		
	Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain	1	4	1,3
	Architecture, Identities and Policies	1	4	1,2
	Membership and Access Control	1	4	2,5
	Channels, Transaction Validation	1	4	2,3
	writing smart contract using Hyperledger Fabric	1	4	1,2,5
	Lab Experiment: Hyperledger Fabric Installation	2	4	1,2,5

	Lab Experiment: Implementation and deployment of smart contracts and channel creation over Hyperledger fabric	2	4	2,5
Unit 5	**Application of Blockchain**	**16**		
	Cross border payments, Know Your Customer (KYC)	2	5	1
	Food Security	2	5	1
	Mortgage over Blockchain	2	5	1,2
	Blockchain enabled Trade	2	5	1,3
	Trade Finance Network, Supply Chain Financing, Identity on Blockchain	2	5	1,4
	Lab Experiment: Implementation of supply chain management for various domain like medicine supply chain, food supply chain	2	5	1,2,3
	Lab Experiment: Dapp Development and deployment over different web3.0 servers	2	5	1,2,3
	Lab Experiment: Learning of token based implementation and token wallet	2	5	1,2,3
	Total Contact Hours required	**75**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	CLA-2 (10%)	CLA-3 (5%)	Mid-1 (10%)		Th	Prac
Level 1	Remember	50%	40%	40%	40%	50%	30%	40%
	Understand							
Level 2	Apply	50%	60%	60%	60%	50%	70%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Bashir, I. (2020). Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more. Packt Publishing Ltd.
2. Laurence, T. (2019). Introduction to blockchain technology. Van Haren.
3. Modi, R. (2018). Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain. Packt Publishing Ltd.

Other Resources

1. Swan, M. (2015). Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.".
2. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. " O'Reilly Media, Inc.".

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Warehousing and Mining

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 463</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Stream Elective (SE)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td>CSE 304
MAT 221</td><td>Co-Requisite Course(s)</td><td>Nil</td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6">Nil</td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the basic concepts of data mining techniques
2. Explain the concepts of association rule mining and frequent pattern mining, classification and clustering.
3. Discuss and analyse various classification algorithms, clustering algorithms. Data Mining trends and research frontiers.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understanding of data warehouse modelling and implementation.	3	75%	70%
Outcome 2	Compare and evaluate association rule mining methods.	5	70%	65%
Outcome 3	Compare and evaluate classification and prediction methods.	5	70%	65%
Outcome 4	Compare and evaluate clustering methods.	5	70%	65%
Outcome 5	Study on Data Warehouse Trends and Research Frontiers	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	2	2								2	2	2	2
Outcome 2	2	2	3	3								2	3	2	2
Outcome 3	2	2	3	3								2	3	2	2
Outcome 4	2	2	3	3								2	3	2	2
Outcome 5	2	2	3	3								2	3	2	2
Average	**2**	**2**	**3**	**3**								**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	Data Warehousing and online analytical processing.	1	1	1
	Data Warehouse Modelling.	3	1	1, 2
	Data Warehouse Implementation.	3	1	1, 2
	Lab Experiment 1: Implementation of OLAP operations	2	1	1,5
Unit 2	**Association Rules in Knowledge Discovery**	**10**		
	Introduction, Market-Basket Analysis	1	1	1
	Mining Frequent Patterns, Associations, and Correlations, Apriori Algorithm	1	1	1
	Pattern-Growth Approach for Mining Frequent Itemsets	1	1	1
	Mining Frequent Itemsets using Vertical Data Format, Mining Closed and Max Patterns	1	1, 2	1
	Pattern Mining in Multilevel, Multidimensional Space	1	1, 2	1
	Constraint-Based Frequent Pattern Mining	1	1, 2	1
	Mining High-Dimensional Data and Colossal Patterns	1	1, 2	1
	Mining Compressed or Approximate Patterns	1	1, 2	1
	Lab Experiment 2: Data pre-processing techniques. **Lab Experiment 3:** Write a program in any programming language to generate at least 10,000 transactions in a text file with at least three items. **Lab Experiment 4:** Write a program to implement the APRIORI algorithm **Lab Experiment 5:** Write a program for FP-Growth algorithm.	2	1	1,2,3,4
Unit 3	**Classification**	**10**		
	Basic Concepts, Decision Tree Induction	2	1, 3	1
	Bayes Classification Methods: Bayes' Theorem, Na¨ıve Bayesian Classification, Rule-Based Classification	2	1, 3	1
	Model Evaluation and Selection	1	1, 3	1
	Bagging, Boosting and AdaBoost, Random Forests	2	1, 3	1, 3
	Improving Classification Accuracy of Class-Imbalanced Data	1	1, 3	1
	Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches	2	1, 3	1, 2
	Lab Experiment 8: Write a program to implement Decision tree-based classification. **Lab Experiment 9:** Write a program to implement Bayesian classification	2	2,3	1,2,3,4
Unit 4	**Cluster Analysis**	**12**		
	Introduction, k-Means, k-Medoids	2	1, 4	1
	Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods	2	1, 4	1
	Multiphase Hierarchical Clustering Using Clustering, Feature Trees	2	1, 4	1
	Multiphase Hierarchical Clustering Using Dynamic Modelling, Probabilistic Hierarchical Clustering	2	1, 4	1
	Density-Based Methods, Grid-Based Methods	2	1, 4	1
	Lab Experiment 10: Write a program to implement K-means clustering. **Lab Experiment 11**: Write a program to implement Divisive clustering **Lab Experiment 12**: Write a program to implement Agglomerative clustering **Lab Experiment 13:** Write a program to implement DBSCAN clustering	2	2,3	1,2,3,4
Unit 5	**Data Warehouse Trends and Research Frontiers**	**12**		

	Mining complex data type.	3	1, 5	1
	Data Mining Applications	3	1, 5	1
	Data Mining and Society.	2	1, 5	1
	Data Mining Trends	2	1, 5	1, 2, 3
	Case Study	**2**	2,3	1,2,3,4
	Total Hours	53		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**Mid-2 (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember Understand	70%	50%	40%	40%	30%	30%	30%	30%	30%	30%
Level 2	Apply Analyse	20%	30%	40%	40%	50%	50%	40%	50%	50%	50%
Level 3	Evaluate Create	10%	20%	20%	20%	20%	20%	30%	20%	20%	20%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Han, J. Kamber, M. Pei, J. (2011). Data Mining Concepts and Techniques, Third Edition Morgan Kaufmann
2. Olson, D. L., & Delen, D. (2008). Advanced data mining techniques. Springer Science & Business Media.
3. Aggarwal CC. (2013) Data mining: the textbook. Springer. William

Other Resources

Course Designers

Applied Data Science

Course Code	CSE 464	**Course Category**	Stream Elective (SE)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the skill sets and technologies required for data science.
2. Gain knowledge of data science process and basic tools for Exploratory Data Analysis
3. Learn various data science algorithms and its application domain.
4. Understand the implement recommendation system using fundamental mathematical and algorithmic ingredients.
5. Understand the use of data visualization tool.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate statistical measures to fit a model to a data.	2	75%	70%
Outcome 2	Apply data science algorithms such as Linear Regression, k-Nearest Neighbors (k-NN), k-means, and Naive Bayes to solve the given problems.	5	75%	70%
Outcome 3	Apply Feature Selection algorithms such as Filters, Wrappers, Decision Trees and Random Forests to solve a given problem	3	70%	60%
Outcome 4	Compute Recommendation Systems using Visualization tools based on the acquired data	4	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	2		1									1		3
Outcome 2	2	2	3	3									3	2	3
Outcome 3	2	2	3	3									3	2	3
Outcome 4	2	2	2	3									3	2	3
Average	**2**	**2**	**3**	**3**									**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**13**		
	Introduction: What is Data Science? - Big Data and Data Science hype – and getting past the hype - Why now?	2	1	1,2,3,6,8
	Datafication- Current landscape of perspectives	1	1	1,2,3,5,9,10
	Skill sets needed	1	1	1,2
	Statistical Inference - Populations and samples	1	1	1,2,6,9
	Statistical modelling,	1	1	1,2,6,9
	probability distributions,	1	1	1,2,6,9
	fitting a model	1	1	1,2,6,9
	Introduction to R	1	1	1,2,8
	Lab Experiment 1: Write R program to calculate the central tendency of any popular data set. The inbuilt functions in the python should not be used.	2	3	2
	Lab Experiment 2: Write R – Programming to plot various charts and graphs. You have to consider minimum two popular data sets and draw all the statistical observations.	2	3	2
Unit 2		**17**		
	Exploratory Data Analysis and the Data Science Process	2	1	1,2,3
	Philosophy of EDA - The Data Science Process	2	1	1,2,3
	The Data Science Process	1	1	1,2,6
	Three Basic Machine Learning Algorithms – Introduction	1	1, 2	1-10
	Linear Regression	1	1, 2	5,7
	K-Nearest Neighbours (K-NN)	1	1, 2	5,7
	K-means	1	1, 2	5,7
	Lab Experiment 3: Write a R Program to apply EDA on any two popular data sets and provided your analysis and interpretations. Use matplotlib library of python along with other libraries for the analysis and interpretation.	2	2	3
	Lab Experiment 4: Write R program to implement Linear Regression. Also, write your own program to implement Linear Regression without using the inbuilt function. Compare and contrast the results.	2	2	5
	Lab Experiment 5: Write R program to implement K-Nearest Neighbors. Also, write your own program to implement K-Nearest Neighbors without using the inbuilt function. Compare and contrast the results.	2	2	5
	Lab Experiment 6: Write R program to implement K-Means using inbuilt Library. Also, write your own	2	3	5

	program to implement K-Means without using the inbuilt function. Compare and contrast the results.			
Unit 3		**19**		
	One More Machine Learning Algorithm and Usage in Applications	**1**	2	5,7
	Motivating application: Filtering Spam - Why Linear Regression and k-NN are poor choices for Filtering Spam	1	1, 2	5,7,9,10
	Naive Bayes and why it works for Filtering Spam	1	1, 2	5,7
	Data Wrangling: APIs and other tools for scrapping the Web	1	1, 2	4-10
	Feature Generation and Feature Selection (Extracting Meaning From Data)	1	3	4-10
	Motivating application: user (customer) retention	1	3	4-10
	Feature Generation (brainstorming, role of domain expertise, and place for imagination) -	1	3	4-10
	Feature Selection algorithms	1	3	4-10
	Filters; Wrappers; Decision Trees; Random Forests	1	3	4-10
	Lab Experiment 7: Write a R program to implement a Spam Filter using Linear Regression and K-NN. Use a popular dataset.	2	3	5
	Lab Experiment 8: Write a R Program to Scrapping the Web using suitable API. Create a usable dataset for classification and clustering purpose.	2	3	5
	Lab Experiment 9: Write a R program to generate the features from the data set created by you for Lab experiment 8.	2	3	5
	Lab Experiment 10: Write a R Program to implement Filter and Wrappers.	2	3	5
	Lab Experiment 11: Write a R Program to implement Decision Trees, Random Forests – The inbuilt functions should not be used for the implementation.	2	3	5
Unit 4		**15**		
	Recommendation Systems: Building a User-Facing Data Product	2	4	1,2,8
	Algorithmic ingredients of a Recommendation Engine	1	4	1,2,8
	Dimensionality Reduction	2	4	8,9
	Singular Value Decomposition - Principal Component Analysis -	1	4	8,9
	Mining Social-Network Graphs	1	4	8,9
	Clustering of graphs - Direct discovery of communities in graphs	1	4	8,9
	Partitioning of graphs - Neighbourhood properties in graphs	1	4	8,9
	Lab Experiment 12: Write a R Program to implement Singular Value Decomposition and Principal Component Analysis. Use any popular data set.	2	4	8

	Lab Experiment 13: Write a R Program to extract the friendship details of your face book account as Social network Graph and represent in various visual forms.	2	4	8
	Lab Experiment 14: Write a R program to extend the above exercise to discover the communities in the graph, partition the graph and extracting the neighbourhood properties of the graphs.	2	4	8
Unit 5		**11**		
	Data Visualization	1	4	1,2,3,6
	Basic principles, ideas and tools for data visualization	2	4	1,2,3,6
	Examples of inspiring (industry) projects -	2	4	1,2,3,6
	Data Science and Ethical Issues	1	4	1,2,3,6
	Discussions on privacy, security, ethics	1	4	1,2,3,6
	A look back at Data Science	1	4	1,2,3,6
	Next-generation data scientists	1	4	1,2,3,6
	Lab Experiment 15: Write R Program using Bokeh 2.1.1 to realize the all the basic principles of data visualization.	2	4	2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	70%	50%	40%	40%	30%	30%	30%	30%	30%	30%
Level 2	Apply Analyse	20%	30%	40%	40%	50%	50%	40%	50%	50%	50%
Level 3	Evaluate Create	10%	20%	20%	20%	20%	20%	30%	20%	20%	20%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Grus, J. (2019). Data science from scratch: first principles with python. O'Reilly Media.
2. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".
3. O'Neil, C., & Schutt, R. (2013). Doing data science: Straight talk from the frontline. " O'Reilly Media, Inc.".
4. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). Mining of massive data sets. Cambridge university press.
5. Murphy, K. P. (2012). Machine learning: a probabilistic perspective. MIT press.
6. Provost, F., & Fawcett, T. (2013). Data Science for Business: What you need to know about data mining and data-analytic thinking. " O'Reilly Media, Inc.".
7. Hastie, T., Tibshirani, R., Friedman, J. H., & Friedman, J. H. (2009). The elements of statistical learning: data mining, inference, and prediction (Vol. 2, pp. 1-758). New York: springer.
8. Blum, A., Hopcroft, J., & Kannan, R. (2020). Foundations of data science. Cambridge University Press.
9. Zaki, M. J., & Meira, W. (2014). Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press.
10. Mining, W. I. D. (2006). Data mining: Concepts and techniques. Morgan Kaufinann, 10(559-569), 4.

Other Resources

1. No Data

Course Designers

1. No Data

Principles of Big Data Management

Course Code	CSE 465	**Course Category**	Stream Electives (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	SE1 VI	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the Big Data Platform and its Use cases.
2. Learn the overview of Apache Hadoop.
3. Gain knowledge of HDFS Concepts and Interfacing with HDFS.
4. Understand Map Reduce Jobs, Provide hands on Hadoop Eco System.
5. Apply analytics on Structured, Unstructured Data.
6. Exposure to Data Analytics with R.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify Big Data and its Business Implications	2	70%	65%
Outcome 2	List the components of Hadoop and Hadoop Eco-System	1	70%	65%
Outcome 3	Access and Process Data on Distributed File System	2	70%	65%
Outcome 4	Analyse Job Execution in Hadoop Environment	4	70%	65%
Outcome 5	Develop Big Data Solutions using Hadoop Eco System	4	70%	65%
Outcome 6	Apply Machine Learning Techniques using R	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	1		1										1	2	2
Outcome 2	2		1	1	3							1	3	2	2
Outcome 3	1	2	2	2	3							1	3	3	3
Outcome 4	1	2	2	2	3							1	3	3	3
Outcome 5	2	2	3	2	3							1	3	3	3
Outcome 6	2	2	2	2	3				2			1	3	3	3
Average	**2**	**2**	**2**	**2**	**3**				**2**			**1**	**3**	**3**	**3**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I		**9**		
1.	Big Data introduction - Big data: definition and taxonomy.	1	1	1
2.	Big data value for the enterprise.	1	1	1
3.	The Hadoop ecosystem	1	2	1,2,3
4.	Introduction to Distributed computing	1	3	1,2,3
5.	Introduction to Hadoop.	1	2	1,2,3
6.	Hadoop Distributed File System (HDFS) Architecture	1	3	1,2,3
7.	HDFS commands for loading/getting data	1	3	1,2,3
8.	Accessing HDFS through Java program	2	3	1,2,3
Unit II		**9**		
9.	Introduction to Map Reduce frame work	1	4	2,3
10.	Basic Map Reduce Programming	1	4	2,3
11.	Advanced Map Reduce programming	1	4	2,3
12.	Basic template of the Map Reduce program	1	4	2,3
13.	Word count problem	1	4	2,3
14.	Streaming in Hadoop	1	4	2,3
15.	Improving the performance using combiners	1	4	2,3
16.	Chaining Map Reduce jobs	1	4	2,3
17.	Joining data from different sources	1	4	2,3
Unit III		**6**		
18.	Querying big data with Hive: Introduction to HIVEQL.	2	5	4,5
19.	Hive QL: data definition	2	5	4,5
20.	Data manipulation	3	5	4,5
.Unit IV		**7**		
21	Querying big data with Hive – Hive QL queries	2	5	4,5
22.	Hive QL Views	2	5	4,5
23.	Hive QL indexes	1	5	4,5
Unit V		**14**		
24.	Data Analytics using R: Introduction to R	3	6	6,7
25.	Creating a dataset	2	6	6,7
26.	Getting started with graphs	2	6	6,7
27.	Basic data management	4	6	6,7
28.	Advanced data management	3	6	6,7
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Session No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1.	a. Hadoop Installation b. Hadoop Shell Commands	4	2	1,2
2.	a. Writing a file from local file system to Hadoop Distributed file system (HDFS) b. Reading a file from HDFS to local file system.	4	3	2,3
3.	a. Implementation of Word Count program using MapReduce without combiner logic. b. Implementation of Word Count program using MapReduce with combiner logic.	3	4	2,3
4.	Implementation of MapReduce algorithm for Matrix Multiplication.	3	4	3
5.	Use HiveQL to analyze the stock exchange dataset and calculate the covariance between the stocks for each month. This will help a stock-broker in recommending the stocks to his customers.	4	5	4

6.	Implement JOINS using HIVE a. Inner Join b. Left outer join c. Right outer Join d. Full outer join	3	5	4,5
7.	Write a R program to create student record using Vector concept.	3	6	6
8.	Write a R program to create medical patients' status using data frame i) Patient age ii) Gender iii) Symptoms iv) Patient Status	3	6	6,7
9.	Write a R program to visualize student marks of various subjects using Bar-chart and Scatter plot.	3	6	7
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**					**End Semester Exam (50%)**	
		Theory (30%)				**Practical (20%)**		
		CLA-1 (5%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**Mid-2 (10%)**		**Th**	**Prac**
Level 1	Remember Understand	50%	40%	40%	40%	50%	30%	40%
Level 2	Apply Analyse	50%	60%	60%	60%	50%	70%	60%
Level 3	Evaluate Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Erl, T., Khattak, W., & Buhler, P. (2016). Big data fundamentals: concepts, drivers & techniques. Prentice Hall Press.
2. White, T. (2012). Hadoop: The definitive guide. " O'Reilly Media, Inc.".
3. Lam, C. (2010). Hadoop in action. Simon and Schuster.
4. Capriolo, E., Wampler, D., & Rutherglen, J. (2012). Programming hive. " O'Reilly Media, Inc.".
5. Bansal, H., Chauhan, S., & Mehrotra, S. (2016). Apache Hive Cookbook. Packt Publishing Ltd.
6. Kabacoff, R. (2022). R in action: data analysis and graphics with R and Tidyverse. Simon and Schuster.Practical Data Science with R, Nina Zumel John Mount, Manning publications

Other Resources

Course Designers

Information Retrieval

Course Code	CSE 466	**Course Category**	Stream Elective (SE)		L	T	P	C
					3	0	1	4
Pre-Requisite Course(s)	DS&A, PS, LA, ST	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

The aim of this course is to prepare the graduate and undergraduate computer science students for designing and evaluating IR systems. So that, the learning objectives of this course include:

1. To learn the major milestones of historical development of IR systems.
2. To learn an architecture of a generic IR system and how to build one from scratch.
3. To understand how users interact with IR systems and how to maximize their satisfaction.
4. To learn the major theories and algorithms that are powering the modern search engines.
5. To gain hands-on experience in developing a working IR system.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Students will understand and implement the basic concepts in indexing and its compressed construction	3	70%	60%
Outcome 2	Students will understand and implement the statistical IR models such as Probabilistic model, vector-space model, and language models.	3	70%	60%
Outcome 3	Students will build a document retrieval system through the practical sessions, including the implementation of a relevance feedback mechanism.	3	70%	60%
Outcome 4	Students will implement the Text/Document classification and clustering algorithms	4	70%	60%
Outcome 5	Students will understand the issues involved IR techniques for the web including crawling, link-based algorithms.	3	70%	60%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2												1	3	
Outcome 2	2	2	3	2	3							1	3	3	
Outcome 3	2	2	3	2	3							1	3	3	
Outcome 4	1	2	2	2	3							1	3	3	
Outcome 5	1	2	2	2	3							1	3	3	
Average	**2**	**2**	**3**	**2**	**3**							**1**	**3**	**3**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTRODUCTION TO IR**	**9L hrs**		
	IR Problem, IR System, The Web	1	1	1
	Search Interface, Visualizing Search Interface	1	1	1
	Inverted Index and Boolean Queries	1	1	1
	Tokenization, Stemming, Stop-words, Phrases, Phrasal Queries	1	1	1
	Index Construction	2	1	2
	Index Compression	2	1	2
	k-gram Indexes	1	1	1
		12P hrs		
	Lab Experiment: Tokenization, Stemming, Stop words removal	2	1	1,2
	Lab Experiment: Inverted index construction - Token sequence, Sort, Dictionary & Postings, Implementation of Boolean queries.	2	1	1,2
	Lab Experiment: Sort-based index construction.	2	1	1,2
	Lab Experiment: Implementation of External memory indexing - BSBI, SPIMI.	2	1	1,2
	Lab Experiment: Implementation of External memory indexing - SPIMI.	2	1	1,2
	Lab Experiment: Implementations of Dynamic indexing - Logarithmic merge.	2	1	1,2
Unit 2	**BOOLEAN MODELS, EVALUATION OF IR SYSTEM**	**8L hrs**		
	Boolean Modes	1	2	1,2
	Vector Space Model	1	2	1,2
	TF-IDF	1	2	1,2
	Cosine Measure, Document Length Normalization	1	2	1,2
	Probabilistic Models, Binary Independence Model	1	2	1,2
	Language Modelling	1	2	1,2
	Precision, Recall, F-Measure, E-Measure, Normalized Recall	1	2	1,2
	Evaluation Problems	1	2	1,2
		6P hrs		
	Lab Experiment: Implementation of TF-IDF, Vector space model, Cosine similarity.	2	2	1,2
	Lab Experiment: Implementation of Binary Independence Model	2	2	1,2
	Lab Experiment: Implementation of Okapi BM25	2	2	1,2
Unit 3	**RELEVANCE FEEDBACK AND QUERY EXPANSION**	**5L hrs**		
	Explicit relevance feedback, Explicit Feedback through clicks and local analysis	1	3	1,2
	Implicit relevance feedback through local & global analysis	1	3	1,2
	Document Format, Markup Language, Text Properties	1	3	1,2
	Document Processing, Organization, Text Compression	1	3	1,2
	Query Language and Properties	1	3	1,2
		2P hrs		
	Lab Experiment: Dictionary compression - Implementation of Blocking, Posting Compression - Implementation of Gamma codes	2	3	1,2
Unit 4	**TEXT/DOCUMENT CLASSIFICATION CLUSTERING AND LSI**	**11L hrs**		
	Introduction to Classification, Naïve Bayes Models	1	4	1,2
	Rocchio Classification, K-Nearest Neighbours, SVM,	2	4	1,2
	Decision Trees, Bagging, Boosting, Choosing Right Classifier	2	4	1,2
	Introduction of Clustering, Evaluation of Clustering	1	4	1,2
	K-means, Hierarchical agglomerative clustering	2	4	1,2
	Divisive clustering, Low-Rank approximations	2	4	1,2
	Latent Semantic Indexing	1	4	1,2
		8P hrs		

	Lab Experiment: Implementation of Text/Document classification algorithms: Naive Bayes models, Rocchio, k-Nearest Neighbours.	2	4	1,2
	Lab Experiment: Implementation of Text/Document classification algorithms: Support vector machine classifiers, Decision trees, Bagging, Boosting.	2	4	1,2
	Lab Experiment: Implementation of Text/Document clustering algorithms: k-means clustering, Hierarchical agglomerative clustering, Divisive clustering.	2	4	1,2
	Lab Experiment: Implementation of Low-rank approximations, Latent semantic indexing	2	4	1,2
Unit 5	**Web IR**	**9L hrs**		
	Hypertext, Web Crawling, Indexes	2	5	1,2
	Search Engines	1	5	1,2
	Ranking	2	5	1,2
	Link Analysis	2	5	1,2
	Page Rank, Hits	2	5	1,2
		2P hrs		
	Lab Experiment: Development of a Web Crawler and a small-scale web search engine - Ranking, PageRank, HITS	2	5	1,2
	Total Contact Hours required	**42L hrs + 30P hrs**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**					**End Semester Exam (50%)**	
		Theory (30%)				**Practical (20%)**		
		CLA-1 (5%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**Mid-2 (10%)**		**Th**	**Prac**
Level 1	Remember	50%	40%	40%	40%	50%	30%	40%
	Understand							
Level 2	Apply	50%	60%	60%	60%	50%	70%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, (2007), Compilers – Principles, Techniques and Tools, 2nd Edition, Pearson Education.
2. Vassiliadis, Vassilis, et al. (2016) "D2. 3: Advanced compiler implementation." Centre for Research and Technology Hellas, Tech.
3. Cooper, Keith, and Linda Torczon. (2011), Engineering a compiler. Elsevier.
4. Charles N. Fischer, Richard. J. LeBlanc, (2008) "Crafting a Compiler with C", Pearson Education
5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-004-computation-structures-spring-2017/c11/

Other Resources

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-035-computer-language-engineering-spring-2010/
2. https://web.stanford.edu/class/archive/cs/cs143/cs143.1128/

Course Designers

Parallel and Distributed Computing

Course Code	CSE 467	**Course Category**	Stream Elective (SE)		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To acquire a profound understanding of the principles and practical application of Parallel and Distributed Computing, to assess students' comprehension of the course.
2. Understand the distributed and parallel computing systems.
3. Acquainted with parallel and distributed programming languages such as MPI, Pthread, and OpenMP.
4. Create parallel and distributed algorithms utilizing these parallel programming languages.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	The capability to analyze intricate computing problems and employ computing principles, as well as other pertinent disciplines, to identify solutions.	2	70%	65%
Outcome 2	The capacity to create, execute, and assess a computing-centric solution for fulfilling a specified set of computing requirements within the program's field.	3	70%	65%
Outcome 3	The skill to employ computer science theory and fundamental software development principles in order to generate computing-centric solutions.	3	70%	65%
Outcome 4	The capacity to conceive, execute, and assess a computing-driven solution that aligns with a specified set of computing requirements within the program's domain.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	1	1	3	1							1	2	2	2
Outcome 2	3	3	2	1	3							2	2	2	2
Outcome 3	3	1	3	1	2							3	3	3	3
Outcome 4	2	1	3	1	3							3	3	3	3
Outcome 5	3	3	3	3	3							3	3	3	3
Average	**3**	**2**	**3**	**2**	**3**							**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Parallel Programming Platforms	7		
	Scope , issues, applications and challenges of Parallel and Distributed Computing	2	1	1
	Implicit Parallelism: Trends in Microprocessor Architectures, Dichotomy of Parallel Computing Platforms	2	1	1
	Physical Organization, Communication Costs in Parallel Machines	1	1	1
	Routing Mechanisms for Interconnection Networks	1	1	1
	GPU, co-processing.	1	1	1
Unit 2	Principles of Parallel Algorithm Design	13		
	Decomposition Techniques, Characteristics of Tasks and Interactions	2	2	1,2
	Mapping Techniques for Load Balancing.	1	2	1,2
	CUDA programming model: Overview of CUDA, Isolating data to be used by parallelized code	2	2	1,3
	API function to allocate memory on parallel computing device, to transfer data	2	2	1,3
	Concepts of Threads, Blocks, Grids, Developing a kernel function to be executed by individual threads	2	2	1,3
	Execution of kernel function by parallel threads	2	2	1,3
	transferring data back to host processor with API function	2	2	1,3
Unit 3	Analytical Modeling of Parallel Programs	7		
	Sources of Overhead in Parallel Programs	2	3	1,4
	Performance Metrics for Parallel Systems	1	3	2,3
	The Effect of Granularity on Performance	1	3	1,5
	Scalability of Parallel Systems	1	3	1,2
	Minimum Execution Time and Minimum Cost Optimal Execution Time	2	3	1,3
Unit 4	Dense Matrix Algorithm	9		
	Matrix-Vector Multiplication	2	4	1,3
	Matrix-Matrix Multiplication	2	4	1,2
	Issues in Sorting on Parallel Computers	1	4	1,5
	Bubble Sort and Variants	1	4	1,3
	Quick Sort, Other Sorting Algorithms	3	4	6
Unit 5	Graph Algorithms	9		
	Minimum Spanning Tree: Prim's Algorithm	1	5	1
	Single-Source Shortest Paths: Dijkstra's Algorithm	1	5	1
	All-Pairs Shortest Paths	1	5	1,2
	Transitive Closure, Connected Components	1	5	1,3
	Algorithms for Sparse Graph	1	5	1,4
	Search Algorithms for Discrete Optimization Problems: Sequential Search Algorithms,	1	5	1,2,3
	Parallel Depth-First Search	1	5	1,2
	Parallel Best-First Search, Speedup Anomalies in Parallel Search Algorithms	2	5	1,2

Learning Assessment

<table>
<tr><th colspan="2" rowspan="3">Bloom's Level of Cognitive Task</th><th colspan="5">Continuous Learning Assessments (50%)</th><th colspan="2" rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th colspan="4">Theory (30%)</th><th rowspan="2">Practical (20%)</th></tr>
<tr><th>CLA-1 (5%)</th><th>Mid-1 (15%)</th><th>CLA-2 (5%)</th><th>CLA-3 (5%)</th><th>Th</th><th>Prac</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">50%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td><td rowspan="2">30%</td><td rowspan="2">40%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">50%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">50%</td><td rowspan="2">70%</td><td rowspan="2">60%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. Barry Wilkinson and Michael Allen, (2001), Parallel Programming - Techniques and applications Using Networked Workstations and Parallel Computers (2nd Edition), Prentice Hall.
2. A Grama, A Gupra, G Karypis, V Kumar, (2003). Introduction to Parallel Computing (2nd ed.). Addison Wesley.
3. C Lin, L Snyder. (2008), Principles of Parallel Programming. USA: Addison-Wesley Publishing Company.
4. J Jeffers, J Reinders. Intel Xeon Phi Coprocessor, (2013), High-Performance Programming. Morgan Kaufmann Publishing and Elsevier.
5. T Mattson, B Sanders, B Massingill, (2004). Patterns for Parallel Programming. Addison Wesley Professional.

Other Resources

Course Designers

Cloud Computing

Course Code	CSE 468	**Course Category**	Stream Elective (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**	IEEE				

Course Objectives / Course Learning Rationales (CLRs)

1. To study the evolving computer model (cloud computing) and its characteristics
2. To discuss various virtualisation technologies and tools.
3. To distinguish different Service Models and Deployment Models
4. To gain knowledge over different cloud software environments, platforms and simulators.
5. To understand the security issues in the Cloud computing.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define cloud computing and explain its essential characteristics. Analyze the trade-offs between deploying applications in the cloud and over the local infrastructure.	1	70%	70%
Outcome 2	Explain emerging Virtualisation technologies and tools including virtualisation of CPU, Memory and I/O devices.	2	70%	70%
Outcome 3	Describe and distinguish the cloud service (IaaS, Saas, Paas) & deployment models (Public, Private, Hybrid), and its infrastructure	3	70%	70%
Outcome 4	Understand the idea behind the cloud computing environments, platforms, and purpose of the cloud simulators.	3	70%	65%
Outcome 5	Identify security and privacy issues in cloud computing.	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	1	1	3	1							1	2	2	2
Outcome 2	3	3	2	1	3							2	2	2	2
Outcome 3	3	1	3	1	2							3	3	3	3
Outcome 4	2	1	3	1	3							3	3	3	3
Outcome 5	3	3	3	3	3							3	3	3	3
Average	**3**	**2**	**3**	**2**	**3**							**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Cloud Computing	8		
	Evolution of Cloud Computing	1	1	1,4
	Cloud Computing definition and characteristics (elasticity, multi-tenant, on-demand, ubiquitous access)	2	1	1,4
	Cloud Computing characteristics (usage metering, self-service, sla-monitoring, etc.)	2	1	14
	Basic concepts and Terminology	1	1	1,4
	Goals and Benefits	1	1	1,4
	Issues, Risks and Challenges	1	1	1,4
Unit 2	Virtualization	9		
	Implementation levels of virtualization	1	2	2
	Virtualization structures/tools	1	2	2
	Virtualization mechanisms	1	2	2
	Virtualization of CPU, Memory and I/O devices	2	2	2
	Virtual clusters and resource management	3	2	2
	Virtualization for Data center automation.	1	2	2
	Lab Experiment: Basics of Virtualization: VMM, Example of VMM (virtualbox), Cretaion of a VM, Networking and communication between VMs..	4	2	1
Unit 3	Service Models and Deployment Models	10		
	Cloud Computing Architecture and reference model	1	3	1,2
	Infrastructure- and hardware-as-a-service	1	3	1,2
	Platform as a service	1	3	1,2
	Software as a service	1	3	1,2
	Public clouds	1	3	1,2
	Private clouds	1	3	1,2
	Hybrid clouds	1	3	1,2
	Community clouds and Multi Clouds	1	3	
	Cloud computing applications and paradigms	2	3	1,2
	Lab Experiment: VM Creation in public cloud and deployment of web application in created VM.	3	3	1
	Lab Experiment: Hadoop Map Reduce application	3	3	1
Unit 4	Cloud Software Environment, Platforms, and Simulators	9		
	Open Stack Cloud, Aneka Cloud	1	4	2,5

	Amazon EC2, Google App-Engine	2	4	2
	Windows Azure, Rack space	1	4	2
	VMware vCloud, Eucalyptus	1	4	2
	HDFS, Google Storage	2	4	2
	ObjectStore S3, Amazon Dynamo,	1	4	2
	CloudSim, CloudAnalyst, GreenCloud	1	4	2
	Lab Experiment: Introduction to CloudSim: Installation and Execution, Cloud Datacenter, Network Topology.	2	4	1
	Lab Experiment: Simulation of a Cloud Framework: Creating a DC, Creation of Tasks, Creation of VMs, Defining task and VM characteristics, execution of tasks on VMs.	4	4	Internet resource
	Lab Experiment: Resource Allocation in Cloud Datacenter: Experimenting and understanding various resource allocation policies, Changing the resource allocation policy, effects of resource allocation policies.	4	4	2,4,5
	Lab Experiment: Power Management in Cloud Datacenters: Creation of a power datacenter, understanding various power saving techniques.	4	4	50%
Unit 5	Security	9		
	The Top Concern for Cloud Users, Privacy and Privacy Impact Assessment	2	5	3
	Trust, Operating System Security	1	5	3
	Virtual Machine Security	1	5	3
	Security of Virtualization	1	5	3
	Security Risks Posed by Shared Images	1	5	3
	Security Risks Posed by a Management	2	5	3
	A Trusted Virtual Machine Monitor	1	5	3
	Lab Experiment: Understanding Commercial Cloud Frameworks: Amazon AWS, Elastic Cloud, Amazon Load Balancer and Security..	4	5	Internet resource
	Lab Experiment: Project Development.	2	3,4,5	Internet resources
Total Contact Hours- Theory		45		
Total Contact Hours- Lab		30		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember Understand	50%	40%	40%	40%	50%	30%	40%	40%	40%	40%
Level 2	Apply Analyse	50%	60%	60%	60%	50%	70%	60%	60%	60%	50%
Level 3	Evaluate Create										10%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. (2013), Mastering cloud computing: foundations and applications programming. Newnes.
2. Kai Hwang. Geoffrey C. Fox. Jack J. Dongarra, (2012). Distributed and Cloud Computing. Elsevier.
3. Marinescu, Dan C. (2017), Cloud computing: theory and practice. Morgan Kaufmann.

Other Resources

1. Thomas, Erl, Mahmood Zaigham, and Puttini Ricardo, (2013). "Cloud Computing Concepts, Technology & Architecture."
2. Cloud computing, Black book. Deven Shah, Kailash Jayaswal, Donald J. Houde, Jagannath Kallakurchi.

Course Designers

Edge Computing

Course Code	CSE 469	**Course Category**	Stream Elective (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**	Open Edge, IEEE 1934, IETF				

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. To understand the limitations of today's Cloud computing models which are not designed for the volume, variety, and velocity of data generated by billions of Internet of Things (IoT) devices.
2. To understand the features of Edge Computing architecture and analyse business models that address the challenges of resource management and optimization.
3. To familiarize with Edge applications that monitor real-time data from network-connected things and initiating action involving machine-to-machine (M2M) communication.
4. To understand how developers, write IoT applications for Edge Computing nodes that are closest to the network edge and ingest the data from IoT devices.
5. To understand how Edge Nodes, extend the Cloud to the Network Edge through the Case studies for Response time, Data storage time, coverage area, and kinds of applications.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate various architectural models and design issues in Edge Computing.	2	65%	60%
Outcome 2	Learn and apply various Edge+IoT communication paradigms and Edge+Edge Middleware.	4	65%	60%
Outcome 3	Identify and mitigate Resource management and optimization challenges of Edge Computing model.	3	65%	60%
Outcome 4	Develop efficient models for deployment and dimensioning of edge networks	2	65%	60%
Outcome 5	Will gain hands on experience with different case studies and simulation frameworks for real-life Edge applications.	6	65%	60%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	1	1	3	1							1	2	2	2
Outcome 2	3	3	2	1	3							2	2	2	2
Outcome 3	3	1	3	1	2							3	3	3	3
Outcome 4	2	1	3	1	3							3	3	3	3
Outcome 5	3	3	3	3	3							3	3	3	3
Average	**3**	**2**	**3**	**2**	**3**							**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction			
	Cloud Computing Fundamentals	1	1,2	1,2
	Limitation of Cloud computing, the Needs of Edge Computing	1	1,2	1,2
	Edge definition, Characteristic Features of Edge computing – SCALE	1	1,2	1,2
	Architectural differences between Cloud and Edge computing	1	1,2	1,2
	Edge Computing Models (Service models)	2	1,2	1,2,3
	Edge and Edge Illustrative Use Cases	2	1,2	1,2,3
	Opportunities and Challenges	1	1,2	1,2,3
Unit 2	Disruptive Technology Enablers for Edge Computing			
	Edge Computing for IoT: Definition and Requirements	1	1,2	1,2
	OpenEdge	1	1,2	1,2
	Communication technologies for edge computing- 4G, 5G, 6LoPAN, DSRC	2	1,2	1,2
	Protocols and Algorithms for edge communication	2	1,2	1,2
	Software defined networking for edge computing	1	1,2	3
	Caching and Networking in 5G edge networks	1	1,2	3
Unit 3	Middleware for Edge and Edge Computing			
	Need for Edge and Edge Computing Middleware	1	2,3	1,3
	Design goals	1	2,3	1,3
	Quality of Service (QoS) in edge computing	2	2,3	1,2,3
	Authentication. privacy and security of edge nodes	2	2,3	1
	Data management in edge computing	1	2,3	1
	Challenges and research prospects	1	2,3	1,2,3
Unit 4	Deployment and Dimensioning of Edge Networks			
	Introduction to Edge node placement problem	1	3,4	1,2
	Optimization models for edge node placement problem	2	3,4	1,2
	Resource provisioning in edge networks	2	3,4	1,2,3
	Mobility models for edge nodes	1	3,4	2
	Edge orchestration	1	3,4	1
Unit 5	Modeling and Simulation of Distributed Edge Environment			
	Introduction to modeling and simulation	1	2,3,5	1
	EdgeNetSim++: Architecture	1	2,3,5	1
	EdgeNetSim++: Installation and Environment Setup	1	2,3,5	1
	OMNeT++ Installation and sample programs	1	2,3,5	1
	Sample Edge Simulation	2	2,3,5	1
	Advanced topics in edge research	2	2,3,5	1,2,3

Course Utilization Plan- Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	iFogSim Simulator and its Components and Installation of iFogSim			
2	Create Fog nodes with heterogeneous configurations and create different application models.			
3	Designing Sensors with different tuple emission rate			
4	Mobility of a Fog device and Make Cluster of Fog devices.			
5	Connect lower-level Fog devices with nearby gateways			
6	Placement Policies			
7	A Case Study in Smart Healthcare			
8	A Case Study in Gaming			
9	A Case Study of Multi Application Placement			
10	Introduction Raspberry Pi			
11	Installing Raspbian OS on a Raspberry Pi			
12	Setting up an IoT testbed and coding of a simple IoT+Edge application to monitor health of the patients / soil.			

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		60%		50%		40		50%	50%
Level 2	Apply Analyse	60%		40%		50%		60%		50%	50%
Level 3	Evaluate Create										
Total		100 %		100%		100%		100%		100%	100%

Recommended Resources

Other Resources

Course Designers

Service Oriented Computing

					L	T	P	C
Course Code	CSE 470	**Course Category**	Stream Elective (SE)		3	0	1	4
Pre-Requisite Course(s)	CSE 467 & CSE 468	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the limitations of today's computing models which are not designed for the volume, variety, and velocity of data generated by billions of IoT devices.
2. To understand the features of Service-based architecture and analyse the applications of new and futuristic computing models.
3. To familiarize with application development models which can be deployed at cloud to handle different applications.
4. To understand and develop applications for different types of users accessing various services from heterogeneous devices.
5. To understand how service model works, along with monitoring and metering policies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate architectural models and design issues in service-based computing.	2	70%	65%
Outcome 2	Develop features of Service-based architecture and analyse the applications of new and futuristic computing models.	3	70%	65%
Outcome 3	Identify application development models which can be deployed at cloud to handle different applications.	3	70%	65%
Outcome 4	Develop applications for different types of users accessing various services from heterogeneous devices.	3	70%	65%
Outcome 5	Working of service-based model along with monitoring and metering.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	3	1							1	2	2	2
Outcome 2	3	3	2	1	3							2	2	2	2
Outcome 3	3	1	3	1	2							3	3	3	3
Outcome 4	2	1	3	1	3							3	3	3	3
Outcome 5	3	3	3	3	3							3	3	3	3
Average	**3**	**2**	**3**	**2**	**3**							**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	7		
	Introduction to Web Services - fundamental of web services, basic operational model of web services	1	1	1
	Business motivations for web services, B2B, B2C, Technical motivations, basic steps of implementing web services.	1	1	1
	Benefits and challenges of using web services, tools and technologies enabling web services	1	1	1
	Web services Architecture and its characteristics, web services communication models, core building blocks of web services, web services technology stack	2	1	1
	Orchestration, Choreography. Service layer Abstraction - Application Service Layer, Business Service Layer, Orchestration Service Layer	2	1	
Unit 2	Service Oriented Architecture	12		
	Service–oriented Architecture (SOA), implementation view	1	2	1,2
	Logical view, process view, deployment view	1	2	1,2
	Composition of web services, from application server to peer to peer, life in the runtime	2	2	1,3
	Characteristics of SOA	1	2	1,3
	Comparing SOA to client-server and distributed internet architectures, Anatomy of SOA, How components in an SOA interrelate	2	2	1,3
	Fundamentals of SOAP-SOAP Message Structure, SOAP encoding, Encoding of different data types	2	2	1,3
	SOAP communication and messaging, SOAP message exchange models, limitations of SOAP	2	2	1,3
	REST Protocol, SOAP vs REST	1	2	1,3
Unit 3	Service Oriented Platforms	11		
	WSDL, Anatomy of WSDL, Manipulating WSDL, web service policy	1	3	1,4
	UDDI, Anatomy of UDDI	1	3	2,3
	UDDI- UDDI registries, uses of UDDI Registry, UDDI data structures, Programming with UDDI	1	3	1,5
	Publishing, searching and deleting information in a UDDI Registry, Publishing API, limitations of UDDI	1	3	1,2
	Discovering Web Services, service discovery mechanisms, role of service discovery in a SOA, Service Selection	1	3	1,3
	SOA support in J2EE: Java API for XML based web services (JAX-WS), Java architecture for XML binding (JAXB), Java API for XML Registries (JAXR)	2	3	1,4
	Java API for XML based RPC (JAXRPC), Web Services Interoperability Technologies (WSIT)	2	3	1,2
	SOA support in .NET: Common Language Runtime, ASP.NET web forms, ASP.NET web services, Web Services Enhancements (WSE)	2	3	1,2
Unit 4	Application Development Using Open Stack	7		
	Understanding Open stack eco system: Open stack Heat, Open stack Database As A Service: Trove	2	4	1,3
	Designate: DNS As A Service, Magnum	1	4	1,2
	Murano: Application As A Service, Ceilometer: Telemetry As A Service Application development and deployment in Open stack	2	4	1,5
	Building applications from the scratch, converting legacy applications into Open stack applications. Event Driven Programs with Cloud	2	4	1,3
Unit 5	Monitoring And Metering	8		
	Monitoring and metering, Updating and patching	1	5	1
	Kubernetes: Concepts, Cluster Architecture	1	5	1

	Containers and Dockers, Workloads	1	5	1,2
	Services, Load Balancing, and Networking	1	5	1,3
	Policies, Scheduling and Eviction	2	5	1,4
	Cluster Administration. Apigee Edge, API development lifecycle	2	5	1,2,3

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Develop Java Based Program using JAXP or XML API in reading XML file for Students Information and Display HTML Table	2	1,2	1,4,7
2	Develop Java Based web Service using REST and SOAP Based web service in Netbeans for University Course List and Search Course based Course Title and Course ID	2	1,2	1,4,7
3	Create web calculator service in .NET and create Java client to consume this web service deployed using Apache AXIS	2	1,2	1,4,5
4	Develop same web service using JX-WS.	2	1,2	1,5,7
5	Using WS —GEN and WS-Import develop the java web service & call it by Java Client	2	2,3	1,5,7
6	Design WSDL document and UDDI registry for your web service	2	2,3	1,5,7
7	Open stack Heat	2	2,3,4	2
8	Opens tack Database As A Service: Trove	2	3,4	2
9	Designate: DNS As A Service	2	3,4	2
10	Magnum	2	3,4	2,6
11	Murano: Application As A Service	2	3,4	2
12	Building applications from the scratch	2	3,4	2
13	Converting legacy applications into Open stack applications	2	3,4	2
14	Kubernetes: Containers and Dockers	2	4,5	3
15	Kubernetes: Load Balancing, Scheduling	2	4,5	3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (5%)	CLA-3 (5%)		Th	Prac
Level 1	Remember Understand	50%	40%	40%	40%	50%	30%	40%
Level 2	Apply Analyse	50%	60%	60%	60%	50%	70%	60%
Level 3	Evaluate Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Erl, T. (2005). Service-Oriented Architecture: Concepts, Technology, and Design. Prentice Hall
2. Adkins, S., Belamaric, J., Giersch, V., Makogon, D., & Robinson, J. E. (2015). Openstack Cloud Application Development. John Wiley & Sons.
3. Sayfan, G. (2018). Mastering Kubernetes: Master the art of container management by using the power of Kubernetes. Packt Publishing Ltd.
4. Singh, M. P., & Huhns, M. N. (2005). Service-oriented computing: semantics, processes, agents. John Wiley & Sons.
5. Woods, D., & Mattern, T. (2006). Enterprise SOA: designing IT for business innovation. " O'Reilly Media, Inc.".
6. Kambhampaty, S. (2008). Service-oriented architecture for enterprise applications. John Wiley & Sons.
7. Hansen, M. D. (2007). SOA using java web services. Pearson Education.

Other Resources

Course Designers

Embedded Systems

					L	T	P	C
Course Code	CSE 471	**Course Category**	Stream Elective (DE)		3	0	1	4
Pre-Requisite Course(s)	ECE 211, CSE 204	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. To make student aware of the challenges in development of embedded systems.
2. To make a student capable of analysing the requirements for developing a new embedded system.
3. A student should be able to Evaluate and select appropriate processor, memory, sensor/actuators, etc. components as per the requirement of the embedded system.
4. To make a student aware of the role of an operating system in context of embedded system.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe the challenges in development of embedded systems.	2	90%	90%
Outcome 2	Analyse the requirements for developing a new embedded system.	4	80%	80%
Outcome 3	Evaluate appropriate processor, memory, sensor/actuators components as per the given requirement of an embedded system.	5	80%	80%
Outcome 4	Discuss the role of an operating system in context of an embedded system.	2	80%	80%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	3	2	2				1	1	1	2	2	2	2
Outcome 2	3	3	3	3	3				3	2	3	3	3	3	3
Outcome 3	3	3	3	3	3				3	2	3	3	3	3	3
Outcome 4	3	3	3	3	3				2	2	2	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**				**2**	**2**	**2**	**3**	**3**	**3**	**3**

Course Unitization Plan Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction to embedded system	9		
	Introduction to embedded system	2	1	1
	Typical Components of an embedded system	1	1,2,3	1
	Sensors and actuators (overview)	1	1,2.3	1
	Processor	1	1,2,3	1
	Memory, timers, LCD etc. components	2	1,2,3	1
	Interfacing	2	1,2,3	1
UNIT 2	Instruction set of processors	9		
	Overview of a processor architecture.	1	1,2,3	1
	Instruction set of typical family of a processor	2	1,2.3	1
	ARM instruction set	1	1,2,3	1
	PIC microcontrollers	1	1,2,3	1
	Digital Signal Processor (DSP)	1	1,2,3	1
	Co-processor (why it is required?)	1	1,2,3	1
	I/O interfacing	2	1,2.3	1
UNIT 3	Input output sub-systems	9		
	DMA, busy-wait, interrupt-driven	2	1,2,3	1
	Timers and counters	1	1,2.3	1
	Analog to digital (A/D) convertor, D/A convertor	2	1,2,3	1
	Interfacing protocols (USB, Firewire, etc.)	1	1,2,3	1
	Typical sensors and actuators	3	1,2,3	1
UNIT 4	Program design and analysis	10		
	Data flow graph	1	2,3	1
	Control flow graph	1	2.3	1
	Finite state machine	1	2,3	1
	Performance analysis	2	2,3	1
	Performance optimization	3	2,3	1
	Power analysis	2	2,3	1
UNIT 5	Operating System	8		
	OS requirement in context of Embedded System	2	2,3,4	2
	Real time OS.	2	2,3,4	2
	Multi-rate system.	2	2,3,4	2
	Real-time memory management.	2	2,3,4	2
Total contact hours		**45**		

Course Unitization Plan Lab

S. No.	Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Introduction to Kiel Microcontroller Development Kit Software tool.	4	1	1
2	Interfacing of 8-bit ADC 0809 with 8051 Microcontroller.	2	2, 3	1
3	Interfacing of 8-bit DAC 0800 with 8051 Microcontroller.	2	2, 3	1
4	Implementation of Serial Communication by using 8051 serial ports.	2	1	1
5	Interfacing of individual LEDs and program them to blink after a fixed time interval.	2	2, 3	1
6	Interfacing of 16*2 LCD panel with 8051 Microcontroller.	2	2, 3	1
7	Interfacing of stepper motor with 8051 Microcontroller.	2	2, 3	1
8	Mini Project	14	1, 2, 3, 4	1
Total contact hours		**30**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (20%)	CLA-2 (20%)	CLA-3 (20%)	Mid-1 (40%)	
Level 1	Remember	40%	40%	30%	40%	30%
	Understand					
Level 2	Apply	40%	40%	40%	50%	50%
	Analyse					
Level 3	Evaluate	20%	20%	30%	10%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)		End Semester Exam (50%)
		Lab Performance (30%)	Project Viva (20%)	
Level 1	Remember	20%	50%	20%
	Understand			
Level 2	Apply	50%	30%	30%
	Analyse			
Level 3	Evaluate	30%	20%	50%
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Wolf, M. (2017) Computers as components: principles of embedded computing system design. Elsevier.
2. Mall, R. (2009) Real-time systems: theory and practice. Pearson Education India.

Other Resources

1. Kamal, R. (2020). Embedded Systems-SoC, IoT, AI and Real-Time Systems|. McGraw-Hill Education.
2. Vahid, F., & Givargis, T. D. (2001). Embedded system design: a unified hardware/software introduction. John Wiley & Sons.
3. Patel, M. K. (2014). The 8051 Microcontroller Based Embedded Systems. Tata McGraw-Hill Education.

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

IoT System Design and Implementation

Course Code	CSE 472	**Course Category**	Stream Elective (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	Computer Networks, Programming languages: C, C++, Python and/or Java (one or more)	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. Explain the terms sensors, actuators, devices and gateways.
2. Describe the functionalities of 6LowPAN, TLS and CoAP protocols
3. List the challenges involved while implementing different levels of IoT security protocols.
4. Determine the various performance metrics of machine learning models used in IoT use cases.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Build a simple IoT system to monitor temperature, humidity, pressure etc., for the given application scenario.	6	70	75
Outcome 2	Choose the right connectivity technologies of IoT platforms to deploy in given applications use case.	4	70	75
Outcome 3	Explain the challenges involved with implementing appropriate levels of security in IoT.	4	70	75
Outcome 4	Evaluate the performance of various analytical and machine learning models through the use of various performance metrics	5	70	75

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2		3		2								2		1
Outcome 2	2	1			3								1	1	
Outcome 3	3												2		1
Outcome 4	2	1	3	3	2								1		1
Average	2	1	3	1	2								2	1	1

<u>Course Unitization Plan Theory</u>

UNIT	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction, applications, percussors, and IoT devices	9		*
1	Introduction to IoT, Physical Design of IoT	1	CLO1	1
2	Logical Design of IoT, IoT Enabling Technologies.	3	CLO1	1
3	IoT Levels & Deployment Templates, applications	1	CLO1	1
4	Predecessor of IoT: WSN, M2M and CPS	1	CLO1	1,2
5	Introduction to Arduino and Raspberry pi	1	CLO1	1,3
6	integrating sensors and actuators with Arduino and Raspberry Pi. (1 hour)	2	CLO1	1,3
UNIT 2	Sensing & Actuating, and IoT Data Link Layer	9		*
7	Sensors, sensor characteristics, sensorial deviations, sensing types, sensing considerations,	1	CLO1	3
8	Actuators, actuators types and actuators characteristics.	1	CLO1	3
9	IEEE 802.15	1	CLO2	3,4
10	Wireless HART	1	CLO2	3,4
11	RFID, NFC	1	CLO2	3,4
12	Zigbee Smart Energy, Z-Wave	1	CLO2	3,4
13	Bluetooth Low Energy	1	CLO2	3,4
14	DASH7	1	CLO2	3,4
15	LoRA	1	CLO2	3,4
UNIT 3	Network Layer Protocols and Associated Technologies	9		*
16	6LoWPAN	1	CLO2	2,4
17	6TiSCH	1	CLO2	2,4
18	RPL	1	CLO2	2
19	CORPL	1	CLO2	2
20	CARP and CCN	1	CLO2	2
21	SDN and NFV for IoT	1	CLO1, CLO2	2
22	Cloud Model and Implementations.	1	CLO1, CLO2	2
23	Sensor as cloud.	1	CLO1, CLO2	2
24	Fog nodes and fog node deployment model, fog computing architecture.	1	CLO1, CLO2	2
UNIT 4	Transport Layer & Session Layer Protocols	9		*
24	MPTCP	1	CLO2	1,2,3
25	DCCP	1	CLO2	1,2,3
26	TLS	1	CLO2	1,2,3
27	DTLS	1	CLO2	1,2,3
28	CoAP	1	CLO2	1,2,3
29	XMPP	1	CLO2	1,2,3
30	AMQP	1	CLO2	1,2,3
31	MQTT	1	CLO2	1,2,3
32	MQTTSN	1	CLO2	1,2,3
UNIT 5	Security in IoT & Variants of IoT	9		*
33	Security and Privacy issues in IoT protocols e.g., MQTT and CoAP	1	CLO3	*
34	Introduction to Internet of Things by Cisco NetAcademy – Hand on (2 hours)	2	CLO2	5
35	Attack Surfaces and Attack Vectors in IoT	1	CLO3	
36	Industrial IoT (IIoT): Use cases in smart/digital manufacturing.	1	CLO1, CLO3	
37	Architecture: Edge Tier, Platform Tier, Enterprise Tier	1	CLO1	

38	Cyber security: Attack surfaces and attack vectors in IIoT	1	CLO3	
39	Industry 4.0 and Introduction to Industry 5.0	1	CLO1	
40	Data Analytics and Machine Learning for IoT applications.	1	CLO4	
Total		45		

Course Unitization Plan - Lab

Session	Description of the Experiments	Required Contact Hours	CLOs Addressed	References Used
Week1:	Introduction to lab and Install Arduino IDE and study the tool thoroughly. Write program using Arduino IDE to 1. Blink an LED Hardware Requirements: ▪ 1x Breadboard ▪ 1x Arduino Uno R3 ▪ 1x RGB LED ▪ 1x 330Ω Resistor 2x Jumper Wires	2	1,2	1, 2, 3
Week 2:	Write program using Arduino IDE to 1. Blinking the RGB LED: With a simple modification of the breadboard, we could attach the LED to an output pin of the Arduino. Move the red jumper wire from the Arduino 5V connector to D13 Hardware Requirements: ▪ 1x Breadboard ▪ 1x Arduino Uno R3 ▪ 1x RGB LED ▪ 1x 330Ω Resistor ▪ 2x Jumper Wires	2	1, 2	1, 2, 3.
Week 3:	Write a program using Arduino IDE and Arduino board to measure the temperature and humidity of the room using the temperature-humidity sensor. Display the results on the serial monitor. 1. System -1 2. Arduino Uno Board -1 3. Arduino dumping cable -1 4. Temperature-Humidity sensor 6. Breadboard-1 7. Connecting Wires -Required	2	1, 2	1, 2, 3
Week 4:	Write a program using Arduino IDE and Arduino board to measure the intensity of the room. Display the results on the serial monitor. Hardware Required. 1. System -1 2. Arduino Uno Board -1 3. Arduino dumping cable -1 4. LDR-1 5. Resistor 1KΩ -1 7. Bread Board-1 8. Connecting Wires -Required	2	1, 2	1, 2, 3
Week 5:	Write a program to Study and Configure Raspberry Pi.	2	1 , 2	1, 2, 3
Week 6:	WAP to LED blink using Raspberry Pi. Hardware Requirements:	2	1, 2	1, 2, 3

	1x Breadboard 1x Raspberry Pi 1x RGB LED 1x 330Ω Resistor			
Week 7:	Study and Implement Zigbee Protocol using Raspberry Pi or Arduino	2	1, 2	1, 2, 3
Week 8:	Study and implement 6LoWPAN Border Router Implementation for IoT Devices on Raspberry Pi or Arduino	1	1, 1	1, 2, 3
Week 9:	Study and implement DTLS protocol for IoT devices using Raspberry Pi or Arduino	1,2	1, 2	1, 2, 3
Week 10:	Study and implement CoAP protocol for IoT devices using Raspberry Pi or Arduino	2	1, 2	1, 2, 3
Week 11:	Study and implement RPL protocol for IoT devices using Raspberry Pi or Arduino	1	1, 1	1, 2, 3
Week 12:	Study and implement MQTT protocol for IoT devices using Raspberry Pi or Arduino	1,2	1,2, 3	1, 2, 3
Week 14	Study and implement AMQP protocol for IoT devices using Raspberry Pi or Arduino	2	1, 2, 3,4	1, 2, 3
Week 15	Study LORA protocol using Raspberry Pi or Arduino	1	1, 2,3,4	1, 2, 3

Learning Assessment

Question Difficulty	**Bloom's Level of Cognitive Task**	**Continuous Learning Assessments (50%)**						**End Semester Exam (50%)**
		Mid-1 (40%)	**CLA-1 (10%)**	**CLA-2 (10%)**	**Lab Record (10%)**	**Project (20%)**	**Viva (10%)**	
Level 1	**Remember**							
	Understand							
Level 2	**Apply**	50	50	50	50	50	50	50
	Analyse							
Level 3	**Evaluate**	50	50	50	50	50	50	50
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
2. Misra, S., Mukherjee, A., & Roy, A. (2021). Introduction to IoT. Cambridge University Press.
3. Dhondge, K. (2021). Lifecycle IoT Security for Engineers. Artech House.

Other Resources

1. Waher, P. (2015). Learning internet of things. Packt publishing.
2. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
3. https://www.netacad.com/courses/iot/introduction-iot
4. Industry IoT Consortium: https://www.iiconsortium.org/
5. Select papers in reputed Journals and Conferences

Course Designers

1. No Data

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

IoT Data Analytics

Course Code	CSE 473	**Course Category**	Stream Elective (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

<u>Course Objectives / Course Learning Rationales (CLRs)</u>

1. Provide an overview of an exciting growing field of big data analytics for IoT data.
2. Introduce the tools required to manage and analyze big data like Hadoop, MapReduce in IoT Networks.
3. Apply big data processing and mining techniques for the IoT data traffic.
4. Understand how to perform cluster analysis using machine Learning Tools for the IoT networks.

<u>Course Outcomes / Course Learning Outcomes (CLOs)</u>

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand the key issues in big data management and its associated applications in intelligent business and scientific computing	2	70 %	65%
Outcome 2	Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in IoT big data analytics	3	70 %	65%
Outcome 3	Interpret business models and scientific computing paradigms and apply software tools for IoT big data analytics.	3	70 %	65%
Outcome 4	Achieve adequate perspectives of IoT big data analytics in various applications like recommender systems, social media applications	3	70 %	65%
Outcome 5	Design an agglomerative hierarchical clustering technique and to apply to apply clustering to real world scenarios.	4	70 %	65%

<u>Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)</u>

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2	3	3	3	2								3	2	
Outcome 2	2	2	3	3	2								2	2	
Outcome 3	2	3	3	2	2								2	2	
Outcome 4	3	3	3	3	2								2	3	
Outcome 5	2	3	3	3	2								2	2	
Average	**2**	**3**	**3**	**3**	**2**								**2**	**2**	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
	Introduction to IoT Networks	1	1	1,2
	Overview of IoT and its applications	1	1	1
	Importance of data analytics in IoT	1	1	1,2
	IoT data sources and types	1	1	1
	Introduction to Big Data Analytics	1	1	1
	Challenges and opportunities in IoT data analytics	1	1	1
	Tools and technologies for IoT data collection	1	1	1,2
	Applications of Big Data Analytics	1	1	1,2
	Integration of IoT with Data Analytics	1	1	1,2
Unit 2	**Data Analysis**	**9**		
	Data Preprocessing for IoT Data Analytics	1	2	1,2
	Overview of the Data cleaning	1	2	1,2
	Overview of quality assessment			
	Data transformation and normalization	1	2	1,2
	Introduction to IoT datasets	1	2	1,2
	Overview of different data sets available for IoT data	1	2	1,2
	Handling missing data in IoT datasets	1	2	1,2
	Introduction to data preprocessing techniques	1	2	1,2
	Time series data preprocessing techniques	1	2	1,2
Unit 3	**Descriptive Analytics for the IoT Data**	**9**		
	Exploratory data analysis (EDA) for IoT data	2	3	1,2
	Statistical summary and visualization of IoT data	2	3	1,2
	Identifying patterns and anomalies	2	3	1,2
	Real-time monitoring and dashboard creation	2	3	1,2
	Case studies on descriptive analytics in IoT applications	1	3	1,2
Unit 4	**Predictive Analytics in IoT Networks**	**7**		
	Introduction to predictive modelling in IoT	1	4	1
	Machine learning algorithms for IoT data prediction	2	4	1
	Model evaluation and selection	2	4	1
	Time series forecasting for IoT applications	1	4	1
	Anomaly detection using machine learning	1	4	1
Unit 5	**Advanced Analytics and Visualization in IoT**	**11**		
	Clustering and classification in IoT data	1	5	1
	Predictive maintenance and fault detection	2	5	1
	Overview of Edge computing	2	5	1
	IoT data analytics in edge computing	2	5	1
	Overview of Data Visualization	2	5	1
	Visualizing IoT data for decision-making	2	5	1
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
	Lab Experiment 1: Perform setting up and Installing Hadoop in its two operating modes	2	3	2
	Lab Experiment 2: Overview of Cooja Simulator for IoT data	2	3	2
	Lab Experiment 3: Use web based tools to monitor your Hadoop setup	2	3	2
	Lab Experiment 4 : Implement the file management tasks in Hadoop.	2	3	2
	Lab Experiment 5: Create and test an Apache Hadoop cluster.	2	3	2
	Lab Experiment 6: Basic Word Count Map Reduce program.	2	3	2
	Lab Experiment 7: Performing a MapReduce Job for word Search	2	3	2
	Lab Experiment 8: HiveQL Queries	2	3	2
	Lab Experiment 9: Mapreduce program that mines weather data (Weather sensors collecting data every hour at many locations across the globe gather large volume of log data)	2	3	2
	Lab Experiment 10: Install and Run Hive.	2	3	2
	Lab Experiment 11: Data analytics using Apache Spark on Amazon food dataset.	2	3	2
	Lab Experiment 12: Install, Deploy & configure Apache Spark Cluster	2	3	2
	Lab Experiment 13: Apache spark applications using Scala	2	3	2
	Lab Experiment 14: Write Pig Latin scripts to sort, group, join, project, and filter your data.	2	3	2
	Lab Experiment 15: Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)	2	3	2
Total Contact Hours		**30**		

Learning Assessment (Theory)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (30%)				End Semester Exam (30%)
		CLA-1 (10%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**CLA-3 (5%)**	
Level 1	Remember	70%	60%	30%	30%	60%
	Understand					
Level 2	Apply	30%	40%	70%	70%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (20%)		End Semester Exam (20%)
		Lab Record (5%)	**Lab Performance (15%)**	
Level 1	Remember	50%	50%	50%
	Understand			
Level 2	Apply	50%	50%	50%
	Analyse			
Level 3	Evaluate			
	Create			
Total		**100%**	**100%**	**100%**

Recommended Resources

1. Chris Eaton, Dirk deroos et al. , (2012). "Understanding Big data ", McGraw Hill.
2. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

Other Resources

1. Stackowiak, R., Licht, A., Mantha, V., Nagode, L., (2015), " Big Data and The Internet of Things Enterprise Information Architecture for A New Age", Apress.
2. Dr. John Bates (2015), "Thingalytics - Smart Big Data Analytics for the Internet of Things", john Bates.

Course Designers

IoT Security and Blockchain

Course Code	CSE 474	**Course Category**	Stream Elective (SE)	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)	IoT System Design and Protocols	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the foundational concepts of IoT and the unique security challenges associated with interconnected devices.
2. Explore the architecture of IoT systems and understand the security implications
3. Identify and analyze the potential security threats and vulnerabilities in IoT
4. To navigate the complex landscape of IoT security and contribute to the development of secure and resilient IoT solutions in various industries.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	To explain the architecture of IoT systems, including the roles of devices, communication protocols, and cloud platforms.	2	75 %	70%
Outcome 2	Able to acquire the practical competency through emerging technologies and open- source platforms related to the areas of Cyber Security, IoT and Block Chain	3	70 %	65%
Outcome 3	To implement authentication and authorization mechanisms to control access to IoT devices and networks, ensuring secure interactions.	3	70 %	65%
Outcome 4	To select and implement secure communication protocols suitable for IoT devices, ensuring the secure exchange of data.	3	70 %	65%
Outcome 5	To develop and implement IoT security policies and blockchains considering regulatory compliance and organizational requirements.	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1									2	2	3
Outcome 2	3	3	2	1									3	2	3
Outcome 3	3	3	2	2									3	2	3
Outcome 4	3	3	2	2									3	2	3
Outcome 5	3	3	2	2								2	3	2	2
Average	**3**	**3**	**2**	**2**								**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	INTRODUCTION-THREATS AND ATTACKS	14	1	1
	Internet of Things (IoT) as Interconnection of Threats (IoT)	2	1	1,2
	Cyber Security versus Cyber-Physical IoT Security	2	1	1,2
	IoT deployment architecture,	2	1	1,2
	Security challenges in IoT: Privacy, Data Integrity, Authenticati Authentication, Threats, Vulnerabilities	1	1	1,2
	Evolution of cyber-physical attacks, IoT security architecture	1	1	1,2
	IoT use cases: Smart city and Autonomous transportation, Healthcare and Pharmaceutical,	2	1	1,2
	Lab Experiment 1: The definition of the Internet of Things, main assumptions and perspectives. Platform for IoT devices Device architectures.	2	1	1,2
	Lab Experiment 2: Communication protocols for IoT Service oriented protocols (COAP).	2	1	1,2
UNIT II	PRIVACY PRESERVATIONS	15		
	Privacy Preservation Data Dissemination. Privacy Preservation for IoT Used in Smart Buildings.	1	1	1,2
	Social Features for Location Privacy Enhancement in Internet of Vehicles.	1	1	1,2
	Lightweight and Robust Schemes for Privacy Protection in Key Personal I IoT Applications: Mobile WBSN and Participatory Sensing.	1	1	1,2
	Lab Experiment 3 Communication protocols based on the exchange of messages (MQTT). Service discovery protocols.	2	1, 2	1,2
	Lab Experiment 4: Study of different types of vulnerabilities for hacking a websites / Web Applications.	2	1, 2	1,2
	Lab Experiment 5: Architecture of Amazon AWS IoT	2	1, 2	1,2
UNIT III	TRUST AND AUTHENTICATION	19		
	Trust and Trust Models for the IoT. Self-Organizing	1	2,3	1,2
	"Things" and Their Software Representatives.	1	2,3	1,2
	Preventing Unauthorized Access to Sensor Data. Authentication in IoT.	2	2,3	1,2
	Lab Experiment 6: Master the use of AWS IoT managing IoT devices	2	2,3	1,2
	Lab Experiment 7: Master programming AWS IoT	2	2,3	1,2
	Lab Experiment 8: Applications Smart Grid. Home Automation	2	2,3	1,2
UNIT IV	IoT DATA SECURITY	14		

	Computational Security for the IoT and Beyond.	1	3,4	1,2
	Privacy-Preserving Time Series Data Aggregation for Internet of Things.	2	3,4	1,2
	Secure Path Generation Scheme for Real-Time Green Internet of Things.	2	3,4	1,2
	Security Protocols for IoT Access Networks	2	3,4	1,2
	Lab Experiment 9: Study of System threat Attacks DoS	2	3, 4	1,2,3
	Lab Experiment 10: Connecting to the Internet (eg. the device showing the current weather forecast)	2	3, 4	1,2,3
	Lab Experiment 11: Machine-to-machine communication (broadcast communication protocols)	2	3, 4	1,2,3
	Lab Experiment 12: Machine to Machine Communications (MQTT protocol)	2	3,4	1,2,3
UNIT V	BLOCKCHAIN	13		
	Introduction, Applications, Ethereum, Ethereum Networks, Infura, Solidity	2	5	2, 3, 4
	Smart Contracts, Sample code for Smart Contracts, How to deploy smart Contracts, Use cases	2	5	2, 3, 4
	Hyperledger Fabrics, How to deploy Hyper ledger Fabrics, Use cases	2	5	2, 3, 4
	Lab Experiment 13: Basic Ehereum Transactions, Implementing a Dapp using Solidity	2	5	2, 3, 4
	Lab Experiment 14: Implement Fabric Smart Contracts	2	5	2, 3, 4
	Lab Experiment 15: Implementation of Hyperledger Fabrics	2	5	2, 3, 4
Total Hours		**75**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (40%)				Practical (10%)		
		CLA-1 (10%)	Mid-1 (10%)	CLA-2 (10%)	CLA-3 (10%)		Th	Prac
Level 1	Remember	70%	60%	30%	30%	50%	50%	50%
	Understand							
Level 2	Apply	30%	40%	70%	70%	50%	50%	50%
	Analyse							
Level 3	Evaluate							
	Create							
Total		100%	100%	100%	100%	100%	100%	100%

Recommended Resources

1. David Etter, (2016). “IoT Security: Practical guide book “Create Space, 1st Edition.
2. Drew Van Duren, Brian Russell, (2016). “Practical Internet of Things Security”, Packt, 1st Edition.
3. Sean Smith, (2017). “The Internet of Risky Things”, O'Reilly Media, 1st Edition.
4. Bhattacharjee, (2018). Practical Industrial Internet of Things security, Packt Publishing.
5. Imran Bashir, Packt Publishing, 2020. Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition.

Other Resources

Course Designers

Human Computer Interaction

					L	T	P	C
Course Code	CSE 421	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)	CSE 101 CSE 236	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the capabilities of both humans and computers through human information processing.
2. Gain knowledge of typical HCI models, styles and various historic HCI paradigms.
3. Understand interactive design process and universal design principles to designing HCI systems.
4. Comprehend HCI design principles, standards and guidelines.
5. Understand user models, user support, socio-organizational issues and stakeholder requirements of HCI systems.
6. Familiarize with tasks and dialogues of relevant HCI systems based on task analysis and dialogue design.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the user requirements and challenges of HCI	2	70%	65%
Outcome 2	Apply theories and principles to design and model new HCI interface concepts	3	75%	65%
Outcome 3	Infer design patterns of HCI interfaces for mobile applications	2	70%	65%
Outcome 4	Develop graphical design interfaces for web applications based on design parameters	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	2	2	2	2								2	2	1
Outcome 2	2	2	3	2	3								3	2	2
Outcome 3	2	3	3	2	2								2	3	2
Outcome 4	2	2	3	3	3								2	3	2
Average	2	2	3	2	3								2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Foundations Of HCI	9		
	The Human: I/O channels and Memory	1	1	1
	Reasoning and problem solving	1	1	1
	The computer: Devices and Memory	1	1	1
	Processing and networks	1	1	1
	Interaction: Models	1	1	1
	Interaction: Frameworks	1	1	1
	Ergonomics	1	1	1
	Interaction: Styles and Elements	1	1	1
	Interactivity and Paradigms	1	1	1
UNIT 2	Design and Software Process	9		
	Interactive design basics and process	1	1,2	1
	Scenarios and Navigation	1	1,2	1
	Screen design	1	1,2	1
	Iteration and prototyping	1	1,2	1
	HCI in software process and life cycle	1	1,2	1
	Usability engineering	1	1,2	1
	Prototyping in practice, design rationale	1	1,2	1
	Design rules, principles, standards, and guidelines	1	1,2	1
	Evaluation Techniques, Universal Design.	1	1,2	1
UNIT 3	Models and Theories	8		
	Cognitive models	1	1,2	1
	Socio-Organizational issues and stake holder requirements	2	1,2	1
	Communication and collaboration Models	2	1,2	1
	Hypertext	1	1,2	1
	Multimedia	1	1,2	1
	WWW	1	1,2	1
UNIT 4	Mobile HCI	10		
	Mobile Ecosystem: Platforms	1	3	1,2
	Mobile Ecosystem: Application frameworks	2	3	1,2
	Types of Mobile Applications	1	3	1,2
	Widgets and Applications	1	3	1,2
	Games	1	3	1,2
	Mobile Information Architecture	1	3	1,2
	Mobile 2.0	1	3	1,2

	Mobile Design: Elements of Mobile Design	1	3	1,2
	Mobile Design: Tools	1	3	1,2
UNIT 5	WEB Interface Design	9		
	Designing Web Interfaces	2	4	1,3
	Drag and drop	1	4	1,3
	Direct Selection	1	4	1,3
	Contextual Tools	1	4	1,3
	Overlays	1	4	1,3
	Inlays and Virtual Pages	1	4	1,3
	Process Flow	1	4	1,3
	Case Studies.	1	4	1,3
	Total Contact Hours	45		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**CLA-3 (15%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember Understand	70%		65%		60%		50%		40%	
Level 2	Apply Analyze	30%		35%		40%		50%		60%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale (2004). Human Computer Interaction. Pearson Education.
2. Brian Fling (2009). Mobile Design and Development. O'Reilly Media Inc.
3. Bill Scott and Theresa Neil (2009). Designing Web Interfaces. O'Reilly Media Inc

Other Resources

1. Dr. Samit Bhattacharya and Dr. Pradeep G. Yammiyavar, NPTEL Lecture serias. http://nptel.ac.in/courses/106103115/

Course Designers

Advanced Computer Architecture

Course Code	CSE 422	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	CSE 235	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Learn how to measure performance of a computing system.
2. Gain knowledge of several optimization in advanced computer architectures.
3. Understand several advanced memory optimization techniques.
4. Familiarize with the architectural issues of a computing systems (devices).

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Explain processor performance improvement using instruction level parallelism	2	85%	75%
Outcome 2	Demonstrate the optimization techniques for improving performance of advanced computer architectures	3	70%	70%
Outcome 3	Illustrate advanced memory optimization techniques	2	70%	65%
Outcome 4	Identify the architectural issues in computing systems (devices).	2	65%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	1	1	1								1	1	1
Outcome 2	3	3	3	3	3						2	3	3	3	3
Outcome 3	3	3	3	3	3						2	3	3	3	3
Outcome 4	3	3	3	3	3						2	3	3	3	3
Average	3	3	3	3	3						2	3	3	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Instruction Level Parallelism	7		
	ILP – Concepts and challenges	2	1	1, 3
	Hardware and software approaches	1	1	1, 3
	Dynamic scheduling	1	1	1, 3
	Speculation	1	1	1
	Compiler techniques for exposing ILP	1	1	1
	Branch prediction.	1	1	1
UNIT 2	Multiple Issue Processors	10		
	VLIW & EPIC	1	2	1, 3
	Advanced compiler support	1	2	1, 3
	Hardware support for exposing parallelism	1	2	1, 3
	Hardware versus software speculation mechanisms	2	2	1, 3
	IA 64 and Itanium processors	3	2	1, 3
	Limits on ILP	2	2	1, 3
UNIT 3	Multiprocessors and Thread Level Parallelism	9		
	Symmetric and distributed shared memory architectures	2	2	1, 3, 4
	Performance issues	2	2	1, 3, 4
	Synchronization	2	2	1, 3, 4
	Models of memory consistency	2	2	1, 3, 4
	Introduction to Multithreading	1	2	1, 2
UNIT 4	Memory and I/O	10		
	Cache performance	1	3	1
	Reducing cache miss penalty and miss rate	1	3	1
	Reducing hit time	1	3	1
	Main memory and performance	1	3	1
	Memory technology	1	3	1
	Types of storage devices	1	3	1
	Buses – RAID – Reliability	1	3	1
	Availability and dependability	1	3	1
	I/O performance measures	1	3	1
	Designing an I/O system	1	3	1
UNIT 5	Multi-core Architectures	9		
	Software and hardware multithreading	2	4	1, 5
	SMT and CMP architectures	1	4	1, 5
	Design issues	1	4	1, 5
	Case studies	1	4	1, 5
	Intel Multi-core architecture	1	4	1, 5
	SUN CMP architecture	1	4	1, 5
	Heterogeneous multi-core processors	1	4	1, 5
	Case study: IBM Cell Processor	1	4	1, 5
	Total Contact Hours	45		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	100 %		70%		80%		80%		70%	
	Understand										
Level 2	Apply			30%		20%		20%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100 %		100%		100%		100%		100%	

Recommended Resources

1. Hennessy, John L., and David A. Patterson (2017). Computer architecture: a quantitative approach. 6th edition Morgan Kaufman

Other Resources

1. Shen, John Paul, and Mikko H. Lipasti (2013). Modern processor design: fundamentals of superscalar processors. Waveland Press
2. Dally, William James, and Brian Patrick Towles (2004). Principles and practices of interconnection networks. Elsevier.
3. Hwang, Kai, and Naresh Jotwani (2016). Advanced computer architecture. McGraw-Hill Education.
4. Dezsosima, Terence Fountain, Peter Kacsuk (1997). Advanced Computer Architectures-A Design Space Approach. Pearson Education India.
5. Brian Tuomanen (2018). Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA. First edition.
6. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-on Approach. 3rd edition. Morgan Kaufman.

Course Designers

Natural Language Processing

Course Code	CSE 423	**Course Category**	Technical Elective	**L** 3	**T** 0	**P** 0	**C** 3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Learn the basics of natural language processing and understand various steps in it.
2. To introduce the fundamentals of language processing from the algorithmic viewpoint.
3. To discuss various issues that make natural language processing a hard task.
4. To discuss some well-known applications of natural language processing

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Recall the fundamental concepts of natural language processing.	1	70%	68%
Outcome 2	Demonstrate algorithms for word level and syntactic analysis of textual data.	2	70%	65%
Outcome 3	Develop systems for language processing and information related tasks using text processing.	3	70%	60%
Outcome 4	Implement systems using natural language generation algorithms and machine translation techniques based on user queries	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	2
Outcome 2	2	2	3	3	2								2	2	2
Outcome 3	2	3	3	2	2								2	2	2
Outcome 4	3	3	3	3	2								2	3	2
Average	**2**	**3**	**3**	**3**	**2**								**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	11		
	Natural Language Processing tasks in syntax, semantics, and pragmatics – Issues – Applications	2	1	1
	The role of machine learning	1	1	1
	Probability Basics	2	1	1
	Information theory	2	1	1
	N-gram Language Models	2	1,2	1
	Estimating parameters and smoothing	1	1,2	1
	Evaluating language models	1	1,2	1
UNIT 2	Word Level and Syntactic Analysis	9		
	Word Level Analysis: Regular Expressions	1	1	1,2
	Finite-State Automata	1	1	1,2
	Morphological Parsing	1	1	1,2
	Spelling Error Detection and Correction-Words	1	1,2	1,2
	Word Classes-Part-of Speech Tagging	1	1,2	1,2
	Syntactic Analysis: Context-free Grammar	2	1	1,2
	Constituency	1	1,2	1,2
	Parsing-Probabilistic Parsing	1	1,2	1,2
UNIT 3	Semantic Analysis and Discourse Processing	8		
	Semantic Analysis: Meaning Representation	2	1,2,3	3
	Lexical Semantics	1	1,3	3
	Ambiguity-Word Sense Disambiguation	1	1,3	3
	Discourse Processing: Cohesion	1	1,3	3
	Reference Resolution	1	1,3	3
	Discourse Coherence and Structure	2	1,3	3
UNIT 4	Natural Language Generation and Machine Translation	10		
	Natural Language Generation: Architecture of NLG Systems	2	4	1,3
	Generation Tasks and Representations	1	4	1,3
	Application of NLG	1	4	1,3
	Machine Translation: Problems in Machine Translation	2	4	1,3
	Characteristics of Indian Languages	1	4	1,3
	Machine Translation Approaches	2	4	1,3
	Translation involving Indian Languages	1	4	1,3
UNIT 5	Information Retrieval and Lexical Resources	7		
	Information Retrieval: Design features of Information Retrieval Systems	2	3,4	1,2,3
	Classical, Non-classical Retrieval systems	1	3,4	1,2,3
	Alternative Models of Information Retrieval - Valuation	1	3,4	1,2,3
	Lexical Resources: WorldNet	1	3,4	1,2,3
	Frame Net-Stemmers	1	3,4	1,2,3
	POS Tagger- Research Corpora	1	3,4	1,2,3
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	70%		65%		60%		50%		40%	
Level 2	Apply Analyse	30%		35%		40%		50%		60%	
Level 3	Evaluate Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. James Allen (1994), Natural Language Understanding. The Benajmins/Cummings Publishing Company Inc. 2nd Edition.
2. Manning, Christopher, and Hinrich Schutze (1999). Foundations of statistical natural language processing. MIT press.
3. Daniel Jurafsky, James H. Martin (2024) . Speech & language processing. Pearson publications. 3rd Edition

Other Resources

1. Dr. Pawan Goyal. IIT Kharagpur. NPTEL Lecture series. https://youtu.be/02QWRAhGc7g
2. Dr. Pushpak Bhattacharya. IIT Bombay. NPTEL Lecture series. https://youtu.be/aeOLjFe256E
3. Bird, Steven, Ewan Klein, and Edward Loper (2009). Natural language processing with Python: Analyzing text with the natural language toolkit. O'Reilly Media, In.

Course Designers

Computer Graphics

Course Code	CSE 424	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce how graphics are represented in digital media.
2. Gain knowledge on how digital is presented in viewing devices and computers.
3. Understand the modification and representation in 2D and 3D media over a wide domain.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand 2d and 3D model graphics media in computer vision.	2	80%	70%
Outcome 2	Examine the inner content of 2D and 3D media.	4	70%	65%
Outcome 3	Use of heterogeneous display devices (like mobile, tv, hologram etc.) in computer vision to display the content of 2D and 3D media.	3	80%	70%
Outcome 4	Implement a system using graphic design skills to fulfil user requirements.	3	90%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	2	1	2							2	3	2	1
Outcome 2	3	2	1	2	2							3	3	2	2
Outcome 3	3	3	3	2	2							3	3	2	2
Outcome 4	3	3	3	3	3							3	3	3	2
Average	3	2	2	2	2							3	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Application areas of Computer Graphics,	1	1	1, 2
	Overview of graphics systems, video-display devices,	1	1	1, 2
	Raster-scan systems,	1	1	1, 2
	Random scan systems	1	1	1, 2
	Graphics monitors and workstations and input devices	1	1	1, 2
	Points and lines, line drawing algorithms,	1	1	1, 2
	Mid-point circle and ellipse algorithms.	1	1	1, 2
	Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood-fill algorithms.	2	1	1, 2
UNIT 2	2-D Geometrical transforms	10		
	Translation, scaling, rotation	2	1,2	1, 2
	Reflection and shear transformations	1	1,2	1, 2
	Matrix representations and homogeneous coordinates,	2	1,2	1, 2
	Composite transforms,	1	1, 2	1, 2
	Transformations between coordinate systems.	1	1, 2	1, 2
	The viewing pipeline, viewing coordinate reference frame,	1	1, 2	1, 2
	Window to view-port coordinate transformation, viewing functions,	1	1, 2	1, 2
	Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland –Hodgeman polygon clipping algorithm.	1	1,2	1,2
UNIT 3	3-D Object representation	11		
	Polygon surfaces, quadric surfaces,	1	1, 2	1, 2
	Spline representation	1	1, 2	1, 2
	Hermite curve,	1	1, 2	1, 2
	Bezier curve and B-spline curves, Bezier and B-spline surfaces.	2	1, 2	1, 2
	Basic illumination models,	1	1, 2	1, 2
	Polygon rendering methods.	1	1, 2	1, 2
	Translation, rotation, scaling, reflection and shear Transformations, composite transformations.	2	1, 2	1, 2
	3-D viewing: Viewing pipeline, viewing coordinates, view volume and general projection transforms and Clipping	2	1, 2	1, 2
UNIT 4	Visible surface detection methods	7		
	Classification,	1	3	1, 2
	Back-face detection,	1	3	1, 2
	Depth-buffer,	1	3	1, 2
	Scan-line,	1	3	1, 2
	Depth sorting	1	3	1, 2
	BSP-tree methods,	1	3	1, 2
	Area sub-division and octree methods	1	3	1, 2
UNIT 5	omputer animation	8		
	Design of animation sequence,	1	4	1, 2
	General computer animation functions,	1	4	1, 2
	Raster animation,	1	4	1, 2
	Computer animation languages,	2	4	1, 2
	Key frame systems,	1	4	1, 2
	Motion specifications	2	4	1, 2
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (20%)		CLA-2 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	50%		50%		50%		50%		30%	
	Understand										
Level 2	Apply	50%		50%		50%		50%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Hearn, D., & Baker, M. P. (2002). Computer Graphics C Version. Pearson Education.
2. Foley, J. D., Van Dam, A., Feiner, S. K., & Hughes, J. F. (2013). Computer Graphics Principles & Practice (2nd ed. in C). Pearson Education

Other Resources

1. Xiang, Z., & Plastock, R. (2000). Computer Graphics, Second Edition. Schaum's Outlines. Tata McGraw-Hill Education.
2. Rogers, D. F. (2017). Procedural Elements for Computer Graphics (2nd ed.). Tata McGraw-Hill.
3. Neumann, P. G., & Sproull, R. F. (2001). Principles of Interactive Computer Graphics. Tata McGraw-Hill.
4. Govil-Pai, S. (2007). Principles of Computer Graphics. Springer.

Course Designers

Advanced Data Structures and Algorithms

					L	T	P	C
Course Code	CSE 425	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)	CSE 223	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Gain knowledge on a variety of advanced data structures and their implementations.
2. Learn to analyze the efficiency of algorithms.
3. Understand approximation algorithms and NP-completeness.
4. Comprehend different algorithm design techniques to solve problems.
5. Learn complex problems by implementing learned algorithm design techniques and data structures.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate advanced data structures and red-black trees, AVL trees, heaps, Hamiltonian graphs, Euler graphs, eternal sorting and randomized algorithms	2	70%	65%
Outcome 2	Analyze the performance of asymptotic, probabilistic, amortized, competitive and approximation algorithms in terms of time and space complexity – the efficiency.	4	70%	65%
Outcome 3	Develop TSP & Knapsack optimal and approximation algorithms based on P or NP-hard or NP-complete.	5	70%	65%
Outcome 4	Solve the given problem based on algorithmic design paradigms and method of analysis - dynamic programming, branch-n-bound & backtracking	5	70%	65%
Outcome 5	Justify the algorithmic approach used to calculate time complexity and class of problems based on P, NP and NP hard	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	1	2								3	2	
Outcome 2	3	3	1	1	2								3	2	
Outcome 3	3	3	3	3	2								3	2	
Outcome 4	3	3	3	3	2								3	2	1
Outcome 5	3	2	2	2	2				3	2	1		1	1	1
Average	3	3	3	2	2				3	2	1		3	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1		9		
	Importance and need of good data structures and algorithms Heaps,	1	1, 2	1
	AVL Trees	1	1, 2	1
	Red-Black Trees	1	1, 2	1
	Red-Black Trees	1	1, 2	1
	Splay Trees	1	1, 2	1
	B-trees, B+ Trees	1	1, 2	1
	Fibonacci heaps	1	1, 2	1
	Data Structures for Disjoint Sets	1	1, 2	1
	Augmented Data Structures	1	1, 2	1
UNIT 2		8		
	Basics of graphs and algorithms	1	1, 4	1
	Cut-sets, Connectivity and Separability,	1	1, 4	1
	Planar Graphs, Isomorphism	1	1, 4	1
	Graph Colouring, Covering and Partitioning	1	1, 4	1
	Topological Sort	1	1, 4	1
	Ford-Fulkerson Algorithm, Max-flow and Min-cut.	1	1, 4	1
	Few Algorithms for Dynamic Graphs	1	1	1, 3
	Union Find Algorithms	1	1	1,3
UNIT 3		10		
	Basics of geometric algorithms	1	1,4	1
	Point location, Convex hulls and Voronoi diagrams	1	1, 4	1
	Arrangement and Graph connectivity	1	1, 4	1
	Network Flow and Matching, Flow algorithms	1	1, 4	1
	Maximum Flow – Cuts	1	1, 4	1
	Maximum Bipartite Matching	1	1, 4	1
	Graph partitioning via multi-commodity flow	1	1, 4	1
	Karger'r Min Cut Algorithm	1	1, 4	1
	String matching	1	1, 4	1
	Document processing algorithms	1	1, 4	1
UNIT 4		9		
	Approximation algorithms for known NP hard problems	1	3,5	1
	Need of approximation algorithms	1	3,5	1
	Introduction to P, NP, NP-Hard	1	3,5	1
	NP-Complete	1	3,5	1
	Deterministic, non-Deterministic Polynomial time algorithms	1	3,5	1
	Use of Linear programming and primal dual	1	3,5	1
	Local search heuristics	1	3,5	1
	Basic techniques for sorting, searching, merging	1	3,5	1
	list ranking in PRAMs and Interconnection	1	3,5	1
UNIT 5		9		
	Randomized algorithms	1	3,4	1
	Type of Randomized Algorithms	1	3,4	1
	Quick Sort	1	3,4	1
	Min-cut	1	3,4	1
	2-SAT	1	3,4	1
	Game Theoretic Techniques	1	3,4	2
	Game Theoretic Techniques	1	3,4	2
	Random Walks	1	3,4	1,3
	Random Walks	1	3,4	1,3
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	CLA-3 (10%)	Course Project (20%)	
		Th	Th	Th	Th		Th
Level 1	Remember	20%	20%	20%	20%	20%	20%
	Understand						
Level 2	Apply	40%	40%	40%	40%	40%	40%
	Analyse						
Level 3	Evaluate	40%	40%	40%	40%	40%	40%
	Create						
Total		100%	100%	100%	100%	100%	100%

Recommended Resources

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms. Prentice Hall India.
2. Goldberg, D. E. (2005). Genetic Algorithms. Pearson Education.
3. Sedgewick, R., & Wayne, K. (2011). Algorithms. Addison-Wesley Professional

Other Resources

1. Sahni, S. (2005). Data Structures, Algorithms, and Applications in C++. MIT Press

Course Designers

Distributed Operating Systems

Course Code	CSE 426	**Course Category**	Technical Elective			**L**	**T**	**P**	**C**
						3	0	0	3
Pre-Requisite Course(s)	CSE 302	**Co-Requisite Course(s)**		**Progressive Course(s)**					
Course Offering Department	CSE	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the concepts that underlie distributed computing systems along with design and implementation issues.
2. To study the key mechanisms and models for distributed systems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate the architectural models and design issues in distributed systems.	3	70%	65%
Outcome 2	Illustrate the time services in distributed systems.	3	70%	65%
Outcome 3	Explain concurrent programming languages.	2	70%	65%
Outcome 4	Identify Inter Process Communication techniques.	2	70%	65%
Outcome 5	Compare and contrast distributed scheduling algorithms.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	1
Outcome 2	2	2	3	3	2								2	2	2
Outcome 3	2	3	3	2	2								2	2	2
Outcome 4	3	3	3	3	2								2	3	2
Outcome 5	3	3	3	3	2								2	3	2
Average	2	3	3	3	2								2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Fundamentals	9		
	What is distributed operating system	1	1	1, 2, O1
	Issues in designing distributed operating system	1	1	1, 2, O1
	Computer networks: Lan, WAN technologies	1	1	1, 2
	Communication protocols, internetworking	1	1	1, 2
	Message passing	1	1	1, 2
	Issues in IPC by message passing	1	1	1, 2
	Synchronization	1	1, 2	1, 2
	Buffering group communication	1	1, 2	1, 2
	Case study	1	1, 2	1, 2
UNIT 2	Remote Procedure Calls	9		
	The RPC model	1	1, 3, 4	1, 2
	Implementing RPC	1	3, 4	1, 2
	RPCs in heterogeneous environment	1	3, 4	1, 2
	Lightweight RPC	1	3, 4	1, 2
	Distributed shared memory: general architecture of DSM systems	1	1	1, 2
	Design and implementation issues of DSM	1	1	1, 2
	Consistency models	1	1	1, 2
	Replacement strategies, advantages of DSM	1	1	1, 2
	Case study	1	1, 3, 4	1, 2
UNIT 3	Process Management	9		
	Introduction, Process migration	1	1, 4	1, 2
	Threads. Synchronization: Clock synchronization	1	1, 4	1, 2, 3
	Event ordering	1	1, 4	2, 3
	Mutual exclusion	1	4	2, 3
	Deadlock	1	4	2, 3
	Election algorithms	1	4	1, 2
	Resource management: global scheduling algorithm	1	4, 5	1, 2
	Task assignment	1	5	1, 2
	Load sharing and balancing approaches.	1	5	1, 2
UNIT 4	Distributed File System	9		
	Desirable features of a good DFS	1	1	1, 2, 3
	File models	1	1	1, 3
	File accessing models	1	1	1, 3
	File sharing semantics	1	1	1, 3
	File caching schemes	1	1, 2	1, 3
	File replication	1	1	1, 3
	Fault tolerance	1	1, 2	1, 3
	Atomic transactions, design principles	1	1, 2, 4	1, 3
	Case study: Google DFS and Hadoop DFS	1	1, 2, 4	1, 3
UNIT 5	Naming	9		
	Desirable features of a good naming system, system-oriented names	1	1	2, 3, O1
	Object locating mechanisms, human oriented names	1	1	2, 3
	Name caches	1	1	2, 3
	Naming and security	1	1	2, 3
	Security: potential attacks	1	1	2, 3
	Cryptography	1	1	2, 3
	Authentication	1	1, 2	2, 3
	Access control	1	1, 2	2, 3
	Digital signatures, design principles	1	1	2, 3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	CLA-2 (15%)	CLA-3 (10%)	Mid-1 (15%)	
		Th	Th	Th	Th	Th
Level 1	Remember Understand	70%	60%	50%	40%	30%
Level 2	Apply Analyse	30%	40%	50%	60%	70%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Sinha, P. K. (2007). Distributed Operating Systems: Concepts and Design, Prentice Hall of India.
2. Singhal, M., & Shivratri, N. (2017). Advanced Concepts in Operating System, Mc Graw hill publications.
3. Tanenbaum A. S. & Steen, M. V. Distributed Systems, Principles and Paradigms, Pearson publications, 2nd edition

Other Resources

1. Tannenbaum, A. S. Distributed Operating Systems, Pearson Education, 5th edition

Course Designers

Data and Web Mining

					L	T	P	C
Course Code	CSE 427	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)	CSE 209	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the need for data mining.
2. Gain knowledge various stages in data mining process.
3. Learn various data mining algorithms and its application domain.
4. Familiarize web mining in detail and the need for web mining.
5. Understand the use of web mining in social network analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply data mining algorithms to solve the given problems.	2	75%	70%
Outcome 2	Compare and evaluate data mining techniques	5	75%	70%
Outcome 3	Apply web crawling, web-page pre-processing and page ranking	3	70%	60%
Outcome 4	Acquire data from social networking websites and analyse it for efficient recommendation purpose.	4	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	2		1									1		3
Outcome 2	2	2	3	3									3	2	3
Outcome 3	2	2	3	3									3	2	3
Outcome 4	2	2	2	3									3	2	3
Average	2	2	3	3									3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Introduction to Data Mining: What is data mining? Data Mining Goals.	2	1	1, 2
	Related technologies - Machine Learning, DBMS, OLAP, Statistics.	1	1	1
	Stages of the Data Mining Process.	1	1	1, 2
	Data Mining Techniques.	1	2	1, 2
	Knowledge Representation Methods.	1	2	1, 2
	Data Warehouse and OLAP: Data Warehouse and DBMS.	1	1	1
	Multidimensional data model.	1	1	1
	OLAP operations.	1	1	1
UNIT 2	Data pre-processing	9		
	Data pre-processing: Data cleaning. Data transformation.	2	1	1
	Data reduction. Data mining knowledge representation	2	1	1
	Attribute-oriented analysis.	1	1	1
	Data mining algorithms: Association rules: Motivation and terminology.	1	1, 2	1, 2
	Basic idea: item sets.	1	1, 2	1, 2
	Generating item sets and rules efficiently.	1	1, 2	1, 2
	Correlation analysis.	1	1, 2	1, 2
UNIT 3	Data mining algorithms	9		
	Data mining algorithms: Classification.	1	1, 2	1, 2
	Basic learning/mining tasks, inferring rudimentary rules: 1R algorithm.	2	1, 2	1, 2
	Decision trees, Covering rules.	1	1, 2	1, 2
	Data mining algorithms: Prediction, The prediction task.	2	1, 2	1, 2
	Statistical (Bayesian) classification.	1	1, 2	1, 2
	Bayesian networks.	1	1, 2	1, 2
	Instance-based methods (nearest neighbour), Linear models.	1	1, 2	1, 2
UNIT 4	Web crawling	9		
	Web crawling: Basic crawler algorithm.	2	3	3, 4
	Focused crawlers, Topical crawlers.	2	3	3, 4
	Web search: Web page pre-processing.	2	3	3, 4
	Inverted index, HITS algorithm.	1	3	3, 4
	Page ranking algorithm.	1	3	3, 4
	Leadership algorithm.	1	3	3, 4
UNIT 5	Social network analysis	9		
	Social network analysis: Co-citation and bibliographic coupling	2	4	5
	Community discovery.	2	4	5
	Web usage mining: Recommender systems.	2	4	5
	Mining Twitter.	1	4	5
	Mining Face book.	1	4	5
	Mining Instagram.	1	4	5
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	20%	-	10%	-	-	-	10%	-	10%	-
Level 2	Apply Analyse	70%	-	70%	-	70	-	80%	-	80%	-
Level 3	Evaluate Create	10%	-	20%	-	30%	-	10%	-	10%	-
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Han, J., Kamber, M., & Pei, J. (2011). Data mining: Concepts and techniques, 3rd ed. Morgan Kaufmann publications.
2. Michael, V. K., Steinbach, Pang-Ning Tan, (2016). Introduction to Data Mining, Pearson publications.
3. Chakrabarti, S. (2002). Mining the web, Elsevier publications.
4. Liu, B. (2011). Web Data Mining, Second Edition, Springer publications.
5. Russel, M. A., & Klassen, M. (2018). Mining the Social Web, Third edition, Oreily publications.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Complexity Theory

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 428</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Technical Elective</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td>CSE 207</td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the complexity of a problem that can be solved using algorithms, and how much resources (in form of time and space) it takes to solve a problem algorithmically.
2. Studies problems that cannot be solved and problems for which it is difficult to design efficient algorithms and how we can recognize such hard problems.
3. Gives a precise definition of what an algorithm is via Turing machines.
4. Learn central complexity classes, in particular NP-complete problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define an algorithm and identify the given problems that be solved using an algorithm.	1	70%	65%
Outcome 2	Illustrate the ideas of solvability, computational models, and working with Turing Machines.	1	65%	60%
Outcome 3	Classify and apply decision problems into appropriate complexity classes, including P, NP, PSPACE and complexity classes based on randomised machine models	2	65%	60%
Outcome 4	Demonstrate NP-completeness basic hard problems.	2	60%	55%
Outcome 5	Apply interactive proofs in the analysis of optimisation problems.	3	60%	55%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	1	2									3	2	
Outcome 2	1	2	3	3	1								2	2	
Outcome 3	1	3	2	3	1								3	2	
Outcome 4	1	3	2	3	1								3	2	
Outcome 5	1	3	1	3									2	1	
Average	1	3	2	3	1								3	2	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	COMPUTABILITY	9		
	A recap of automata theory and the Church-Turing Thesis	1	1,2	1
	Computational models: Lambda calculus, Turing machine	1	1,2	1
	Decidability	2	1,2	1
	Reducibility	2	1,2	1
	The PCP problem & Mapping reducibility	1	1,2	1
	The Recursion Theorem	1	2,3	1
	Definition of Information	1	2,3	1
UNIT 2	TIME COMPLEXITY	10		
	Measuring Complexity, Big-O and small-o notation, Analysing algorithms.	1	3	1
	Complexity relationships among computational models	1	3	1
	The Class-P, Examples	2	3	1
	The Class-NP, Examples	2	3	1
	The P versus NP question	1	3	1
	NP-completeness	1	3	1
	The Cook-Levin Theorem	1	3	1
	Additional NP-completeness Problems	1	3	1
UNIT 3	SPACE COMPLEXITY	9		
	Space complexity.	1	3	1
	Savitch's Theorem and NL.	2	3	1
	NL-completeness and log-space reductions.	2	3	1
	From P-completeness to PSPACE-completeness.	2	3	1
	The Classes L and NL	1	3	1
	NL completeness, NL equals coNL	1	3	1
UNIT 4	INTERACTABILITY	9		
	Hierarchy Theorems	3	4	1
	Relativization	3	4	1
	Circuit Complexity	3	4	1
UNIT 5	ADVANCED TOPICS IN COMPLEXITY THEORY	8		
	Approximation Algorithms	1	1,5	1
	Probabilistic Algorithms	2	1,5	1
	Alternation	2	1,5	1
	Interactive Proof Systems	3	1,5	1
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (20%)		CLA-2 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	80%		80%		65%		65%		60%	
Level 2	Apply Analyse	20%		20%		35%		35%		40%	
Level 3	Evaluate Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Sipser M. (2012), Introduction to the Theory of Computation, 3rd edition. Cengage Learning

Other Resources

1. Arora, S., & Barak, B. (2009). Computational complexity: a modern approach. Cambridge University Press.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Software Project Management

Course Code	CSE 429	**Course Category**	Technical Elective	**L** 3	**T** 0	**P** 0	**C** 3
Pre-Requisite Course(s)	CSE 306	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Deliver successful software projects that support organization's strategic goals.
2. Match organizational needs to the most effective software development model.
3. Plan and manage projects at each stage of the software development life cycle (SDLC).
4. Create project plans that address real-world management challenges.
5. Develop the skills for tracking and controlling software deliverables.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply the process to be followed in the software development life-cycle models.	3	70%	65%
Outcome 2	Implement communication, modelling, construction & deployment practices in software development.	3	70%	65%
Outcome 3	Describe the key phases of project management.	2	70%	65%
Outcome 4	Apply the concepts of project management & planning.	3	70%	65%
Outcome 5	Explain the quality management & different types of metrics used in software development.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	3	2	1				1	1	3	1	3	2	1	
Outcome 2	3	2	2	1						3	1	3	2	1	
Outcome 3	3	2	2	2				1	1	3	1	3	2	1	
Outcome 4	3	3	2	2				1	1	3	1	3	2	1	
Outcome 5	3	3	2	2				1	1	3	2	3	2	1	
Average	3	3	2	2				1	1	3	1	3	2	1	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	SOFTWARE MANAGEMENT & ECONOMICS	12		
	Conventional Software Management	1	1	1, 2
	SDLC -waterfall model	1	1	1, 2
	Conventional software Management performance.	2	1	1, 2
	Software Economics.	1	1	1, 2
	pragmatic software cost estimation.	1	1	1, 2
	Improving Software Economics-Reducing software product size	1	1	1, 2
	Improving Software Processes & Team Effectiveness.	1	1	1, 2
	Improving Automation through Software Environments.	1	1	1, 2
	The principles of conventional software Engineering	1	1	1, 2
	Principles of modern software management	1	1	1, 2
	Transitioning to an iterative process.	1	1	1, 2
UNIT 2	THE OLD AND THE NEW WAY OF PROJECT MANAGEMENT	8		
	The principles of conventional software engineering	1	2	1, 2
	Principles of modern software management	1	2	1, 2
	Transitioning to an iterative process	1	2	1, 2
	Basics of Software estimation – Effort and Cost estimation techniques	1	2	1, 5
	COSMIC Full function points	1	2	1, 5
	COCOMO-I and COCOMO II	2	2	1, 5
	A Parametric Productivity Model - Staffing Pattern.	1	2	1, 5
UNIT 3	SOFTWARE MANAGEMENT PROCESS FRAMEWORK	9		
	Life cycle phases: Engineering and production stages.	1	3	1, 2
	Inception, Elaboration.	1	3	1, 2
	Construction, transition phases.	1	3	1, 2
	Artifacts of the process: The artifact sets, Management artifacts.	1	3	1, 2
	Engineering artifacts, programmatic artifacts.	1	3	1, 2
	Model based software architectures: A Management perspective and technical perspective.	2	3	1, 2
	Work Flows of the process: Software process workflows, Iteration workflows.	1	3	1, 2
	Checkpoints of the process: Major milestones, Minor Milestones, Periodic status assessment.	1	3	1, 2
UNIT 4	PROJECT ORGANIZATION AND PLANNING	8		
	Iterative Process Planning: Work breakdown structures, planning guidelines,	2	4	1, 2
	Cost and schedule estimating.	1	4	1, 2
	Iteration planning process.	1	4	1, 2
	Pragmatic planning.	1	4	1, 2
	Project Organizations and Responsibilities: Line-of-Business Organizations.	1	4	1, 2
	Project Organizations, evolution of Organizations.	1	4	1, 2
	Process Automation: Automation Building blocks, The Project Environment.	1	4	1, 2
UNIT 5	PROJECT CONTROL AND PROCESS INSTRUMENTATION	8		
	The seven core Metrics, Management indicators.	1	5	1, 3
	Quality indicators, life cycle expectations.	1	5	1, 3
	Pragmatic Software Metrics, Metrics automation.	1	5	1, 3
	Tailoring the Process: Process discriminates.	1	5	1, 3
	Future Software Project Management	1	5	1, 3
	Modern Project Profiles	1	5	1, 3, 4
	Next generation Software economics	1	5	1, 3, 4
	Modern process transitions.	1	5	1, 3, 4
Total Contact Hours		**45**		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="8">Continuous Learning Assessments (50%)</th><th colspan="2" rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th colspan="2">CLA-1 (10%)</th><th colspan="2">Mid-1 (15%)</th><th colspan="2">CLA-2 (10%)</th><th colspan="2">CLA-3 (15%)</th></tr>
<tr><th colspan="2"></th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">50%</td><td rowspan="2"></td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">30%</td><td rowspan="2"></td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">50%</td><td rowspan="2"></td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">70%</td><td rowspan="2"></td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td></tr>
</table>

Recommended Resources

1. Royce, W. (2006), "Software Project Management", 1st Edition, Pearson Education.
2. Huges, B. Cotterell, M. Mall, R. (2017). Software Project Management, 6th Edition, Tata McGraw Hill.
3. Kelkar, SA (2013). Software Project Management: A Concise Study, 3rd Edition, PHI.
4. Henry, J. (2009). Software Project Management: A Real-World Guide to Success, Pearson Education.
5. Pankaj Jalote, (2015). Software Project Management in Practice, Pearson Education

Other Resources

1. Weck, O. de, &b Lyneis, J. Braha, D. (2012) System Project Management. https://ocw.mit.edu/courses/engineering-systems-division/esd-36-system-project-management-fall-2012/
2. https://uit.stanford.edu/pmo/pm-life-cyclea

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Multimedia

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 430</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Technical Elective</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td></td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Introduces multimedia elements including image, graphics, sound, and video components.
2. To learn the fundamentals of multimedia processing with relation to the multimedia elements.
3. To gain knowledge over accessing and modification of multimedia content in real-world scenario.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand content creation editing and managing of multimedia as image, video, and sound media.	2	80%	70%
Outcome 2	Use and examine the inner content of multimedia signal	3	70%	65%
Outcome 3	Use spatial and temporal analysis in the frequency domain of the signal processing to process multimedia signals and make them easy to handle.	3	80%	70%
Outcome 4	Implement a system using MM techniques to solve user requirements.	6	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	2	1	2							3	3	2	1
Outcome 2	3	2	1	2	2							3	3	2	2
Outcome 3	3	3	3	2	2							3	3	2	2
Outcome 4	3	3	3	2	3							3	3	3	2
Average	3	2	2	2	2							3	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	INTRODUCTION TO MULTIMEDIA	8		
	What is Multimedia?	1	1	1, 2
	Multimedia and Hypermedia	1	1	1
	Overview of Mu1timedia Software Tools	1	1	1, 2
	Graphics Image Data Types	2	1	1, 2
	File Formats and representation (image, video, and sound)	3	1	1, 2
UNIT 2	COLOUR IN IMAGE AND VIDEO	9		
	Color Science	1	1,2	1
	Color Models in Images	1	1,2	1
	Color Models in Video	1	1,2	1
	Fundamental Concepts in Video	1	1,2	1,2
	Analog Video	1	1,2	1,2
	Digital Video	1	1,2	1,2
	Digitization of Sound, MIDI: Musical Instrument Digital Interface,	1	1,2	1,2
	Quantization and Transmission of Audio.	1	1,2	1,2
	Color Science	1	1,2	1,2
UNIT 3	LOSSLESS COMPRESSION ALGORITHMS	9		
	Basics of Information Theory, Run-Length Coding,	1	2	1,2
	Variable-Length Coding,	2	2	1,2
	Dictionary-Based Coding	1	2	1,2
	Arithmetic Coding	1	2	1,2
	Lossless Image Compression	1	2	1,2
	Distortion Measures, The Rate-Distortion Theory	1	2	1,2
	Quantization, Transform Coding,	1	2	1,2
	Wavelet-Based Coding, Embedded Zero tree of Wavelet Coefficients,	1	2	1,2
UNIT 4	IMAGE COMPRESSION STANDARDS	10		
	The JPEG Standard	1	3	1
	The JPEG2000 Standard,	1	3	1
	The JPEG-LS Standard, Bilevel Image Compression Standards	1	3	1
	Introduction to Video Compression,	1	3	1
	Video Compression Based on Motion Compensation,	1	3	1
	Search for Motion Vectors,	2	3	1
	H.261	1	3	1
	H.263	1	3	1
	ADPCM in Speech Coding, G.726 ADPCM, Vocoders	1	3	1
UNIT 5	MPEG Video Coding I - MPEG-1 and 2	9		
	MPEG-1	1	4	1
	PEG-2	1	4	1
	Overview ofMPEG-4	1	4	1
	Object-Based Visual Coding in MPEG-4	1	4	1
	Synthetic Object Coding in MPEG-4	1	4	1
	MPEG-4 Part10/H.264, H.264/SVC	1	4	1
	MPEG-7, H.265/HEVC, 3D-HEVC	1	4	1
	MPEG Audio, Commercial Audio codes.	1	4	1
	MPEG-1	1	4	1
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40 %		40%		40%		40%		10%	
Level 2	Apply Analyse	40 %		40%		40%		40%		50%	
Level 3	Evaluate Create	20 %		20%		20%		20%		40%	
Total		**100 %**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Ze-Nian Li, Mark S. Drew, (2004). Fundamentals of Multimedia (FM), in Prentice Hall, (Springer 2nd Edition, 2014 with additional author of Dr.Jiangchuan Liu)
2. Nigel P./ Chapman, Jenny, (2009). Digital Multimedia by Chapman (DM), in John Wiley & Sons Inc (3rd Edition)

Other Resources

1. Multimedia: Making It Work, (2014). 9 Edition by Vaughan, Tay in McGraw-Hill.
2. Multimedia: Computing, Communications and Applications (2012). by Ralf Steinmetz in Pearson Education.
3. Recent articles about multimedia (recommended at classes)

Course Designers

Deep Learning

				L	T	P	C
Course Code	CSE 457	**Course Category**	Technical Elective	3	0	0	3
Pre-Requisite Course(s)	CSE 303	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamental concepts of ML/DL, tensor flow, and keras.
2. Study of different activation functions and ANN.
3. Study and application of CNN, and RNN models
4. Application of different deep learning concepts.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Illustrate the concepts of ML/DL	1	70%	68%
Outcome 2	Design and implement CNN model	2	70%	65%
Outcome 3	Design and implement RNN model	2	70%	65%
Outcome 4	Apply deep learning models to given problems.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	1	2								2	2	2
Outcome 2	2	2	3	2	3								3	2	2
Outcome 3	2	2	3	2	3								2	3	2
Outcome 4	2	2	3	3	3								2	3	2
Average	2	2	3	2	3								2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction:	15		
1	Overview of machine learning	2	1	1
2	Linear classifiers, loss functions	1	1	1
3	Introduction to TensorFlow	1	1	1
4	Computational Graph, Key highlights, Creating a Graph	2	1	1
5	Regression example	1	1	1
6	Gradient Descent	1	1	1
7	TensorBoard	3	1	1
8	Modularity, Sharing Variables	1	1	1
9	Keras	3	4	3
Unit 2	Activation functions, perceptron, ann	7		
10	Activation Functions: Sigmoid, ReLU, Hyperbolic Fns, Softmax	2	1	1,2
11	Perceptrons: What is a Perceptron, XOR Gate	1	1	1
12	Artificial Neural Networks: Introduction	1	1	2
13	Perceptron Training Rule	1	1	2
14	Gradient Descent Rule	1	1	2
15	Vanishing gradient problem and solution	1	1	2
Unit 3	Convolutional Neural Networks	7		
16	Introduction to CNNs	1	1,2	3
17	Kernel filter	1	1,2	3
18	Principles behind CNNs	1	1,2	3
19	Multiple Filters	2	1,2	3
20	Problem and solution of under fitting and overfitting	2	1,2	3
Unit 4	Recurrent Neural Networks	8		
21	Introduction to RNNs	1	1,3	2
22	Unfolded RNNs	1	1,3	2
23	Seq2Seq RNNs	1	1,3	2
24	LSTM	1	1,3	2
25	GRU	2	1,3	2
26	Encoder Decoder architectures	2	1,3	2
Unit 5	Deep Learning applications	8		
27	Image segmentation	1	4	3
28	Self-Driving Cars	1	4	3
29	News Aggregation and Fraud News Detection	1	4	3
30	Natural Language Processing	1	4	3
31	Virtual Assistants	1	4	3
32	Entertainment	1	4	3
33	Visual Recognition	1	4	3
34	Fraud Detection, Healthcare	1	4	3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (05%)	CLA-3 (15%)	
Level 1	Remember	70%	65%	60%	50%	40%
	Understand					
Level 2	Apply	30%	35%	40%	50%	60%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Buduma, N, & Nicholas, L. (2017). Fundamentals of deep learning: Designing next-generation machine intelligence algorithms. O'Reilly Media, Inc..
2. Goodfellow, I., Bengio,Y., & Courville, A. (2016). Deep Learning, MIT Press.
3. Gibson, A., & Patterson, J. (2017). Deep Learning: A Practitioner's Approach, oreilly media.

Other Resources

1. Gulli, A., & Pal, S. (2017). Deep learning with Keras. Packt Publishing Ltd.
2. https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT
3. https://www.coursera.org/professional-certificates/tensorflow.

Course Designers

Advanced Database Management Systems

				L	T	P	C
Course Code	CSE 432	**Course Category**	Technical Elective	3	0	0	3
Pre-Requisite Course(s)	CSE 209	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To implement index structures in the file.
2. To implement query parsing and execution.
3. To understand concurrency control protocols used for transaction processing.
4. To understand recovery techniques for recovering from transaction failures

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Outline DBMS components, data storage in files and implement indexing schemes for fast retrieval of data. Explain B-tree, hash tables for complex data storage.	2	75%	80%
Outcome 2	Plan query execution. Construct query compiler, planner and executor.	3	70%	75%
Outcome 3	Analyse data base operations and Compare concurrency control protocols for transaction processing system.	4	75%	80%
Outcome 4	Explain concurrency control and system failure	2	75%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	-	-	-	-	-	-	-	-	2	2	2	1
Outcome 2	3	3	2	-	-	-	-	-	-	-	-	2	3	3	2
Outcome 3	3	3	2	2	-	-	-	-	-	-	-	2	3	3	2
Outcome 4	3	3	2	2	-	-	-	-	-	-	-	2	3	1	2
Average	3	3	2	2	-	-	-	-	-	-	-	2	3	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	9		
	Overview of the DBMS, Representing data elements	1	1	1
	Introduction to DBMS implementation using Megatron 2000 database system.	1	1	1
	Data storage using main memory and hard disks, Disk failures	1	1	1
	Recovery from disk crashes	2	1	1,2
	Representing data elements such as record address, block, variable length data and solve various numeric	2	1	1
	Variable length data and records, Record modifications, solve various numeric	1	1	1
	Doubt clearing class.	1	1	1
Unit 2	Index Structure	9		
	Index structures: Indexes on sequential files	1	2	1
	Secondary indexes	1	2	1,2
	B-Trees Concept, B-Tree examples, solving numeric	2	2	1,2
	Hash tables concepts	2	1,2	2
	Multidimensional indexes: Hash and tree like structures for multidimensional data	2	1,2	1,2
	Bitmap indexes, solve numeric and doubt clearing class	1	1,2	1
Unit 3	Query Execution	9		
	Query execution: Algebra for queries	1	2	1
	Introduction to Physical-Query-Plan Operators	1	2	1,3
	One-Pass Algorithms for Database Operations	1	2	1
	Nested-Loop Joins	1	2	1
	Two-Pass Algorithms Based on Sorting. Example discussion.	1	2	2
	Index-Based Algorithms ,Buffer Management. More example	2	2	1
	Algorithms Using More Than Two Passes. Solving numeric	1	2	1
	Parallel Algorithms for Relational Operations.	1	2,3	1
Unit 4	Query compiler	9		
	The query compiler: Parsing	2	2	1,2
	Algebraic Laws for Improving Query Plans	2	2	1
	From Parse Trees to Logical Query Plans	1	2	1
	Estimating the Cost of Operations	1	2	1(other),1
	Introduction to Cost-Based Plan Selection	1	2	2(other),1
	Choosing an Order for Joins	1	2	3(other),2
	Completing the Physical-Query-Plan Selection	1	2	1
Unit 5	Concurrency Control	9		
	Concurrency control: Conflict-Serializability	1	3	1
	View serializability	1	3	1
	Locking Systems with Several Lock Modes	1	3	1
	An Architecture for a Locking Scheduler	1	3,4	1
	Concurrency control by timestamps and validation	1	3,4	1
	Transactions that Read Uncommitted Data	1	3,4	1
	Coping with system failures: Undo/Redo logging, Examples on Undo/Redo, view serializability	2	3,4	2 (other)
	Protecting media failures, Numeric solved, Doubt clearing.	1	3,4	2
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (15%)	Mid-1 (20%)	CLA-2 (5%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	70%	60%	70%	40%	70%
	Understand					
Level 2	Apply	30%	40%	30%	60%	30%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Garcia-Molina, H. (2008). Database System Implementation. Pearson Education India.
2. Garcia-Molina, H. (2008). Database systems: the complete book. Pearson Education India.

Other Resources

1. Bhalotia, G., Hulgeri, A., Nakhe, C., Chakrabarti, S., & Sudarshan, S. (2002, February). Keyword searching and browsing in databases using BANKS. In Proceedings 18th international conference on data engineering (pp. 431-440). IEEE.
2. Srivastava, D., Stuckey, P. J., & Sudarshan, S. (2000). U.S. Patent No. 6,032,144. Washington, DC: U.S. Patent and Trademark Office.
3. Shanbhag, A., & Sudarshan, S. (2014). Optimizing join enumeration in transformation-based query optimizers. Proceedings of the VLDB Endowment, 7(12), 1243-1254.

Course Designers

Fog Computing

Course Code	CSE 433	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	CSE 301	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the limitations of today's Cloud computing models which are not designed for the volume, variety, and velocity of data generated by billions of Internet of Things (IoT) devices.
2. To understand the features of Edge Computing architecture and analyse business models that address the challenges of resource management and optimization.
3. To familiarize with Edge applications that monitor real-time data from network-connected things and initiating action involving machine-to-machine (M2M) communication.
4. To understand how developers, write IoT applications for Edge Computing nodes that are closest to the network edge and ingest the data from IoT devices.
5. To understand how Edge Nodes, extend the Cloud to the Network Edge through the Case studies for Response time, Data storage time, coverage area, and kinds of applications.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate various architectural models and design issues in Edge Computing.	2	65%	60%
Outcome 2	Learn and apply various Edge+IoT communication paradigms and Edge+Edge Middleware.	4	65%	60%
Outcome 3	Identify and mitigate Resource management and optimization challenges of Edge Computing model.	3	65%	60%
Outcome 4	Develop efficient models for deployment and dimensioning of edge networks	2	65%	60%
Outcome 5	Will gain hands on experience with different case studies and simulation frameworks for real-life Edge applications.	6	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							3	3	1	2
Outcome 2	3	3	3	2	2	1			3			2	3	2	2
Outcome 3	3	3	3	2	2				3			3	3	2	2
Outcome 4	3	3	3	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	2	2	1			2			2	3	2	2
Average	3	3	3	2	2	1			3			2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Cloud Computing Fundamentals	1	1,2	1,2
	Limitation of Cloud computing, the Needs of Edge Computing	1	1,2	1,2
	Edge definition, Characteristic Features of Edge computing – SCALE	1	1,2	1,2
	Architectural differences between Cloud and Edge computing	1	1,2	1,2
	Edge Computing Models (Service models)	2	1,2	1,2,3
	Edge and Edge Illustrative Use Cases	2	1,2	1,2,3
	Opportunities and Challenges	1	1,2	1,2,3
UNIT 2	Disruptive Technology Enablers for Edge Computing	9		
	Edge Computing for IoT: Definition and Requirements	1	1,2	1,2
	OpenEdge	2	1,2	1,2
	Communication technologies for edge computing- 4G, 5G, 6LoPAN, DSRC	2	1,2	1,2
	Protocols and Algorithms for edge communication	2	1,2	1,2
	Software defined networking for edge computing	1	1,2	3
	Caching and Networking in 5G edge networks	1	1,2	3
UNIT 3	Middleware for Edge and Edge Computing	9		
	Need for Edge and Edge Computing Middleware	1	2,3	1,3
	Design goals	1	2,3	1,3
	Quality of Service (QoS) in edge computing	2	2,3	1,2,3
	Authentication. privacy and security of edge nodes	2	2,3	1
	Data management in edge computing	1	2,3	1
	Challenges and research prospects	2	2,3	1,2,3
UNIT 4	Deployment and Dimensioning of Edge Networks	9		
	Introduction to Edge node placement problem	1	3,4	1,2
	Optimization models for edge node placement problem	2	3,4	1,2
	Resource provisioning in edge networks	2	3,4	1,2,3
	Mobility models for edge nodes	2	3,4	2
	Edge orchestration	2	3,4	1
UNIT5	Modeling and Simulation of Distributed Edge Environment	9		
	Introduction to modeling and simulation	2	2,3,5	1
	EdgeNetSim++: Architecture	1	2,3,5	1
	EdgeNetSim++: Installation and Environment Setup	1	2,3,5	1
	OMNeT++ Installation and sample programs	1	2,3,5	1
	Sample Edge Simulation	2	2,3,5	1
	Advanced topics in edge research	2	2,3,5	1,2,3
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	40%	60%	20%		30%
	Understand					
Level 2	Apply	60%	40%	50%	60%	50%
	Analyse					
Level 3	Evaluate			30%	40%	20%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Buyya, R., & Srirama, S. N. (Eds.). (2019). Fog and edge computing: principles and paradigms. John Wiley & Sons.
2. Mahmood, Z. (Ed.). (2018). Fog computing: concepts, frameworks and technologies. Springer.
3. Abbas, A., Khan, S. U., & Zomaya, A. Y. (Eds.). (2020). Fog computing: theory and practice. John Wiley & Sons.

Other Resources

1. Articles from IEEE, ACM, Springer and Elsevier

Course Designers

Parallel Algorithms

Course Code	CSE 434	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	CSE 207	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamental concepts of parallel processing, interconnection networks, parallel computation models.
2. To design, analyse, and implement the modern parallel algorithms techniques.
3. To measure the performance of various parallel algorithms and comparison with sequential algorithms
4. To learn various problem-solving strategies to achieve parallelism

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Illustrate the requirements of parallel programming systems and its facilitation in concurrent systems	2	65%	60%
Outcome 2	Analyse the strengths and limitations of parallel computing approaches for problem solving	4	65%	60%
Outcome 3	Compute the performance of parallel algorithms	3	65%	60%
Outcome 4	Design the parallel searching and sorting algorithms	2	65%	60%
Outcome 5	Evaluate the differences among parallel algorithms solving the same problem and defend the best approach.	5	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							3	3	1	2
Outcome 2	3	3	3	2	2	1			3			2	3	2	2
Outcome 3	3	3	3	2	2				3			3	3	2	2
Outcome 4	3	3	3	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	2	2	1			2			2	3	2	2
Average	3	3	3	2	2	1			3			2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	12		
	Sequential model need of alternative model	1	1,2	3,4
	Parallel computational models: PRAM, LMCC	1	1,2	3,4
	Parallel computational models: Hypercube, Cube Connected Cycle	2	1,2	3,4
	Parallel computational models: Butterfly, Perfect Shuffle Computers	2	1,2	3,4
	Parallel computational models: Tree model, Pyramid model	2	1,2	3,4
	Fully Connected model	1	1,2	3,4
	PRAM-CREW, EREW models	2	1,2	3,4
	Simulation of one model from another one	1	1,2	3,4
UNIT 2	Performance of Parallel Algorithms	8		
	Performance measures of parallel algorithms	2	2,3	1,2
	Speed-up and efficiency of parallel algorithms	2	2,3	1,2
	Cost-optimality	2	2,3	1,2
	Example of cost-optimal algorithms: summation	1	2,3	1,2
	Example of cost-optimal algorithms: min/max	1	2,3	1,2
UNIT 3	Parallel Sorting Networks	8		
	Parallel Sorting Networks	1	4,5	2,3
	Parallel Merging Algorithms on CREW	1	4,5	2,3
	Parallel Merging Algorithms on EREW	1	4,5	2,3
	Parallel Merging Algorithms on MCC	1	4,5	2,3
	Parallel Sorting Networks on CREW	1	4,5	2,3
	Parallel Sorting Networks on EREW	1	4,5	2,3
	Parallel Sorting Networks on MCC	1	4,5	2,3
	Linear array	1	4,5	2,3
UNIT 4	Parallel Searching Algorithm	9		
	Parallel Searching Algorithms	1	4,5	2,3
	Kth element in X+Y on PRAM	2	4,5	2,3
	Parallel matrix transportation	2	4,5	2,3
	Multiplication algorithm on PRAM	1	4,5	2,3
	Multiplication algorithm on MCC	1	4,5	2,3
	Vector-Matrix multiplication	1	4,5	2,3
	Solution of linear equation, root finding	1	4,5	2,3
UNIT 5	Graph Algorithms	8		
	Connected graphs	1	1	4
	Search and traversal	1	1	4
	Combinatorial algorithms-permutation	2	1	4
	Combinatorial algorithms- combinations	2	1	4
	Derangements	2	1	4
	Total Contact Hours	**45**		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="3">Bloom's Level of Cognitive Task</th><th colspan="8">Continuous Learning Assessments (50%)</th><th colspan="2" rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th colspan="2">CLA-1 (10%)</th><th colspan="2">Mid-1 (20%)</th><th colspan="2">CLA-2 (10%)</th><th colspan="2">CLA-3 (10%)</th></tr>
<tr><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th><th>Th</th><th>Prac</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">20%</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">30%</td><td rowspan="2"></td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">50%</td><td rowspan="2"></td><td rowspan="2">60%</td><td rowspan="2"></td><td rowspan="2">50%</td><td rowspan="2"></td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">30%</td><td rowspan="2"></td><td rowspan="2">40%</td><td rowspan="2"></td><td rowspan="2">20%</td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td><td>100%</td><td></td></tr>
</table>

Recommended Resources

1. Quinn, M. J. (1987). Designing efficient algorithms for parallel computers. McGraw-Hill, Inc..
2. Akl, S. G. (1989). The design and analysis of parallel algorithms. Prentice-Hall, Inc..
3. Rajasekaran, S., & Reif, J. (Eds.). (2007). Handbook of parallel computing: models, algorithms and applications. CRC press.
4. Pacheco, P. (2011). An introduction to parallel programming. Elsevier

Other Resources

1. Leighton, F. T. (2014). Introduction to parallel algorithms and architectures: Arrays· trees· hypercubes. Elsevier.

Course Designers

Web Services

						L	T	P	C
Course Code	CSE 435	**Course Category**	Technical Elective			3	0	0	3
Pre-Requisite Course(s)	CSE 210	**Co-Requisite Course(s)**		**Progressive Course(s)**					
Course Offering Department	CSE	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. Learn the overview of service oriented architecture, service roles and its architectural stack.
2. Comprehend web services and the various ways to implement the web services.
3. Gain knowledge for the design and implementation Restful Web Services.
4. Understand the composition of various services.
5. Gain knowledge on Service Component Architecture.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe service-oriented architecture and service roles in service-oriented architecture	2	70%	65%
Outcome 2	Implement web services	3	70%	65%
Outcome 3	Demonstrate Restful Services	3	70%	65%
Outcome 4	Compare and Contrast web service compositions	3	70%	65%
Outcome 5	Illustrate Service Component Architecture and its importance.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2												1	3	2
Outcome 2	3	3	3	2	3							1	3	3	2
Outcome 3	3	3	3	3	3							1	3	3	2
Outcome 4	3	2	2	2	3							1	3	3	2
Outcome 5	3	2	2	3	3							1	3	3	2
Average	3	2	2	2	2							1	3	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	Introduction to Service Oriented Architecture	8		
	Basics of service-oriented architecture (SAO)	1	1	1
	Goals of service-oriented architecture	1	1	1
	Introduction to services	1	1	1
	Service roles and interaction in the Service Oriented Architecture	1	1	1
	The SOA Architectural Stack	1	1	1
	Service Composition and Data Flow	1	1	1
	Data-Flow Paradigms	1	1	1
	Composition Techniques	1	1	1
Unit II	Web Services	10		
	Introduction to web services	1	2	1, 2
	History of web services	1	2	1
	Basics of Simple Object Access Protocol (SOAP)	2	2	1, 2
	Web Services Description Language (WSDL)	2	2	1, 2
	WSDL Main Elements	1	2	1
	Message Communication Model in SOAP/WSDL	1	2	1
	Develop simple web services	2	2	1
Unit III	Web Services: REST or Restful Services	12		1
	Introduction to REST	1	3	1
	REST Design Principles	2	3	1, 2
	Web API Design for RESTful Services	2	3	1, 2
	Building REST Web Services	2	3	1, 2
	Data Access as a Service and implementing data services	1	3	1, 2
	XML Transformation and Query Techniques	2	3	1
	Consuming data via direct data access to the sources	2	3	1
Unit IV	Web Service Composition	8		
	Introduction to web service composition	1	4	1
	Workflow representation of a composite service	1	4	1
	Web service composition environment with detailed discussion on the benefits of web services	1	4	1
	Web service composition: control flow	1	4	1
	BPEL (Business Process Execution Language)	1	4	1
	BPMN (Business Process Model and Notation)	1	4	1
	Web Service Composition: Data Flows	1	4	1
	Data flow paradigms	1	4	1
Unit V	Service Component Architecture	7		
	Introduction to Service Component Architecture (SCA)	1	5	1
	The SOA Integration Problem	1	5	1
	Overview of SCA	1	5	1
	High-level overview of the assembly model	1	5	1
	Application of SCA to Use Case	1	5	1
	SCA Runtime	1	5	1
	Benefits of SCA	1	5	1
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (20%)		CLA-2 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		50%		30%		30%		30%	
Level 2	Apply Analyse	60%		50%		70%		70%		70%	
Level 3	Evaluate Create										
Total		**100 %**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Paik, H. Y., Lemos, A. L., Barukh, M. C., Benatallah, B., & Natarajan, A. (2017). Web service implementation and composition techniques (Vol. 256, pp. 149-158). Springer International Publishing.
2. Kalin, M. (2013). Java Web Services. " O'Reilly Media, Inc.".

Other Resources

Course Designers

Advances in Data Mining

Course Code	CSE 436	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)	CSE 209	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the basic concepts of data mining techniques
2. Explain the concepts of association rule mining and frequent pattern mining, classification and clustering
3. Discuss and analyse various classification algorithms, clustering algorithms and methods for outlier analysis.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand advanced data mining algorithms to solve the given real-world problems.	2	75%	70%
Outcome 2	Identify and apply appropriate data mining algorithms to solve the given real-world problems.	3	75%	70%
Outcome 3	Compare and evaluate classification and prediction methods.	5	70%	65%
Outcome 4	Compare and evaluate clustering methods.	5	70%	65%
Outcome 5	Compare and evaluate association rule mining methods.	5	70%	65%
Outcome 6	Compare and evaluate outlier detection methods.	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3													
Outcome 2	2	2	2	2								2	2	2	2
Outcome 3	2	2	3	3								2	3	2	2
Outcome 4	2	2	3	3								2	3	2	2
Outcome 5	2	2	3	3								2	3	2	2
Outcome 6	2	2	3	3								2	3	2	2
Average	2	2	3	3								2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	7		
	What is Data Mining, Compiling need of Data Mining, Business Data Mining	1	1,2	1
	Data Mining Process, CRISP-DM, Business Understanding, Data Understanding, Data Preparation, Modelling, Evaluation, Deployment.	3	1,2	1, 2
	SEMMA, Steps in SEMMA Process, Comparison of CRISP & SEMMA, Handling Data	3	2	1, 2
Unit 2	Association Rules in Knowledge Discovery	8		
	Introduction, Market-Basket Analysis	1	1	1
	Mining Frequent Patterns, Associations, and Correlations, Apriori Algorithm	1	1	1
	Pattern-Growth Approach for Mining Frequent Itemsets	1	1	1
	Mining Frequent Itemsets using Vertical Data Format, Mining Closed and Max Patterns	1	2, 3	1
	Pattern Mining in Multilevel, Multidimensional Space	1	2, 3	1
	Constraint-Based Frequent Pattern Mining	1	2, 3	1
	Mining High-Dimensional Data and Colossal Patterns	1	2, 3	1
	Mining Compressed or Approximate Patterns	1	2, 3	1
Unit 3	Classification	10		
	Basic Concepts, Decision Tree Induction	2	1, 4	1
	Bayes Classification Methods: Bayes' Theorem, Na¨ıve Bayesian Classification, Rule-Based Classification	2	1, 4	1
	Model Evaluation and Selection	1	1, 4	1
	Bagging, Boosting and AdaBoost, Random Forests	2	1, 4	1, 3
	Improving Classification Accuracy of Class-Imbalanced Data	1	1, 4	1
	Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches	2	1, 4	1, 2
Unit 4	Cluster Analysis	10		
	Introduction, k-Means, k-Medoids	2	1, 5	1
	Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods	2	1, 5	1
	Multiphase Hierarchical Clustering Using Clustering, Feature Trees	2	1, 5	1
	Multiphase Hierarchical Clustering Using Dynamic Modelling, Probabilistic Hierarchical Clustering	2	1, 5	1
	Density-Based Methods, Grid-Based Methods	2	1, 5	1
Unit 5	Outlier Analysis	10		
	Introduction, Outlier Detection Methods: Supervised, Semi-Supervised, and Unsupervised Methods	3	1, 6	1

	Outlier Detection Methods: Statistical Methods, Proximity-Based Methods, and Clustering-Based Methods	3	1, 6	1
	Mining Contextual and Collective Outliers, Outlier Detection in High-Dimensional Data	2	1, 6	1
	Mining Complex Data Types, Data Mining Applications, Social Impacts of Data Mining.	2	1, 6	1, 2, 3
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	20%	-	10%	-	-	-	10%	-	10%	-
Level 2	Apply Analyse	40%	-	50%	-	-	-	50%	-	50%	-
Level 3	Evaluate Create	40%	-	40%	-	100%	-	40%	-	40%	-
Total		100 %		100%		100%		100%		100%	

Recommended Resources

1. Mining, W. I. D. (2006). Data mining: Concepts and techniques. Morgan Kaufinann, 10(559-569), 4.
2. Olson, D. L., & Delen, D. (2008). Advanced data mining techniques. Springer Science & Business Media.
3. Aggarwal, C. C. (2015). Data mining: the textbook (Vol. 1, p. 1). New York: springer.

Other Resources

Course Designers

Social Network Analysis

Course Code	CSE 437	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. To give details of the key mathematical concepts that characterize a network
2. To explain different analytical tasks on social graphs such as centrality, link prediction and community detection.
3. To demonstrate computational tools for social networks tasks in the real world.
4. Examine social networks analysis using case studies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand of the key mathematical concepts that characterize a network	2	65%	65%
Outcome 2	Develop network models with various topological structures using the main algorithms for graph analysis and implementation.	3	65%	65%
Outcome 3	Demonstrate practical knowledge of analytical and computational tools for complex networks in the real world.	3	65%	65%
Outcome 4	Demonstrate knowledge of recent research in the area and exhibit technical writing and presentation skills..	3	65%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	1	1	1								1	1	1
Outcome 2	3	3	3	3	3						2	3	3	3	3
Outcome 3	3	3	3	3	3						2	3	3	3	3
Outcome 4	3	3	3	3	3						2	3	3	3	3
Average	3	3	3	3	3						2	3	3	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	UNIT I: Fundamentals of Network Science	7		
	Networks in the real world: Social networks, Information networks, Technological networks, Biological networks	2	1	1, 3
	The large-scale structure of networks: Components, Shortest paths and small-world effect,	1	1	1, 3
	Degree distributions, Power laws and scale-free networks, Six degrees of separation, Random graphs models of network formation.	1	1	1, 3
	Mathematics of networks: Networks and their representation	1	1	1
	Types of networks: Weighted, directed and hypergraphs, The adjacency, Laplacian, and incidence matrices Degree, paths, components, independent paths, connectivity, and cut sets.	2	1	1
UNIT 2	Centrality measures	10		
	Degree centrality, Closeness centrality	2	2	1, 3
	Homophily, Transitivity and Preferential attachment	2	2	1, 3
	Clustering coefficient and Assortative mixing	1	2	1, 3
	Eigenvector centrality, Katz centrality	2	2	1, 3
	Betweenness centrality Page rank, Hubs and Authorities	3	2	1, 3
UNIT 3	Community Detection in Social Networks	12		
	Detecting communities in social networks, Definition of community, Applications of community detection	3	2	1, 2, 3
	Algorithms for community detection: The Kernighan-Lin Algorithm	2	2	1, 2, 3
	Agglomerative/Divisive Algorithms, Markov Clustering	2	2	1, 2, 3
	Multi-level Graph Partitioning Spectral Algorithms	2	2	1, 2, 3
	Modularity Maximization Other Approaches	2	2	1, 2
	Evaluating communities	1	2	1
UNIT 4	Predictive Analytics in Social Networks	9		
	Link prediction problem, Link prediction measures	1	3	1
	Feature based Link Prediction, Evaluation Node	2	3	1
	classification problem Node classification: Problem definition and applications	2	3	1
	Iterative classification methods; Label propagation method; Graph regularization method; Evaluation	1	3	1
	Motif analysis: Definition of network motifs	1	3	1
	Triangle counting and enumeration algorithms	1	3	1
	Applications of network motifs	1	3	1
UNIT 5	Current Research in Social Networks	7		
	Social Influence Analysis	2	4	1, 3
	privacy in social networks	2	4	1, 3
	Integrating sensors and social networks	1	4	1, 3
	Multimedia information networks in social media and social tagging and applications.	2	4	1, 3
	Total Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Assessments (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember Understand	30%	20%	30%	0%	30%
Level 2	Apply Analyse	70%	80%	70%	100%	70%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Newman, M. E. J. (2010). Networks: an introduction. Oxford; New York: Oxford University Press.
2. Aggarwal, C. C. (2011). An introduction to social network data analytics. In Social network data analytics (pp. 1-15). Springer, Boston, MA.
3. Barabási, A. L. (2013). Network science. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 371(1987), 20120375

Other Resources

Course Designers

Recommender Systems

Course Code	CSE 438	**Course Category**	Technical Elective		L 3	T 0	P 0	C 3
Pre-Requisite Course(s)	Linear Algebra	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand principles behind recommender systems.
2. To design suitable models for applications in various domains.
3. To apply the recommendation models such as content-based, collaborative filtering to real-world applications.
4. Evaluate the performance of various recommendation models for chosen application.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand principles behind recommender systems.	3	65%	65%
Outcome 2	Design suitable models for applications in various domains	3	65%	65%
Outcome 3	Apply the recommendation models such as content-based, collaborative filtering to real-world applications.	3	65%	65%
Outcome 4	Evaluate the performance of various recommendation models for chosen application.	3	65%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1															
Outcome 2															
Outcome 3															
Outcome 4															
Average															

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	INTRODUCTION	6		
	Introduction to Recommender Systems,	1	1	1
	Applications of Recommender Systems, Goals of Recommender Systems	1		1
	Basic Models of Recommender Systems-I	1	1	1
	Basic Models of Recommender Systems-II	1	1	1
	Domain-Specific Challenges in Recommender Systems	1	1	1
	Exploring Datasets and domains	1	1	1
UNIT 2	Non-Personalised Recommender Systems	9		2
	Non personalised Recommendation	2	2	2
	Coding demo of Summary statistics based RS	1	2	2
	Guided Activity - 1: Implementation of summary statistics based RS	1	2	3
	Activity - 1: Implementing summary statistics based RS for the dataset of chosen domain	1	2	2
	Guided Activity - 2: Implementation of demographics based RS	1	2	3
	Guided Activity - 3: Implementation of product association based RS	1	2	3
	Activity - 2: Implementation of demographics based and product association based RS for the dataset of chosen domain	2	2	2
UNIT-III	Neighborhood-Based Recommender Systems	13		
	Key Properties of Ratings Matrices, Ratings, mean-centered ratings	1	3	4
	Introduction to neighborhood-based recommendation	1	3	4
	Variations of neighborhood-based CF solutions	1	3	4
	User-based neighborhod models	1	3	4
	Guided Activity - user-based CF	1	3	6
	Tutorial-7	1	3	6
	Item-based neighborhod models	1	3	4
	Strengths and limitations of neighborhood-based CF models	1	3	4
	Variations of neighborhood-based CF solutions: Dimensinality reduction	1	3	4
	Singular Value Decomposition and Principle Component Analysis	1	3	5
	Bias in the recommendation models, problems and solutions	1	3	5
	Graph Models for neighborhood-based CF	2	3	7
UNIT-IV	Evaluating Recommender Systems	10		
	Goal of evaluation	1	4	3
	Evaluation taxonomy	1	4	3
	Accuracy and Error metrics - I	1	4	3
	Accuracy and Error metrics - II	1	4	3
	Tutorial	1	4	4
	Decision Support metrics	1	4	4

	Tutorial	1	4	4
	Rank-aware Top-n metrics - I	1	4	4
	Rank-aware Top-n metrics - II	1	4	4
	Tutorial	1	4	4
UNIT-V	Model-Based Collaborative Filtering	6		
	Geometric Intuition for Latent Factor Models	1	3	6
	Stochastic Gradient Descent	1	3	6
	Guided Activity	1	3	7
	Demo of SVD on toy Movielens dataset	1	3	7
	CLA 3 evaluation	2		
	Total Contact Hours	45		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**				**End Semester Assessments (50%)**
		CLA-1 (10%)	**Mid-1 (20%)**	**CLA-2 (10%)**	**CLA-3 (10%)**	
Level 1	Remember Understand	30%	20%	30%	0%	
Level 2	Apply Analyse	70%	80%	70%	100%	
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Shlomo Berkovsky, Collaborative Recommendations Algorithms, Practical Challenges and Applications, 2019.
2. Nick Seaver, Computing Taste Algorithms and the Makers of Music Recommendation, 2022.
3. Aristomenis, Machine Learning paradigms- Applications in Recommender Systems, 2015.
4. Gulden Uchyigit, Personalization Techniques and Recommender Systems, 2008.

Other Resources

1. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. F. Ricci, L Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010.
3. Falk, Kim. Practical recommender systems. Simon and Schuster, 2019.
4. Michael Schrage. Recommendation Engines.2020.
5. Oliver Theobald. Machine Learning-Make your own Recommender System. 2018.
6. Dietmar Jannach. Recommender Systems An Introduction, 2010.
7. Deepak K. Agarwal. Statistical Methods for Recommender Systems, 2016

Course Designers

Computational and Complexity Theory

					L	T	P	C
Course Code	CSE 439	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To clarify the practical view towards the applications of these ideas in the engineering part of computer science.
2. Studies problems that cannot be solved and problems for which it is difficult to design efficient algorithms and how we can recognize such hard problems.
3. Gives a precise definition of what an algorithm is via Turing machines.
4. Learn central complexity classes, in particular NP-complete problems.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the methods to prove the limitations of computational models.	1	70%	65%
Outcome 2	Illustrate the ideas of solvability, computational models, and working with Turing Machines.	1	65%	60%
Outcome 3	Classify and apply decision problems into appropriate complexity classes, including P, NP, PSPACE and complexity classes based on randomised machine models	2	65%	60%
Outcome 4	Demonstrate NP-completeness basic hard problems.	2	60%	55%
Outcome 5	Apply interactive proofs in the analysis of optimisation problems.	3	60%	55%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	1	2									3	2	1
Outcome 2	1	2	3	3	1								2	2	1
Outcome 3	1	3	2	3	1								3	2	1
Outcome 4	1	3	2	3	1								3	2	2
Outcome 5	1	3	1	3									2	1	1
Average	1	3	2	3	1								3	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Context Free Grammars	9		
	Ambiguity in context free grammars. Minimisation of Context Free Grammars	1	1,2	1
	Chomsky normal form, Greiback normal form, Pumping Lemma for Context Free Languages	2	1,2	1
	Push down automata	2	1,2	1
	PDA model, acceptance of CFL	2	1,2	1
	Equivalence of CFL and PDA	1	1,2	1
	Introduction to DCFL and DPDA	1	2,3	1
UNIT 2	Turning Machine	8		
	Turing Machine, definition, model,	2	1,2	1
	Computable functions, recursively enumerable languages	2	1,2	1
	types of Turing machines (proofs not required). Universal Turing Machine	2	1,2	1
	linear bounded automata and context sensitive language	1	1,2	1
	Church-Turing Thesis Computational models	1	1,2	1
UNIT 3	Computability	9		
	A recap of automata theory and the Church-Turing Thesis	1	1,2	1
	Computational models: Lambda calculus, Turing machine	1	1,2	1
	Decidability	2	1,2	1
	Reducibility	2	1,2	1
	The PCP problem & Mapping reducibility	1	1,2	1
	The Recursion Theorem	1	2,3	1
	Definition of Information	1	2,3	1
UNIT 4	Time Complexity	10		
	Measuring Complexity, Big-O and small-o notation, Analyzing algorithms.	1	3	1
	Complexity relationships among computational models	1	3	1
	The Class-P, Examples	2	3	1
	The Class-NP, Examples	2	3	1
	The P versus NP question	1	3	1
	NP-completeness	1	3	1
	The Cook-Levin Theorem	1	3	1
	Additional NP-completeness Problems	1	3	1
UNIT 5	Space Complexity	9		
	Space complexity.	1	3	1
	Savitch's Theorem and NL.	2	3	1
	NL-completeness and log-space reductions.	2	3	1
	From P-completeness to PSPACE-completeness.	2	3	1
	The Classes L and NL	1	3	1
	NL completeness, NL equals coNL	1	3	1
	Total contact hours	**45**		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="2">Bloom's Level of Cognitive Task</th><th colspan="4">Continuous Learning Assessments (50%)</th><th rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th>CLA-1 (10%)</th><th>Mid-1 (15%)</th><th>CLA-2 (10%)</th><th>CLA-3 (15%)</th></tr>
<tr><th colspan="2"></th><th>Th</th><th>Th</th><th>Th</th><th>Th</th><th>Th</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">80%</td><td rowspan="2">80%</td><td rowspan="2">65%</td><td rowspan="2">65%</td><td rowspan="2">60%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">20%</td><td rowspan="2">20%</td><td rowspan="2">35%</td><td rowspan="2">35%</td><td rowspan="2">40%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. Sipser, M. (2012). Introduction to the Theory of Computation (3rd ed.). Publisher.

Other Resources

1. Arora, S., & Barak, B. (2007). Computational Complexity: A Modern Approach. Cambridge University Press.

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Cryptography and Network Security

Course Code	CSE 459	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce cryptographic principles, methods, and algorithms for data protection.
2. Understand network vulnerabilities and apply security measures to counter threats.
3. Explore authentication techniques, key management, and digital signatures for communication.
4. Analyse security protocols, access controls, and secure communication in networks.
5. Develop skills to assess risks, design secure systems, and ensure data integrity.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understand cryptographic algorithms, their principles, and applications in data protection	2	70 %	65%
Outcome 2	Analyze network vulnerabilities and apply measures to safeguard against attacks.	3	70 %	65%
Outcome 3	Implement secure communication protocols ensuring data integrity and confidentiality.	3	70 %	65%
Outcome 4	Evaluate and deploy encryption techniques for data privacy and non-repudiation.	3	70 %	65%
Outcome 5	Develop skills to manage network access, authentication, and intrusion detection.	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2								3	2	1
Outcome 2	2	2	3	3	2								2	2	1
Outcome 3	2	3	3	2	2								2	2	1
Outcome 4	3	3	3	3	2								2	3	1
Outcome 5	2	3	3	3	2								2	2	1
Average	2	3	3	3	2								2	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Introduction, Traditional Cipher structure	1	1	1,2
	Substitution Techniques: Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher	1	1	1
	Hill Cipher, Poly Alphabetic Cipher, One TimePad	1	1	1,2
	Transposition Cipher: Rail Fence Cipher, Simple Columnar or Row Transposition	1	1	1
	Motivation for the feistel Cipher structure, Stream Ciphers and block Ciphers	1	1	1
	The data encryption Techniques, Finite Fields	1	1	1
	Advanced Encryption Standard, AES encryption, AES decryption, AES example, results	1	1	1,2
	The avalanche effect, the strength of AES	1	1	1,2
	Stream Ciphers, RC1, RC4	1	1	1,2
UNIT 2	Public-Key Cryptosystems	8		
	Fermat's and Euler's Theorems	1	2	1,2
	Public-Key Cryptography and RSA, Principles of public-key cryptosystems	1	2	1,2
	Applications for public-key cryptosystems, requirements for public-key cryptosystems	1	2	1,2
	public-key cryptanalysis. The RSA algorithm, description of the algorithm computational aspects	1	2	1,2
	the security of RSA, Diffie-hellman key exchange	1	2	1,2
	Elliptic Curve Cryptography systems, key exchange protocols	1	2	1,2
	man in the middle attack	1	2	1,2
	Elgamal Cryptographic systems	1	2	1,2
UNIT 3	Cryptographic Hash Functions and MAC	6		
	Introduction to Cryptographic Hash Functions	1	3	1,2
	Hash Functions Based on Cipher Block Chaining	1	3	1,2
	Secure Hash Algorithm (SHA), SHA1	1	3	1,2
	SHA-3, Application of Cryptographic Hash Functions	1	3	1,2
	Message Authentication Codes (MAC): Message Authentication Requirements	1	3	1,2
	Message Authentication Functions, Security of MACs, MACs Based on Hash Functions: HMAC	1	3	1,2
UNIT 4	Authentication	10		
	Digital Signature: Digital Signatures, Elgamal Digital Signature Scheme	1	4	1
	Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm	1	4	1
	RSA-PSS Digital Signature Algorithm	1	4	1
	Overview of Authentication Systems: Password-Based Authentication, Address-Based Authentication, Cryptographic Authentication Protocols	1	4	1
	KDCs, Certification Authorities (CAs), Session Key Establishment	1	4	1
	Security Handshake Pitfalls: Login, Mutual Authentication, Integrity/Encryption for Data	1	4	1
	Two-Way Public Key Based Authentication, One-Way Public Key Based Authentication	1	4	1
	Mediated Authentication (with KDC), Needham-Schroeder, Expanded Needham-Schroeder	1	4	1
	Otway-Rees, Nonce Types. Strong Password Protocols: Lamport's Hash,	1	4	2

	Strong Password Protocols, Strong Password Credentials Download Protocols	1	4	2
UNIT 5	Internet Security	12		
	IPSec: Overview of IP Security (IPSec), IP Security Architecture, Modes of Operation	1	5	1
	Security Associations (SA), Authentication Header (AH), Encapsulating Security Payload (ESP)	1	5	1
	Comparison of Encodings	1	5	1
	Comparison of Encodings, Phase 1 IKE - Aggressive Mode and Main Mode	1	5	1
	Phase 2/Quick Mode, Traffic Selectors, The IKE Phase 1 Protocols	1	5	1
	Phase-2 IKE: Setting up IPsec SAs, ISAKMP/IKE Encoding	1	5	1
	Fixed Header, Payload Portion of ISAKMP Messages, SA Payload, SA Payload Fields	1	5	1
	Web Security Requirements: Web Security threats	1	5	1
	Web traffic Security Approaches. SSL/TLS: Secure Socket Layer (SSL)	1	5	1
	Transport Layer Security (TLS), TLS Architecture, TLS record protocol	1	5	1
	change cipher spec protocol, Alert Protocol, Handshake Protocol, Https, SSH. Secure Electronic Transaction (SET): SET functionalities	1	5	1
	Dual Signature, Roles & Operations, Purchase Request Generation, Purchase Request Validation, Payment Authorization and Payment Capture.	1	3	2
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember Understand	70%	60%	50%	40%	30%
Level 2	Apply Analyse	30%	40%	50%	60%	70%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Perlman, R., Kaufman, C., & Speciner, M. (2016). Network security: private communication in a public world. Pearson Education India.
2. Stallings, W. (1995). Network and internetwork security: principles and practice. Prentice-Hall, Inc.

Other Resources

1. Menezes, B. (2010). Network security and cryptography: Cengage Learning. Chapter, 14, 18-19. Krawetz, N. (2007). Introduction to network security. Charles River Media.
2. Kahate A., Cryptography and Network Security. (2015) Mc Graw Hill, 3rd Edition.

Course Designers

Machine Learning on Edge Computing

					L	T	P	C
Course Code	CSE 442	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)	CSE 311	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate architectural models and design issues in edge computing.	2	70%	65%
Outcome 2	Apply various Edge + IoT communication paradigms for AI/ML applications.	3	70%	65%
Outcome 3	Identify and mitigate resource management and optimization challenges for training of ML models.	3	70%	65%
Outcome 4	Develop efficient ML models for deployment at the IoT-Edge platforms.	3	70%	65%
Outcome 5	Demonstrate case studies and ML simulation frameworks for different real-worldapplications.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							3	3	1	2
Outcome 2	3	3	3	2	2	1			3			2	3	2	2
Outcome 3	3	3	3	2	2				3			3	3	2	2
Outcome 4	3	3	3	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	2	2	1			2			2	3	2	2
Average	**3**	**3**	**3**	**2**	**2**	**1**			**3**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	8		
	Introduction to Computing, Internet of Things (IoT)	1	1	1
	Cloud Computing and its limitations to support low latency use cases.	1	1	1
	Edge Computing and its Ecosystem	2	1	1
	Edge Computing Architecture, Edge ML	2	1	1
	Applications of AI in Edge Computing	2	1	
UNIT 2	Exploring the Landscape of Artificial Intelligence and Machine Learning	12		
	Supervised Learning	2	2	1,2
	Unsupervised Learning	1	2	1,2
	Limited Supervised Learning and Reinforcement Learning,	2	2	1,3
	Regression Analysis	1	2	1,3
	Bayesian Networks	2	2	1,3
	Genetic Algorithms	2	2	1,3
	PSO	2	2	1,3
UNIT 3	Exploring Embedded AI at the Edge	11		
	Systems on a Chip (SoC) and their characteristics	1	3	1,4
	Exploring the Landscape of Embedded AI Devices	1	3	2,3
	Raspberry Pi, Intel Movidius Neural Compute Stick	1	3	1,5
	Google Coral USB Accelerator, NVIDIA Jetson Nano, FPGA + PYNQ	1	3	1,2
	Arduino, A Qualitative Comparison of Embedded AI Devices	1	3	1,3
	Google Colab Machine, GPU/TPUs	2	3	1,4
	IoT-Edge platforms such as Azure IoT hub	2	3	1,2
	IoT-Edge platforms such as AWS IoT platform	2	3	1,2
UNIT 4	Training and Inference of ML workloads in Edge Computing Environments	7		
	Hands-On with the Raspberry Pi	2	4	1,3
	Speeding Up with the Google Coral USB Accelerator	1	4	1,2
	Port to NVIDIA Jetson Nano, Comparing the Performance of Edge Devices,	2	4	1,5
	Case Studies: JetBot, Squatting for Metro Tickets, Cucumber Sorter	2	4	1,3
UNIT 5	Advanced topics in Edge ML	7		
	Different use cases of Edge AI	1	5	1
	Predictive maintenance, image classification, self-driving cars	1	5	1
	Docker container and Kubernetes	2	5	1,2
	MQTT and Kafka for end-to-end IoT pipeline	1	5	1,3
	Federated Edge learning (FEEL)	1	5	1,4
	Challenges and opportunities in Edge ML, Future research directions.	1	5	1,2,3
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (50%)						
		CLA-1 (10%)	CLA-2 (10%)	Mid-1 (20%)	CLA-3 (10%)		Th	
Level 1	Remember	50%	40%	40%	40%		30%	
	Understand							
Level 2	Apply	50%	60%	60%	60%		70%	
	Analyse							
Level 3	Evaluate							
	Create							
Total		100%	100%	100%	100%		100%	

Recommended Resources

1. Buyya, R., & Srirama, S. N. (Eds.). (2019). Fog and edge computing: Principles and paradigms. Wiley.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
3. Pandey, R., Khatri, S. K., Singh, N. K., & Verma, P. (Eds.). (2022). Artificial intelligence and machine learning for EDGE computing. Academic Press.
4. Koul, A., Ganju, S., & Kasam, M. (2019). Practical deep learning for cloud, mobile, and edge: Real-world AI & computer-vision projects using Python, Keras & TensorFlow. O'Reilly Media.
5. Web resources as per the recommendation of the instructor

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Mobile and wireless security

						L	T	P	C
Course Code	CSE 443	**Course Category**	Technical Elective			3	0	0	3
Pre-Requisite Course(s)	CSE 315	**Co-Requisite Course(s)**		**Progressive Course(s)**					
Course Offering Department	CSE	**Professional / Licensing Standards**							

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the terminology and classification associated with various IEEE wireless technology standards.
2. Describe the major software and hardware components and subcomponents used to secure mobile wireless and ad-hoc networks.
3. Describe security issues in resource constraint wireless networks such as: Wireless sensor network and Internet of Things.
4. Understand prevention against security threats using various wireless security protocols and algorithms for different wireless networks.
5. Discuss security & privacy issues of Android Applications. Understand the Android Security Architecture.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Identify the security goals and adversarial models of wireless and mobile networks.	1	70 %	65%
Outcome 2	Illustrate security algorithms for mobile wireless and ad-hoc networks.	3	70 %	65%
Outcome 3	Analyse wireless security protocols and protection techniques with their limitations.	5	70 %	65%
Outcome 4	Design authentication, key management, secure localization, device pairing protocols for wireless networks	4	70 %	65%
Outcome 5	Discuss the security and privacy vulnerabilities of mobile application.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	3			1					3	2	1
Outcome 2	3	3	2	3	3			2					2	2	2
Outcome 3	3	3	3	3	3			2					2	2	2
Outcome 4	3	3	3	3	3			2					2	3	2
Outcome 5	3	3	3	3	3			3	2				2	2	2
Average	3	3	3	3	3			2	2				2	2	2

Course Unitization Plan

Unit no.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction to Mobile and Wireless Security	9		
	WLAN: IEEE 802.11 (a : n)	1	1	1
	WPAN: IEEE 802.15 (Bluetooth & Zigbee)	1	1	1
	WMAN: IEEE 802.16 (WiMAX)	1	1	1
	WMAN mobile: IEEE 802.20 (MBWA)	1	1,2	2
	IEEE 802.21 framework (MIH)	1	1,2	2
	WEP	1	1,2	2
	WEP Tools	1	1,2	2
	WEP Shortcomings	1	1,2	2
	IEEE 802.11i	1	1,2	2
UNIT 2	Next Generation Wireless Networks	9		
	Evolution of mobile networks	1	2	1,2
	Mobility with MIPv6	1	2	1,2
	Mobility with Mobile IPv4	1	2	1,2
	IP mobility with HIP and NetLMM	1	2	2
	Ad Hoc Networks	1	2	2
	Destination Sequenced Distance Vector (DSDV)	1	2,3	2
	Wireless Routing Protocol	1	2,3	1
	Ad Hoc On-demand Distance Vector	1	2,3	1
	Key Management in Ad Hoc Networks	1	2,3	1
UNIT 3	Wireless Sensor Network Security	9		
	Attacks on Wireless Sensor Networks and Countermeasures	1	3	1,2
	Prevention by Authentication and Traffic Protection	1	3	1,2
	Secure Network Encryption Protocol	1	3	1,2
	μTESLA Protocol	1	3	1
	Tinysec Protocol	1	3	1
	Centralized and Passive Intruder Detection	1	3	1
	Decentralized Intrusion Detection	1	3	1
	Intrusion Tolerance with Multiple Routes	1	3	1
	Key Management in WSN	1	3	1
UNIT 4	Preventing Malicious Behaviour	9		
	Naming and addressing	1	3,4	2
	Establishing Security Association: Key Establishment in Sensor Network	1	3,4	2
	Establishing Security Association: Utilizing Mobility	1	3,4	2
	Exploiting the properties of Vicinity and of the radio link	1	3,4	2
	Wormhole Detection: Centralized	1	3,4	2
	Wormhole Detection: Decentralized	1	3,4	2
	Privacy in RFID System	1	3,4	2
	Location Privacy in Vehicular Network	1	3,4	2
	Privacy Preserving Routing in Ad-hoc Networks	1	3,4	2
UNIT 5	Mobile Application Security	9		
	Brief Introduction to Android - I	1	5	3
	Brief Introduction to Android - II	1	5	3
	Android Security Model	1	5	3
	Permission	1	5	3
	Package Management	1	5	3
	User Management	1	5	3
	Cryptographic Providers	1	5	3
	Network Security and PKI	1	5	3
	Credential Storage	1	5	3
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (15%)**	
		Th	**Th**	**Th**	**Th**	**Th**
Level 1	Remember	70%	60%	50%	40%	30%
	Understand					
Level 2	Apply	30%	40%	40%	50%	50%
	Analyse					
Level 3	Evaluate			10%	10%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Boudriga, N. (2010). Security of mobile communications. Springer.
2. Buttyán, L., & Hubaux, J.-P. (2008). Security and cooperation in wireless networks. Cambridge University Press.
3. Elenkov, N. (2014). Android security internals: An in-depth guide to Android's security architecture (1st ed.). No Starch Press

Other Resources

1. Kempf, J. (2008). Wireless Internet security: Architectures and protocols. Cambridge University Press.
2. Doherty, J. (2021). Wireless and mobile device security (2nd ed.). Elsevier

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Internet protocols and networking

					L	T	P	C
Course Code	CSE 444	**Course Category**	Technical Elective		3	0	0	3
Pre-Requisite Course(s)	CSE 301	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To learn architecture, design principles and techniques for internetworking of computer networks.
2. To gain in-depth knowledge on analysing, design, implement, monitor, and test the internetworking systems.
3. To understand the networking algorithms (specifically network, Transport) in the network simulator or through programming languages.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Define about basic network principles	1	70%	65%
Outcome 2	Identify network layer architecture(framework) along with its functionalities for network protocol design.	1	70%	65%
Outcome 3	Discuss internetworking protocols for wired and wireless networking.	2	70%	65%
Outcome 4	Discuss the performance of heterogeneous networks with respect to transport layer protocols	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	1	1									1	2	3
Outcome 2	2	3	3	3	1							1	3	2	3
Outcome 3	2	3	3	3	1							1	3	2	3
Outcome 4	1	3	2	2	2							1	3	2	3
Average	2	3	3	3	1							1	3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Internetworking models	10		
	Introduction- Networking models.	1	1	1
	Introduction about TCP/IP protocol suite	1	1,2	1
	Overview of Connecting devices	1	1	1
	Overview of Switches(Layer-2)	2	1	1
	Overview of Routers (Layer-3)	2	1	1,2
	Spanning tree for discovering the path in LAN Networks	1	1	1,2
	Introduction to Gateways	1	1,2	1
	Overview of Backbone networks:	1	1	1
	In detail explanation about LAN, MAN and WAN networks	1	1	1
UNIT 2	Principles of Internetworking	11		
	Overview of connection oriented and Connectionless services : Classless and Classful Addressing	1	2	1,2
	Internet Architecture: Overview of IPv4 and IPv6 addressing	2	2,3	1
	Overview of Transport Layer Services	2	2,3	1
	Overview of UDP and TCP protocols	2	2,3	1
	Introduction to flow control and Error control in Transport layer	1	2,3	1
	Flow control mechanisms in Transport layer	1	1,2	1,2
	Error control and Congestion Control in Transport layer	2	1,2,3	1.2
UNIT 3	Traffic management in networking	13		
	Overview of data traffic and different traffic flows	2	3	1
	Different types of congestion control mechanisms	1	3	1
	Congestion control in TCP	2	3	1,2
	Network assisted congestion control	2	3	1
	Introduction to Quality of Service	1	3	1
	Techniques to improve QoS service	1	3,4	1.2
	Introduction to Deterministic traffic flows	2	3,4	1
	Overview of Integrated services and Differentiated services: RSVP protocol	2	3	1,2
UNIT 4	Buffer Management	11		
	Overview of Buffer management	2	4	1
	Operation of Drop tail, Drop front and Random drop	2	4	1
	Introduction to Passive buffer management schemes	2	4	1
	Introduction to Active Queue management	1	3,4	1
	Overview of different Queue management mechanisms	1	1,4	1,2
	Overview and operation of Early Random Drop	1	4	1,2
	Overview and operation of Random Early Detection	1	3,4	1,2
	Implementation of RED algorithm in congestion control	1	3,4	1
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%) Theory (50%)				End Semester Exam (50%)	
		CLA-1 (10%)	Mid-1 (15%)	CLA 2 (10%)	CLA-3 (15%)	Th	Prac
Level 1	Remember Understand	50%	40%	40%	40%	30%	
Level 2	Apply Analyse	50%	60%	60%	60%	70%	
Level 3	Evaluate Create						
Total		100%	100%	100%	100%	100%	

Recommended Resources

1. Comer, D. E., & Stevens, D. L. (2000). Internetworking with TCP/IP, Vol. 3: Client-Server Programming and Applications, Linux/Posix Sockets Version. Prentice Hall PTR.
2. Forouzan, B. A. (2002). TCP/IP protocol suite. McGraw-Hill Higher Education

Other Resources

1. Forouzan, B. A. (2007). Data communications and networking. Huga Media.
2. Shay, W. A. (1998). Understanding data communications and networks. International Thomson Publishing.
3. Kurose, J. F. (2005). Computer networking: A top-down approach featuring the internet, 3/E. Pearson Education India.

Course Designers

Mobile application security testing

Course Code	CSE 445	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department		**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Students learn cryptography basics (concepts, algorithms, techniques, implementation, and evaluation) for mobile apps.
2. Students learn basic cryptography implementation for Android mobile security.
3. Deal with the various aspects arising in architecting secure complex systems, such as analysing and identifying system threats and vulnerabilities, and investigating operating systems security.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Understanding of Android and iOS ecosystems, exploring key components and security models, laying the groundwork for comprehensive mobile security assessments	2	70%	65%
Outcome 2	Apply mobile pentesting tools, enabling effective setup, session execution, and application attack surface analysis	3	70%	65%
Outcome 3	Obtain analytical skills to assess and counteract diverse mobile threats, including program security vulnerabilities and dynamic analyses for threat mitigation	4	70%	65%
Outcome 4	Obtain critical evaluation skills to address authentication, communication, and privacy vulnerabilities, proposing strategic enhancements for resilient mobile app security	4	70%	65%
Outcome 5	Analyze advanced mobile security measures, covering robust transport layer protection, countermeasures for client-side injection, secure authentication, and modern cryptographic practices.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	1	1								3	1	
Outcome 2	2	3	3	3	2								3	3	
Outcome 3	2	3	3	3	2								3	2	
Outcome 4	2	3	3	3	3								2	2	
Average	2	3	3	3	2								3	2	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Android Pentesting	9		
	Android Architecture: Linux Kernel	1	1	1
	Native User space, Dalvik VM	1	1	1
	Java Runtime Libraries	1	1	1
	Android Security -Developing and debugging on Android	1	1	1
	RSA, Review of Cryptography Basics	1	1	1
	Androids Securable IPC mechanisms	1	1	1
	Androids Security Model	1	1	1
	Android Permissions Review–Content Providers	1	1	1,2
	Mass storage - Android Security tools	1	1	1,2
UNIT 2	Android Security Assessment Tools	9		
	Introduction, and Setting up drozer	1	2	2,3
	Running a drozer session	1	2	2,3
	enumerating installed packages, Enumerating activities	1	2	2
	Enumerating activities	1	2	2
	Enumerating content providers	1	2	2,3
	Enumerating services	1	2	2,3
	Enumerating broadcast receivers	1	2	3
	determining application attack surfaces	1	2	3
	launching activities.	1	2	3
UNIT 3	IoSPentesting	9		
	IoS Architecture: Cocoa Touch	1	3	1,2
	Media, Core Services,	1	3	1,2
	Core OS, iOS Security Architecture, Secure Enclave,	1	3	1,2
	Boot ROM, Touch ID, Code Signing	1	3	1
	IoS Security- Introducing	1	3	2,3
	iOS Application Security, Basics of iOS	1	3	2,3
	application development, developing your first iOS app,	1	3	1
	Running apps on iDevice, iOS MVC design,	1	3	2,3
	iOS security model, iOS secure boot chain, iOS application signing	1	3	1,2
UNIT 4	Mobile Malware and App Security	9		
	Program Security: Secure Programs	1	4	1,2
	Non-malicious Program Errors	1	4	1
	Viruses, and Other Malicious Code,	1	4	3,4
	Targeted Malicious Code, and Controls against Program Threats	1	4	2,3,4
	Software vulnerabilities: Buffer and stack overflow,	1	4	1,2
	Cross-site scripting (XSS), and vulnerabilities,	1	4	1,2
	SQL injection and vulnerabilities,	1	4	2,3
	Phishing, Privacy Issues.	1	4	2,3
	Static Analysis, Dynamic Analysis	1	4	1,2,3
UNIT 5	Mobile Risks	9		
	Introduction	1	5	1,2
	Insecure Authentication/Authorization,	1	5	1
	Insecure Communication, Improper Session Handling,	1	5	1,2
	Inadequate Privacy Controls,	1	5	3
	Improper Credential Usage, Insufficient Transport layer protection,	1	5	3
	Client Side Injection, security Misconfiguration	1	5	2,3
	security Misconfiguration, Insufficient Cryptography,	1	5	1,4
	Insecure Data Storage,	1	5	1,2
	Insufficient Binary Protections	1	5	2,3,4
Total Contact Hours		**45 Hours**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (15%)**	
Level 1	Remember Understand	70%	60%	30%	30%	60%
Level 2	Apply Analyse	30%	40%	70%	70%	40%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Elenkov, N. (2014). Android security internals: An in-depth guide to Android's security architecture. No Starch Press. 2015 edition.
2. Dwivedi, H., Clark, C., & Thiel, D. V. (2010). Mobile application security (Vol. 275). New York: McGraw-Hill.
3. Makan, K., & Alexander-Bown, S. (2013). Android security cookbook. Packt Publishing Ltd.
4. Yermalkar, S. (2016). Learning iOS Penetration Testing. Packt Publishing Ltd

Other Resources

1. OWASP TOP 10 Mobile Risks-Research papers

Course Designers

IoT security

Course Code	CSE 446	**Course Category**	Technical Elective	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide an understanding the security requirements in IoT architecture and the significance of securing the Internet of Things.
2. To explore the cryptographic fundamentals essential for IoT, including encryption, digital signatures, and key management.
3. To gain knowledge about identity and access management solutions tailored for IoT, covering identity lifecycle and access control.
4. Master privacy preservation techniques for IoT, focusing on data dissemination, location privacy, and robust schemes.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Analyse and identify security concerns in IoT applications and propose suitable security measures.	2	70%	65%
Outcome 2	Implement cryptographic techniques for data protection in IoT systems.	3	70%	65%
Outcome 3	Possess the skills to design and implement identity and access management solutions for IoT devices and applications.	3	70%	65%
Outcome 4	Develop privacy preservation strategies for IoT scenarios, safeguarding sensitive information.	3	70%	65%
Outcome 5	Understand and evaluate cloud security solutions for IoT, enabling secure integration of IoT devices with cloud services.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	2												1	3	
Outcome 2	2	2	3	2	3							1	3	3	
Outcome 3	2	2	3	2	3							1	3	3	
Outcome 4	1	2	2	2	3							1	3	3	
Outcome 5	1	2	2	2	3							1	3	3	
Average	2	2	3	2	3							1	3	3	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction	9		
	Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications.	2	1	1
	Security Architecture on the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability,	3	1	1
	Attacks Specific to IoT. Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication/Authorization for Smart Devices	2	1	1
	Transport Encryption, Attack and Fault trees, The secure IoT system implementation lifecycle.	2	1	1
UNIT 2	CRYPTOGRAPHIC FUNDAMENTALS FOR IOT	8		
	Cryptographic primitives and its role in IoT	2	2	1,2
	Encryption and Decryption, Hashes, Digital Signatures, Random number generation	2	2	1,2
	Cipher suites, Key management fundamentals	2	2	1,3
	Cryptographic controlsbuilt into IoT messaging and communication protocols	1	2	1,3
	IoT Node Authentication	1	2	1,3
UNIT 3	IDENTITY & ACCESS MANAGEMENT SOLUTIONS F OR IOT	10		
	Identity lifecycle	2	3	1,3
	Authentication credentials	2	3	2,3
	IoT IAM infrastructure	2	3	1,2
	Authorization with Publish/Subscribe schemes	2	3	1,2
	Access control	2	3	1,3
UNIT 4	PRIVACY PRESERVATION FOR IOT	9		
	Privacy Preservation Data Dissemination	2	4	1,3
	Privacy Preservation for IoT Used in Smart Building	2	4	1,2
	Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles	2	4	1,3
	Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing	3	4	1,3
UNIT 5	CLOUD SECURITY FOR IOT	9		
	Cloud services and IoT	2	5	1
	Offerings related to IoT from cloud service providers, Cloud IoT security controls	3	5	1
	An enterprise IoT cloud security architecture	2	5	1,2
	New directions in cloud enabled IoT computing	2	5	1,3
	Total Contact Hours	**45**		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="3">Bloom's Level of Cognitive Task</th><th colspan="5">Continuous Learning Assessments (50%)</th><th colspan="2" rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th colspan="4">Theory (30%)</th><th rowspan="2">Practical (20%)</th></tr>
<tr><th>CLA-1 (5%)</th><th>Mid-1 (10%)</th><th>CLA-2 (5%)</th><th>CLA-3 (10%)</th><th>Th</th><th>Prac</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">50%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td><td rowspan="2">30%</td><td rowspan="2">40%</td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">50%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">50%</td><td rowspan="2">70%</td><td rowspan="2">60%</td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

Recommended Resources

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
3. Research Papers

Other Resources

Course Designers

Biometric Security

Course Code	CSE 447	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamentals of biometric technologies and distinguish them from traditional techniques.
2. Analyse the strengths and weaknesses of leading physiological biometrics like finger-scan, facial-scan, and iris-scan.
3. Evaluate the principles and components of behavioral biometrics such as signature-scan and keystroke scan.
4. Assess privacy risks in biometric systems, design privacy-sensitive solutions, and comprehend biometric standards.
5. Gain proficiency in image processing techniques, image enhancement, segmentation, and its application in fingerprint and iris biometrics

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate a comprehensive understanding of biometric fundamentals, technologies, and their applications in security systems	2	75 %	70%
Outcome 2	Evaluate the strengths and weaknesses of different biometric modalities, including physiological and behavioural biometrics	4	70 %	65%
Outcome 3	Privacy risks associated with biometric systems and design privacy-compliant solutions.	2	70 %	65%
Outcome 4	Develop proficiency in image processing techniques, enhancing their ability to process and analyse biometric data.	5	70 %	65%
Outcome 5	Implement fingerprint and iris biometric systems, including minutiae determination and iris recognition.	5	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	3			3					3	2	2
Outcome 2	2	2	3	3	3			3					2	2	2
Outcome 3	2	3	3	2	3			3					2	2	2
Outcome 4	3	3	3	3	3			3					2	3	3
Outcome 5	2	3	3	3	3			3					2	3	2
Average	2	3	3	3	3			3					2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	Introduction: Biometric Fundamentals and Physiological Biometrics	11	1	1,2
	Biometric fundamentals – Biometric technologies, Biometrics Vs traditional techniques, Characteristics of a good biometric system	2	1	1,2
	Benefits of biometrics, Key biometric processes: verification, identification and biometric matching	1	1	1,2,3
	Performance measures in biometric systems, FAR, FRR, FTE rate, EER and ATV rate, Applications of Biometric Systems, Security and Privacy Issues.	2	1	1,2
	Physiological Biometrics: Leading technologies: Finger-scan, Facial-scan, Iris-scan, Voice-scan, components, working principles,	2	1	1,2,3
	Competing technologies, strengths and weaknesses	1	1,2	1,2,3
	Other physiological biometrics: Hand-scan, Retina-scan –components, working principles, competing technologies, strengths and weaknesses	2	1	1,2
	Automated fingerprint identification systems	1	1	1,2
UNIT II	Behavioural Biometrics and Privacy and Standards in Biometrics	6		
	Leading technologies: Signature-scan, Keystroke scan, components, working principles, strengths and weaknesses.	2	1,2	1,2
	Assessing the Privacy Risks of Biometrics	2	3	1,2
	Designing Privacy Sympathetic Biometric System	1	3	1,2
	Need for standards – different biometric standards.	1	3	1,2
UNIT III	Fundamentals of Image Processing	12		
	Digital Image representation, grayscale image, colour image: RGB, YCbCr, Binary Image	2	4	1,2
	Fundamental steps in Image Processing Image Enhancement: The Spatial Domain Methods,	2	4	1,2
	Image Enhancement: The Frequency Domain Methods	2	4	1,2
	Image Segmentation: Pixel Classification by Thresholding, Histogram Techniques	2	4	1,2
	Smoothing and Thresholding	1	4	1,2
	Gradient Based Segmentation: Gradient Image, Boundary Tracking	2	4	1,2
	Laplacian Edge Detection	1	4	1,2
UNIT IV	Fingerprint Biometrics	9		
	Fingerprint Patterns, Fingerprint Features	2	4	1,2
	Fingerprint Image, width between two ridges	2	4	1,2
	Fingerprint Image Processing	2	4	1,2
	Minutiae Determination	1	4,5	1,2, 3
	Fingerprint Matching: Fingerprint Classification, Matching policies.	2	4,5	1,2, 3
UNIT V	Iris Biometrics	7		
	Iris System Architecture, Definitions and Notations	1	4,5	1,2,3
	Iris Recognition: Iris location, Doubly Dimensionless Projection, Iris code, Comparison	2	5	1,2
	Coordinate System: Head Tilting Problem, Basic Eye Model	2	5	1,2
	Searching Algorithm	1	5	1,2
	Texture Energy Feature	1	4,5	1,2
Total Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (25%)	
Level 1	Remember	70%	50%	70%	10%	50%
	Understand					
Level 2	Apply	30%	50%	30%	60%	50%
	Analyse					
Level 3	Evaluate				30%	
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Anil K Jain, Patrick Flynn, Arun A Ross, (2008) "Handbook of Biometrics", Springer.
2. Anil K Jain, Arun A Ross, Karthik Nandakumar, (2011) "Introduction to Biometrics", Springer.
3. Samir Nanavati, Michael Thieme, Raj Nanavati, (2003). "Biometrics – Identity Verification in a Networked World", Wiley-dreamtech India Pvt Ltd, New Delhi

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Cyber Law

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">CSE 448</td><td rowspan="2">Course Category</td><td rowspan="2" colspan="2">Technical Elective</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-Requisite Course(s)</td><td></td><td>Co-Requisite Course(s)</td><td></td><td>Progressive Course(s)</td><td colspan="4"></td></tr>
<tr><td>Course Offering Department</td><td>CSE</td><td>Professional / Licensing Standards</td><td colspan="6"></td></tr>
</table>

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the historical development and significance of Intellectual Property Law and its role in the digital age.
2. Demonstrate knowledge of the trademark registration process, maintenance, and international trademark laws.
3. Comprehend the principles of copyright law, including ownership, duration, and international copyright issues.
4. Analyze the concept of Trade Secrets, their protection, and legal implications, including breach of contract and unfair competition.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply Intellectual Property Law principles to real-world scenarios effectively.	2	70%	65%
Outcome 2	Navigate trademark registration processes and handle trademark-related legal issues competently.	3	70%	65%
Outcome 3	Interpret copyright laws and address copyright-related disputes and challenges.	3	70%	65%
Outcome 4	Comprehend and engage with patent law, including patent searches and international aspects.	3	70%	65%
Outcome 5	Assess and safeguard trade secrets while understanding the legal consequences of breaches and unfair competition.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2												1	3	
Outcome 2	2	2	3	2	3							1	3	3	
Outcome 3	2	2	3	2	3							1	2	3	
Outcome 4	1	2	3	2	3							1	3	3	
Outcome 5	1	2	2	2	3							1	3	3	
Average	2	2	3	2	3							1	3	3	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT 1	Introduction to Intellectual Property Law	7		
	The Evolutionary Past, The IPR Tool Kit – Para	1	1	1
	Legal Tasks in Intellectual Property Law	2	1	1
	Ethical obligations in Para Legal Tasks in Intellectual Property Law	1	1	1
	Introduction to Cyber Law	1	1	1, 3
	Innovations and Inventions Trade related Intellectual Property Right.	2	1	
UNIT 2	Introduction to Trade Mark	8		
	Trade mark Registration Process	1	2	1,2
	Post registration Procedures	1	2	1,2
	Trade mark maintenance, Transfer of Rights, Inter partes Proceeding	1	2	1,3
	Infringement, Dilution Ownership of Trade mark	1	2	1,3
	Likelihood of confusion, Trademarks claims	2	2	1,3
	Trademarks Litigations, International Trade mark Law	2	2	1,3
UNIT 3	Introduction to Copyrights	11		
	Principles of Copyright Principles	1	3	1,4
	The subjects Matter of Copy right	1	3	2,3
	The Rights Afforded by Copyright Law	1	3	1,5
	Copy right Ownership, Transfer and duration	1	3	1,2
	Right to prepare Derivative works	1	3	1,3
	Rights of Distribution	1	3	1,4
	Rights of Perform the work Publicity Copyright Formalities and Registrations, Limitations	2	3	1,2
	Copyright disputes and International Copyright Law	2	3	1,2
	Semiconductor Chip Protection Act	1	3	1,3,4
UNIT 4	The Law of Patents	6		
	Patent searches	1	4	1,3
	Patent ownership and transfer	2	4	1,2
	Patent infringement	1	4	1,5
	International Patent Law.	2	4	1,3, 5
UNIT 5	Introduction to Trade Secret	13		
	Maintaining Trade Secret	2	5	1
	Physical Security	1	5	1
	Employee Limitation Employee confidentiality agreement	2	5	1,2
	Trade Secret Law	1	5	1,3, 5
	Unfair Competition	2	5	1,4, 5
	Trade Secret Litigation	2	5	1,2,3
	Breach of Contract	1	5	1,2,3
	Applying State Law	2	5	1,2,3
	Total Contact Hours required	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)
		Theory (50%)				Practical	
		CLA-1 (10%)	CLA-2 (10%)	CLA-3 (5%)	Mid-1 (25%)		Theory
Level 1	Remember	50%	40%	40%	50%	--	30%
	Understand						
Level 2	Apply	50%	60%	60%	60%	--	70%
	Analyse						
Level 3	Evaluate						
	Create						
Total		100%	100%	100%	100%	--	100%

Recommended Resources

1. Bouchoux, D. E. (2013). Intellectual property: The law of trademarks, copyrights, patents, and trade secrets. Delmar, Cengage Learning.
2. M.Ashok Kumar and Mohd.Iqbal Ali. (2004) "Intellectual Property Right" Serials Pub.
3. Ferrera, G. R., August, Lichtenstein, S., & Reder, M. (2000). Cyberlaw: Text and cases. South-Western Thomson Learning.
4. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company.
5. Martin, J. and Turner C. "Intellectual Property" CRC Press.

Other Resources

Course Designers

Ethical Hacking

Course Code	CSE 449	**Course Category**	Technical Elective		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand key issues in information security, incident management, and penetration testing.
2. Learn various foot printing techniques, tools, and competitive intelligence gathering methods, along with countermeasures.
3. Explore network scanning and enumeration techniques and their respective countermeasures.
4. Gain expertise in malware analysis, web application attacks, and penetration testing, including SQL injection detection and testing methodologies.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Analyze and address security vulnerabilities in information systems effectively.	2	70%	65%
Outcome 2	Conduct ethical hacking assessments and penetration tests with proficiency.	3	70%	65%
Outcome 3	Develop countermeasures against various cyber threats, including foot printing and malware attacks.	3	70%	65%
Outcome 4	Demonstrate expertise in Windows OS security and system hacking techniques.	3	70%	65%
Outcome 5	Apply ethical hacking knowledge to enhance web application security and prevent SQL injection vulnerabilities.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2												1	3	2
Outcome 2	2	2	3	2	3							1	3	3	2
Outcome 3	1	2	2	2	3							1	3	3	2
Outcome 4	1	2	3	2	3							1	3	3	2
Outcome 5	2	2	2	2	3							1	3	3	2
Average	**2**	**2**	**3**	**2**	**3**							**1**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction to Information Security and Incident Management	5		
	Key issues plaguing the information security world	2	1	1
	Incident management process	2	1	1
	Penetration testing	1	2	1,2
Unit 2	Foot printing and Competitive Intelligence Gathering	10		
	Various types of foot printing	2	3	1,3
	Foot printing tools	2	3	1,3
	Competitive intelligence gathering	2	3	1,3
	Countermeasures against foot printing	2	3	1,3
	Competitive intelligence gathering	2	3	1,3,5
Unit 3	Network Scanning and Enumeration	8		
	Network scanning techniques	2	2	1,4
	Scanning countermeasures	2	2	2,3
	Enumeration techniques	2	2	1,5
	Enumeration countermeasures	2	2	1,2
Unit 4	System Hacking and Windows OS Security	10		
	System hacking methodology	2	4	1,3,5
	Steganography and steganalysis attacks	2	4	1,2
	Covering tracks	2	4	1,5
	Windows OS security	2	4	1,3
	Hacking into systems by changing passwords and elevating privileges	2	4	1,2
Unit 5	Malware Analysis, Web Application Attacks, and Penetration Testing	12		
	Malware analysis procedure and countermeasures	2	5	1,5
	Web application attacks and hacking methodology	2	5	1,5
	SQL injection attacks and detection tools	2	2,5	1,2,3
	Penetration testing concepts	2	2, 5	1,2,4
	Penetration testing methodologies	2	2, 5	1,2,4
	Penetration testing roadmap	2	2, 5	1,2,4
	Total Contact Hours required	**45**		

Learning Assessment

<table>
<tr><th colspan="2" rowspan="3">Bloom's Level of Cognitive Task</th><th colspan="5">Continuous Learning Assessments (50%)</th><th colspan="2" rowspan="2">End Semester Exam (50%)</th></tr>
<tr><th colspan="4">Theory (50%)</th><th rowspan="2">Practical</th></tr>
<tr><th>CLA-1 (10%)</th><th>CLA-2 (10%)</th><th>CLA-3 (5%)</th><th>Mid - 1 (25%)</th><th>Th</th><th>Prac</th></tr>
<tr><td rowspan="2">Level 1</td><td>Remember</td><td rowspan="2">50%</td><td rowspan="2">40%</td><td rowspan="2">40%</td><td rowspan="2">50%</td><td rowspan="2">--</td><td rowspan="2">30%</td><td rowspan="2"></td></tr>
<tr><td>Understand</td></tr>
<tr><td rowspan="2">Level 2</td><td>Apply</td><td rowspan="2">50%</td><td rowspan="2">60%</td><td rowspan="2">60%</td><td rowspan="2">50%</td><td rowspan="2">--</td><td rowspan="2">70%</td><td rowspan="2"></td></tr>
<tr><td>Analyse</td></tr>
<tr><td rowspan="2">Level 3</td><td>Evaluate</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Create</td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>--</td><td>100%</td><td></td></tr>
</table>

Recommended Resources

1. Dafydd, S. & Marcus, P. (2011) The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws.
2. David, K., Jim, O., Devon, K., & Mati, A. (2011) Metasploit: The Penetration Tester's Guide.
3. Stuart, Mc., Joel, S., & George, K. (2009) Hacking Exposed: Network Security Secrets and Solutions.
4. Patri, E. (2013) The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy
5. Michael, S., & Andrew, H. (2012) Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Security audit and Risk Assessment

Course Code	CSE 450	**Course Category**	Technical Elective	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand information security performance metrics, common issues, and audit methodologies.
2. Learn pre-audit preparations, vulnerability analysis, and post-audit actions, including report writing and result analysis.
3. Explore vulnerabilities, threats, and vulnerability management techniques, including scanning and remediation.
4. Master vulnerability assessments, risk assessment, and management, including risk treatment and feedback loops.
5. Gain insights into configuration management, policy development, and testing for secure environments.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Analyse and report on information security performance metrics and variances effectively	1	70 %	65%
Outcome 2	Conduct thorough information security audits, including vulnerability analysis and result interpretation	3	70 %	65%
Outcome 3	Manage vulnerabilities, conduct threat assessments, and implement remediation strategies	5	70 %	65%
Outcome 4	Perform comprehensive information security risk assessments and managing residual risks.	4	70 %	65%
Outcome 5	Demonstrate competence in configuring and managing secure environments through effective configuration reviews and policy development.	2	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	3			1					3	2	1
Outcome 2	3	3	2	3	3			2					2	2	2
Outcome 3	3	3	3	3	3			2					2	2	2
Outcome 4	3	3	3	3	3			2					2	3	2
Outcome 5	3	3	3	3	3			3	2				2	2	2
Average	3	3	3	3	3			2	2				2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Information Security Performance Metrics and Audit	9		
1	Introduction to Security Metrics and Reporting	1	1	1
2	Common Issues and Variances of Performance Metrics	1	1	1
3	Introduction to Security Audit	1	1	1
4	Servers and Storage Devices Security	1	1	1
5	Infrastructure and Network Security	1	1	1
6	Communication Routes and Information Flow	1	1	1
7	Information Security Methodologies (Black-box, White-box, Greybox)	1	1	1
8	Phases of Information Security Audit and Strategies	1	1	1
9	Ethics of an Information Security Auditor and NOS 9003	1	1	1
Unit 2	Information Security Audit Tasks, Reports and Post Auditing Actions	9		
10	Pre-Audit Checklist and Information Gathering	1	2	1
11	Vulnerability Analysis and Assessment	1	2	1
12	External Security Audit	1	2	1
13	Internal Network Security Audit	1	2	1
14	Firewall Security Audit	1	2	1
15	IDS Security Auditing	1	2	1
16	Social Engineering Security Auditing	1	2	1
17	Web Application Security Auditing	1	2	1
18	Information Security Audit Deliverables & Reporting	1	2	1
Unit 3	Vulnerability Management	9		
19	Introduction to Information Security Vulnerabilities	1	3	1,2
20	Human-based Social Engineering Techniques	1	3	1,2
21	Computer-based Social Engineering Strategies	1	3	1,2
22	Social Media Countermeasures and Defense	1	3	1,2
23	Vulnerability Management Fundamentals	1	3	1,2
24	Vulnerability Scanning Methods	1	3	1,2
25	Vulnerability Testing and Assessment	1	3	1,2
26	Threat Management and Mitigation	1	3	1,2
27	Remediation and Security Improvement Processes	1	3	1,2
Unit 4	Information Security Assessments	9		
28	Introduction to Vulnerability Assessment	1	4	1,2
29	Classification of Vulnerabilities	1	4	1,2
30	Types of Vulnerability Assessment	1	4	1,2
31	Vulnerability Assessment Phases	1	4	1,2
32	Vulnerability Analysis Stages	1	4	1,2
33	Characteristics of a Good Vulnerability Assessment Solution	1	4	1,2
34	Considerations in Vulnerability Assessment	1	4	1,2
35	Vulnerability Assessment Reports and Tools	1	4	1,2
36	Information Security Risk Assessment and Management	1	4	1,2
Unit 5	Configuration Reviews	9		
37	Introduction to Configuration Management	1	5	1,2
38	Configuration Management Requirements and Documentation	1	5	1,2
39	Developing a Configuration Management Plan	1	5	1,2
40	Configuration Control and Change Management	1	5	1,2
41	Creating Configuration Control Policies	1	5	1,2
42	Testing in Configuration Management	1	5	1,2
43	Configuration Audits and Compliance	1	5	1,2
44	Configuration Management Tools and Software	1	5	1,2
45	Best Practices in Configuration Management	1	5	1,2
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember Understand	70%	60%	50%	40%	30%
Level 2	Apply Analyse	30%	40%	40%	50%	50%
Level 3	Evaluate Create	-	-	10%	10%	20%
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Vladimirov, A. A., & Gavrilenko, K. V. (2010). Assessing information security: strategies, tactics, logic and framework. IT Governance Ltd.
2. Szor, P. (2005). The art of computer virus research and defense. Pearson Education.

Other Resources

1. https://www.sans.org/readingroom/whitepapers/threats/implementing-vulnerability-management-process-34180.
2. http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf.

Course Designers

Digital Forensics and Incident Response

Course Code	CSE 451	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamentals of incident response, cybersecurity forensics principles, and their relevance to cybersecurity operation.
2. Develop proficiency in preparation, including the formulation of policies, incident handling workflows, and the use of various incident response tools.
3. Gain expertise in the identification phase by mastering techniques for detection, triage, and incident classification, along with the use of indicators of compromise (IOCs).
4. Acquire the skills needed for effective containment, including damage limitation, system isolation, and forensic backup and imaging, while limiting malware spread.
5. Explore the digital forensics investigation process, including applicable laws, evidence collection, chain of custody, and the use of technical forensics tools and techniques, such as those for analysing hard disks, file systems, network devices, and mobile devices.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply incident response phases, policies, and procedures in real-world cybersecurity scenarios	3	75 %	70%
Outcome 2	Effectively identify and classify security incidents using indicators of compromise (IOCs) and triage techniques.	2	70 %	65%
Outcome 3	Demonstrate proficiency in containing and mitigating security incidents while limiting damage and malware spread.	4	70 %	65%
Outcome 4	Conduct digital forensics investigations in compliance with applicable laws and chain of custody requirements.	3	70 %	65%
Outcome 5	Utilize a range of technical forensics tools and techniques to analyze digital evidence and investigate cyberattacks.	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	3			3	3				3	2	2
Outcome 2	2	2	3	3	3			3	3				2	2	2
Outcome 3	2	3	3	2	3			3	3				2	3	2
Outcome 4	3	3	3	3	3			3	3				2	3	2
Outcome 5	2	3	3	3	3			3	3				2	3	2
Average	2	3	3	3	3			3	3				2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	Introduction	08		
	Definitions of incident response and forensic analysis, relation of incident response to the rest of cybersecurity operations	2	1	1,2
	Incident response phases - preparation, identification, containment, eradication, recovery,	2	1,2	1,2
	Incident response phases- follow-up, indicators of compromise (IOC)	1	1,2	1,2,3
	forensic analysis as an incident response tool and as support for cybercrime investigations	2	1,2	1,2,3
	cybersecurity forensics principles	1	1,2	3,7
UNIT II	Preparation, Identification, Containment	12		
	Preparation: Policies and procedures, incident workflows, guidelines, incident handling forms, principles of malware analysis	2	3	3,7
	Preparation: log analysis, threat intelligence, vulnerability management, penetration testing	2	3	3,7
	Preparation: digital forensics, incident ticketing systems, incident documentation templates	2	2	3,7
	Identification: Detection, incident triage, information gathering and reporting, incident classification, indicators of compromise (IOC).	2	2	3,7
	Identification: incident classification, indicators of compromise (IOC).	1	2	3,7
	Containment: Damage limitation, network segment isolation, system isolation	1	2,3	3,7
	Containment forensic backup and imaging, use of write blockers, temporary fixes, malware spread limitation.	2	2,3	3,7
UNIT III	Eradication, Recovery, Follow-up	9		
	Eradication: Actual removal and restoration of affected systems, removal of attack artifacts, scanning of other systems to ensure complete eradication, use of IOCs on other systems and local networks,	2	3	4,5
	Eradication: cooperation with forensic analysis to understand the attack fully.	1	3	4,5
	Recovery: Test and validate systems before putting back into production, monitoring of system behaviour	2	3	4,5
	Recovery: ensuring that another incident will not be created by the recovery process.	1	3	4,5
	Follow-up: Documenting lessons learned	1	3	4,5
	Follow-up: preparatory activities for similar future incident, technical training, process improvement.	2	3	4,5
UNIT IV	Digital Forensics Investigation Process:	6		
	Applicable laws,	1	4	6,7
	investigation methodology,	1	4,5	6,7
	chain of custody, evidence collection, digital evidence principles	2	4	6,7
	rules and examination process, first responder procedures.	2	4	6,7
UNIT V	Technical forensics tools and techniques:	10		
	Hard disks, removable media and file systems,	1	4,5	5,6
	Windows forensics, duplication/imaging of forensic data,	2	4,5	4,5,6
	recovering deleted files and hidden or deleted partition	1	4,5	5,6
	steganography and image forensics	2	5	7
	log analysis, password crackers, network device forensics, packet capture analysis,	2	5	5,6
	email tracking, mobile forensics, investigation of attacks, common tools (Encase, FTK, etc.)	2	5	5,6
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (25%)	
Level 1	Remember Understand	70%	50%	70%	30%	50%
Level 2	Apply Analyse	30%	50%	30%	70%	50%
Level 3	Evaluate Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Jason, T. L., & Matthew, P. (2014) Incident Response & Computer Forensics, 3rd ed.
2. Murdoch, D. W., Murdoch, D. (2014) Blue Team Handbook: Incident Response Edition: A condensed field guide for the Cyber Security Incident Responder. Createspace Independent Publishing Platform
3. Johnson, L. (2013). Computer incident response and forensics team management: Conducting a successful incident response. Newnes.
4. Sammons, J. (2014). The basics of digital forensics: the primer for getting started in digital forensics. Syngress.
5. Carvey, H., & Altheide, C. (2011). Digital forensics with open source tools. Elsevier.
6. Watson, D. L., & Jones, A. (2013). Digital forensics processing and procedures: Meeting the requirements of ISO 17020, ISO 17025, ISO 27001 and best practice requirements. Newnes.
7. IEEE Journals and Magazines.

Other Resources

Course Designers

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Security Analytics

Course Code	CSE 452	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the fundamentals of information security and its relevance in modern data-driven environments
2. Explore deep packet inspection techniques for web security, including one-class multi-classifier systems and host intrusion detection.
3. Develop skills in automated correlation for constructing attack scenarios and gain insights into the challenges of privacy in security analytics.
4. Analyse security challenges and solutions for big data environments, including anomaly detection, anonymization, and encryption.
5. Examine the importance of privacy in big data and its legal aspects, covering topics such as GDPR or PDP compliance, digital identity protection, and defence against model poisoning attacks.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply data mining techniques for effective network intrusion detection and web security.	1	70 %	65%
Outcome 2	Understand and apply adversarial machine learning concepts to enhance security analytics	3	70 %	65%
Outcome 3	Implement security measures for big data, including anonymization and encryption.	5	70 %	65%
Outcome 4	Evaluate privacy preservations in big data, compliance data protection laws.	4	70 %	65%
Outcome 5	Develop the capability to defend against model poisoning attacks in machine learning for security applications.	3	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	3			1					3	2	1
Outcome 2	3	3	2	3	3			2					2	2	2
Outcome 3	3	3	3	3	3			2					2	2	2
Outcome 4	3	3	3	3	3			2					2	3	2
Outcome 5	3	3	3	3	3			3	2				2	2	2
Average	3	3	3	3	3			2	2				2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Information Security Performance Metrics and Audit	9		
1	Introduction to Information Security	1	1	1
2	Data Mining for Information Security Fundamentals	1	1	1
3	Signature-Based Network Intrusion Detection (e.g., Snort)	1	1	1
4	Data Mining-Based Network Intrusion Detection (Supervised)	1	1	1
5	Data Mining-Based Network Intrusion Detection (Unsupervised)	1	1	1
6	NIDS Overview and Significance	1	1	1
7	Hands-on with Snort: Signature-Based Detection	1	1	1
8	Building Supervised Data Mining Models for NIDS	1	1	1
9	Unsupervised Data Mining for Network Anomaly Detection	1	1	1
Unit 2	Information Security Audit Tasks, Reports and Post Auditing Actions	9		
10	Introduction to Deep Packet Inspection (DPI)	1	2	1
11	Alert Aggregation for Web Security	1	2	1
12	One-Class Multi-Classifier Systems for Packet Payload Modeling	1	2	1
13	Network Intrusion Detection with Multi-Classifiers	1	2	1
14	Host Intrusion Detection: Shell Command Sequence Analysis	1	2	1
15	Host Intrusion Detection: System Call Sequence Analysis	1	2	1
16	Host Intrusion Detection: Audit Trails Analysis	1	2	1
17	Insider Threats in Network Security	1	2	1
18	Strategies for Detecting Masqueraders, Impersonators, and Insider Threats	1	2	1
Unit 3	Vulnerability Management	9		
19	Introduction to Automated Correlation	1	3	1,2
20	Attack Trees: Understanding the Concept	1	3	1,2
21	Building Attack Scenarios from Individual Alerts	1	3	1,2
22	Privacy Issues in Security Analytics	1	3	1,2
23	Introduction to Adversarial Machine Learning	1	3	1,2
24	Overview of Multi-classifier Systems (MCS)	1	3	1,2
25	Advantages of MCS in Security Analytics	1	3	1,2
26	Security Implications of Machine Learning	1	3	1,2
27	Conclusion and Recap of Unit	1	3	1,2
Unit 4	Information Security Assessments	9		
28	Introduction to Anomaly Detection in Cloud Big Databases	1	4	1,2
29	Data Anonymization and Pseudonymization Techniques	1	4	1,2
30	Understanding Differential Privacy	1	4	1,2
31	Differential Privacy Methods and Algorithms	1	4	1,2
32	Homomorphic Encryption for Data Privacy	1	4	1,2
33	Secure Multiparty Computation (SMC) Fundamentals	1	4	1,2
34	Combining Privacy Techniques for Enhanced Security	1	4	1,2
35	Privacy Challenges in Cloud Big Databases	1	4	1,2
36	Anomaly Detection for Data Protection	1	4	1,2
Unit 5	Configuration Reviews	9		
37	Introduction to Anomaly Detection in Cloud Big Database Metrics	1	5	3
38	Anonymizing and Pseudonymizing Data for Privacy	1	5	3
39	Understanding Differential Privacy Principles	1	5	3
40	Methods of Implementing Differential Privacy	1	5	3
41	Exploring Homomorphic Encryption for Data Security	1	5	3
42	Secure Multiparty Computation Techniques	1	5	3
43	Data Protection Laws for Big Data and Their Implications	1	5	3
44	Compliance with Data Protection Regulations	1	5	3
45	Ensuring Data Privacy in Big Data: From Personal Data to Model Poisoning Attack Defense	1	5	3
	Total contact hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember Understand	70%	60%	50%	40%	30%
Level 2	Apply Analyse	30%	40%	40%	50%	50%
Level 3	Evaluate Create	-	-	10%	10%	20%
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Daniel, B., & SushilJajodia. (2002). Applications of Data Mining in Computer Security, Vol. 6. Springer Science & Business Media.
2. Marcus A. M. (2006). Machine Learning and Data Mining for Computer Security", Springer Science & Business Media.
3. Mark, T., Robert, McP., Miyamoto, I., & Jason, M. (2014). Information Security Analytics: Finding Security Insights, Patterns, and Anomalies in Big Data, Syngress Media, U.S.

Other Resources

1. Vemuri, V. R. (2005). Enhancing Computer Security with Smart Technology, Auerbach Publications.
2. William Stallings. (2010). Cryptography and Network security: Principles and Practices Pearson/PHI, 5th ed.
3. Douglas, R. S. (2006). Cryptography Theory and Practice. Chapman & Hall/CRC, 3rd ed.
4. Siddhartha Bhattacharyya (2017). Frontiers in Computational Intelligence. Vol. 3, De Gruyter.

Course Designers

Multiview Geometry

Course Code	CSE 453	**Course Category**	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the basic and advanced imaging technique
2. Explain the concepts of 3D modelling using single view to multi view
3. To gain knowledge over accessing and modification of 3D models in real-world scenario

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Understand Content creation editing and managing of camera model.	2	70%	65%
Outcome 2	Use and examine the inner content of the image for 3D modelling	3	70%	65%
Outcome 3	Use the architecture of 3D mesh, texture, point cloud and make them easy to handle.	3	70%	65%
Outcome 4	Implement systems using multiview and stereo camera system to solve user requirements.	6	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	**Problem Analysis**	**Design and Development**	**Analysis, Design and Research**	**Modern Tool and CT Usage**	**Society and Multicultural Skills**	**Environment and Sustainability**	**Moral, and Ethical Awareness**	**Individual and Teamwork Skills**	**Communication Skills**	**Project Management and Finance**	**Self-Directed and Life Long Learning**	**PSO 1**	**PSO 2**	**PSO 3**
Outcome 1	3	1	2	1	2							3	3	2	1
Outcome 2	3	2	1	2	2							3	3	2	2
Outcome 3	3	3	3	2	2							3	3	2	2
Outcome 4	3	3	3	2	3							3	3	3	2
Average	**3**	**2**	**2**	**2**	**2**							**3**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	UNIT I: Introduction	10		
	Multiple View Geometry	1	1	1
	Projective Geometry	1	1	1
	Transformations and Estimation	1	1	1
	Projective Geometry and Transformations of 3D, Estimation – 2D Projective Transformations	3	1	1
	Algorithm Evaluation and Error Analysis, Feature points (SIFT, SURF, etc)	4	1	1
Unit 2	Camera system	8		
	Camera Models	3	1,2	1
	Computation of the Camera Matrix	3	1,2,4	1
	More Single View Geometry,	2	1,2	1
Unit 3	Epipolar Geometry	9		
	Epipolar Geometry and the Fundamental Matrix	1	2	1
	3D Reconstruction of Cameras and Structure	1	2	1
	Computation of the Fundamental Matrix	1	2,4	1
	Structure Computation	3	2,4	1
	Scene planes and homographies	1	2,3	1
	Affine Epipolar Geometry	2	2	1
Unit 4	Multiple camera	7		
	Three-View Geometry/ multiview geometry	2	3	1
	The Trifocal Tensor	2	3	1
	Computation of the Trifocal Tensor	1	3	1
	Linearities and Multiple View Tensors	1	3	1
	Auto-Calibration	1	3	1
Unit 5	3D Model	11		
	Stereo Calibration	2	3,4	1
	Stereo Modelling	2	4	1
	3D modelling rectification	2	4	1
	Depth Estimation	1	4	1
	Stereo SFM	1	4	1
	3D model application like :planner form from 3D image, crack and fault detection, stereo camera-based 3D inspection	3	4	1
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (20%)		CLA-2 (10%)		Mid-2 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember Understand	40%		40%		40%		40%		10%	
Level 2	Apply Analyse	40%		40%		40%		40%		50%	
Level 3	Evaluate Create	20%		20%		20%		20%		40%	
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Hartley, R., & Zisserman, A. (2003). Multiple view geometry in computer vision. Cambridge university press.

Other Resources

1. Recent articles about multimedia (recommended at classes)

Course Designers

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Quantum Computation

Course Code	CSE 454	Course Category	Technical Elective		L	T	P	C
					3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	CSE	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

1. Expose students to quantum mechanics, linear algebra, and familiarity with the Dirac notation.
2. Develop students' professional skills to get one's quantum moorings right.
3. Demonstrate the concepts of quantum computation and quantum information.
4. Students develop an understanding of quantum entanglement, quantum algorithms, quantum channels.
5. Provide an authentic introduction to IBM quantum computer and associated simulators students develop an understanding of quantum entanglement, quantum algorithms, quantum channels.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Demonstrate an understanding of mathematical concepts, underlying quantum computing.	2	70%	65%
Outcome 2	Discuss an authentic introduction to IBM quantum computer and associated simulators	2	70%	65%
Outcome 3	Students illustrate to work with Quantum Information System and Quantum Mechanics.	3	70%	65%
Outcome 4	Students learn to analyse systems applying the concept of Quantum information.	4	70%	65%
Outcome 5	Students learn to develop a special algorithm suited for quantum Computing.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and CT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2								3	3	2
Outcome 2	2	3	3	3	3								2	2	2
Outcome 3	2	3	2	3	3								2	2	2
Outcome 4	2	3	3	3	3								2	2	2
Average	2	3	3	3	3								2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	Introduction	14		
	Elementary quantum mechanics	2	1	1,2
	linear algebra for quantum mechanics	3	1	1,2
	Quantum states in Hilbert space,	3	1	1,2
	The Bloch sphere, Density operators,	3	1	1,2
	generalized measurements, no-cloning theorem	3	1	1,2
Unit 2	Quantum correlations	7		
	Bell inequalities and entanglement,	2	2	1
	Schmidt decomposition,	3	2	1
	Super- dense coding, teleportation.	2	2	1,2
Unit 3	Quantum cryptography	5		
	Quantum key distribution	5	3	1,2
Unit 4	Quantum gates and algorithms	13		
	Universal set of gates,	3	4	1
	quantum circuits,	3	4	1,2
	Solovay-Kitaev theorem,	2	4	1,2
	Deutsch-Jozsa algorithm,	3	4	1
	Factoring	2	4	1
Unit 5	Programming a quantum computer	6		
	The IBMQ,	2	5	1,2
	Coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis.	4	5	1,2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	70%	60%	30%	30%	60%
	Understand					
Level 2	Apply	30%	40%	70%	70%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Parag, K. K. (2020). Quantum Computing: A Beginner's Introduction, McGraw Hill Publications.
2. Chris, B. (2020). Quantum Computing for Everyone, The MIT Press,Cambridge.

Other Resources

1. Nielsen, M. A. & Chuang, I. (2013). Quantum Computation and Quantum Information. Cambridge University Press.
2. Eleanor, G. R. & Wolfgang, H. P. (2014). Quantum Computing, A Gentle Introduction. MIT press

Course Designers