Department of Electronics and Communication Engineering

B.Tech. Electronics and Communication Engineering Curriculum and Syllabus

(Applicable to the students admitted during AY: 2022-23)

School of Engineering and Sciences

SRM University *AP*, Andhra Pradesh

Department Vision

To be a globally recognized leader in the field of Electronics and Communications, by fostering innovation through cutting-edge collaborative research to inform interdisciplinary education.

Department Mission

1. Create inclusive and highly motivated individuals and leaders who promote diversity, innovation, creativity, and a high sense of responsibility towards societal progress.
2. Strive for excellence by promoting interdisciplinary education and research through global collaborations.
3. Deliver state-of-the-art research-based education that equips students with the skills to address contemporary challenges and contribute to the field's advancement.
4. Foster a culture of innovation and entrepreneurship, by working closely with leading industry partners to translate ideas into real-life solutions.
5. Aim to be a global knowledge hub by collaborating with leading institutions and industries.

Program Educational Objectives (PEO)

1. Enable the undergraduate students to learn the fundamentals of Electronics and Communication Engineering deeply and lay a strong foundation for their professional careers or higher studies.
2. Impart the skills to design and develop solutions for complex electronics engineering problems in a multi-disciplinary environment.
3. Work in guided multi-disciplinary electronics and communication-related field research groups using technical know-how, common tools and environments to achieve project objectives.
4. Facilitate the development of effective communication skills, lifelong learning, leadership qualities and ethical professional conduct across their higher education and career paths.

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

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

Program Specific Outcomes (PSO)

1. Architect modern communication systems to meet stated requirements.
2. Design, build and test electronic systems for given specifications.
3. Analyse, plan and apply the acquired knowledge in basic sciences, mathematics and Electronics and Communication Engineering to solve complex problems with technical, economic, environmental, and social contexts.

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

Program Learning Outcomes (PLO)															
PEOs	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	2	1	1	2	-	-	1	2	1	-	2	1	1	1
PEO 2	2	3	3	3	3	-	2	2	2	2	2	3	3	3	3
PEO 3	3	3	3	3	3	1	2	3	3	3	3	2	3	2	2
PEO 4	2	2	2	2	-	2	2	3	3	3	1	3	1	1	3

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		5	150
University AEC	3		
School AEC	2		
Value Added Courses (VAC)		4	120
University VAC	4		
School VAC	0		
Skill Enhancement Courses (SEC)		17	510
School SEC	6		
Department SEC	5		
SEC Elective	6		
Foundation / Interdisciplinary courses (FIC)		31	930
School FIC	31		
Department FIC	0		
Core + Core Elective including Specialization (CC)		80	2400
Core	65		
Core Elective (Inc Specialization)	15		
Minor (MC) + Open Elective (OE)	15	15	450
Research / Design / Internship/ Project (RDIP)		17	510
Internship / Design Project / Startup / NGO	5		
Internship / Research / Thesis	12		
Total		**169**	**5070**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	3	0	2	0	0	0	0	0	5	3
Value Added Courses - VAC	0	0	0	0	0	4	0	0	4	2
Skill Enhancement Courses - SEC	3	3	3	2	3	3	0	0	17	10
Foundation / Interdisciplinary Courses - FIC	12	16	3	0	0	0	0	0	31	18
CC / SE / CE / TE / DE / HSS	0	6	15	19	18	13	9	0	80	47
Minor / Open Elective - OE	0	0	3	3	3	3	3	0	15	9
(Research / Design / Industrial Practice / Project / Thesis / Internship) - RDIP	0	0	0	0	0	3	2	12	17	10
Grand Total	**18**	**25**	**26**	**24**	**24**	**26**	**14**	**12**	**169**	**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	EGL 101	Communicative English	3	0	0	3
2	FIC	S FIC	PHY 101/ CHE 103	Engineering Physics/ Chemistry for Engineers	2	0	0	2
3	FIC	S FIC	PHY 101 L/ CHE 103 L	Engineering Physics Lab/ Chemistry for Engineers Lab	0	0	1	1
4	FIC	S FIC	CSE 108	Introduction to Computer Science and Programming Using C	3	0	0	3
5	FIC	S FIC	CSE 108 L	Introduction to Computer Science and Programming Using C Lab	0	0	1	1
6	FIC	S FIC	MAT 113	Calculus	3	0	0	3
7	SEC	S SEC	ISES 101	Industry Specific Employability Skills – I	0	0	1	1
8	Core	S FIC	BIO 103	Introductory Biology for Engineers	2	0	0	2
9	SEC	S SEC	ENTR 100	Exploratory Learning and Discovery	0	0	1	1
10	SEC	S SEC	IRH 101	Orientation on Internationalization	1	0	0	1
				Semester Total	**14**	**0**	**4**	**18**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	FIC	S FIC	MAT 211	Linear Algebra	3	0	0	3
2	SEC	S FIC	ISES 102	Industry Specific Employability Skills-II	0	0	1	1
3	Core	S FIC	CSE 107	Data Structures	3	0	0	3
4	Core	S FIC	CSE 107L	Data Structures Lab	0	0	1	1
5	Core	S FIC	EEE 103	Basic Electrical and Electronics	3	0	0	3
6	Core	S FIC	EEE 103L	Basic Electrical and Electronics Lab	0	0	1	1
7	Core	S FIC	ENV 111	Environmental Science	2	0	0	2
8	Core	S FIC	CHE 103/ PHY 101	Principles of chemistry / Engineering Physics	2	0	0	2
9	Core	S FIC	CHE 103L/ PHY 101L	Principles of chemistry Lab / Engineering Physics Lab	0	0	1	1
10	Core	CC	ECE 119	Electronic Workshop (Introduction to Arduino, Raspberry PI and PCB design)	1	0	1	2
11	Core	S SEC	CSE 131	Industry Standard Coding Practice-I	0	0	2	2
12	Core	CC	EEE 113	Network Analysis	3	1	0	4
				Semester Total	**17**	**1**	**7**	**25**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 105	Analytical Skills for Engineers	1	0	1	2
2	FIC	S FIC	FIC 106	Differential Equations	3	0	0	3
3	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2*
4	VAC	U VAC	VAC 104	Community Service and Social Responsibility	2	0	0	2*
5	SEC	D SEC	ECE 201	Hands on with Python	2	0	1	3
6	Core	CC	ECE 202	Digital Design with HDL	3	0	1	4
7	Core	CC	ECE 203	Signals and Systems	3	0	1	4
8	Core	CC	ECE 204	Probability and Random Processes	3	0	0	3
9	Core	CC	ECE 205	Microelectronic Devices and Circuits	3	0	1	4
10	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**23**	**0**	**7**	**26**

SEMESTER - IV								
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	2	0	0	2*
3	SEC	D SEC	ECE 211	FPGA Design for Embedded Systems	2	0	0	2
4	Core	CC	ECE 206	Design and Analysis of Analog, Mixed Signal Circuits	3	0	1	4
5	Core	CC	ECE 207	Principles of Modern Communication Systems	3	0	1	4
6	Core	CC	ECE 208	Digital Signal Processing	3	0	1	4
7	Core	CC	ECE 209	Control Systems	2	1	0	3
8	Core	CC	ECE 210	AI/ML for Electronics Engineers	3	0	1	4
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**21**	**1**	**6**	**24**

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	2	0	0	2*
3	SEC	E SEC	SEC	Career Skills- I	2	0	1	3
4	Core	CC	ECE 301	Basic CMOS VLSI Design	3	0	1	4
5	Core	CC	ECE 302	Wireless Communication	3	0	1	4
6	Core	CC	ECE 303	Microprocessors and Microcontrollers	3	0	1	4
7	Core	CC	ECE 304	Electro Magnetics and Wave Propagation	3	0	0	3
8	Core	CC	ECE 305	Internet of Things	2	0	1	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**21**	**0**	**7**	**24**

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	2	0	0	2
3	SEC	E SEC	SEC	Career Skills - II	2	0	1	3
4	Core	CC	ECE 306	Antenna Design	2	0	1	3
5	Core	CC	ECE 307	Embedded System Design	3	0	1	4
6	Elective	CE/SE	CE/SE	Core/Specialization Elective	2	0	1	3
7	Elective	CE/SE	CE/SE	Core/Specialization Elective	2	0	1	3
8	RDIP	RDIP	ECE 308	UROP	0	0	3	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**16**	**0**	**10**	**26**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	CE/SE	Core/Specialization Elective	2	0	1	3
2	Elective	CE/SE	CE/SE	Core/Specialization Elective	2	0	1	3
3	Elective	CE/SE	CE/SE	Core/Specialization Elective	2	0	1	3
4	RDIP	RDIP	ECE 401	Internship	0	0	2	2
5	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**9**	**0**	**5**	**14**

SEMESTER - VIII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	ECE 402	Major Project	0	0	12	12
				Semester Total	**0**	**0**	**12**	**12**

Specialization: Embedded Systems and IoT								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	ECE 421	Embedded Programming	2	0	1	3
2	Elective	CE/SE	ECE 422	RTOS	2	0	1	3
3	Elective	CE/SE	ECE 423	Embedded Networking	2	0	1	3
4	Elective	CE/SE	ECE 424	IoT Architecture and Protocols	2	0	1	3
5	Elective	CE/SE	ECE 426	SOC Design for IoT	3	0	0	3
6	Elective	CE/SE	ECE 428	FPGA-based Embedded System Design	2	0	1	3
7	Elective	CE/SE	ECE 429	Embedded Systems for Electric Vehicles	3	0	0	3
8	Elective	CE/SE	ECE 438	CAD for VLSI IC Design	3	0	0	3
9	Elective	CE/SE	ECE 463	Embedded System with UML	2	0	1	3

Specialization: VLSI Design								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	ECE 431	VLSI Physical Design	3	0	0	3
2	Elective	CE/SE	ECE 432	Advanced CMOS Digital IC Design	3	0	0	3
3	Elective	CE/SE	ECE 433	CMOS RFIC Design	3	0	0	3
4	Elective	CE/SE	ECE 436	Design Verification and Testing	3	0	0	3
5	Elective	CE/SE	ECE 437	Nanoelectronics	3	0	0	3
6	Elective	CE/SE	ECE 438	CAD for VLSI IC Design	3	0	0	3
7	Elective	CE/SE	ECE 440	Semiconductor Device Modelling	3	0	0	3

Specialization: Advanced Communication Systems								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	ECE 441	Advanced Wireless Communication Systems(5G/6G)	2	0	1	3
2	Elective	CE/SE	ECE 442	Quantum Communications	3	0	0	3
3	Elective	CE/SE	ECE 443	Information Theory and Coding	3	0	0	3
4	Elective	CE/SE	ECE 444	Optical communication	3	0	0	3
5	Elective	CE/SE	ECE 472	Computer Networks and Internet Protocols	3	0	0	3

6	Elective	CE/SE	ECE 446	Detection and Estimation theory	3	0	0	3
7	Elective	CE/SE	ECE 447	Satellite communication	3	0	0	3
8	Elective	CE/SE	ECE 452	Deep Learning for IoT	2	0	1	3
9	Elective	CE/SE	ECE 464	Adaptive Signal Processing	2	0	1	3

Specialization: Advanced Signal Processing With AIML								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE/SE	ECE 451	Advanced Signal Processing	3	0	0	3
2	Elective	CE/SE	ECE 452	Deep Learning	2	0	1	3
3	Elective	CE/SE	ECE 453	Image Processing and Computer Vision	3	0	0	3
4	Elective	CE/SE	ECE 454	Biomedical Signal Processing	3	0	0	3
5	Elective	CE/SE	ECE 455	Detection and Estimation Theory	3	0	0	3
6	Elective	CE/SE	ECE 456	Digital Speech Processing	3	0	0	3
7	Elective	CE/SE	ECE 459	Pattern recognition	2	0	1	3
8	Elective	CE/SE	ECE 464	Adaptive Signal Processing	2	0	1	3

Minor: Electronic Product Design for IoT Applications								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	OE	ECE 241	Microelectronic Devices and Circuits	3	0	0	3
2	Elective	OE	ECE 242	Digital Design with HDL	3	0	0	3
3	Elective	OE	ECE 243	Hands on with Python and Raspberry PI	3	0	0	3
4	Elective	OE	ECE 244	Internet of Things	3	0	0	3
5	Elective	OE	ECE 245	Embedded System Design	3	0	0	3

Career Skills Courses								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	SEC	SEC 126	ARM Programming	2	0	1	3
2	SEC	SEC	SEC 127	Data Structures Algorithms	3	0	0	3

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

Communicative English

Course Code	EGL 101	Course Category	AEC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	English	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduce the Principles and Practices of Effective Communication Skills in various contexts.
2. To understand the purpose and differentiate various types of audience.
3. To encourage self-evaluation while collaborating with peers during learning.
4. To prepare the students to produce Language in various contexts be it Oral or Written form

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	Employ all four skills (listening/speaking/ reading/writing) to express themselves using production skills (Speak and Write)	3	90%	90%
Outcome 2	Illustrate views using Power Point and Word.	3	70%	80%
Outcome 3	Express with proper grammar.	2	60%	50%
Outcome 4	Apply listening skills to practice.	3	80%	80%
Outcome 5	Employ reading skills to read the given text.	4	60%	50%
Outcome 6	Demonstrate the forms of writings	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	2	3			3	3	3		3			
Outcome 2					3	3		3	3	3		3			
Outcome 3								3	2	3		3			
Outcome 4										3		3			
Outcome 5								2	3	3		3			
Outcome 6								3	3	3		3			
Average			2	2	3	3		3	3	3		3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1		**7**		
	Course Introduction and Overview	1	1,2,3	
	Parts of Speech	1		1,2
	Tenses	1		1,2
	Vocabulary (Etymology, Prefixes, Suffix)	2		1,2
	Capitalization & Punctuations	1		1,2
	Principles of Sentence Structure & Paragraph Writing (*S+V+O*)	1		1,2,3
Unit 2		**6**		
	The Fundamentals of Speech (*Ethos, Pathos & Logos*)	1	1,2	1,2
	How to give a good Speech? (*Rhetoric & Speech Delivery*)	1		1,2
	Verbal Communication (Turn taking strategies, Questioning, Types of Qs)	2		1,2
	Nonverbal Communication (Cultural Contexts, Importance and Types)	1		1,2
	Fundamentals of Personal, Informative, and Scientific Speech	1		1,2
Unit 3		**10**		
	Listening Skills: Definition, Barriers, Steps to Overcome	2	4	2
	Listening Comprehension	3		2
	Listening to Influence, Negotiate	2		2
	Listening to Specific Information	1		2
	Note taking & Making while Listening	2		2
Unit 4		**10**		
	Read to Skim, and Scan	2	5	1,2
	Read to Comprehend (Predict, Answer Questions & Summarize)	2		1,2
	Read to Appreciate, Compose and Present	3		1,2
	Read to Understand Referencing Skills for Academic Report Writing and Plagiarism (APA 6th Ed)	3		1,2
Unit 5		**12**		
	Write to Interpret Data (Flow charts, Bar Diagrams)	2	6	4
	Write to Inform (News, Emails, Notice, Agenda & Minutes)	2		4
	Write to Define (Definitions & Essays)	2		4
	Resume and Cover Letter	2		4
	Write an Effective Abstract and a Comprehensive Summary	2		4
	Write Project Proposal	2		4

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%		30%		40%		50%	
	Understand										
Level 2	Apply	60%		50%		70%		60%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Shoba, Lourdes. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Steven, Susan, Diana. (2015). Communication: Principles for a Lifetime. U.S.A: Pearson 6th Ed.
3. Publication Manual of the American Psychological Association, (2010). 6th Ed.
4. Kosslyn, S.M. "Understanding Charts and Graphs", Applied Cognitive Psychology, vol. 3, pp. 185-226, 1989.

Other Resources

Course Designers

1. Dr. Priyank Verma, Assistant Professor. Department of English, SRM University- AP
2. Dr. Ugen Bhutia, Assistant Professor. Department of Journalism, SRM Unviersity-AP

SRM University *AP*, Andhra Pradesh

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

Engineering Physics

Course Code	PHY 101	Course Category	FIC		L	T	P	C
					2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)	PHY 101L	Progressive Course(s)				
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	Interpret experimental observation that led to the progress of modern physics and optics	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	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	2	2	2	1			2	2			2	2	1	2
Average	2.0	2.5	1.8	1.8	1.5			1.8	2.0			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	**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, 2, 3	1, 4
	Electrostatic field due to conducting and insulating sphere.	1	1, 2, 3	1, 4
	Concept of Electrostatic Potential and Potential Energy. Inter-relation with electrostatic field.	1	1	1, 4
	Capacitor and Capacitance:	1	1	1, 4
	Capacitance of a parallel plate capacitor.	1	1, 2, 3	1, 4
Unit No. 3	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, 2, 3	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, 4	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
Unit No. 4	Concept of Electromagnetic waves & EMW Spectra	1	1	1, 2
	Geometrical & Wave Optics: Laws of reflection and refraction	1	1	1, 2
	Concept of Interference	1	1	1, 2
	Phase Difference and Path Difference	1	1	1, 2
	Newton's Ring	1	1, 2	1, 2
	The Michelson Interferometer	1	1, 2, 3, 4	1, 2
Unit No. 5	Black Body Radiation; Wien's displacement law	1	1, 2	1, 2
	Discussion on failure of classical laws to explain Black Body Radiation, and concept of Planck's Hypothesis	1	1, 4	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, 4	1, 2
	Photoelectric effect – Intensity vs Current, Frequency vs Kinetic Energy, the drawback of Wave theory to explain Photoelectric effect	1	1, 2, 3, 4	1, 2
	Wave properties of particle: De Broglie wave	1	1, 4	1, 2

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	20%		10%				10%		20%	
	Understand	40%		30%				30%		40%	
Level 2	Apply	30%		40%				40%		30%	
	Analyse	10%		20%				20%		10%	
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**				**100%**		**100%**	

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
3. Massachusetts Institute of Technology: Open Courseware. (2023). Physics I: Classical Mechanics. Retrieved from Massachusetts Institute of Technology: MIT Open Courseware https://ocw.mit.edu/courses/physics/8-01x-classical-mechanics-fall-2023/
4. Massachusetts Institute of Technology: Open Courseware. (2023). Physics II: Electricity and Magnetism. Retrieved from Massachusetts Institute of Technology: MIT Open Courseware https://ocw.mit.edu/courses/physics/8-02x-electricity-and-magnetism-fall-2023/

Course Designers

1. Dr. Sidhartha Ghosh, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
2. Dr. Jatis Kumar Dash, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
3. Dr. Pranab Mandal, Assistant Professor & Faculty coordinator, Department of Physics. SRM University – AP, Andhra Pradesh.
4. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras.
5. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad, Hyderabad.

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Engineering Physics Lab

Course Code	PHY 101L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 101	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Operate physics equipment and measurement tools following safety protocols.
2. Determine the physical parameters of mechanics, electromagnetism, modern physics and optics.
3. Collect experimental data, analyse, and interpret.

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 experimental set-up and equipment operation	2	75%	70%
Outcome 2	Demonstrate accurate data collection using modern equipment	3	70%	65%
Outcome 3	Evaluate experimental data to interpret and explain the underlying physics concepts	3	70%	65%
Outcome 4	Determine physical properties and verify physics laws	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	2			2	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	3.0	2.0	2.0	2.3			2.0	2.3			2.0	1.8	1.0	1.3

Course Unitization Plan

Exp No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
1	Moment of inertia of a flywheel	2	1,2,3,4	1,2
2	Hooke's law and determine spring constant for a given spring	2	1,2,3,4	1,2
3	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	1,2,3,4	1,2
	To determine the rigidity modulus of steel wire by torsional Pendulum **[Optional]**			
	To calculate Young's modulus of a given material by deflection method **[Optional]**			
4	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2	1,2,3,4	1,2
	To study the B-H curve of the given material and the permeability curve of the given material. [**Optional**]			
5	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	2	1,2,3,4	1,2
	Hall Effect: Determination of type of semiconductor and carrier concentration in a given semiconductor **[optional]**			
	Magnetic field in Helmholtz coil [**Optional**] a. To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field. b. To demonstrate the superposition of the magnetic fields of the two individual coils.			
6	To determine the dielectric constant of air using dielectric constant kit.	4	1,2,3,4	1,2
	Measurement of Resistivity of a semiconductor using Four probes [**Optional**]			
7	Michelson interferometer kit with diode laser	4	1,2,3,4	1,2
	Resolving power of A Telescope **[Optional]**			
	Balmer Series and Rydberg constant **[Optional]**			
8	He-Ne laser kit: Optical Interference and Diffraction	4	1,2,3,4	1,2
	Solar cell characteristics**[Optional]**			
	Frank Hertz Experiment **[Optional]**			
9	Particle size measurement	2	1,2,3,4	1,2
10	Verification of Stefan's Law	4	1,2,3,4	1,2
	Measurement of specific heat capacity of any given material **[optional]**			

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)						End Semester Exam (50 %)	
		Experiments (20 %)		Record Book/ Observation Note (10 %)		Mid Term - Model Exam (20 %)			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember				20%		10%		
	Understand				20%		20%		
Level 2	Apply		20%		20%		10%		20%
	Analyse		20%		40%		20%		30%
Level 3	Evaluate		60%				40%		50%
	Create								
Total			**100%**		**100%**		**100%**		**100%**

Recommended Resources

1. Shukla, R. K., & Srivastava, A. (2006). *Practical Physics*. New Delhi: New Age International (P) Limited Publishers.
2. Department of Physics, SRM University AP. Engineering Physics lab manuals. Retrieved from Engineering Physics Lab (FIC102) https://srmap.edu.in/seas/physics-teaching-lab/

Course Designers

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2. Dr. Jatis Kumar Dash, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
3. Dr. Pranab Mandal, Assistant Professor & Faculty coordinator, Department of Physics. SRM University – AP, Andhra Pradesh.
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Chemistry for Engineers

Course Code	CHE 103	**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	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To distinguish the types of bonding and can predict the structure, electronic and magnetic properties of small molecules.
2. To learn the type of chemical reactions based on the reaction energetics and kinetics. Also interpret stability of the binary materials based on temperature, pressure, and concentration.
3. To gain in-depth knowledge about crystalline materials.
4. To understand the types of polymers and familiar with industrial applications of common synthetic and biodegradable polymers.
5. To learn the formation of proper electrochemical cell. Also, can choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions.

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	Distinguish the types of bonding and also can predict the structure, electronic and magnetic properties of small molecules	2	70%	85%
Outcome 2	Interpret Phase rule and Kinetics based on temperature, pressure, and concentration	2	70%	85%
Outcome 3	Summarize crystalline materials.	2	70%	85%
Outcome 4	Identify the types of polymers and industrial applications of common synthetic and biodegradable polymers	2	70%	85%
Outcome 5	Demonstrate electrochemical cell	3	70%	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		2	1	2	1	2	2		2	3	1	2	3	2	2
Outcome 2		2	3	2	2	2	2		2	2	2	1	2	2	2
Outcome 3		2	3	2	2	1	2		2	2	1	2	2	2	3
Outcome 4		2	2	2	2	1	2		2	2	2	2	2	2	2
Outcome 5		2	2	2	2	1	1		1	1	1	2	2	3	2
Average		2	2	2	2	2	2		2	2	1	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**CHEMICAL BONDING**	**13**		
	Ionic, covalent, and metallic bonds	1	1	1, 2, 4
	Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond.	1	1	1, 2, 4
	Hybridization: Types of hybridization, sp, sp2, sp3, sp3d, d2sp3.	1	1	1, 2, 4
	Shapes of molecules (VSEPR Theory): $BeCl_2$, CO_2, BF_3, H_2O, NH_3, CH_4, PCl_5, XeF_2, SF_6, XeF_4.	4	1	1, 2, 4
	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method)	1	1	1, 2, 4
	Bond order, homo- nuclear diatomic Molecules (H_2, O_2, N_2)	1	1	1, 2, 4
	Hetero-nuclear diatomic Molecules (NO, CO).	1	1	1, 2, 4
	Non-covalent interactions: Van der Waals interactions	1	1	1, 2, 4
	Dipole-dipole interactions	1	1	1, 2, 4
	Hydrogen bonding	1	1	1, 2, 4
Unit 2	**PHASE RULE, THERMOCHEMISTRY AND KINETICS**	**9**		
	Phase rule: Introduction	1	2	1, 2, 4
	Definition of the terms used in phase rule with examples	1	2	1, 2, 4
	Application of phase rule to water system water system	1	2	1, 2, 4
	Basics of thermochemistry: Standard terms in thermochemistry and their significance.	1	2	1, 2, 4
	Heat of combustion, formation and sublimation (with examples in fuels and propellants).	2	2	1, 2, 4
	Kinetics: Order and molecularity of reactions	1	2	1, 2, 4
	Zero order and first order reactions	1	2	1, 2, 4
	Second order reactions	1	2	1, 2, 4
Unit 3	**CRYSTALLINE AND ELECTRONIC MATERIALS**	**10**		
	Crystal structure: crystal systems	2	3	2,4
	Properties of cubic crystals, Bragg's Law, Bravais lattices	1	3	2,4
	Miller indices	2	3	2,4
	Point defects	1	3	2,4
	Band theory: metals, insulators, and semiconductors.	2	3	2,4
	Band gaps, doping, anddevices.	2	3	2,4
Unit 4	**MATERIALS CHEMISTRY**	**9**		
	Classification of polymers: Natural and synthetic.	1	4	1, 3
	Thermoplastic and Thermosetting polymers. Degree of polymerization.	2	4	1, 3
	Properties of polymers: Tg, Tacticity, Molecular weight, weight average.	2	4	1, 3
	Degradation of polymer	1	4	1, 3
	Common Polymers: Elastomer, Conducting polymer, biodegradable polymer.	1	4	1, 3
	Examples: PET (Polyethylene terephthalate), nylon, polystyrene.	1	4	1, 3
	Demineralization of water and Zeolite process.	1	4	1, 3
Unit 5	**ELECTROCHEMISTRY**	**4**		
	Electrochemical cells	1	5	1, 2, 4
	Primary and secondary cells	1	5	1, 2, 4
	Lead-acid battery	1	5	1, 2, 4
	Li+ batteries and Fuel cells	1	5	1, 2, 4
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 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%		60%		40%		30%	
	Understand										
Level 2	Apply	40%		60%		40%		60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. A. Bahl, B.S. Bahl, G.D. Tuli, Essentials of Physical Chemistry, (2016), S Chand Publishing Company
2. T. Jain, Y. Jain, Engineering Chemistry, 16th Edition (2017), Dhanpat Rai Publication Company
3. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International, 1986. ISBN: 0-85226-307-4
4. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Edition (2013), Vishal Publication Company

Other Resources

Course Designers

1. Dr. S. Mannathan, Associate Professor, Department of Chemistry, SRM University – AP.
2. Dr. S. Chakrabortty, Assistant Professor, Department of Chemistry, SRM University – AP.
3. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
4. Prof. K.C. Kumaraswamy, Professor, Department of Chemistry, University of Hyderabad.
5. Prof. G Ranga Rao, Professor, Department of Chemistry, IITM.

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Chemistry for Engineers Lab

Course Code	CHE 103L	**Course Category**	FIC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CHE 103	**Progressive Course(s)**			
Course Offering Department	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To gain knowledge on different kinds of quantitative analyses.
2. To apply various analytical titration techniques.

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	Choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions	3	70%	80%
Outcome 2	Predict the pH and pOH of the given solutions	4	70%	80%
Outcome 3	Explain the principles and working of electrochemistry.	3	70%	80%
Outcome 4	Demonstrate the electroanalytical technique in the volumetric titration.	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	2	2	2	2	2		1	2		2	2	3	2
Outcome 2	2	2	3	2	1	2	2		2	2		2	2	2	2
Outcome 3	2	2	1	2	2	2	1		2	1		2	2	2	2
Outcome 4	2	2	2	2	2	1	1		2	2		2	2	2	3
Average	2	2	2	2	2	2	2		2	2		2	2	2	2

Course Unitization Plan

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Volumetric titration of HCl vs NaOH	4	2,4	1,2,3
2	Standardization of potassium permanganate by Oxalic acid	4	2,4	1,2,3
3	Conductometric titration of HCl vs NaOH	4	2,4	1,2,3
4	Determination of strength of given hydrochloric acid using pH meter	4	3,4	1,2,3
5	Determination of hardness of water by EDTA method	4	1,2	1,2,3
6	Estimation of iron content of the given solution using potentiometer	4	3,4	1,2,3
7	Iodometric Determination of Ascorbic Acid (Vitamin C)	6	1,2	1,2,3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Experiments (20%)		Record/ Observation Note (10%)		Viva Voce + Model examination (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember		40%		40%		60%		50%
	Understand								
Level 2	Apply		60%		60%		40%		50%
	Analyse								
Level 3	Evaluate								
	Create								
Total		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Text Book of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Text Book of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.

Other Resources

Course Designers

1. Internal (Institutional) Subject Matter Experts
2. Dr. S. Mannathan, Associate Professor, Department of Chemistry, SRM University – AP.
3. Dr. Sabyasachi Chakrabortty, Associate Professor, Department of Chemistry, SRM University – AP.
4. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
5. Prof. K.C. Kumaraswamy, Professor, Department of Chemistry, University of Hyderabad.
6. Prof. G. Ranga Rao, Professor, Department of Chemistry, IITM.

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Introduction to Computer Science and Programming Using C

Course Code	CSE 108	**Course Category**	FIC	**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. 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**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	2	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	1	1	1,2
UNIT II	**C PROGRAMMING BASICS**	**9**		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	1	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	1	1	1,2
	Conditional operator, assignment operator, expressions Type conversion	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.	2	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.	2	1,2	1,2
UNIT III	**FUNCTIONS AND ARRAYS**	**10**		
	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.	2	2,3	1,2
	C Pre-processor and header files	1	2,3	1,2
	Concepts, declaration, definition, storing and accessing elements	1	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	2	2,3	1,2
UNIT IV	**POINTERS**	**10**		
	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	2	3,4	1,2
	pointers and multi-dimensional arrays, dynamic memory management functions	2	3,4	1,2
	command line arguments	1	3,4	1,2
UNIT V	**ENUMERATED, STRUCTURE AND UNION TYPES**	**7**		
	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,	1	5	2, 3, 4
	self-referential structures. Unions, typedef, bit-fields, program applications	2	5	2, 3, 4
	Bit-wise operators: logic, 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.	2	5	2, 3, 4
	Total 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	70%		60%		50%		40%		30%	
	Understand										
Level 2	Apply	30%		40%		50%		60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012.

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016

Course Designers

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

Introduction to Computer Science and Programming using C Lab

Course Code	CSE 108L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 108	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Learn and understand C programming basics and paradigm.
2. Acquire knowledge on decision making and functions in C.
3. Acquire knowledge on decision making, loop concept, control statements, arrays, string and functions using C.
4. Learn basics of Structures, Union, and File handling concepts in C.

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 fundamentals in C, enumerators, datatypes, vakeywords, 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	2	3	3	3	2				2				3	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				3				2	3	
Outcome 5	2	3	3	3	3				3				2	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 I	**INTRODUCTION TO COMPUTER SCIENCE**	**4**		
1	**Lab Experiment 1:** GCC Compiler using Linux, various Linux commands used to edit, compile and executing	2	1	1,2
2	**Lab Experiment 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
UNIT II	**C PROGRAMMING BASICS**	**6**		
3	**Lab Experiment 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.	2	1,2	1,2
4	**Lab Experiment 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	**Lab Experiment 5:** Triangle star patterns  I II	2	1,2	1,2
UNIT III	**FUNCTIONS AND ARRAYS**	**9**		
6	**Lab Experiment 6:** **a)** (nCr) and (nPr) of the given numbers $1+x+x^2\backslash 2+x^3\backslash 3!+x^4\backslash 4!+\ldots\ldots\ldots X^n\backslash n!$	2	2,3	1,2
7	**Lab Experiment 7: a)** Interchange the largest and smallest numbers in the array. b. Searching an element in an array b. Sorting array elements.	2	2,3	1,2
8	**Lab Experiment 8:** a. Transpose of a matrix. b.Addition and multiplication of 2 matrices.	2	2,3	1,2
9	**Lab Experiment 9:** a. Function to find both the largest and smallest number of an array of integers. b. Liner search. c. Replace a character of string either from beginning or ending or at a specified location.	2	2,3	1,2
10	**Lab Experiment 10:** Pre-processor directives a. If Def b. Undef c. Pragma	1	2,3	1,2
UNIT IV	**POINTERS**	**6**		
11	**Lab Experiment 10:** a. Illustrate call by value and call by reference.	2	3, 4	1,2,3

	b. Reverse a string using pointers Compare two arrays using pointers			
12	**Lab Experiment 11:** a. Array of Int and Char Pointers. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
13	**Lab Experiment 12:** a. To find the factorial of a given integer. b. To find the GCD (greatest common divisor) of two given integers. c. Towers of Hanoi	2	3, 4	1,2,3
UNIT V	**ENUMERATED, STRUCTURE AND UNION TYPES**	**4**		
14	**Lab Experiment 13:** a. Reading a complex number b. Writing a complex number. c. Addition of two complex numbers Multiplication of two complex numbers	2	5	2, 3, 4
15	**Lab Experiment 14:** a. File copy b. Word, line and character count in a file.	2	5	2, 3, 4
Total Hours		**29**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		**End Semester Exam (50%)**	
		Lab Record (20%)	**Projects Presentations (30%)**	**Lab Record (20%)**	**Projects Presentations (30%)**
		Practical	Practical	Practical	Practical
Level 1	Remember	70%	60%	30%	40%
	Understand				
Level 2	Apply	30%	40%	70%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016

Course Designers

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

Calculus

Course Code	MAT 113	Course Category	FIC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		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. Apply calculus to analyze monotonic functions, identify inflection points, and sketch curves.
3. Apply Lagrange multipliers to solve optimization problems with single constraints. 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 single-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

Session	Description of Topic	Contact Hours Required	CLOs Addressed	References Used
1	**Unit I: Limit, Continuity, Derivative, and Integrals of Single Variable**	**10 Hours**		
2	Functions and Their Graphs,	1	**CO 1**	1
3	Limit of a function at a point and limit laws,	2	**CO 1**	1
4	Continuity of a function,	1	**CO 1**	1
5	Derivative of a function at a point,	2	**CO 2**	1
6	Various rules of Derivative,	1	**CO 2**	1
7	Definite and indefinite integral,	2	**CO 3**	1
8	Fundamental Theorem of Calculus.	1	**CO 3**	1
9	**Unit II: Applications of Calculus (Single Variable)**	**9 Hours**		
10	Extreme Values of Functions	2	**CO 4**	1
11	The Mean Value Theorem, Monotonic Functions	2	**CO 4**	1
12	Concavity and curve sketching	2	**CO 4**	1
1	Newton's Method to find roots	1	**CO 4**	1
14	Area between curves	1	**CO 4**	1
15	Arc length.	1	**CO 4**	1
16	**Unit III: Limit, Continuity, Partial Derivatives of Multi-Variables Function**	**10 Hours**		
17	Three-dimensional rectangular coordinate systems	1	**CO 1**	1
18	Functions of several variables	2	**CO 1**	1
19	Limits and continuity	2	**CO 2**	1
20	Partial Derivatives	1	**CO 3**	1
21	The Chain Rule, Directional Derivatives,	2	**CO 3**	1
22	Gradient.	2	**CO 3**	1
23	**Unit IV: Extrema of Multi-Variables Function**	**6 Hours**		
24	Extreme values	1	**CO 4**	1
25	Saddle points	1	**CO 4**	1
26	Absolute Maxima and Minima on Closed Bounded Regions,	2	**CO 4**	1
27	Lagrange multipliers (Single Constraints).	2	**CO 4**	1
28	**Unit V: Multiple Integrals**	**10 Hours**		
29	Double and Iterated Integrals over Rectangles	2	**CO 5**	1
30	Double Integrals over General Regions.	2	**CO 5**	1
31	Area by Double Integration,	1	**CO 5**	1
32	Double Integrals in Polar Form	1	**CO 5**	1
33	Triple Integrals in Rectangular Coordinates	2	**CO 5**	1
34	Applications.	2	**CO 5**	1
Total		**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	50%	40%	55%	40%	50%
	Understand					
Level 2	Apply	50%	60%	45%	60%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018.

Other Resources

Course Designers

1. Prof. V. Kannan, Professor, Mathematics Department, SRM University AP.
2. Dr. Fouzul Atik, Assistant Professor, Mathematics Department, SRM University AP.
3. Dr. Sazzad Ali Biswas, Assistant Professor, Mathematics Department, SRM University AP.
4. Dr. Anirban Bose, Assistant Professor, Mathematics Department, SRM University AP.

SRM University *AP*, Andhra Pradesh

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

Industry Standard Employability Skills-I

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

Course Objectives / Course Learning Rationales (CLRs)

1. Gain the ability to work in a team and learn leadership skills.
2. Gain the ability to be a leader who can cope up with the challenges, risks, and change management.
3. Gain the ability to understand and be professionals with idealistic practical and moral values.
4. Gain ability to acquire decision making skills in different situations.

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	Recognise the leadership skills for teamwork.	1	70%	60%
Outcome 2	Demonstrate the ability to cope up with changes and challenges.	3	80%	70%
Outcome 3	Manage stress and control emotions.	3	70%	60%
Outcome 4	Apply decision making and problem-solving skills to given scenarios.	3	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			
Outcome 2		2					1								
Outcome 3						2		2							
Outcome 4		2		1					2		1				
Average		2		1		1	1	1	2		1	1			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	COs Addressed	References Used
Unit 1	**Interpersonal skills**	**9**		
	Understanding the relationship between Leadership Networking and Teamwork, Realizing Ones Skills in Leadership	3	1,2	1,2
	Networking & Teamwork and Assessing Interpersonal Skills Situation description of Interpersonal Skill.	3	1,4	1,3
	Teamwork Necessity of Team Work Personally, Socially and Educationally.	3	1,4	1,3
Unit 2	**Leadership**	**9**		
	Skills for a good Leader, Assessment of Leadership Skills	3	1,2	1,2
	Change Management, Exploring Challenges	3	1,3	1,2
	Risking Comfort Zone, Managing Change	3	1,3	1,3
Unit 3	**Stress management**	**9**		
	Causes of Stress and its impact, how to manage & distress, Understanding the circle of control, Stress Busters.	3	2,3	3,4
	Emotional Intelligence What is Emotional Intelligence, emotional quotient	3	2,3	3,4
	why Emotional Intelligence matters, Emotion Scales. Managing Emotions.	3	2,3	3,4
Unit 4	**Conflict resolution**	**9**		
	Conflicts in Human Relations	3	1,4	2,3
	Reasons Case Studies	3	4	2,3
	Approaches to conflict resolution	3	1,4	2,3
Unit 5	**Decision making**	**9**		
	Importance and necessity of Decision Making	3	1,4	1,4
	process of Decision Making	3	1,4	1,4
	Practical way of Decision Making, Weighing Positives & Negatives.	3	2,4	1,4
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%)			
		Prac.		Prac.		Prac.		Prac.		Prac.	
Level	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

1. Covey Sean, Seven Habit of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to Win Friends and Influence People, New York: Simon& Schuster, 1998.
3. Thomas A Harris, I am ok, you are ok, New York-Harper and Row, 1972
4. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006.

Other Resources

Course Designers

1. Mr. Asghar Ahamad, Soft skills trainer, Department of CDC, SRM University AP.

SRM University *AP*, Andhra Pradesh

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

Introductory Biology for Engineers

Course Code	BIO 103	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	Biological Sciences	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the importance of Biological Sciences
2. To understand the biomolecules and their importance in biological systems.
3. To understand the structure and function of prokaryotic and eukaryotic cells, as whole entities and in terms of their subcellular processes including the molecular biology of cells.
4. To understand the importance of bioinformatics in biological sciences research

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 importance of biology in everyday life.	2	80%	75%
Outcome 2	Describe the evolution of life forms and the importance of biomolecules in living systems	2	80%	65%
Outcome 3	Explain the structure of different types of cells and cellular respiration, photosynthesis.	2	70%	65%
Outcome 4	Describe the molecular biology of cells and the process of cell division	2	70%	65%
Outcome 5	Discuss the use of bioinformatics tools for analysis of DNA and proteins.	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	2	3	3	1	1	3	3	3	3		2			
Outcome 2	3	2	3	3	2	1	3		1			2			
Outcome 3	3	2	3	3	3	1	3		1			2			
Outcome 4	3	2	3	3	3	1	3		1			2			
Outcome 5	3	2	3	3	3	3	2		2			3			
Average	**3**	**2**	**3**	**3**	**2**	**1**	**3**	**3**	**2**	**3**		**2**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Biomolecules**	**6**		
	Why study Biology?	1	1	1, 2, 3
	Evolution of complex biomolecules	1	1, 2	1, 2, 3
	Life on earth	1	1, 2	1, 2, 3
	Biomolecules - carbohydrates	1	1, 2	1, 2, 3
	Biomolecules – lipids and fats	1	1, 2	1, 2, 3
	Biomolecules – nucleic acids and proteins	1	1, 2	1, 2, 3
Unit 2	**Cell Biology**	**6**		
	Prokaryotic cell structure	2	1, 2, 3	1, 2, 3
	Eukaryotic cell (Animal and Plant) - structure and functions of organelles	2	1, 2, 3	1, 2, 3
	Diversity of life: virus, bacteria, archaea and eukarya	2	1,2,3	1, 2, 3
Unit 3	**Cell Physiology**	**6**		
	Membrane transport	1	2,3,4	1, 2, 3
	Cellular respiration and energy generation	2	2,3,4	1, 2, 3
	Brief account of Photosynthesis	1	2,3,4	1, 2, 3
	Enzymes and their kinetics	1	2,3,4	1, 2, 3
	Vitamins, Hormones	1	2,3,4	1, 2, 3
Unit 4	**Molecular Biology**	**6**		
	DNA and Chromosomes: structure and organization	1	2,3	1, 2, 3
	Central Dogma- DNA replication, transcription and translation	2	2,3	1, 2, 3
	Cell division – mitosis and meiosis	1	2,3	1, 2, 3
	Mutations, Cancer, and genetic diseases.	2	2,3	1, 2, 3
Unit 5	**Biological Sequences and Databases**	**6**		
	Concept of genomics, transcriptomics, proteomics, and metabolomics	1	2,3,5	4, 5
	FASTA file format	1	2,3,5	4, 5
	Biological databases – NCBI	1	2,3,5	4, 5
	Applications of BLAST and protein/Gene ID conversion	1	2,3,5	4, 5
	Hands on experience in analyzing biological data using above mentioned tools	2	2,3,5	4, 5
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	Th	Th	Th	Th
Level 1	Remember	90%	90%	90%	80%	80%
	Understand					
Level 2	Apply	10%	10%	10%	20%	20%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thrives in Biochemistry and Molecular Biology, Edition 1, 2014, Cox, Harris, Pears, Oxford University Press.
2. Thrives in Cell Biology, Ed. 1, 2013, Qiuyu Wang, Chris Smith and Davis, Oxford University Press.
3. Genetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition.
4. Bioinformatics Introduction – Mark Gerstein

Other Resources

1. The Physiological Society (https://www.youtube.com/user/PhysocTV)

Course Designers

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

Exploratory Learning and Discovery

Course Code	ENTR 100	**Course Category**	SEC	**L**	**T**	**P**	**C**
				0	0	1	1
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				
Outcome 4				

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.

Orientation on Internationalization

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

Course Objectives / Course Learning Rationales (CLRs)

1. To Understand the need and Importance of Internationalization as per the New Education Policy and to make student aware about the different pathways of Internationalization, which will help them to achieve their International Goals.

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 Need and importance of internationalization in Indian Higher Education system and Comparison with the global standards			
Outcome 2	Know the guidelines issued by the University grant commission for the internationalization of institutions and the importance in New Education Policy			
Outcome 3	Know the Different Pathways of Internationalization, Efforts of SRM University AP for various Pathways, available opportunities and application process.			

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 Lifelong 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	**INTERNATIONALISATION OF HIGHER EDUCATION**	**3**		
	Internationalization, Global Trends and Indian Initiatives	1		
	Internationalization and Indian higher education	1		
	Internationalization as the pathway to the Future universities	1		
Unit 2	**GUIDELINES FOR INTERNATIONALIZATION OF HIGHER EDUCATION**	**3**		
	NEP and Internationalization	1		
	Strategic Programs and Initiatives - I	1		
	Strategic Programs and Initiatives – II and Role of Institutions	1		
Unit 3	**INTENATIONALIZATION PATHWAYS**	**10**		
	International Partnerships, Need and Importance, Key for Internationalization goals, Type, Process and Current status	1		
	Pathway -1: International Internships, its role in internationalization, Need, Scope and Benefits, Comparison with global institutions1	1		
	Opportunities, Process and Policy guidelines	1		
	Languages, Centre of Excellences for Languages, Purpose and Scope	1		
	Pathway -2: Immersion Programs (Inbound and Outbound), its role in internationalization, Need, Scope and Benefits, Comparison with global institutions, how it is different from Internships	1		
	Opportunities, Process and Policy guidelines	1		
	Pathway -3: Semester Abroad and Exchange Program, Its role in Internationalization, Scope and Benefits, Process and Guidelines	1		
	Pathway -4: International Transfer Program Program, Its role in Internationalization, Scope and Benefits, Process and Guidelines, Credit Transfer	1		
	Pathway -5: Higher Studies (India or Abroad), Importance, Need and Scope, Process and Component of Higher Studies abroad, Benefits, Training and Support	1		
	Other Pathways of Internationalizations, SRM University AP Goals and Vision for Internationalizations, Intranet Portal a tool.	1		
	Total contact hours	**16**		

Learning Assessment

Course Nature				**Theory**
Assessment Method – Theory Component (Weightage 100%)				
In-semester	Assessment tool	Mid Term I	Mid Term II	Total
	Weightage	15%	15%	30%
End semester examination Weightage: 70%				70%

Recommended Resources

Other Resources

1. https://drive.google.com/drive/u/1/folders/1uUiQV30enEAuU3Ov6Gx0R0EGSaha4rzl
2. https://drive.google.com/file/d/1yTO36ezB8x2kDIh-RtEfg6J-W3SxEai_/view?usp=sharing
3. https://drive.google.com/file/d/1AYeCeGaGb4pQ4a7VvEAbmooywRJHDZVY/view?usp=sharing

Course Designers

1. Directorate of International Relations and Higher Studies

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

Linear Algebra

Course Code	MAT 211	Course Category	FIC	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	Mathematics	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To make students understand the central ideas of linear algebra like solving linear equations performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors.
2. Equip the student with various solution techniques and modelling of linear and non-linear first and second-order differential equations, including systems of equations.

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 the systems of linear equations for solving given problems in science and engineering.	2	80%	70%
Outcome 2	Demonstrate the procedures of solving linear equations.	3	80%	70%
Outcome 3	Performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors.	3	80%	70%
Outcome 4	Demonstrate the qualitative nature of system of differential equations using matrix algebra.	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	3	2	2											
Outcome 2	2	3	2	2											
Outcome 3	2	3	2	2											
Outcome 4	3	3	3	3											
Average	2	3	2	2											

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Matrices and Gaussian elimination**	**10**		
1	Introduction, Geometry of Linear Equations	1	1	1
2	Gaussian Elimination	2	1,2	1
3	Matrix Notation and Matrix Multiplication	2	2	1
4	Triangular Factors and Row Exchanges	3	1,2	1
5	Inverses and Transposes	2	3, 4	1
Unit II	**Vector spaces**	**9**		
6	Vector spaces and Subspaces	1	1,2	1
7	Solving $Ax = 0$ and $Ax = b$	2	1,2	1
8	Linear Independence, Basis and Dimension	2	1,2	1
9	The Four Fundamental Subspaces	2	1,2	1
10	Graphs and Networks, Linear Transformations	2	2	1,2
Unit III	**Orthogonality**	**8**		
11	Orthogonal Vectors and Subspaces	1	1,2	1
12	Cosines and Projections onto Lines	2	,2,3	1
13	Projections and Least Squares	3	2	1,2
14	Orthogonal Bases and Gram-Schmidt	2	1,3	1,2
Unit IV	**Determinants**	**8**		
15	ntroduction	1	3	1
16	Properties of the Determinant	2	1,3	1
17	Formulas for the Determinant	2	1,3	1
18	Applications of Determinants	3	1,3	1,2
Unit V	**Eigenvalues and eigenvectors**	**10**		
19	Introduction, Diagonalization of a Matrix	3	3	1,2
20	Difference Equations and Powers Ak	2	3	1,2
21	Differential Equations and etA and phase portrait	3	3,4	1,2
22	Complex Matrices, Similarity Transformations	2	3	1,2
Total 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	50%		60%		40%		60%		50%	
	Understand										
Level 2	Apply	50%		40%		60%		40%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Gilbert Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007
2. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010

Other Resources

Course Designers

1. Dr. Tapan Kumar Hota, Assistant Professor, Mathematics Department, SRM University AP.

SRM University *AP*, Andhra Pradesh

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

Industry Standard Employability Skills -II

Course Code	ISES 102	Course Category	AEC	L	T	P	C
				0	0	1	1
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	CDC	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop interpersonal skills to be a good team player.
2. Develop socialization skills, positive attitude, and behavioural skills
3. Eliminate the barriers of communication and make conscious efforts to improve skill sets.
4. Recognise practice and acquire the skills necessary to deliver effective presentation with clarity and impact.

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	Recognise the intrinsic motivating factors.	1	70%	60%
Outcome 2	Demonstrate the ability to conceptualize an original idea.	3	80%	70%
Outcome 3	Solve the given problems using lateral thinking techniques	3	70%	60%
Outcome 4	Apply interpersonal skills to be a team player	3	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			2	3			2			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	COs Addressed	References Used
Unit 1	**Motivation**	**9**		
	Soldiers' walk (Activity on factors of motivation)	3	1,4	1,4
	The Japanese fan (An activity on factors 1of motivation)	3	1,4	1,4
	Steps to ward off demotivation.	3	1,4	1,4
Unit 2	**Creativity and innovation**	**9**		
	Short film: (Students are encouraged to make a ten-minute documentary on various topics to enhance the power of aesthetics and precision)	3	1,2	1,4
	Creative short film (This activity is aimed at creating an interest on research and think out of the box)	3	1,2	1,4
Unit 3	**Critical and lateral thinking**	3		
	Fill me up, stimulating lateral thinking	**9**	1,2	2,4
	The curious case of Mary and Kevin (Activity triggering the different types of thinking)	3	2,3	2,4
	The creative college	3	2	2,4
Unit 4	**Team dynamics**	3		
	Story boarding, Frenzy, come to my island.	**9**	1,2,3	2,3
	Striking cars	3	1,2	2,3
	Defend the egg, tallest tower (Activities on the different stages of team building, team communication, coordination, and collaboration.	3	1,2,3	2,3
Unit 5	**Mini project**	3		
	Concept 1: Mini project presentation	**9**	1,2,3,4	1,4
	Concept 2: Mini project presentation	3	1,2,3,4	1,4
	Concept 3: Mini project presentation	3	1,2,3,4	1,4
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%)			
		Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th
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

1. Mitra BK. Personality development and soft skills. Oxford University Press; 2019 Jul 5.
2. Key to success in workplace and life – Meenakshi Roman, Shalini Upadhyay.
3. Vyner J. Mastering Soft Skills "Win and Build Better Client Relationships with a New Approach to Influence", Persuasion and Selling. Matador; 2018.
4. Henry T. The accidental creative: How to be brilliant at a moment's notice. Penguin; 2013 Aug 27.

Other Resources

Course Designers

1. Mr. Asghar Ahamad, Soft skills trainer, Department of CDC, SRM University AP.

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

Data Structures

Course Code	CSE 107	**Course Category**	FIC	**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 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.	3	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	2	3	3	3	2				2				3	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				3				2	3	
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 to Data Structures	9		
	Abstract Data Type (ADT), Time and space requirements of algorithms	2	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.	1	1	1
	Example applications on Stacks	1	1	
	Queues: representation and application, implementation of queue operations using C.	1	1	1,2
	Example applications on Queues	2	1	1,2
Unit 2	Linked lists	8		
	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	10		
	Tree terminology	1	2	1
	Binary tree, Representation of Binary Trees using Arrays and Linked lists	1	2	1
	Binary search tree	1	2	1
	Binary Search Trees- Basic Concepts, BST Operations: Insertion, Deletion	2	2	1
	Tree Traversals, Construction of tree using traversals	2	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)	1	3	3
	DFS (depth first search)	2	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	1	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.	2	4	5
	Hashing techniques and hash functions	1	4	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (5%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	Th
Level 1	Remember	40%	40%	40%	40%	40%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate	20%	20%	20%	20%	20%
	Create					
Total		100%	100%	100%	100%	100%

Recommended Resources

1. Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein "Data structure using C", Pearson publication.
2. Mark Allen Weiss, "Data structures and Algorithm Analysis in C", Pearson publications, Second Edition.
3. Horowitz, Sahani & Anderson Freed "Fundamentals of data structure in C", Computer Science Press.
4. Schaums Series, "Fundamental of Data Structures", Tata-McGraw-Hill
5. "Data Structures and Algorithms: Concepts, Techniques & Algorithm" G.A.V.Pai: Tata McGraw Hill.
6. Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode "Data Structures and Program Design in C"

Other Resources

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

Course Designers

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

Data Structures Lab

Course Code	CSE 107L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 107	**Progressive Course(s)**				
Course Offering Department	CSE	**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.	3	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	1	2		1	2				2				1		3
Outcome 2	2	2	3	3	3				2				3	2	3
Outcome 3	2	2	3	3	3				2				3	2	3
Outcome 4	2	2	2	3	3				3			2	3	2	3
Average	1	2		1	2				2				1		3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1 and 2	Simulate the following operations: a. Conversion of infix expression to postfix expression a. Evaluation of expressions a. Assignment-1: Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: Only one disk can be moved at a time. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack. i.No disk may be placed on top of a smaller disk You can choose to use the function *move (4, 1, 3, 2), w*here 4 represents the number of disks. 1 represents disks on source shaft, 3 represents the destination shaft which holds the disks after the move and finally 2 represents the intermediate support shaft – temporary storage. Write a C program to simulate the given problem and: Perform the algorithmic complexity analysis for the solution you propose. Resources: https://www.youtube.com/watch?v=YstLjLCGmgg	4	1	1,6
Unit 3 & 4:	Simulate the following tasks: a. Implementation the following operations: enqueue, dequeue and finding an element: Linear Queue using arrays Circular queue arrays Priority queue singly linked list. b. Assignment-2: The "*4-Queens Problem*" consists of placing four queens on a 4 x 4 chessboard so that no two queens can capture each other. That is, no two queens are allowed to be placed on the same row, the same column or the same diagonal (both primary and secondary diagonals). Write a C program to simulate the given problem and perform the algorithmic complexity analysis for the solution you propose.	4	1	1,6
Unit 5 &6:	Demonstrate the following though simulation: a. Create a singly linked list and perform the following operations: i.Add an element at the end of the list Delete an element from the beginning of the list Find the middle element of the list Search the given key form the list Polynomial addition using linked list Sparse matrix operations using linked list b. Assignment-3: Let us consider a small but busy airport with only one run-way (shown in figure). In each time unit, one plane can land or one plane can take off, but not both. Planes arrive ready to land or to take off at random times, so at any given unit of time, the runway may be idle or a plan may be landing or taking off, and there may be several planes waiting either to land or take off. We therefore need two queues, called *landing* and *takeoff*, to hold these planes. It is better to keep a plane waiting on the ground than in the air, so a small airport allows a plane to take off only if there are no planes waiting to land. Hence, after receiving requests from new planes to land or take off, our simulation will first service the head of the queue of planes waiting to land, and only if the landing queue is empty will it allow a plane to take off. We shall wish to run the simulation through many units of time, and therefore, we embed the main action of the program in a loop that runs for cur-time (denoting current time) from 1 to a variable end-time. the given scenario using and write the output for different inputs.	4	1	1,6
Unit7 & 8:	Write code to perform the following operations: a. Develop a code to test whether the given tree is binary tree or not. a. Implementation of Binary tree traversals techniques – pre-order, in-order, and post-order. a. Implementation of AVL tree and its operations	4	2	5

	a. Assignment-4: Given a mathematical expression, evaluate it using appropriate tree structure.			
Unit 9:	Write a C program for implementation of Graph traversals techniques (BFS and DFS).	2	3	1,6
Unit 10:	The Dijkstra's algorithm is an algorithm that gives the shortest path between two given vertices of a graph. In this problem we are given a directed graph with each edge having a non-negative weight. Thus, a solution requires a path of many other that costs least. We can think of the problem as like this: think graph G as a map of the airline routes, each node of the graph as the cities and the weights on each edge as the cost of flying from one city to another city. The solution we have to find a routing from a city v to city w such that the total cost is minimum. Write a C program to simulate the given problem. That is find the shortest path between node A and node F in the given graph.	1	3	1,6
Unit 11:	Write a C program for Linear search and Binary search algorithms. What is the best case and worst-case time complexity of those searching algorithms?	2	4	2
Unit 12:	Write a C program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm? Write a C program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?	2	4	2
Unit 13:	Write a C program for Insertion sort algorithm. What is the worst case or average case time complexity of Insertion sort algorithm?	1	4	2
Unit 14:	Write a C program for Quick sort algorithm. What is the worst case or average case time complexity of Quick sort algorithm?	1	4	3
Unit 15:	Write a C program for Merge sort algorithm. What is the worst case or average case time complexity of Merge sort algorithm?	1	4	3

Learning Assessment

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

Recommended Resources

1. Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein "Data structure using C", Pearson publication.
2. Mark Allen Weiss, "Data structures and Algorithm Analysis in C", Pearson publications, Second Edition.
3. Horowitz, Sahani & Anderson Freed "Fundamentals of data structure in C", Computer Science Press.
4. Schaums Series, "Fundamental of Data Structures", Tata-McGraw-Hill
5. "Data Structures and Algorithms: Concepts, Techniques & Algorithm" G.A.V.Pai: Tata McGraw Hill.
6. Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode "Data Structures and Program Design in C"

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016
2. "Programming in C". P. Dey and M Ghosh, Second Edition, Oxford University Press.
3. Data Structures and Program Design in C by Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode, refer the following pages 201 to 209.
4. Online resources: Use the following link to get a better understanding https://www.youtube.com/watch?v=TrR-suFO4to&list=PLWZxDaGQjf0sgrCJXH- OjMQQUcQlFcUsP&index=

Course Designers

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

Basic Electrical and Electronics

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

Course Objectives / Course Learning Rationales (CLRs)

1. To provide the basic idea on electrical and electronic circuits.
2. Describe the laws and concepts on electrical circuits.
3. Discuss the network theorems under DC Excitation
4. Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
5. Illustrate the basic semiconductor devices, analog circuits 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	Describe the application on electrical engineering in daily life	2	70%	70%
Outcome 2	Discuss the laws and concepts for electrical circuits.	2	70%	70%
Outcome 3	Apply the network theorems under DC Excitation	3	70%	70%
Outcome 4	Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
Outcome 5	Describe the basic semiconductor devices and applications.	2	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 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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basic Circuit Analysis**	**8**		
	Ohm's law, Kirchhoff's laws, Concept of Node, Path, Loop, Branch, Mesh	2	1, 2	1, 2
	Voltage and Current Division, Ideal and Practical Voltage and Current Source, Source transformations	2	1, 2	1, 2
	Nodal Analysis and Supernode - Presence of independent voltage and current sources.	2	1, 2	1, 2
	Mesh Analysis and Super mesh - Presence of independent voltage and current sources. Illustrative examples.	2	1, 2	1, 3
Unit 2	**Network Theorems with DC Source**	**6**		
	Introduction to Network Theorems and Techniques, Superposition Theorem	1	1, 3	2, 3
	Thevenin's Theorem	2	1, 3	1, 2
	Norton's Theorem	1	1, 3	1, 2
	Maximum Power Transfer Theorem, Illustrative examples.	2	1, 3	1, 2
Unit 3	**Single-Phase AC Circuits**	**11**		
	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	2	1, 4	1, 2
	Steady State Analysis of Pure R, L, C Circuits.	2	1, 4	1, 2
	Steady State Analysis of RL, RC and RLC Series Circuits with Phasor Diagrams	5	1, 4	1, 2
	Definitions of Real Power, Reactive Power, Apparent Power, and Power Factor. Concepts of Resonance Illustrative examples.	2	1, 4	1, 2
Unit 4	**Semiconductor Devices and Circuits**	**12**		
	PN junction diode structure	1	1, 5	1, 2
	Forward and reverse bias operation and characteristics of PN junction diode	1	1, 5	1, 2
	Half-wave, full wave, bridge rectifiers, clipping circuits using PN junction diode	2	1, 5	2, 3
	Bipolar junction transistors (BJTs) structure and operation	2	1, 5	1, 2
	common-base, common-collector, and common-emitter configurations using BJTs	6	1, 5	1,2
Unit 5	**Basic Analog Circuits and Applications**	**8**		
18.	Characteristics of an operational amplifier and Definitions of characteristics	3	1, 5	1, 2
19.	Inverting and non-inverting op-amps, summing amplifier, Difference amplifier, Integrator and differentiator design using op-amp	3	1, 5	4,5
20.	Op Amp Applications as Voltage to Current Converter and Current to Voltage converters, filters	2	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 (20%)	Mid-1 (10%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	60%	30%	30%	30%
	Understand					
Level 2	Apply	70%	40%	70%	70%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011

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

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Basic Electrical and Electronics Lab

Course Code	EEE 103L	**Course Category**	FIC	**L**	**T**	**P**	**C**
				0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide the basic idea for electrical and electronic circuits.
2. Describe the laws and concepts on electrical circuits.
3. Discuss the network theorems under DC Excitation
4. Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
5. Summarize the basic semiconductor devices, analog circuits 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	Describe the electrical engineering application in daily life	2	70%	70%
Outcome 2	Discuss the electrical circuits laws and concepts	2	70%	70%
Outcome 3	Apply the network theorems under DC Excitation	3	70%	70%
Outcome 4	Conduct Steady State Analysis on Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
Outcome 5	Describe the basic semiconductor devices and applications.	2	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 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	3
Outcome 2	3	3	1		2				1	1		2	2	1	3
Outcome 3	3	3	1		2				1	1		2	2	1	3
Outcome 4	3	3	1		2				1	1		2	1	1	3
Outcome 5	3	3	1		2				1	1		2	2	1	3
Average	**3**	**2**	**1**		**2**				**1**	**1**		**2**	**2**	**1**	**3**

Course Unitization Plan

Exp. No.	Name of Experiment	Required Contact Hours	CLOs Addressed	References Used
1	Verification of Ohm's Law	3	1,2	1, 2
2	Verification of Kirchoff's Law	3	1,2	1, 2
3	Verification of Superposition theorem	3	1,3	1, 2
4	Verification of Thevenin's and Norton's theorem	3	1,3	1, 3
5	Verification of Maximum Power transfer theorem.	3	3,4	1, 2
6	P-N junction diode I-V characteristics	3	1,5	4, 5
7	Application of P-N junction diode	3	1,5	1, 3
8	BJT I-V characteristics (I/P and O/P)	3	4,5	1, 2
9	Op-Amp Inverting and Non-inverting mode - Gain verification	3	1,5	2, 4
10	Verification of truth tables of basic logic gates	3	3,5	1, 2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)			End Semester Exam (50%)
		Lab Performance (20%)	Observation Notes (10%)	Viva Voce + Model examination (20%)	
Level 1	Remember	30%	60%	30%	30%
	Understand				
Level 2	Apply	70%	40%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

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

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011

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

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Environmental Science

Course Code	ENV 111	Course Category	FIC	L	T	P	C
				2	0	0	2
Pre-Requisite Course(s)	Environmental Science	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department		Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Aims to provide a comprehensive introduction to wide-ranging environmental issues and their drivers.
2. To understand numerous approaches to reduce a variety of contemporary environmental problems for a sustainable future.

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 sustainable solutions for various environmental issues.	3	80%	70%
Outcome 2	Interpret the functioning of ecosystems, matter cycling, and diversity of species around us.	3	80%	70%
Outcome 3	Investigate natural resources and impact of their overexploitation on our environment.	4	80%	70%
Outcome 4	Inspect the extent of environmental pollution and diverse regulations, policies and efforts to reduce the environmental burden.	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	1	-	-	-	-	-	3	1	-	-	-	1			
Outcome 2	1	1	-	-	-	-	3	-	-	-	-	1			
Outcome 3	1	-	-	-	-	-	3	-	-	-	-	1			
Outcome 4	1	1	-	-	-	-	3	-	-	-	-	1			
Average	1	1	-	-	-	-	3	1	-	-	-	1			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**ENVIRONMENTAL CRISIS AND SUSTAINABLE DEVELOPMENT**	**3**	1	1, 2
	Need for environmental science studies, Fundamentals of ENV – Atmosphere, lithosphere, hydrosphere, biosphere. Global environmental crisis and its causes, Man-Environment relationship & interaction	2		
	Ecological footprint, Sustainable development	1		
Unit 2	**ECOSYSTEMS**	**5**	2, 3	1, 3
	Ecosystem - Structure and functions of an ecosystem	1		
	Energy flow in an ecosystem, biomass flow in an ecosystem, food chain and web, Ecological Succession	1		
	Ecological pyramid, Water cycle, Carbon cycle, Sulphur cycle, Nitrogen cycle	1		
	Forest ecosystems: tropical rain forest, coniferous forests, tundra forests, temperate forests, Grasslands and desert ecosystems	2		
	Aquatic ecosystems: Freshwater zones, streams, rivers, state of rivers in India, wetlands, Zones in ocean, ocean activities, coastal zones, Estuaries, Mangroves	1		
Unit 3	**RENEWABLE AND NON-RENEWABLE RESOURCES**	**5**	3, 4	1, 2
	Energy resources: Global energy crisis, energy sources, energy needs, global energy consumption, Renewable and Non-renewable energy sources: Hydropower, Solar, tidal, wind, energy, Bioenergy, coal, natural gas	2		
	Energy resources: fossil fuel vs renewable fuels, peak oil Conventional and unconventional oil, oil price determination	1		
	Environmental implications of Energy use: India and world, Energy use pattern – national and global	1		
	Water availability, Water for irrigation, water situation in India	1		
Unit 4	**BIODIVERSITY**	**6**	2, 3	1, 2, 3
	Significance of biodiversity, Current state of biodiversity: National and global, Causes of biodiversity loss	2		
	Biological hotspots, aquatic biodiversity	1		
	Endangered species and endemic species of India	1		
	Biodiversity conservation: Seed banks, botanical gardens, marine biodiversity protection, national and international efforts	2		
Unit 5	**Environmental Pollution and Control**	**11**	1, 4	1, 2, 4
	Types of Environmental Pollution Air pollution: Sources, effects, and control Air standards, Air pollution in India and the world Sources of air pollution, Outdoor & Indoor air pollution Point source, mobile, area source, Effects of air pollution: Smog, urban heat island, ozone layer depletion, acid rain, Controlling air pollution: Emission regulation, e-cars	2		
	Water pollution: Sources & effects, Water Quality standards, Water pollutants, eutrophication, thermal pollution, bio-magnification, Wastewater treatment, Methods of water purification	2		
	Soil pollution: Sources, causes and effects Control of soil pollution: Air purging, phytoremediation, and bio-remediation	2		

	Solid waste management, Types and sources of solid wastes, Hazardous waste, and electronic wastes, Recycling, and management of solid wastes (4Rs), Sanitary landfills and leachate management	2		
	Noise pollution: Sources, effects, and control Air quality standards with respect to noise	1		
	Introduction to Climate change: Impact of climate change, IPCC assessment, Carbon footprint, carbon sequestration, carbon trade, carbon credits, Kyoto protocol, Montreal protocol, Paris agreement	2		
	Lab Experiment / Practical	**30**	4	4
1	Determination of turbidity and pH of water	3		
2	Determination of total suspended solids and total dissolved solids	3		
3	Measurement of Alkalinity & Acidity	4		
4	Measurement of dissolved oxygen using Winkler Method	4		
5	Determination of Biochemical Oxygen Demand	4		
6	Determination of Chemical Oxygen Demand	4		
7	Determination of hardness of water	4		
8	Determination of iron concentration in water	4		

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	70%		70%						30%	
	Understand										
Level 2	Apply	30%	-	30%	-	70%	-	70%		30%	
	Analyse										
Level 3	Evaluate							30%		40%	
	Create										
Total		**100%**		**100%**				**100%**		**100%**	

Recommended Resources

1. R. Rajagopalan (2016). Environmental Studies (3rd edition), Oxford University Press.
2. Deeksha Dave, S.S. Katewa (2012). Textbook of Environmental Studies (2nd edition), Cengage.
3. W. Cunningham, M. Cunningham (2016). Principles of Environmental Science (8th Edition), McGraw-Hill.
4. APHA and AWWA (1999): Standard Methods for the Examination of Water and Wastewater. American Public Health Association (APHA), 20th Ed, Washington, D.C., USA

Other Resources

1. KL Rao (1979). India's water wealth. Orient Black Swan.
2. Saadat, S., Rawtani, D., & Hussain, C. M. (2020). Environmental perspective of COVID-19. Science of The Total Environment, 138870.

Course Designers

1. Dr Pankaj Pathak, Assistant Professor, Department of Environmental Science, SRM University AP
2. Dr Shoji, Assistant Professor, Department of Environmental Science, SRM University AP.

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Chemistry for Engineers

Course Code	CHE 103	**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	Chemistry	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To distinguish the types of bonding and can predict the structure, electronic and magnetic properties of small molecules.
2. To learn the type of chemical reactions based on the reaction energetics and kinetics. Also interpret stability of the binary materials based on temperature, pressure, and concentration.
3. To gain in-depth knowledge about crystalline materials.
4. To understand the types of polymers and familiar with industrial applications of common synthetic and biodegradable polymers.
5. To learn the formation of proper electrochemical cell. Also, can choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions.

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	Distinguish the types of bonding and also can predict the structure, electronic and magnetic properties of small molecules	2	70%	85%
Outcome 2	Interpret Phase rule and Kinetics based on temperature, pressure, and concentration	2	70%	85%
Outcome 3	Summarize crystalline materials.	2	70%	85%
Outcome 4	Identify the types of polymers and industrial applications of common synthetic and biodegradable polymers	2	70%	85%
Outcome 5	Demonstrate electrochemical cell	3	70%	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		2	1	2	1	2	2		2	3	1	2	3	2	2
Outcome 2		2	3	2	2	2	2		2	2	2	1	2	2	2
Outcome 3		2	3	2	2	1	2		2	2	1	2	2	2	3
Outcome 4		2	2	2	2	1	2		2	2	2	2	2	2	2
Outcome 5		2	2	2	2	1	1		1	1	1	2	2	3	2
Average		2	2	2	2	2	2		2	2	1	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**CHEMICAL BONDING**	**13**		
	Ionic, covalent, and metallic bonds	1	1	1, 2, 4
	Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond.	1	1	1, 2, 4
	Hybridization: Types of hybridization, sp, sp2, sp3, sp3d, d2sp3.	1	1	1, 2, 4
	Shapes of molecules (VSEPR Theory): $BeCl_2$, CO_2, BF_3, H_2O, NH_3, CH_4, PCl_5, XeF_2, SF_6, XeF_4.	4	1	1, 2, 4
	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method)	1	1	1, 2, 4
	Bond order, homo- nuclear diatomic Molecules (H_2, O_2, N_2)	1	1	1, 2, 4
	Hetero-nuclear diatomic Molecules (NO, CO).	1	1	1, 2, 4
	Non-covalent interactions: Van der Waals interactions	1	1	1, 2, 4
	Dipole-dipole interactions	1	1	1, 2, 4
	Hydrogen bonding	1	1	1, 2, 4
Unit 2	**PHASE RULE, THERMOCHEMISTRY AND KINETICS**	**9**		
	Phase rule: Introduction	1	2	1, 2, 4
	Definition of the terms used in phase rule with examples	1	2	1, 2, 4
	Application of phase rule to water system water system	1	2	1, 2, 4
	Basics of thermochemistry: Standard terms in thermochemistry and their significance.	1	2	1, 2, 4
	Heat of combustion, formation and sublimation (with examples in fuels and propellants).	2	2	1, 2, 4
	Kinetics: Order and molecularity of reactions	1	2	1, 2, 4
	Zero order and first order reactions	1	2	1, 2, 4
	Second order reactions	1	2	1, 2, 4
Unit 3	**CRYSTALLINE AND ELECTRONIC MATERIALS**	**10**		
	Crystal structure: crystal systems	2	3	2,4
	Properties of cubic crystals, Bragg's Law, Bravais lattices	1	3	2,4
	Miller indices	2	3	2,4
	Point defects	1	3	2,4
	Band theory: metals, insulators, and semiconductors.	2	3	2,4
	Band gaps, doping, anddevices.	2	3	2,4
Unit 4	**MATERIALS CHEMISTRY**	**9**		
	Classification of polymers: Natural and synthetic.	1	4	1, 3
	Thermoplastic and Thermosetting polymers. Degree of polymerization.	2	4	1, 3
	Properties of polymers: Tg, Tacticity, Molecular weight, weight average.	2	4	1, 3
	Degradation of polymer	1	4	1, 3
	Common Polymers: Elastomer, Conducting polymer, biodegradable polymer.	1	4	1, 3
	Examples: PET (Polyethylene terephthalate), nylon, polystyrene.	1	4	1, 3
	Demineralization of water and Zeolite process.	1	4	1, 3
Unit 5	**ELECTROCHEMISTRY**	**4**		
	Electrochemical cells	1	5	1, 2, 4
	Primary and secondary cells	1	5	1, 2, 4
	Lead-acid battery	1	5	1, 2, 4
	Li+ batteries and Fuel cells	1	5	1, 2, 4
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 (10%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%		60%		40%		30%	
	Understand										
Level 2	Apply	40%		60%		40%		60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. A. Bahl, B.S. Bahl, G.D. Tuli, Essentials of Physical Chemistry, (2016), S Chand Publishing Company
2. T. Jain, Y. Jain, Engineering Chemistry, 16th Edition (2017), Dhanpat Rai Publication Company
3. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International, 1986. ISBN: 0-85226-307-4
4. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Edition (2013), Vishal Publication Company

Other Resources

Course Designers

1. Dr. S. Mannathan, Associate Professor, Department of Chemistry, SRM University – AP.
2. Dr. S. Chakrabortty, Assistant Professor, Department of Chemistry, SRM University – AP.
3. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
4. Prof. K.C. Kumaraswamy, Professor, Department of Chemistry, University of Hyderabad.
5. Prof. G Ranga Rao, Professor, Department of Chemistry, IITM.

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Neerukonda, Mangalagiri Mandal,
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Chemistry for Engineers Lab

Course Code	CHE 103L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CHE 103	**Progressive Course(s)**				
Course Offering Department	Chemistry	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. To gain knowledge on different kinds of quantitative analyses.
2. To apply various analytical titration techniques.

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	Choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions	3	70%	80%
Outcome 2	Predict the pH and pOH of the given solutions	4	70%	80%
Outcome 3	Explain the principles and working of electrochemistry.	3	70%	80%
Outcome 4	Demonstrate the electroanalytical technique in the volumetric titration.	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 Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	2	2	2	2	2	2		1	2		2	2	3	2
Outcome 2	2	2	3	2	1	2	2		2	2		2	2	2	2
Outcome 3	2	2	1	2	2	2	1		2	1		2	2	2	2
Outcome 4	2	2	2	2	2	1	1		2	2		2	2	2	3
Average	2	2	2	2	2	2	2		2	2		2	2	2	2

Course Unitization Plan

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Volumetric titration of HCl vs NaOH	4	2,4	1,2,3
2	Standardization of potassium permanganate by Oxalic acid	4	2,4	1,2,3
3	Conductometric titration of HCl vs NaOH	4	2,4	1,2,3
4	Determination of strength of given hydrochloric acid using pH meter	4	3,4	1,2,3
5	Determination of hardness of water by EDTA method	4	1,2	1,2,3
6	Estimation of iron content of the given solution using potentiometer	4	3,4	1,2,3
7	Iodometric Determination of Ascorbic Acid (Vitamin C)	6	1,2	1,2,3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Experiments (20%)		Record/ Observation Note (10%)		Viva Voce + Model examination (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember		40%		40%		60%		50%
	Understand								
Level 2	Apply		60%		60%		40%		50%
	Analyse								
Level 3	Evaluate								
	Create								
Total		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Text Book of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Text Book of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.

Other Resources

Course Designers

1. Internal (Institutional) Subject Matter Experts
2. Dr. S. Mannathan, Associate Professor, Department of Chemistry, SRM University – AP.
3. Dr. Sabyasachi Chakrabortty, Associate Professor, Department of Chemistry, SRM University – AP.
4. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
5. Prof. K.C. Kumaraswamy, Professor, Department of Chemistry, University of Hyderabad.
6. Prof. G. Ranga Rao, Professor, Department of Chemistry, IITM.

SRM University *AP*, Andhra Pradesh

Neerukonda, Mangalagiri Mandal,
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Engineering Physics

Course Code	PHY 101	Course Category	FIC		L	T	P	C
					2	0	0	2
Pre-Requisite Course(s)		Co-Requisite Course(s)	PHY 101L	Progressive Course(s)				
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	Interpret experimental observation that led to the progress of modern physics and optics	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	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	2	2	2	1			2	2			2	2	1	2
Average	2.0	2.5	1.8	1.8	1.5			1.8	2.0			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	**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, 2, 3	1, 4
	Electrostatic field due to conducting and insulating sphere.	1	1, 2, 3	1, 4
	Concept of Electrostatic Potential and Potential Energy. Inter-relation with electrostatic field.	1	1	1, 4
	Capacitor and Capacitance:	1	1	1, 4
	Capacitance of a parallel plate capacitor.	1	1, 2, 3	1, 4
Unit No. 3	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, 2, 3	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, 4	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
Unit No. 4	Concept of Electromagnetic waves & EMW Spectra	1	1	1, 2
	Geometrical & Wave Optics: Laws of reflection and refraction	1	1	1, 2
	Concept of Interference	1	1	1, 2
	Phase Difference and Path Difference	1	1	1, 2
	Newton's Ring	1	1, 2	1, 2
	The Michelson Interferometer	1	1, 2, 3, 4	1, 2
Unit No. 5	Black Body Radiation; Wien's displacement law	1	1, 2	1, 2
	Discussion on failure of classical laws to explain Black Body Radiation, and concept of Planck's Hypothesis	1	1, 4	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, 4	1, 2
	Photoelectric effect – Intensity vs Current, Frequency vs Kinetic Energy, the drawback of Wave theory to explain Photoelectric effect	1	1, 2, 3, 4	1, 2
	Wave properties of particle: De Broglie wave	1	1, 4	1, 2

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	20%		10%				10%		20%	
	Understand	40%		30%				30%		40%	
Level 2	Apply	30%		40%				40%		30%	
	Analyse	10%		20%				20%		10%	
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**				**100%**		**100%**	

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

Other 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/

Course Designers

1. Dr. Sidhartha Ghosh, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
2. Dr. Jatis Kumar Dash, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
3. Dr. Pranab Mandal, Assistant Professor & Faculty coordinator, Department of Physics. SRM University – AP, Andhra Pradesh.
4. Prof. M. S. Ramachandra Rao, Professor, Department of Physics, Indian Institute of Technology, Madras.
5. Prof. D. Narayana Rao, Raja Ramanna Fellow, University of Hyderabad, Hyderabad.

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Engineering Physics Lab

Course Code	PHY 101L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 101	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

1. Operate physics equipment and measurement tools following safety protocols.
2. Determine the physical parameters of mechanics, electromagnetism, modern physics and optics.
3. Collect experimental data, analyse, and interpret.

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 experimental set-up and equipment operation	2	75%	70%
Outcome 2	Demonstrate accurate data collection using modern equipment	3	70%	65%
Outcome 3	Evaluate experimental data to interpret and explain the underlying physics concepts	3	70%	65%
Outcome 4	Determine physical properties and verify physics laws	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	2			2	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	3.0	2.0	2.0	2.3			2.0	2.3			2.0	1.8	1.0	1.3

Course Unitization Plan

Exp No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
1	Moment of inertia of a flywheel	2	1,2,3,4	1,2
2	Hooke's law and determine spring constant for a given spring	2	1,2,3,4	1,2
3	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	1,2,3,4	1,2
	To determine the rigidity modulus of steel wire by torsional Pendulum **[Optional]**			
	To calculate Young's modulus of a given material by deflection method **[Optional]**			
4	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2	1,2,3,4	1,2
	To study the B-H curve of the given material and the permeability curve of the given material. [**Optional**]			
5	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	2	1,2,3,4	1,2
	Hall Effect: Determination of type of semiconductor and carrier concentration in a given semiconductor **[optional]**			
	Magnetic field in Helmholtz coil [**Optional**] a. To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field. b. To demonstrate the superposition of the magnetic fields of the two individual coils.			
6	To determine the dielectric constant of air using dielectric constant kit.	4	1,2,3,4	1,2
	Measurement of Resistivity of a semiconductor using Four probes [**Optional**]			
7	Michelson interferometer kit with diode laser	4	1,2,3,4	1,2
	Resolving power of A Telescope **[Optional]**			
	Balmer Series and Rydberg constant **[Optional]**			
8	He-Ne laser kit: Optical Interference and Diffraction	4	1,2,3,4	1,2
	Solar cell characteristics**[Optional]**			
	Frank Hertz Experiment **[Optional]**			
9	Particle size measurement	2	1,2,3,4	1,2
10	Verification of Stefan's Law	4	1,2,3,4	1,2
	Measurement of specific heat capacity of any given material **[optional]**			

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50 %)						End Semester Exam (50 %)	
		Experiments (20 %)		Record Book/ Observation Note (10 %)		Mid Term - Model Exam (20 %)			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember				20%		10%		
	Understand				20%		20%		
Level 2	Apply		20%		20%		10%		20%
	Analyse		20%		40%		20%		30%
Level 3	Evaluate		60%				40%		50%
	Create								
Total			**100%**		**100%**		**100%**		**100%**

Recommended Resources

1. Shukla, R. K., & Srivastava, A. (2006). *Practical Physics*. New Delhi: New Age International (P) Limited Publishers.
2. 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

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2. Dr. Jatis Kumar Dash, Assistant Professor, Department of Physics, SRM University – AP, Andhra Pradesh.
3. Dr. Pranab Mandal, Assistant Professor & Faculty coordinator, Department of Physics. SRM University – AP, Andhra Pradesh.
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Electronic Workshop-I with Arduino Uno

Course Code	ECE 119	**Course Category**	CC	**L**	**T**	**P**	**C**
				1	0	1	2
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. To be able to comprehend the smart IoT system design for different applications in Communication, Defence, Space, and Civil such as agriculture, smart cities, and so on.
2. To be able to understand the different IoT kits and sensors and their efficient use.
3. To be able to build a circuit at the system level and code for meaningful operation.
4. To be able to debug the IoT circuit.

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 different IoT kits and sensors, their operation, specifications, advantages, and drawbacks.	2	85%	85%
Outcome 2	Explain the use of IoT technology for efficient and low-cost solutions related to agriculture, smart cities, management, tracking, scanning, sensing, etc.	2	75%	75%
Outcome 3	Explain the circuit design, relevant code, and its debug.	2	80%	75%
Outcome 4	Understanding about IoT system simulation and analyses.	4	70%	75%
Outcome 5	Interpret data acquisition for data analysis based on ML/AI.	2	85%	80%
Outcome 6	Different IoT system designs.	6	55%	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	3	2			1		1			1	1		
Outcome 2	3	1	2	2	1		1		1			1	2	1	
Outcome 3	3	1	2	2	2		1		1			1	1		
Outcome 4	3	3	3	3	3		3		2		1	3	2	2	1
Outcome 5	2	1	2	2	3				2			1	2	2	
Outcome 6	3	3	3	3	3		3		3		2	3	3	2	3
Average	3	2	3	2	2		2		2		2	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**7**		
	IoT Systems and applications	1.5	1,2	1,2
	Basic understanding of functions	1.5	1,2	1,2
	Read and write data from sensors	3	1,2,3,4,5,6	1,2
	Data processing	2	1,2,3,4,5,6	1,2
	coding	2	1,2	1,2
Unit 2	**IoT Circuit Analysis**	**8**		
	Introduction to Arduino Uno, Nano, Mega, and Programming.	2	1,2,3	1,2
	Arduino and LED, LCD displays	1	2,4,6	1,2
	Arduino and Digital Input/Output Devices	2	1,2,3,4,5,6	1,2
	Arduino and Wireless Communication: Transmitter	1	1,3,5,6	
	Arduino and Wireless Communication: Receiver	1	1,3,5,6	1,2
	Arduino and Wireless Communication: Transceiver	1	1,3,5,6	1,2
Unit 3	**Mini Project I**	**10**		
	IoT system-related smart agriculture	10	1,2,3,4,5,6	1,2
Unit 4	**Mini Project II**	**10**		
	IoT system-related smart city	10	1,2,3,4,5,6	1,2
Unit 5	**Mini Project III**	**10**		
	IoT system-related smart home	10	1,2,3,4,5,6	1,2
	Total Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (70%)**								**End Semester Exam (30%)**	
		CLA-1 (25%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**CLA-3 (20%)**			
		Th (10%)	**Prac** (15%)	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th (20%)**	**Prac (10%)**
Level 1	Remember	10%	10%	15%	15%	15%	15%	15%	15%	20%	20%
	Understand										
Level 2	Apply	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyse										
Level 3	Evaluate	25%	25%	15%	15%	15%	15%	15%	15%	10%	10%
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Rajesh Singh, Anita Gehlot, and Bhupendra Singh, "Arduino-Based Embedded Systems: Interfacing, Simulation, and LabVIEW GUI ", Taylor and Francis, CRC press, 2018.
2. Jeremy Blum, "EXPLORINGARDUINO®: Tools and Techniques for Engineering Wizardry", Wiley 2nd Edition, 2020.

Other Resources

Course Designers

1. Dr. Rupesh Kumar. Professor. Dept of ECE. SRM University - AP

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Industry Standard Coding Practice - I

Course Code	CSE 131	**Course Category**	SEC	**L**	**T**	**P**	**C**
				0	0	2	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. Develop foundational programming skills.
2. Enhance problem-solving abilities with a focus on efficiency.
3. Master advanced programming concepts related to memory.
4. Explore advanced problem-solving techniques and programming constructs.
5. Introduce Python programming for problem-solving.

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	Students will have a strong foundation in basic coding practices and be able to apply them to solve programming problems.	3	75%	70%
Outcome 2	Students will develop efficient problem-solving skills, especially in dealing with linear list data, arrays, and matrix-related challenges.	4	70%	60%
Outcome 3	Proficiency in advanced programming concepts like pointers, memory handling, and string manipulation will be achieved.	4	75%	70%
Outcome 4	Students will gain expertise in advanced problem-solving techniques, including parameter passing, recursion, and working with structures and unions.	5	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 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
Outcome 1	2	3	1	1	3	-	-	-	-	-	-	1	3	2	-
Outcome 2	2	3	1	1	3	-	-	-	-	-	-	1	3	2	-
Outcome 3	2	3	1	1	3	-	-	-	-	-	-	1	3	2	-
Outcome 4	2	3	1	1	3	-	-	-	-	-	-	1	3	2	-
Average	2	3	1	1	3	-	-	-	-	-	-	1	3	2	-

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	Problem Solving with - Basic coding practices	10		
	Expression Evaluation	2	1	1,2
	Operators Usage	2	1	1,2
	Expressions	2	1	1,2
	Control Structures	2	1	1,2
	Loop & Iterations for all test case scenarios	2	1	1,2
Unit II	Problem Solving using time efficient logics	12		
	Linear list data	4	2	1,2
	Array problems	4	2	1,2
	2D Arrays and Matrix Data for all test case scenarios	4	2	1,2
Unit III	Problem Solving	8		
	Pointers & Memory referencing,	4	3	1,2
	String Handling functions for all test case scenarios	4	3	1,2
Unit IV	Problem Solving	8		
	Parameter passing	2	4	1,2
	Recursion	2	4	1,2
	Recursion Analysis	2	4	1,2
	Structures and unions	2	4	1,2
	Enumerations & Memory allocation for all test case scenarios	1	4	1,2
Unit V	Problem Solving using Python	12		
	String manipulations	2	3	3
	Lists	2	2	3
	Display patterns	1	2	3
	Matrix	2	2	3
	Tuples	1	2	3
	Dictionaries	1	2	3
	Modules	1	4	3
	Packages	1	4	3
	Exception handling	1	4	3
Total Hours		**50**		

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%)		Theory 30%	Practical 20%
Level 1	Remember							
	Understand							
Level 2	Apply	80%	70%	80%	70%	40%	70%	
	Analyse							
Level 3	Evaluate	20%	30%	20%	30%	40%	30%	100%
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Problem solving with C++ -9e- Walter Savitch – Pearson.
2. The complete Reference C, Fourth REdition – Herbert Schildt – MC Graw Hill.
3. Programming in Python 3, A complete introduction to Python language - 2e - Mark Summerfield – Addison-Wiley.

Other Resources

Course Designers

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Network Analysis

Course Code	EEE 113	Course Category	CC	L	T	P	C
				3	1	0	4
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. To remember different laws and understand the electrical circuits.
2. To understand and analyse the response of electrical circuits to different types of signals.
3. To understand the frequency response and Q-factors of different electrical components.
4. To design electrical systems and analyse their parameters

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	Study different laws and understand the electrical circuits	2	80%	70%
Outcome 2	Apply the laws to understand the response of electrical circuits to different signals	3	70%	70%
Outcome 3	Understand the frequency response and Q-factor of electrical components	4	65%	70%
Outcome 4	Design electrical systems and verify their functioning	4	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	3	3	1									1	2	3	1
Outcome 2	3	3	1									1	2	3	1
Outcome 3	3	2	3	2								1	2	3	1
Outcome 4	3	1	2	3								1	1	2	3
Average	3	3	2	3								1	2	3	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Basic laws and circuit theorems**	**7**		
	Review of Kirchhoff's Laws	1	1	1, 2
	Circuit Analysis - Nodal and Mesh	1	1	1, 2
	Linearity and Superposition	1	1	1, 2
	Source Transformations	2	1	1, 2
	Thevenin and Norton Equivalents	2	1	1, 2
Unit 2	**Capacitors and inductors with first order and second order circuits**	**7**		
	Review of Inductor and Capacitor as Circuit Elements	1	2	2
	Source-free RL and RC Circuits	2	2	2
	Transient Response, Unit-Step Forcing	2	2	2
	Forced Response, RLC Circuit	2	2	2
Unit 3	**Sinusoids and phasors with steady state analysis**	**12**		
	Sinusoidal Forcing, Complex Forcing	2	3	1, 2
	Phasors, and Complex Impedance	2	3	1,2
	Sinusoidal Steady State Response	2	3	1, 2
	Nodal and Mesh Revisited	2	3	1, 2
	Average Power, RMS	2	3	1, 2
	Introduction to Polyphase Circuits	2	3	1, 2
Unit 4	**Magnetically coupled circuits**	**8**		
	Mutual Inductance	1	4	2
	Linear and Ideal Transformers	1	4	2
	Circuits with Mutual Inductance	2	4	2
	Frequency Response of Series/Parallel Resonances	2	4	2
	High-Q Circuits	2	4	2
Unit 5	**Frequency response**	**11**		
	Complex Frequency	1	4	2
	s-Plane, Poles and Zeros	2	4	2
	Response Function	2	4	2
	Bode Plots	2	4	2
	Two Port Networks, Admittance, Impedance	2	4	2
	Hybrid and Transmittance Parameters	2	4	2
Tutorial		**14**		
Total Hours		**59**		

Learning Assessment

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

Recommended Resources

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition, 2019.
2. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven M. Durbin, 9 th Edition 2020.

Other Resources

Course Designers

1. Dr. Rituparna Choudhury, Assistant Professor, Department of Electronics & Communication Engineering, SRM University - AP.

SRM University *AP*, Andhra Pradesh

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

Analytical Skills for Sciences

Course Code	AEC 105	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	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 Aptitude 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**			
	Data interpretation – Introduction and basics to solve data interpretation	4	1,4	1,4
	Data interpretation line graphs, Data interpretation bar graph.	6	1,4	1,4
Unit II	**Quants**			
	Data interpretation – Pie charts,	2	1,4	1,4
	Data interpretation – Tabular, Data interpretation – case lets.	2	1,4	1,4
Unit III	Statistics	6	1,2	2,3
Unit IV	Functions and graphs	3	1,2	1,2
	graph theory with respect to coding	2	1,2	1,2
	math graph theory and coding problems	2	2,3	2,3
	discrete planar theory and coding problems.	3	1,2	2,4
Total 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

1. Arun Sharma – How to prepare for Quantitative Aptitude, Tata Mcgraw Hill.
2. R.S. Agarwal – Reasoning. Reasoning for competitive exams – Agarwal.
3. Objective Quantitative Aptitude – Oswaal books.
4. Test of reasoning and numerical ability, quantitative aptitude book – Sahitya bhavan.
5. Radian's Quantitative Aptitude.
6. Quantitative Aptitude and Reasoning – Shyam Saraf / Abhilasha Swarup.
7. Fast track objective Arithmetic – Rajesh Verma.

Other Resources

Course Designers

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

Differential Equations

Course Code	FIC 106	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 111	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Introduction to the theory, qualitative & quantitative analysis of solutions of ordinary differential equations (ODEs).
2. Equip the student with various solution techniques and modelling of linear and non-linear first and second-order differential equations, including systems of equations.

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 genesis of ordinary differential equations and geometrical interpretation.	2	70%	70%
Outcome 2	Solve first and higher order linear differential equations.	3	80%	70%
Outcome 3	Apply Picard's method of obtaining successive approximations of solutions to first order differential equations and power series method for higher order linear equations.	4	80%	70%
Outcome 4	Demonstrate the general solution of a linear differential equation using Laplace transformation technique.	4	70%	70%
Outcome 5	Formulate mathematical models for physical, chemical, and biological disciplines in the form of ordinary differential equations.	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	2	3		1					3						
Outcome 2	3	3		1					3						
Outcome 3	2	3		1					3						
Outcome 4	3	3		2					3						
Outcome 5	3	2		2					3						
Average	3	2		2					2						

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit-I	**First Order Differential Equations**	**8**		
1	Geometric meaning of y'=f(x,y), Direction Fields	1	CO1	1
2	Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable	1	CO1, CO2	1,2
3	Integrating Factor, Bernoulli Equations	2	CO1, CO2	1,2
4	Existence of solution to initial value problem and Picard's approximation	2	CO1, CO3	1,2
5	Modelling (Free falling object, Radioactivity, RL-circuit).	2	CO5	1
Unit-II	**Second and Higher Order Linear ODEs**	**8**		
6	Homogeneous Linear ODEs	1	CO2	1,2
7	Modelling of Free Oscillations of a Mass-Spring System	2	CO5	1
8	Euler-Cauchy Equations	1	CO2	1,2
9	Non-homogeneous ODEs	2	CO2,CO4	1,2
10	Variation of Parameters, Modelling (Forced Oscillations, Electric Circuits)	2	CO2,CO5	1,2
Unit-III	**System of ODEs**	**9**		
11	Modelling physical problems as systems of ODEs	2	CO5	1
12	Wronskian, Phase-Plane Method	2	CO4	1,2
13	Qualitative Methods for Nonlinear Systems: Critical Points & Stability	3	CO4	1,2
14	Nonhomogeneous Linear Systems of ODEs	2	CO2, CO4	1,2
Unit-IV	**Series Solutions of ODEs**	**10**		
15	Introduction to power series method	1	CO1	1,2
16	Legendre's equation & polynomials	2	CO3	1,2
17	Properties of Legendre's polynomial and generating functio	2	CO3	1,2
18	Frobenius Method	2	CO2,CO3	1,2
19	Bessel's Equations & Functions and their properties	3	CO2,CO3	1,2
Unit-V	**Laplace Transforms**	**10**		
20	Existence of Laplace transform, and Laplace transform of standard functions	1	CO2,CO4	1,2
21	Shifting Theorems, Transforms of derivatives and integrals	2	CO3	1,2
22	Unit step function, Dirac's delta function	2	CO3	1,2
23	Inverse Laplace transforms, Convolution	2	CO3	1,2
24	Application: Solutions of ordinary differential equations using Laplace transforms	3	CO4,CO5	1,2
Total 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	60%	50%	50%	50%	60%
	Understand					
Level 2	Apply	40%	50%	50%	50%	40%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William Boyce and Richard DiPrima, Elementary Differential Equations and Boundary Value Problems, 11th Edition, Wiley-India.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Other Resources

Course Designers

1. Dr. Tapan Kumar Hota, Assistant Professor, Dept. of Mathematics, SRM University-AP
2. Dr. Koyel Chakravarty, Assistant Professor, Dept. of Mathematics, SRM University-AP

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

Hands on With Python

Course Code	ECE 201	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	1	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. 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	Efficiently manage data by selecting appropriate data structures for mutable and immutable types.	1,2	85%	80%
Outcome 2	Demonstrate clear code logic and improved readability through proficient use of data type operations.	1,2	85%	80%
Outcome 3	Master flow control statements and functions to design programs with robust control flow and modular code structures.	1,2	85%	80%
Outcome 4	Develop skills to design resilient software capable of handling errors gracefully.	1,2	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	2				2			3	1	1	3
Outcome 2	1	1	3	2	2				2			3	1	1	3
Outcome 3	1	1	3	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

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)								End Semester Exam (40%)	
		CLA-1 (20%)		Mid-1 (10%)		CLA-2 (15%)		CLA-3 (15%)			
		Th	**Prac**	Th	Prac	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	60%	40%	50%	40%	40%	40%	50%	40%	40%	40%
	Understand										
Level 2	Apply	40%	60%	50%	60%	60%	60%	50%	60%	60%	60%
	Analyze										
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.

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

Digital Design with HDL

Course Code	ECE 202	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	ECE 211	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To familiarize students with industry standard HDL based FPGA design flow and introduction to one of the HDL such as Verilog.
2. To review combinational logic circuits and circuit design using Verilog
3. To review sequential logic circuits, FSMs and circuit design using Verilog
4. To familiarize students with state of the art Xilinx FPGA architectures and implement digital circuits on Xilinx FPGA

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	Thorough with one of the industry standard HDLs, Verilog	2	80%	70%
Outcome 2	Apply combinational logic design concepts and able to design using Verilog	3	80%	65%
Outcome 3	Apply sequential logic design concepts and FSM design concepts and able to design using Verilog	3	70%	65%
Outcome 4	Able to design and implement digital circuits on Xilinx FPGA	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	3	2	2	2	2			2	2	2		2	1	3	2
Outcome 2	3	2	2	2	2			2	2	2		2	1	3	2
Outcome 3	3	2	2	2	2			2	2	2		2	1	3	2
Outcome 4	3	2	2	2	2			2	2	2		2	1	3	2
Average	3	2	2	2	2			2	2	2		2	1	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INTRODUCTION TO LOGIC DESIGN USING VERILOG HDL**	**7**		
	Introduction to HDL	1	1	1, 2
	Expressions, Modules and Ports, Built-in Primitives, User-Defined Primitives	2	1	1, 2
	Dataflow Modeling, Behavioral Modeling, Structural Modeling	1	1	1, 2
	Tasks and Functions	2	1	1, 2
	Testbenches	1	1	1, 2
Unit 2	**COMBINATIONAL AND SEQUENTIAL LOGIC DESIGN USING VERILOG HDL**	**6**		
	Adder, subtractor, multiplexer	1	2	2
	Priority encoder, magnitude comparator	1	2	2
	ALU sequential logic, latches, flipflops	2	2	2, 3
	Counters, registers	2	2	2, 3
Unit 3	**FIELD PROGRAMMABLE GATE ARRAYS**	**9**		
	FPGA Evolution, Programmable Logic Devices, Field Programmable Gate Arrays, FPGA Design Techniques	2	3	1, 2
	Design Constraints using FPGAs	1	3	1, 2
	Design Automation of FPGAs	1	3	1, 2
	Simulation, Synthesis, RTL Design Flow	1	3	1, 2
	Physical Design Flow	1	3	1, 2
	Place and Route, Timing Analysis	2	3	1, 2
	Design pitfalls	1	3	1, 2
Unit 4	**BEST PRACTICES FOR SUCCESSFUL FPGA DESIGN**	14		
	Three Steps to Successful FPGA design, The Role of Project Management, Design Specification: Communication Is Key to Success	2	4	2, 3
	Engineering Resources, Device Selection, FPGA design environment	2	4	2, 3
	Challenges That FPGAs Create for Board Design, Key Factors in Accurate Power Estimation	2	4	2, 3
	Recommended Team Based Design Flow	2	4	2, 3
	RTL Design for FPGA devices, Writing Effective HDL	2	4	2, 3
	RTL Coding Styles for Synthesis, Analyzing the RTL Design	2	4	2, 3
	Timing Closure Challenges, Design Sign-off	2	4	2, 3
Unit 5	**HDL COMPLEX DESIGN EXAMPLES AND FPGA APPLICATIONS-FSM design**	9		
	Moore and Mealy FSM design examples1- 3 or more consecutive 1s detector	2	4	2
	Moore and Mealy FSM design examples2- Vending machine FSM	2	4	2
	Design of Computer Arithmetic Designs- Floating-Point Addition.	2	4	2
	Design of Computer Arithmetic Designs- Floating-Point multiplier	3	4	2
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Verilog HDL Implementation, Simulation and Synthesis of Logic gates, 1-bit Adder, subtractors	3	1	1, 4
2.	Verilog HDL Implementation, Simulation and Synthesis of Decoders, Multiplexers and Magnitude comparators	3	2	1, 4
3.	Verilog HDL Implementation, Simulation and Synthesis of 4- bit adder, subtractors.	3	2	1, 4
4.	Verilog HDL Implementation, Simulation and Synthesis of Latches and Flip-flops	3	2	1, 4
5.	Verilog HDL Implementation, Simulation and Synthesis of 4-bit Register, Counter, Shift register, universal shift register	3	2	1, 4
6.	Verilog HDL Implementation, Simulation and Synthesis of FSMs	3	2	3, 4
7.	FPGA Introduction and Implementation of above simple Designs.	3	3	3, 4
8.	FPGA Introduction and Implementation of above complex Designs.	3	3	3, 4
9.	Course Project	6	4	1, 3, 4
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (70%)								End Semester Exam (30%)	
		CLA-1 (20%)		Mid-1 (15%)		CLA-2 (15%)		CLA-3 (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	20%	40%	40%	30%	20%	30%	20%	30%	40%	25%
	Understand										
Level 2	Apply	80%	60%	60%	70%	80%	40%	80%	50%	60%	70%
	Analyse										
Level 3	Evaluate						30%		20%		5%
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Joseph Cavanagh, Verilog HDL Design Examples, Taylor and Francis, CRC press, 2018.
2. Peter Wilson - Design Recipes for FPGAs using Verilog and VHDL [2nd ed.]-Elsevier (2016).
3. Philip Andrew Simpson (auth.) - FPGA Design_ Best Practices for Team-based Reuse-Springer International Publishing (2015).
4. Pong P. Chu - FPGA Prototyping Using Verilog Examples, Springer.
5. Douglas J Smith-HDL Chip Design: A Practical Guide for Designing, Synthesizing and Simulating ASICs and FPGAs using VHDL or Verilog, Doone Publications.

Other Resources

Course Designers

1. Dr Ramesh Vaddi, Associate Professor, Department of Electronics & Communication Engineering, SRM University - AP.

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

Signals and Systems

Course Code	ECE 203	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. Understand the mathematical representation of continuous and discrete time signals and systems.
2. Learn to build input/output relationship for linear shift invariant system; understand the convolution operator for continuous and discrete time system.
3. Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
4. Understand the limitations of Fourier transform; Understands the necessity of Laplace and Z transform.

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	Classify the given signal and system	2	80%	75%
Outcome 2	Discuss the LTI system and compute its output	2	80%	70%
Outcome 3	Compute the frequency components in the given signal and the bandwidth of signal and system	3	80%	65%
Outcome 4	Design the stable system based on the given parameters	4	80%	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	2	1	2	1					1		3			
Outcome 2	3	3	3	3	3					1		3			
Outcome 3	3	3	3	3	3					1		3			
Outcome 4	3	3	3	3	3					1		3			
Average	3	3	3	3	3					1		3			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Signals classification, transformations, representation**	**9**		
	Classification of signals: continuous-time/discrete-time.	2	1	1,2
	Even odd	1	1	
	Periodic-aperiodic, energy-power, random-deterministic.	1	1	
	Standard signals: impulse, step	1	1	
	Ramp, exponential and sinusoids	1	1	
	Transformations of the independent variable: shifting	1	1	
	Scaling and reversal. Representation of periodic signals using Fourier series	2	1	
	Lab Experiment / Practical / Programming	12	1	
	Plotting even and odd components of continuous-time signals	2	1	
	Plotting even and odd components of discrete-time signals	2	1	
	Time period calculation of continuous time signals	2	1	
	Time period calculation of discrete time signals	2	1	
	Shifting, scaling and reflection of discrete time signals	2	1	
	Energy and power of signals	2	1	
Unit 2	**Systems: classification and time domain analysis**	**9**		
	Classification of systems: linear-nonlinear	1	2	1, 2
	Time-invariant/time-variant	1	2	
	Memory, causal	1	2	
	Continuous-time/discrete-time	1	2	
	LTI System properties: causality, memory	1	2	
	Stability, and invertibility	1	2	
	Impulse response	1	2	
	Linear convolution and discrete-time convolution	1	2	
	Graphical method to solve convolution	1	2	
	Lab Experiment / Practical / Programming	8	2	
	Verification of Reciprocity theorem	4	2	
	Convolution between two discrete time signals	4	2	
Unit 3	**Continuous & discrete time systems: frequency domain analysis**	**9**		
	Introduction to Laplace transform and region of convergence	2	3,4	1, 2
	Properties of Laplace transform	1	3,4	
	Inverse Laplace transform	1	3,4	
	Initial and final value theorems	1	3,4	
	Introduction to Z-transform and its region of convergence	1	3,4	
	Properties of Z-transform	1	3,4	
	Inverse Z-transform	1	3,4	
	The unilateral Z-transform	1	3,4	
	Lab Experiment / Practical / Programming	4		
	Finding of Laplace transform	2	3,4	
	Finding of Z-transforms	2	3,4	
Unit 4	**Continuous & discrete time signals: Fourier analysis**	**9**		
	Introduction to sampling and reconstruction	1	3,4	1, 2
	Aliasing	1	3,4	
	Continuous time Fourier transform (CTFT)	1	3,4	
	Properties of CTFT	1	3,4	
	Convolution property	1	3,4	
	CTFT of periodic signals	1	3,4	
	Discrete time Fourier transform (DTFT) and its properties	2	3,4	
	DTFT of periodic signals	1	3,4	
	Lab Experiment/Practical/Programming	2		
	Fourier series representation of periodic signals	2	3,4	

Unit 5	**Discrete Fourier transform and fft**	**9**		
	Introduction to discrete Fourier transform (DFT) and its relation to DTFT	2	3,4	
	Properties of DFT	1	3,4	
	Inverse DFT	1	3,4	
	Convolution using DFT	1	3,4	1, 2
	Computation of DFT using fast Fourier transform (FFT)	2	3,4	
	Decimation in time FFT	1	3,4	
	Decimation in frequency FFT	1	3,4	
	Lab Experiment/Practical/Programming	4		
	Discrete Fourier Transform (DFT) and Inverse DFT	4	3,4	
Total Hours (Theory + Practical)		**75**		

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	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
	Understand										
Level 2	Apply	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Oppenheim, Wilsky and Nawab "Signals and Systems" Prentice Hall, 2nd edition. ISBN: 9780138147570.
2. Simon Haykin and Berry van Veen "Signals and Systems" 2nd edition, ISBN: 9780471164746.

Other Resources

1. "Principles of Signal Processing and Linear Systems" by B P Lathi, 2nd edition, ISBN: 9780198062271.
2. "Signals and Systems using MATLAB" by Louis F Chaparro, 2014 edition, Academic Press, ISBN: 9780123948434.

Course Designers

1. Dr. Sudhakar. T, Assistant Professor, Department of ECE, SRM University – AP.

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Probability and Random Process

Course Code	ECE 204	Course Category	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. Appreciate the importance of probability and statistics in the field of communication and signal processing.
2. Model the channel noise and understand its effect on information that is being transmitted over the channel.
3. Gain simulation capability of probability and stochastic process in Matlab.

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 probability and statistics	1	80%	60%
Outcome 2	Solve Random Variables problems	3	80%	80%
Outcome 3	Design and develop stochastic processes	4	80%	70%
Outcome 4	Analysis, design and research in applied stochastic problems	5	80%	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	2	1	3	2	1	1	1	2	1	3	2	1	1	1
Outcome 2	3	3	3	3	3	1	1	1	1	1	3	1	1	1	1
Outcome 3	3	3	3	3	3	1	1	1	1	1	3	1	1	1	1
Outcome 4	3	3	3	3	3	1	1	1	1	1	3	1	1	1	1
Average	3	3	3	3	3	1	1	1	1	1	3	1	1	1	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact hours	CLOs Addressed	References Used
	UNIT I: Review of basic probability theory	**9**		1,2
Unit 1	Definition and axioms of probability.	2	1	1,2
	Probability spaces.	1	1	1,2
	Joint and conditional probabilities.	2	1	1,2
	Independent events.	2	1	1,2
	Total probability theorem – Bayes' theorem.	2	1	1,2
	UNIT II– Random Variables	**9**		1,2
Unit 2	Introduction to the concept of random variables.	1	1,2	1,2
	Continuous and Discrete random variables.	1	1,2	1,2
	Probability (Cumulative) distribution function (CDF)	1	1,2	1,2
	Probability Distribution Function (PDF)	1	1,2	1,
	Joint distribution function of two random variables.	1	1,2	1,2
	Conditional CDF and PDF.	1	1,2	1,2
	Independent random variables.	1	1,2	1,2
	Various Continuous and Discrete random distributions (Special focus is on Uniform, Gaussian, Poisson random variables).	2	1,2	1,2
	UNIT III - Statistical Averages	**9**		
Unit 3	Introduction to the concept of statistical averages.	2	1,2	
	various statistical averages – Expectation.	2	1,2	1,2
	Variance.	1	1,2	1,2
	Mean square value etc.	1	1,2	1,2
	Chebyshev inequality.	2	1,2	1,2
	Central limit theorem.	1	1,2	1,2
	UNIT IV: Random Processes: Time domain analysis	**9**		
Unit 4	Introduction to the concept of random process.	2	1,2,3	1,2
	Classification of random processes.	1	1,2,3	1,2
	Stationary random processes.	1	1,2,3	1,2
	Ergodic random processes.	1	1,2,3	1,2
	Correlation functions and their properties	1	1,2,3	1,2
	Gaussian and Poisson random process.	1	1,2,3	1,2
	Sample t-tests.	1	1,2,3	1,2
	Analysis of statistical means	1	1,2,3	1,2
	UNIT V: Random Processes: Frequency domain analysis	**9**		
Unit 5	Introduction to the concept of Power Spectral Density.	2	1,2,3, 4	1,2
	Relation between Power spectral density and auto correlation function – Wiener Kinchine Theorem.	2	1,2,3, 4	1,2
	Noise: White and Colored.	2	1,2,3, 4	1,2
	Linear Time Invariant (LTI) systems with random processes as inputs.	2	1,2,3, 4	1,2
	Noise equivalent bandwidth.	1	1,2,3, 4	1,2
	Total Contact Hours	**45**		

Learning Assessment

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

Recommended Resources

1. Probability, Random variables and Stochastic processes – A Papoulis and Unnikrishnan Pillai, 4th Edition, Mc Grahill Publisher.
2. Communication Systems, Simon Haykin, 4th Edition, John Wiley & Sons

Other Resources

1. Probability and Random Processes for Electric and Computer Engineers, John A Gubner, 1st Edition, CAMBRIDGE University press
2. Probability theory, Random variables and Random signal principles, Peebles, 4th Edition, TMH

Course Designers

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

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Microelectronic Device and Circuits

Course Code	ECE 205	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. Learn the various linear application of op-amp.
2. Understand the various non-linear application of op-amp.
3. Gain knowledge of filter circuits using op-amp.
4. Learn oscillators and multivibrator circuits using op-amp.
5. Understand the various application of 555 timer.
6. Gain knowledge of performance of oscillators and multivibrators using PSPICE.

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 linear application of op-amp	2	70%	65%
Outcome 2	Identify non-linear application of op-amp	2	70%	65%
Outcome 3	Discuss filter circuits using op-amp	2	70%	65%
Outcome 4	Discuss oscillators and multivibrator circuits using op-amp	3	70%	65%
Outcome 5	Illustrate the applications of 555 timer	2	70%	65%
Outcome 6	Demonstrate oscillators and multivibrators circuits using PSPICE	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	2										1	2	2
Outcome 2	1	1	2	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

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**BJT biasing and Single Stage Amplifiers**	**9**		
1	BJT Device Structure and Physical Operation	2	1	1,4
2	BJT Current Voltage characteristics	1	1	1,4
3	BJT Circuits at DC	1	2	1,4
4	Amplifier Basic Principles	1	3	1,4
5	Circuit Models for Amplifier	1	2	1,4
6	Small Signal Models for BJT	1	2	1,4
7	BJT Biasing	1	2	1,4
8	Analysis of CE, CB. CC Amplifiers	1	2	1,4
Unit II	**MOSFET Biasing and Single Stage Amplifiers**	**9**		
9	MOSFET Device Structure and Physical Operation	2	1	1,4
10	MOSFET Current Voltage characteristics	2	1	1,4
11	MOSFETS Circuits at DC	1	2	1,4
12	MOSFET Biasing	1	3	1,4
13	Small Signal models for MOSFET	1	2	1,4
14	Analysis of CG, CS	1	2	1,4
15	CD Amplifiers.	1	2	1,4
Unit III	**Differential Amplifiers and Frequency Response of single stage Amplifiers**	**9**		
16	MOS Current Mirror	1	2	1,2
17	Analysis of MOS Differential Pair	1	2	1,2
18	Common Mode Rejection Ratio	1	2	1,2
19	DC Offset	1	2	1,2
20	MOS Differential Amplifier with current mirror load	1	2	1,2
21	Low frequency response of CS amplifier	1	2	1,2
22	High frequency response of CS amplifier	1	2	1,2
23	Millers Theorem	1	2	1,2
24	High frequency response of CMOS Differential Amplifier	1	2	1,2
Unit IV	**Feedback Amplifiers, Signal Generators and wave shaping circuits**	**9**		
25	General Feedback structure	1	3	1,2
26	Negative feedback	1	3	1,2
27	Feedback amplifier types	1	3	1,2
28	Stability problem	1	4	1,2
29	frequency compensation	1	4	1,2
30	Basic principles of sinusoidal oscillators	1	3	1,2
31	Op-amp RC oscillator	1	4,5,6	1,2
32	Wein Bridge oscillator	1	4,5,6	1,2
33	MOSFET Crystal oscillators, Bistable multivibrators, 555 timer IC and applications	1	4,5,6	1,2
Unit V	**Power Amplifiers and Active Filters**	**9**		
34	Classification of output stages	1	4	1,2
35	Class A output stage	1	4	1,2
36	Class B output stage	1	4	1,2
37	Class AB output stage	1	4	1,2
38	Class C output stage, Class D and S power amplifiers	1	3	1,2
39	Filter Transmission, Types and specifications	1	3	1,2
40	Filter Transfer function	1	4	1,2
41	Butterworth and Chebyshev filters	1	4	1,2
42	First order and second order Filter functions	1	4	1,2
Total Hours		**45**		

Course Unitization Plan - Lab

Session No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1.	Analysis of Feedback circuits with Op-amps.	2	2	4,5
2.	Analysis of Feedback circuits with MOSFETs.	2	3	4,5
3.	Design and Analysis of RC phase shift, LC oscillators.	2	3,5,6	4
4.	Design and Analysis of Wien Bridge oscillator.	2	3,5,6	4
5.	Design and Analysis of 555 timer based Astable and Monostable Multivibrators.	2	3,5,6	4
6.	Design and Analysis of MOSFET based Class A, Class B, Class AB Power amplifier.	2	3	4,5
7.	Design and Analysis of Op-amp based Active filters.	2	3	5
8.	Design and Analysis of Voltage regulator circuits.	2	4	4,5
9.	Design and Analysis of Voltage reference circuits.	2	4	4
10.	Design and Analysis of ADCs, DACs-I.	4	4	4,5
11.	Design and Analysis of ADCs, DACs-II.	4	4	4,5
12.	Course project.	4	4	5
Total Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (5%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (5%)		Th	Prac
Level 1	Remember	60%	40%	60%	40%	50%	30%	40%
	Understand							
Level 2	Apply	40%	60%	40%	60%	50%	70%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Adel S. Sedra and K . C. Smith, "Microelectronic Circuits: Theory and Applications", 7th Edition, Oxford University press
2. Bezhad Rizavi "Fundamentals of Microelectronics", Wiley, (2006)
3. Jacob Millman, Christos C Halkias "Integrated Electronics", McGraw Hill Education.
4. Robert L. Boylestead, Louis Nashelsky "Electronic Devices and Circuits theory", 11th Edition, 2009, Pearson.
5. Thomas L. Floyd "Electronic Devices", Edition 9, illustrated, Prentice Hall, 2012.

Other Resources

Course Designers

1. Dr. Ramesh Vaddi, Associate Professor, Department of ECE, SRM University – AP.

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FPGA Design for Embedded Systems

Course Code	ECE 211	**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	ECE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the internal architecture and functionality of PLDs.
2. Gain a knowledge of VHDL for describing combinational and sequential digital circuits.
3. Learn about hardware design using VIVADO.
4. Understand the various steps of High-Level Synthesis Process.
5. Understand how to use the IP Integrator in VIVADO for building complex designs.

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 various PLD structures	2	70%	65%
Outcome 2	Design digital systems using VHDL.	3	65%	65%
Outcome 3	Proficiently design and verify digital circuits on FPGA using the Vivado Design Suite.	2	70%	60%
Outcome 4	Comprehensively grasp and apply the sequential stages involved in converting high-level language descriptions into optimized hardware implementations	2	60%	65%
Outcome 5	Ability to proficiently utilize Vivado's IP Integrator tool to construct intricate and optimized digital designs	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									2	2	2
Outcome 2	3	3	2	3	2				2				2	2	2
Outcome 3	1	2	2	1	3								2	2	2
Outcome 4	1	2	2	1	3								2	2	2
Outcome 5	2	2	3	3	3				2				3	3	3
Average	2	3	2	2	3				1				2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction**	**5**		
1.	Introduction to PLDs and its benefits	1	1	2,4,5
2.	Architecture of SPLDs	1	1	2,4,5
3.	SPLDs programming	1	1	2,4,5
4.	Architecture of CPLDs	1	1	2,4,5
5.	Basics of FPGAs– Structure of FPGAs.	1	1	2,4,5
Unit II	**Fundamentals of HDL Programming**	**9**		
6	Hardware Description Language: Design flow, program structure	1	1,2	1,2,5
7	Libraries and packages, Data flow design elements	2	1,2	1,2,5
8	Behavioural design elements	1	1,2	1,2,5
9	Structural design elements	1	1,2	1,2,5
10	VHDL implementations of combinational and Sequential circuits	2	1,2	1,2,5
11	VHDL implementations of combinational and Sequential circuits	2	1,2	1,2,5
Unit III	**Hardware Design Using VIVADO**	**5**		
12.	General view of soc, XILINX ZYNQ System on Chips	1	1,3	3,4,5
13.	ZYNQ SOC Hardware Design Using VIVADO	1	1,3	3,4,5
14.	Programming Processor Side Using SDK Tool	1	1,3	3,4,5
15.	Creating ZYNQ System Employing Interrupts.	1	1,3	3,4,5
16.	Creating ZYNQ System Employing AXI Timer Interrupt.	1	1,3	3,4,5
Unit IV	**VIVADO High Level Synthesis (HLS)**	**7**		
17.	Introduction, Steps of High-Level Synthesis Process, Project Creation in VIVADO HLS,	5	1,4	3,4,5
18.	Arbitrary Precision Data Types used In VIVADO HLS.	1	1,4	3,4,5
19.	HLS Interface Specification and Synthesis, HLS Metrics and Pipelining Operation.	1	1,4	3,4,5
20.	Loop and array optimization for hardware implementation in VIVADO HLS.	1	1,4	3,4,5
21.	Creating multiple solutions in HLS and solution optimization.	1	1,4	3,4,5
Unit V	**IP Cores**	**5**		
22.	IP Core Creation Using VHDL,	1	1,2,5	3,4,5
23.	IP Core Creation Using MATLAB HDL-Coder.	1	1,2,5	3,4,5
24.	IP Core Creation Using VIVADO HLS.	1	1,2,5	3,4,5
25.	Importing user created IP cores to the IP catalogue of VIVADO	1	1,2,5	3,4,5
26.	Use of IP cores in Project	1	1,2,5	3,4,5
Total Contact Hours		**30**		

Learning Assessment

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

Recommended Resources

1. Charles Roth, "Digital System Design using VHDL", 2nd Edition Tata McGraw Hill, 2012.
2. John F. Wakerly, "Digital Design Principles & Practices",3rd Edition PHI/ Pearson Education Asia, 2005
3. https://www.udemy.com/course/system-on-chip-design-using-vivado-and-zybo-z7-10/?couponCode=ST22FS22724
4. https://extendedstudies.ucsd.edu/courses-and-programs/fpga-design-fundamentals
5. https://archive.nptel.ac.in/courses/117/108/117108040/

Other Resources

Course Designers

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Design and Analysis of Analog, Mixed Signal Circuits

Course Code	ECE 206	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. Learn various feedback structures and frequency compensation techniques.
2. Gain Knowledge of various oscillations, multivibrators, and timer circuits using op-amp.
3. Learn about various filter circuits using op-amp and tuned amplifiers.
4. Understand the output stages of the power amplifier.
5. Understand the voltage reference circuits, power supply, and data converters circuits.

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 various feedback structures with the knowledge of frequency compensation techniques	2	70%	65%
Outcome 2	Demonstrate oscillators, multivibrators, and timer circuits using PSPICE	3	65%	65%
Outcome 3	Discuss filter circuits using op-amp and tuned amplifier	2	70%	60%
Outcome 4	Discuss output stages of various power amplifier	2	60%	65%
Outcome 5	Illustrate the applications of voltage reference, power supply, and data converter circuits	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	1											1	2	2
Outcome 2	3	1	2	1	2							1	3	2	2
Outcome 3	3	2	2	2								1	3	3	2
Outcome 4	3	2	2	2								1	3	3	2
Outcome 5	3	2	2	2	2							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	**Feedback Amplifiers**	**9**		
1.	General Feedback Structure	2	1	1,2,4
2.	Negative Feedback	1	1	1,2,4
3.	Feedback Amplifier Types	2	1	1,2,4
4.	Stability Problem	2	1	1,2,4
5.	Frequency Compensation	2	1	1,3
Unit II	**Signal Generation and Waveform Shaping Circuits**	**9**		
6	Basic Principles of Sinusoidal Oscillators	1	2	1,4
7	Op-amp RC Oscillator	2	2	1,4
8	Wein Bridge Oscillator	1	2	1,4
9	MOSFET Crystal Oscillators	1	2	1,4
10	Bistable Multivibrators	2	2	1,4
11	555 timer IC and Applications	2	2	1,4
Unit III	**Active Filter and Tuned Amplifiers**	**9**		
12.	Filter Transmission	1	3	1,2
13.	Types and Specification	1	3	1,2
14.	Filter Transfer Function	1	3	1,2
15.	Butterworth and Chebyshev Filters	1	3	1,2
16	First order and second order Filter Functions	2	3	1,2
17	SC Filters, Gm-C Filters	1	3	1,2
18	Tuned Amplifiers	1	3	1,2
Unit IV	**Output Stages and Power Amplifiers**	**9**		
19.	Classification of output stages	2	4	1,2,4
20.	Class A output stage	2	4	1,2,4
21.	Class B output stage	2	4	1,2,4
22.	Class C output stage	2	4	1,2,4
23.	Class D Power Amplifiers	1	4	1,2,4
Unit V	**Voltage Reference Circuits and Data Converters**	**9**		
24.	Voltage Reference Circuits	1	5	1,4
25.	Power Supplies: Ripple Removal and Regulation	2	5	1,4
26.	Data Converters: Sample and Hold Circuits	2	5	1,4
27.	ADCs	2	5	1,4
28.	DACs	2	5	1,4
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Session No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1.	Analysis of Feedback circuits with Op-amps.	2	2	4,5
2.	Analysis of Feedback circuits with MOSFETs.	2	3	4,5
3.	Design and Analysis of RC phase shift, LC oscillators.	2	3,5,6	4
4.	Design and Analysis of Wien Bridge oscillator.	2	3,5,6	4
5.	Design and Analysis of 555 timer-based Astable and Monostable Multivibrators.	2	3,5,6	4
6.	Design and Analysis of MOSFET-based Class A, and Class C Power amplifier.	2	3	4,5
7.	Design and Analysis of Op-amp-based Active filters.	4	3	5
8.	Design and Analysis of Voltage regulator circuits.	4	4	4,5
9.	Design and Analysis of Voltage reference circuits.	2	4	4
10.	Design and Analysis of ADCs, DACs-I.	4	4	4,5
11.	Design and Analysis of ADCs, DACs-II.	4	4	4,5
Total Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**					**End Semester Exam (40%)**	
		Theory (35%)				**Practical (25%)**		
		CLA-1 (10%)	**CLA-2 (5%)**	**CLA-3 (10%)**	**Mid-1(10%)**		**Th (25%)**	**Prac (15%)**
Level 1	Remember	60%	40%	60%	40%	50%	40%	40%
	Understand							
Level 2	Apply	40%	60%	40%	60%	50%	60%	60%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Microelectronic Circuits: Theory and Applications, Adel S. Sedra and K . C. Smith, 7th Edition, Oxford University press
2. BezhadRizavi "Fundamentals of Microelectronics", Wiley, (2006)
3. Integrated Electronics, Jacob Millman, Christos C Halkias, McGraw Hill Education.
4. Electronic Devices and Circuits theory– Robert L. Boylestead, Louis Nashelsky, 11th Edition, 2009, Pearson.
5. Electronic Devices: Thomas L. Floyd, Edition 9, illustrated, Prentice Hall, 2012

Other Resources

Course Designers

1. Dr. Sanjeev Mani Yadav, Assistant Professor, Department of ECE, SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Principles of Modern Communication Systems

Course Code	ECE 207	Course Category	CC	L	T	P	C
				3	0	1	4
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. To introduce the concept of modulation and different techniques and apply the concepts of stochastic process for performance evaluation of the different schemes.
2. To understand the concept of sampling and different baseband digital modulation schemes along with line coding and pulse shaping.
3. To apply the concept of modulation in the AI context of digital communication.
4. To understand the source and channel coding concept and their relevance to digital communication.

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 AM, FM, and PM and use the relevant mathematical tools required to evaluate their noise performance.	3	80%	75%
Outcome 2	Apply the Sampling Theorem to discrete-time modulations and examine the importance of line coding and pulse shaping	4	70%	65%
Outcome 3	Illustrate the difference between passband and baseband digital modulations and their suitability for applications.	3	70%	65%
Outcome 4	Interpret the importance of Information Theory in Digital Communication	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	2	2				3			1	3	1	3
Outcome 2	3	2	1	2	2				3			3	3	2	3
Outcome 3	3	2	1	3	2				3			3	3	2	3
Outcome 4	3	2	1	3	2				3			3	3	2	3
Average	3	2	1	3	2				3			3	3	2	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**ANALOG COMMUNICATION**	**18**		
	Baseband vs Carrier Communication	1	1	1
	Modulation	1	1	1
	Amplitude Modulation – DSB-SC, DSB	2	1	1
	Amplitude Modulation - SSB	2	1	1
	Angle Modulation - FM	1	1	1
	Angle Modulation - PM	1	1	1
	Superheterodyne Receivers	1	1	1
	Analyze and Test DSB and DSB-SC (Lab Experiment - 1)	3	1	3
	Analyze and Test SSB-SC (Lab Experiment - 2)	3	1	3
	Analyze and Test FM (Lab Experiment - 3)	3	1	3
Unit 2	**PERFORMANCE OF ANALOG MODULATION IN THE PRESENCE OF NOISE**	**10**		
	Noise – Thermal, White, Filtered Noise, Noise Equivalent Bandwidth	2	2	1
	Baseband Noise – additive noise and Signal-to-Noise Ratio	2	2	1
	Bandpass Noise – System Models, Quadrature Components, Envelope and Phase	2	2	1
	Linear Continuous Wave Modulation with Noise–Analysis	2	2	1
	Angle Modulation with Noise – Analysis	1	2	1
	Performance comparison between amplitude and angle modulation	1	2	1
Unit 3	**PULSE AND BASEBAND DIGITAL MODULATION**	**25**		
	Introduction to sampling theorem	1	2	1
	Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)	2	2	1
	Quantization; Pulse Code Modulation (PCM)	1	2	1
	Differential Pulse Code Modulation (DPCM), Delta Modulation (DM); Adaptive Delta Modulation (ADM)	2	2	1
	Line Coding	1	2	1
	Pulse Shaping Nyquist's First criterion for zero Intersymbol Interference (ISI)	1	2	1
	Raised Cosine Pulse, Partial Response Signaling	2	2	1
	Sampling Theorem Verification (Lab Experiment - 4)	3	2	3
	Analyze and Test PAM, PPM, and PWM (Lab Experiment - 5)	3	2	3
	Analyze and Test PCM and DPCM (Lab Experiment - 6)	3	2	4

	Analyze and Test DM (Lab Experiment – 7)	3	2	4
	Data Formatting (Lab Experiment - 8)	3	2	4
Unit 4	**DIGITAL PASSBAND MODULATION AND NOISE ANALYSIS**	**11**		
	Binary and M-ary Signaling Features and Classification	1	3	2
	Carrier Modulations Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK)	2	3	2
	Carrier Modulations Minimum Shift Keying (MSK), Gaussian MSK (GMSK), Quadrature Phase Shift Keying (QPSK) and Quadrature Amplitude Modulation (QAM)	2	3	2
	Signal Space Introduction	1	3	2
	Generation and BER Calculation of Carrier Modulations	1	3	2
	Optimum Detector Matched Filter	1	3	2
	Analyze and Test ASK, FSK, and PSK (Lab Experiment - 9)	3	3	4
Unit 5	**INTRODUCTION TO INFORMATION THEORY**	**11**		
	Information & Entropy, Conditional Entropy & Mutual Information	1	4	2
	Shannon's Source Coding Theorem, Huffman Coding, and Lempel-Ziv Algorithm	2	4	2
	Shannon Hartley Theorem for Channel Capacity, Capacity of Binary Symmetric Channel, and Binary Erasure Channel	2	4	2
	Channel Coding Theorem, Forward Error Correction, Automatic Repeat Request (ARQ)	1	4	2
	Linear Block Codes and Cyclic Codes – CRC	2	4	2
	Analyze and Test Linear Block Codes (Lab Experiment - 10)	3	4	4

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Analyze and Test DSB and DSB-SC	3	1	3
2.	Analyze and Test SSB-SC	3	1	3
3.	Analyze and Test FM	3	1	3
4.	Sampling Theorem Verification (Lab Experiment - 4)	3	2	3
5.	Analyze and Test PAM, PPM, and PWM (Lab Experiment - 5)	3	2	3
6.	Analyze and Test PCM and DPCM (Lab Experiment - 6)	3	2	4
7.	Analyze and Test DM (Lab Experiment – 7)	3	2	4
8.	Data Formatting (Lab Experiment - 8)	3	2	4
9.	Analyze and Test ASK, FSK, and PSK (Lab Experiment - 9)	3	3	4
10.	Analyze and Test Linear Block Codes (Lab Experiment - 10)	3	4	4
Total Contact Hours		**30**		

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%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	30%	50%	40%	60%	30%	50%	40%	40%	40%
	Understand										
Level 2	Apply	40%	70%	50%	60%	40%	70%	50%	60%	60%	60%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. B. P. Lathi, Z. Ding, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2017
2. A. B. Carlson, P. B. Crilly, "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", 5th Edition, McGraw Hill Higher Education
3. Physitech 60, 71 PD, 101, 133, 138, 139, 156, 157, 165, 422
4. Scientech 2152, 2153, 2154, 2155, 2156, 2157, 2113, 2121A, 2121B and 2807

Other Resources

1. H. Taub, D. L. Schilling, G. Saha, "Principles of Communication Systems", 4th Edition, McGraw Hill Higher Education
2. J. G. Proakis, M. Salehi, "Fundamentals of Communication Systems", 2nd Edition, Pearson Higher Education.

Course Designers

1. Dr. Anirban Ghosh, Asst Professor, Dept of ECE, SRM University - AP

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Digital Signal Processing

Course Code	ECE 208	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. To familiarise the time domain signal processing techniques.
2. To analyse a given signal in the frequency domain.
3. To understand various analog filtering techniques.
4. To understand various digital filtering techniques.
5. To have a basic understanding of advanced signal processing algorithms.

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 response of an LTI system in both time and frequency domain.	2	85%	80%
Outcome 2	Apply and analyse transformation techniques	4	80%	75%
Outcome 3	Apply and verify analog filters for signal filtering applications	3	85%	70%
Outcome 4	Apply IIR and FIR digital filters that operate on discrete-time signals.	3	80%	70%
Outcome 5	Analyse multi-rate signal processing techniques.	4	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3								1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	3	2	3	3				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction and Time Domain Processing**	**9**		
	Review of signals and systems.	1	1	1, 2
	Differences between analog and digital signal processing.	2	1	1, 2
	Filtering in time domain: linear convolution.	2	1	1, 2
	Circular convolution.	2	1	1, 2
	Linear correlation and circular correlation; auto correlation and cross correlation of signals.	2	1	1, 2
Unit 2	**Frequency Domain Processing**	**9**		
	Discrete Fourier transform (DFT).	1	2	1, 2
	Methods to compute DFT: Cooley-Tukey FFT algorithm, properties of FFT.	3	2	1, 2
	Decimation in time and decimation in frequency algorithms to compute DFT using FFT.	3	2	1, 2
	Rader's and Bluestein's FFT algorithms.	2	2	1, 2
Unit 3	**Analog Filters**	**9**		
	Transfer function.	1	3	1, 2
	Design of Butterworth, elliptic.	1	3	1, 2
	Chebyshev, and Bessel filters.	1	3	1, 2
	Filter order and roll-off rate.	1	3	1, 2
	Lowpass, High pass.	1	3	1, 2
	Bandpass and band stop filters.	1	3	1, 2
	Higher order filters	1	3	1, 2
	Linear phase and its importance.	1	3	1, 2
	Phase delay and group delay of the filters.	1	3	1, 2
Unit 4	**Digital Filters**	**9**		
	Finite impulse response (FIR) filters.	1	4	2, 3
	Infinite Impulse Response (IIR) filters.	2	4	2, 3
	Realization of digital filters: canonical form.	2	4	2, 3
	Direct form-I, form-II methods.	1	4	2, 3
	Converting analog filters to digital filers: bilinear transformation	2	4	2, 3
	All-pass filter and inverse filter.	1	4	2, 3
Unit 5	**Multi-rate Signal Processing**	**9**		
	Decimation.	1	5	2, 4
	Interpolation.	1	5	2, 4
	Sampling rate conversion of non-integer factors; multistage implementation and polyphase implementation of decimation and interpolation.	4	5	2, 4
	Introduction to sub-band coding and multi-resolution analysis.	3	5	2, 4
Total Hours		**45**		

Course Unitization Plan - Lab

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
1	Obtain DFT / IDFT of given Discrete Time signals.	2	1	2, 4
2	Obtain circular convolution of two finite length sequences.	2	1	2, 4
3	Obtain linear correlation of two finite length sequences.	2	1	2, 4
4	Implementation of FFT of given sequence.	2	2	2, 4
5	Implementation of properties of FFT.	2	2	2, 4
6	Transfer function analysis	2	2	2, 4
7	Implementation of Butterworth Low Pass Filter.	2	3	2, 4
8	Implementation of Chebyshev Low Pass Filter	2	3	2, 4
9	Implementation of High Pass IIR filter for a given sequence.	2	3	2, 4
10	Implementation of Low Pass FIR filter for a given sequence.	2	4	2, 4
11	Implementation of Low Pass IIR filter for a given sequence.	2	4	2, 4
12	Implementation of band stop and band pass filters.	2	4	2, 4
13	Implementation of Decimation Procedure.	2	5	2, 4
14	Implementation of Interpolation Procedure.	2	5	2, 4
15	Implementation of sub-band coding and multi-resolution analysis	2	5	2, 4
Total Hours		**30**		

Learning Assessment-Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)								End Semester Exam (20%)	
		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%		60%		40%		60%		30%	
	Understand										
Level 2	Apply	60%		40%		60%		40%		70%	
	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%)
		Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	
Level 1	Remember	60%	50%	40%	50%
	Understand				
Level 2	Apply	40%	50%	60%	50%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Digital Signal Processing" by Tarun Kumar Rawat, Oxford Higher Education, 2017 edition.
2. "Discrete-time signal processing" by A. Oppenheim and R. W. Schafer, Pearson, 2014 edition.
3. "Principles of Signal Processing and Linear Systems" by B P Lathi, Oxford University Press, 2009 edition
4. "Digital Signal Processing" by J. G. Proakis and D. G. Manolakis, 2007 edition, Pearson India.

Other Resources

Course Designers

1. Dr .Sudhakar Tummala, Asst. Professor. Dept. Of ECE. SRM University – AP

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Control Systems

Course Code	ECE 209	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	1	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. To provide a basic understanding of the concepts and techniques involved in the design of control schemes for dynamic systems
2. To understand and modify a system based on time response analysis
3. To understand and modify a system based on frequency response analysis
4. To design compensators and controllers for the practical control 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	Understand control system classifications	2	90%	95%
Outcome 2	Represent a system in terms of equations and block diagrams	3	80%	80%
Outcome 3	Analyse the system behaviour with time and frequency variations	4	70%	80%
Outcome 4	Evaluate the stability and relative stability with different methods	5	60%	70%
Outcome 5	Design a stable control system with compensators and controllers	6	50%	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			2
Outcome 2	3	3	2	2								1		2	3
Outcome 3	3	3	2	3	2							2		3	3
Outcome 4	3	3	3	3	3							3		3	3
Outcome 5	3	3	3	3	3				3			3		3	3
Average	3	3	3	3	3				3			3		3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction to Control Systems**	**10**		
1.	Concept of feedback and automatic control	1	1	1,2,3
2.	Effects of feedback, Objectives of control system.	1	1	1,2,3
3.	Types of Control Systems, Definition of linear and nonlinear systems.	1	1	1,2,3
4.	Mathematical modelling of Physical Systems –Mechanical Systems	1	2	2
5.	Electrical Systems, Electromechanical systems, Analogous Systems.	1	2	2
6.	Transfer function concept, Properties of Transfer function.	2	2	1,2
7.	Block diagram representation of closed loop systems.	1	2	1,2
8.	Block diagram algebra	1	2	2
9.	Signal Flow graphs, Mason's gain formula.	1	2	2
Unit II	**Time Response of Feedback Control Systems**	**10**		
10.	Need of test signals, Standard test signals.	1	3	1,2,3
11.	Step response of First Order Systems and its time domain specifications.	1	3	1,2,3
12.	Step response of Second Order Systems and its time domain analysis-Concept of undamped natural frequency.	2	3	1,2,3
13.	Damping, overshoot, rise time and settling time.	1	3	1,2,3
14.	Dependence of time domain performance parameters on natural frequency and damping ratio.	1	3	1,2,3
15.	Effects of Pole and Zeros on transient response, pole dominance.	1	3,4	1,2,3
16.	approximation of higher order systems	1	3	1,2,3
17.	Error Analysis-Steady state errors in control systems due to step, Ramp, and parabolic inputs.	1	3	1,2,3
18.	Concepts of system types and error constants.	1	3	1,2,3
Unit III	**Stability Analysis**	**10**		
19.	Concepts of stability.	1	4	1,2,3
20.	Necessary conditions for Stability.	1	4	1,2,3
21.	Routh stability criterion.	1	4	1,2,3
22.	Relative stability analysis.	1	4	1,2,3
23.	Introduction to Root-Locus Techniques. The root locus concepts.	2	4	1,2,3
24.	Construction of root loci.	1	4	1,2,3
25.	Introduction to lead, lag and lead-lag compensating networks	2	4,5	1,2,3
26.	Compensator design with Root locus.	1	4,5	1,2,3
Unit IV	**Frequency Domain Analysis and Stability**	**10**		
27.	Correlation between time and frequency response.	1	1,3	1,2,3
28.	Introduction to polar and inverse polar plots,	1	1,3	1,2,3
29.	Nyquist stability criterion.	1	3,4	
30.	Assessment of relative stability: gain margin and phase margin.	1	4	1,2,3
31.	Bode Plots, Determination of stability with Bode plots.	2	4	1,2,3
32.	Examples of Bode Plot	2	4	1,2,3
33.	Experimental determination of transfer function	1	4	
34.	Compensator design with Bode plots.	1	5	1,2,3
Unit V	**Controller Design**	**5**		
35.	Introduction to Controllers, Classification Controller.	1	5	2,4
36.	Need and properties of controllers	2	5	2,4
37.	Proportional Control Mode, Integral Control Mode, Derivative Control Mode, Proportional-integral (PI) controller, Proportional-derivative (PD) controller, Proportional-integral- derivative (PID) controller	1	5	2,4
38.	Tuning rules of Ziegler-Nichols method.	1	5	4
Total Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Norman S. Nise, Control Systems Engineering, 6th Edition, John Wiley & Sons Inc, 2010.
2. M Gopal, Control Systems: Principles and Design, McGraw Hill Education; 4th Edition, 2012.
3. K. Ogata, Modern Control Engineering, Prentice Hall India, 2006.
4. J. R. Leigh, Control Theory – A guided tour, IET Control Engineering Series 72, 3rd Edition, 2012

Other Resources

Course Designers

1. Dr. Anuj Deshpande, Assistant Professor, Dept. of ECE. SRM University – AP.

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

AI/ML for Electronics Engineers

Course Code	ECE 210	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. To familiarise the domains of supervised and unsupervised learning.
2. To understand and apply various binary classifiers.
3. To understand and apply clustering methods.
4. To understand and analyse Feedforward neural networks.
5. To have a basic understanding of CNNs and Reinforcement Learning.

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	Familiarise supervised and unsupervised learning	1	85%	80%
Outcome 2	Understand and apply various binary classifiers	1, 2	80%	75%
Outcome 3	Understand and apply clustering methods	1, 2	85%	70%
Outcome 4	Understand and Evaluate Feedforward neural networks	3	80%	70%
Outcome 5	Understand the CNNs and Reinforcement learning	1	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3				2	1		1	1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	3	2	3	3				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**12**		
	Introduction to machine learning	1	1	1, 2
	Supervised learning	1	1	1, 2
	Unsupervised learning	1	1	1, 2
	Linear regression	2	1	1, 2
	Logistic regression	1	1	1, 2
	Generalized linear models	2	1	1, 2
	L1: Implement Linear Regression on the given dataset using python/MATLAB	2	1	1, 2
	L2: Implement Logistic Regression on the given dataset using python/MATLAB	2	1	1, 2
Unit 2	**Classifiers**	**18**		
	Gaussian discriminant analysis (GDA)	2	2	1, 2
	Naive Bayes	1	2	1, 2
	Support Vector Machines	2	2	1, 2
	K-Nearest Neighbor	1	2	1, 2,3
	Decision Trees	2	2	1, 2
	Random forest	2	2	1, 2
	L3: Implement Naïve Bayes classifier using Python/MATLAB	2	2	1, 2
	L4: Implement SVM algorithm using Python/MATLAB	2	2	1, 2
	L5:Implement Decision tree classifier using python/MATLAB	2	2	1, 2
	L6:Implement Random Forest classifier using python/MATLAB	2	2	1, 2
Unit 3	**Clustering**	**13**		
	Clustering in machine learning	1	3	1, 2
	Different types of clustering algorithms	2	3	1, 2
	K-Means clustering	2	3	1, 2
	Gaussian mixture models	2	3	1, 2
	Bias-variance trade off	2	3	1, 2
	L7: Implement K-means algorithm for clustering the data using python/MATLAB	2	3	1, 2
	L8: Implement K-Nearest Neighbour classifier using python/MATLAB	2	3	1, 2
Unit 4	**Feedforward neural networks**	**14**		
	Introduction to Neural Networks	1	4	1, 2
	Feed-forward Network	2	4	1, 2
	Gradient descent optimization	2	4	1, 2
	Error Back propagation	2	4	1, 2
	Evaluation of error-function derivatives	1	4	1, 2
	Efficiency of back propagation	1	4	1, 2
	Under and over fitting	1	4	1, 2
	L9: Emulate logic gates using neural network using python	2	4	1, 2
	L10: Implement Convolution Neural Network for image/data analysis using Python/MATLAB	2	4	1, 2
Unit 5	**Deep Learning**	**8**		
	Introduction to convolutional neural network (CNN)	1	5	1, 2
	Backpropagation in CNN	2	5	1, 2
	Sparse Kernel Machines	2	5	1, 2
	Markov Chain Monte Carlo	1	5	1, 2
	Introduction to Reinforcement learning	2	5	1, 2
Total Hours		**65**		

Learning Assessment

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

Recommended Resources

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning" by Springer, 2007.
2. Tom M. Mitchell, "Machine Learning", First Edition by Tata McGraw-Hill Education, 2013.
3. EthemAlpaydin, "Introduction to Machine Learning" 2nd Edition, The MIT Press, 2009
4. Google Colab
5. MATLAB
6. Scikit-Learn

Other Resources

Course Designers

1. Dr. Sudhakar Tummala. Asst. Professor. Dept. Of ECE. SRM University - AP.

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

Basic CMOS VLSI Design

Course Code	ECE 301	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
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. To understand IC Fabrication Process & teach the VLSI design flow.
2. To gain knowledge of CMOS technology-specific layout rules in the placement and routing of and interconnect and to inform the functionality, timing, power, and parasitic effects.
3. To understand CMOS Inverter based logic gates and its transfer characteristics analysis.
4. To learn VLSI chip design concept of constructing gate based Datapath to integrate it into larger complex system.
5. To learn design and testing of VLSI circuits using CAD tools.

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	Implement MOS IC fabrication process and VLSI design ow to FPGA	2	80%	70%
Outcome 2	Apply CMOS technology-specific layout rules in placement & routing of transistors, interconnect and to verify the functionality, timing, power, & parasitic effects.	3	70%	60%
Outcome 3	Analyse the transfer characteristics of logic gates based on CMOS inverter	4	80%	70%
Outcome 4	Design integrated circuits based on PLDs and CMOS testing techniques	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	3	2	1	2					2		1			1	2
Outcome 2	3	3	2	2					3				1	3	2
Outcome 3	3	3	3	3					2				1	3	3
Outcome 4	3	3	3	3					3		3		1	3	3
Average	3	3	3	3					3		1		1	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to IC Technology**	**9**		
	Basic Electrical Properties of MOS Circuits	1	1	1, 2
	Basic Electrical Properties of CMOS Circuits	1	1	1, 2
	I_{ds}-V_{ds} relationships	1	1	1, 2
	MOS transistor threshold Voltage	1	1	1, 2
	gm, gds, & Figure of merit ωo	1	1	1, 2
	Pass transistor	1	1	1, 2
	NMOS Inverter	1	1	1, 2
	Various pull ups, CMOS Inverter analysis and design	1	1	1, 2
	Bi-CMOS Inverters	1	1	1, 2
Unit 2	**VLSI Circuit Design Processes**	**9**		
	VLSI Design Flow	1	2	2
	MOS Layers	1	2	2
	Stick Diagrams	1	2	2, 3
	Design Rules and Layout	1	2	2, 3
	2 μm CMOS Design rules for wires, Contacts	1	2	1, 2, 3
	Transistors Layout Diagrams for NMOS	1	2	1, 2, 3
	Transistors Layout Diagrams CMOS Inverters	1	2	3
	Transistors Layout Diagrams Gates	1	2	3
	Scaling of MOS circuits	1	2	2,3
Unit 3	**Gate Level Design**	**9**		
	Logic Gates	1	3	1, 2
	Other complex gates	1	3	1, 2
	Switch logic	1	3	1, 2
	Alternate gate circuits	1	3	1, 2
	Time delays	1	3	1, 2
	Driving large capacitive loads	1	3	1, 2
	Wiring capacitance	1	3	1, 2
	Fan in, Fan out	1	3	1, 2
	Choice of layers	1	3	1, 2
Unit 4	**Datapath Subsystems**	**9**		
	Subsystem Design	1	4	2, 3
	Shifters, Adders	1	4	2, 3
	ALUs, Multipliers	1	4	2, 3
	Parity generators	1	4	2, 3
	Comparators	1	4	2, 3
	Zero/One Detectors	1	4	2, 3
	Counters	1	4	2, 3
	Array Subsystems: SRAM, DRAM	1	4	2, 3
	ROM, Serial Access Memories	1	4	2, 3
Unit 5	**Programmable Logic Device**	**9**		
	PLAs, FPGAs	1	4	2
	CPLDs, Standard Cells	1	4	2
	Programmable Array Logic	1	4	2
	Design Approach	1	4	2
	Parameters in sequencing low power design	1	4	2
	CMOS Testing	1	4	2
	Need for testing, Test Principles	1	4	2
	Design Strategies for test	1	4	2
	Chip level Test Techniques	1	4	1, 2, 3
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	HDL code to realize all the logic gates	3	3	1, 4
2.	Design of 2-to-4 decoder & Design of 8-to-3 encoder (without and with priority)	3	3	1, 4
3.	Design of 8-to-1 multiplexer and 1-to-8 demultiplexer	3	4	1, 4
4.	Design of 4 bit binary to gray code converter	2	4	1, 4
5.	Design of 4-bit comparator	3	4	1, 4
6.	Design of Full adder using 3 modelling styles	3	4	3, 4
7.	Design of flip fops: SR, D, JK, T	3	4	3, 4
8.	Design of 4-bit binary, BCD counters (synchronous/ asynchronous reset) or any sequence counter	3	4	3, 4
9.	Finite State Machine Design	3	4	1, 3, 4
10.	CMOS inverter design	4	1	1, 2, 5
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	80%	30%	50%	30%	20%	30%	20%	30%	20%	30%
	Understand										
Level 2	Apply	20%	70%	50%	70%	80%	70%	80%	70%	80%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, 3rdEdition, MHE, 2002, ISBN-10: 0070530777.
2. F Neil H. E Weste, David Harris, Ayan Banerjee, CMOS VLSI Design a Circuits and Systems Perspective, 4th Edition, Addison-Wesley, 2010, ISBN 10: 0-321-54774-8.
3. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikoli, "Digital Integrated Circuits: A
4. Design Perspective", 2 nd Edition, Pearson, 2003, ISBN-10: 0130909963.
5. Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, 2e, Pearson, 2010.
6. John P. Uyemura, CMOS Logic Circuit Design, Wiley, 2005.

Other Resources

1. Kamran Eshraghian, Dougles A. Pucknell & Sholeh Eshraghian "Essentials of VLSI circuits and systems", 1st Edition, PHI,2005, ISBN-10-9788120327726.

Course Designers

1. Internal (Institutional) Subject Matter Experts
2. Dr. Pradyut Kumar Sanki, Assistant Professor, Department of Electronics & Communication Engineering, SRM University - AP.
3. Expert Reviewers from Institutes of National Importance / Institutes of International Repute
4. Prof. Goutam Saha, Professor, Department of E & ECE, IIT Kharagpur, India.

SRM University *AP*, Andhra Pradesh

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

Wireless Communications

Course Code	ECE 302	Course Category	CC	L	T	P	C
				3	0	1	4
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. To understand the fundamentals of wireless communications and modelling the wireless channel.
2. To understand the concepts of diversity, beamforming, and interferences.
3. To have a basic understanding in TDMA, FDMA, CDMA and AWGN channel capacity.
4. To study MIMO & OFDMA and its use in the advanced wireless communication systems.
5. To have a basic understanding of challenging research topics in wireless networks.

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 existing and future wireless communications systems.	2	85%	80%
Outcome 2	Analyse the path loss models like free space propagation, ray tracing, log normal and log shadowing.	4	80%	75%
Outcome 3	Design a wireless channel.	4	85%	70%
Outcome 4	Implement the multiple access technologies like FDMA, TDMA, CDMA and OFDMA in modern communication systems.	3	80%	70%
Outcome 5	Illustrate the 5G communications systems and the technologies involved.	2	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3								1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	2	2	3	2				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Wireless Communications**	**9**		
	Physical Modeling for Wireless Channels	2	1	1, 2
	Input/output model of wireless channel	2	1	1, 2
	Time and Frequency Coherence	1	1	1, 2
	Statistical Channel models	1	1	1, 2
	Time diversity	1	1	1, 2
	Antenna diversity	1	1	1, 2
	Frequency diversity	1	1	1, 2
Unit 2	**Wireless Channel Modeling**	**9**		
	Uplink/Downlink Fading channels	2	2	1, 2
	Doppler Fading, Jakes modeling	2	2	1, 2
	RMS delay spread, Autocorrelation	1	2	1, 2
	SNR and BER Performance	2	2	1, 2
	Noise and Interference	2	2	1, 2
Unit 3	**CDMA**	**9**		
	Narrowband Cellular Systems	2	3	1, 2
	Wideband systems: CDMA	1	3	1, 2
	Wideband systems: OFDM	2	3	1, 2
	AWGN channel capacity	2	3	1, 2
	Capacity of fading channels	2	3	1, 2
Unit 4	**MIMO, OFDM Systems**	**9**		
	Introduction to MIMO, MIMO channel capacity	2	4	1, 2
	SVD and Eigen modes of MIMO Channel	1	4	1, 2
	MIMO spatial multiplexing	2	4	1, 2
	MIMO diversity, Beamforming	2	4	1, 2
	OFDM, multicarrier modulation, PAPR	2	4	1, 2
Unit 5	**Wireless Networks and Advanced Topics**	**9**		
	Spread spectrum, direct sequence spread spectrum	2	5	3, 4
	Wide Area Network, GSM	2	5	1, 3
	Long term Evolution- Advanced	2	5	1,4
	Wi-Fi	1	5	2,4
	WiMAX & mm wave communications	2	5	2,3
Total Contact Hours for Theory		**45**		

Course Unitization Plan – Lab

Exp. No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Rayleigh and Rician Channel fading model	3	1,2	1,2
2	Jakes Channel model	3	1,2	1,2
3	Path loss model – Free space, and Ray tracing	3	1,3	1,2
4	Log distance and log normal shadowing model	3	1,3	1,2
5	Filtered White Gaussian Noise	3	1,3	1,2,3
6	MIMO Channel Capacity	3	3,4	1,2,4
7	MIMO Beamforming	3	3,4	1,3,4
8	OFDM Channel Capacity	3	3,4	1,2,4
9	IEEE 802.11 Wireless LAN	3	4,5	2,3,4
10	IEEE 802.16 Wi-Max	3	4,5	1,2,3
Total Contact Hours for 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%)		CLA-3 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	20%	60%	20%	40%	20%	60%	20%	30%	20%
	Understand										
Level 2	Apply	60%	40%	40%	40%	60%	40%	40%	40%	70%	40%
	Analyse										
Level 3	Evaluate		40%		40%		40%		40%		40%
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Tse, David, and Pramod Viswanath. Fundamentals of Wireless Communication. Cambridge, UK: Cambridge University Press, 2005.
2. Rappaport Theodore S., Wireless Communications, Principles and Practice, 2/e, Prentice Hall of India, 2003.
3. Goldsmith, Andrea. Wireless communications. Cambridge university press, 2005.
4. Haykin, S., Moher M., Modern Wireless Communications,1/e, Pearson Education, 2011

Other Resources

Course Designers

1. Dr. Sunil Chinnadurai. Asst. Professor. Dept. Of ECE. SRM University – AP.

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

Microprocessors and Microcontrollers

Course Code	ECE 303	**Course Category**	CC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	ECE/EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Analyse the internal organization, addressing modes and instruction sets of 8085 and 8086 processors.
2. Study the various functional units of 8051 microcontroller
3. Analyse the various peripheral devices such as 8255, 8279, 8251, 8253, 8259 and 8237.
4. Understand microcontroller-based system design for various 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	Develop an ALP in 8085 and 8086 microprocessors using the internal organization for the given specification.	3	80%	70%
Outcome 2	Describe the architecture and functional block of 8051 microcontroller.	3	80%	70%
Outcome 3	Explain peripherals devices such as 8255, 8279, 8251, 8253, 8259 and 8237 among others.	3	80%	70%
Outcome 4	Demonstrate microcontroller application and architecture of PIC, ARM and ATMEGA processors on MP Lab.	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	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 2	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 3	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 4	3	3	3	3	3	1		1	1		3	1	1	1	1
Average	2	2	2	2	2	1		1	2		2	2	1	1	1

Course Unitization Plan

Session	Description of Topic	Contact hours required	CLOs Addressed	Reference Used
	UNIT I: 8086 MICROPROCESSORS	**9**		
1.	8086 architecture- Functional Diagram.	1	1	1, 2
2.	Register Organization, Memory segmentation, Memory addresses.	2	1	1, 2
3.	physical memory organization, Signal descriptions of 8086-common function signals.	2	1	1, 2
4.	Minimum and Maximum mode signals, Read Write cycles.	2	1	1, 2
5.	Timing diagrams, Interrupt structure of 8086.	2	1	1, 2
	UNIT II– ASSEMBLY LANGUAGE PROGRAMMING OF 8086	**9**		
6.	Instruction formats, addressing modes, instruction set, assembler directives.	2	1	1, 2
7.	Simple programs involving logical.	2	1	1, 2
8.	Branch and call instructions.	2	1	1, 2
9.	Sorting, evaluating arithmetic expressions	2	1	1, 2
10.	String manipulations.	1	1	1, 2
	UNIT III - PERIPHERAL INTERFACING WITH 8086 MICROPROCESSORS	**9**		
11.	8255 PPI, Keyboard, display controllers, Stepper motor.	2	3	1, 2
12.	A/D & D/A Converter Interfacing with 8086 microprocessors.	1	3	1, 2
13.	Static and Dynamic memories, Vector interrupt table.	1	3	1, 2
14.	Interrupt service routine, Introduction to DOS & BIOS interrupts.	1	3	1, 2
15.	Programmable Interrupt Controller 8259.	2	3	1, 2
16.	DMA controller 8257 Interfacing with 8086 microprocessors.	2	3	1, 2
	UNIT IV: COMMUNICATION INTERFACE	**9**		
17.	Serial communication standards.	2	3	1, 2
18.	serial data transfer schemes.	2	3	1, 2
19.	8251 USART architecture and Interfacing.	2	3	1, 2
20.	RS232.	1	3	1, 2
21.	prototyping and trouble shooting.	2	3	1, 2
	UNIT V: INTRODUCTION TO MICROCONTROLLERS	**9**		
22.	Overview of 8051 microcontroller.	2	2, 4	1, 2, 3
23.	Architecture.	2	2, 4	1, 2, 3
24.	I/O ports and Memory organization.	2	2, 4	1, 2, 3
25.	Addressing modes and instruction set of 8051, Simple programs.	3	2, 4	1, 2, 3
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	16-bit addition, subtraction and multiplication	2	1	1, 2
2.	32- Bit Division.	2	1	1, 2
3.	Program for addition of two numbers and display it on LCD.	2	1	1, 2
4.	Moving data form 500 memory locations to 600 memory locations. Searching a number in given array.	2	1	1, 2
5.	Program for comparing two strings	2	1	1, 2
6	To ADD two Binary numbers each 8 Bytes long	2	1	1, 2
7	To find the maximum no. in a given string (16 Bytes long) and store it in location 0510.	2	1	1, 2
8	To sort a string of a no. of bytes in descending order.	2	1	1, 2
9	To multiply an ASCII string of eight numbers by a single ASCII digit.	2	1,2	1, 2
10	To Divide a String of Unpacked ASCII Digits	2	1,2	1, 2
11	BCD Addition of two bytes.	2	1,2	1, 2
12	BCD Subtraction of two bytes.	2	1,2	1, 2
13	Find whether a no is even or odd.	2	1,2	1, 2
14	Find whether a no is positive or negative.	2	1,2	1, 2
15	Logical Operations (AND, OR, NOT, XOR)	2	1,2	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	50%	30%	50%	60%	60%	30%	60%		60%	30%
	Understand										
Level 2	Apply	50%	70%	50%	40%	40%	70%	40%		40%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**		**100%**	**100%**

Recommended Resources

1. Ramesh S Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", 6th edition, Penram.
2. D V Hall, "Microprocessors and Interfacing", MGH, 2nd edition.
3. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Edition.

Other Resources

Course Designers

1. Dr Sreenivasulu Tupakula, Assistant Professor, Department of ECE, SRM University AP
2. Prof T Srinivias (Professor, Department of ECE, IISc),
3. Prof Goutam Saha (Professor, Department of ECE, IIT, Kharagpur)

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

Electro Magnetics and Wave Propagation

Course Code	ECE 304	**Course Category**	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. To impart concepts related to static electric and magnetic fields in material space along with boundary conditions.
2. To impart concepts of Faraday's law, induced emf and Maxwell's equations
3. To impart the concepts of EM wave propagation and Poynting's theorem

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 apply the concepts of static electric and derive boundary conditions over material space	3	80%	70%
Outcome 2	To apply the concepts of static magnetic fields to solve problems and derive boundary conditions over material space	3	80%	70%
Outcome 3	To derive and apply Maxwell's equations	3	80%	70%
Outcome 4	To analyse EM wave propagation through material space and solve power constraint related 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	2	2	1	2	2	1	-	1	2	-	1	2	1	1	1
Outcome 2	2	2	1	2	2	1	-	1	2	-	1	2	1	1	1
Outcome 3	2	2	1	2	2	1	-	1	2	-	1	2	1	1	1
Outcome 4	3	3	3	3	3	1	-	1	1	-	3	1	1	1	1
Average	2	2	2	2	2	1	-	1	2	-	2	2	1	1	1

Course Unitization Plan

Unit.No	Unit Name	Required hours required	CLOs Addressed	Reference Used
Unit I:	**Electrostatics and Magnetostatics**	**10**		
1.	Review of Electro statics and Magneto statics: Basic laws.	2	1	1,2
2.	Maxwell's equations for static fields.	2	1	1,2
3.	Electric fields in material space: Properties of materials.	2	1	1,2
4.	Continuity equation.	2	1	1,2
5.	Electric and Magnetic boundary conditions.	2	1	1,2
Unit II	**Time varying Electromagnetic fields**	**10**		
6.	Faradays law.	1	1,2	1,2
7.	Displacement current.	1	1,2	1,2
8.	Maxwell's equations (final form)	1	1,2	1,2
9.	Time varying fields – Maxwell's equations.	1	1,2	1,2
10.	Time harmonic fields – Maxwell's equations.	1	1,2	1,2
11.	Waves in general- various parameters of wave.	1	1,2	1,2
12.	EM wave propagation in lossy dielectric media.	1	1,2	1,2
13.	Planewave in lossless dielectric media.	1	1,2	1,2
14.	Plane waves in free space	1	1,2	1,2
15.	Plane waves in good conductors.	1	1,2	1,2
Unit III	**Power Consideration of EM Wave**	**10**		
16.	Power of EM wave.	1	1,2,3, 4	1,2
17.	Poynting's vector.	1	1,2,3, 4	1,2
18.	Poynting's theorem.	1	1,2,3, 4	1,2
19.	EM wave at boundary between two different media: Reflection of plane wave at normal incidence.	2	1,2,3, 4	1,2
20.	Reflection of plane wave at oblique incidence: Parallel polarization.	2	1,2,3, 4	1,2
21.	Perpendicular polarization. Illustrative Problems.	1	1,2,3, 4	1,2
22.	Illustrative Problems.	2		
Unit IV	**Transmission Lines Theory and Parameters**	**11**		
23.	Transmission Lines Types, Parameters, Transmission Line Equations.	2	1,2,3, 4	1
24.	Primary & Secondary Constants, Expressions for Characteristics Impedance.	2	1,2,3, 4	1
25.	Propagation Constant, Phase and Group Velocities, Infinite Line Concepts.	1	1,2,3, 4	1
26.	Losslessness/Low Loss Characterization.	2	1,2,3, 4	1
27.	Distortion - Condition for Distortionlessness and Minimum Attenuation	1	1,2,3, 4	1
28.	Loading - Types of Loading, Illustrative Problems.	1	1,2,3, 4	1
29.	Illustrative Problems.	2		
Unit V	**Impedance Matching in High Frequency Transmission-lines**	**11**		
30.	Transmission Lines - II: Input Impedance Relations.	2	1,2,3	1
31.	SC and OC Lines, Reflection Coefficient.	2	1,2,3	1
32.	VSWR. UHF Lines as Circuits Elements; λ/4, λ /2, λ /8 Lines - Impedance Transformations.	2	1,2,3	1
33.	Significance of and , Smith Chart.	1	1,2,3	1
34.	Configuration and Applications, Single and Double Stub Matching.	1	1,2,3	1
35.	Illustrative Problems.	3	1,2,3	1
Total Contact Hours		**52**		

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	50%		50%		60%		60%		40%	
	Understand										
Level 2	Apply	50%		50%		40%		40%		60%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Mathew N.O. Sadiku, "Elements of Electromagnetics", 3rd edition, Oxford University press.
2. William Hayt , Buck, "Engineering Electromagnetics", 8th edition, TMH.

Other Resources

1. K D Prasad, "Antenna and Wave propagation", Satya Prakashan, New Delhi
2. E C Jordan and Balmain, "Electromagnetic waves and Radiating systems", Pearson Education

Course Designers

1. Dr Sreenivasulu Tupakula, Assistant Prof., SRM University-AP
2. Dr. Divya Chaturvedi, Assistant Prof., SRM University-AP
3. Prof T Srinivias (Professor, Department of ECE, IISc)
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Internet of Things

Course Code	ECE 305	**Course Category**	CC	**L**	**T**	**P**	**C**
				2	0	1	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. To acquire knowledge on sensors, actuators used in IoT and its interfacing.
2. To IoT Architecture and the communication protocols
3. To design secured IoT projects using cloud platforms

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 Understand the sensors, actuators used in IoT and its interfacing.	1,2	80%	75%
Outcome 2	To Understand the IoT Architecture and the communication protocols used in it	1,2	80%	70%
Outcome 3	To have hands on in a IoT cloud platform	2,3,4	75%	65%
Outcome 4	To understand the IoT security mechanisms	2,3,4	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	2	1	1	1							2	1	2	1
Outcome 2	3	2	1	1	1							2	2	2	1
Outcome 3	3	2	3	2	1							2	3	2	2
Outcome 4	3	3	3	3	2							3	2	2	2
Average	3	2	2	2	1							2	2	2	1

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Sensors, actuators & its interfacing**	**13**		
	Temperature, Humidity Sensor	1	1	1
	Accelerometer, Barometer	1	1	1
	Gyro Sensor	1	1	1
	Sensor – Analog and Digital Interfacing	1	1	1
	DC Motor (Brushed, Brushless), Stepper motor, Servo Drive	2	1	1
	Solenoids, Valves and Pumps	1	1	1
	LE 1: Analog/Digital sensor interfacing	3	1	1
	LE 2: Actuators interfacing – Motor/Relay interface	3	1	1
Unit 2	**IoT Architecture and Protocols**	**12**		
	IoT Architecture	1	2	2,3
	Zigbee, Zwave, Dash7	1	2	2,3
	Bluetooth Low Energy	1	2	2,3
	IEEE 802.11, TCP, UDP, CoAP	2	2	2,3
	6LowPAN, RPL	1	2	2,3
	LE 3: Wi-Fi Embedded Web Server	3	2	1
	LE 4: Wi-Fi TCP Server/Client	3	2	1
Unit 3	**IoT Thing/Gateway- Cloud connectivity**	**11**		
	MQTT	1	2	2,3
	Hyper Text Transfer Protocol (HTTP)	1	2	2,3
	REST	1	2	2,3
	Network Layer-IPv4, IPv6	1	2	2,3
	AMCP, web sockets	1	2	2,3
	LE 5: Wi-Fi – UDP Communication	3	2	2
	LE 6: HTTP Server with REST API	3	2	3
Unit 4	**Cloud Platform (AWS)**	**11**		
	Various Cloud platforms	1	3	2
	MQTT communication /Data Retrieval	1	3	2
	Database storage	1	3	2
	SMS/Email Alert services	1	3	2
	Data Analytics using algorithm/Serverless computing	1	3	2
	LE7:MQTT Publish Subscribe Client with AWS/Mosquitto Broker - Python	3	2,4	5
	LE 8: CoAP Server/Client - Arduino - Browser Add on)	3	2	4

Unit 5	**IoT Security**	**13**		
	Private, Public key Encryption	1	4	3
	Advanced Encryption Standard (AES)	1	4	3
	Hash Algorithms, Digital signature	1	4	3
	TLS/DTLS	1	4	3
	LE 9: Bluetooth Low Energy - Notify example with nRF Connect app - (Arduino ESP32)	3	3	5
	LE 10: IOT Cloud platform Connectivity -MQTT	3	2,3,4	1
	LE 11: IoT Cloud Platform – SMS/Email alerts, DB Storage and serverless computing.	3	3,4	1

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	20%	30%	40%	25%	20%	30%	20%	30%	40%	25%
	Understand										
Level 2	Apply	80%	70%	60%	75%	80%	70%	80%	70%	60%	70%
	Analyse										
Level 3	Evaluate										5%
	Create										
Total		100%	**100%**	100%	**100%**	100%	**100%**	100%	**100%**	100%	**100%**

Recommended Resources

1. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited.
2. Agus Kurniawan, "Learning AWS IoT Effectively Manage Connected Devices on the AWS Cloud Using Services Such as AWS Greengrass, AWS Button, Predictive Analytics and Machine Learning", Packt Publisher, 2018
3. Ammar Rayes and Samer Salam, "Internet of Things from Hype to Reality - The Road to Digitization", Springer, Second Edition.
4. Agus Kurniawan, "Internet of Things Projects with ESP32", Packt Press, 2019
5. Neil Cameron, "Electronics Projects with the ESP8266 and ESP32", APress, 2020

Other Resources

1. https://www.w3schools.com/php/php_mysql_intro.asp
2. https://flask-restful.readthedocs.io/en/latest/
3. https://www.arduino.cc/reference/en/libraries/coap-simple-library/
4. http://www.steves-internet-guide.com/into-mqtt-python-client/
5. Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, "Getting Started with Bluetooth Low Energy", O'Reilly Media, Inc, 2014.

Course Designers

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

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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	15%	15%	15%	15%
	Analyse				
Level 3	Evaluate	10%	10%	10%	10%
	Create				
Total		**25%**	**25%**	**25%**	**25%**

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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%**

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Antenna Design

Course Code	ECE 306	Course Category	CC	L	T	P	C
				2	0	1	3
Pre-Requisite Course(s)	ECE 223	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To provide the fundamental concepts of generation of radiation and basic parameters of antenna characterization
2. To provide comprehensive knowledge of different design and performance parameters of antenna.
3. To impart knowledge on the design and operation of antenna-arrays
4. To provide the overall idea about various existing antennas and different advance antennas presently in practice.

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 fundamental concepts of radiation	2	85%	85%
Outcome 2	Apply the basic concepts in antenna design and understand various characteristic parameters	2	85%	80%
Outcome 3	To understand the concept of Antenna-array and its radiation	2	80%	75%
Outcome 4	To provide principle of design, operation, analysis and application of different practical antennas such as micro-strip, Yagi-Uda, horn, and Helical antennas etc	5	85%	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	1	3	2			1		1			1	1		2
Outcome 2	3	1	2	2	1		1		1			1	2	2	
Outcome 3	3	1	2	2	2		1		1		1	1	1		
Outcome 4	3	3	3	3	3		3		2		1	3	2	2	2
Average	3	2	3	2	2		2		2		2	2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamental of Radiation**	**9**		
	Definition and functions of an antenna	1	1,2	1,2
	Comparison between an antenna & Transmission line	1	1,2	1,2
	Radio communication link with transmitting antenna and a receiving antenna	1	1,2,4	1,2
	Radiation fundamentals	1	2,4	1,2
	Radiation from a current element & Radiation from quarter wave monopole	1	1,2,3	1,2
	Radiation from quarter wave monopole and half wave dipoles	1	1,2	1,2
	Derivation for radiation resistance, application of reciprocity	1	1,2	1,2
	Directional properties of dipole antennas, antenna feeding methods			
	Tutorial Classes (Numerical Problems related to the unit)	2	1,2, 3	1,2,4,5
Unit 2	**Antenna Parameters and definitions**	**9**		
	Antenna-parameters, Bandwidth, Beam area, beam width- Half-Power Beam width (HPBW)and First Null Beam	1	1,2,4	1,2,3
	Radiation Intensity, Beam Efficiency	1	2,4	1,2,3
	Radiation resistance, Radiation efficiency	1	2,4	1,2,4
	Resolution, Antenna aperture-physical and effective apertures	1	2,4	1,2,4
	Effective height	1	3, 4	1,2,4
	Friss-free transmission formula	1	3, 4	1,2
	Antenna field zones	1	1,2,4,5	1,2
	Tutorial Classes (Numerical Problems related to the unit)	2	1,2,4	1,2,5
Unit 3	**Arrays of point sources**	**9**		
	Antenna Arrays: Point Sources	1	3, 4	1,2,3
	Definition, Pattern, arrays of 2 Isotropic Sources	1	3, 4	1,2,3
	Different cases of arrays of 2 Isotropic Sources	1	1,2, 3, 4	1,2,3
	Principle of Pattern Multiplication	1	1,2, 3, 4	1,2,3
	Uniform Linear Arrays – Broadside Arrays	1	1,2, 3, 4	1,2,3
	EFA with Increased Directivity	1	1,3,4	1,2,3
	Derivation of their Characteristics and Comparison	1	1,3,4	1,2,3
	BSAs with Non- UNIT form Amplitude Distributions, General Considerations and Binomial Arrays	1	3,4,5	1,2,3
	Tutorial Classes (Numerical Problems related to the unit)	2	1,3,5	1,2,3
Unit 4	**Types of Antennas**	**9**		
	Loop Antenna	1	4,5	1,2
	Slot antenna	1	4,5	1,2
	Micro-strip (Patch) antennas	1	3, 4	1,2
	Yagi-Uda antenna	1	3, 4	1,2
	Log periodic antenna	1	3	1,2
	Helical antenna	1	3, 4	1,2
	Tutorial Classes (Numerical Problems related to the unit)	1	1,3,5	1,2
Total Hours		**30**		

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Exp.1	Characterization of dipole antenna.	3	1,2,3	1,2,4
Exp.2	Characterization of Yagi-Uda antenna.	3	1,2,3	1,2,4
Exp.3	Design of Micro strip patch antenna with the help of CST MWS/Ansys HFSS	3	1, 3, 4	1,2,4
Exp. 4	Characterization of Micro strip patch antenna.	3	3,4	1,2,3
Exp. 5	Characterization of ring resonator.	3	1,5	1,2,3
Exp.6	Characterization of parallel coupler	3	1, 5	1,2,3
Exp. 7	Characterization of a two-way power divider.	3	1, 5, 6	1,2,3
Exp.8	Characterization of a RF passive detector.	3	1, 5	1,2.3
Exp. 9	Radiation Pattern & Gain of Yagi-Uda Antenna.	3	1,2,3	1,2,3
Exp.10	Study of Vector Network Analyzer.	3	5,6	1, 2
Total Hours		**30**		

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%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		30%		30%		30%		40%	
	Understand										
Level 2	Apply	60%		50%		40%		40%		40%	
	Analyse										
Level 3	Evaluate			20%		30%		30%		20%	
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Learning Assessment- Lab

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (40%)	
		Lab Performance (30%)	Model Exam (15%)	Observation notes (15%)			
		Pract	Pract	Pract		Theo.	Prac
Level 1	Remember	30%	30%	30%			30%
	Understand						
Level 2	Apply	30%	50%	30%			30%
	Analyse						
Level 3	Evaluate	40%	20%	30%			40%
	Create						
Total		**100%**	**100%**	**100%**			**100%**

Recommended Resources

1. C.A. Balanis, John Wiley &amp "Antenna Theory", Sons, 3rd Ed., 2005.
2. K.D. Prasad, Satya Prakashan "Antennas and Wave Propagation", Tech India Publications, New Delhi.
3. H.J. Visser "Antenna Theory and Applications", Wiley Publications, 2012
4. Peter A Rizzi "Microwave Engineering & Passive circuits", Wiley Publications, 1998
5. NPTEL lectures on "Antennas" by Prof. Girish Kumar IIT Bombay

Other Resources

Course Designers

1. Dr. Divya Chaturvedi. Asst. Professor. Dept of ECE. SRM University – AP.

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Embedded System for Design

Course Code	ECE 307	Course Category	CC	L	T	P	C
				3	0	1	4
Pre-Requisite Course(s)	ECE 303	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To cover the basic and essential aspects of embedded systems design.
2. To understand the design process and design considerations of different processors.
3. To understand the interfacing of various devices with microprocessors.
4. To understand the communication protocols used in Embedded Systems.
5. To understand the fundamental working and application of a real time operating system.

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	Differentiate between different processor architectures and selection of appropriate processor	2	80%	70%
Outcome 2	Design a single purpose processor for a specific application	2	60%	60%
Outcome 3	Understand the PIC Architecture, Instruction set and do the programming with MPLAB.	3	70%	70%
Outcome 4	Use communication protocols to interface PIC microcontroller with peripheral devices, like LCD display, memories, and sensors.	3	70%	60%
Outcome 5	Compare and contrast scheduling algorithms in RTOS to run multiple Tasks.	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	3	2	2	2	1				1		1	1	1		1
Outcome 2	3	3	3	3	1				1		1	2	2	3	2
Outcome 3	3		1		3				2			1	1		2
Outcome 4	3	2	3	2	3				2			2	2	3	2
Outcome 5	3	3	3	3	3				3		1	2	2	3	2
Average	3	3	2	3	2				2		1	2	2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**7**		
1	Introduction to embedded systems, examples of embedded systems,	1	1	1,2
2	Components of embedded systems hardware	1	1	1,2
3	Design process in embedded system	1	1	1,2
4	Design metrics, design metrics optimization	1	1	1,2
5	Time to market, The NRE and unit cost design metrics, The performance design metrics	1	1	1,2
6	Von Neumann and Harvard Architecture, CISC and RISC architectures	1	1	1,2
7	Introduction to different controllers: Atmel 89C52, ATMEGA 32, Microchip PIC16F877, ARM 7.	1	1	1,2,3
Unit 2	**Custom Processor Designs**	**11**		
8	Processor technology – General-purpose processor, single-purpose processor, and application specific processors	1	**2**	1
9	IC Technology – PLD, semi-custom, full custom.	1	2	1
10	Design Technology – RT Synthesis. RT-level combinational and sequential components.	1	2	1
11	Finite state machine with data (FSMD)	1	2	1
12	Finite state machines (FSM)	1	2	1
13	controller and data path design	1	2	1
14	Optimization of design	2	2	1
15	Operation of general-purpose processors – Instruction execution, pipelining, superscalar and VLIW architectures.	1	2	1
16	Design of Soda Vending machine	1	2	1
17	Design of Elevator controller	1	2	1
Unit 3	**PIC MICROCONTROLLER – ARCHITECTURE AND INTERFACING**	**13**		
18	Baseline, Mid-range and High-performance PIC devices	1	3	6,7
19	PIC Architecture, Memory Organization	1	3	6,7
20	Instruction Set - Branch, Call, Time Delay Loop	3	3	6,7
21	Arithmetic logical instructions	1	3	6,7
22	Assembly Language Programs	1	3	6,7
23	Bank Switching, Table processing, Macros and Modules	1	3	6,7
24	Development tools –MPLAB – Cross compilers, PIC I/O Ports	2	3	6,7
25	Timers and Counters, Capture Compare, PWM Modules	1	3	6,7
26	Interrupts, Watch Dog Timer	2	3	6,7
Unit 4	**Communication Protocols**	**6**		
27	Concept of protocols. Study of serial and parallel communication protocols – UART, SPI,	1	4	1,2,6

28	SCI, I2C, CAN, USB, PCI, Ethernet	2	4	1,2,6,7
29	Study of wireless protocols - IrDA, Bluetooth, IEEE802.11,	1	4	6,7
30	Zigbee, RF modules, GSM modem for AT command study.	2	4	6,7
Unit 5	**Basics of Real-Time Operating System**	**8**		
31	Need of RTOS in Embedded system software, RTOS services in contrast with computer OS. Features of µCOS II.	1	5	4
32	Foreground/Background systems, Kernel architecture,	1	5	4,5
33	Task, Task scheduler, context switching.	1	5	4,5
34	Scheduling algorithms – First come first serve, Round Robin, Round Robin with Priority, Shortest job first.	1	5	4
35	Multitasking, Interrupt service routine (ISR),	1	5	4
36	Semaphores, Mutexes, Events	1	5	4
37	Inter process communication (IPC) - mailbox, message queues,	1	5	4,7
38	Pipes, timers, memory management.	1	5	4, 7
	Total Contact Hours	**45**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	Assembly language programming for PIC microcontrollers. Arithmetic Operations Port I/O Programming	4	3	6
2.	Timers and Counter Programming and usage of CCP module.	4	3,4	6
3.	ADC and Data EEPROM Programming.	4	4	6, 7
4.	Asynchronous Serial Communication UART Programming.	2	3,4	6
5.	Peripheral Interfacing using synchronous serial communication (SPI/ I2C)	2	3,4	6,7
6	Program for making PIC's USB as virtual COM Device (CDC class device)	2	4	7
7	Controller Area Network (CAN) Interface.	2	4	7
8	RTOS program to demonstrate Task management.	2	5	4
9	RTOS program to demonstrate Inter task communication and inter task synchronization.	4	5	4
10	Mini Capstone Project.	4	3,4,5	4,6,7
Total Contact Hours		**30**		

Learning Assessment- Theory

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		Mid-1 (10%)		CLA-2 (15%)		CLA-3 (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%		70%		40%		50%	
	Understand										
Level 2	Apply	40%		40%		30%		40%		40%	
	Analyse										
Level 3	Evaluate			20%				20%		10%	
	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 (15%)	Record / Observation Note (10%)	Viva + Model (25%)	
Level 1	Remember	30%	60%	30%	30%
	Understand				
Level 2	Apply	70%	40%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Vahid and Givargis,"Embedded system design : A unified hardware/software introduction", John Wiley & Sons, Inc. 2002.
2. Raj Kamal, "Embedded Systems : Architecture, Programming, and Design", The McGraw-Hill Companies, Edition 2, 2008.
3. Steve Furber, "ARM System-on-chip architecture", Addison-Wesley Publications, 2nd Ed., 2000.
4. Jean J. Labrosse, "MicroC/OS-II : The Real-Time Kernel", CMP Books, Edition 2, 2002.
5. S.V. Iyer and P. Gupta, "Embedded Realtime Systems Programming", The McGraw-Hill Companies, 2004.
6. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey "PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008.
7. Dogan Ibrahim, "Advanced PIC Microcontroller Projects in C: From USB to RTOS with PIC18F Series", Newnes, 2008.

Other Resources

Course Designers

1. Dr. Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University – AP.

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

UROP

Course Code	ECE 308	**Course Category**	RDIP	**L**	**T**	**P**	**C**
				0	0	3	3
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				
Outcome 4				

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.

Internship

Course Code	ECE 401	Course Category	RDIP	L	T	P	C
				0	0	4	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	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 Life Long 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	100%	40%	50%	20%	20%
	Understand					
Level 2	Apply		60%	50%	60%	60%
	Analyse					
Level 3	Evaluate				20%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

Other Resources

Course Designers

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

Major Project

Course Code	ECE 402	Course Category	RDIP	L	T	P	C
				0	0	12	12
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. To find own research problem
2. In depth study of the topic under consideration
3. Application of knowledge gained in building up to a system that solves real life problems
4. Understanding the social, economic, and environmental constraints in making of a new project

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	Conduct a literature survey in the field of interest / proposed topic of the work and identify a problem to solve.	4	60%	80%
Outcome 2	Design and conduct a Modelling / Simulation / /Experiment	6	65%	80%
Outcome 3	Present finding and analysis to a review committee	5	90%	90%
Outcome 4	Submit a paper / patent	6	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	3				2	2	3	3		2	3			1
Outcome 2	3	3	3	3	3	2	2	3	3		3	3	3	3	3
Outcome 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Outcome 4	3	3	3	3	3	3	3	3	3	3	3	3	3		1
Average	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	COs Addressed	References Used
Unit 1	**Literature Survey**	**70**		
	Do a thorough literature survey in the domain of interest and conceive an idea	20	1	1
	Continue the literature survey specifically related to the idea conceived and determine your contribution	25	1	1
	Make an abstract of the proposed idea	5	1	1
	Preparation of biweekly reports	20	1	1
Unit 2	**Methodology**	**70**		
	Device project plan.	5	2	1
	Acquire necessary components, software, dataset etc requirements.	15	2	1
	Testing the existing algorithms, tools, or components	30	2	1
	Preparation of biweekly reports and test plans	20	2	1
Unit 3	**Results**	**110**		
	Development of complete methodology	55	2	1
	Prototype building	35	2	1
	Preparation of biweekly reports and test plans	20	2	1
Unit 4	**Dissertation and demonstration of the project**	**72**		
	Completion of project dissertation	60	3	1
	Demonstration of the project	12	3	1
Unit 5	**Writing and submitting a research article/patent**	**38**		
	writing of a technical paper / patent	8	4	1
	Writing and submission of a journal research paper	30	4	1
	Total Contact Hours	**360**		

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		70%		50%		20%		10%		
	Understand										
Level 2	Apply		30%		30%		40%		50%		30%
	Analyse										
Level 3	Evaluate				20%		40%		40%		70%
	Create										
Total			**100%**		**100%**		**100%**		**100%**		**100%**

Recommended Resources

1. As deem appropriate by the student under guidance of project faculty guide.

Other Resources

Course Designers

1. Dr. Anuj Deshpande (Assistant Professor, Department of Electronics and Communication Engineering)
2. Prof. Siva Sankar Y (Professor, Department of Electronics and Communication Engineering)

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

Embedded Programming

Course Code	ECE 421	Course Category	CE	L	T	P	C
				2	0	1	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. Understand the basics of Embedded Systems.
2. Learn the ARM architecture, instruction set and its assembly programming.
3. Learn to develop C programs for ARM processors and interfacing the peripherals.
4. Understand the software architectures used in Embedded 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	Understand and explain the basics of Embedded Systems.	2	80%	70%
Outcome 2	Understand the ARM Cortex M Architecture, instruction set and do ARM assembly & C programming.	3	80%	70%
Outcome 3	Develop ARM assembly & C programs.	2	80%	70%
Outcome 4	Understand the architecture used in Embedded Software.	2	80%	70%
Outcome 5	Understand the RTOS concepts and develop RTOS applications for ARM Microcontrollers.	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	2	2	1				1		1	1	1	1	1
Outcome 2	3	3	3	3	1				1		2	2	2	2	2
Outcome 3	3	3	3	3	1				1		2	2	2	2	2
Outcome 4	3	2	1	2	1				1		1	1	2	2	2
Outcome 5	3	3	1	2	1				1		2	2	2	2	2
Average	3	2	1	2	1				1		1	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**OVERVIEW**	**9**		
1	Embedded System Case Studies	2	1	1,3
2	Introduction to Embedded Systems	2	1	1,3,4
3	Getting to Know the Hardware	2	1	1,3,4
4	Learn How to Communicate	1	1	1,3,4
5	Getting to Know the Processor	1	1	1,3,4
6	Study the External Peripherals	1	1	1,3,4
Unit 2	**ARM REFERENCE ARCHITECTURE**	**13**		
7	ARM Processor Architecture	1	**2**	6,4
8	ARM Software Development	1	2	6,4
9	ARM Instruction Sets	2	2	6,4
10	Getting Started with Embedded Software Development (Tools, Packages, Platforms, etc.)	1	3	1,6,4
11	Your First Embedded Program-Hello, ARM!	1	3	1,6,4
12	The Blinking LED Program	1	3	1,6,4
13	The Role of the Infinite Loop	1	3	1,6,4
14	Compiling, Linking, and Locating	1	3	1,6,4
15	The Build Process	1	3	1,6,4
18	Embedded Software Architecture	3	3	3
Unit 4	**EMBEDDED OPERATING SYSTEM**	**8**		
27	Real-Time Operating Systems	2	4	2,7
29	Tasks and Task States, its transition	2	4	2,7
30	Task scheduling	2	4	2,7
28	Interrupt Routines in an RTOS Environment	2	4	2,7
	Total contact hours	**30**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1	ARM Assembly language program for doing arithmetic operation.	1	3	5
2	ARM assembly language program for Memory operations	1	3	5
3	ARM Assembly - Interfacing memory mapped peripherals 1. Binary Counter with LEDs 2. Real Time Clock 3. Analog to Digital converter 4. Digital to Analog Converter	2	3	5
4	C Program for peripheral interfacing 1. GPIO 2. Real Time Clock 3. Analog to Digital Converter 4. Digital to Analog Converter	2	3	5
5	C Program for Asynchronous and synchronous serial communication 1. UART 2. I2C/SPI	2	3	5
6	Timer programming with Interrupt	1	3	5
7	LCD/Keypad Interface	2	3	5
8	RTOS Task Management	1	4	7
9	RTOS Inter Task Synchronization and Inter Task communication	2	4	7
10	Mini Capstone Project	1	2,3	
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	Mid-1(15%)		Th (35%)	Prac (15%)
Level 1	Remember	60%	40%	60%	60%	20%	40%	30%
	Understand							
Level 2	Apply	40%	60%	40%	40%	80%	60%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Barr, Michael, and Anthony Massa. Programming embedded systems: with C and GNU development tools. " O'Reilly Media, Inc.", 2006.
2. Simon, David E. An embedded software primer. Vol. 1. Addison-Wesley Professional, 1999.
3. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017.
4. Wolf, Wayne (2008), Computers as components : principles of embedded computing system design. 2 edition. Amsterdam : Elsevier (507 p).
5. Ata Elahi, Trevor Arjeski, "ARM Assembly Language with Hardware Experiments", Springer, 2015.
6. A.N.Sloss et al., "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2004
7. Richard Barry, "Mastering the FreeRTOS™ Real Time Kernel", Real Time Engineers Ltd 2016

Other Resources

Course Designers

1. Dr Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University - AP

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

RTOS

Course Code	ECE 422	Course Category	CE	L	T	P	C
				2	0	1	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. To understand the basics of operating systems.
2. To understand and appreciate the RTOS based firmware development.
3. To understand the internals of RTOS and apply it for the firmware development.
4. To design an RTOS based system using microcontroller to solve the specific problem

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 operating systems and RTOS concepts.	2	80%	70%
Outcome 2	Apply the FreeRTOS scheduling algorithms and other task system calls.	4	60%	60%
Outcome 3	Apply FreeRTOS inter task synchronization means for synchronizing tasks.	4	60%	60%
Outcome 4	Write FreeRTOS program with interrupts and software timers	4	70%	60%
Outcome 5	Apply FreeRTOS memory management and inter task communication concepts	4	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	3	2	2	2	1							2	1		1
Outcome 2	3	3	3	3	3				2	1	1	2	2	3	2
Outcome 3	3	3	3	3	3				2	1	1	2	1		2
Outcome 4	3	3	3	3	3				2	1	1	2	2	3	2
Outcome 5	3	2	3	3	3				3	1	1	2	2	3	2
Average	**3**	**3**	**3**	**3**	**3**				**2**	1	**1**	**2**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
	UNIT I: INTRODUCTION	**7**		
Unit I	Basics of Operating Systems Threads and Processes.	1	1	1,5,6
	Scheduling - Inter process synchronization Inter process communication.	2	1	1,5,6
	Memory Management File System – Introduction to Real Time Systems.	2	1	1,5,6
	RTOS Vs General purpose OS Types of RTOS.	1	1	1,2
	Firmware development approaches When to use RTOS.	1	1	1,2
	UNIT II: TASK MANAGEMENT	**6**		
Unit II	Task -Task states -Task State Transition.	1	2	3
	Task creation Task Priorities Idle Task.	1	2	3
	Task scheduling	2	2	3
	Task Context Task Context switch.	2	2	3
	UNIT III: INTER TASK SYNCHRONIZATION AND COMMUNICATION	**9**		
Unit III	Inter Task Synchronization – Semaphores Types of semaphores.	2	3	3
	Mutexes, System Calls for Task synchronization, Critical sections.	2	3	3
	Priority inversion, Priority Inheritance, Deadlocks.	2	3	3
	Events - Event groups Inter Task Communication.	1	3	3
	Message queues, Queue creation, Queue Send/Receive System Calls.	2	5	3
	UNIT IV: RESOURCE MANAGEMENT AND INTERRUPTS	**8**		
Unit IV	Memory Management, Dynamic Memory Allocation.	2	5	3
	Heap, Stack Overflow detection -Software Timers.	2	5	3
	Attributes, States, Context, and system calls.	1	2	3
	Interrupt Management - Interrupt Safe System Calls.	2	4	3
	Deferred Interrupt Processing.	1	4	3
	Total Contact Hours	**30**		

Course Unitization Plan - Lab

Session No.	Description of Experiments	Required Contact Hours	CLOs Addressed	References Used
1.	RTOS Configuration, Task creation and Task management API	2	2	3
2.	Task scheduling Priority based pre-emptive / Round Robin Scheduling	2	2	3
3.	Cooperative scheduling & co routines	1	2	3
4.	Inter Task synchronization Semaphores, Mutexes and Events	2	3	3
5.	Priority Inversion & Priority inheritance	2	3	3
6.	Program to demonstrate Inter Task Communication using message queues.	2	5	3
7.	One shot and auto reload software timers	1	4	3
8.	Profiling: Viewing Run Time and task state information	2	2	3
10.	Mini Capstone Project	1	5	3,4,5
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	Mid-1(15%)		Th (35%)	Prac (15%)
Level 1	Remember	60%	40%	60%	60%	20%	40%	30%
	Understand							
Level 2	Apply	40%	60%	40%	40%	80%	60%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, "Operating System concepts",9th edition, John Wiley & Sons Inc, 2018
2. Raj Kamal, "Embedded Systems- Architecture, Programming and Design", 3rd edition, McGraw Hill Education, 2017.
3. Richard Barry, "Mastering the FreeRTOS Real Time Kernal", Real Time Engineers Ltd, 2016.
4. Brian Amos, "Hands-on RTOS with Microcontrollers", Packet Publishing, 2020.
5. www.freertos.org
6. Robert Love, "Linux System Programming", 2nd edition, O'Reily Publications, 2013

Other Resources

Course Designers

1. Dr. Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University – AP.
2. Dr. Anuj Deshpande, Assistant Professor, Department of Electronics and Communication Engineering, SRM University – AP.

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

Embedded Networking

Course Code	ECE 423	Course Category	CE	L	T	P	C
				2	0	1	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. Application Development using USB and CAN bus with microcontrollers.
2. Understand the lightweight TCP/IP protocol and its usage.
3. Understand the MODBUS RTU and MODBUS TCP protocols.
4. Application development for 6LoWPAN network on Contiki 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	Understand Embedded Communication Protocols like UART, RS232, RS485, SPI, I2C.	2	80%	70%
Outcome 2	Understand USB BUS interface and develop USB device applications.	2	80%	70%
Outcome 3	Understand and apply the Controller Area Network	3	80%	70%
Outcome 4	Develop Embedded TCP/IP applications.	3	80%	70%
Outcome 5	Understand and develop application using Modbus RTU and Modbus TCP	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	2	2	2				2	2	1	2	1	1	1
Outcome 2	3	3	3	3	3				2	2	1	2	2	2	2
Outcome 3	3	3	3	3	3				2	2	1	2	3	3	3
Outcome 4	3	3	3	3	3				2	2	1	2	2	2	2
Outcome 5	3	3	3	3	3				2	2	1	2	3	3	3
Average	3	3	3	3	3				2	2	2	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**EMBEDDED COMMUNICATION PROTOCOLS**	**6**		
1	Embedded Networking - Introduction	1	1	1,3
2	Serial/Parallel Communication	1	1	1,3
3	Serial communication protocols - RS232 standard – RS485	1	1	1,3
4	Synchronous Serial Protocols -Serial Peripheral Interface (SPI)	1	1	1,3
5	Inter Integrated Circuits (I2C)	1	1	1,3
6	PC Parallel port programming	1	1	2
Unit 2	**USB AND CAN BUS**	**8**		
	USB bus – Introduction	1	2	1,3
	Speed Identification on the bus, USB States	1	2	3
	USB bus communication: Packets –Data flow types, Enumeration –Descriptors	1	2	3
	USB Device Classes (CDC,MSC, HID) and USB Host	1	2	3
	CAN Bus – Introduction	1	3	3
	Frames –Bit stuffing –Types of errors –Nominal Bit Timing	1	3	3
	A simple application with CAN	1	3	3
Unit 3	**EMBEDDED TCP/IP**	**9**		
	Light Weight TCP/IP - Introduction	1	4	7,8,9
	Process model, Memory management and Network Interfaces	1	4	7,8,9
	IP Processing	2	4	7,8,9
	UDP, TCP Processing	2	4	7,8,9
	Interfacing the stack – API	1	4	7,8,9
	TCP/UDP Server Client	1	4	7,8,9
	HTTP Server, SSI and CGI	1	4	7,8,9
Unit 4	**MODBUS**	**7**		
	Modbus RTU - Introduction	1	5	5
	Protocol Description – Data Encoding – Data Model – Address Model	1	5	5
	MODBUS Transaction – Function code categories	1	5	5
	Function code descriptions	2	5	5
	Modbus Exception Responses	1	5	5
	Modbus TCP/IP – Protocol Description	1	5	5,6
	Total Contact Hours	**30**		

Course Unitization Plan – Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1	I2C/SPI Communication	1	1	1,3
2	RS485 Bus Communication – Modbus RTU	2	1	1,3,5
3	Embedded TCP Client/Server	2	3	3,8
4	Embedded UDP application	2	3	3,8
5	Modbus TCP	2	4	3,8
6	Embedded HTTP	1	3	3,8
7	USB -CDC Class Device	2	2	3
8	USB - HID Class Device	2	2	3
9	CAN communication	1	2	3
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	Mid-1(15%)		Th (35%)	Prac (15%)
Level 1	Remember	60%	40%	60%	60%	20%	40%	30%
	Understand							
Level 2	Apply	40%	60%	40%	40%	80%	60%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software Introduction', Student Edition, Wiley Publications, 2006.
2. Jan Axelson, 'Parallel Port Complete: Programming, Interfacing, & Using the PC's Parallel Printer', First Edition, Penram publications, 1997.
3. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008
4. Microchip Technology, "AN2059 LIN Basics and Implementation of the MCC LIN Stack Library on 8-Bit PIC® Microcontrollers", http://ww1.microchip.com/downloads/en/appnotes/00002059b.pdf.
5. Modbus.org, "MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3", https://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf
6. Modbus.org, "MODBUS MESSAGING ON TCP/IP IMPLEMENTATION GUIDE V1.0b", https://www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf
7. Adam Dunkels, "Design and Implementation of the lwIP", https://www.artila.com/download/RIO/RIO-2010PG/lwip.pdf
8. Microchip Technology, Microchip TCP/IP Lite Stack, https://ww1.microchip.com/downloads/en/Appnotes/Microchip-AN1921-8-bit-PICMCU-TCP-IP-LiteStack-ApplicationNote-00001921D.pdf2
9. Edward Insam, "TCP/IP Embedded Internet Applications", Newnes, 2003.

Other Resources

Course Designers

1. Dr Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University – AP.

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

IoT Architecture and Protocols

Course Code	ECE 424	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	0	1	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. Understand the Architectural Overview of IoT
2. Understand the IoT Reference Architecture and Real-World Design Constraints
3. Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service) and its security aspects.

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 various IoT Architectures	2	80%	70%
Outcome 2	Understand IoT wireless networking standards.	2	80%	70%
Outcome 3	Understand and use the IoT network and transport layer protocols.	4	80%	70%
Outcome 4	Understand and use the IoT application layer protocols.	4	80%	70%
Outcome 5	Understand and use IoT Security at different layers.	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	2	2	1				1	1	1	1	1	1	3	2
Outcome 2	3	2	3	3				1	1	2	3	2	2	3	2
Outcome 3	3	3	3	3				1	1	1	3	2	2	3	3
Outcome 4	3	3	3	3				1	1	2	3	2	2	3	3
Outcome 5	3	3	3	3				1	1	2	3	2	2	3	3
Average	3	2	3	3				1	1	2	3	2	2	3	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**OVERVIEW**	**7**		
1	IoT Architecture – Different layers	2	1	1,3
2	Sensors and Actuators	1	1	1,3
3	Gateways	1	1	1,3
4	Analytics and Data services	1	1	1,3
5	Application layer, Communication Models	1	1	1,3
6	IoT Architecture - Case Study	1	1	1,3
Unit 2	**Lower Layer Protocols/Standards**	**8**		
7	Zigbee, Zwave, Dash7	2	**2**	2
8	Bluetooth Low Energy	2	2	2,4
9	IEEE 802.11, IEEE 802.15.4, TCP, UDP	2	2,3	2
10	Network Layer-IPv4, IPv6,6LoWPAN, RPL	1	3	2
11	Cellular IoT -NB-IoT, LTE-m	1	2	6
Unit 3	**IoT –Application Layer Protocols**	**9**		
12	MQTT	2	4	2
13	Hyper Text Transfer Protocol (HTTP)	1	4	2
14	Web sockets, REST	2	4	2
15	CoAP	2	4	2
16	AMCP, XMPP	2	4	2
Unit 4	**IoT Security**	**6**		
17	IoT Device/Embedded Security	1	5	7
18	Encryption – Private and Public key Encryption	1	5	7
19	Hash Algorithms, Digital Signature	1	5	7
20	Transport Layer Security - TLS/DTLS	2	5	7
21	Network Layer Security	2	5	7
	Total Contact Hours	**30**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1	TCP Server - Single Client Socket Program (C)	1	3	2
2	TCP Server - Multi Client Socket Program (C)	1	3	2
3	UDP Server - Client Communication (C)	1	3	2
4	HTTP Server (Apache Server) - Web Page and Server side script for MySQL Connectivity (PHP - MySQL)	2	4	2
5	HTTP Server with REST API	1	4	2
6	MQTT Publish Subscribe Client with AWS/Mosquitto Broker - Python	2	1,4	5
7	CoAP Server/Client - Arduino - Browser Add on)	2	4	1,2
8	Bluetooth Low Energy - Notify example with nRF Connect app - (Arduino ESP32)	2	2	4
9	IPV6 TCP Client-Server communication program (C)	1	3	2
10	Contiki /Cooja Demonstration	2	1,2	8
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (10%)	CLA-2(5%)	CLA-3 (5%)	Mid-1(15%)		Th (35%)	Prac (15%)
Level 1	Remember	60%	40%	60%	60%	20%	40%	30%
	Understand							
Level 2	Apply	40%	60%	40%	40%	80%	60%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Edition, Orient Blackswan Private Limited, New Delhi, 2015.
2. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, " Internet of Things: Architectures, Protocols and Standards", Wiley Publishers, 2018
3. Dieter Uckelmann, Florian Michahelles, Mark Harrison, "Architecting the Internet of Things", Springer Berlin Heidelberg, 2011.
4. Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, "Getting Started with Bluetooth Low Energy: Tools and Techniques for Low-Power Networking", 1st Edition, O'Reilly Media, 2014.
5. Agus Kurniawan, "Learning AWS IoT", Packt Publishing, 2018.
6. Cameron Coursey, "The Practitioner's Guide to Cellular IoT", Artech House, 2020.
7. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016.
8. Agus Kurniawan, "Practical Contiki-NG, Programming for Wireless Sensor Networks", Apress, 2018.

Other Resources

Course Designers

1. Dr Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University - AP

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

SoC Design for IoT

Course Code	ECE 426	Course Category	CE	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. Understand the basics of SoC Design.
2. Learn the techniques to choose a processor for SoC Implementation.
3. Learn different type of memory blocks used in SoC Design.
4. Understand the bus architecture and Custom SoC Design.
5. Learn the designing methods for customized SoC Design using hardware and software co-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	Understand and explain the basics of SoC Design.	2	80%	70%
Outcome 2	Understand the techniques in choosing a best processor for SoC implementation.	3	80%	70%
Outcome 3	Understand the memory blocks used in SoC Design.	2	80%	70%
Outcome 4	Understand various bus architecture in designing Custom SoCs.	3	80%	70%
Outcome 5	Understand various terminologies using hardware and software co-design for designing customized SoC using suitable Processor.	2	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	2	1				1		1	1	1	1	3	2
Outcome 2	3	3	3	2				1		2	2	2	2	3	3
Outcome 3	3	2	2	1				1		1	2	2	2	3	2
Outcome 4	3	3	2	1				1		2	2	2	2	3	3
Outcome 5	3	2	2	2				1		2	2	2	2	3	2
Average	**3**	**2**	**2**	**1**				**1**		**2**	**2**	**2**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**SYSTEM ARCHITECTURE: OVERVIEW**	**9**		
1	Components of the system, Processor architectures	2	1	1,3
2	Processor architectures, Memory and addressing – system level interconnection.	2	1	1,3,4
3	SoC design requirements and specifications, Design integration – design complexity.	2	1	1,3,4
4	Cycle time, die area and cost, Ideal and practical scaling.	1	1	1,3,4
5	Design integration – design complexity, Area-time-power tradeoff in processor design.	1	1	1,3,4
6	Configurability.	1	1	1,3,4
Unit 2	**PROCESSOR SELECTION FOR SOC**	**9**		
7	Overview – soft processors.	1	**2**	1,3,4
8	Processor core selection.	1	2	1,3,4
9	Basic concepts – instruction set, branches.	1	2	1,3,4
10	Interrupts and exceptions.	1	2	1,3,4
11	Basic elements in instruction handling.	1	2	1,3,4
12	Minimizing pipeline delays	1	2	1,3,4
13	Reducing the cost of branches – Robust processors	1	2	1,3,4
14	Vector processors, VLIW processors	1	2	1,3,4
15	Superscalar processors.	1	2	1,3,4
Unit 3	**MEMORY DESIGN**	**9**		
16	SoC external memory, SoC internal memory	1	3	3
17	Scratch pads and cache memory	1	3	3
18	Cache organization and write policies	1	3	2, 3, 4
19	Srategies for line replacement at miss time	1	3	2,3
20	Split I- and D-	1	3	3,4
21	Caches – multilevel caches	1	3	3
22	SoC memory systems	**1**	3	1,4
23	Board based memory systems	1	3	2
24	Simple processor/memory interaction.	1	3	2
Unit 4	**INTERCONNECT ARCHITECTURES ANDSOCCUSTOMIZATION**	9		2
25	Bus architectures – SoC standard buses.	1	4	2
26	AMBA, Core Connect.	1	4	2,3
27	Processor customization approaches.	**1**	4	2,3
28	Reconfigurable technologies.	1	4	2
29	Mapping designs onto reconfigurable devices.	1	4	2
30	FPGA based design.	1	4	2
31	Architecture of FPGA.	**1**	4	2
32	FPGA interconnect technology.	1	4	2,4
33	FPGA memory, Floor plan and routing	1	4	2,3,4
Unit 5		9		
34	Hardware software task partitioning – FPGA fabric Immersed Processors	1	5	1,2
35	Soft Processors and Hard Processors	1	5	2,3,4
36	Tool flow for Hardware/Software Co-design	1	5	2,3
37	Interfacing Processor with memory and peripherals	1	5	2,3
38	Types of On-chip interfaces – Wishbone interface	1	5	2,3
39	Avalon Switch Matrix.	1	5	2,3,4
40	OPB Bus Interface	1	5	2,3
41	Creating a Customized Microcontroller	1	5	1,4
42	FPGA-based Signal Interfacing and Conditioning.	1	5	2,3,4
	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-II (10%)		CLA-III (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		30%		40%		40%		50%	
	Understand										
Level 2	Apply	60%		70%		60%		60%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. Michael J. Flynn and Wayne Luk, "Computer System Design: System-on-Chip", John Wiley and sons,2011.
2. Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays", Springer Verlag London Ltd.,2009.
3. Sudeep Pasricha and Nikil Dutt, On-Chip Communication Architectures - System on Chip Interconnect, Elsevier, 2008.
4. Steve Furber, System-on-chip Architecture, Addison-Wesley, 2000

Other Resources

Course Designers

1. Dr Saswat Kumar Ram. Assistant Professor, Department of Electronics and Communication Engineering, SRM University - AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

FPGA-based Embedded System Design

Course Code	ECE 428	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	0	1	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. To introduce the internal architecture of programmable logic with focus on FPGA.
2. To provide knowledge in FPGA design flow at the architectural and system design.
3. To impart a good background in block-based design using standard system level tools.

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	Ability to understand the structure of the fabric of programmable logic	2	80%	75%
Outcome 2	Implement ideas on Placement and Partitioning of Circuits	3	80%	75%
Outcome 3	Identify concepts and Algorithms of Floor planning and Routing	3	80%	75%
Outcome 4	Develop circuit level techniques and apply in logic Synthesis	3	80%	75%
Outcome 5	Working on High Level Synthesis of Circuits	4	80%	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	3	3	3	3	1		2	1				3	3	1	2
Outcome 2	3	3	3	3	2	1	2	1	3			2	3	2	2
Outcome 3	3	3	3	3	2		2	1	3			3	3	2	2
Outcome 4	3	3	3	3	2	1	2	1	3			2	3	2	2
Outcome 5	3	3	3	3	2	1	2	1	2			2	3	2	2
Average	3	3	3	3	2	1	2	1	3			2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Programmable Logic Devices**	**10**		
	PROM - PAL - PLA - CPLD - Gate Arrays - MPGA	1	1	1
	FPGA - Programming Technologies - EPROM - EEPROM - FLASH - SRAM - FPGA Fabric	2	1	1
	Configurable Logic Block - LUT - Slice - Slicem	1	1	1
	Programmable Interconnects - Input Output Blocks - Keeper Circuit - Xilinx 7 Series Architecture.	2	1	1
	Introduction to Edge Zynq SoC FPGA Development Board. (Lab Experiment - 1)	2	1	4
	Controlling LED in Edge Zynq SoC FPGA Development Board. (Lab Experiment - 2)	2	1	4
Unit 2	**FPGA Design Flow and Abstraction Levels**	**10**		
	Verilog Design for Synthesis	1	2	1
	One Hot Encoding - Memory Blocks - Block Memory Generator (BRAM/BROM)	2	2	1
	Single Port Memory - Dual Port Memory	1	2	2
	FIFO - Distributed RAM - Synthesis Pitfalls - Latch Inference	2	2	2
	Designing Combinational Logic circuits Edge Zynq SoC FPGA Development Board. (Lab Experiment - 3)	2	2	5
	Designing Sequential Logic circuits Edge Zynq SoC FPGA Development Board. (Lab Experiment - 4)	2	2	5
Unit 3	**Static Timing Analysis**	**14**		
	Speed Performance - Timing Constraints	2	3	2
	Clock Management - Clock Buffers.	3	3	2
	Clock Tree Routing	3	3	2
	Control relay using switch on the Edge Zynq Board. (Lab Experiment - 5)	2	3	5
	Produce sound at piezo Buzzer at regular interval on Edge Zynq Board. (Lab Experiment - 6)	2	3	5
	LDR Interface using ADC. (Lab Experiment - 7)	2	3	5
Unit 4	**Introduction to SoC Design**	**10**		
	Hard Macros - Multipliers - DSP Block	2	4	3
	Hard Core Processors - Interface Circuits	2	4	3
	Configuration Chain - JTAG Interface - Zynq7000 Architecture	2	4	3
	2x16 Liquid Crystal Display Interface. (Lab Experiment - 8)	2	4	4
	4-bit BCD to Seven Segment Display. (Lab Experiment - 9)	2	4	4
Unit 5	**Timing Simulation and Programming**	**10**		
	Timing Simulation using Modelsim/Icarusverilog,	2	5	3
	Programming using JTAG, System Level testing and debugging	1	5	3
	Debugging techniques	1	5	3

	Debugging using chip scope and Logic analyzers, Protocols on FPGA	2	5	3
	Seven Segment Display Counter. (Lab Experiment - 10)	2	5	3
	Displays 128x160 pixel image on the SPI TFT Display interfaced to Edge board. (Lab Experiment - 11)	2	5	4
	Project			

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%)		CLA3 (15%)			
		Th	**Prac**	Th	Prac	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	60%	30%	50%	40%	60%	30%	50%	40%	50%	50%
	Understand										
Level 2	Apply	40%	50%	50%	50%	40%	60%	50%	50%	40%	40%
	Analyze										
Level 3	Evaluate		20%		10%		10%		10%	10%	10%
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Amano, Hideharu, Principles and Structures of FPGAs, First Edition, Springer, 2018.
2. Readler, Blaine C., Verilog by example: a concise introduction for FPGA design, Full Arc Press, 2011.
3. ZainalabedinNavabi, Embedded Core Design with FPGAs, First Edition, McGraw Hill, 2008.
4. Xilinx Inc, Vivado Design Suite User Guide, 2021.

Other Resources

Course Designers

1. Dr. Saswat Kumar Ram, Assistant Professor, Dept of ECE, SRM University - AP

SRM University *AP*, Andhra Pradesh
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Embedded Systems for Electric Vehicles

Course Code	ECE 429	**Course Category**	CE	**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. To understand the fundamental concepts of embedded systems and electric vehicles.
2. To know the advanced versions of the microcontrollers and microprocessors
3. To understand the integration of hardware and software from the electric vehicles' perspective
4. To design embedded systems for electric vehicles

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 basics of embedded systems and electric vehicles	2	70%	65%
Outcome 2	Know the usage of the latest microcontrollers and microprocessors	2	65%	65%
Outcome 3	Integrate hardware and software through communication protocols	3	70%	60%
Outcome 4	Know how to design embedded systems for electric vehicles	2	60%	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														
Outcome 2	3	1		1								1			
Outcome 3	3	2	2	2								1	2	3	2
Outcome 4	3	3	3	3	3							1	3	3	2
Average	3	2	2	2	3							1	2	3	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION TO EMBEDDED SYSTEMS AND ELECTRIC VEHICLES**	**7**	1	1,2
	Importance of embedded systems	1	1	1,2
	Microcontrollers vs. microprocessors, Real-time systems and applications	2	1	1,2
	Glance of electric vehicle technology, Types of electric vehicles – BEV, PHEV, HEV	2	1	7
	Constituents of electric vehicles – batteries, motors, controllers	2	1	7
Unit No. 2	**MICROCONTROLLERS AND MICROPROCESSORS**	**11**	2	5,6
	Basic architecture of microcontrollers in EVs	1	2	5,6
	Brief of microcontrollers used in EVs – TI C2000 series, Infineon AURIX series, NXP S32K and MPC series, Renesas RH850 series, Microchip PIC32 and dsPIC series, STMicroelectronics STM32 series	6	2	5,6
	Interfacing microcontrollers	4	2	5,6
Unit No. 3	**HARDWARE IN ELECTRIC VEHICLES**	**10**	2	7
	Power Electronics - Basics of power electronics, DC-DC converters, inverters, and rectifiers, Motor control techniques and algorithms	3	2	7
	Battery Management System - Battery chemistry and characteristics, Constituents of BMS, State of Charge (SoC), and State of Health (SoH) estimation	4	2	7
	Electronic motors and control strategies	3	2	7
Unit No. 4	**COMMUNICATION PROTOCOLS IN ELECTRIC VEHICLES**	**9**	3	1,2,3
	Importance of communication protocols in EVs, Evolution of EV communication standards	2	3	1,2,3
	Understanding Controller Area Network (CAN), CAN protocol layers and message structure	3	3	1,2,3
	EV Charging communication protocols, OCPP, ISO 15118 (Plug and charge)	3	3	1,2,3
	Vehicle-to-Grid (V2G) communication, Vehicle-to-Vehicle (V2V) communication, Vehicle-to-Infrastructure (V2I) communication	1	3	1,2,3
Unit No. 5	**EMBEDDED SYSTEM DESIGN FOR ELECTRIC VEHICLES**	**8**	4	4,7
	Hardware design considerations	2	4	4,7
	Software design and development	2	4	4,7
	Real-time operating systems (RTOS) and their applications in EVs	4	4	4,7

Learning Assessment

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

Recommended Resources

1. Vahid and Givargis,"Embedded system design: A unified hardware/software introduction", John Wiley & Sons, Inc. 2002.
2. Raj Kamal, "Embedded Systems: Architecture, Programming, and Design", The McGraw-Hill Companies, Edition 2, 2008.
3. Steve Furber, "ARM System-on-chip architecture", Addison-Wesley Publications, 2nd Ed., 2000.
4. Jean J. Labrosse, "MicroC/OS-II: The Real-Time Kernel", CMP Books, Edition 2, 2002.
5. Ramesh S Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", 6th edition, Penram.
6. D V Hall, "Microprocessors and Interfacing", MGH, 2nd edition.
7. Per Enge, Nick Enge, Stephen Zoepf, "Electric Vehicle Engineering", McGraw Hill, 1st edition, 2021.

Other Resources

1. https://skill-lync.com/plus/embedded/embedded-systems-for-ev-applications
2. https://www.udemy.com/course/cortex-m/?couponCode=ST9MT71624

Course Designers

1. Dr. Sujith Kalluri, Associate Professor, Dept. Of ECE, SRM University – AP.

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VLSI Physical Design

Course Code	ECE 431	Course Category	CE	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. To understand the requirements of VLSI automation Tools.
2. To understand the requirements Proper placement and Routing of Circuits.
3. To familiarize with methods and algorithms for efficient Floor Planning and Routing
4. To understand different circuit level techniques for logic synthesis.
5. To understand how high-level synthesis is carried out for proper allocation, scheduling and assignment.

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 various VLSI Automation Tools	2	70%	65%
Outcome 2	Implement ideas on Placement and Partitioning of Circuits	3	70%	65%
Outcome 3	Identify concepts and Algorithms of Floor planning and Routing	3	70%	65%
Outcome 4	Develop circuit level techniques and apply in logic Synthesis	3	70%	65%
Outcome 5	Working on High Level Synthesis of Circuits	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					3	3	1	2
Outcome 2	3	3	3	2	2	1	2		3			2	3	2	2
Outcome 3	3	3	3	2	2		2		3			3	3	2	2
Outcome 4	3	3	3	3	2	1	2		3			2	3	2	2
Outcome 5	3	3	3	2	2	1	2		2			2	3	2	2
Average	3	3	3	2	2	1	2		3			2	3	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**VLSI DESIGN AUTOMATION TOOLS**	**16**		
	Algorithms and system design, Structural and logic design	2	1	1
	Transistor level design, Layout design	2	1	1
	Verification methods	1	1	1
	Design management tools	1	1	1
	Layout compaction	2	2	1
	placement and routing, Pin Assignment	2	2	1
	Design rules, symbolic layout, Applications of compaction	2	2	2
	Formulation methods, Algorithms for constrained graph compaction	2	2	2
	Circuit representation, Wire length estimation, Placement algorithms, Partitioning algorithms	2	2	2
Unit 3	**FLOOR PLANNING AND ROUTING**	**10**		
	Floor planning concepts	2	3	1,2
	Shape functions and floor planning sizing	2	3	1,2
	Local routing, Area routing	2	3	1,2
	Channel routing	2	3	1,2
	Global routing and its algorithms.	2	3	1,2
Unit 4	**SIMULATION AND LOGIC SYNTHESIS**	**10**		
	Gate level and switch level modelling and simulation	1	4	2,3
	Introduction to combinational logic synthesis	1	4	2,3
	STA	2	4	2,3
	ROBDD principles, Implementation, construction and manipulation	2	4	2,3
	Two level logic synthesis.	2	4	3,4
	Timing Closure	2	4	3,4
Unit 5	**HIGH-LEVEL SYNTHESIS**	**11**		
	Hardware model for high level synthesis	2	5	3,4
	Internal representation of input algorithms	1	5	3,4
	Allocation, assignment, and scheduling	2	5	3,4
	Scheduling algorithms, Aspects of assignment	1	5	3,4
	High level transformations	1	5	3,4

Learning Assessment

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

Recommended Resources

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley ,1998.
2. N.A.Sherwani , "Algorithms for VLSI Physical Design Automation", (3/e), Kluwer,1999..
3. S.M. Sait , H. Youssef, "VLSI Physical Design Automation", World scientific, 1999
4. cadence.com/content/dam/cadence-www/global/en_US/documents/tools/digital-design-signoff/innovus-implementation-system-ds.pdf

Other Resources

Course Designers

1. Dr. Ramesh Vaddi, Associate Professor, Dept of ECE, SRM University – AP.

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

Advanced CMOS Digital IC Design

Course Code	ECE 432	**Course Category**	CE	**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. To study advanced concepts of CMOS Digital Design. It will be helpful for the students when they work in VLSI industries or R&D's.
2. To cover crucial real world system design issues such as signal integrity, power dissipation, interconnect packaging, timing and synchronization.
3. To provide unique coverage of the latest design methodologies and tools.
4. To learn Low-power design concepts and voltage-frequency scaling.

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 understand the fundamental principles of CMOS technology, including the operation of MOS transistors, logic gates, and basic building blocks.	2	75%	65%
Outcome 2	Modelling and estimation of R, C, and L parasitic, effect of technology scaling, sheet resistance, techniques to cope with ohmic drop and capacitive cross talk, estimating RCdelay, and inductive effects.	1	75%	65%
Outcome 3	Several lab team assignments to design actual VLSI subsystems from high-level specifications, culminating in a course project involving the software design of a modest complexity chip.	3	75%	65%
Outcome 4	Several homework assignments based on core concepts and reinforcing analytical skills learned in class.	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	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	3	2	2	3	1	-	3	2	3	3	2	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION, THE WIRE, COPING WITH INTERCONNECT**	**9**		
	Impact of Interconnect Parasitic	2	1,2	1,2
	Impact of Resistance,	2	1	1
	Impact of Capacitance, Crosstalk	2	1,2	1
	Reducing RC-delay	1	1	1
	Dealing with inductance	2	1,2	1,3
Unit No. 2	**DESIGNING SEQUENTIAL LOGIC CIRCUITS**	**12**		
	Self-Timed Circuit Design, Self-Timed Signaling, Muller-C Element, Two Phase Handshake Protocol, Self-Resetting CMOS, Synchronizer	2	1	1,2,3
	Designing Latch and Edge triggered Register using different approaches, Clock Overlaps, C2MOS Logic, TSPC Logic	2	1,2	2,3
	Specialized edge-triggered TSPCR	2	1,2	1
	Pulse Registers, Pipelining	2	1,2	1,3
	Designing Schmitt Trigger and multi-vibrators,	2	1,2	2,3
	Design Techniques for large Fan in, Sizing combinational circuits for minimum delay,	2	3	1,2
Unit No. 3	**RATIOED LOGIC**	**6**		
	DCVSL	2	1	1,2,3
	Pass transistor Logic	2	1,2	2,3
	Differential Pass Transistor Logic	2	1,2	1
Unit No. 4	**ARITHMETIC CIRCUITS**	**9**		
	Adders- Ripple-Carry Adder, Complimentary Static CMOS FullAdder,	1	1,2	3,4
	Mirror Adder, Transmission Gate Full Adder	1	1	4
	Carry-Bypass Adder, Carry-Select Adder	2	1	4
	Logarithmic Look-Ahead Adder, Tree Adders	2	1,2	4
	Multipliers (Array Multiplier, Wallace-Tree Multiplier, Booths Multiplier Algo)	2	1,2	3,4
	Shifters (Barrel Shifter, Logarithmic Shifter).	1	3	3,4
Unit No. 5	**SEMICONDUCTOR MEMORIES**	**9**		
	Memory Timing, Memory Architecture, Read-Only Memory Cells	1	4	1,5
	MOS OR ROM, MOS NOR ROM, MOS NAND ROM	2	4	2,5
	Dual Data rate Synchronous Dynamic RAM	2	4	5
	DRAM Timing, Sources of Power Dissipation in Memories, Data Retention in SRAM	2	4	5
	Suppressing Leakage in SRAM, Data Retention in DRAM	2	4	3,5

Learning Assessment

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

Recommended Resources

1. Rabaey, A. Chandrakasan and Nikolic, B., Digital Integrated Circuits – A Design perspective, Pearson Education (2007) 2nd ed.
2. John P. Uyemura; "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc, 2002.
3. Kang, S. and Leblebici, Y., CMOS Digital Integrated Circuits – Analysis and Design, Tata McGraw Hill
4. Weste, N.H.E. and Eshraghian, K., CMOS VLSI Design: A Circuits and Systems Perspective, eddision Wesley (1998) 2nd ed.
5. Baker, R.J., Lee, H. W. and Boyce, D. E., CMOS Circuit Design, Layout and Simulation, Wiley - IEEE Press (2004) 2nd ed.

Other Resources

1. URL1:- http://nptel.ac.in/courses/117106092/
2. 2. URL2:- http://nptel.ac.in/courses/117106093

Course Designers

1. Dr. Pradyut Kumar Sanki, Associate Professor, Dept. Of ECE, SRM University – AP

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CMOS RFIC Design

Course Code	ECE 433	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	VLSI Analog IC Design	**Progressive Course(s)**			
Course Offering Department	ECE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamentals of RFIC design and its applications in wireless communication systems.
2. To learn CMOS technology basics and its suitability for RF applications.
3. To gain proficiency in designing and optimizing RF building blocks such as amplifiers, mixers, oscillators, and filters.
4. To develop skills in simulation and verification of RFIC designs using CAD tools.
5. To explore advanced topics in RFIC design, including noise analysis, linearity, and power management.
6. To Apply design methodologies to achieve desired specifications for wireless transceivers.

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 fundamental of analog IC Design, including the single-stage amplifiers and Differential Amplifiers	1,2	85%	80%
Outcome 2	Design operational amplifiers and performance of various Op-Amp topologies	3	80%	75%
Outcome 3	Create layout designs for operational amplifier circuits and understand the stability in feedback system and noise performance	3	85%	70%
Outcome 4	Apply theoretical knowledge to real-world analog and digital converter IC design projects	3	80%	70%
Outcome 5	Explore emerging trends in RFIC design including mm-wave and high-frequency applications.	3	80%	70%
Outcome 6	Collaborate in teams to solve design challenges and implement solutions in RFIC design projects.	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	2	2	2	--	--	--	--	3	3	2	2	3	2
Outcome 2	3	3	3	2	2	--	--	--	--	3	2	3	2	3	3
Outcome 3	3	3	3	3	2	--	--	2	--	2	3	3	2	3	3
Outcome 4	3	3	3	3	2	--	--	3	--	3	3	3	3	3	3
Outcome 5															
Outcome 6															
Average	3.00	2.75	2.75	2.50	2.00	--	--	1.25	--	2.75	2.75	2.75	2.25	3.00	2.75

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Introduction to RFIC Design**	**10**		
	Overview of RF systems and applications	2	1	1,2
	Challenges in RFIC design and performance metrics	2	1	1,2
	CMOS Technology Basics for RFICs	2	1	1,2
	Overview of CMOS process technology	2	1	1,2
	Impact of technology scaling on RF performance	2	1,3	1,2
Unit 2	**RFIC Building Blocks and Passive RF Components**	**9**		
	Low Noise Amplifiers (LNAs)	1	1	1,2
	Mixers and frequency synthesizers	2	1	1,2
	Power amplifiers (PAs) and modulators	2	1	1,2
	Inductors, capacitors, and transmission lines in CMOS	2	1	1,2
	Modeling and layout considerations for passive components	2	2,3	1,2
Unit 3	**RFIC Design Methodologies, Simulation and Characterization**	**9**		
	Design specifications and trade-offs	1	2	1,2
	Transistor-level design techniques (e.g., cascode, current mirrors)	2	1,2	1,2
	CAD tools for RFIC design (e.g., ADS, Cadence Virtuoso)	3	2	1,2
	Noise analysis, linearity, and stability analysis	3	2	1,2
Unit 4	**Advanced RFIC Design, Testing and Validation**	**9**		
	Frequency planning and synthesis	1	1	1,2
	Phase-locked loops (PLLs) and clock generation circuits	2	1,2	1,2
	Nonlinear distortion and intermodulation analysis	2	2	1,2,3
	Test methodologies and measurement techniques	2	2,3	1,2,3
	Yield analysis and reliability considerations	2	3	1,2,3
Unit 5	**Case Studies and Applications**	**8**		
	Design examples of RF front-end circuits (e.g., for wireless communication standards)	4	3,4	2,3
	Emerging trends in RFIC design (e.g., IoT, mm-wave applications)	4	3,4	2,3
	Total	**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 (15%)	CLA-3 (10%)	
Level 1	Remember	60%	50%	--	50%	40%
	Understand					
Level 2	Apply	40%	50%	60%	30%	40%
	Analyse					
Level 3	Evaluate	--	--	40%	20%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Razavi, B., & Behzad, R. (2012). RF microelectronics (Vol. 2, pp. 255-333). New York: Prentice hall.
2. Yuan, J. S. (2016). CMOS RF Circuit Design for Reliability and Variability. Springer.
3. Research papers and application notes from semiconductor manufacturers

Other Resources

Course Designers

1. Dr. M. Durga Prakash, Associate Professor, Dept. Of ECE. SRM University - AP

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Design Verification and Testing

Course Code	ECE 436	**Course Category**	CE		**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. (To ensure Quality and Reliability): As VLSI circuits become more complex and denser, the likelihood of defects and errors increases. Testing and verification techniques are employed to ensure that the fabricated chips meet the desired specifications and are free from manufacturing defects. This is crucial to ensure the overall quality and reliability of the integrated circuits used in various electronic devices.
2. (To detect and Fix Design Errors): During the design phase of VLSI circuits, errors and bugs can be introduced inadvertently. Proper testing and verification processes help identify these design errors early in the development cycle. This allows designers to correct the mistakes before the chips are manufactured; thus, saving time and costs associated with rework.
3. (Functional Verification): VLSI circuits are designed to perform specific functions. This subject is focused on verifying that these functions are correctly implemented and that the chip behaves as intended under various operating conditions.
4. (Performance Analysis): VLSI Testing and Verification also involve assessing the performance of the integrated circuits. This includes verifying that the chips meet the required speed, power, and area constraints specified during the design phase.
5. (To know about the Test Methodologies and Techniques): This subject will also cover various test methodologies and techniques used to evaluate the performance and functionality of VLSI circuits. This includes design for testability (DFT), built-in self-test (BIST), automatic test pattern generation (ATPG), and scan-based testing, among others.
6. (Fault Models and Test Coverage): Understanding and dealing with different fault models are essential for designing effective tests to identify potential defects in VLSI circuits. This subject will cover various fault models and techniques to achieve high test coverage.
7. (Manufacturability and Yield Enhancement): Testing and verification are critical for assessing the manufacturability of VLSI circuits and improving yield during the chip fabrication process. A higher yield means fewer defective chips, leading to cost savings and better overall productivity.

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	have a solid understanding of testing methodologies, verification techniques, and design-for-testability principles	2	80%	70%
Outcome 2	acquire confidence to work on real-world projects, use industry-standard tools, and simulate various testing scenarios	3	80%	70%
Outcome 3	gain insights into the current trends and challenges in VLSI Testing and Verification, such as dealing with increased complexity, power constraints, and manufacturing defects	4	75%	65%
Outcome 4	be able to explore career opportunities in the semiconductor industry, particularly in roles related to design verification, validation, and test engineering	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	3	2	2	3	2	2	1	3	3	3	2	3	2	3	2
Outcome 2	3	3	2	3	2	2	1	2	2	3	2	3	2	3	3
Outcome 3	3	3	2	3	2	2	1	3	2	3	2	3	2	3	3
Outcome 4	3	2	2	2	2	2	1	3	2	3	2	3	3	3	2
Average	3	2.5	2	2.75	2	2	1	2.75	2.25	3	2	3	2.25	3	2.5

Course Unitization Plan

Unit No.	Description of Topic	Required Contact Hours	CLOs addressed	References Used
Unit 1	**Introduction to testing and verification**	**7**	1, 3	1, 2
	VLSI design flow	1		
	Overview of Verification and Testing			
	Need of pre-silicon verification			
	Need of post-silicon validation and debug			
	VLSI Testing needs and challenges	1		
	Possible Outcome of Testing			
	Stages of IC Product			
	Types of Testing: Implicit, Explicit			
	Production Test	1		
	Characterization Test	1		
	Reliability Test	1		
	Test Quality Measures	1		
	Yield and defects			
	Scope of testing and verification in VLSI design process	1		
	Issues in test and verification of complex chips			
Unit 2	**Fault modeling and fault simulation**	**12**	1, 3	3, 4, 7, 8
	Overview of Defect, Fault, Error, Failure	1		
	Random and Systematic defects			
	Overview of Test pattern, Test Set, Test Length, Fault Coverage			
	Importance of Fault modeling			
	Introduction to Fault models	1		
	Single stuck-at-fault model			
	Fanout stem and branch for Stuck-at-fault model			
	Multiple stuck at fault	1		
	Bridging faults			
	Bridging fault models: Wired-OR, Wired-AND, A-Dominant	2		
	Feedback bridging faults	2		
	Fanout Stem and Branch for Bridge Fault			
	Permanent and Transient Bridge Fault			
	Delay fault and its detection	2		
	Delay fault models Introduction			
	Path delay fault: Falling transition, Rising transition			
	Transition delay fault: Slow-to-rise (STR) and slow-to-fall (STF)	1		
	Overview of Transistor level or Switch level fault model	1		
	Stuck-open fault			
	Stuck-short fault			
	Fault Simulation Overview	1		
	Yield and Fault Equivalence			
Unit 3	**Testability measures and analysis**	**6**	1, 3, 4	2, 7
	Introduction and need of testability measures	1		
	Testability Components: Controllability and Observability			

	Overview of Testability Analysis			
	Topology-based Analysis	2		
	SCOAP: Combinational Controllability and Combinational Observability			
	Probability-based Analysis	2		
	COP: Combinational Controllability and Combinational Observability			
	High-level Analysis	1		
Unit 4	**ATPG and design for testability methods**	**14**	1, 2, 3	5, 6, 7, 8, 9
	Test pattern generation Overview: Random and Deterministic	1		
	Automatic test pattern generation: Complete and Incomplete ATPG			
	Combinational ATPG Introduction	2		
	Boolean Difference Method			
	SAT	1		
	Path-sensitization Method	2		
	Single Path Sensitization			
	Multiple Path Sensitization			
	D Algorithm	1		
	PODEM	1		
	FAN	1		
	Sequential ATPG Introduction	3		
	Scan design			
	Issues in Scan Design			
	Test interface and boundary scan			
	Iddq testing			
	Delay fault testing	2		
	Built-in Self-Test			
Unit 5	**Design verification**	**6**	3, 4	7, 8, 10
	Design verification techniques: Introduction	1		
	Techniques based on simulation approach			
	Techniques based on analytical approach	1		
	Techniques based on formal approach	1		
	Functional verification	3		
	Timing verification			
	Formal verification			
Total Contact Hours: 45				

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**				**End Semester Exam (40%)**
		CLA-1 (15%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (20%)**	
Level 1	Remember	65%	50%	45%	60%	50%
	Understand					
Level 2	Apply	35%	50%	55%	40%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. L.T. Wang, C.W. Wu, and X. Wen, "VLSI Test Principles and Architectures", Morgan Kaufmann, 2006
2. M.L. Bushnell and V.D. Agrawal, "Essentials of electronic testing," Kluwer Academic Publishers, 2000
3. George W. Zobrist, VLSI Fault Modeling and Testing Techniques (VLSI Design Automation Series), Praeger Publishers Inc, 1993
4. RL Wadsack, "Fault modeling and logic simulation of CMOS and MOS integrated circuits" Bell System
5. Technology, 1978
6. Hideo Fujiwara, Logic testing and design for testability, MIT Press, 1985
7. M. Abramovici, M. A. Breuer and A.D. Friedman, "Digital systems testing and testable design," IEEE Press,1994
8. P. K. Lala, "Digital Circuits Testing and Testability", Academic Press
9. Stephan Eggersgluss and Rolf Drechsler, High Quality Test Pattern Generation and Boolean Satisfiability, Springer, 2012
10. P.H. Bardell, W.H. McAnney, and J. Savior, "Built-in Test for VLSI: Pseudorandom Techniques," Wiely Interscience, 1987
11. Khosrow Golshan, Physical Design Essentials: An ASIC Design Implementation Perspective, Springer, 2007

Other Resources

Course Designers

1. Dr. Swagata Samanta, Assistant Professor, Department of Electronics & Communication Engineering, SRM University – AP

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

Nanoelectronics

Course Code	ECE 437	Course Category	CE	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	IEEE, COMSOL, Microsoft				

Course Objectives / Course Learning Rationales (CLRs)

1. To gain an in-depth understanding of design techniques of nanoscale transistors and the effect of nanoscale phenomena on the behavior of electronic devices.
2. To understand and analyze various fabrication and characterization methods for nanoscale electronic devices.
3. To explore the challenges and strategies involved in integrating nanoscale devices into existing microelectronics and nanotechnology platforms.
4. To gain the knowledge and skills needed to contribute to cutting-edge research, technology development, and innovation in the rapidly evolving field of semiconductor devices and nanoelectronics.

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 design techniques of nanoscale transistors and effect of nanoscale phenomena on the behavior of electronic devices.	3	80%	75%
Outcome 2	Understand and analyze various fabrication and characterization techniques for nanoscale electronic devices.	2	80%	70%
Outcome 3	Explore the challenges and strategies involved in integrating nanoscale devices into existing microelectronics and nanotechnology platforms.	2	85%	70%
Outcome 4	Gain the knowledge and skills needed to contribute to cutting-edge research, technology development, and innovation in the rapidly evolving field of semiconductor devices and nanoelectronics.	2	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	3	3	2	3	2		1		2	3	1	2	1	1	2
Outcome 2	3	2	1	1	2		1		2	2	2	2	1	2	2
Outcome 3	2	2	1	2	1		1		2	2	2	2	2	2	2
Outcome 4	2	2	1	2	1		1		2	2	2	3	2	2	2
Average	3	2	1	2	2		1		2	2	2	2	2	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit 1	CMOS Scaling Theory	1	1,4	2,3,4
	Short Channel Effects	1	1,4	2,3,4
	Subthreshold Conduction & Drain Induced Barrier Lowering	1	1,4	2,3,4
	Channel and Source Drain Engineering	1	1,4	2,3,4
	CMOS Process Flow	2	1,4	2,3,4
	Gate Oxide Scaling and Reliability	1	1,4	2,3,4
	Metal Gate Transistor	1	1,4	2,3,4
	Industrial CMOS Technology	2	1,4	2,3,4
Unit 2	Ideal MOS C-V Characteristics	1	1,3,4	2,3,4
	Effect of Non Idealities on C-V	1	1,3,4	2,3,4
	MOS Parameter Extraction from C-V and I-V Characteristics	1	1,3,4	2,3,4
	MOS Parameter Extraction from I-V Characteristics	1	1,3,4	2,3,4
	Interface State Density Effects on Short Channel Effects and Drain-Induced Barrier Lowering	2	1,3,4	2,3,4
	Velocity Saturation, Ballistic Transport and Velocity Overshoot Effects	2	1,3,4	2,3,4
Unit 3	Need for Metal-Semiconductor contact Source/Drain Junction in Nanoscale MOSFETs	1	1,3,4	1,2,4
	Rectifying and Ohmic Contacts and Challenges in Source-Drain MOSFET Technology	1	1,3,4	1,2,4
	Effect of Interface States and Fermi Level Pinning on MS Contacts	2	1,3,4	1,2,4
	Challenges in Germanium Technology	1	1,3,4	1,2,4
	Natural Language Processing (NLP) in Healthcare	1	1,3,4	1,2,4
	Compound Semiconductors and Heterojunction FETs for High Performance	2	1,3,4	1,2,4
	Heterojunctions and High Electron Mobility Transistors	2	1,3,4	1,2,4
Unit 4	Basic Principles of Quantum Mechanics	4	1,3,4	1,2,4
	Energy Bands in Crystalline Solids	4	1,3,4	1,2,4
	Quantum Structure and Devices	4	1,3,4	1,2,4
Unit 5	Crystal Growth and Nanocrystals	2	2,4	1,2,4
	Nanocrystals and Nanostructured Thin Films	2	2,4	1,2,4
	Nanowires and Other Nanostructures	2	2,4	1,2,4
	Chemical Vapour Deposition (CVD) and Atomic Layer Deposition (ALD)	2	2,4	1,2,4
	Characterization of Nanomaterials	2	2,4	1,2,4
Total Hours		**50**		

Learning Assessment

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

Recommended Resources

1. "Fundamentals of Modern VLSI Devices" by Taur and Ning, Cambridge University Press.
2. "Solid State Electronic Devices" by Streetman and Banerjee.
3. "Fundamentals of Electronic Devices" by Achutan and Bhat, McGraw Hill.
4. "MOS Physics and Technology" by E.H. Nicollian and J.R. Brews, Wiley Publishers.

Other Resources

1. Silicon VLSI Technology: Fundamentals, Practice and Modelling by James D. Plummer, Michael D. Deal, Peter B. Griffin.
2. Advanced Semiconductor Fundamentals, Second Edition, by Robert F. Pierret, Pearson Education, Inc. (1983).

Course Designers

1. Dr. Patta Supraja. Asst. Professor. Dept. Of ECE. SRM University – AP.

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CAD for VLSI IC Design

Course Code	ECE 438	**Course Category**	CE	**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. To study the various CAD tools and methodologies employed in the design of VLSI circuits.
2. To understand the RTL (Register-Transfer Level) design, logic synthesis, physical design, and simulation.
3. To learn design and testing of VLSI circuits using CAD tools.
4. To evaluate and enhance the performance of VLSI designs through CAD tools.

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	Learn industry-standard CAD tools, navigating schematic capture, layout design, and verification tools for VLSI circuits.	2	80%	70%
Outcome 2	Apply theoretical concepts into practical applications.	3	70%	60%
Outcome 3	Analyse, identify bottlenecks, optimize VLSI designs for Performance, Power, and Area (PPA) using CAD tools.	4	80%	70%
Outcome 4	Exhibit adaptability to evolving CAD technologies, ensuring they stay current with advancements in the dynamic field of VLSI design.	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	3	2	1	2					2		1			1	2
Outcome 2	3	3	2	2					3				1	3	2
Outcome 3	3	3	3	3					2				1	3	3
Outcome 4	3	3	3	3					3		3		1	3	3
Average	3	3	3	3					3		1		1	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOsAddressed	References
Unit 1	**Introduction to VLSI Design and CAD Tools**	**9**		
	Understand the stages of the VLSI design process, from conceptualization to fabrication.	1	1	1,2
	Trace the historical development of VLSI technology and its impact on computing.	1	1	1,2
	Examine key milestones and breakthroughs that shaped the VLSI landscape.	1	1	1,2
	Analyze the pivotal role of Computer-Aided Design (CAD) tools in VLSI design.	1	1,2	1,2
	Discuss how CAD tools enhance efficiency, accuracy, and productivity in VLSI workflows.	1	1,2	1,2
	Explore Electronic Design Automation (EDA) tools and their roles in the design flow.	1	1,2	1,2
	Discuss the impact of CAD tools on reducing time-to-market and overall design cost.	1	1,2	1,2
	Introduce students to a basic CAD tool interface.	1	1,2	1,2,4,6
	Conduct introductory exercises to familiarize students with basic CAD operations.	1	1,2	1,2,4,6
Unit 2	**Digital Design Fundamentals**	**9**		
	Apply Boolean algebra to simplify and manipulate logical expressions.	1	2,3	1,2
	Design and analyze combinational circuits using logic gates.	1	2,3	1,2
	Introduce sequential circuits, including flip-flops and latches.	1	1,2,3	1,2
	Discuss the concept of clocking and its importance in sequential circuit design.	1	1,2,3	1,2
	Define Register-Transfer Level (RTL) design and its role in VLSI.	1	1,2,3	1,2
	Demonstrate the translation of high-level design concepts into RTL descriptions.	1	1,2,3	1,2
	Engage students in practical RTL design exercises.	1	2,3	1,2
	Implement simple digital circuits using RTL design principles.	1	2,3	1,2
	Utilize simulation tools to validate the functionality of RTL designs.	1	2,3	1,2
Unit 3	**Schematic Capture and Simulation Tools**	**9**		
	Introduce functional simulation using Verilog or VHDL.	1	2,3,4	1,2,3
	Create and simulate basic digital circuits to understand functional behavior.	1	2,3,4	1,2,3
	Optimize circuit designs for better performance using timing constraints	1	2,3,4	1,2,3
	Apply simulation tools to analyze and troubleshoot real-world digital circuits.	1	2,3,4	1,2,3
	Discuss the significance of simulation in identifying design flaws.	1	2,3,4	1,2,3
	Introduce advanced simulation techniques such as mixed-signal simulation.	1	2,3	1,2,3
	Explore co-simulation of analog and digital components.	1	2,3,4	1,2,3
	Conduct hands-on sessions for students to create and simulate circuits using schematic capture tools.	1	2,3,4	1,2,3
	Emphasize the practical application of simulation results in design refinement.	1	2,3	1,2,3
Unit 4	**Logic Synthesis and Optimization Techniques**	**9**		
	Define logic synthesis and its role in transforming RTL descriptions into gate-level netlists.	1	2,3,4	1,2,5
	Discuss strategies for optimizing designs in terms of area, power, and performance (PPA).	1	2,3,4	1,2,5
	Introduce technology mapping as a critical step in the synthesis process.	1	2,3,4	1,2,5
	Cover advanced logic synthesis techniques, including retiming and resynthesis.	1	2,3,4	1,2,5

	Explore the impact of these techniques on design quality and efficiency.	1	2,3,4	1,2,5
	Demonstrate the application of logic synthesis techniques through practical examples.	1	2,3,4	1,2,5
	Guide students in optimizing designs for specific criteria.	1	2,3,4	1,2,5
	Discuss current challenges in logic synthesis.	1	2,3,4	1,2,5
	Explore emerging trends and future directions in logic synthesis research and development.	1	2,3,4	1,2,5
Unit 5	**Physical Design and Layout**	**9**		
	Provide an overview of the physical design process, from initial floor planning to tape-out.	1	3,4,5	1,2,5
	Introduce floor planning as a critical step in physical design.	1	2,3,4	1,2,5
	Explain the global and detailed routing stages in the physical design flow.	1	2,3,4	1,2,5
	Discuss algorithms and techniques for efficient and effective routing.	1	3,4,5	1,2,5
	Cover the significance of physical verification in ensuring design correctness.	1	2,3,4	1,2,5
	Introduce Design Rule Checking (DRC) and its role in identifying layout violations.	1	2,3,4	1,2,5
	Conduct hands-on sessions for students to implement physical design principles.	1	3,4,5	1,2,5
	Guide students through the process of floorplanning, placement, and routing.	1	2,3,4	1,2,5
	Discuss advanced topics such as clock tree synthesis and power planning.	1	2,3,4	1,2,5
	Total 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	80%		50%		20%		20%		20%	
	Understand										
Level 2	Apply	20%		50%		80%		80%		80%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. K. K. Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation," Wiley, 1999.G. S. May, S. M. Sze, "Fundamentals of Semiconductor Fabrication" Wiley, 2003
2. J. M. Rabaey, A. Chandrakasan, and B. Nikolić, "Digital Integrated Circuits: A Design Perspective," 2nd ed. Prentice Hall, 2003
3. T. R. K. Chetty, M. Balakrishnan, and N. Kittipiyakul, "VLSI Design Methodology Development," IEEE Trans. Very Large Scale Integr. (VLSI) Syst., vol. 18, no. 6, pp. 890-902, Jun. 2010.
4. C. Mead and L. Conway, "Computer-Aided Design of VLSI Circuits and Systems," in Proc. IEEE Int. Symp. Circuits Syst., New York, NY, USA, 1980, pp. 468-471.
5. C. Mead and L. Conway, "Introduction to VLSI Systems," 2014. [Online]. Available: https://www.cim.mcgill.ca/~langer/273/3-introduction.pdf.

Other Resources

1. NPTEL Video lecturer (https://archive.nptel.ac.in/courses/106/106/106106088/#)

Course Designers

1. Dr. Pradyut Kumar Sanki, Associate Professor, Dept. of ECE, SRM University – AP

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Neerukonda, Mangalagiri Mandal,
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Semiconductor Device Modelling

Course Code	ECE 440	**Course Category**	CE	**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. To learn the basics of current flow though solid state semiconductor devices.
2. To Understand some elementary concepts of quantum- and statistical-mechanics.
3. To Gain the knowledge of electrostatics of P-N junction diodes.
4. To learn the design of Bipolar transistors and MOSFETs

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 understand the current flow though semiconductor devices	2	70%	65%
Outcome 2	Understand the concepts of quantum- and statistical-mechanics	2	70%	65%
Outcome 3	Understand and design the electrostatics of P-N junction diodes	3	70%	65%
Outcome 4	Understand the discuss BJT and MOSFET design	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	2	1	3	2	2	2
Outcome 2	2	-	-	-	2	-	-	-	2	2	-	3	2	3	3
Outcome 3	3	1	1	2	2	-	-	-	2	2	-	3	2	3	3
Outcome 4	2	2	1	2	2	-	-	-	3	3	2	3	3	3	3
Average	2.00	0.75	0.50	1.00	2.00	-	-	-	2.00	2.00	0.75	3.00	2	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Basic Semiconductor Properties & Elements of Quantum Mechanics**	**9**		
	General Material Properties	2	1	1,3
	Crystal Structure, The Unit Cell Concept	1	1	1,3
	Simple 3-D Unit Cells	1	2	1,3
	Bravais Lattices and Crystal Systems	1	3	1,3
	Specific Semiconductor Lattices	1	2	1,3
	Miller Indices, Example Use of Miller Indices	1	2	1,3
	The Quantum Concept	1	2	1,3
	Basic Formalism, Simple Problem Solutions	1	2	1,3
	Miller Indices, Example Use of Miller Indices	1	2	1,3
Unit 2	**Energy Band Theory & Equilibrium Carrier Statistics**	**9**		
	Preliminary Considerations, Approximate One-Dimensional Analysis	2	1	1,4
	Extrapolation of Concepts to Three Dimensions	2	1	1,4
	Density of States, Fermi Function	1	2	1,4
	Equilibrium Distribution of Carriers	1	3	1,4
	The Energy Band Diagram, Donors	1	2	1,4
	Acceptors, Band Gap Centers	1	2	1,4
	Equilibrium Concentration Relationships, Concentration and E_F Calculations.	1	2	1,4
Unit 3	**Recombination-Generation Processes & Carrier Transport**	**9**		
	Introduction	1	2	2,3
	Recombination-Generation Statistics	2	2	2,3
	Surface Recombination-Generation	2	2	2,3
	Supplemental R-G Information	1	2	2,3
	Drift	1	2	2,3
	Diffusion	1	2	2,3
	Equations of State	1	2	2,3
Unit 4	**Electrostatics of P-N Junction Diodes & Introduction to Bipolar Transistors**	**9**		
	P-N Diode I-V Characteristics	1	3	2,4
	Non-ideal Effects	1	3	2,4
	AC Response	1	3	2,4
	Large Signal Response	1	4	2,4
	Schottky Diode I	1	4	2,4
	Schottky Diode II	1	3	2,4
	BJT Design I	1	4,5,6	2,4
	BJT Design II	1	4,5,6	2,4
	Heterojunction Bipolar Transistors	1	4,5,6	2,4
Unit 5	**MOS**	**9**		
	MOS Electrostatics	2	4	2,4
	MOSCAP Frequency Response	1	4	2,4
	MOSFET I-V Characteristics	2	4	2,4
	Nonideal Effects in MOSFET	2	4	2,4
	Modern MOSFET	1	3	2,4
	Reliability of MOSFET	1	3	2,4
	Total	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (5%)	Mid-1 (20%)	CLA-2 (15%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	80%	60%	50%	40%	50%
	Understand					
Level 2	Apply	15%	30%	40%	40%	30%
	Analyse					
Level 3	Evaluate	5%	10%	10%	20%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Advanced Semiconductor Fundamentals, Second Edition, by Robert F. Pierret, Pearson Education, Inc. (1983).
2. Semiconductor Device Fundamentals, Robert F.Perret, (1996).
3. Sze, S. M., & Ng, K. K. (2006). Physics of semiconductor devices. John wiley& sons.
4. B. G. Streetman, S. K. Banerjee, Solid State Electronic Devices, Pearson, (2016)
5. Arora, N. (2007). MOSFET modeling for VLSI simulation: theory and practice. World Scientific

Other Resources

1. https://onlinecourses.nptel.ac.in/noc23_ee35/preview
2. https://archive.nptel.ac.in/courses/108/105/108105188/

Course Designers

1. Dr. M. Durga Prakash. Associate Professor. Dept. Of ECE. SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Advanced Wireless Communication Systems (5G/6G)

Course Code	ECE 441	**Course Category**	CE	**L**	**T**	**P**	**C**
				2	0	1	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. To provide an understanding of the fundamentals of 5G technology and its evolution from 4G.
2. To impart comprehensive knowledge of 5G network architecture and components, including 5G radio access technology and the 5G core network.
3. To familiarize students with emerging technologies and trends in 5G, such as Intelligent Reflecting Surfaces (IRS), cell-free massive MIMO, and IoT.
4. To enable students to gain deeper insights into research challenges and opportunities in the field of 5G communications.
5. To prepare students to design, deploy, and manage 5G networks and services effectively.

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 fundamentals of 5G technology and its evolution from 4G	**1**	85%	80%
Outcome 2	Comprehend 5G network architecture and components, 5G radio access technology, and the 5G core network	**2**	80%	75%
Outcome 3	Familiarize with emerging technologies and trends in 5G such as IRS and cell-free massive MIMO	**1,2**	85%	75%
Outcome 4	Understand research challenges and opportunities in the field of 5G communications	**3**	80%	70%
Outcome 5	Design, deploy, and manage 5G networks and services effectively	**3**	85%	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	1	1	1	1	1			1				1	1	1	1
Outcome 2	2	3	2	3	2			2	2	1		1	1	2	3
Outcome 3	2	2	2	3	3			1	2	1		1	1	2	2
Outcome 4	2	3	3	3	3			1	2	1		1	2	3	3
Outcome 5	3	3	2	3	3			1	2	1		2	2	2	2
Average	2	3	2	3	3				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Overview of 5G Technology	1	1	1,2
	Key features and benefits of 5G	1	1,2	1,2
	Evolution of mobile communication systems from 1G to 5G	1	1	1,2
	5G architecture and components, Radio access and core network technologies in 5G and 5G frequency bands and spectrum usage.	2	1	1,3
	L1: A 2x2 MIMO Communication System using the NI USRP module in the LabVIEW platform.	2	1	1,2
	L2: Amplitude and Phase Amplitude Modulation Using LABVIEW	2	1	1,2
Unit No. 2	5G New Radio.	1	1	1,2
	5G milli meter (mm) wave technology.	1	1,2	1,2
	5G Beamforming and Beam management.	1	2	1,2
	5G Carrier Aggregation and Inter-band Carrier Aggregation. 5G Radio Resource Management	2	1	1,2
	L3: Single-sideband and Double-sideband suppressed-carrier transmission using LabVIEW.	2	1,2	1,2
	L4: Phase Shift keying using LABVIEW	2	1,2	1,2
Unit No. 3	Introduction to Intelligent Reflecting Surfaces	1	3	1,2
	IRS Components and Architecture	1	3	1,2
	Channel Modeling and Analysis	1	1,2	1,2
	Optimization Techniques for IRS, Practical Deployment and Implementation	2	3	1,2
	L5: OFDM signal transmission and reception using MATLAB.	2	3	1,2
Unit No. 4	Introduction to Cell-Free Massive MIMO	1	2	1,2,4
	System Architecture and Design	1	3	1,2,4
	Channel Modeling and Analysis	1	2	1,2,4
	Resource Allocation and Scheduling, Interference Management	2	3	1,2,4
	L6: Analysis of Spectral efficiency with Relay, IRS, and Hybrid mode system.	2	4	1,2,4
	L7: Energy efficiency analysis by varying power with number of antennas using MATLAB.	2	4	1,2,4
Unit No. 5	5G use cases in Telecommunications	3	4	1,2,3
	5G Applications in various industries like Healthcare, Transportation, Energy and Agriculture.	2	5	1,2,3
	Impact of 5G on Society and Economy.	2	4,5	1,2,3
	Implementation, Challenges and Solutions in 5G. Future Developments in 5G.	4	4,5	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%)		CLA-2 (15%)		CLA-3 (10%)		Mid Term (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	60%	60%	50%	40%	40%	60%	40%	30%	50%
	Understand										
Level 2	Apply	60%	40%	40%	50%	60%	60%	40%	60%	70%	50%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Trinh Van Chien, Emil Björnson, "Massive MIMO Communications," in 5G Mobile Communications, W. Xiang et al. (eds.), pp. 77-116, Springer, 2017.
2. Osseiran A, Monserrat JF, Marsch P, editors. 5G mobile and wireless communications technology. Cambridge University Press; 2016 Jun 2.
3. Yu, F. Richard, Chunming Qiao, and Sheng Chen. 5G Wireless Communications: Fundamentals, Devices, and Applications. Cambridge University Press, 2016
4. Gursoy, Mustafa Cenk, Ozan K. Tonguz, and Ali Ghrayeb. 5G Mobile and Wireless Communications Technology. Cambridge University Press, 2016.
5. MATLAB & LABVIEW.

Other Resources

Course Designers

1. Dr. Sunil Chinnadurai. Associate Professor. Dept. of ECE. SRM University – AP.

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

Quantum Communications

Course Code	ECE 442	Course Category	CE	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. To understand Quantum computing and communication concepts.
2. To understand mathematical concepts and algorithms related to Quantum computing and Communications.
3. To explore towards research in Quantum computing and communications.

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 understand difference between bits and Qubits	1,2	80%	75%
Outcome 2	To understand Linear Operator, Hilbert spaces and Bloch sphere related to quantum concepts	2,3,4	80%	70%
Outcome 3	To understand quantum gates,	2,3,4	75%	65%
Outcome 4	To understand quantum algorithms, quantum Fourier transform and quantum error correction concepts, Quantum information processing	2,3,4	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	2	1	2	1				1			2	1	3	3
Outcome 2	3	2	1	2	1				1			2	1	3	3
Outcome 3	3	3	3	3	2				3			3	1	3	3
Outcome 4	3	3	3	3	2				3			3	3	2	3
Average	3	3	2	3	2				2			3	2	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**QUANTUM OPERATORS, STATES AND THEIR APPLICATIONS**	**9**		
	Introduction to Quantum computing	1	1,2	1,2
	Quantum states & wave functions, Dirac notation(bra–ket notation) of states	1	1,2	1,2
	Basis vectors and orthogonality	2	1,2	1,2
	Linear operators and matrices in Hilbert spaces	2	1,2	1,2
	Qubits and Bloch sphere, Base states and superposition	1	1,2	1,2
	Structural randomness & Heisenberg's Uncertainty Principle	1	1,2	1,2
	Unitary operators and projectors	1	1,2	1,2
Unit 2	**QUANTUM LOGICS**	**10**		
	Abramsky-Coecke semantics	1	3	1,2
	No-cloning theorem	1	3	1,2
	Quantum entanglement & Entangled states	2	3	1,2
	Bell states & Bell inequalities	2	3	1,2
	Pauli, Hadamard gates, CNOT, Toffoli gates	2	3	1,2
	Quantum teleportation	1	3	1,2
	Universality of two-qubit gates.	1	3	1,2
Unit 3	**QUANTUM ELECTRONICS USING OPTICS**	**9**		
	Introduction to Photon and Laser pulses as quantum states	1	4	1,2
	Single photon (quanta) counting with avalanche photodiode	1	4	1,2
	HOM interference, Pure and mixed states	1	4	1,2
	Quantum states of single photons	1	4	1,2
	Optical Qubits and Optical Two-Qubit Gates (CNOT)	1	4	1,2
	Deutsch-Josza algorithm and applications	1	4	1,2
	Quantum Fourier transform	2	4	1,2
	Shor’s Algorithm – Periodicity	1	4	1,2
Unit 4	**QUANTUM INFORMATFION PROCESSING**	**10**		
	Quantum information processing features and basic mathematics	3	4	2,3
	Von Neumann entropy and Schumacher’s noiseless quantum coding theorem	3	4	2,3
	Quantum channels	4	4	2,3
Unit 5	**QUANTUM COMPUTING AND COMMUNICATIONS**	**9**		
	Density matrix and information propagations	1	4	1,2
	Quantum cryptography	1	4	1,2

	Communication across two-input quantum gate (C-NOT) and Teleportation	2	4	1,2
	Physical realization of quantum computation: ion trap	1	4	1,2
	Physical realization of quantum computation: cavity QED, Quantum key distribution	1	4	1,2
	Noise and decoherence: DiVincenzo's criteria	1	4	1,2
	Quantum error correction and examples	1	4	1,2
	Circuit for a quantum Fourier transform	1	4	1,2

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	60%		50%		40%		50%		40%	
	Understand										
Level 2	Apply	40%		50%		60%		50%		60%	
	Analyze										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Phillip Kaye, Raymond Laflamme, and Michele Mosca (2007). An Introduction to Quantum Computing. Oxford University Press.
2. Michael A. Nielsen and Isaac L. Chuang (2000). Quantum Computation and Quantum Information. Cambridge University Press.
3. Ivan B. Djordjevic. Quantum Communication, Quantum Networks, and Quantum Sensing, Academic Press, Elsevier.

Other Resources

Course Designers

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

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Information Theory and Coding

Course Code	ECE 443	**Course Category**	CE	**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. To review the basic principles of information theory.
2. To introduce the concept of source, channel coding, and channel capacity.
3. To impart knowledge on the concepts of data and voice coding.
4. To impart knowledge on the concepts of error control coding.
5. To impart knowledge on the concepts of audio and video coding.

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 basic principles of information theory	2	85%	85%
Outcome 2	Understand the concept of source, channel coding, and channel capacity	2	85%	80%
Outcome 3	Apply the concept of pulse modulation to data and voice coding	3	80%	75%
Outcome 4	Understand the concept of error control coding	2	75%	75%
Outcome 5	Apply the concept of source coding for data compression	3	85%	80%
Outcome 6	Analyze the concept of coding in audio and video coding	4	55%	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	3	2			1		1			1	1		
Outcome 2	3	1	2	2	1		1		1			1	2	1	
Outcome 3	3	1	2	2	2		1		1			1	1		
Outcome 4	3	3	3	3	3		3		2		1	3	2	2	1
Outcome 5	2	1	2	2	3				2			1	2	2	
Outcome 6	3	3	3	3	3		3		3		2	3	3	2	3
Average	3	2	3	2	2		2		2		2	2	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**INFORMATION ENTROPY FUNDAMENTALS**	**8**		
	Uncertainty, Information, Entropy	1	1	1,2
	Source coding Theorem, Huffman coding	2	1,2	1,2
	Shannon Fano coding	2	1,2	1,2
	Discrete Memoryless channels, Channel capacity	1	1,2	1,2
	Channel coding Theorem, Channel capacity Theorem	2	1,2	1,2
Unit 2	**DATA AND VOICE CODING**	**11**		
	Pulse code Modulation	2	1,3	1,2
	Differential Pulse Code Modulation	2	1,3	1,2
	Adaptive Differential Pulse Code Modulation	2	1,3	1,2
	Adaptive sub-band coding	1	1,3	1,2
	Delta Modulation, Adaptive Delta Modulation	2	1,3	1,2
	Coding of speech signal at low bit rates	1	1,3	1,2
	Vocoders, Linear Prediction Coding	1	1,3	1,2
Unit 3	**ERROR CONTROL CODING**	**12**		
	Linear Block codes	1	2,4	1,2
	Syndrome Decoding	2	2,4	1,2
	Minimum distance consideration	1	2,4	1,2
	Cyclic codes	2	2,4	1,2
	Generator Polynomial, Parity check polynomial	2	2,4	1,2
	Encoder for cyclic codes, Calculation of syndrome	2	2,4	1,2
	Convolutional codes	2	2,4	1,2
Unit 4	**COMPRESSION TECHNIQUES**	**7**		
	Principles, Text compression	1	2,5	1,2
	Static Huffman Coding	1	2,5	1,2
	Dynamic Huffman coding	2	2,5	1,2
	Arithmetic coding	1	2,5	1,2
	Image Compression, Graphics Interchange format, Tagged Image File Format	1	2,5	1,2
	Digitized documents and Introduction to JPEG standards	1	2,5	1,2
Unit 5	**AUDIO AND VIDEO CODING**	**7**		
	Linear Predictive coding	1	2,4,5,6	1,2
	Code excited LPC	1	2,4,5,6	1,2
	Perceptual coding	1	2,4,5,6	1,2
	MPEG audio coders	1	2,4,5,6	1,2
	Dolby audio coders	1	2,4,5,6	1,2
	Video compression - Principles	1	2,4,5,6	1,2
	Introduction to H.261,MPEG Video standards	1	2,4,5,6	1,2
Total Hours		**45**		

Learning Assessment

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

Recommended Resources

1. Thomas M. Cover and Joy A Thomas, “Elements of Information Theory”, 2nd edition, Wiley.
2. Simon Haykin, “Communication Systems”, 4th edition, Wiley

Other Resources

1. https://nptel.ac.in/courses/117101053
2. https://nptel.ac.in/courses/117105077

Course Designers

1. Dr. Anirban Ghosh, Asst. Professor, Dept of ECE, SRM University – AP

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Optical Communication

Course Code	ECE 444	Course Category	CE	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. Understanding Fundamentals: Grasp the basic principles of optical communication, including the behaviour of light, optical fibers, and the transmission of data through light waves.
2. System Components: Identify and explain the components of an optical communication system, such as optical transmitters, receivers, modulators, and amplifiers.
3. Optical Fiber Properties: Understand the properties of optical fibers, including types of fibers, modes of propagation, attenuation, dispersion, and non-linear effects.
4. Signal Transmission: Learn the techniques for efficient signal transmission in optical networks, including wavelength division multiplexing (WDM), time division multiplexing (TDM), and code division multiplexing (CDM).
5. Optical Networking: Explore the principles and architectures of optical networks, such as passive optical networks (PONs), synchronous optical networking (SONET), and optical transport networks (OTNs).

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 thorough understanding of the fundamental principles of optical communication, including the nature of light and the basics of optical fibres.	2	85%	75%
Outcome 2	understand the properties and types of optical fibres, and will be able to explain concepts such as attenuation, dispersion, and non-linear effects.	3	75%	70%
Outcome 3	identify and describe the key components of an optical communication system, such as optical transmitters, receivers, and amplifiers.	2	80%	70%
Outcome 4	gain proficiency in various signal transmission techniques, including Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), and Code Division Multiplexing (CDM).	4	70%	65%
Outcome 5	understand the principles and architectures of different optical networks, including Passive Optical Networks (PONs), Synchronous Optical Networking (SONET), and Optical Transport Networks (OTNs)	2	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	1	1
Outcome 2	3	3											1	1	1
Outcome 3	3	1											1	1	1
Outcome 4	3	3	3	3	3				1				1	1	1
Outcome 5	3	3	3	3	3				2				1	1	1
Average	3	2	3	3	3				1				1	1	1

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
	Unit:01 Introduction	9 hrs		
Unit No. 1	Introduction to Telecommunications and fiber optics	1	1	1
	Evolution of Light wave Systems	1	1	1
	Need of Fiber Optic Communications	1	1	1
	point to point systems and Networks	1	1	1
	Information carrying capacity	1	1	1
	Basic block diagram of fiber optic communication systems: Optical Communication System	1	1	1
	Light wave System Component	1	1	1
	Optical Fibers as a Communication Channel	1	1	1
	Optical Transmitters, Optical Receivers	1	1	1
	Unit:02 Optical Fibers	9 hrs		
Unit No. 2	Optical fiber description: How optical fiber conducts light, ore cladding, Total internal reflection,	1	2	1
	Fiber Modes	1	2	1
	Dispersion in Single-Mode Fibers	1	2	1
	Modal dispersion	1	2	1
	Step-Index Fibers, Graded Index Fibers	1	2	1
	Understanding Numerical Aperture, Acceptance cone	1	2	1
	Attenuation, bending losses, scattering, absorption, total attenuation,	1	2	1
	Bit rate and bandwidth,	1	2	1
	Cables, Connectors and Splicing	1	2	1
	Unit:03 Optical Sources and Detectors	9 hrs		
Unit No. 3	Basic Concepts; Emission and Absorption concept in p-n Junctions	1	3	1
	non-radiative Recombination	1	3	1
	Semi-conductor Materials, Light Emitting Diodes	1	3	1
	Light radiation by a semiconductor, Power-current Characteristics, LED Structures	1	3	1
	Semi-Conductor Lasers Diodes; Principle of action, DFB Lasers	1	3	1
	Coupled Cavity semiconductor Lasers, Vertical Cavity Semiconductor Lasers	1	3	1
	Laser Characteristics. Basic concepts of detectors, p-n Photo Diodes	1	3	1
	p-i-n Photo Diodes, Avalanche Photo Diode	1	3	1
	Receiver Design, Receiver Noise; Noise mechanism, Receiver sensitivity, Bit error rate, Minimum Receiver Power	1	3	1
	Unit:4 Optical Communication Systems	8 hrs		
Unit No. 4	System Architecture	1	4	1
	Components of fiber optic Network	1	4	1
	point to point links	1	4	1
	Optical Amplifiers, Principle of operation	1	4	1
	Wavelength Division Multiplexers and Demultiplexers	1	4	1
	Semiconductor optical amplifiers, Erbium doped fiber amplifiers, Dispersion limited Light wave systems	2	4	1
	Optical TDM Systems	1	4	1
	Unit:5 Optical Networks	8 hrs		
Unit No. 5	principles and architectures of different optical networks	2	5	1
	Passive Optical Networks (PONs)	2	5	1
	Synchronous Optical Networking (SONET)	2	5	1
	Optical Transport Networks (OTNs).	2	5	1
Total Hours		**43**		

Learning Assessment

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

Recommended Resources

1. Senior J. Optical Fiber Communications, Principles & Practice, PHI 1985.
2. Keiser G., Optical Fiber Communication, Mc Graw-hill 2008.
3. Govind P. Agrawal, Fiber Optics Communication Systems, John Wiley & Sons (Asia) Pvt. Ltd 1998.
4. Djafar K. Mynbeav, Fiber-Optics Communications Technology, Pearson 2001.

Other Resources

1. https://www.coursera.org/learn/introduction-optical-communication
2. https://ocw.mit.edu/courses/electrical-engineering

Course Designers

1. Dr. Goutam Rana, Assistant Professor, Dept. of ECE, SRM University – AP.

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Computer Networks and Internet Protocols

Course Code	ECE 472	**Course Category**	CE	**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. To Understand the computer network.
2. To Understand internet and protocols.
3. To Study how to apply internet protocols on IoT.
4. Understand the importance of protocols

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 basics and structures of Computer network	2	75%	70%
Outcome 2	Identifies the different types of network layers	2	75%	70%
Outcome 3	Identifies different protocols in the different layers	2	75%	70%
Outcome 4	Understand and build the skills on wireless technologies and Internet of things	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	1		1										1	2	
Outcome 2	2		1	1	2							1	3	2	
Outcome 3	1	2	2	2	2							1	3	3	
Outcome 4	1	2	2	2	2							1	3	3	
Average	2	2	2	2	2							1	3	3	

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit I	**Introduction**	**9**		
1.	Introduction to Computer Networks	2	1	1,2
2.	Data network	2	1	1,2
3.	Circuit Switching Network	2	2	1,2
4.	Packet Switching Network	2	1	1,2
5.	TCP/IP Protocol Stack	1	2	1,2
Unit II	**Application Layer**	**8**		1,2
6.	Introduction to application layer	2	2	1,2
7.	Introduction to HTTP, FTP	2	3	1,2
8.	Email, DNS	2	3	1,2
9.	World wide web	2	3	1,2
Unit III	**Transport Layer**	**9**		
10.	Introduction to Transport Layer Connection Establishment and Closure	2	3	1,2
11.	Flow Control at the Transport Layer	2	3	1,2
12.	Congestion Control	2	3	1,2
13.	Transmission Control Protocol – Basic Features, TCP Congestion Control	3	3	1,2
Unit IV	**Recognition And Reconstruction**	**9**		
14.	Introduction to Transport layer	2	2	1,2
15.	Intra Domain Routing Protocols	2	3	1,2
16.	Inter Domain Routing Protocols (BGP)	2	3	1,2
17.	Simple Network Management Protocol (SNMP)	3	3	1,2
Unit V	**Wireless LAN**	**10**		
18.	Introduction to IOT	3	4	1,2
19.	Network security	3	4	1,2
20.	WiMAX Broadband Wireless Access	3	4	1,2
21.	WiMAX vs LTE	1	4	1,2
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 (15%)	CLA-2 (15%)	CLA-3 (15%)	
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. Ames Kurose, Keith Ross "Computer Networking: A Top - Down Approach" Pearson; 7th edition, ISBN-10 : 9780133594140
2. 2. Andrew S Tanenbaum "Computer Networks" Pearson Education India; 5th edition, ISBN-10 : 9332518742

Other Resources

Course Designers

1. Dr. Karthikeyan E, Assistant Professor, Dept. of ECE. SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Detection and Estimation Theory

Course Code	ECE 446	**Course Category**	CE	**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. To understand the importance of detection and estimation
2. To understand and design the various detectors
3. To understand and design various estimators
4. To understand how to apply detection and estimation algorithms to a particular situation

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 understand the importance of detection and estimation	3	85%	80%
Outcome 2	To understand and design the various detectors	3	80%	75%
Outcome 3	To understand and design various estimators	3	85%	70%
Outcome 4	To understand how to apply detection and estimation algorithms to a particular situation.	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	1	1	1	1	1				1	1		3	1	1	1
Outcome 2	2	3	3	3	2				2	1		3	1	2	3
Outcome 3	2	3	3	3	2				2	1		3	1	2	2
Outcome 4	3	3	3	3	3				2	1		3	2	3	3
Average	2	3	3	3	3				2	1		3	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**8**		
	Introduction to Detection and Estimation	2	1	1, 2,3
	Review of Probability	2	1	1, 2,3
	Review of Linear Algebra	2	1	1, 2,3
	Hypothesis Testing	2	1	1, 2,3
Unit 2	**Detection Theory**	**8**		
	Neyman-Pearson Detector	3	2	1, 2,3
	Bayes detector	2	2	1, 2,3
	Matched Filters	3	2	1, 2,3
Unit 3	**Estimation Theory**	**8**		
	Introduction to Estimation Theory	1	3	1, 2,3
	Minimum Variance Unbiased Estimation	2	3	1, 2,3
	CR Rao Lower Bound	2	3	1, 2,3
	General Minimum Variance Unbiased Estimator	1	3	1, 2,3
	Best Linear Unbiased Estimator	2	3	1, 2,3
Unit 4	**Estimation Theory (Contd..)**	**11**		
	Maximum likelihood estimator	2	4	1, 2,3
	Linear Bayesian Estimator-Minimum Mean squared Estimator	3	4	1, 2,3
	Wiener and Kalman Filters	4	4	1, 2,3
Unit 5	**Applications of Detection and Estimation**	**8**		
	Application to Detection Theory	3	5	1, 2,3
	Application to Estimation Theory	5	5	1, 2,3
Total Contact Hours		**41**		

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	40%		60%		40%		60%		30%	
	Understand										
Level 2	Apply	60%		40%		60%		40%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory, S.M. Kay, Prentice Hall 1993, ISBN-13: 978-0133457117.
2. Fundamentals of Statistical Signal Processing, Volume II: Detection Theory, S.M. Kay, Prentice 1993, ISBN-13: 978-0135041352.
3. An Introduction to Signal Detection and Estimation, H.V. Poor, Springer, 2nd edition, 1998, ISBN-13: 978-0387941738

Other Resources

Course Designers

1. Dr. V. Udaya Sankar, Asst. Professor, Department of ECE, SRM University-AP.

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Satellite Communication

Course Code	ECE 447	Course Category	CE	L	T	P	C
				3	0	0	3
Pre-Requisite Course(s)	Wireless Communications	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. Comprehend the fundamental equations of motion governing satellite orbits and their application in tracking and orbit determination.
2. Master techniques for orbital correction and control to ensure optimal satellite positioning and functionality.
3. Demonstrate proficiency in utilizing FDMA, TDMA, CDMA, and random-access techniques in satellite communication systems.
4. Gain insight into spacecraft subsystems, emphasizing reliability considerations and the integration process in communication satellite design.
5. Understand the performance requirements and standards for satellite links and develop the skills to design effective satellite communication links, considering various satellite 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	Apply orbital mechanics equations to accurately predict and determine satellite orbits, facilitating efficient tracking and management.	2	85%	80%
Outcome 2	Demonstrate proficiency in utilizing FDMA, TDMA, CDMA, and random-access techniques in satellite communication systems.	4	80%	75%
Outcome 3	Upon completion, students will demonstrate the application of FDMA, TDMA, CDMA, and random-access techniques	3	75%	70%
Outcome 4	Apply knowledge of spacecraft subsystems and reliability considerations to practically design and integrate communication satellites.	3	80%	70%
Outcome 5	Develop skills to design satellite communication links meeting standards across diverse satellite systems.	4	85%	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3							1	1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	2	2	3	2				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**ELEMENTS OF ORBITAL MECHANICS**	**9**		
	Equations of motion.	2	1	1, 2
	Tracking and orbit Determination	2	1	1, 2
	Orbital correction/control	2	1	1, 2
	Satellite launch systems	2	1	1, 2
	Multistage rocket launchers and their performance	1	1	1, 2
Unit 2	**ELEMENTS OF COMMUNICATION SATELLITE DESIGN**	**9**		
	Spacecraft subsystems	4	2	1, 3
	Reliability considerations	3	2	1, 3
	Spacecraft integration	2	2	1, 3
Unit 3	**MULTIPLE ACCESS TECHNIQUES**	**9**		
	FDMA	2	3	2, 3
	TDMA	2	3	2, 3
	CDMA	2	3	2, 3
	Random access techniques	1	3	2, 3
	Satellite onboard processing	2	3	2, 3
Unit 4	**SATELLITE LINK DESIGN**	**9**		
	Performance requirements and standards	2	4	1, 2
	design of satellite links	2	4	1, 2
	DOMSAT, INSAT	2	4	1, 2
	INTELSAT and IMMaRSAT	2	4	2, 3
	Satellite-based personal communication	1	4	2, 3
Unit 5	**EARTH STATION DESIGN**	**9**		
	Configurations	3	5	1, 3
	Antenna and tracking systems	3	5	2, 3
	Satellite broadcasting	3	5	2, 3

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	35%		35%		35%		35%		35%	
	Understand										
Level 2	Apply	65%		65%		65%		65%		65%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Dennis Roddy, Satellite Communications, 4/e, Tata McGraw Hill, 2006
2. T. Pratt, S. W. Bostian, Satellite Communication, 2/e, John Wiley and Sons, 2006.
3. D. C. Agarwal, Satellite Communication, 1/e, Khanna Publishers, 1991

Other Resources

1. Dharma Raj Cheruku, Satellite Communication, 1/e, IK International Publishing, 2010.

Course Designers

1. Dr. Sunil Chinnadurai. Associate Professor. Dept. Of ECE. SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Advanced Signal Processing

Course Code	ECE 451	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Signals and Systems, Digital Signal processing, Control System	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	ECE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the Linear Algebra in Modern Digital Signal processing.
2. To learn the principles of different type digital filter designs.
3. To understand the different Spectrum Estimation Algorithms.
4. Application of DSP in Real-World 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	Understand the techniques for analysing and processing signals in the presence of noise.	2	90%	95%
Outcome 2	Learn the principles of digital filter design.	3	80%	80%
Outcome 3	Analyse estimation theory, detection theory, and parameter estimation.	4	70%	80%
Outcome 4	Process the digital Signal using Statistical methods.	5	60%	70%
Outcome 5	Apply modern digital signal processing techniques to solve real-world problems in areas such as telecommunications, audio processing, or biomedical signal processing.	6	50%	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			2
Outcome 2	3	3	2	2								2	3	2	3
Outcome 3	3	3	2	3	2							2	3	3	3
Outcome 4	3	3	3	3	3							3		3	3
Outcome 5	3	3	3	3	3				3			3	3	3	3
Average	3	3	3	3	3				3			3	3	3	3

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	UNIT I: LINEAR ALGEBRA	**12**		
1.	Vectors, linear independence, vector spaces and basis vectors, matrices, matrix inverse	1	1,4	1,2
2.	The determinant and trace, linear equations, special matrix forms, quadratic and hermitian forms	1	1,4	1,2
3.	Eigen values and eigen vectors	1	1,4	1,2
4.	Discrete Time Random Process: Introduction, Random Variables: Ensemble averages, jointly distributed random variables, joint moments, independent, uncorrelated orthogonal random variables, linear mean square estimation	3	1,4	1,2
5.	Gaussian random variables. Random processes: Ensemble averages,	2	1,4	1,2
6.	Gaussian processes, stationary processes, auto covariance and auto correlation matrices, ergodicity, white noise, power spectrum, filtering random processes, special types of random processes (ARMA, MA, AR Harmonic processes).	4	1,4	1,2
	UNIT II: OPTIMUM FILTERS	**7**		
7.	About FIR Wiener Filter	1	1-3	1,2
8.	Filtering, linear prediction	2	1-3	1,2
9.	Noise cancellation	1	1-3	1,2
10.	Lattice representation for the FIR Wiener filter	2	1-3	1,2
11.	Causal linear prediction	1	1-3	1,2
	UNIT III: ADAPTIVE FILTERS	**8**		
12.	FIR Adaptive Filters: Steepest descent adaptive filter	1	1-3	1-4
13.	LMS algorithm, convergence of LMS algorithm, normalized LMS	2	1-3	1-4
14.	Application: Noise cancellation.	1	1-3	1-4
15.	Other LMS based adaptive filters, gradient adaptive lattice filter, joint process estimator, channel equalization, adaptive recursive filters.	2	1-3	1-4
16.	Recursive Least squares: Exponentially weighted RLS, sliding window RLS	2	1-3	1-4
	UNIT IV: SPECTRUM ESTIMATION- Part-A	**7**		
17.	Non-Parametric Methods: Periodogram, performance of the periodogram, modified periodogram,	2	3-5	1-4
18.	Bartlett's method: periodogram averaging.	2	3-5	1-4
19.	Blackman-Tukey approach: periodogram smoothing.	2	3-5	1-4
20.	Performance comparisons, minimum variance spectrum estimation, maximum entropy method	1	3-5	1-4
	UNIT V: SPECTRUM ESTIMATION- Part-B	**7**		
21.	Parametric Methods: AR, MA, ARMA spectrum estimation techniques	2	3-5	2-5
22.	Frequency estimation: Eigen decomposition of the autocorrelation matrix, Pisarenko harmonic decomposition, music, other eigen decomposition methods.	3	3-5	2-5
23.	Principal components spectrum estimation: Bartlett frequency estimation, minimum variance frequency estimation, autoregressive frequency estimation	2	3-5	2-5
Total Contact Hours		**41**		

Learning Assessment

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

Recommended Resources

1. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, 1/e, Wiley Student Edition, 1996.
2. Proakis, J. Gard, D.G.Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2006.
3. D. G. Manolakis, Vijay Ingle, Statistical and Adaptive Signal Processing, 1/e, Artech Book House, 2009.
4. A.V. Oppenheim, R.W.Schafer, Discrete Time Signal Processing, 2/e, Prentice Hall of India, 1999.
5. S.J. Orfanidis, Optimum Signal Processing, 2/e, McGraw Hill, 1989.

Other Resources

Course Designers

1. Dr. Sibendu Samanta, Assistant Professor, Dept. of ECE, SRM University – AP

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Deep Learning

Course Code	ECE 452	Course Category	CE	L	T	P	C
				2	0	1	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. To familiarise the domain of fully connected neural networks.
2. To understand and design convolutional neural networks.
3. To understand and design recurrent neural networks.
4. To understand autoencoders and generative models.
5. To have a basic understanding of applications of deep learning.

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 fully connected neural networks	3	85%	80%
Outcome 2	Apply and analyse convolutional neural networks	3	80%	75%
Outcome 3	Apply recurrent neural networks	3	85%	70%
Outcome 4	Apply autoencoders and generative models.	3	80%	70%
Outcome 5	Understand the applications of deep learning to Computer vision and NLP	2	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3								1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	3	2	3	3				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to neural network**	**18**		
	Introduction to Neural network	1	1	1, 2
	Feedforward Neural networks	1	1	1, 2
	Gradient descent algorithm	1	1	1, 2
	Back propagation algorithm	1	1	1, 2
	Activation function	1	1	1, 2
	Training neural network	1	1	1, 2
	Risk minimization, loss function	1	1	1, 2
	Regularization and model selection	1	1	1, 2
	Optimization and hyperparameters	1	1	1, 2
	Shallow neural networks and Deep neural networks	1	1	1, 2
Expt 1	Binary Classification using Fully connected neural network	2	1	4
Expt 2	Regression using Fully connected neural network	2	1	4
Expt 3	Multi-class classification using Fully connected neural network	2	1	4
Expt 4	MNIST digit classification using fully connected neural network	2	1	4
Unit 2	**Convolutional neural networks**	**16**		
	Introduction to CNN	1	2	1, 2
	Convolutions and Pooling	1	2	1, 2
	Invariance, stability	1	2	1, 2
	Understanding ConvNets via Visualization	1	2	1, 2
	ConvNet Architectures	2	2	1, 2
	CNN on ImageNet	1	2	1, 2
	Overfitting Bias/Variance trade-off	1	2	1, 2
	Deep Convolutional Neural Networks	2	2	1, 2
Expt 5	MNIST digit classification using CNNs	2	2	4
Expt 6	CIFAR10 classification using AlexNet	2	2	4
Expt 7	CIFAR10 classification using Transfer Learning	2	2	4
Unit 3	**Recurrent neural networks**	**13**		
	Introduction to Recurrent Networks	1	3	1, 2
	Back propagation through time	1	3	1, 2
	The problem of Exploding and Vanishing Gradients	2	3	1, 2
	Long Short Term Memory (LSTM)	2	3	1, 2
	Gated Recurrent Units (GRUs)	1	3	1, 2
	How LSTMs avoid the problem of vanishing gradients	2	3	1, 2
Expt 8	Stock price prediction using RNNs	2	3	4
Expt 9	Sentiment Analysis using RNNs	2	3	4
Unit 4	**Autoencoders**	**11**		
	Introduction to Autoencoders	1	4	1, 2
	Introduction to Encoder and Decoder models	1	4	1, 2
	Link between PCA and Autoencoders	1	4	1, 2
	Regularization in autoencoders	1	4	1, 2
	Denoising Autoencoders	1	4	1, 2
	Sparse Autoencoders	1	4	1, 2
	Introduction to Generative Adversarial Networks (GAN)	2	4	1, 2
	Introduction to Reinforcement Learning	1	4	1, 2
Expt 10	Design of Autoencoders	2	4	4
Unit 5	**Applications of Deep Learning**	**8**		
	Introduction	2	5	1, 2,3
	Computer vision applications	3	5	1, 2,3
	NLP Applications	3	5	1, 2,3
Total Contact Hours		**66**		

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	40%	50%	60%	40%	40%	50%	60%		40%	40%
	Understand										
Level 2	Apply	60%	50%	40%	60%	60%	50%	40%		60%	60%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Ravichandiran, S., 2019. Hands-On Deep Learning Algorithms with Python: Master deep learning algorithms with extensive math by implementing them using TensorFlow. Packt Publishing Ltd..
2. Goodfellow, I., Bengio, Y., Courville, A. and Bengio, Y., 2016. Deep learning (Vol. 1). Cambridge: MIT press.
3. Research Papers
4. TensorFlow

Other Resources

Course Designers

1. Dr. Sudhakar Tummala. Asst. Professor. Dept. Of ECE. SRM University - AP
2. Dr. V. Udaya Sankar, Asst. Professor, Department of ECE, SRM University-AP

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Image Processing and Computer Vision

Course Code	ECE 453	Course Category	CE	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. To understand the geometric relationships between 2D images and the real-world 3D objects.
2. To analyse the foundation of camera geometry, measurement, and analysis.
3. To apply various advanced computer vision techniques.
4. To understand standard image processing and computer vision algorithms.
5. To develop the practical skills necessary to build futuristic imaging 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	Understand the geometric relationships between 2D images and the real-world 3D objects.	1	85%	80%
Outcome 2	Analyse the foundation of camera geometry, measurement, and analysis.	2	80%	75%
Outcome 3	Apply various advanced computer vision techniques.	2	85%	70%
Outcome 4	Understand standard image processing and computer vision algorithms.	1	80%	70%
Outcome 5	Create futuristic imaging systems.	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3				2	1		1	1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	2	3	2	3	3				2	1		1	1	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to Image processing**	**10**		
	Image acquisition, image sampling and quantization and image representation, spatial and intensity resolutions.	1	1	1, 2
	Intensity transformations, Histogram processing, Histogram equalization and modification.	1	1	1, 2
	Spatial filtering and convolution, smoothening and Sharpening filters, median filter.	1	1	1, 2
	2D DFT and filtering in frequency domain	2	1	1, 2
	Image Restoration, Linear Degradation model, Inverse filtering, Wiener filter	3	1	1, 2
	Color image processing: Color fundamentals, color models.	2	1	1, 2
Unit 2	**Camera Geometry and Depth Estimation**	**10**		
	Image formation: perspective projection. Cameras with lenses.	1	2	1, 2
	Rigid Transformations and Homogeneous coordinates, Intrinsic and extrinsic parameters	2	2	1, 2
	Geometric camera calibration	1	2	1, 2
	Binocular Camera Geometry and Epipolar constraint, Essential and fundamental matrices	2	2	1, 2
	Binocular fusion: Local and Global Methods.	2	2	1, 2
	Multi- view stereo	2	2	1, 2
Unit 3	**Motion Estimation and Structure from Motion**	**10**		
	Optical Flow, Horn-Shunck and Lucas-Kanade algorithms	2	3	1, 2
	Geometric Intrinsic calibration and pose estimation	2	3	1, 2
	Two- frame and Multi-frame SFMs	4	3	1, 2
	SLAM and applications	2	3	1, 2
Unit 4	**Feature Extraction and Image Segmentation**	**8**		
	Edge and Line detection	1	4	1, 2
	Orientation Histograms, HOG, SIFT and SURF	2	4	1, 2
	Principal Component Analysis	1	4	1, 2
	Segmentation by region growing and region splitting	2	4	1, 2
	Segmentation using graph cuts	2	4	1, 2
Unit 5	**Applications**	**10**		
	Computational Photography: HDR imaging, Super resolution, denoising and blur removal	4	5	1, 2
	Image-Based Rendering	2	5	1, 2
	Image classification, Face Recognition	2	5	1, 2
	Object Detection: Face detection, Pedestrian detection	2	5	1, 2
Total 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	40%		60%		40%		60%		30%	
	Understand										
Level 2	Apply	60%		40%		60%		40%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Digital Image Processing, by Rafael Gonzalez and Richard Woods.
2. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce. Pearson Education.
3. Multiple View Geometry in Computer Vision, by Richard Hartley and Andrew Zisserman.
4. Computer Vision: Algorithms and Applications, by Richard Szeliski.

Other Resources

Course Designers

1. Dr. Sudhakar Tummala. Asst. Professor. Dept. Of ECE. SRM University - AP

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Biomedical Signal Processing

Course Code	ECE 454	**Course Category**	CE	**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. Understand the physiological basis and origin of biomedical signals.
2. Familiarize with different types of biomedical signals and the challenges in their analysis.
3. Analyse EEG signals using advanced methods like autoregressive modeling and adaptive segmentation.
4. Learn ECG data acquisition and advanced techniques for ECG waveform analysis and apply adaptive filter techniques to enhance the accuracy and quality of biomedical signals.

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	Ability to understand the origin and physiological basis of biomedical signals.	2	80%	70%
Outcome 2	Ability to Identify and describe various types of biomedical signals and their analysis challenges.	3	80%	70%
Outcome 3	Ability to Analyse EEG signals using advanced techniques like autoregressive modelling.	3	80%	70%
Outcome 4	Ability to Acquire and process ECG data to detect and analyse waveforms and arrhythmias and apply adaptive filters to enhance the quality and accuracy of biomedical signals.	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	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 2	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 3	2	2	1	2	2	1		1	2		1	2	1	1	1
Outcome 4	3	3	3	3	3	1		1	1		3	1	1	1	1
Average	2	2	2	2	2	1		1	2		2	2	1	1	1

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**UNIT I: PHYSIOLOGY TO UNDERSTAND BIOMEDICAL SIGNAL ORIGIN**	**9**		
	Cell and its structure – Resting and Action Potential	1	1	1, 2
	Nervous system and its fundamentals - Basic components of a biomedical system	2	1	1, 2
	Cardiovascular systems- Respiratory systems	2	1	1, 2
	Electrodes – Limb electrodes –floating electrodes	2	1	1, 2
	pregelled disposability electrodes - Micro, needle and surface electrodes	2	1	1, 2
Unit No. 2	**UNIT II– FUNDAMENTALS OF BIOMEDICAL SIGNALS**	**9**		
	Bioelectric signals- Electro-neurogram, Electro-oculogram, Electroencephalogram	2	1	1, 2
	Evoked potential, Electro-cardiogram, Electro-gastrogram, PPG,	2	1	1, 2
	Bio Impedance Signals, Mechanical Signals - Bioacoustics Signals, Biochemical Signals	2	1	1, 2
	Objectives Of Biomedical Signal Analysis,	2	1	1, 2
	Difficulties In Biomedical Signal Analysis	1	1	1, 2
Unit No. 3	**UNIT III - NEUROLOGICAL SIGNAL PROCESSING**	**9**		
	EEG signal and its characteristics, EEG analysis,	2	3	1, 2
	Linear prediction theory-Autoregressive method, Moving average model, Autoregressive moving average mode	1	3	1, 2
	Estimation of AR, MA, ARMA parameters.	1	3	1, 2
	AR modelling of Seizure EEG	1	3	1, 2
	Spectral error measure	2	3	1, 2
	Adaptive segmentation	2	3	1, 2
Unit No. 4	**UNIT IV: CARDIOLOGICAL SIGNAL PROCESSING**	**9**		
	Basic Electrocardiography, ECG data acquisition, ECG lead system	2	3	1, 2
	ECG signal characteristics (parameters and their estimation)	2	3	1, 2
	Power spectrum of the ECG, Analog filters, ECG amplifier, Event Detection: Example events (viz. P, QRS and T wave in ECG),	2	3	1, 2
	Derivative based Approaches for QRS Detection Pan Tompkins Algorithm for QRS Detection	1	3	1, 2
	ECG interpretation, ST segment analyser, Portable arrhythmia monitor	2	3	1, 2
Unit No. 5	**UNIT V: ADAPTIVE FILTERS FOR NOISE CANCELLATION IN BIOSIGNALS**	**9**		
	Adaptive filter- principles, steepest descent algorithm, Widrow-Hoff least mean square adaptive algorithm,	2	2, 4	1, 2, 3
	Adaptive noise canceller-cancellation of 60Hz interference in ECG-cancelling donor heart interference in Heart-transplant	2	2, 4	1, 2, 3
	ECG-cancellation of ECG signals from electrical activity of chest muscles- cancelling of maternal ECG from fetal ECG- cancellation of high frequency noise in Electro-surgery.	2	2, 4	1, 2, 3
	Adaptive line enhancement of diastolic heart sound, Applications of adaptive noise cancelling method to enhance electro gastric measurements.	3	2, 4	1, 2, 3

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	50%		50%		60%		60%		60%	
	Understand										
Level 2	Apply	50%		50%		40%		40%		40%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis: A Case-Study Approach, Publisher: Wiley India; 2009.
2. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, Wiley-Inderscience; 1 edition, 2000.
3. John L. Semmlow, Biosignal and Biomedical Image Processing: MATLAB-based applications, CRC; 1 edition, 2004.
4. MetinAkay, Time Frequency and Wavelets in Biomedical Signal Processing, Wiley- IEEE Press; IEEE Press; 1 edition, 1997.

Other Resources

Course Designers

1. Dr. KA Sunitha, Associate Professor, Department of ECE, SRM University AP

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Detection and Estimation Theory

Course Code	ECE 455	**Course Category**	CE	**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. To understand the importance of detection and estimation
2. To understand and design the various detectors
3. To understand and design various estimators
4. To understand how to apply detection and estimation algorithms to a particular situation

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 understand the importance of detection and estimation	3	85%	80%
Outcome 2	To understand and design the various detectors	3	80%	75%
Outcome 3	To understand and design various estimators	3	85%	70%
Outcome 4	To understand how to apply detection and estimation algorithms to a particular situation.	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	1	1	1	1	1				1	1		3	1	1	1
Outcome 2	2	3	3	3	2				2	1		3	1	2	3
Outcome 3	2	3	3	3	2				2	1		3	1	2	2
Outcome 4	3	3	3	3	3				2	1		3	2	3	3
Average	2	3	3	3	3				2	1		3	2	2	2

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**8**		
	Introduction to Detection and Estimation	2	1	1, 2,3
	Review of Probability	2	1	1, 2,3
	Review of Linear Algebra	2	1	1, 2,3
	Hypothesis Testing	2	1	1, 2,3
Unit 2	**Detection Theory**	**8**		
	Neyman-Pearson Detector	3	2	1, 2,3
	Bayes detector	2	2	1, 2,3
	Matched Filters	3	2	1, 2,3
Unit 3	**Estimation Theory**	**8**		
	Introduction to Estimation Theory	1	3	1, 2,3
	Minimum Variance Unbiased Estimation	2	3	1, 2,3
	CR Rao Lower Bound	2	3	1, 2,3
	General Minimum Variance Unbiased Estimator	1	3	1, 2,3
	Best Linear Unbiased Estimator	2	3	1, 2,3
Unit 4	**Estimation Theory (Contd..)**	**11**		
	Maximum likelihood estimator	2	4	1, 2,3
	Linear Bayesian Estimator-Minimum Mean squared Estimator	3	4	1, 2,3
	Wiener and Kalman Filters	4	4	1, 2,3
Unit 5	**Applications of Detection and Estimation**	**8**		
	Application to Detection Theory	3	5	1, 2,3
	Application to Estimation Theory	5	5	1, 2,3
Total Hours		**41**		

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	40%		60%		40%		60%		30%	
	Understand										
Level 2	Apply	60%		40%		60%		40%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory, S.M. Kay, Prentice Hall 1993, ISBN-13: 978-0133457117.
2. Fundamentals of Statistical Signal Processing, Volume II: Detection Theory, S.M. Kay, Prentice 1993, ISBN-13: 978-0135041352.
3. An Introduction to Signal Detection and Estimation, H.V. Poor, Springer, 2nd edition, 1998, ISBN-13: 978-0387941738.

Other Resources

Course Designers

1. Dr. V. Udaya Snakar, Asst. Professor, Department of ECE, SRM University-AP.

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Digital Speech Processing

Course Code	ECE 456	**Course Category**	CE	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Signals and Systems, DSP	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	ECE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. To understand the fundamentals of speech production and perception.
2. To analyse and synthesize speech signal
3. To implement speech and speaker recognition algorithms.
4. To develop robust speech coding and compression methods.
5. Exploring applications and emerging trends in speech technology.

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 basic concepts of speech production and perception, information source in the speech signal, applications of speech signal processing for the modern world.	2	90%	70%
Outcome 2	Extract relevant information and enhancement of speech signals in the presence of different background noises	3	80%	70%
Outcome 3	Implement the concepts pattern recognition system and different statistical modelling approaches for speech processing applications	4	70%	70%
Outcome 4	Develop human-machine interactive systems using speech signals.	6	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	3	2	2	3									3	1	
Outcome 2	3	2	3	3									3	2	
Outcome 3	3	2	3	3									3	3	
Outcome 4	3		3	3									3	3	3
Average	3	2	3	3									3	3	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
	Unit 1: Introduction to Speech Processing	**8**		
Unit No.1	Speech production and perception	1	1	1
	information sources in speech signal, linguistic aspect of speech, acoustic and articulatory phonetics	2	1	1
	nature of speech, models for speech analysis and perception	1	1	1
	short-term processing of speech	1	1	1
	time, frequency and time-frequency analysis	1	1	1
	development of short-term Fourier transform (STFT), transform and filter-bank views of STFT.	2	1	1
	Unit 2: Analysis of speech	**12**		
Unit No.2	Basis and development cesptrum analysis of speech	2	1	1
	real and complex cepstrum, pitch detection, formant estimation	2	1,2	1
	Mel-frequency cepstral coefficient (MFCC), delta and delta-delta MFCC	2	1,2	1
	Linear Prediction (LP) analysis, LP analysis of speech,	3	1,2	1
	solution of LP equation using Levinson-Durbin's method, normalized error, LP spectrum, LP cepstrum, LP residual.	3	1,2	1
	Unit 3: Speech Enhancement	**6**		
Unit No.3	Speech enhancement: objective, issues	1	2	1
	enhancement of noisy speech	2	2	1
	reverberant speech and multi-speaker speech using time, frequency and time-frequency approaches	2	2	1
	Unit 4: Speech recognition	**10**		
Unit No.4	Basic concepts of pattern recognition: feature extraction, modeling, testing, Objective, issues	2	3	1
	block diagram description of automatic speech recognition (ASR) system	2	3	1
	development of ASR system using vector quantization (VQ)	2	3	1
	dynamic time warping (DTW)	2	3	1
	Hidden Markov Model (HMM)	1	3	
	Neural networks (NN)	1	3	
	Unit 5: Speaker Recognition	**9**		
Unit No.5	Objective, issues	1	3,4	1
	block diagram description of speaker recognition system	1	3,4	1
	classification of speaker recognition systems	2	3,4	1
	development of speaker recognition system using VQ	2	3,4	1
	Speaker recognition system using Gaussian mixture model (GMM), Adapted-GMM	2	3,4	1
	Speaker recognition system using I-vetor	1	3,4	2
Total Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Exam (40%)
		CLA-1 (15%)	Mid-1 (15%)	CLA-2 (15%)	CLA-3 (15%)	
Level 1	Remember	75%	25%	30%		35
	Understand					
Level 2	Apply	25%	75%	30%	25%	30
	Analyse					
Level 3	Evaluate			40%	75%	35
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana, "Fundamentals of speech recognition", Pearson Education, 2009.
2. Selected research papers as recommended by the course instructor.

Other Resources

1. L. Rabiner and R. W. Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
2. K. Sayood, Introduction to Data Compression, 2nd Ed, Morgan Kaufmann, 2000.
3. D. O'Shaughnessy, Speech Communications: Human and Machine, 2nd Ed, IEEE Press, 2000.
4. A. Gersho and R. M. Gray, Vector Quantization and Signal Compression, Kluwer Academic, 1991

Course Designers

1. Dr. Anuj Deshpande, Asst. Professor, Department of ECE, SRM University AP

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Pattern Recognition

Course Code	ECE 459	Course Category	CE	L	T	P	C
				2	0	1	3
Pre-Requisite Course(s)	Signal Processing, Digital Signal Processing, Image Processing, Linear Algebra	Co-Requisite Course(s)		Progressive Course(s)			
Course Offering Department	ECE	Professional / Licensing Standards					

Course Objectives / Course Learning Rationales (CLRs)

1. To familiarise the domains of supervised and unsupervised learning.
2. To understand and apply various classifiers.
3. To understand and apply clustering methods.
4. To understand and analyse numerous techniques for feature extraction and selection.
5. To have a basic understanding of recent advances in pattern recognition.

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	Familiarise supervised and unsupervised learning	1	85%	80%
Outcome 2	Implement and apply various classifiers	1, 2	80%	75%
Outcome 3	Understand and apply clustering methods	1, 2	85%	70%
Outcome 4	Learn and evaluate various techniques for feature extraction and selection	3,4	80%	70%
Outcome 5	Understand and implement the support vector machine (SVM)	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	1	1	1	1	1							1	1	1	1
Outcome 2	2	3	2	3	2				2	1		1	1	2	3
Outcome 3	2	2	2	3	3				2	1		1	1	2	2
Outcome 4	2	3	3	3	3				2	1		1	2	3	3
Outcome 5	3	3	2	3	3				2	1		2	2	2	2
Average	**2**	**3**	**2**	**3**	**3**				**2**	**1**		**1**	**1**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction and mathematical preliminaries**	**8+4**		
	Principles of Pattern recognition	1	1	1, 2
	Clustering vs Classification; Supervised vs unsupervised	1	1	1, 2
	Relevant basics of Linear Algebra, vector spaces	2	1	1, 2
	Probability Theory basics and Basics of Estimation theory	2	1	1, 2
	Decision Boundaries, Decision region/ Metric spaces/ distances	2	1	1, 2
	L1: Implement Linear Regression on the given dataset using python/MATLAB	2	1	4-6
	L2: Implement Logistic Regression on the given dataset using python/MATLAB	2	1	4-6
Unit 2	**Classification**	**13+8**		
	Bayes decision rule, Error probability	1		
	Linear Discriminant Function (equal covariance matrices)	1		
	Non-linear Decision Boundaries (unequal covariance matrices)	2		
	K-Nearest Neighbor	2	2	1, 2
	Naive Bayes	1	2	1, 2
	Single Layer Perceptron	1	2	1, 2,3
	Multi-layer Perceptron	1		
	Training set, test set; standardization and normalization	1		
	Decision Trees, Random Forest	3	2	1, 2
	L3: Implement Naïve Bayes classifier using Python/MATLAB	2	2	4-6
	L4: Implement KNN algorithm using Python/MATLAB	2	2	4-6
	L5: Implement Decision tree classifier using python/ MATLAB	2	2	4-6
	L6: Implement Random Forest classifier using python/ MATLAB	2	2	4-6
Unit 3	**Clustering**	**5+4**		
	Clustering in machine learning	1	3	1, 2, 3
	Different types of clustering algorithms	1	3	1, 2, 3
	K-Means clustering	1	3	1, 2, 3
	Gaussian mixture models	1	3	1, 2 3
	Bias-variance trade off	1	3	1, 2 3
	L7: Implement K-means algorithm for clustering the data using python/MATLAB	2	3	4-6
	L8: Implement K-Nearest Neighbour classifier using python/MATLAB	2	3	4-6
Unit 4	**Feature selection and Extraction**	**6+4**		
	Problem statement and uses Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms	2	4	1, 2
	Probabilistic separability-based criterion functions, interclass distance-based criterion functions	2	4	1, 2
	PCA + Kernel PCA	2		
	L9: Emulate logic gates using neural network using python	2	4	4-6
	L10: Implement PCA for image/data analysis using Python/MATLAB	2	4	4-6
Unit 5	**Recent advances in Pattern Recognition**	**3**		
	Structural Pattern recognition, SVM	1	5	1, 2 3
	FCM	1	5	1, 2 3
	Soft-computing and Neuro-fuzzy techniques, and real-life examples	1	5	1, 2
Total Hours		**55**		

Learning Assessment

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

Recommended Resources

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning" by Springer, 2007.
2. Tom M. Mitchell, "Machine Learning", First Edition by Tata McGraw-Hill Education, 2013.
3. EthemAlpaydin, "Introduction to Machine Learning" 4th Edition, The MIT Press, 2020
4. Google Colab
5. MATLAB
6. Scikit-Learn

Other Resources

Course Designers

1. Dr. Sibendu Samanta. Asst. Professor. Dept. Of ECE. SRM University – AP
2. Dr. Anuj P. Deshpande, Asst. Professor. Dept. Of ECE. SRM University – AP

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

ARM Programming

Course Code	SEC	**Course Category**	SEC	**L**	**T**	**P**	**C**
				2	0	1	3
Pre-Requisite Course(s)	Microprocessors and Microcontrollers	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	ECE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Understand the basics of Embedded software design.
2. Learn to develop C programs for interfacing the peripherals.
3. Understand the ARM interrupts and its programming.
4. Learn to apply low power programming techniques.

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 and explain the basics of Embedded Software Design.	2	80%	70%
Outcome 2	Develop ARM mixed Assembly & C programming.	4	80%	70%
Outcome 3	Understand the interrupts and do programs using it.	4	80%	70%
Outcome 4	Develop programs for the internal peripherals like GPIO, Timers, UART and ADC.	4	80%	70%
Outcome 5	Understand and apply ARM low power programming	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 Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	1				1		1	1	1	1	1
Outcome 2	3	3	3	3	1				1		2	2	2	2	2
Outcome 3	3	3	3	3	1				1		2	2	2	2	2
Outcome 4	3	2	1	2	1				1		1	1	2	2	2
Outcome 5	3	3	1	2	1				1		2	2	2	2	2
Average	**3**	**2**	**1**	**2**	**1**				**1**		**1**	**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
	ARM Cortex M Programming			
1	Introduction to Embedded System Design	1	1	1,2
2	Software Design Basics	2	1	1,2,3
3	ARM Cortex M Processor	2	2	1,2,3
4	ARM Cortex M Instruction set	2	2	1,2,3
5	ARM – C to Assembly, ARM Procedure Call Standard	2	2	1,2,4
6	Interrupts, Nested Vectored Interrupt Controller	2	3	1,3,4
7	General purpose Input Output (GPIO) Interfacing	2	3,4	1,3,4,6
8	Analog to Digital Converter	2	3,4	1,2,6
9	Digital to Analog Converter	2	3,4	1,2,6
10	Timers, PWM	2	3,4	1,2,6
11	Asynchronous Serial Communication	2	3,4	1,2,6
12	Synchronous Serial Communication	2	3,4	1,2,6
13	Direct Memory Access	2	3,4	1,2,6
14	Low Power Programming Techniques	3	5	1,2,6
15	Multi-channel Data acquisition System	2	2,3,4	2,5,6
	Total Contact Hours	**30**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	ARM Programming Environment - Introduction	1	1	1
2.	ARM Cortex M - Clock Configuration	1	4	1,2
3.	Mixed C and Assembly Programming	2	2	1,2
4.	GPIO Interfacing	1	3,4	1,2,6
5.	External Interrupt	2	3,4	1,2,6
6	Analog to Digital Converter with Interrupt	2	3,4	1,2,6
7	Timers	2	3,4	1,2,6
8	Serial Communication	1	3,4	1,2,6
9	Low Power Programming	2	5	1,2,6
10	Mini Capstone Project	1	-	5,6
Total Contact Hours		**15**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (35%)				Practical (15%)		
		CLA-1 (10%)	CLA-2 (5%)	CLA-3 (5%)	Mid-1(15%)		Th (35%)	Prac (15%)
Level 1	Remember	60%	40%	60%	60%	20%	40%	30%
	Understand							
Level 2	Apply	40%	60%	40%	40%	80%	60%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. ARM Education, Efficient Embedded Systems Design Education Kit Repository: https://github.com/arm-university/Efficient-Embedded-Systems-Design-Education-Kit
2. Rob Toulson, Tim Wilmshurst, Fast and Effective Embedded Systems Design: Applying the ARM mbed, Newnes, 2016.
3. Ata Elahi, Trevor Arjeski, "ARM Assembly Language with Hardware Experiments", Springer, 2015.
4. A.N.Sloss et al., "ARM System Developer's Guide", Morgan Kaufmann Publishers, 2004
5. LPC176x Datasheet. https://www.nxp.com/docs/en/data-sheet/LPC1769_68_67_66_65_64_63.pdf
6. LPC176x User Manual. https://www.nxp.com/webapp/Download?colCode=UM10360

Other Resources

Course Designers

1. Dr Ramakrishnan M, Associate Professor, Department of Electronics and Communication Engineering, SRM University – AP.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Structures Algorithms

Course Code	SEC 127	**Course Category**	SEC	**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)

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				
Outcome 4				

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															
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