Department of Electronics and Communication Engineering

M. Tech in – IoT

Curriculum and Syllabus

(Applicable to the students admitted From AY 2023-24 onwards)

SRM UNIVERSITY *AP*

Andhra Pradesh

School of Engineering and Sciences

SRM University - AP, Andhra Pradesh.

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

M. Tech in Internet of Things

Vision Statement

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

Mission Statements

- Create inclusive and highly motivated individuals and leaders who promote diversity, innovation, creativity, and a high sense of responsibility towards societal progress.
- Strive for excellence by promoting interdisciplinary education and research through global collaborations.
- 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.
- Foster a culture of innovation and entrepreneurship, by working closely with leading industry partners to translate ideas into real-life solutions.
- Aim to be a global knowledge hub by collaborating with leading institutions and industries.

Program Educational Objectives (PEOs)

PEO1: Enable the postgraduate students to be proficient in Embedded Systems and Internet of Things and develop strong skills and competencies for their professional careers and higher studies.
PEO2: Gain hands-on learning experiences in Embedded System Design skills which can be applied to find exceptional solutions to industrial and research problems in an inter-disciplinary environment.
PEO3: Develop 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
Mission Statement 1	3	1	2
Mission Statement 2	3	3	2
Mission Statement 3	2	1	3
Mission Statement 4	3	2	3
Mission Statement 5	3	3	2

Program Specific Outcomes (PSOs)

PSO1: Design and integrate embedded systems solutions for real-life and industrial scenarios using appropriate technology and tools.
PSO2: Develop secure and scalable Internet of Things for efficient communication.
PSO3: Conduct exceptional research in the field of Embedded Systems and the Internet of Things using advanced technologies & platforms, analyse data and report.

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

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Design / Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork	Communication	Life-long Learning	PSO1	PSO2	PSO3
PEO 1	**3**	**3**	**3**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**3**	**2**	**2**
PEO 2	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**1**	**2**	**2**	**3**	**2**	**3**
PEO 3	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**

Programme Outcomes (POs)

PO 1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Design / Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and cultural, societal, and environmental considerations.

PO 3: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

PO 4: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO 5: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 6: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO 7: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 8: Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO 9: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 10: Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change

Semester wise Course Credit Distribution Under Various Categories

Category	Semester									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	0	0	0	0	0	0	0	0	0	0.0
Value Added Courses - VAC	0	1	0	0	0	0	0	0	1	1.3
Skill Enhancement Courses - SEC	2	2	0	0	0	0	0	0	4	5.0
Foundation / Interdisciplinary Courses - FIC	3	0	0	0	0	0	0	0	3	3.8
CC / SE / CE / TE / DE / HSS	16	20	0	0	0	0	0	0	36	45.0
Minor / Open Elective - OE	0	0	0	0	0	0	0	0	0	0.0
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) - RDIP	0	4	17	15	0	0	0	0	36	45.0
Grand Total	**21**	**27**	**17**	**15**	**0**	**0**	**0**	**0**	**80**	**100.0**

SEMESTER I									
S.no	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Rr**	**C**	**LH**
1	AEC	AEC	VAC 501	Community Engagement and Social Responsibility	0	0	1	1*	30
2	SEC	SEC	SEC 502	Design Thinking	1	0	1	2	60
3	FIC	FIC	FIC 503	AI/ML Techniques	2	0	1	3	90
4	Core	CC	EIT 501	Embedded Programming	3	0	1	4	120
5	Core	CC	EIT 502	Embedded Networking	3	0	1	4	120
6	Core	CC	EIT 503	Smart Sensors and Actuators	3	0	1	4	120
7	Core	CC	EIT 504	Computer Network and Internet Protocol	3	0	1	4	120
8	RDIP	RDIP	AEC 502	Research Seminar	0	0	1	1*	30
				Toal	**15**	**0**	**8**	**21**	**690**

SEMESTER II									
S.no	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Rr**	**C**	**LH**
1	VAC	VAC	VAC 502	Community Engagement and Social Responsibility	0	0	1	1	30
2	SEC	SEC	SEC 103	Entrepreneurial Mindset	1	0	1	2	60
3	Core	CC	IOT 505	IoT Architecture and Protocols	3	0	1	4	120
4	Core	CC	IOT 506	SOC Design for IoT	3	0	1	4	120
5	Core	CC	IOT 507	Wireless Sensor Networks & IoT	3	0	1	4	120
6	Elective	CE	CE	Industry - Core Elective	3	0	1	4	120
7	Elective	CE	CE	Industry - Core Elective	3	0	1	4	120
8	RDIP	RDIP	PGM 501	Project Management	0	2	1	3	90
9	RDIP	RDIP	AEC 503	Research Seminar	0	0	1	1	30
				Total	**16**	**2**	**9**	**27**	**810**

SEMESTER III									
S.no	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Rr**	**C**	**LH**
1	RDIP	RDIP	IOT 509	Thesis I	0	0	14	14	420
2	RDIP	RDIP	IOT 510	Industrial Practice	0	0	3	3	90
				Total	**0**	**0**	**17**	**17**	**510**

SEMESTER IV									
S.no.	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Rr**	**C**	**LH**
1	RDIP	RDIP	IOT 511	Thesis II	0	0	15	15	450
				Total	**0**	**0**	**15**	**15**	**450**

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

a. Every 1 credit of Lecture/Tutorial per week is equal to one contact hour of 60 minutes
b. Every 1 credit of Discussion per week is equal to two contact hours of 60 minutes
c. Every 1 credit of Practical per week is equal to two contact hours of 60 minutes
d. Every 1 credit of Project per week is equal to two contact hours of 60 minutes (timetable not required)

S.No	Semester	Credits
1	I	21
2	II	27
3	III	17
4	IV	15
Total		**80**

List of Core Electives									
S. No	**Category**	**Sub Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Rr**	**C**	**LH**
1.	CE	CE	IOT 532	Designing Embedded systems with UML	3	0	1	4	120
2.	CE	CE	IOT 552	Signal Processing and Computer Vision	3	0	1	4	120
3.	CE	CE	IOT 544	Machine Learning for Communication systems	3	0	1	4	120
4.	CE	CE	IOT 534	CMOS Digital IC Design	3	0	1	4	120
5.	CE	CE	IOT 543	Hardware Security for IoT	3	0	1	4	120
6.	CE	CE	IOT 535	CMOS Analog and Mixed Signal IC Design	3	0	1	4	120
7.	CE	CE	IOT 553	VLSI Technology	3	0	1	4	120
8.	CE	CE	IOT 558	Deep Learning for IoT	3	0	1	4	120

SEMESTER- I

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Design Thinking

Course Code	**SEC 502**	Course Category	**SEC**	L-T-P-C	**1**	**0**	**1**	**2**
Pre-Requisite Course(s)	**NA**	Co-Requisite Course(s)	**NA**	Progressive Course(s)				
Course Offering Department	**Management**	Professional / Licensing Standards	*NA*					

Course Objectives

1. Familiarize with the principles of Design Thinking
2. Learn to apply the principles of Design Thinking
3. Apply Design Thinking to solve 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	Grasp the Concepts and process of Design Thinking	2	85	90
Outcome 2	Learn the process of Design Thinking	2	85	90
Outcome 3	Solve a problem using Design Thinking Principles	5	75	65

Course Articulation Matrix (CLO) to (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Management Knowledge	Analytical Reasoning and	Critical and Reflective	Strategic Thinking and	Modern Tools and ICT Usage	Environment and	Moral, Multicultural	Individual and Teamwork	Communicatio n Skills	Leadership Readiness	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3										1	3	1	3
Outcome 2	3							3			2	3	2	3
Outcome 3	3	3	3	3				3	3	3	3	3	3	3
Course Average	**3**	**3**	**3**	**3**				**3**	**3**	**3**	**2**	**3**	**2**	**3**

Course Unitization Plan - Theory

Unit No.	**Unit Name**	**Required Contact Hours**	**CLOs Addressed**	**References Used**
Unit 1	**Incubation and understanding**			1,2
1.	Understanding of Design Thinking & its Importance	4	1	1,2
2.	Importance of Design Thinking	3	1	1,2

3.	Pillars of Design Thinking	3	1	1,2
Unit 2	**Process – Understanding the Stages of Design Thinking**			1,2
4.	Stage 1- Empathy	2	2	1,2
5.	Stage 2 - Define	2		
6.	Stage 3 – Ideate	2		
7.	Stage 4 – Prototype	2	2	1,2
8.	Stage 5 – Test & Implement	2	2	1,2
Unit 3	**Application**			
9.	Project Work	7	3	1,2
10.	Viva	3	3	1,2
Total Contact Hours		**30**		

Recommended Resources

1. Design Thinking – Techniques and Approaches, N. Siva Prasad

Other Resources

1. HBS – Online – Design Thinking & Innovation – course material
2. Case studies
3. Nigel Cross , Design Thinking, BERG Publishing, (2011)
4. Thomas Lockwood , Design Thinking- Integrating Innovation, Customer Experience and Brand Value, , Design Management Institute, (2009)

Learning Assessment (Theory)

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

Course Designers

a. ***Satyanarayana Duvvuri,*** *Visiting Faculty, Paari school of business, SRM University AP.*

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AI/ML Techniques

Course Code	**FIC 503**	Course Category	**Core (FIC)**	L-T-P-C	**2**	**0**	**1**	**3**
Pre-Requisite Course(s)		Co-Requisite Course(s)	**Nil**	Progressive Course(s)	**Nil**			
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: To familiarise the domains of supervised and unsupervised learning.
Objective 2: To understand and apply various binary classifiers.
Objective 3: To understand and apply clustering methods.
Objective 4: To understand and analyse Feedforward neural networks and CNNs
Objective 5: Able to work on real time projects related to AI/ML

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 able to work on real time projects	2,3,4	75%	70%

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

CLO	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and	Modern Tool and ICT	Society and Multicultural	Environment and	Moral, and Ethical	Individual and	Communication Skills	Project Management	Self-Directed and Lifelong	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
Course Average	**2**	**3**	**2**	**3**	**3**				**2**	**1**		**1**	**1**	**2**	**2**

Course Unitization Plan - Theory

Unit No.	**Unit Name**	**Required Contact Hours**	**CLOs Addressed**	**References Used**
Unit 1	**Introduction**	**6**		

1.	Introduction to machine learning	1	1	1, 2,3
2.	Supervised learning	1	1	1, 2,3
3.	Unsupervised learning	1	1	1, 2,3
4.	Linear regression	1	1	1, 2,3
5.	Logistic regression	2	1	1, 2,3
Unit 2	**Classifiers**	**5**		
6.	Naive Bayes	1	2	1, 2,3
7.	Support Vector Machines	1	2	1, 2,3
8.	K-Nearest Neighbor	1	2	1, 2,3
9.	Decision Trees	1	2	1, 2,3
10.	Random forest	1	2	1, 2,3
Unit 3	**Clustering**	**6**		
11.	Clustering in machine learning	1	3	1, 2,3
12.	Different types of clustering algorithms	1	3	1, 2,3
13.	K-Means clustering	1	3	1, 2,3
14.	Loss functions in regression and classification	2	3	1, 2,3
15.	Bias-variance trade off	1	3	1, 2,3
Unit 4	**Feedforward neural networks**	**7**		
16.	Introduction to Neural Networks	1	4	1, 2,3
17.	Activation functions	1	4	1,2,3
18.	Feed-forward Network	1	4	1, 2,3
19.	Backpropagation algorithm	2	4	1, 2,3
20.	Introduction to convolutional neural network (CNN)	2	5	1, 2,3
Unit 5	**Applications of AI/ML**	**6**		
21.	Applications in VLSI	3	5	4
22.	Applications in IoT	3	5	4
Total Contact Hours		**30**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	Implement Linear Regression on the given dataset using Python/MATLAB	2	1	1, 2,3
2.	Implement Naïve Bayes classifier using Python/MATLAB	2	1	1, 2,3
3.	Implement Logistic Regression on the given dataset using Python/MATLAB	2	1	1, 2,3
4.	Implement SVM algorithm using Python/MATLAB	2	2	1, 2,3
5.	Implement Decision Tree classifier using Python/MATLAB	2	2	1, 2,3
6.	Implement Random Forest classifier using Python/MATLAB	2	2	1, 2,3
7.	Implement K-means algorithm for clustering the data using python/MATLAB	2	3	1, 2,3
8.	Implement K-Nearest Neighbor classifier using python/MATLAB	2	2	1, 2,3
9.	Emulate logic gates using neural Network using python	2	4	1, 2,3

10.	Implement single-Layer Neural Network for image/data analysis using Python/MATLAB	4	4	1, 2,3
11.	Implement Convolution Neural Network for image/data analysis using Python/MATLAB	4	5	1, 2,3
12.	Implement Markov model for analysis of stock market data using python/MATLAB	4	1	1, 2,3
Total Contact Hours		**30**		

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. Luis G. Serrano, "Grooking Machine Learning" 2nd Edition, Manning Publications, 2021.
4. Reference papers from various journals such as IEEE, Elsevier etc.

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

Learning Assessment - Lab

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

Course Designer(s)

a. ***Dr. Sudhakar Tummala***. *Asst. Professor, Dept. Of ECE. SRM University - AP*

b. ***Dr. V. Udaya Sankar***, *Asst. Professsor, Dept. Of ECE. SRM University - AP*

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Embedded Programming

Course Code	EIT 501	Course Category	Core Course (CC)	L-T-P-C	3	0	1	4
Pre-Requisite Course(s)	Microprocessors and Microcontrollers	Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	Electronics and Communication Engineering	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: Understand the basics of Embedded Systems.
Objective 2: Learn the ARM architecture, instruction set and its assembly programming.
Objective 3: Learn to develop C programs for ARM processors and interfacing the peripherals.
Objective 4: Understand the software architectures used in Embedded Systems.
Objective 5: Learn the embedded system security including the network security.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	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	Understand the architecture used in Embedded Softwares	2	80%	70%
Outcome 4	Understand the RTOS concepts and develop RTOS applications for ARM Microcontrollers.	3	80%	70%
Outcome 5	Understand various Embedded System Attacks & its security measures.	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	Modern Tool and ICT	Society and Multicultural	Environment and	Moral, and Ethical	Individual and	Communication Skills	Project Management	Self-Directed and Life	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	2	1	2	1				1		1	1	2	2	2
Outcome 4	3	3	1	2	1				1		2	2	2	2	2
Outcome 5	3	2	1	3	1				1		1	2	2	2	2
Course 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**	**9**		
7	ARM Processor Architecture	1	**2**	1,3,4
8	ARM Software Development	1	2	1,3,4
9	ARM Instruction Sets	1	2	1,3,4
10	Getting Started with Embedded Software Development (Tools, Packages, Platforms, etc.)	1	2	1,3,4
11	Your First Embedded Program-Hello, ARM!	1	2	1,3,4
12	The Blinking LED Program	1	2	1,3,4
13	The Role of the Infinite Loop	1	2	1,3,4
14	Compiling, Linking, and Locating	1	2	1,3,4
15	The Build Process	1	2	1,3,4
Unit 3	**SOFTWARE ARCHITECTURE**	**11**		
18	Four types of common architectures	3	3	3
19	Peripherals (drivers)	2	3	3
20	Interrupts (ISR, IVT, pitfalls, etc.)	1	3	3,5
21	Round-Robin	2	3	3,5
22	The Shared Data Problems	2	3	3,5
23	Function-Queue-Scheduling Architecture	1	3	3
Unit 4	**EMBEDDED OPERATING SYSTEM**	**10**		
27	Real-Time Operating Systems	3	4	2,8
28	Interrupt Routines in an RTOS Environment	2	4	2,8
29	Tasks and Task States	3	4	2,8
30	Tasks and Data	2	4	2,8
Unit 5	**EMBEDDED PROGRAMMING AND SECURITY**	**6**		
31	Embedded Systems Attacks: Uniquely Embedded Insecurities	3	5	2
32	Attackers and Assets: Common Firmware Vulnerabilities	2	5	2
33	Java: Concurrency, Pitfalls, and Wireless Applications	1	5	2
	Total Contact Hours	**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (15%)		Mid-1 (15%)		CLA-2 (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%	

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	ARM Assembly language program for doing arithmetic operation.	2	2	6,8
2.	ARM assembly language program for Memory operations	2	2	6,8
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	4	2	6
4.	C Program for peripheral interfacing 1. GPIO 2. Real Time Clock 3. Analog to Digital Converter 4. Digital to Analog Converter	4	2	6
5.	C Program for Asynchronous and synchronous serial communication 1. UART 2. I2C/SPI	4	2	6
6.	Embedded Ethernet applications	4	2	6
7.	Controller Area Network (CAN) interface	2	2	6
8.	RTOS Task Management	2	3	8
9.	RTOS Inter Task Synchronization and Inter Task communication	4	3	8
10.	Mini Capstone Project	2	2,3	
Total Contact Hours		**30**		

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. Richard Barnett, Sarah Cox, Larry O'Cull, Embedded C programming and the Atmel AVR. 2 edition. Clifton Park, N.Y. : Thomson Delmar Learning (532 p).
5. Wolf, Wayne (2008), Computers as components : principles of embedded computing system design. 2 edition. Amsterdam : Elsevier (507 p).
6. Ata Elahi, Trevor Arjeski, "ARM Assembly Language with Hardware Experiments", Springer, 2015.
7. A.N.Sloss *et al*., "*ARM System Developer's Guide*", Morgan Kaufmann Publishers, 2004
8. Richard Barry, "Mastering the FreeRTOS™ Real Time Kernel", Real Time Engineers Ltd 2016

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

Course Designers

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Embedded Networking

Course Code	**EIT 502**	**Course Category**	**Core Course (CC)**	**L-T-P-C**	**3**	**0**	1	**4**
Pre-Requisite Course(s)	Microprocessors and Microcontrollers	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Electronics and Communication Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: Application Development using USB and CAN bus with microcontrollers.
Objective 2: Understand the lightweight TCP/IP protocol and its usage.
Objective 3: Understand the MODBUS RTU and MODBUS TCP protocols.
Objective 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 and apply the Controller Area Network and Local Interconnect Network	3	80%	70%
Outcome 3	Develop Embedded TCP/IP applications.	3	80%	70%
Outcome 4	Understand and develop application using Modbus RTU and Modbus TCP	3	80%	70%
Outcome 5	Develop simple Contiki applications and simulate it using COOJA simulator.	2	80%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigation	Design and Development	Modern Tool Usage	Engineer and Society	Environment and	Ethics	Individual and	Communication Skills	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	2	2	2	2
Outcome 3	3	3	3	3				1	1	2	2	2	2
Outcome 4	3	3	3	3				1	1	2	2	2	2
Outcome 5	3	2	1	3				1	1	2	2	2	2

Course Average	**3**	**2**	**2**	**3**				**1**	**1**	**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**EMBEDDED COMMUNICATION PROTOCOLS**	**9**		
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
7.	ISA/PCI Bus protocols	1	1	1,3
8.	Firewire	1	1	1,3
Unit 2	**USB, CAN AND LIN BUS**	**8**		
9.	USB bus – Introduction	1	1	1,3
10.	Speed Identification on the bus, USB States	1	1	3
11.	USB bus communication: Packets –Data flow types, Enumeration –Descriptors	1	1	3
12.	USB Device Classes (CDC, MSC, HID) and USB Host	1	1	3
13.	CAN Bus – Introduction	1	2	3
14.	Frames –Bit stuffing –Types of errors – Nominal Bit Timing	1	2	3
15.	A simple application with CAN	1	2	3
16.	Local Interconnect Network (LIN)	2	2	4
Unit 3	**EMBEDDED TCP/IP**	**9**		
17.	Light Weight TCP/IP - Introduction	1	3	7
18.	Process model, Memory management and Network Interfaces	2	3	7,8
19.	IP Processing	2	3	7,8
20.	UDP, TCP Processing	2	3	7,8
21.	Interfacing the stack – API	1	3	7,8
22.	TCP/UDP Server Client	1	3	7,8
23.	HTTP Server, SSI and CGI	1	3	7,8
Unit 4	**MODBUS**	**9**		
25.	Modbus RTU - Introduction	1	4	5
26.	Protocol Description – Data Encoding – Data Model – Address Model	1	4	5
27.	MODBUS Transaction – Function code categories	1	4	5
28.	Function code descriptions	2	4	5
29.	Modbus Exception Responses	1	4	5
30.	Modbus TCP/IP – Protocol Description	1	4	5,6
31.	TCP Connection Management	2	4	5.6

Unit 5	CONTIKI OS & 6LOWPAN	10		
32.	Contiki OS -Introduction	1	5	9
33.	Hello World Program – Cooja Simulator	1	5	9
34.	Basic Programming	1	5	9
35.	Concurrency	2	5	9
36.	Networking in Contiki	1	5	9
37.	UDP Network Simulation	1	5	9
38.	IPV6 Networking	1	5	9
39.	Routing on Contiki -IPV6 Multicast	1	5	9
40.	6LowPAN implementation with COOJA	1	5	9
	Total Contact Hours	**45**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	I2C/SPI Communication	2	1	9,10
2.	RS485 Bus Communication – Modbus RTU	4	1,4	9,10
3.	Embedded TCP/UDP application	4	3	9
4.	Modbus TCP	2	4	9
5.	Embedded HTTP	2	3	9
6.	USB -CDC Class, HID Class	4	1	9
7.	CAN/LIN communication	2	2	9
8.	Contiki OS- Hello World	2	5	11
9.	UDP Network simulation - Cooja	4	5	11
10.	6LOWPAN simulation - Cooja	4	5	11
Total Contact Hours		**30**		

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. 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.
4. Modbus.org, “MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3”, https://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf
5. Modbus.org, “MODBUS MESSAGING ON TCP/IP IMPLEMENTATION GUIDE V1.0b”, https://www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf
6. Adam Dunkels, “Design and Implementation of the lwIP”, https://www.artila.com/download/RIO/RIO-2010PG/lwip.pdf
7. 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
8. Agus Kurniawan, “Practical Contiki-NG, Programming for Wireless Sensor Networks”, Apress, 2018
9. Dogan Ibrahim, ‘Advanced PIC microcontroller projects in C’, Elsevier 2008
10. Edward Insam, “TCP/IP Embedded Internet Applications”, Newnes, 2003
11. Agus Kurniawan, “Practical Contiki-NG, Programming for Wireless Sensor Networks”, Apress, 2018

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-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%	

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

Course Designers

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Smart Sensors and Actuators

Course Code	**EIT 503**	Course Category	**Speciality Stream Courses (CC)**	L-T-P-C	**3**	**0**	1	**4**
Pre-Requisite Course(s)	**Electrical & Electronic Measurement, Control Systems, Embedded System.**	Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: To understand the basics and standards of Smart sensors.
Objective 2: To study different types of Sensors.
Objective 3: To study different types of Actuators.
Objective 4: To use smart sensors in the control system 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	Understand the basics and manufacturing of sensors	2	90%	80%
Outcome 2	Design and applications of strain, force, torque, and pressure sensors	3	80%	80%
Outcome 3	Design and applications of motion and level sensors	3	70%	75%
Outcome 4	Understand the functioning and application of actuators	3	60%	75%
Outcome 5	Designing a control system with smart sensors and applications	4	80%	80%

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

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and 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	3	2	-	2	2			1	3	1	-	3	2	1	
Outcome 2	3	2	2	2	2			1	3	1	2	3	3	2	
Outcome 3	3	2	2	2	2			1	3	1	2	3	3	2	

Outcome 4	3	2	-	2	2			1	3	1	-	3	3	2	
Outcome 5	3	2	-	3	2			1	3	1	-	3	3	3	3
Course Average	**3**	**2**	**2**	**2**	**2**			**1**	**3**	**1**	**2**	**3**	**3**	**2**	**3**

Course Unitization Plan- Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamental of Smart Sensors**	**10**		
1.	Basics of smart sensors	1	1	1
2.	general sensing system, definition of smart sensor, Smart sensor model,	1	1	1,5
3.	Micromachining	2	1	1
4.	parameters, characteristics, environmental parameters, Performance, error Analysis characteristics.	1	1	1,2
5.	Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication	2	1	1,2
6.	Sensor Communication and MEMS	1	1	1,2
7.	Standards for smart sensors	2	1	1
Unit 2	**Strain, Force, Torque and Pressure sensors**	**6**		
8.	Strain gages, strain gage beam force sensor,	1	2	2,4
9.	piezoelectric force sensor, load cell, torque sensor,	1	2	2,4
10.	Piezo-resistive and capacitive pressure sensor,	1	2	2,4
11.	optoelectronic pressure sensors, vacuum sensors	1	2	2,4
12.	Design of signal conditioning circuits for strain gauges, piezo, capacitance and optoelectronics sensors	2	2	2,4
Unit 3	**Motion and Level Sensors**	**13**		
13.	Potentiometric and capacitive sensors, Inductive and magnetic sensor,	1	3	2,4
14.	LVDT, RVDT, eddy current, transverse inductive,	2	3	2,4
15.	Hall effect, magneto resistive, magneto strictive sensors	2	3	2,4
16.	Fiber optic liquid level sensing, Fabry Perot sensor,	1	3	2,4
17.	ultrasonic sensor, capacitive liquid level sensor.	1	3	2,4
18.	Signal condition circuits for reactive and self-generating sensors.	1	3	2,4
19.	Electromagnetic velocity sensor, Doppler with sound, light,	2	3	2,4
20.	Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer,	2	3	2,4
21.	rotor, monolithic and optical gyroscopes.	1	3	2,4
Unit 4	**Actuators**	**10**		
22.	Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves,	2	4	3
23.	Cylinders, Servo and proportional control valves, Process control valves,	1	4	3
24.	Rotary actuators, Mechanical Actuation Systems, Types of motion, Kinematic chains,	2	4	3

25.	Cams, Gears, Ratchet and pawl, Belt and chain drives, Bearings,	1	4	3
26.	Mechanical aspects of motor selection, Electrical Actuation Systems,	1	4	3
27.	Electrical systems, Mechanical switches, Solid-state switches, Solenoids,	2	4	3
28.	D.C. Motors, A.C. Motors, Stepper motors.	1	4	3
Unit 5	**Sensors in a Control Loop**	**6**		
29.	Programmable logic controllers, Open- Vs Closed-loop systems,	1	5	1
30.	PID control	1	5	1
31.	Fuzzy logic and neural networks	2	5	1
32.	Adaptive control	1	5	1
33.	Impact of AI on sensing	1	5	1
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
	Demonstration of Arduino Kit and other hardware peripherals.	4 Hours	-	6,7,8
	Demonstration of Virtual Lab.	3 Hours	-	9
1.	Study the characteristics of temperature sensor (RTD).	3 Hours	2	6,7,8
2.	Study the characteristics of DHT11 using Raspberry Pi.	2 Hours	2	6,7,8
3.	Demonstration of image capturing using IR camera with Raspberry Pi.	3 Hours	2	6,7,8
4.	Study the characteristics of Strain gauge.	3 Hours	2	6,7,8
5.	Study the characteristics of DC Motor using Arduino IDE.	2 Hours	3	6,7,8
6.	Study the characteristics of Servo Motor using Arduino IDE.	2 Hours	3	6,7,8
7.	Study the characteristics of Stepper Motor using Arduino IDE.	2 Hours	3	6,7,8
8.	Study the characteristics of Light sensor.	2 Hours	2	6,7,8
9.	Study the characteristics of Microphone sensor.	2 Hours	2	6,7,8
10.	Study the characteristics of Air pressure sensor	2 Hours	3	6,7,8
Total Contact Hours		**30 hours**		

Recommended Resources

1. Randy Frank," Understanding Smart Sensors", Artech House Publication, 2013, Edition 3.
2. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited, Edition 2.
3. W. Bolton, "Mechatronics", Pearson Education Limited.
4. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
5. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition.

6. Agus Kurniawan, “Internet of Things Projects with ESP32”, Packt Press, 2019.
7. Neil Cameron, “Electronics Projects with the ESP8266 and ESP32”, APress, 2020.
8. https://m5stack.oss-cn-shenzhen.aliyuncs.com/resource/docs/Demo-Board_en_sht30.pdf
9. https://www.vlab.co.in/

Learning Assessment (Theory)

Bloom’s Level of Cognitive Task		Continuous Learning Assessments (40%)				End Semester Exam (20%)
		Theory (40%)				
		Mid – 1 (15%)	CLA - 1 (5%)	CLA-2 (10%)	CLA-3 (10%)	Theory (40%)
Level 1	Remember	55%	45%	40%	40%	37%
	Understand					
Level 2	Apply	45%	55%	60%	60%	63%
	Analyse					
Level 3	Evaluate					
	Create					
Total		100%	100%	100%	100%	100%

Learning Assessment (Lab)

Bloom’s Level of Cognitive Task		Continuous Learning Assessments (30%)			End Semester Exam (10%)
		Lab Performance (15%)	Model Exam (10%)	Observation Note (5%)	
Level 1	Remember	30%	30%	70 %	30%
	Understand				
Level 2	Apply	70%	70%	30%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

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Computer Networks and Internet Protocol

Course Code	**EIT 504**	Course Category	**Core Course (CC)**	L-T-P-C	**3**	**0**	1	**4**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**ECE**	Professional / Licensing Standards						
Board of Studies Approval Date		Academic Council Approval Date						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To Understand the computer network.
Objective 2: To Understand internet and protocols.
Objective 3: To Study how to apply internet protocols on IOT.
Objective 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	Conduct Investigations of	Design and Development	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1		1								1	2	2
Outcome 2	2		1	2						1	3	2	2
Outcome 3	1	2	2	2						1	3	3	3
Outcome 4	1	2	2	2						1	3	3	3
Course Average	**2**	**2**	**2**	**2**						**1**	**3**	**3**	**3**

Course Unitization Plan- Theory

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**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1.	Dijkstra's algorithm	2	3	4
2.	RSA Algorithm	2	3	4
3.	Broadcast routing algorithm	2	4	2
4.	Implement the Data Link Layer Framing Method on Character Stuffing	2	2	5
5.	Cyclic Redundancy check (CRC)	2	3	2
6.	Implement a data set of characters of the CRC polynomials	2	3	6
7.	FIFO (First in First out) IPC channels	2	2	6
8.	Round-robin CPU scheduling algorithm	2	3	4
9.	Subnet graph with weights indicating delay between nodes	2	3	1

10.	Congestion control using Leaky bucket algorithm	2	3	1
Total Contact Hours		**20**		

Recommended Resources

1. Ames Kurose, Keith Ross "Computer Networking: A Top - Down Approach" Pearson; 7th edition, ISBN-10 : 9780133594140
2. Andrew S Tanenbaum "Computer Networks" Pearson Education India; 5th edition, ISBN-10 : 9332518742.
3. Randall Nagy "TCP/IP and UDP/IP for Python 3: Using Python's Internet Protocols", Publisher(s): Apress, ISBN: 9781484294543.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein, "Introduction to Algorithms", ISBN: 978-0-262-04630-5.
5. Behrouz A. Forouzan "Data Communications and Networking", ISBN:9780072967753, 0072967757.
6. Abraham Silberschatz, Peter B. Galvin, Greg Gagne "Operating System Concepts", ISBN: 9781119439257, 1119439256

Learning Assessment

Bloom's Level of Cognitive Task		**Theory (30%)**				**End Semester Exam (50%)**
		CLA-1 (5%)	**Mid-1 (10%)**	**CLA-2 (5%)**	**Mid-2 (10%)**	**Theory**
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%

Learning Assessment (Lab)

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

Course Designers

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Research Seminar

Course Code	**AEC 502**	**Course Category**	**Core Course (CC)**	**L-T-P-C**	**0**	**0**	**1**	**1**
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Electronics and Communication Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Survey the existing research works/literature and analyse them.

Objective 2: Attain adequate knowledge of a research problem chosen.

Objective 3: Improve the presentation/communication skills to articulate their research work.

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	Review and analyse the existing research work in a systematic way.	3	80%	70%
Outcome 2	Attain strong technical, domain knowledge in the research topic chosen.	3	80%	70%
Outcome 3	Attain good presentation skills to articulate the research problem, analysis and its solution	2	80%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigation	Design and Development	Modern Tools Usage	The Engineer and Society	Environment and	Ethics	Individual and	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2					2	2	2	1	1	3
Outcome 2	3	3	2					2	1	2	1	1	3
Outcome 3	1	1	1	1			1	2	1	2	1	1	3
Course Average	**2**	**3**	**2**	**1**			**1**	**2**	**2**	**2**	**1**	**1**	**3**

Course Unitization Plan
Student is expected to spend minimum 2 hours/week for the Project work.

Learning Assessment

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

Course Designers

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SEMESTER- II

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Entrepreneurial Mindset

Course Code	**SEC 103**	Course Category	**Foundation Course (SEC)**	L-T-P-C	**1**	**0**	**1**	**2**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**Management**	Professional / Licensing Standards	-					

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To develop a foundation in innovation and entrepreneurship among the students.
Objective 2: To enhance analytical skills of students for practical application of their ideas.
Objective 3: To make students proficient in designing solutions.
Objective 4: To introduce students to different phases of entrepreneurship.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Describe and classify the basic concepts of Innovation and Entrepreneurship	2	90%	80%
Outcome 2	Discuss the concept of Design Thinking and prototyping	2	80%	70%
Outcome 3	Apply design thinking to generate innovative ideas and strategize implementation plan	3	65%	60%
Outcome 4	Prepare a business plan by assessing customer segment, market validation and product development	4	60%	60%

Course Articulation Matrix (CLO) to (PLO)

CLOs	**Program Learning Outcomes (PLO)**													
	Management Knowledge	Analytical Reasoning and	Critical and Reflective	Strategic Thinking and	Modern Tools and ICT Usage	Environment and	Moral, Multicultural	Individual and Teamwork	Communication Skills	Leadership Readiness Skills	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1									2	3	2
Outcome 2	2	2	2		2		2					3	2	2
Outcome 3	1	3	3	2				3		3	3		3	2
Outcome 4	2	3	3	2				3	2	3	3	3		3
Course Average	**2**	**2**	**3**	**2**	**1**	**0**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**3**

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Entrepreneurship & Inventions**	**5**		
1.	Entrepreneurship and Types of Entrepreneurships	2	1	3,4
2.	Entrepreneurs and their Characteristics	1	1	3,4
3.	Innovation & its Types	2	1	1
Unit 2	**Exploration & Summarizing Facts**	**3**		
4.	Structured exploration and quantifying the data	2	3,4	3,4
5.	Analysing the data	1	3,4	3,4
Unit 3	**Reflection, Synthesizing and ideating**	**3**		
6.	Summarizing facts and designing a workable model	3	3,4	3,4
Unit 4	**Prototyping**	**8**		
7.	Definition and Basics of Prototyping	2	2,3,4	2
8.	Types and methods of Prototyping	4	2,3,4	2
9.	Innovations in prototyping	2	2,3,4	2
Unit 5	**Concept Ideation & Design Thinking**	**8**		
10.	Importance of Idea	1	3,4	1,2
11.	Idea Generation Techniques	1	3,4	1,2
12.	Validating the idea	1	3,4	1,2
13.	Definition and Basics of Design Thinking	2	2	5
14.	Stages of Design Thinking	3	2	5
Unit 6	**Market Validation**	**5**		
15.	Concept of Market Validation and its importance	2	3,4	3,4
16.	Customer survey	1	3,4	3,4,5
17.	Feedback and modifying the idea	2	3,4	3,4,5
Unit 7	**Segmentation of the potential users/ customers**	**3**		
18.	Customer segment and its types	2	4	3,4
19.	Understanding niche customer segment	1	4	3,4
20.	Reaching the real customers	1	4	3,4
Unit 8	**Industry Validation**	**2**		
21.	Industry validation and mentoring	2	3,4	3,4,5
Unit 9	**Solution Design**	**8**		
22.	Generate an Innovative Idea	3	3,4	1,2,5
23.	Develop a Business Plan	5	4	3,4
Total Contact Hours		**45**		

Recommended Resources

1. Larry Keeley Brian Quinn Ryan Pikkel. Ten types of innovation -the discipline of building breakthroughs, John Wiley& Sons, Inc; 2013
2. Eric Ries. The lean startup how constant innovation creates radically successful businesses, Penguin Books
3. Bruce R. Barringer, R. Duane Ireland. Entrepreneurship Successfully Launching New Ventures, Pearson; 2020
4. Robert D. Hasrich, Dean A. Shepherd, Michael P. Peters, Entrepreneurship, McGraw Hill, 2020
5. Siva Prasad N. Design Thinking : Techniques And Approaches, Ane Books, New Delhi; 2023

Learning Assessment (Theory)

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

Course Designers

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IoT Architecture and Protocol

Course Code	**IoT 505**	**Course Category**	**Core Course (CC)**	**L-T-P-C**	**3**	**0**	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Electronics and Communication Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: Understand the Architectural Overview of IoT
Objective 2: Understand the IoT Reference Architecture and Real World Design Constraints
Objective 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 protocols and the lower layer protocols	2	80%	70%
Outcome 3	Understand the application layer protocols used in IoT.	3	80%	70%
Outcome 4	Understand and use the IoT platform.	3	80%	70%
Outcome 5	Understand the IoT Security concepts.	2	80%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of	Design and Development	Modern Tools Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1				1		1	1	1	1
Outcome 2	3	2	3	1				1		2	2	2	2
Outcome 3	3	3	1	1				1		1	2	2	2
Outcome 4	3	3	1	1				1		2	2	2	2
Outcome 5	3	3	1	1				1		2	2	2	2
Course Average	**3**	**2**	**1**	**1**				**1**		**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**IoT Architecture**	**9**		
1	IoT Architecture – Different layers	2	1	1,3
2	Sensors and Actuators	2	1	1,3
3	Gateways	2	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/Wireless Protocols**	**10**		
7	Zigbee, Zwave, Dash7	1	**2**	1,6
8	Bluetooth Low Energy	2	2	2
9	IEEE 802.11, IEEE 802.15.4, TCP, UDP	3	2	1,6
10	Network Layer-IPv4, IPv6,6LoWPAN, RPL	3	2	1,6
11	Cellular IoT -NB-IoT, LTE-m	1	2	4
Unit 3	**IoT –Application Layer Protocols**	**10**		
12	MQTT	3	3	1,3
13	Hyper Text Transfer Protocol (HTTP)	1	3	1
14	Web sockets, REST	2	3	1
15	CoAP	2	3	1
16	AMCP, XMPP	2	3	1
Unit 4	**IoT Cloud Platforms**	**9**		
17	Various Cloud platforms	1	4	3,5
18	MQTT communication /Data Retrieval	2	4	3
19	Database storage	2	4	3
20	SMS/Email Alert services	2	4	3
21	Data Analytics using algorithm/Serverless computing	2	4	3
Unit 5	**IoT Security**	7		
22	IoT Device/Embedded Security	1	5	5
23	Encryption – Private and Public key Encryption	1	5	5
24	Hash Algorithms, Digital Signature	1	5	5
25	Transport Layer Security - TLS/DTLS	2	5	5
26	Network Layer Security	2	5	5
	Total Contact Hours	**45**		

Course Unitization Plan - Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1.	TCP Server - Single Client Socket Program (C)	2	2	7
2.	TCP Server - Multi Client Socket Program (C)	4	2	7
3.	UDP Server - Client Communication (C)	2	2	7
4.	HTTP Server (Apache Server) - Web Page and Server side script for MySQL Connectivity (PHP - MySQL)	4	1, 3,4	8
5.	HTTP Server with REST API	2	3	9

6	MQTT Publish Subscribe Client with AWS/Mosquitto Broker - Python	4	1, 4,5	11
7	CoAP Server/Client - Arduino - Browser Add on)	4	3	10
8	Bluetooth Low Energy - Notify example with nRF Connect app - (Arduino ESP32)	2	2	12
9	IPV6 TCP Client-Server communication program (C)	2	2	7
10	Contiki /Cooja Demonstration	4	2,3	13
Total Contact Hours		**30**		

Recommended Resources

1. Arsheep Bahga, Vijay Madisetti, "INTERNET OF THINGS - A HANDS-ON APPROACH", 1st Edition, Orient Blackswan Private Limited, New Delhi, 2015.
2. Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, “Getting Started with Bluetooth Low Energy”, O'Reilly Media, Inc, 2014
3. 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 Publishing, 2018.
4. Cameron Coursey, “The Practitioner's Guide to Cellular IoT”, Artech House, 2020.
5. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016.
6. Simone Cirani, Gianluigi Ferrari, Marco Picone, “Internet of Things: Architectures, Protocols and Standards”, Wiley Publications, 2018.
7. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, “UNIX Network Programming, Volume 1: The Sockets Networking API”, Volume I, 3rd Edition, Addison-Wesley Professional, 2003.
8. https://www.w3schools.com/php/php_mysql_intro.asp
9. https://flask-restful.readthedocs.io/en/latest/
10. https://www.arduino.cc/reference/en/libraries/coap-simple-library/
11. http://www.steves-internet-guide.com/into-mqtt-python-client/
12. Kevin Townsend, Carles Cufí, Akiba, Robert Davidson, “Getting Started with Bluetooth Low Energy”, O'Reilly Media, Inc, 2014.
13. http://www.contiki-os.org/

Learning Assessment - Theory

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

Learning Assessment - Lab

Bloom’s Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Exam (50%)**
		Experiments (15%)	**Record / Observation Note (10%)**	**Viva + Model (25%)**	
	Remember	30%	70%	30%	30%

Level 1	Understand				
Level 2	Apply	70%	30%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		100%	100%	100%	100%

Course Designers

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SoC Design for IoT

Course Code	**IoT 506**	**Course Category**	**Core Course (CC)**	**L-T-P-C**	**3**	**0**	1	4
Pre-Requisite Course(s)	Microprocessors and Microcontrollers	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	Electronics and Communication Engineering	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: Understand the basics of SoC Design.
Objective 2: Learn the techniques to choose a processor for SoC Implementation.
Objective 3: Learn different type of memory blocks used in SoC Design.
Objective 4: Understand the bus architecture and Custom SoC Design.
Objective 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	Conduct Investigation	Design and Development	Modern Tool Usage	Society and Multicultural	Environment and	Moral, and Ethical	Individual and	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1				1		1	1	1	1
Outcome 2	3	3	3	2				1		2	2	2	2
Outcome 3	3	2	2	1				1		1	2	2	2
Outcome 4	3	3	2	1				1		2	2	2	2
Outcome 5	3	2	2	2				1		2	2	2	2
Course Average	**3**	**2**	**2**	**1**				**1**		**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Description of Topic	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction and Background**	9		
1	Overview of SoC Design Approach	1	1	1,3
2	SoC design requirements and specifications.	1	1	1,3,4
3	Design integration – design complexity.	1	1	1,3,4
4	Cycle time, die area and cost,	1	1	1,3,4
5	Ideal and practical scaling.	1	1	1,3,4
6	Area-time-power trade-off in processor design.	1	1	1,3,4
7	SoC Design – Behavioural Synthesis	1	1	1,3
8	On-Chip Communication Architecture	1	1	1,3,4
9	Modelling and Co-Simulation	1	1	1,3
Unit 2	**Processor Selection for SoC**	9		
10	Processor architectures	1	2	1
11	Processor core selection.	1	2	1,2
12	Basic concepts – instruction set, branches.	1	2	1,2
13	Interrupts and exceptions.	1	2	1,2
14	Basic elements in instruction handling.	1	2	1,2
15	Minimizing pipeline delays	1	2	1,2
16	Reducing the cost of branches – Robust processors	1	2	1,2
17	Vector processors, VLIW processors	1	2	1,2
18	Superscalar processors.	1	2	1,2
Unit 3	**Memory Design for SOC**	9		
19	Memory and addressing.	1	3	1
20	SoC external memory, SoC internal memory	1	3	1,2,4
21	Scratch pads and cache memory	1	3	1,2,4
22	Cache organization and write policies	1	3	1,2,4
23	Strategies for line replacement at miss time	1	3	1,2,4
24	Split I- and D-Caches	1	3	1,2,4

25	Multilevel Caches	1	3	1,2,4
26	SoC memory systems	1	3	1,2,4
27	Simple processor/memory interaction.	1	3	1,2,4
Unit 4	**Interconnects**	7		
28	System-Level Interconnection	1	4	2
29	Basic Bus Architecture	1	4	2,3
30	SOC Standard Buses – AMBA	1	4	2,3
31	SOC Standard Buses – Core Connect	1	4	2
32	Bus Interface Units	1	4	2
33	Analytical Bus Models	1	4	2
34	Network on Chip	1	4	2,3
Unit 5	**SoC Customization and Case studies**	8		
35	Overview of SoC Customization	1	C	1,3
36	Customizing Instruction Processors	1	C	1,3
37	Customizable Soft Processor	1	C	1,3
38	Case study: AES	1	C	1,3
39	Case study: JPEG Compression	1	C	1,3
40	Case study: Video Compression	1	C	1,3
41	Case study: MP3 Audio Decoding	1	C	1,3
42	Case study: Software Defined Radio	1	C	1,3
	Total contact hours	**42**		

Course Unitization Plan – Lab

Session	Description of Experiment	Contact hours required	CLOs Addressed	Reference Used
1	Design of basic building blocks of the processor using HDL	2	1	5,6
2	Design of basic building blocks of the processor using HDL	2	1	5,6
3	IP Core Creation Using VHDL- Multiplier	2	1,2	5,6
4	IP Core Creation Using VHDL – Adders and Comparator	2	1,2	5,6
5	IP Core Creation Using VIVADO HLS.	2	1,2	5,6
6	IP Core Creation Using MATLAB HDL-Coder.	2	2,3	5,6
7	Creating a Micro Blaze Soft Processor	2	2,3	5,6

8	Designing an Interrupt-based System targeting Xilinx Zynq	2	2	5,6
9	Design a Block RAM Memory with IP using Vivado	2	2	5,6
10	DMA System level Design with custom IP using Vivado	2	2	5,6
11	Generating custom AXI4-Stream IP core using Vivado	2	2	5,6
12	Use of IP cores for DSP applications.	4	2,3	5,6
13	Project	2	2,3	5,6,7
14	Project	2	2,3	5,6,7
Total Contact Hours		30		

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.
5. Xilinx Documentation www.xilinx.com
6. nanoHUB.org - Courses: ECE 695R: System-on-Chip Design: o1a
7. https://www.udemy.com/course/system-on-chip-design-using-vivado-and-zybo-z7-10/?couponCode=KEEPLEARNING

Learning Assessment -Theory

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%	

Learning Assessment - Lab

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

Course Designers

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Wireless Sensor Network and IoT

Course Code	**IoT 507**	Course Category	**Core Course (CC)**	L-T-P-C	3	0	1	4
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Acquire comprehensive knowledge of wireless sensor network technologies, including Bluetooth, ZigBee, Wi-Fi, and UWB.

Objective 2: Master the fundamentals of MAC protocols, including low duty cycle and wakeup concepts, and apply them in diverse WSN scenarios.

Objective 3: Design efficient sensor network architectures based on optimization goals, understanding data dissemination techniques, and incorporating gateways.

Objective 4: Implement IP-based WSNs, including 6LOWPAN, and gain practical experience using Tiny OS for WSNs and IoT 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	Identify and differentiate between various wireless technologies used in WSN, including Bluetooth, ZigBee, and Wi-Fi.	2	75%	70%
Outcome 2	Implement and analyse low duty cycle, contention based, and schedule-based MAC protocols, such as SMAC, BMAC, TRAMA, and IEEE 802.15.4 MAC, to optimize communication in WSN.	2	70%	65%
Outcome 3	Develop strategies for data dissemination, flooding, and gossiping in different WSN scenarios, while setting optimization goals and understanding key figures of merit.	4	85%	70%
Outcome 4	Demonstrate the ability to transition from circuit switching to packet switching, comprehend IPV4, IPV6, and 6LOWPAN concepts, and integrate IP-based WSN with a focus on applications using Tiny OS in IoT and M2M communication.	4	80%	70%

Course Articulation Matrix (CLO) to (PLO)

CLOs	**Program Learning Outcomes (PLO)**

	Engineering Knowledge	Design / Development of	Conduct Investigations of	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	1	1						**1**	1	1
Outcome 2	2	3	2	3	2				2	1	**1**	1	1
Outcome 3	2	2	2	3	3						**1**		1
Outcome 4	2	3	3	3	3				2	1	**1**	1	2
Course Average	3	3	2	3	3				2	1	**1**	2	2

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Fundamentals of Wireless Sensor Network (WSN)**	**9**		
1.	Bluetooth, ZigBee, Wi-Fi.	2	1	1, 2
2.	Wireless LAN & PAN, UWB.	2	1	1, 2
3.	Characteristic and challenges.	1	1	1, 2
4.	WSN vs Adhoc Networks.	1	1	1, 2
5.	Sensor node architecture.	1	1	1, 2
6.	Physical layer and transceiver design considerations in WSNs.	1	1	1, 2
7.	Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.	1	1	1, 2
Unit 2	**WSN (Medium access control)**	**9**		
8.	Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts.	2	2	1, 2
9.	Contention Based protocols.	2	2	1, 3
10.	Schedule-based protocols - SMAC – BMAC.	2	2	1, 3
11.	Traffic-adaptive medium access protocol (TRAMA).	2	2	1, 3
12.	The IEEE 802.15.4 MAC protocol.	1	2	1, 3
Unit 3	**Sensor Network Architecture**	**9**		
13.	Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios.	1	3	1, 2
14.	Optimization Goals and Figures of Merit	2	3	1, 2
15.	Design Principles for WSNs- Gateway Concepts, Need for gateway.	2	3	1, 2
16.	WSN and Internet Communication	2	3	1, 2
17.	WSN Tunnelling	2	3	1, 2
Unit 4	**IP based WSN**	**9**		
18.	Circuit switching, packet switching.	1	4	1, 2
19.	concept of IPV4, IPV6.	2	4	1, 2
20.	6LOWPAN and IP	2	4	1, 2
21.	IP based WSN.	2	4	1, 2

22.	6LOWPAN based WSN.	2	4	1, 2
Unit 5	**Tiny OS**	**9**		
23.	Tiny OS for WSN	2	4	1, 3
24.	Tiny OS for IoT	2	4	1, 3
25.	M2M communication	1	4	1, 3
26.	AllJoyn network	2	4	1, 3
27.	Contemporary issues and Applications.	2	4	1, 3
Total Contact Hours		**45**		

Course Unitization Plan - Lab

Exp No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
1	Sensor Node Deployment over Simulated Testbed	3	1	1
2	Connection Establishment among Sensor Nodes	3	2	1
3	Simulated Wireless Sensor Network Development.	3	2	2
4	Various Network Topology Implementation for WSN.	3	2	2
5	Data Routing over Wireless Sensor Network.	3	3	2
6	Energy Measurement Models and Implementation over WSN.	3	3	2
7	LEACH Protocol Implementation	3	3	1
8	Clustering of Sensor Nodes.	3	4	2
9	Time Synchronization over WSN.	3	4	2
10	Node Localization over WSN	3	4	1
Total Contact Hours				

Recommended Resources

1. Waltenegus W. Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", 2014, 1 st ed., John Wiley & Sons, New Jersey
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” 2011, 1 st ed., John Wiley & Sons, New Jersey
3. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, “Wireless Sensor Network: Technology, Protocols and Application”, John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).

Other Resources

1. Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, 2014, 1 st ed., Wiley-IEEE Press, USA.

Learning Assessment (Theory)

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

Course Designers

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

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Project management

Course Code	**PGM 501**	Course Category	**Course (RDIP)**	L-T-P-C	**0**	**2**	**1**	**3**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**Mechanical Engineering**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: To understand the fundamentals of production and operations management.
Objective 2: To learn about capacity planning, plant layout, scheduling and sequencing
Objective 3: To learn about operation management, work study, time study
Objective 4: To understand about Inventory control, supply chain management

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course students will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	Expected Attainment Percentage
Outcome 1	Define and explain the basic concepts and principles of production and operations management (POM),	1	80%	75%
Outcome 2	Develop proficiency in capacity planning, plant layout etc.	2	70%	75%
Outcome 3	Able to perform work study, time study, gantt chart	3	80%	70%
Outcome 4	Explain supply chain management functions and applicaions	2	80%	75%

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

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

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT-I	**Fundamental concepts**	**8**		
1.	Production planning and control	2	1	1
2.	New product development	1	1	1,2
UNIT-II	**Plant layout**	**8**		
3.	Capacity planning, facility planning	2	1	1
4.	Plant location and layout	2	1,2	1,2
5.	Scheduling and sequencing	2	1,2	1,2
UNIT-III	**Operation management**	**9**		
6.	CPM	3	3	1
7.	Gantt chart	3	3	2
8.	Work study, time study	3	3	1,2
UNIT-IV	**Material management**	**10**		
9.	ABC analysis, EOQ	3	3,4	1
10.	Supply chain management	4	3,4	1
11.	Preventive maintenence	3	3,4	2
UNIT – V	**Tools**	**10**		
12.	Six sigma, Poka yoke, BPR, ERP, Kanban, ISO 9000,	5	3,4	2
13.	JIT, TQM, FMS, Push/Pull, Kaizen, CAD CAM	5	3,4	2
Total Contact hours		**45**		

Recommended Resources

1. Bhattacharyya, “Production and Operations Management”, Universal Press , Edition
2. Panneer selvam R; “Production and Operations Management”, Prentice Hall of India, Edition

Learning Assessment

Bloom’s Level of Cognitive Task	Continuous Learning Assessments (50%)				End Semester Exam (50%)
	CLA-1 (20%)	CLA-1 (15%)	Midterm-1 (15%)		

		Th.	Th.	Th.	Th.	Th.
Level 1	Remember	50%	40%	50%	45%	30%
	Understand					
Level 2	Apply	50%	60%	50%	55%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**		**100%**

Course Designers

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SEMESTER- III

SRM University – AP, Andhra Pradesh

Neerukonda, Mangalagiri Mandal

Guntur District, Mangalagiri, Andhra Pradesh 522240

Thesis I

Course Code	**IoT 509**	Course Category	**Project (RDIP)**	L-T-P-C	**0**	**0**	**14**	**14**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**Electronics and Communication Engineering**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Survey the existing research works/literature and analyze them.

Objective 2: Demonstrate the skills acquired to solve a technical problem.

Objective 3: To have a systematic approach to solve the given 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	Review and analyze the existing research work systematically.	3	80%	70%
Outcome 2	Attain strong technical, and domain knowledge in the field of project.	3	80%	70%
Outcome 3	Formulate the complex problem and have a systematic approach for the solution.	2	80%	70%
Outcome 4	Conduct research project	2	80%	70%
Outcome 5	Communicate the technical problems with peers and mentors to move towards appropriate solutions.	2	75%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tools Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2					2	2	2	1	1	3

Outcome 2	3	3	3	1			1	2	1	2	1	1	3
Outcome 3	2	3	2		1	1	1	2	1	2	1	1	3
Outcome 4	2	3	2	1	1	1	1	2	2	3	1	1	3
Outcome 5	2	3	2		1	1	1	2	3	3	1	1	3
Course Average	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**1**	**3**

Course Unitization Plan

The student is expected to spend a minimum of 12 hours/week on the Project work.

Learning Assessment

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

Course Designers

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SEMESTER-IV

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Neerukonda, Mangalagiri Mandal
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M. Tech Dissertation/Major project Part II

Course Code	**IoT 511**	Course Category	**Project (RDIP)**	L-T-P-C	**0**	**0**	**15**	**15**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**Electronics and Communication Engineering**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: Survey the existing research works/literature and analyse them.

Objective 2: Demonstrate the skills acquired to solve a technical problem.

Objective 3: To have systematic approach to solve the given 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	Review and analyse the existing research work in a systematic way.	3	80%	70%
Outcome 2	Attain strong technical, domain knowledge in the field of project.	3	80%	70%
Outcome 3	Formulate the complex problem and to have systematic approach for the solution.	2	80%	70%
Outcome 4	Conduct research project	2	80%	70%
Outcome 5	Communicate the technical problems with peers and mentors to move towards appropriate solution.	2	75%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tools Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2					2	2	2	1	1	3

Outcome 2	3	3	3	1			1	2	1	2	1	1	3
Outcome 3	2	3	2		1	1	1	2	1	2	1	1	3
Outcome 4	2	3	2	1	1	1	1	2	2	3	1	1	3
Outcome 5	2	3	2		1	1	1	2	3	3	1	1	3
Course Average	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**1**	**3**

Course Unitization Plan

The student is expected to spend at least 32 hours/week on the Project work.

Learning Assessment

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

Course Designers

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ELECTIVES

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Designing Embedded Systems using UML

Course Code	**IoT 532**	Course Category	**Core Elective (CE)**	L-T-P-C	**3**	**1**	**0**	**4**
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department	**Electronics and Communication Engineering**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To Understand the UML diagrams used in modelling.
Objective 2: To understand an agile development process and to describe the various industry standards for the software design.
Objective 3: To understand the application of UML to model and design distributed concurrent 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 various UML Diagrams	2	80%	70%
Outcome 2	Understand the embedded software development process and workflow.	2	80%	70%
Outcome 3	Capture the System Requirements and organize the system model.	3	80%	70%
Outcome 4	Understand and apply the design patterns	3	80%	70%
Outcome 5	Understand the modelling of concurrent, distributed systems.	2	80%	70%

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

CLOs	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tools Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	2	1				1		1	2	1	1
Outcome 2	3	2	2	1				1		2	2	1	1
Outcome 3	3	2	2	1				1		1	2	2	2

Outcome 4	3	2	2	1				1		2	2	2	2
Outcome 5	3	2	2	1				1		2	2	2	2
Course Average	**3**	**2**	**2**	**1**				**1**		**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
UNIT I	**Introduction to UML**	**9**		
1.	UML Basic Modelling concepts	1	1	1,5
2.	Structural Elements and Diagrams	1	1	1,5
3.	Objects, Classes and Interfaces	1	1	1,5
4.	Relations	1	1	1,5
5.	Subsystems, components, and Packages	1	1	1,5
6.	Behavioural elements and diagrams	1	1	1,5
7.	Action and Activities	1	1	1,5
8.	Operations and methods	1	1	1,5
9.	State Diagrams, Interactions	1	1	1,5
UNIT II	**Development Process**	**9**		
10.	Harmony Development Process	1	2	1
11.	Need for Process, Harmony process overview	1	2	1
12.	System Engineering Harmony workflow	1	2	1
13.	System Functional Analysis	1	2	1
14.	Use Case Model Workflow	1	2	1
15.	The Hand-off from system engineering	1	2	1
16.	Software workflow, Analysis and Design	1	2	1
17.	Verification and Validation	1	2	1
UNIT III	**System Requirements and Architecture**	**9**		
18.	Representing requirements on UML and SysML	2	3	1
19.	State Machines for Requirement capture	1	3	1
20.	System Architecture	1	3	1
21.	Organizing the system Model	1	3	1

22.	Subsystem identification	1	3	1
23.	Mapping Operational contracts into sub system architecture	2	3	1
24.	Identification of sub system use cases	1	3	1
UNIT IV	**Design Patterns and Modelling**	**9**		
25.	Design patterns	1	4	1,2
26.	Basic Structures of Design Patterns	1	4	1,2
27.	Using Design Patterns in Development	2	4	1,2
28.	Design for Safety, Reliability and Security	1	4	1
29.	High Fidelity Modelling	1	4	1
30.	Structured Design with UML	1	4	1
31.	Modelling Workflow	1	4	1
32.	Object Identification	1	4	1
UNIT V	**Distribution, Concurrency and Resource Architecture**	**9**		
33.	Asymmetric and Symmetric Distributed Architecture	1	5	1
34.	Concurrency and Resource Architecture	2	5	1,2,3,4
35.	Concurrency Architecture Harmony Workflow	1	5	1,2,3,4
36.	Concurrency Problems	2	5	1,2,3,4
37.	Collaboration Design	2	5	1
38.	Detailed Design	1	5	1
Total Contact Hours		**45**		

Recommended Resources

1. Bruce Powel Douglass, "Real-Time UML Workshop for Embedded Systems", 2nd Edition, Newnes, 2014Peter Waher, "Learning Internet of Things", Packt Publishers, 2015
2. Lavagno, Luciano, Martin, Grant, Selić, Bran (Eds.), "UML for Real, Design of Embedded Real-Time Systems", Springer, US, 2003
3. Bran Selic, Sebastien Gerard, "Modeling and Analysis of Real-Time and Embedded Systems with UML and MARTE: Developing Cyber-Physical Systems", The MK/OMG Press,2013.
4. Miro Samek, "Practical UML Statecharts in C/C++: Event-Driven Programming for Embedded Systems", Newnes, 2008.
5. Joseph Schmuller, "Sams Teach Yourself UML in 24 Hours", Third Edition, Sams Publishing, 2004.

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-III (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%		70%		60%		70%		60%	
	Understand										
Level 2	Apply	30%		30%		40%		30%		40%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Course Designers

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Signal Processing and Computer Vision

Course Code	**IoT 552**	Course Category	**Core Elective (CE)**	L-T-P-C	**3**	**0**	**1**	**4**
Pre-Requisite Course(s)	**Signal Processing and Computer Vision**	Co-Requisite Course(s)	**Nil**	Progressive Course(s)	**Nil**			
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the geometric relationships between signals and 2D images.
Objective 2: To analyse the foundation of camera geometry, measurement, and analysis.
Objective 3: To apply various advanced computer vision techniques.
Objective 4: To understand standard image processing and computer vision algorithms.
Objective 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 signals and 2D images.	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)

CLO	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tool Usage	Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3

Outcome 1	1	1	1	1						1	1	1	1
Outcome 2	2	3	2	2				2	1	1	1	2	3
Outcome 3	2	2	2	3				2	1	1	1	2	2
Outcome 4	2	3	3	3				2	1	1	2	3	3
Outcome 5	3	3	2	3				2	1	2	2	2	2
Course Average	**2**	**3**	**2**	**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 advanced signal and Image processing**	**10**		
1.	Convolution and correlation	1	1	1, 2
2.	Random Signals	1	1	1, 2
3.	LTI Systems	1	1	1, 2
4.	Transforms A/D, D/A conversion	2	1	1, 2
5.	Image Restoration, Linear Degradation model, Inverse filtering, Wiener filter	3	1	1, 2
6.	Polyphase structures and filter banks	2	1	1, 2
Unit 2	**Camera Geometry and Depth Estimation**	**10**		
7.	Image formation: perspective projection. Cameras with lenses.	1	2	1, 2
8.	Rigid Transformations and Homogeneous coordinates, Intrinsic and extrinsic parameters	2	2	1, 2
9.	Geometric camera calibration	1	2	1, 2
10.	Binocular Camera Geometry and Epipolar constraint, Essential and fundamental matrices	2	2	1, 2
11.	Binocular fusion: Local and Global Methods.	2	2	1, 2
12.	Multi- view stereo	2	2	1, 2
Unit 3	**Motion Estimation and Structure from Motion**	**10**		
13.	Optical Flow, Horn-Shunck and Lucas-Kanade algorithms	2	3	1, 2
14.	Geometric Intrinsic calibration and pose estimation	2	3	1, 2
15.	Two- frame and Multi-frame SFMs	4	3	1, 2
16.	SLAM and applications	2	3	1, 2
Unit 4	**Feature Extraction and Image Segmentation**	**8**		
17.	Edge and Line detection	1	4	1, 2
18.	Orientation Histograms, HOG, SIFT and SURF	2	4	1, 2
19.	Principal Component Analysis	1	4	1, 2
20.	Segmentation by region growing and region splitting	2	4	1, 2
21.	Segmentation using graph cuts	2	4	1, 2
Unit 5	**Applications**	7		

22.	Computational Photography: HDR imaging, Super resolution, denoising and blur removal	2	5	1, 2
23.	Image-Based Rendering	1	5	1, 2
24.	Image classification, Face Recognition	2	5	1, 2
25.	Object Detection: Face detection, Pedestrian detection	2	5	1, 2
Total Contact Hours		**45**		

Recommended Resources

1. Rafael Gonzalez and Richard Woods, "Digital Image Processing", Publication and edition
2. David Forsyth and Jean Ponce, "Computer Vision: A Modern Approach", Pearson Education, Edition.

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%**	

Course Designer(s)

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Machine Learning for Communication systems

Course Code	**IOT 544**	Course Category	**Core Elective (CE)**	L-T-P-C	**3**	**0**	**1**	**4**
Pre-Requisite Course(s)		Co-Requisite Course(s)	**Nil**	Progressive Course(s)	**Nil**			
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)
Objective 1: To familiarise the domains of supervised and unsupervised learning.
Objective 2: To understand and apply various binary classifiers.
Objective 3: To understand and apply clustering methods.
Objective 4: To understand and analyse Feedforward neural networks and CNNs
Objective 5: Able to work on real time projects related to AI/ML

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 able to work on real time projects	2,3,4	75%	70%

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

CLO	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tool Usage	Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	1	1	1	1						1	1	1	1
Outcome 2	2	3	2	2				2	1	1	1	2	3

Outcome 3	2	2	2	3				2	1	1	1	2	2
Outcome 4	2	3	3	3				2	1	1	2	3	3
Outcome 5	3	3	2	3				2	1	2	2	2	2
Course Average	**2**	**3**	**2**	**3**				**2**	**1**	**1**	**1**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction**	**9**		
1.	Introduction to machine learning	2	1	1, 2,3
2.	Supervised learning	2	1	1, 2,3
3.	Unsupervised learning	2	1	1, 2,3
4.	Linear regression	2	1	1, 2,3
5.	Logistic regression	1	1	1, 2,3
Unit 2	**Classifiers**	**9**		
6.	Naive Bayes	2	2	1, 2,3
7.	Support Vector Machines	2	2	1, 2,3
8.	K-Nearest Neighbor	2	2	1, 2,3
9.	Decision Trees	2	2	1, 2,3
10.	Random forest	1	2	1, 2,3
Unit 3	**Clustering**	**9**		
11.	Clustering in machine learning	2	3	1, 2,3
12.	Different types of clustering algorithms	2	3	1, 2,3
13.	K-Means clustering	2	3	1, 2,3
14.	Loss functions in regression and classification	2	3	1, 2,3
15.	Bias-variance trade off	1	3	1, 2,3
Unit 4	**Feedforward neural networks**	**9**		
16.	Introduction to Neural Networks	2	4	1, 2,3
17.	Activation functions	1	4	1,2,3
18.	Feed-forward Network	2	4	1, 2,3
19.	Backpropagation algorithm	2	4	1, 2,3
20.	Introduction to convolutional neural network (CNN)	2	5	1, 2,3
Unit 5	**Applications of AI/ML**	**9**		
21.	Applications in Communication Domain	9	5	4
Total Contact Hours		**45**		

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.Luis G. Serrano, "Grooking Machine Learning" 2nd Edition, Manning Publications, 2021.
4. Reference papers from various journals such as IEEE, Elsevier etc

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%**	

Course Designer(s)

Dr. Sudhakar Tummala*. Asst. Professor. And Dr. V. Udaya Sankar, Asst. Professsor, Dept. Of ECE. SRM University - AP*

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

CMOS Digital IC Design

Course Code	**IOT 534**	Course Category	**Core Elective (CE)**	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	*IEEE, Microsoft, Cadence, SPICE*					

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To understand the fundamental principles of CMOS technology, including the operation of MOS transistors, logic gates, and basic building blocks.

Objective 2: To learn the techniques for designing and analyzing CMOS digital circuits, including combinational and sequential logic circuits.

Objective 3: To gain proficiency in creating layout designs for CMOS circuits (considering area, power, and performance) and understand the importance of timing in digital circuits, and learn how to perform timing analysis for CMOS circuits.

Objective 4: To apply the knowledge gained in the course through hands-on projects that involve the design, simulation, and layout of CMOS digital 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	Understand the fundamental principles of CMOS Technology along with its advantages and limitations	2	85%	80%
Outcome 2	Design both combinational & sequential circuits using CMOS technology	3	80%	75%
Outcome 3	Create layout designs for CMOS digital circuits and understand the impact of the fabrication process on circuit design	6	85%	70%
Outcome 4	Apply theoretical knowledge to real-world digital IC design projects	4	80%	70%

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

CLOs	**Program Learning Outcomes (PLO)**

	Engineering Knowledge	Design / Development of Solutions Conduct	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life-long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	**3**	**2**	**2**	**2**	**2**			**2**	**2**	**3**	**3**	**2**	**2**
Outcome 2	**3**	**3**	**3**	**2**	**2**			**2**	**3**	**3**	**2**	**3**	**2**
Outcome 3	**3**	**3**	**3**	**3**	**2**			**2**	**3**	**2**	**3**	**3**	**2**
Outcome 4	**3**	**3**	**3**	**3**	**2**			**3**	**3**	**3**	**3**	**3**	**3**
Course Average	**3**	**3**	**3**	**2**	**2**			**2**	**3**	**3**	**3**	**3**	**2**

Course Unitization Plan -Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**MOSFET Introduction and Layout of CMOS Logic Circuits**	**9**		
1.	Basic MOSFET Characteristics– Threshold Voltage, Body Bias concept, Current- Voltage Characteristics – Square-Law Model	2	1	1,2
2.	MOSFET Modeling– Drain-Source Resistance, MOSFET Capacitances	1	1	1,2
3.	Geometric Scaling Theory– Full-Voltage Scaling, Constant-Voltage Scaling, Challenges of MOSFET Scaling	2	1	1,2
4.	CMOS fabrication processing steps	1	1	1,2,4,6
5.	Design Rules, Stick diagram, Layout of logic circuits	2	1,3	
6.	Layout of logic circuits, latch-up	1	1,3	1,2,4,6
Unit 2	**Switching Properties of MOSFET and CMOS Inverter**	**9**		
7.	Static and dynamic characteristics of Pass Transistors	2	1,2	1,2
8.	Transmission Gate, TG based logic circuits, Introduction to CMOS Inverter	2	1,2	1,2
9.	CMOS Inverter - DC Characteristics, Noise Margins, Layout Considerations	1	1,2	1,2
10.	Inverter Switching Characteristics, Transient Effects on the VTC, RC Delay Modeling, Elmore Delay, Output Capacitance	2	1,2	1,2
11.	Inverter Design – DC Design, Transient Design, Driving Large Capacitive Loads	2	1,2	1,2

Unit 3	**Static CMOS Logic Elements & Power Dissipation in CMOS Logic Circuits**	**9**		
12.	CMOS NAND Gate, CMOS NOR Gate	1	2,3	1,2,3
13.	CMOS AND, OR, NOT, and Complex Logic Functions	2	2,3	1,2,3
14.	CMOS SRAM and DRAM Cell	1	2,3	1,2,3
15.	Dynamic Power Dissipation– Switching Power Dissipation	2	2,3	1,2,3
16.	Short Circuit Power Dissipation, Glitching Power Dissipation	1	1,3	1,2,3
17.	Static Power Dissipation, Diode Leakage Current, Subthreshold Leakage Current	2	1,3	1,2,3
Unit 4	**Dynamic Logic Circuit Concepts and CMOS Dynamic Logic Families**	**9**		
18.	Charge Leakage in CMOS circuits	2	2,4	1,2,5
19.	Charge Sharing, Dynamic RAM Cell	2	2,4	1,2,5
20.	Clocked-CMOS	2	2,4	1,2,5
21.	Pre-Charge/ Evaluate Logic, Domino Logic	2	2,4	1,2,5
22.	CMOS Single-Phase Logic	1	2,4	1,2,5
Unit 5	**Issues In Chip Design**	**9**		
23.	ESD Protection	2	2,3,4	1,2,5
24.	On-Chip Interconnects – Line Parasitics	2	2,3,4	1,2,5
25.	Modeling of the Interconnect Line	2	2,3,4	1,2,5
26.	Clock Distribution	2	2,3,4	1,2,5
27.	Input-Output circuits	1	2,3,4	1,2,5
	Total	**45**		

Recommended Resources

1. Rabaey, J.M., Chandrakasen, A.P. and Nikolic, B., Digital Integrated Circuits – A Design perspective, Pearson Education (2007) 2nd ed.
2. Kang, S. and Leblebici, Y., CMOS Digital Integrated Circuits – Analysis and Design, Tata McGraw Hill
3. J P Uyemura, CMOS Circuit Design, Springer
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.
6. Weste, N.H.E., Harris, D. and Banerjee, A., CMOS VLSI Design, Dorling Kindersley (2006) 3rd ed.

Other Resources

1. James D. Plummer, Michael D. Deal, Peter B. Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modelling, Pearson Education, 2009.

Learning Assessment (Lab)

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)			End Semester Exam (60%)
		Experiments (13%)	Record / Observation Note (13%)	Viva + Model (13%)	
Level 1	Remember	40%	50%	50%	40%
	Understand				
Level 2	Apply	40%	40%	40%	40%
	Analyse				
Level 3	Evaluate	20%	10%	10%	20%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Course Designer(s)

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

b. ***Dr***. ***Durga Prakash Matta.*** *Asst. Professor. Dept. Of ECE. SRM University – AP*

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

Hardware security for IoT

Course Code	**IoT 543**	Course Category	**Core (C)**	L-T-P-C	**3 0 0 3**
Pre-Requisite Course(s)	Digital Circuits/Digital Electronics	Co-Requisite Course(s)		Progressive Course(s)	
Course Offering Department	**ECE**	Professional / Licensing Standards			

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To Understand the basic concepts of various levels of IoT security issues and countermeasures
Objective 2: To Design and simulate emerging circuit/architecture countermeasures for improving security.
Objective 3: To make students understand the side channel attacks such as power and EM attacks and techniques for prevent SCA's.
Objective 4: Design and verification of cryptographic hardware for different fault attacks.
Objective 5: Design systems to minimize or prevent various forms of trojans.

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 strong understanding of the basic concepts of various levels of IoT layer security issues and countermeasures	2	80%	70%
Outcome 2	Design and simulate emerging circuit/architecture countermeasures like PUF/TRNG designs for improving hardware security	3	70%	60%
Outcome 3	Design and verify cryptographic algorithms on hardware for various attacks	4	80%	70%
Outcome 4	Well understand and can design the side channel attacks such as power and EM attacks and techniques to prevent such SCA's	4	70%	60%

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

CLOs	Program Learning Outcomes (PLO)												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tool Usage	Engineer and Society	Environment and Sustainability	Ethics	Individual and Teamwork Skills	Communication Skills	Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	1					2		2	1	3	2
Outcome 2	3	3	2					3		2	1	3	2
Outcome 3	3	3	2					2		2	1	3	2
Outcome 4	3	3	3					3		2	1	3	2
Course Average	**3**	**3**	**2**					**3**		**2**	**1**	**3**	**2**

Course Unitization Plan

Session	Description of Topic	Required Contact hours	CLOs addressed	References used
	UNIT I: Overview of IoT security and hardware security	**8**		
1.	IoT system and building blocks,	1	1	1,2,3
2.	Network, Data, software and Hardware security basics	2	1	1,2,3
3.	Introduction to Cryptography	1	1	1,2,3
4.	Block Ciphers Rijndael in Composite Field	2	1	1,2,3
5.	Elliptic Curves	2	1	1,2,3
6.	Scalar Multiplications	2	1	1,2,3
7.	Montgomery's Algorithm for Scalar Multiplication	2	1	1,2,3
a.	**UNIT II: Hardware Design of Cryptographic Algorithms for IoT**	**10**		
8.	Hardware Design of the Advanced Encryption Standard (AES)	2	1,3	1,2,3

9.	Algorithmic and Architectural Optimizations for AES Design	1	1,3	1,2,3
10.	Circuit for the AES S-Box	1	1,3	1,2,3
11.	An Example Reconfigurable Design for the Rijndael Cryptosystem	1	1,3	1,2,3
12.	Design of Finite Field Arithmetic on FPGAs	1	1,3	1,2,3
13.	Finite Field Multipliers for High Performance Applications	1	1,3	1,2,3
14.	Karatsuba Multipliers for Elliptic Curves	1	1,3	1,2,3
15.	Designing for the FPGA Architecture	1	1,3	1,2,3
16.	Elliptic Curve Cryptoprocessor	1	1,3	
a.	**UNIT III**: **Side-channel Attacks on Cryptographic Hardware for IoT**	**10**		
17.	Introduction to Side Channel Analysis and different Attacks: Power, EM attacks	2	1,2,4	1,2,3
18.	Current-measurement based Side-channel Attacks (Case Study: Kocher's Attack on DES),	2	1,2,4	1,2,3
19.	Design Techniques to Prevent Side-channel Attacks,	2	1,2,4	1,2,3
20.	Improved Side-channel Attack Algorithms (Template Attack, etc.)	2	1,2,4	1,2,3
21.	Cache Attacks	2	1,2,4	1,2,3
a.	**UNIT IV: Testability and Verification of Cryptographic Hardware and Modern IC Design and Manufacturing Practices and Their Implications for IoT**	**9**		
22.	Fault-tolerance of Cryptographic Hardware	1	1,2,4	1,2,3
23.	Fault Attacks, Verification of Finite-field Arithmetic Circuits	1	1,2,4	1,2,3
24.	Hardware Intellectual Property (IP) Piracy and IC Piracy	1	1,2,4	1,2,3
25.	Design Techniques to Prevent IP and IC Piracy	1	1,2,4	1,2,3
26.	Using PUFs to prevent Hardware Piracy	1	1,2,4	1,2,3
27.	Model Building Attacks on PUFs (Case Study: SVM Modeling of Arbiter PUFs	2	1,2,4	1,2,3
28.	Genetic Programming based Modeling of Ring Oscillator PUF)	1	1,2,4	1,2,3

a.	**UNIT V: Hardware Trojans and Detection methods for IoT platforms**	**9**		
29.	Hardware Trojans: Hardware Trojan Nomenclature	1	1,2,3,4	1,2,3
30.	Countermeasures Such as Design and Manufacturing Techniques to Prevent/Detect Hardware Trojans,	1	1,2,3,4	1,2,3
31.	Logic Testing and Side-channel Analysis based Techniques for Trojan Detection,	2	1,2,3,4	1,2,3
32.	Techniques to Increase Testing Sensitivity Infrastructure Security	1	1,2,3,4	1,2,3
33.	Impact of Hardware Security Compromise on Public Infrastructure	1	1,2,3,4	1,2,3
34.	Défense Techniques (Case Study: Smart-Grid Security)	2	1,2,3,4	1,2,3
	Total contact hours	45		

Recommended Resources

1. Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, "Hardware Security: Design, Threats, and Safeguards", CRC Press.
2. Swarup Bhunia and Mark Tehranipoor, “Hardware Security: A Hands-on Learning Approach”, 2019 Elsevier
3. Doug Stinson, Cryptography Theory and Practice, CRC Press

Learning Assessment (Integrated course)

Bloom’s Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**Mid-1 (10%)**		**CLA-2 (10%)**		**Mid-2 (20%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	20%		40%		20%		20%	30%	40%	25%
	Understand										
Level 2	Apply	80%		60%		80%		80%	70%	60%	70%
	Analyse										
Level 3	Evaluate										5%
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Course Designers

a. Internal (Institutional) Subject Matter Experts

Dr Ramesh Vaddi, Associate Professor, Department of Electronics & Communication Engineering, SRM University – AP

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

CMOS Analog and Mixed signal IC design

Course Code	IOT 535	Course Category	CC	L-T/D-P/Pr-C	3	0	1	4
Total Contact Hours			Total Learning Hours					
Pre-Requisite Course(s)		Co-Requisite Course(s)		Progressive Course(s)				
Course Offering Department		Professional / Licensing Standards						

Course Objectives:

Objective 1: To study and understand the basic principles and concepts of electronic components, devices, and circuitry, specifically related to semiconducting P-N junction.
Objective 2: To understand and analyze the characteristics of P-N junction diodes and their applications in designing various electronic devices and circuits
Objective 3: To understand, analyze, and design the Bipolar-Junction (BJT) and Field-Effect transistors (FET) based electronic circuits followed by advanced Operational amplifier (Op-Amp) based circuits.
Objective 4: To apply the knowledge gained in the course to real-world applications and work on practical projects to reinforce theoretical concepts.

Course Outcomes (COs):

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
CO 1		2	85%	80%
CO 2		3	80%	75%
CO 3		3	80%	75%
CO 4		4	75%	70%

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 Lea	PSO1	PSO2	PSO3

											rnin g				
Outcome 1	2	3	1	2	2				1	2	1	3	2	2	2
Outcome 2	2	3	2	3	2				2	2		3	2	3	3
Outcome 3	3	3	2	3	2				2	2		3	2	3	3
Outcome 4	2	2	2	2	2				3	3	2	3	3	3	3
Course Average	**2**	**3**	**2**	**3**	**2**				**2**	**2**	**1**	**3**	**2**	**3**	**3**

Learning Assessment (Macro) - Theory

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (60%)**				**End Semester Assessments (50%)**
		CLA-1 (15%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (10%)**	
Level 1	Remember	50%	40%	35%	30%	40%
	Understand					
Level 2	Apply	45%	30%	35%	30%	40%
	Analyse					
Level 3	Evaluate	5%	30%	30%	40%	20%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Learning Assessment (Macro) - Lab

		Continuous Learning Assessments (50%)	

Question Difficulty	Bloom's Level of Cognitive Task	Experiments (20%)	Record / Observation Note (10%)	Viva + Model (20%)	End Semester Exam (50%)
Level 1	Remember	40%	40%	30%	35%
	Understand				
Level 2	Apply	30%	30%	40%	40%
	Analyse				
Level 3	Evaluate	20%	30%	30%	25%
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Course Designers

a. ***Dr. M. Durga Prakash****. Asst. Professor. Dept. Of ECE. SRM University – AP*

Lesson Plan

Duplicate this page / table as many times as necessary.

This section will serve to complete the B2 part of the Course File

1. Topic(s):		**CO:**
Name of Faculty from Synergy Dept. / Other Institution / Industry *(if any)*		
2. Topic Learning Outcome(s)		
Previous:	**Current:**	**Following:**
3.Pedagogy (all that apply)		
Lecture / CBL (Case Based Learning) **/ PBL** (Problem or Project Based Learning) **/ ABL** (Activity Based Learning) **/ EL** (Experiential Learning) **/IBL** (Inquiry Based Learning) **/ RBL** (Research Based Learning) *Including field visits in Experiential Learning*		**Topic Learning Hours**
4. Active Learning Techniques • Discussions / Interactions /Q&A / Jigsaw etc. • (Subtopics, is the faculty involved) • How many discussions / activities for this topic? • How many groups?	**In Class Hours**	**Out of Class Hours**
5. Resources *(including those used for blended learning if any)* • Book Chapter/ Pages • Notes • E-resources • Problem Sets • Practice Work w/ solutions		**Blended Learning Hours** *(if any)*
6.Assessments		

Assessment Component(s) *(Which Part of Continuous Learning Assessment / ESE)* *(CLA 1) (Example)*	**Assessment Type** *(Refer to types list form delivery / assessment workgroup)* *Quiz (Example)*	**Marks** *5 (Example)*

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VLSI Technology

Course Code	IOT 553	**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**	*IEEE, Microsoft, Cadence*		
Board of Studies Approval Date		**Academic Council Approval Date**			

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To study the various processes of IC fabrication.
Objective 2: To study the device fabrication process.
Objective 3: To understand various issues of defects and stresses in the films.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Outline the basics of semiconductor crystal properties	2	80%	75%
Outcome 2	Identify the fundamentals of IC fabrication	3	80%	75%
Outcome 3	Illustrate the different methods involved in VLSI fabrication process.	4	80%	75%
Outcome 4	Appreciate the advanced methods involved in IC fabrication.	4	80%	75%
Outcome 5	Build the knowledge of process integration-of devices	4	80%	75%
Outcome 6	Build the knowledge of Packaged the devices	4	80%	75%

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

CLOs	Engineering Knowledge	Design and Development of Solutions	Conduct Investigations of Complex Problems	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Team work	Communication	Lifelong Learning	PSO1	PSO2	PSO3
Outcome 1	3	1	1	2	2	2	2	2	2	2	2	2	2
Outcome 2	3	1	1	2	2	2	2	2	2	2	2	2	2
Outcome 3	2	3	3	2	3	3	3	2	3	2	3	3	3
Outcome 4	2	3	3	2	3	3	3	3	3	1	3	3	3
Outcome 5	2	3	3	2	3	3	3	3	3	2	3	3	3
Outcome 6	2	3	3	2	3	3	3	3	3	1	3	3	3
Course Average	**2**	**3**	**3**	**2**	**3**	**3**	**3**	2	**3**	**2**	**3**	**3**	**3**

Course Unitization Plan -Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Clean Room Environment and Wafer Preparation**	**10**		
	Crystal Structure of a solid	1	1	1,2
	Defects in materials	1	1	1,2
	Types of clean room, Contamination in clean room	2	1,2	1,2
	Electronic Grade Silicon, Czochralski crystal growing	2	1,2	1,2,4,6

	Silicon Shaping	2	1,2	
	Wafer cleaning processes and wet chemical etching techniques	2	1,2	1,2,4,6
Unit 2	**Oxidation, Diffusion, and Implantation**	**12**		
	Kinetics of Silicon dioxide growth both for thick, thin, and ultrathin films	3	2,3	1,2
	Oxidation Techniques and Systems Models of Diffusion in Solids	2	2,3	1,2
	Defects due to oxidation	2	1,2,3	1,2
	Solid State diffusion modelling and technology	2	1,2,3	1,2
	Implantation Equipment, Principles, techniques and applications	2	2,3	1,2
	Removal of implant damage	1	2,3	
Unit 3	**Epitaxial Growth, Metallization**	**12**		
	CVD and MBE	3	2,3	1,2,3
	Defects in Epitaxial Layer Dielectric Deposition	2	2,3	1,2,3
	PECVD and Rapid Thermal Annealing	2	2,3,4	1,2,3
	E-beam evaporation	2	2,3,4	1,2,3
	Sputtering and Thermal Evaporation	2	2,3	1,2,3
	Etching	1	2,3,4	1,2,3
Unit 4	**Lithography**	**6**		
	Optical Lithography	2	2,3,4	1,2,5
	E-beam lithography	2	2,3,4	1,2,5
	X-ray	1	2,3,4	1,2,5
	Other Lithography techniques	1	2,3,4	1,2,5
Unit 5	**Fabrication and Packaging**	**6**		
	Fabrication of MOSFET	2	3,4,5	1,2,5
	Process to Package a chip (Dicing, Attaching, wire bonding, Chip package header)	2	2,3,4	1,2,5
	Fabrications of other devices	2	2,3,4	1,2,5
	Total	**46**		

Learning Assessment (Theory)

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%)	
Level 1,2	Understand	40%	40%	20%	30%	30%
	Apply					
Level 2,3	Understand	40%	40%	40%	30%	50%
	Apply					
Level 3,4	Apply	20%	20%	40%	40%	20%
	Analyse					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Course Designer(s)

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Deep Learning for IOT

Course Code	**IoT 558**	Course Category	**Core (C)**	L-T-P-C	**3**	**0**	1	**4**
Pre-Requisite Course(s)	**Nil**	Co-Requisite Course(s)	**Nil**	Progressive Course(s)	**Nil**			
Course Offering Department	**ECE**	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To familiarize the domain of fully connected neural networks.
Objective 2: To understand and design convolutional neural networks.
Objective 3: To understand and design recurrent neural networks.
Objective 4: To understand autoencoders and generative models.
Objective 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	2	75%	65%

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

CLO	**Program Learning Outcomes (PLO)**												
	Engineering Knowledge	Conduct Investigations of Complex Problems	Design and Development	Modern Tool Usage	Society and Multicultural Skills	Environment and Sustainability	Ethics	Individual and Team work Skills	Communication Skills	Lifelong Learning	PSO1	PSO2	PSO3
Outcome 1	1	1	1	1						1	1	1	1

Outcome 2	2	3	2	2				2	1	1	1	2	3
Outcome 3	2	2	2	3				2	1	1	1	2	2
Outcome 4	2	3	3	3				2	1	1	2	3	3
Outcome 5	3	3	2	3				2	1	2	2	2	2
Course Average	**2**	**3**	**2**	**3**				**2**	**1**	**1**	**1**	**2**	**2**

Course Unitization Plan - Theory

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit 1	**Introduction to neural network**	**10**		
	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
Unit 2	**Convolutional neural networks**	**10**		
	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
Unit 3	**Recurrent neural networks**	**9**		
	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
Unit 4	**Autoencoders**	**9**		
	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)	1	4	1, 2
	Introduction to Reinforcement Learning	2	4	1, 2
Unit 5	**Applications of Deep Learning**	**7**		1, 2
	Introduction	2	5	1, 2
	Data mining	2	5	1, 2
	Big data in health care industries	2	5	1, 2
	Sound/ audio analysis using deep learning techniques	1	5	1, 2
Total Contact Hours		**45**		

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.

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%**	

Course Designer(s)

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