INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**EMBEDDED SYSTEMS DESIGN AND PROGRAMMING**				
Course Code	AEC024				
Programme	B.Tech				
Semester	VIII	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Course Coordinator	Ms. M. Suguna Sri, Assistant Professor				
Course Faculty	Ms. M. Suguna Sri, Assistant Professor				

I. COURSE OVERVIEW:

Embedded Systems Design and Programming course is continuous of the Microprocessor and Microcontrollers, is intended to designing, implementation and Test of embedded applications. The topics covered are definition of embedded systems, history, classification, and major applications. Introduction to microcontroller and its interfacing, embedded firmware design and development, RTOS, task scheduling, threads, multitasking, task communication, task synchronization. Understand need of microcontrollers in development of various projects and to know operating systems and RTOS.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	ACS007	IV	Operating Systems	4
UG	AEC013	VI	Microprocessors and Microcontrollers	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Embedded Systems	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✘	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for SEE. Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows: Two full questions with "either" or "choice" are drawn from each unit of the syllabus. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the theoretical concepts and derivation capabilities.
50 %	To test the analytical and problem solving skills.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks of which 25 marks for problem solving and 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lectures, Assignments
PO 3	**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 the public health and safety, and the cultural, societal, and environmental considerations.	2	Lectures, Assignments
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	1	One minute videos
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	Lectures

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Problem Solving**: Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	-	-

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 2	**Professional Skills:** Identify the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	2	Lectures and Assignments
PSO 3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Imbibe knowledge about the basic functions, structure, concepts and applications of Embedded Systems.
II	Understand Real time operating system concepts.
III	Design interfacing of switches, displays and stepper motor.
IV	Analyze different tools for development of embedded software.
V	Be acquainted the architecture of advanced processors.

IX. COURSE OUTCOMES (COs):

Cos	Course Outcomes	CLO's	Course Learning Outcome
CO1	Understand the basic concepts of embedded system and various applications and characteristics, formalisms for system design of embedded system design	CLO 1	Understand basic concept of embedded systems.
		CLO 2	Analyze the applications in various domains of embedded system.
		CLO 3	Develop the embedded system and Design process and tools with examples.
		CLO 4	Understand characteristics and quality attributes of embedded systems, formalisms for system design.

Cos	Course Outcomes	CLO's	Course Learning Outcome
CO2	Discuss the concepts of C and develop the C programming examples with Keil IDE, and understand the concepts of interfacing modules using embedded C.	CLO 5	Understand the basic programming of c and its looping structure.
		CLO 6	Analyze the embedded C programming in Keil IDE, and compiling and building the hardware.
		CLO 7	Understand different concepts of display and keyboard interfacing using embedded C.
		CLO 8	Understand different concepts of serial communication using embedded C and user interfacing
CO3	Understand the basic embedded programming concepts in C and assembly language	CLO 9	Analyze the programming on switches
		CLO 10	Understanding the programming language tools.
		CLO 11	Understand different concepts of display and keyboard interfacing using embedded C.
		CLO 12	Understand different concepts of stepper motor interfacing.
CO4	Understand the fundamentals of RTOS and its programming and Task communication, Task synchronization with its issues and techniques. Develop examples using embedded software and understand the debugging techniques.	CLO 13	Understand and analyze the RTOS concepts for firmware development.
		CLO 14	Remember how to choose an RTOS, task scheduling, semaphores and queues, hard real-time scheduling considerations.
		CLO 15	Understand the task communication, its programming and Task synchronization with its issues and techniques.
		CLO 16	Develop host and target machines for linking to embedded software.
		CLO 17	Develop debugging techniques for testing on host machine with examples.

CO5	Discuss the concepts of advanced processors like ARM and SHARC and protocols of I2C and CAN bus.	CLO 18	Remember the advanced processors such as ARM and SHARC.
		CLO 19	Understand the bus protocols such as I2C and CAN bus.
		CLO 20	Design an application based on advanced technological changes.

3 = High; 2 = Medium; 1 = Low

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to	PO's Mapped	Strength of Mapping
AEC024.1	CLO 1	Understand basic concept of embedded systems.	PO 1	2
AEC024.2	CLO 2	Analyze the applications in various domains of embedded system.	PO 1	2
AEC024.3	CLO 3	Develop the embedded system and Design process and tools with examples.	PO 1 PO 5	1
AEC024.4	CLO 4	Understand characteristics and quality attributes of embedded systems, formalisms for system design.	PO 1 PO 5	1
AEC024.5	CLO 5	Understand the basic programming of c and its looping structure.	PO 3	3
AEC024.6	CLO 6	Analyze the embedded C programming in Keil IDE, and compiling and building the hardware.	PO 3	1
AEC024.7	CLO 7	Understand different concepts of display and keyboard interfacing using embedded C.	PO 3	2
AEC024.8	CLO 8	Understand different concepts of serial communication using embedded C and user interfacing	PO 1 PO 5	2
AEC024.9	CLO 9	Analyse the programming on switches	PO5	2
AEC024.10	CLO 10	Understanding the programming language tools.	PO1, PO5	2
AEC024.11	CLO 11	Understand different concepts of display and keyboard interfacing using embedded C.	PO 3	2
AEC024.12	CLO 12	Understand different concepts of stepper motor interfacing.	PO3	2
AEC024.13	CLO 13	Understand and analyze the RTOS concepts for firmware development.	PO 1	3
AEC024.14	CLO 14	Remember how to choose an RTOS, task scheduling, semaphores and queues, hard real-time scheduling considerations.	PO 1 PO 12	2
AEC024.15	CLO 15	Understand the task communication,its programming and Task synchronization with its issues and techniques.	PO 12	1

AEC024.16	CLO 16	Develop host and target machines for linking to embedded software.	PO 1 PO 3	2
AEC024.17	CLO 17	Develop debugging techniques for testing on host machine with examples.	PO 1 PO 3	2
AEC024.18	CLO 18	Remember the advanced processors such as ARM and SHARC.	PO 3	1
AEC024.19	CLO 19	Understand the bus protocols such as I2C and CAN bus.	PO 3	1
AEC024.20	CLO 20	Design an application based on advanced technological changes.	PO 1 PO 3	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes (PSOs)
	PO1	PO3	PO5	PO12	PSO2
CO 1	2			1	2
CO 2	1	3	2	1	1
CO 3	2	2	2		
CO 4	1	1			
CO 5	2		1	1	2

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

(CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2													1	
CLO 2	2													1	
CLO 3	1				1										
CLO 4			2												
CLO 5			3												
CLO 6			1												
CLO 7			2												
CLO 8	2				2									2	

CLO 9					2								1	
CLO 10	2				2									
CLO 11			2										1	
CLO 12			2											
CLO 13	3													
CLO 14	2										2		1	
CLO 15											1			
CLO 16	2		2										3	
CLO 17			1											
CLO 18			1										3	
CLO 19			1											
CLO 20	2		2											

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO1, PO3, PO5, PO12, PSO2	SEE Exams	PO1, PO3, PO5, PO12, PSO2	Assignments	PO 1, PO 3	Seminars	PSO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO1, PO3, PO5, PO12, PSO2						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Unit-I	EMBEDDED COMPUTING
Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, characteristics and quality attributes of embedded systems, formalisms for system design, design examples	
Unit-II	**PROGRAMMING EMBEDDED SYSTEMS IN C**
Embedded systems programming in C, binding and running embedded C program in Keil IDE, building the hardware; The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the "Hello Embedded World" example.	

Unit-III	EMBEDDED C APPLICATIONS
Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version). Basic techniques for reading and writing from I/O port pins, LED interfacing, interfacing with keyboards, displays, Stepper motor interfacing.	
Unit-IV	**INTRODUCTION TO REAL – TIME OPERATING SYSTEMS**
Tasks and Task States, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer Functions, Events, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Interrupt Routines in an RTOS Environment. Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System; Debugging Techniques: Testing on Host Machine.	
Unit-V	**INTRODUCTION TO ADVANCED ARCHITECTURES**
ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus.	
Text Books:	
1. Shibu K.V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2 nd Edition, 2009. 2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2 nd Edition, 2011. 3. Andrew Sloss, Dominic Symes,Wright, "ARM System Developer's Guide Designing and Optimizing System Software", 1st Edition, 2004.	
Reference Books:	
1. Wayne Wolf, " Computers as Components, Principles of Embedded Computing Systems Design", Elsevier, 2nd Edition, 2009. 2. Dr. K. V. K. K. Prasad, " Embedded / Real-Time Systems: Concepts, Design & Programming", dreamtech publishers, 1st Edition, 2003. 3. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley & Sons, 3rd Edition, 2006. 4. Lyla B Das, "Embedded Systems" , Pearson Education, 1st Edition, 2012. 5. David E. Simon, "An Embedded Software Primer", Addison-Wesley, 1st Edition, 1999. 6. Michael J. Pont, "Embedded C", Pearson Education, 2nd Edition, 2008.	

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Definition of embedded system vs general computing system history of embedded systems	CLO 1	T1-1.1
3-4	Complex systems and microprocessor, classification, major application areas, the embedded system design process,	CLO 1	T1-1.2
5-6	Characteristics and quality attributes of embedded systems, formalisms for system design,	CLO 2	T1-1.3
7	Design examples.	CLO 3	T2-1.4
8-9	C looping structures, register allocation, function calls, pointer Aliasing	CLO 3	T2-1.5

10-12	Structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly,	CLO 3	R2-1.2
13-14	Portability issues; Embedded systems programming in C, binding and running embedded C program in Keil IDE,	CLO 4	T3-1.3
15-16	Dissecting the program, building the hardware; Basic techniques for reading and writing from I/O port pins, switch bounce	CLO 4	T3-2.4
17-18	Applications: Switch bounce, LED interfacing, interfacing with keyboards, displays.	CLO 6	T3-2.5
19-20	A/D conversions, multiple interrupts, serial data communication using embedded C interfacing	CLO 4	T3-2.6
21-22	D/A conversion.	CLO 5	T3-2.7
23-24	Operating system basics, types of operating systems, tasks and task states	CLO 5	T3-2.8
25-26	Process and threads, multiprocessing and multitasking, how to choose an RTOS ,task scheduling, semaphores	CLO 5	T3-2.9
27-28	Queues, hard real-time scheduling considerations, saving memory and power. Task communication: Shared memory,	CLO 7	R2-3.1
29-30	Message passing, remote procedure call and sockets; Task synchronization:	CLO 7	R2-3.2
31-32	Task communication synchronization issues, task synchronization techniques.	CLO 7	R2-3.3
33-34	Device drivers	CLO 8	R2-3.4
35-36	Host and target machines,	CLO 8	R2-3.5
37-38	Linker/locators for embedded software,	CLO 9	R2-3.6
39-40	Getting embedded software into the target system; Debugging techniques:	CLO 10	R3-3.7
41-42	Testing on host machine, using laboratory tools,	CLO 10	R3-3.8
43-44	Example programs	CLO 10	R3-4.1
45-46	Example programs	CLO 11	R3-4.2
47-48	Introduction to advanced architectures	CLO 11	R3-4.3
49-50	ARM and SHARC, processor and memory organization	CLO 12	R3-4.4
51-52	Instruction level parallelism; Networked embedded systems:	CLO 12	R3-4.5
53-54	Bus protocols, I2C bus and CAN bus	CLO 13	T2-8.1
55-56	Internet-Analyzed systems,	CLO 13	T2-8.2
57-58	Design example-Elevator controller.	CLO 14	T2-8.3
59-60	Example programs.	CLO 14	T2-8.4

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed Actions	Relevance with POs	Relevance with PSOs
1	Advanced embedded systems with real time examples.	Guest Lectures	PO 5	PSO 2
2	Real time operating system concepts which applicable to advanced systems.	Seminars / NPTEL	PO 1	PSO 2
3	Design of elevator controller.	NPTEL	PO 3	PSO 2

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