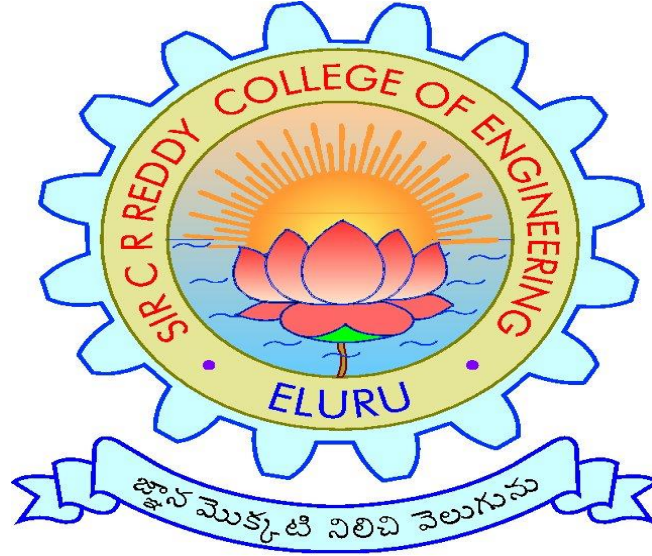**SIR C.R.REDDY COLLEGE OF ENGINEERING, ELURU**

DEPARTMENT OF INFORMATION TECHNOLOGY

COURSE HANDOUT

SUBJECT: EMBEDDED SYSTEMS

CLASS: IV/IV B.Tech., I SEMESTER, A.Y.2022-23

INSTRUCTOR: Smt. T.Satya Nagamani

Course Handout Index

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COLLEGE VISION

To emerge as a premier institution in the field of technical education and research in the state and as a home for holistic development of the students and contribute to the advancement of society and the region.

COLLEGE MISSION

To provide high quality technical education through a creative balance of academic and industry oriented learning; to create an inspiring environment of scholarship and research; to instill high levels of academic and professional discipline; and to establish standards that inculcate ethical and moral values that contribute to growth in career and development of society in general.

VISION OF THE DEPARTMENT

To be a premier Department in the region in the field of Information Technology through academic excellence and research that enable graduates to meet the challenges of industry and society

MISSIONOF THE DEPARTMENT

- ❖ To Provide dynamic teaching-learning environment to make the students industry ready and advancement in career;
- ❖ To inculcate professional and leadership quality for better employability and entrepreneurship;
- ❖ To make high quality professional with moral and ethical values suitable for industry and society

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Solve real world problems through effective professional skills in Information Technology industry and academic research.

PEO2: Analyze and develop applications in Information Technology domain and adapt to changing technology trends with continuous learning.

PEO3: Practice the profession in society with ethical and moral values.

PROGRAM OUTCOMES (POs)

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex engineering problems and system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.

PO4: 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.

PO5: 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.

PO6: 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.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in society and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10: 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.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the

engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PO12: 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Design and develop software in the area of relevance under realistic constraints.

PSO2: Adapt new and fast emerging technologies in the field of Information Technology.

Directorate of Academic Planning
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA-533003, Andhra Pradesh, INDIA
(Established by AP Government Act No. 30 of 2008)

Lr. No. DAP/AC/IV Year /B. Tech/B. Pharmacy/2022   *Date 25.06.2022*

Dr. KVSG Murali Krishna,
M.E. Ph.D.,
Director, Academic Planning
JNTUK, Kakinada

To
All the Principals of Affiliated Colleges,
JNTUK, Kakinada.

Academic Calendar for IV Year - B. Tech/B. Pharmacy for the AY 2022-23

Description	From	To	Weeks
I SEMESTER			
Commencement of Class Work	04.07.2022		
I Unit of Instruction	04.07.2022	27.08.2022	8W
I Mid Examinations	29.08.2022	03.09.2022	1W
II Unit of Instructions	05.09.2022	29.10.2022	8W
II Mid Examinations	31.10.2022	05.11.2022	1W
Preparation & Practicals	07.11.2022	12.11.2022	1W
End Examinations	14.11.2022	26.11.2022	2W
Commencement of II Semester Class Work	05.12.2022		
II SEMESTER			
I Unit of Instructions	05.12.2022	28.01.2023	8W
I Mid Examinations	30.01.2023	04.01.2023	1W
II Unit of Instructions	06.01.2023	01.04.2023	8W
II Mid Examinations	03.04.2023	08.04.2023	1W
Preparation & Practicals	10.04.2023	15.04.2023	1W
End Examinations	17.04.2023	29.04.2023	2W

Director, 25/6/22
Academics & Planning,
JNTUK
Director
Academic Planning
JNTUK Kakinada

Copy to the Secretary to the Hon'ble Vice Chancellor, JNTUK
Copy to Rector, Registrar, JNTUK
Copy to Director Academic Audit, JNTUK
Copy to Director of Evaluation, JNTUK

Department Academic Calendar

Department of Information Technology
IV/IV B.Tech Academic Calendar for 2022-23

2022-23	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T
Jul 22						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Aug 22		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Sep 22				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Oct 22						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Nov 22			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Dec 22				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Jan 23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Feb 23			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Mar 23			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Apr 23						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
May 23		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Jun 23			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

List of Holidays				
July 10: Bakrid	Oct 9: Maulud Nabi	Mar 22 : Ugadhi	Mid exams	
Aug 9:Moharum	Oct 24 : Diwali	Mar 30: Srirama navami	End Examinations	
Aug 15:Independence day	Dec 25 :Christmas	Apr 5: Babu Jagjivan Ram Jayanti	Commencement of Class work	
Aug 31:Ganesh Chaturdi	Jan 14-16: sankranti	Apr 7: Good friday	Workshops	
Oct 2: Gandhi jayanthi	Jan 26:Republic Day	Apr 14:Ambetkar Jayanthi	Department fest/Elite	
Oct 5: Vijayadasami	Feb 18 :Sivaratri	Jun 29: Bakrid		HoD
	Mar 8 : holi			Department of IT

Course Description

This is a graduate course surveying topics in embedded systems. It covers advanced topics like embedded software, hardware and firmware design and real time operating systems. It covers embedded OS, embedded C programming and integration of hardware and firmware designs, different family microprocessors and microcontrollers along with testing tools and their implementation. This course builds upon the topics covered in undergraduate operating systems course, such as interrupts, shared data problems, task states, priority inversion, inter task communication, and after a brief review, these topics are studied in the context of embedded systems.

Course Objectives

The main objectives of this course are given below:

1. The basic concepts of an embedded system are introduced.
2. The various elements of embedded hardware and their design principles are explained.
3. Different steps involved in the design and development of firmware for embedded systems is elaborated. Internals of Real-Time operating system and the fundamentals of RTOS based embedded firmware design is discussed.
4. Fundamental issues in hardware software co-design were presented and explained.

5. Familiarize with the different IDEs for firmware development for different family of processors/ controllers and embedded operating systems.

6. Embedded system implementation and testing tools are introduced and discussed

Course Outcomes

Students are able to

CO No's	COs	Level
CO1	Understand the concepts of ES components, hardware, software, firmware, Embedded OS, RTOS, interrupts, Programming components of Embedded C, design and integration, testing tools.	L2
CO2	Apply the concepts of design and integration with the help of Embedded OS principles and Embedded C, ISR programming and communication between components, testing techniques and tools.	L3
CO3	Analyze various microprocessor and microcontroller families, RTOS and Embedded OS design methodologies, ISR handling functions, hardware, software, firmware integration techniques, different testing tools	L4
CO4	Evaluate different Embedded applications, concepts and constructs using different versions and configurations of microprocessor and micro controllers in real time with various implementations	L5

S.No	Unit	Description	Teaching Aids	CO
1.		Introduction to Embedded system.	BB	CO1
2.		Embedded System Definition,	BB	CO1
3.		History of Embedded systems.	BB	CO1
4.		Classification of embedded systems.	BB	CO3
5.	I	Major application areas of embedded systems,.	BB	CO1
6.		Purpose of embedded systems	PPT	CO1

7.		The typical embedded system– .	BB	CO1
8.		Core of the embedded system	PPT	CO1
9.		Memory, Sensors and Actuators.	PPT	CO3
10.		Communication Interface.	PPT	CO1
11.		Embedded firmware	PPT	CO1
12.		Characteristics of an embedded system,	PPT	CO1
13.		Quality attributes of embedded systems.	BB/PPT	CO1
14.		Application-specific ES .	BB/PPT	CO3
15.		Domain-Specific ES	BB/PPT	CO3
16.		Examples of an embedded system	BB/PPT	CO3
17.	**II**	Analog and digital electronic components.	BB	CO1
18.		I/O types and examples	PPT	CO1
19.		Serial communication devices.	BB	CO1
20.		Parallel device ports, Wireless devices.	BB/PPT	CO1
21.		Timer and counting devices.	BB/PPT	CO2
22.		Watchdog timer, Real time clock.	BB/PPT	CO2
23.	**III**	Embedded Firmware design approaches.	BB	CO2
24.		Embedded Firmware development languages.	BB/PPT	CO2
25.		ISR concept, Interrupt sources.	BB/PPT	CO1
26.		Interrupt servicing mechanism	BB/PPT	CO2
27.		Multiple interrupts.	PPT	CO1
28.		DMA	BB	CO1
29.		Device driver programming	BB	CO2
30.		Concepts of C versus Embedded C	BB	CO3
31.		Compiler versus Cross-compiler.	PPT	CO4

32.		Operating system basics.	BB	CO1
33.		Types of operating systems.	BB/PPT	CO1
34.	**IV**	Tasks, Process and Threads.	BB	CO1
35.		Multiprocessing and Multitasking.	BB/PPT	CO1
36.		Task Scheduling.	BB/PPT	CO2
37.		Threads, Processes and Scheduling.	BB	CO1
38.		Task communication.	BB/PPT	CO2
39.		Task synchronization	BB/PPT	CO2
40.		Device Drivers.	BB	CO1
41.		Fundamental Issues in Hardware Software Co-Design.	BB	CO4
42.		Computational models in embedded design.	BB	CO3
43.		Hardware software Trade-offs.	BB/PPT	CO4
44.		Integration of Hardware and Firmware.	BB	CO2
45.		ICE.	BB/PPT	CO2
46.	V	The Integrated Development Environment.	BB	CO1
47.		Types of files generated on cross-compilation.	BB	CO1
48.		Dissembler/Decompiled,	BB/PPT	CO1
49.		Simulators.	BB/PPT	CO1
50.		Emulators and Debugging.	BB/PPT	CO2
51.		Target hardware debugging.	BB	CO3
52.		Embedded Software development process And tools.	BB/PPT	CO1
53.		Interpreters, Compilers and Linkers.	BB/PPT	CO1
54.		Debugging tools.	BB/PPT	CO1
55.		Quality assurance	BB/PPT	CO3
56.		Testing of the design.	BB/PPT	CO4
57.		Testing on host machine.	BB/PPT	CO2
58.		Simulators, Laboratory Tools.	BB/PPT	CO3
Total Classes			**58**	**10**

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

Evaluation Pattern

S. No	Components	Internal	External	Total
1	Theory	25	75	100
2	Engineering Graphics/Design/Drawing	25	75	100
3	Practical	20	30	50
4	Mini Project/Internship/Industrial Training/ Skill Development programmes/Research Project	-	50	50
5	Project Work – Part I	20	30	50
5	Project Work – Part II	60	90	150

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 75)	Letter Grade	Level	Grade Point
≥ 90	≥ 67	O	Outstanding	10
≥80 to <90	≥60 to <67	S	Excellent	9
≥70 to <80	≥52 to <60	A	Very Good	8
≥60 to <70	≥45 to <52	B	Good	7
≥50 to <60	≥37 to <45	C	Fair	6
≥40 to <50	≥30 to <37	D	Satisfactory	5
<40	<30	F	Fail	0
			Absent	0

Day/Time	09.00-09.50	09.50-10.40	11.00-11.50	11.50-12.40	01.40-02.30	02.30-03.20	03.20-04.10	04.10-05.00
Mon			ES(A)		ES(B)			
Tue		ES(A)		ES(B)				
Wed			ES(B)		Project lab(B)			
Thu			Project lab(A)			ES(B)T		
Fri	ES(B)		ES(A)			ES(A)T		
Sat	ES(A)							

EMBEDDED SYSTEMS UNIT WISE Important Questions

1. Discuss about software MODEM and system on silicon
2. Explain in detail about distributed embedded system architecture
3. Explain in detail about memory allocation related functions
4. Explain in detail about organization of ARM processor and coprocessor
5. Describe how PDA and Data compressor are designed
6. Describe the various stages involved in the design of train controller
7. Explain the method of hardware – software co design for an embedded system application with example
8. Describe the architecture of a typical micro controller with a neat diagram
9. Explain how interrupt routines handled in embedded system
10. Explain the various forms of memories present in a system
11. Explain in detail about inter process communication and synchronization
12. Describe the functions of a typical parallel I/O interface with a neat diagram
13. Explain real time operating system and cyclic scheduling with time slicing
14. Explain the classification of IO devices
15. Explain about the power optimization and its strategies for processes
16. Explain the various bus structures used in embedded system
17. Explain in detail about inter crosses communication and its mechanism
18. Write short notes on ADC and UART
19. Explain about distributed embedded architecture with neat block diagram
20. Explain function pointer, function queues and ISR queues .

 UNIT-1:

21. Explain the classification and applications of Embedded Systems.
22. Define an embedded system. Give the differences between Embedded and General Computing System.
23. Define 'an embedded system'. Discuss the components of Embedded System Model.
24. Explain the following: a) Memory b) Actuators c) Sensors.
25. Write notes on communication interface, embedded firmware and PCB.
26. Explain the characteristics of an Embedded Systems.
27. Explain the Quality Attributes of an Embedded System.
28. Explain application specific embedded system with an example.
29. Explain Automotive Embedded system with an example.

UNIT-2

1. (a) Explain I/O types with suitable examples.
2. Explain the following
    a. Serial Communication devices
    b. Parallel device ports
    c. Wireless devices

3. Explain the following
   a. Timer and Counting devices
   b. Watch dog timer
   c. Realtime Clock
4. Explain
   a. EDA tools.
   b. ORCAD EDA tools.
   c. Integrated Circuit Design.

UNIT-3
1. Explain the concept of firmware design and development approaches.
2. What is ISR? Explain Interrupt sources and Interrupt service mechanism.
3. Differentiate 'C' and Embedded 'C'
4. Differentiate Compiler versus Cross compiler?
5. Explain the Concept of DMA and Device Driver Programming.
6. What are multiple interrupts and give examples?

UNIT-4
1. What is an Operating System? Explain different types of Operating Systems.
2. Explain
   a. Multiprocessing.
   b. Multitasking.
   c. Multischeduling.
3. Explain the Process of Task communication and Task Synchronization.
4. What are tasks, threads and device drivers? Explain how an RTOS can be selected?
5. Explain the following related to embedded system design technology.
   a. Computational Model of Embedded system.
   b. Hardware/Software Co-Design
6. Explain Hardware and Software Tradeoffs and also discuss Integrating hardware and firmware.
7. What is ICE and discuss the issues of Embedded System Design.

UNIT-5
1. (a) Explain integrated development environment and files generated on Cross-compilation?
2. Explain Deassembler/Decompiler, Simulators and Emulators?
3. Write short notes on
   a. Debugging
   b. Target hardware debugging
4. Explain how Boundary Scan is performed?
5. Explain Embedded Software Development Process and Tools?

6. Briefly explain the following in connection with embedded design technology.
a. Main software Utility Tool.
b. CAD and its Hardware.
c. Pre-processors and Interpreters.
7. Write short notes on the following
 a. Explain the use of Compilers and Linkers.
 b. Explain various debugging tools.
8. Explain the following related to embedded system design technology.
    a. Quality assurance and testing of the design.
    b. Testing on host machine.
9. Explain the following related to embedded system design technology.
a) Laboratory Tools (b)Debugging tools