The LNMIIT, Jaipur
Department of Electronics and Communication Engineering
Real Time Embedded Systems and Designs (ECE-XXX)

Programme: B. Tech. (ECE)	Course Title: Advanced Embedded Systems and Designs			Course Code: ECEXXXX
Type of Course: Program Elective	Prerequisites: Micro-I (ECE331)			Total Contact Hours: 40
Year/Semester: 4th/Odd	Lecture Hrs/Week: 3	Tutorial Hrs/Week: 0	Practical Hrs/Week: 0	Credits: 3

Learning Objective:

This course aims to allow students to understand the basic concepts of Embedded Real-Time Operating Systems (E-RTOS). This course will give students an understanding of important fundamentals and essential aspects of the Embedded RTOS, which will help them design and implement E-RTOS. Students will become familiar with the relevant technical vocabulary and will learn about potential career opportunities in the field of E-RTOS. In this course, students will be motivated to develop design skills in embedded systems through well-bounded and open-ended design assignments. After completing this course, students will acquire skills beneficial for obtaining a job in embedded systems and real-time systems.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		Bloom's Level
CO-1	**Analyze** and **classify** an embedded real-time system.	**4, 3**
CO-2	**Understand** and **model** contemporary design challenges about the performance of any embedded RTOS.	**3, 2**
CO-3	**Analyze** embedded hardware and software components for simulation of embedded RTOS.	**4**
CO-4	**Understand** the programming concepts in Embedded C and **apply** them in real-time embedded system design.	**3, 2**
CO-5	**Analyze** and **design** hardware and software problems in embedded real-time systems.	**4, 6**
CO-6	**Understand** and **apply** the concepts of RTOS to design and implement real-time Embedded Systems.	**3, 2**

Course Topics		Lecture Hours
UNIT – I: Introduction to RTOS in Embedded Systems		**05**
1.1 Course overview, expectations, syllabus, FAQ, and prerequisite material. A basic introduction to embedded RTOS.	**1**	
1.2 Classification of Embedded Systems: Real-Time vs. Non-Real Time Systems. Discussion and comparison of popular embedded RTOS.	**1**	
1.3 Introduction to RTOS. Parallel, Distributed, and concurrent programming. Introduction to threads and states of the main thread.	**1**	
1.4 Design goals for RTOS and choosing appropriate IDE for embedded RTOS.	**2**	

Downloading and Installing FreeRTOS.		
UNIT – II: RTOS Tasks and Thread Management		**12**
2.1 Basics of super loop programming and super loops in real-time systems. Super loops and Interrupts.	**2**	
2.2 Comparing super loops to RTOS tasks. Understanding Tasks in RTOS and Creation and implementation of tasks using Embedded FreeRTOS.	**1**	
2.3 IDLE task and Timer SVC task of Embedded FreeRTOS. Deleting Tasks.	**2**	
2.4 Fundamentals of schedulers and types of schedulers. Embedded FreeRTOS Scheduler implementation.	**2**	
2.5 Introduction to Segger System View Tools and its use in debugging Embedded RTOS.	**3**	
2.6 Memory allocation for tasks and context switching.	**2**	
UNIT – III Data Protection and Synchronization		**08**
3.1 Semaphores and synchronization using semaphores.	**2**	
3.2 Time-bound and counting semaphores.	**2**	
3.3 Priority inversion.	**1**	
3.4 Fundamentals of mutexes. Applications of mutexes. Avoiding mutex acquisition failure.	**2**	
3.5 Avoiding Race Conditions.	**1**	
3.6 Software Timers and their usage in Embedded RTOS.		
UNIT – IV: Inter-task Communication		**07**
4.1 Queue management, Passing data through queues by value.	**2**	
4.2 Passing data through queues by reference.	**2**	
4.3 Hook functions, scheduling policies.	**3**	
UNIT-V: Real-time systems		**08**
5.1 Data acquisition systems.	**2**	
5.2 Priority scheduler.	**4**	
5.3 Running event threads as high-priority main threads.	**2**	

Textbook References:

Text Book:

1) Jonathon W. Valvano, ***Real-Time Operating Systems for ARM Cortex-M Microcontrollers***, A Jonathan Valvano; 4th edition, 2017.
2) Brain Amos, ***Hands-On RTOS with Microcontrollers***, Packt, Birmingham-Mumbai, 2020.
3) Collin Walls, ***Embedded RTOS Design: Insights and Implementation***, Newnes, 2020.

Reference books:

1) K. C. Wang, ***Embedded and Real-Time Operating Systems***, Springer, 2017

Evaluation Scheme	
Item	**Weightage**
Assignment	**20%**
Mid-Term Examination	**20%**
Hardware Project and Report	**25%**
End Semester Examination	**45%**

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	2							1	1		
CO2	3	3	1	1	2	1	1					1	2		
CO3	3	3	1	1	2							1	2		
CO4	3	3	1	1	3				2	2		2	3		
CO5	3	3	3	2	3				2	2	2	2	3	2	
CO6	3	3	3	2	3				2	3	3	3	3	2	

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Updated By: Dr. Deepak Nair **Approved By:**