SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B. Tech. Semester VI

Subject Name: Embedded System **Subject Code: BTEL14632**

Type of course: Professional Elective Course (PEC)

Prerequisite: Microprocessor and Microcontroller, Basics of assembly and 'c' programming

Rationale: Embedded System plays vital role in today's industry, where automation is generally achieved by microcontroller based system. Some of higher end multi-processing application requires OS/RTOS to achieve real time requirements. This course will provide an opportunity to the students to learn ARM architecture, instruction set and assembly language as well as embedded C programming. ARM is very popular for portable applications because of its high performance with low power consumption. Students will learn the concept of embedded system design and development using ARM microcontroller for various real world applications.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	20	30	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Introduction to Embedded Systems** Embedded systems definition, description, design considerations & requirements, embedded processor selection & tradeoffs, examples of embedded systems, embedded design life cycle, classification of embedded systems, hardware/software partitioning, CoDesign concept.	3	10
2.	**Embedded Software Architecture** Concept of real time systems, concept of real-time task scheduling, Interrupts, latency, Process state and scheduling, Clock driven and Event driven scheduling, Rate-Monotonic Scheduling, Earliest-Deadline First Scheduling, Fault-Tolerant Scheduling, Round Robin, Round robin with interrupt, function queue scheduling.	4	10
3.	**ARM Controller Architecture and Assembly Language Programming** ARM Cortex-M hardware architecture, Memory systems and registers, interrupt processing, ARM Programmer's model, The	10	20

	Program Counter and Program ROM Space in ARM, ARM CPSR, on chip peripherals, ARM Data Format & Directives, Introduction to ARM Assembly Programming, ARM addressing modes, Load and Store Instructions in ARM, Arithmetic Instructions, Logic Instructions, Shift and Rotate Instructions in ARM, BCD and ASCII Conversions, Looping and Branch Instructions, Calling Subroutine with BL, ARM Time Delay and Instruction Pipeline, Conditional Execution, Assembling an ARM Program, Viewing Registers and Memory with ARM Keil IDE.		
4.	**EMBEDDED 'C' PROGRAMMING** Embedded 'C' programming for ARM, Introduction to Keil IDE, Registers and variables, declarations and mapping, Basic C data types, C Looping structures, Register allocations, function calls, pointer, structure arrangement. C Programming for peripherals like GPIO, Timers, PWM Unit, DAC/ADC, SPI, UART, I^2C Protocols, Interrupt functions in 'C', Software and Hardware debugging techniques.	**9**	**20**
5.	**Communication Protocols:** Basics of Serial and Parallel bus communication protocols: USART, I^2C bus, SPI, CAN bus, USB bus, ISA bus, PCI and PCI/x bus, AMBA bus, Bluetooth, Device driver.	**5**	**10**
6.	**Embedded System Application development:** Introduction of STM32 ARM Board for interfacing, Interfacing LED and LCD, Serial port terminal application, Interfacing of temperature sensor, LDR light sensor, gas sensor, sound sensor, Speaker/Microphone interfacing, Speed control of DC motor using STM32, control of electrical devices, Measurement of analog and electrical variables, Motion sensing using accelerometer, Bluetooth interfacing.	**8**	**15**
7.	**Introduction to OS and Real Time Operating System:** Overview of OS, Processes and Threads, Context Switching, multitasking situations, Features of an Operating System, Need for real time operating system, features of RTOS, task and task state, scheduler type, scheduling policies, Critical section issue and semaphore, shared data, memory management ISR in RTOS, Types of RTOS.	**6**	**15**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**25**	**30**	**10**	**10**	**10**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Embedded System: Architecture, Programming and Design	Raj Kamal	McGraw Hill Education	2015	Third
2.	Embedded System: An Integrated Approach	Lyla B. Das	Pearson	2013	Third
3.	An Embedded Software Primer	David E. Simon	Addison Wesley Pearson Education	1999	
4.	ARM, System-on-chip architecture	Steve Furber	Addison Wesley Publications		second
5.	ARM Assembly Language Programming & Architecture	Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi	Kindle edition		
6.	Arm system Developer's Guide –Designing and Optimizing System Software	Andrew Sloss, Dominic Symes, Chris Wright	Elsevier	2004	First
7.	Embedded C Programming and the Microchip PIC	Barnett, O'cull, Cox	Elsevier Publication	2007	
8.	The Definitive Guide to ARM cortex M3 and M4 Processor	Joseph Yiu	Elsevier Publication	2007	
10.	Embedded Systems	B. Kanta Rao	PHI Learning Pvt. Ltd.	2011	
11.	Embedded Systems: Real-time interfacing to ARM Cortex-M Microcontrollers, Vol. 2	Jonathan W. Valvano		2014	Fourth Edition
12.	Embedded system Design with ARM	Indranil Sengupta & Kamalika Datta	NPTEL course out		

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Recognize the basic elements and functions of embedded systems.	10
CO-2	Explain architecture and programming model of ARM, develop and analyze assembly language programs for ARM microcontroller.	25
CO-3	Develop and debug embedded 'C' language program for ARM based system.	25
CO-4	Learn embedded software architecture, OS functions and Real Time Operating System.	15
CO-5	Interface I/O devices, sensors, actuator with ARM microcontroller to design embedded system for solving real life challenges.	25

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Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	3	2	1	1	2	1	2	-	1	3	3	1	1
CO-2	3	3	3	3	3	-	2	1	2	-	-	3	2	3	-
CO-3	3	3	3	3	3	-	2	-	2	-	-	3	3	3	1
CO-4	3	3	3	2	1	-	-	-	-	-	-	3	2	2	-
CO-5	3	3	3	3	3	1	3	2	3	2	2	3	3	3	3
Rationale *															

Rationale*: Explaining why it is matching this particular program outcome

Suggested List of Practical:

1. Introduction and familiarization with ARM microcontroller, development board and IDE.
2. Programming of arithmetic and logical operations using ARM microcontroller.
3. Executing branching operation in ARM microcontroller.
4. To perform timer operation of ARM microcontroller.
5. To implement interfacing of a LCD/LED using ARM microcontroller.
6. Configuration and generation of PWM pulses using ARM microcontrollers.
7. Perform an experiment for sensing analog signal using ADC channels of ARM microcontrollers
8. Perform an experiment to interface keypad and display with ARM microcontrollers.
9. Interfacing of stepper motor/DC motor driver using ARM microcontrollers.
10. To perform an experiment for familiarizing with various communication protocols
11. To perform an experiment to interface sensors and actuators using various protocols

List of Open Source/learning website:

1. http://nptel.iitm.ac.in/courses.php
2. https://www.st.com
3. www.ti.com

Video lecture:

1. NPTEL and youtube videos on embedded system by satish kashyap.
2. https://www.youtube.com/user/ARMflix/videos

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