ECE: Embedded Systems and Designs

Programme: B.Tech. (ECE)	Year: 2018	Semester:	8
Course: Program Elective	Credits: 3	Hours:	40

Course Context and Overview (100 words): It will encourage students to the field of embedded systems, and will provide a foundation which will empower students to pursue subsequent courses in real-time embedded systems software. Students will become familiar with the technical vocabulary of embedded systems and will learn about its potential career opportunities. Students will have the opportunity to design and develop an embedded systems from the scratch, starting with analog and digital electronic components and data sheets, and progressing through development of hardware and implementation of firmware. Students will be given the opportunity to develop design skills, through well-bounded as well as open-ended design assignments. Students will have the opportunity to learn how information gained in other core engineering classes comes together to be applied to real-world applications. After completion of this course, students will be given an opportunity to experience embedded system design, and will gain knowledge beneficial for obtaining a job in this field.

Prerequisites Courses: Electronics-I (ECE-103), Micro-I (ECE-331)

Course outcomes (COs):

On completion of this course, the students will have the ability to:
CO1: Analyze and explore an embedded system design space, including processors, memories, networks, and sensors
CO2: Address contemporary design challenges pertaining to reliability, power and thermal efficiency, real-time performance
CO3: Model embedded hardware and software components for simulation and exploration
CO4: Program in Embedded C and its application in real time embedded system design
CO5: Design, troubleshoot hardware and software in embedded systems

Course Topics:

Topics	Lecture Hours	
UNIT – I: Introduction to Embedded Systems		**5**
• Course overview, expectations, syllabus, FAQ, and prerequisite material. • Design considerations and requirements, processor selection and tradeoffs process.	**1**	
• Microprocessor / microcontroller architectures and instruction sets, Atmega-328 and TI-MSP430G2 series microcontroller architecture and busses.	**4**	
• SPLD and CPLD devices		
UNIT – II: Embedded System Organization		**10**
• Major components in a typical embedded system, operating requirement, modes of operation, hardware/software code designs, hardware-software trade-offs.	**1**	
• Architectural differences in microcontrollers and memories used.	**1**	
• Digital I/O, Timers, Pulse Width Modulation (PWM) and Demodulation, Analog interfaces, Interrupt services.	**2**	
• Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs) and their applications.	**1**	
• Power management techniques in microcontrollers, Voltage regulators, Thermal considerations, heat sinks.	**1**	
• Data sheets, and importance of Electromagnetic Compatibility (EMC), and Electromagnetic Interference EMI in embedded systems.	**1**	
• Microcontroller supervisory circuits, Oscillators and Reset circuits, Watchdog timer and its applications.	**2**	
• Hardware development and Debugging strategies and techniques. Logic probes, voltmeters and oscilloscopes. Schematics and wiring diagrams, recommended practices and CAD tools.	**1**	
UNIT – III: Embedded C Programming		**14**
• Programming in assembly vs assembly languages, Embedded C programming review. • Defining variables, Bit operations, Software Interrupt design in C. • Mathematical operators, Flow control techniques, Pointers and arrays, multidimensional arrays.	**3**	
• Constructs, Data structures, Compiler directives.	**2**	
• Interfacing different logic families, fanout, signal buffering, noise margins, pullup / pulldown.	**2**	
• Timing requirements, propagation delay, setup, hold, rise / fall times, timing analysis, Clock skew.	**2**	
• Decoding logic, Glue logic.	**1**	
• Code development using Arduino IDE and TI-Energia IDE.	**1**	
• Software based switch / key debouncing in hardware and firmware, keypad decoding. • Timers/counters.	**3**	
UNIT – IV: I/O Interfacing Concepts		**04**
• Bus structures, Peripheral and external communication interfaces. • Operating System: Design and organization of embedded and real-time operating systems, scheduling, power management, debugging.	**1**	

• Serial communication, RS-232/485, UART, line drivers/receivers, charge pumps, terminal emulation, USB, SPI, I2C.	3	
• Synchronous serial communication. Interrupt based serial port management in C.	1	
UNIT – V: Project Development and Troubleshooting Techniques		
• Submit PDR presentations, Final Project Design Review (PDR). • Each project team presents development plan and milestones.	1	07
• Code review exercise: Firmware design, main loop / interrupt driven designs, device drivers.	2	
• Final project design. Debugging session.	4	

Textbook references:

Text Book:

1) David E. Simon, "An Embedded Software Primer", Addison-Wesley Longman Publishing Co., Inc., Boston, MA, 1999
2) Jack G. Ganssle, "In The Art of Programming Embedded Systems", Academic Press, San Diego, 1992
3) Michael Barr, "Programming Embedded Systems in C and C++", O'Reilly & Associates, Inc., Sebastopol, CA, 1998

Reference Books:

1) Tim Williams, "The Circuit Designer's Companion (Second Edition)", Newnes, Oxford, 2005

Evaluation Methods:

Item	Weightage
Attendance	5%
Assignment	25%
Hardware Project	30%
Project Report	15%
End Semester Exam	25%

Attendance: Students with less than 70% attendance will not be allowed to attend end semester exam and will get 0 marks in the attendance.
Students with above 70% attendance will get directly proportional marks.
(e.g.: 95% attendance = 9.5 Marks)

Prepared By: Dr. M V Deepak Nair
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