

**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**  
**WORK INTEGRATED LEARNING PROGRAMMES**  
**M. Tech Automotive Electronics**  
**I Semester 2019-20**

<b>Course Title</b>	Embedded System Design
<b>Course No(s)</b>	AEL ZG512
<b>Credit Units</b>	4
<b>Credit Model</b>	1-1-2
<b>Content Authors</b>	

**Course Description**

Introduction to embedded systems; embedded architectures; Architectures and programming of microcontrollers and DSPs; Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

**Course Objectives**

<b>No</b>	<b>Course Objective</b>
<b>CO1</b>	Introduce Hardware and Software Components of Embedded Systems
<b>CO2</b>	Introduce the challenges in system design and develop system design skills
<b>CO3</b>	Develop basic programming skills required for designing Embedded systems
<b>CO4</b>	Introduction to advanced topics of research in the field of Embedded Systems

**Text Book(s)**

<b>T1</b>	Wolf, Wayne, Computers as Components – Principles of Embedded Computing System Design, Second Edition, Morgan-Kaufmann, 2010.
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**Reference Book(s) & other resources**

<b>R1</b>	James.K.Peckol, Embedded System Design – A Contemporary Design Tool, Wiley Student Edition, 2010
<b>R2</b>	Steve Furber, ARM System-on-chip Architecture, Second Edition, Pearson, 2007
<b>R3</b>	The Unified Modeling Language Reference Manual, by James Rumbaugh, Ivar Jacobson, Grady Booch, Addison-Wesley, 1999
<b>R4</b>	P. A. Laplante & S. J. Ovaska, Real-Time Systems Design and Analysis: Tools for the Practitioner, Wiley, 4th edition
<b>R5</b>	Kamal, Raj, Embedded Systems: Architecture, Programming & Design, Tata McGraw Hill, 2nd Ed., 2008
<b>R6</b>	The Definitive Guide to ARM Cortex M3/M4 Processors. Third Edition. Joseph Yiu
<b>R7</b>	Reference Manuals/ Published Papers a)8051 Microcontroller- Hardware Manual, b)8051RE2 Reference Manual, c)ARM CPU Reference Manual, d)LPC 23xx Reference Manual, e)TI DSP 64xx Manual Note : Required manual and reference papers will be uploaded on course website .

## **Content Structure**

### **1. Introduction to Embedded System**

- 1.1. Introduction
  - 1.1.1. Characteristics and Embodiments of Embedded System
  - 1.1.2. Classification of Embedded Systems
  - 1.1.3. Introduction to Hardware and Software components of an Embedded System
- 1.2. Hardware Components of Embedded System
  - 1.2.1. Introduction to Processor Architectures
  - 1.2.2. Memory Types Organization, Cache
  - 1.2.3. Interrupts
  - 1.2.4. Basic peripherals like Timers , ADC/DAC
- 1.3. Software components of Embedded System
  - 1.3.1. RTOS & Tasks
  - 1.3.2. Introduction to SOC design, Embedded System Design Process/Flow

### **2. Small Scale Embedded System Design**

- 2.1. Problem Specification
  - 2.1.1. User and System Design Requirements
  - 2.1.2. System Block Diagram Development
  - 2.1.3. Selection of Hardware and Software – Considerations
  - 2.1.4. Hardware/Software design & Testing Considerations
  - 2.1.5. Final System Design

### **3. Embedded Architecture 1 – RISC ARM Architecture**

- 3.1. Introduction to ARM CPU Architecture
- 3.2. Programmers Model of ARM CPU
  - 3.2.1. Register Organization
  - 3.2.2. Operating Modes
  - 3.2.3. Pipelining
  - 3.2.4. ARM Exception Handling
- 3.3. ARM Instruction Set

### **4. Embedded Architecture 2 –ARM Based Microcontrollers**

- 4.1. Introduction to LPC23xx
  - 4.1.1. AMBA Bus Architecture
  - 4.1.2. GPIO, Timer, Watch dog
  - 4.1.3. Interrupt Handling -VIC , ADC/DAC
  - 4.1.4. DMAC
- 4.2. Communication Peripherals- Synchronous & Asynchronous
  - 4.2.1. SPI , I2C , I2S , UART
  - 4.2.2. CAN
  - 4.2.3. USB
- 4.3. Introduction to ARM Cortex Architectures
  - 4.3.1. ARM Cortex-M Architecture
  - 4.3.2. Board Design - System Booting related Concepts

### **5. Embedded Architecture 3 –DSP Processors**

- 5.1. Introduction to VLIW & DSP architectures
  - 5.1.1. Fixed and Floating point Datapath /DSP including Numeric Representation
  - 5.1.2. DSP Architectures - Characteristics
- 5.2. TMS 64X+ CPU Architecture –Addressing Modes
  - 5.2.1. TMS 64X+ CPU Introduction
  - 5.2.2. Computational Unit
  - 5.2.3. Instruction Set
- 5.3. TMS 6455 Programmers Model

- 5.3.1. Modes of Operation
- 5.3.2. Exceptions, Interrupts
- 6. Distributed and Multiprocessor based System Design**
  - 6.1. Introduction to Multiprocessor , Distributed and Networked Embedded Systems
  - 6.2. Case Studies – Distributed and Multiprocessor Systems
- 7. Embedded Software Design**
  - 7.1. System Modeling
    - 7.1.1. Hardware software partitioning
    - 7.1.2. System Modeling using UML
  - 7.2. Compilers, Assemblers and Debuggers for Embedded Systems
  - 7.3. Embedded C Programming
    - 7.3.1. Memory Management , Shared Memory
    - 7.3.2. System Initialization
- 8. Embedded Software**
  - 8.1. Tasks & Task management , Context Switching
  - 8.2. RTS –Task Scheduling Concepts , Semaphore, Mutex, Deadlocks
  - 8.3. Multitasking using ARM Cortex M Architectures – Introduction to RTOS Design
- 9. Advanced Embedded System Concepts**
  - 9.1. Performance Analysis and Optimization
  - 9.2. Accelerated Embedded System
  - 9.3. Fault Tolerance and Reliability

**Evaluation Scheme:**

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-I/ Assignment-I	Online	-	5%	February 1 to 10, 2016
	Quiz-II			5%	March 1 to 10, 2016
	Quiz-III/ Assignment-II			5%	March 25 to April 3, 2016
EC-2	Mid-Semester Test	Closed Book	2 hours	35%	28/02/2016 (AN) 2 PM – 4 PM
EC-3	Comprehensive Exam	Open Book	3 hours	50%	10/04/2016 (AN) 2 PM – 5 PM

Syllabus for Mid-Semester Test (Closed Book): Topics in Session Nos. 1 TO 11

Syllabus for Comprehensive Exam (Open Book): All topics (Session Nos. 1 to 22)

**Important links and information:**

Elearn portal: <https://elearn.bits-pilani.ac.in>

Students are expected to visit the Elearn portal on a regular basis and stay up to date with the latest announcements and deadlines.

Contact sessions: Students should attend the online lectures as per the schedule provided on the Elearn portal.

Evaluation Guidelines:

- EC-1 consists of either three Assignments. Students will attempt them through the course pages on the Elearn portal. Announcements will be made on the portal, in a timely manner.
- For Closed Book tests: No books or reference material of any kind will be permitted.
- For Open Book exams: Use of books and any printed / written reference material (filed or bound) is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
- If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam which will be made available on the Elearn portal. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignment , Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.

**Instructor-in-Charge**  
**AEL ZG512**