EMBEDDED SYSTEMS		Semester	7
Course Code	**BIS714C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- Identify the components, purpose and applications of the Embedded Systems
- Learn the RTOS and IDE for Embedded System Design
- Understand the fundamentals of ARM-based systems and basic architecture of CISC and RISC
- Familiarize with ARM programming modules along with registers, CPSR and Flags

Teaching-Learning Process (General Instructions)

These are sample strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but different types of teaching methods may be adopted to achieve the outcomes.
2. Utilize video/animation films to illustrate the functioning of various concepts.
3. Promote collaborative learning (Group Learning) in the class.
4. Pose at least three HOT (Higher Order Thinking) questions in the class to stimulate critical thinking.
5. Incorporate Problem-Based Learning (PBL) to foster students' analytical skills and develop their ability to evaluate, generalize, and analyze information rather than merely recalling it.
6. Introduce topics through multiple representations.
7. Demonstrate various ways to solve the same problem and encourage students to devise their own creative solutions.
8. Discuss the real-world applications of every concept to enhance students' comprehension.
9. Use any of these methods: Chalk and board, Active Learning, Case Studies.

Module-1

Introduction to Embedded Systems: What is an Embedded System? Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification of Embedded systems, Major Application Areas of Embedded Systems. Purpose of Embedded Systems.

The Typical Embedded System: Microprocessor vs. Microcontroller, RISC vs. CISC Processors, Harvard vs. Von-Neumann Processor Architecture, Big-Endian vs. Little-Endian Processors, Memory-ROM and RAM types, Sensors & Actuators, The I/O Subsystem – I/O Devices, Light Emitting Diode (LED), 7-Segment LED Display, Optocoupler, Relay, Piezo Buzzer, Push button switch, Communication Interfaces, On-board Communication Interfaces, External Communication Interfaces.

Textbook 1: Ch. 1.1-1.6, Ch. 2.1-2.4

Module-2

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and Non-Operational Quality Attributes. Embedded Systems-Application and Domain Specific, Hardware Software Co-Design and Program Modelling.

Embedded Firmware Design and Development: Embedded Firmware Design Approaches, Embedded Firmware Development Languages, Programming in Embedded C (Excluding C language).

Textbook 1: Ch. 3.1-3.2, Ch. 4.1-4.2 (4.2.1 and 4.2.2 only), Ch. 7.1-7.2, Ch. 9.1-9.3 (9.3.1 and 9.3.2 only)

Module-3

RTOS and IDE for Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads (Only POSIX Threads with an example program), Thread Preemption, Preemptive Task Scheduling Techniques, Task Communication, Task Synchronization Issues – Racing and Deadlock. How to Choose an RTOS, Integration and Testing of Embedded Hardware and Firmware, The Embedded System Development Environment.

Textbook 1: Ch. 10.1-10.3, 10.5.2, 10.7, 10.8.1.1, 10.8.1.2, 10.10, Ch. 12.1-12.2, Ch. 13.1

Module-4

ARM Embedded Systems: The RISC Design Philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software.

ARM Processor Fundamentals: Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions

Textbook 2: Ch. 1.1-1.4, Ch. 2.1-2.5

Module-5

Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Loading Constants.

Textbook 2: Ch. 3.1-3.6

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

1. Explain the characteristics and attributes of an Embedded System.
2. Illustrate the hardware software co-design and firmware design approaches of Embedded Systems.
3. Demonstrate the need of real time operating system for Embedded System applications.
4. Explain the ARM Architectural features and Instructions.
5. Develop programs using ARM instruction set for an ARM Microcontroller.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Book:

1. Shibu K V, "Introduction to Embedded Systems", Second Edition, Tata McGraw Hill Education.
2. Andrew N Sloss, Dominic Symes and Chris Wright, "ARM System Developers Guide – Designing and Optimizing System Software", Elsevier, Morgann Kaufman Publishers.

Reference Books:

1. Raj Kamal, "Embedded Systems: Architecture and Programming", Tata McGraw Hill, 2008.
2. Raghunandan.G.H, "Microcontroller (ARM) and Embedded System", Cengage learning Publication, 2019.
3. "Insider's Guide to the ARM7 based microcontrollers", Hitex Ltd.,1st edition, 2005.

Web links and Video Lectures (e-Resources):

- https://alison.com/tag/embedded-systems
- https://www.youtube.com/watch?v=uFhDGagZzjs
- https://www.youtube.com/watch?v=G1c_WMD_5pU
- https://archive.nptel.ac.in/courses/106/105/106105193/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrate the Installation and working of Keil Software - Student group of TWO (10 Marks).
- Using Keil software, observe the various Registers, Dump, CPSR etc. and write Assembly Language Programs (15 Marks).