Program :	**Diploma in Computer Engineering / Computer Hardware Engineering**
Course Code : **5131**	Course Title: **Embedded System and Real time Operating System**
Semester : **5**	Credits: **4**
Course Category: **Program Core**	
Periods per week: **4 (L4:T:0:P:0)**	Periods per semester: **60**

Course Objectives:

- Introduce the technologies behind embedded computing systems.
- Provide knowledge on the working of microcontrollers and its applications.
- Familiarize the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices.
- Introduce the basic concepts of Embedded Operating Systems.

Course Prerequisites:

Topic	Course code	Course name	Semester
Digital Electronics		Digital Computer Principles	III
Programming Concepts		Programming in C	III

Course Outcomes :

On completion of the course, the student will be able to:

COn	Description	Duration (Hours)	Cognitive Level
CO1	Explain the basic concepts and structure of Embedded systems	12	Understanding
CO2	Develop Programs for AVR Microcontrollers in C	19	Applying
CO3	Illustrate the interfacing of Microcontroller with external peripherals.	12	Applying
CO4	Explain the key concepts of Real Time Operating Systems.	15	Understanding
	Series Test	2	

CO – PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2						
CO2	3						
CO3	3						
CO4	2						

3-Strongly mapped,   2-Moderately mapped, 1-Weakly mapped

Course Outline

Module Outcomes	Description	Duration (Hours)	Cognitive Level
CO1	**Explain the basic concepts and structure of Embedded systems**		
M1.01	Explain the features of embedded systems.	3	Understanding.
M1.02	Illustrate the building blocks of embedded systems.	4	Understanding.
M1.03	Interpret the AVR architecture.	5	Understanding.

Contents:

Embedded Systems – Definition, Comparison with general purpose computers – Classify embedded systems with different criteria, Applications and Purpose.

Building blocks of an Embedded Systems – Core of Embedded System, Classification of Memory, Memory selection for embedded systems, Role of Sensors, actuators, I/O subsystem, communication interface, Embedded Firmware and other components.

Characteristics and Qualities of Embedded System – Characteristics, Quality Attributes,

AVR Microcontroller Architecture - Factors to be considered in selection – Simplified view of AVR microcontroller, **ATMega32** - Registers, Data Memory, AVR Status register, Program Counter and Program ROM space, I/O ports, Registers associated with I/O ports.

CO2	Develop Programs for AVR Microcontrollers in C		
M2.01	Examine C data types for the AVR microcontroller.	1	Understanding
M2.02	Develop C programs for time delay and I/O operations.	4	Applying
M2.03	Develop C programs for logic and arithmetic operations.	2	Applying

M2.04	Develop C programs for data conversion and data serialisation.	2	Applying
M2.05	Describe the Normal and CTC mode of Timers	2	Understanding
M2.06	Develop C Programs to generate time delays and count events using Timer/Counter.	4	Applying
M2.07	Explain Interrupts in AVR	1	Understanding
M2.08	Illustrate Interrupt Programming in C	3	Understanding
	Series Test – I	1	

Contents:

AVR Programming in C – data types, C programs to generate time delay, I/O Programming, logic and arithmetic operations, Data Conversion, Data Serialisation, Memory Allocation.

Timer and Counter: Timers and their associated registers, Normal and CTC mode, Programming Timers in C, Counter Programming in C.

Interrupts : AVR Interrupts, ISR, Steps executing an Interrupt, Sources of interrupts, Enabling and disabling Interrupts, Interrupt priority, Interrupt Programming in C.

CO3	**Illustrate the interfacing of Microcontroller with external peripherals.**		
M3.01	Illustrate the interfacing of Serial Port, LCD and Keyboard Interfacing.	6	Applying
M3.02	Illustrate the interfacing of ADC, DAC and Sensors.	6	Applying

Contents:

Interfacing: ATMega32 Connection to RS232, Serial Port Programming in C, LCD Interfacing, Keyboard Interfacing, ADC, DAC and Sensor interfacing and Programming in C.

CO4	**Explain the key concepts of Real Time Operating Systems.**		
M4.01	Explain the functions of an Operating System,	1	Understanding
M4.02	Summarize the features of different types of Operating Systems.	1	Understanding
M4.03	Outline key concepts of Task, Process and Threads.	3	Understanding
M4.04	Explain multiprocessing and multitasking.	1	Understanding
M4.05	Outline the key features of Task Scheduling algorithms.	3	Understanding
M4.06	Summaries the key concepts of Task Communication and Synchronization	4	Understanding

M4.07	Explain Device Drivers	1	Understanding
M4.08	List the functional and nonfunctional requirements in selecting a RTOS	1	Understanding
	Series Test – II	1	

Contents:

Real Time Operating Systems (RTOS) – OS Basics, Types of OS, Process, Task and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication, Task Synchronization, Device Drivers, How to choose RTOS.

Text / Reference

T/R	Book Title/Author
T1	**Shibu K.V, Introduction to Embedded Systems** - Mc Graw Hill, First Edition
T2	Muhammad Ali Mazidi, Sarmad Naimi, & Sepehr Naimi, **The AVR Microcontroller and Embedded Systems Using Assembly and C,** Pearson Education
R1	Michael J. Pont**, Embedded C,** Pearson Education, Second Edition
R2	Raj Kamal, **Embedded Systems,**Mc Graw Hill, Second Edition.

Online Resources

Sl.No	Website Link
1	https://www.studyelectronics.in/embedded-programming-tutorial-chapter-1-beginners/
2	https://www.tutorialspoint.com/embedded_systems/index.htm
3	https://embeddedschool.in/avr-microcontroller-programming/