1. **Module Code:** **COE 4161**
2. **Module Title:** **EMBEDDED COMPUTER SYSTEMS ENGINEERING**

Unit1: History and overview, Embedded microcontrollers: Structure of a basic computer system: CPU, memory, I/O devices on a bus - CPU families used in microcontrollers: 4-bit, 8-bit, 16-32-bit - Basic I/O devices: timers/counters, GPIO, A/D, D/A - Polled I/O vs. interrupt-driven I/O - Interrupt structures: vectored and prioritized interrupts - DMA transfers - Memory management units - Memory hierarchies and caches.

Unit2: Embedded programs: The program translation process: compilation, assembly, linking - Representations of programs: data flow and control flow - Fundamental concepts of assembly language and linking: labels, address management - Compilation tasks: mapping variables to memory, managing data structures, translating control structures, and translating expressions.

Unit3: Low-power computing: Sources of energy consumption: toggling, leakage - Instruction-level strategies for power management: function unit management - Memory system power consumption: caches, off-chip memory - Power consumption with multiple processes - System-level power management: deterministic, probabilistic methods.

Unit4: Reliable system design: Transient vs. permanent failures in hardware - Sources of errors from software - The role of design verification in reliable system design - Fault-tolerance techniques - Famous failures of embedded computers.

Unit5: Design methodologies: Multi-person design projects - Designing on-time and on-budget - Design reviews - Tracking error rates and sources - Change management.

Unit6: Embedded multiprocessors: Importance of multiprocessors as in performance, power, and cost - Hardware/software partitioning for single-bus systems - More general architectures - Platform FPGAs as multiprocessors.