SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE – 641035

19MCE304- DESIGN OF EMBEDDED SYSTEMS

TWO MARK QUESTION AND ANSWERS

1. Explain the concept of an embedded system architecture. (2 marks)

Answer:

Embedded system architecture refers to the arrangement and organization of hardware and software components within an embedded system. It includes the selection and integration of microcontrollers, memory types (such as RAM and ROM), communication interfaces (like UART, SPI, I2C), peripherals (sensors, actuators), and the firmware/software that controls these components to perform specific functions.

2. Describe the role of a microcontroller in embedded system architecture. (2 marks)

Answer:

A microcontroller acts as the central processing unit (CPU) in embedded systems. It integrates a CPU core, memory (RAM and ROM), input/output peripherals (GPIO, timers, UART), and sometimes analog-to-digital converters (ADC) and digital-to-analog converters (DAC). It executes the firmware/software instructions, controls peripheral operations, manages data flow, and interacts with external devices to perform designated tasks in real-time.

3. Differentiate between RAM and ROM in embedded system architecture. (2 marks)

Answer:

RAM (Random Access Memory):

Volatile memory used for storing data and program instructions that can be read from and written to.

Provides fast access to data but loses its contents when power is turned off.

ROM (Read-Only Memory):

Non-volatile memory used for storing permanent program instructions.

Contents are pre-programmed during manufacturing and cannot be altered during normal operation.

Used to store firmware and critical system instructions that must remain intact across power cycles.

4. Explain the significance of firmware in embedded system architecture. (2 marks)

Answer:

Firmware in embedded system architecture refers to the software that is stored in non-volatile memory (like ROM or Flash) and provides low-level control of hardware components. It initializes the system, manages communication protocols, controls peripheral devices (such as sensors and actuators), and ensures the overall functionality and reliability of the embedded system. Firmware operates with direct access to hardware and is critical for proper system operation.

5. Discuss the role of buses in embedded system architecture. (2 marks)

Answer:

Buses in embedded system architecture serve as communication channels that connect various components such as the CPU, memory, peripherals, and input/output devices. They facilitate data transfer and control signals between these components. Common buses include I2C, SPI, UART for serial communication, and parallel buses for high-speed data transfer. Proper bus selection and configuration are essential for ensuring efficient and reliable system operation.

6. Describe the function of Real-Time Operating Systems (RTOS) in embedded system architecture. (2 marks)

Answer:

RTOS in embedded system architecture provides a platform for managing tasks and resources with deterministic response times. It schedules tasks based on priority, ensures timely execution of critical operations, manages memory allocation, and handles communication between software components and peripherals. RTOS is essential for applications requiring precise timing, such as industrial automation, automotive systems, and medical devices.

7. Explain the purpose of watchdog timers in embedded system architecture. (2 marks)

Answer:

Watchdog timers are hardware components in embedded system architecture designed to monitor the operation of the system. They require periodic resets or "kicks" from the software to prevent the timer from expiring. If the timer expires due to software hang-up or malfunction, the watchdog timer resets the system, ensuring that it returns to a known state and continues normal operation. This feature enhances system reliability and robustness in critical applications.

8. Discuss the significance of communication protocols in embedded system architecture. (2 marks)

Answer:

Communication protocols in embedded system architecture define rules and procedures for exchanging data and control signals between devices and systems. They ensure compatibility, reliability, and efficiency in data transmission. Examples include UART for serial communication, SPI for high-speed data transfer, I2C for inter-device communication, and protocols like TCP/IP for networking. Proper protocol selection and implementation are crucial for seamless interaction between embedded systems and external devices.

9. Explain the role of DMA (Direct Memory Access) controllers in embedded system architecture. (2 marks)

Answer:

DMA controllers in embedded system architecture facilitate direct data transfer between peripherals and memory without CPU intervention. They improve system performance by offloading data movement tasks from the CPU, allowing it to focus on executing application code. DMA controllers are used in scenarios requiring high-speed data transfer, such as audio/video processing, networking, and data acquisition systems. They enhance overall system efficiency and reduce latency.

10. Describe the function of ADC (Analog-to-Digital Converter) in embedded system architecture. (2 marks)

Answer:

ADC in embedded system architecture converts analog signals from sensors, transducers, or analog devices into digital data that can be processed by the microcontroller or digital logic circuits. It samples the analog signal at regular intervals, quantizes it into discrete digital values, and outputs the digital representation. ADCs are essential for interfacing with the physical world in applications such as temperature sensing, pressure measurement, and audio processing.

11. Discuss the importance of power management units in embedded system architecture. (2 marks)

Answer:

Power management units in embedded system architecture oversee the distribution and regulation of electrical power to ensure efficient operation and longevity of the system. They manage power modes (such as sleep, idle, active) to optimize energy consumption based on workload demands, extend battery life in portable devices, and prevent overheating or voltage fluctuations that could damage components. Effective power management enhances reliability and sustainability in embedded systems.

12. Explain the concept of interrupt handling in embedded system architecture. (2 marks)

Answer:

Interrupt handling in embedded system architecture refers to the mechanism by which the CPU responds to and manages external events or signals that require immediate attention. When an interrupt occurs (e.g., from a peripheral device or timer), the CPU temporarily suspends its current task, saves its state, and executes an interrupt service routine (ISR) to process the event. This allows embedded systems to handle real-time events efficiently without constant polling, enhancing responsiveness and multitasking capabilities.

13. Describe the role of timers and counters in embedded system architecture. (2 marks)

Answer:

Timers and counters in embedded system architecture are hardware modules used to measure time intervals, count events, and generate periodic signals. Timers are often used for scheduling tasks, generating pulse-width modulation (PWM) signals, or implementing timeouts in communication protocols. Counters track occurrences of specific events or pulses, such as encoder counts in motor control systems or frequency measurement in signal processing. They are essential for precise timing and synchronization in embedded applications.

14. Explain the purpose of EEPROM (Electrically Erasable Programmable Read-Only Memory) in embedded system architecture. (2 marks)

Answer:

EEPROM in embedded system architecture is non-volatile memory used for storing data that must be retained even when power is removed from the system. Unlike RAM, which loses its contents when powered off, EEPROM allows for both writing (programming) and erasing data electrically. It is commonly used to store configuration settings, calibration data, and small amounts of user data in applications where persistent storage and data integrity are essential.

15. Discuss the role of heat sinks and cooling mechanisms in embedded system architecture. (2 marks)

Answer:

Heat sinks and cooling mechanisms in embedded system architecture are used to dissipate heat generated by electronic components, such as microcontrollers, processors, power regulators, and high-power devices. Heat sinks enhance thermal conductivity and increase surface area to facilitate heat transfer away from components. Cooling mechanisms, such as fans or thermal management systems, further regulate temperatures to prevent overheating, ensure reliable operation, and extend the lifespan of embedded systems in diverse environmental conditions.