UNIT-I: **Embedded Computing** from *Chapter I (Introduction, Complex Systems and Microprocessor, Embedded System Design Process, Formalisms for System Design, Design Examples)* of the textbook *Embedded Computing: A VLSI Approach* by *Wolf*:

**1. Which of the following is the primary characteristic of embedded systems?**

* A) General-purpose computation
* B) Dedicated function for specific tasks
* C) High processing power
* D) Large memory requirements

**2. Embedded systems are typically designed to:**

* A) Perform a wide variety of tasks
* B) Operate continuously for long periods without human intervention
* C) Be easily reprogrammable
* D) Be connected to the internet

**3. Which of the following is NOT an example of an embedded system?**

* A) Microwave oven
* B) Smart phone
* C) Desktop computer
* D) Digital camera

**4. The design process for embedded systems typically involves:**

* A) Design of software only
* B) Design of hardware only
* C) Both hardware and software design
* D) Only system integration

**5. What is the main challenge in the design of embedded systems?**

* A) Power consumption
* B) Performance optimization
* C) Cost constraints
* D) All of the above

**6. Which of the following is NOT a formalism for embedded system design?**

* A) Dataflow models
* B) Timed automata
* C) State machines
* D) Neural networks

**7. In embedded system design, what does the acronym "RTOS" stand for?**

* A) Random Time Operating System
* B) Real-Time Operating System
* C) Regulated Timing Operating System
* D) Realtime Task Operating System

**8. Which of the following is an example of an application where embedded systems are used?**

* A) Automotive systems
* B) Consumer electronics
* C) Industrial control systems
* D) All of the above

**9. In a complex embedded system, which of the following components plays a crucial role in processing?**

* A) Microprocessor
* B) Sensor
* C) Display
* D) Power supply

**10. Embedded systems require both hardware and software to work together. Which of the following is a component of embedded software?**

* A) Real-time scheduling algorithms
* B) Memory management units
* C) Graphical user interfaces
* D) Disk drives

**11. Which of the following is a key difference between a microprocessor and a microcontroller?**

* A) Microprocessors are used in embedded systems; microcontrollers are used in general-purpose systems
* B) Microcontrollers have integrated memory, whereas microprocessors require external memory
* C) Microprocessors are faster than microcontrollers
* D) Microprocessors are more power-efficient than microcontrollers

**12. Which of the following is a characteristic of real-time embedded systems?**

* A) They must always be connected to the internet
* B) They process data in a sequence
* C) They operate under strict timing constraints
* D) They do not require memory management

**13. What is the purpose of the hardware abstraction layer (HAL) in embedded systems?**

* A) To separate the application software from the hardware
* B) To directly manage the microprocessor
* C) To handle communication between devices
* D) To optimize the hardware performance

**14. Which of the following best defines an embedded system?**

* A) A system that is part of a larger system and dedicated to specific tasks
* B) A system used for personal computing
* C) A system used for general-purpose computing
* D) A system that only functions in isolated environments

**15. The software for embedded systems typically includes which of the following?**

* A) Operating system
* B) Drivers and libraries
* C) Application code
* D) All of the above

**16. In which of the following scenarios is an embedded system commonly used?**

* A) Calculating financial forecasts
* B) Operating a washing machine
* C) Playing games on a computer
* D) Running a database server

**17. Which of the following is a major design challenge for embedded systems?**

* A) Speed
* B) Power consumption
* C) Memory usage
* D) All of the above

**18. In embedded system design, which of the following best describes "modular design"?**

* A) Designing one large system
* B) Designing components that can be reused across multiple systems
* C) Ignoring power consumption
* D) Focusing only on hardware

**19. Which type of microprocessor is commonly used in embedded systems?**

* A) General-purpose microprocessor
* B) RISC-based microprocessor
* C) CISC-based microprocessor
* D) Microcontroller-based processor

**20. The process of software development in embedded systems includes which of the following?**

* A) Testing and debugging
* B) Code optimization
* C) Integration with hardware
* D) All of the above

**21. What does "formalism" mean in the context of embedded system design?**

* A) A hardware-based solution
* B) A set of predefined steps and methodologies for designing systems
* C) A software tool for system simulation
* D) A programming language used for embedded systems

**22. In the embedded system design process, what is typically the first step?**

* A) System integration
* B) Hardware design
* C) Requirements analysis
* D) Code development

**23. What is the role of sensors in embedded systems?**

* A) To control data flow
* B) To collect real-world data
* C) To process signals
* D) To communicate with the internet

**24. What is a common approach for power management in embedded systems?**

* A) High-speed processors
* B) Low-power microcontrollers
* C) Continuous operation without sleep modes
* D) Large memory usage

**25. What is the advantage of using FPGA-based embedded systems?**

* A) They provide flexibility in hardware design
* B) They are faster than microcontrollers
* C) They require no programming
* D) They are easier to integrate with software

**26. Which of the following is a characteristic of a Complex System?**

* A) Simplicity and predictability
* B) Inability to adapt to new requirements
* C) Contains many interacting components
* D) Limited interdependencies between components

**27. The term "embedded system design" refers to:**

* A) The process of designing hardware alone
* B) The process of creating systems for personal computing
* C) The development of systems that combine both hardware and software
* D) The creation of operating systems

**28. Which of the following is a key concern during the design of real-time embedded systems?**

* A) Security of the system
* B) Meeting timing constraints
* C) Internet connectivity
* D) Scalability of the system

**29. The design of embedded systems requires knowledge in which of the following domains?**

* A) Software engineering
* B) Electrical engineering
* C) Computer architecture
* D) All of the above

**30. Which component is commonly used to handle communication in embedded systems?**

* A) Sensors
* B) Communication protocols
* C) Memory units
* D) Operating systems

**31. Which of the following describes the role of "formalism" in system design?**

* A) It defines the physical layout of the system
* B) It provides an abstract representation to improve understanding and validation of designs
* C) It helps to minimize the cost of hardware
* D) It only applies to the software design process

**32. An example of a system that might require embedded system design for automation is:**

* A) Personal computer
* B) Smart thermostat
* C) Cloud storage system
* D) High-performance gaming console

**33. A major advantage of microcontrollers in embedded systems is:**

* A) Low power consumption
* B) High-speed processing
* C) Large memory capacity
* D) Internet connectivity

**34. What is the most common form of software used in embedded systems?**

* A) General-purpose operating systems
* B) Real-time operating systems (RTOS)
* C) Mainframe operating systems
* D) Batch processing systems

**35. Which of the following is a method of testing embedded systems?**

* A) Black-box testing
* B) Simulation-based testing
* C) System integration testing
* D) All of the above

**36. What is the purpose of the debugging process in embedded systems?**

* A) To optimize power usage
* B) To check for and fix errors in the software
* C) To check the connectivity of hardware components
* D) To reduce the cost of the system

**37. Which of the following is an example of a "complex system" in embedded computing?**

* A) Smart car navigation system
* B) Digital alarm clock
* C) Simple home lighting system
* D) Basic LED blink application

**38. The "embedded system design process" involves:**

* A) Conceptual design
* B) System integration
* C) Testing and validation
* D) All of the above

**39. What is the primary purpose of using formal models in embedded system design?**

* A) To reduce the design time
* B) To simulate and validate the system design
* C) To minimize hardware requirements
* D) To improve software debugging

**40. Which of the following is NOT typically part of the system design process for embedded systems?**

* A) Requirements specification
* B) High-level design
* C) Firmware debugging
* D) Software deployment to the cloud

**41. Which technology is frequently used for programming embedded systems?**

* A) C
* B) Python
* C) Java
* D) HTML

**42. What is the primary function of a microprocessor in an embedded system?**

* A) To monitor system power
* B) To perform complex calculations and logic operations
* C) To control input/output devices
* D) To store data for long-term use

**43. What aspect of embedded system design involves determining how the hardware and software interact?**

* A) Interface design
* B) Memory management
* C) Debugging
* D) Testing

**44. Which of the following is a formal system modeling technique?**

* A) Flowcharts
* B) Dataflow diagrams
* C) Petri nets
* D) All of the above

**45. What does "system-on-chip" (SoC) refer to in embedded systems?**

* A) A system with multiple microcontrollers
* B) A single chip that integrates all necessary components of an embedded system
* C) A dedicated chip for system communication
* D) A chip used for memory storage

**46. In embedded system design, which of the following is typically a consideration during the power optimization process?**

* A) Reducing the system’s operational frequency
* B) Increasing processor performance
* C) Reducing code complexity
* D) Using more memory

**47. Which of the following is essential for achieving real-time constraints in embedded systems?**

* A) General-purpose operating system
* B) Real-time operating system (RTOS)
* C) High memory usage
* D) Advanced graphics processing unit (GPU)

**48. Embedded systems are designed to:**

* A) Run on large, complex devices
* B) Perform specific, often repetitive tasks
* C) Be easily reprogrammed
* D) Require constant user input

**49. A system’s architecture in embedded systems design is typically described by:**

* A) The number of components
* B) The communication protocols used
* C) The interactions between hardware and software
* D) The programming language used

**50. What is the key feature of a microcontroller that makes it suitable for embedded systems?**

* A) High clock speed
* B) Integrated components like memory and I/O interfaces
* C) Large storage capacity
* D) High power consumption

ANALYTICAL

**1. You are designing an embedded system for a smart thermostat that needs to interact with temperature sensors and control the heating system. If the system must respond within 1 second to changes in temperature, which of the following approaches is most critical for ensuring this requirement is met?**

* A) Use a high-level programming language like Python for easier development.
* B) Choose a real-time operating system (RTOS) for better scheduling and task management.
* C) Select a microcontroller with a high clock speed.
* D) Use a microprocessor with a complex instruction set to handle complex computations.

**2. You are designing an embedded system that will operate in an industrial environment with limited power availability. You are considering two microcontrollers: one that operates at a lower clock speed and another that operates at a higher clock speed but consumes more power. Which of the following is the most suitable approach to reduce power consumption while maintaining the required performance?**

* A) Use the higher-speed microcontroller and overclock it during idle times.
* B) Use the lower-speed microcontroller and optimize the software to handle tasks efficiently.
* C) Use both microcontrollers in parallel to balance performance and power.
* D) Select an unoptimized microcontroller to minimize design complexity.

**3. A sensor in an embedded system is required to collect data at 100Hz, while the microcontroller needs to process this data and send it to a display at 50Hz. If the microcontroller's processing time for each sample is 5 milliseconds, which of the following modifications would best ensure the system meets its performance requirements?**

* A) Increase the processing speed of the microcontroller to handle the data faster.
* B) Use a faster communication interface between the sensor and microcontroller.
* C) Introduce buffering between the sensor and the microcontroller to store the data temporarily.
* D) Reduce the data collection rate of the sensor to match the processing speed of the microcontroller.

**4. You are tasked with designing an embedded system that needs to run multiple tasks in parallel with stringent timing requirements. Which of the following is the most suitable scheduling approach to ensure that the tasks meet their deadlines?**

* A) Round-robin scheduling with equal time slices for each task.
* B) Priority-based preemptive scheduling where higher priority tasks are executed first.
* C) First-come, first-served scheduling with no preemption.
* D) Time-sharing scheduling where tasks are executed based on availability.

**5. In the context of an embedded system design, you are asked to design a communication protocol between the microcontroller and a peripheral device. The peripheral device can generate interrupt signals that the microcontroller must handle immediately. What is the most suitable method for managing these interrupts?**

* A) Polling: Continuously checking the peripheral status to determine if an interrupt has occurred.
* B) Interrupt-driven: Using interrupt service routines (ISRs) to handle the interrupt when it occurs.
* C) Using a direct memory access (DMA) controller to handle the communication without involving the microcontroller.
* D) Using the real-time operating system’s task scheduler to manage interrupt processing.

**6. In an embedded system design, you are considering whether to use a microprocessor or a microcontroller. The system must have a small footprint, low power consumption, and moderate processing capabilities. Which of the following options would be the most appropriate for this embedded system?**

* A) A general-purpose microprocessor with high processing power.
* B) A microcontroller with integrated memory and I/O interfaces.
* C) A digital signal processor (DSP) with specialized hardware for signal processing.
* D) A microprocessor with external peripherals for I/O functionality.

**7. An embedded system needs to be designed to operate in an environment where temperature fluctuations and voltage fluctuations are significant. What aspect of the system design will be most affected by these environmental conditions, and what approach should be taken to ensure reliable operation?**

* A) The software will need to be robust and handle changes in operating conditions dynamically.
* B) The microcontroller should be selected based on its tolerance to temperature and voltage variations.
* C) The memory should be optimized to reduce the impact of environmental fluctuations.
* D) The system should be over-designed to tolerate all environmental conditions.

**8. You are designing an embedded system that uses wireless communication to send data to a cloud server. The system has strict latency and reliability requirements. Which of the following network protocols would best meet these requirements?**

* A) TCP/IP with a high focus on reliability but high overhead.
* B) UDP for low overhead but without guarantees on data delivery.
* C) Bluetooth with high energy efficiency but lower range.
* D) Zigbee with low energy consumption and adequate range for sensor networks.

**9. In designing an embedded system with a complex user interface (UI), which of the following design principles would best ensure that the system is efficient and meets the requirements of limited hardware resources?**

* A) Design a high-resolution display with extensive graphical interfaces.
* B) Prioritize software optimization for UI rendering to minimize CPU usage.
* C) Use a powerful microprocessor with hardware acceleration for UI rendering.
* D) Rely on a large external display to offload processing from the embedded system.

**10. A microcontroller in an embedded system is running multiple tasks with different priorities. How should the tasks be organized to ensure that higher-priority tasks are executed before lower-priority tasks?**

* A) The microcontroller should use non-preemptive scheduling, where tasks run to completion.
* B) The system should use a round-robin scheduling algorithm.
* C) The system should use a priority-based preemptive scheduling algorithm to handle higher-priority tasks first.
* D) The system should delay all lower-priority tasks until the higher-priority tasks are complete.

**11. You are tasked with designing a wireless sensor network for an embedded system where data from various sensors is sent to a central controller. The system must conserve battery life without sacrificing data integrity. What is the best design choice to achieve this goal?**

* A) Increase the transmission power of the sensors for better communication range.
* B) Use low-power communication protocols like Zigbee or LoRa, which balance power consumption and communication range.
* C) Use Wi-Fi for high-speed communication, sacrificing power efficiency for performance.
* D) Use Bluetooth, as it has the lowest power consumption compared to other wireless protocols.

**12. You are designing an embedded system with limited memory resources. The system needs to process large amounts of data in real-time. Which of the following strategies should be considered to minimize memory usage while ensuring that real-time requirements are met?**

* A) Increase the clock speed of the microcontroller to process data faster.
* B) Use a memory-efficient data structure and implement real-time data processing algorithms.
* C) Reduce the amount of data to be processed by filtering unnecessary information.
* D) Use a microprocessor with a larger memory to handle the increased data load.

**13. In an embedded system that requires rapid response to external events, the use of interrupts is essential. Which of the following would be the best practice for optimizing the handling of interrupts in this system?**

* A) Disabling interrupts globally to ensure the system does not get interrupted during critical sections.
* B) Prioritizing interrupts based on their urgency and using interrupt nesting to handle them efficiently.
* C) Using a polling method to periodically check for interrupt events instead of relying on interrupts.
* D) Using multiple interrupt vectors for each type of interrupt without any prioritization.

**14. In designing an embedded system for a vehicle, which of the following factors should be given the highest priority to ensure the system operates reliably in a high-speed, real-time environment?**

* A) Minimizing the cost of components used in the system
* B) Ensuring that the system is designed for maximum flexibility and future upgrades
* C) Meeting stringent real-time processing and safety requirements
* D) Using the most powerful microcontroller available to maximize computational capabilities

**15. You are designing an embedded system for a battery-powered device that requires both high processing performance and long battery life. Which of the following design considerations would help achieve the best trade-off between performance and power consumption?**

* A) Use a high-performance microprocessor with a large number of cores to handle computations faster.
* B) Use a low-power microcontroller and optimize the software to run efficiently in low-power states.
* C) Use a large external memory to store all data and reduce power consumption in the microcontroller.
* D) Rely on a continuous power supply to avoid worrying about battery life.

**16. A microcontroller has a 10-bit ADC with a reference voltage of 3.3V. What is the ADC value for an input voltage of 2.5V?**

* A) 820
* B) 900
* C) 1024
* D) 768

**17. An embedded system with a microcontroller operates at a clock speed of 16 MHz. How long does it take to execute a task that requires 200,000 clock cycles?**

* A) 12.5 ms
* B) 2 ms
* C) 10 ms
* D) 1.25 ms

**18. A microcontroller is executing instructions at a clock speed of 8 MHz. If each instruction takes 2 clock cycles to execute, how many instructions can be executed in 50 microseconds?**

* A) 100 instructions
* B) 200 instructions
* C) 150 instructions
* D) 250 instructions

**19. An embedded system has a 12-bit ADC with a reference voltage of 5V. What would be the output of the ADC when the input voltage is 3.6V?**

* A) 2273
* B) 2048
* C) 4095
* D) 3200

**20. A microcontroller operates at 12 MHz and needs to process 500,000 instructions. If each instruction takes 4 clock cycles to execute, how much time will be required?**

* A) 0.167 ms
* B) 1.67 ms
* C) 0.167 s
* D) 1.67 s

**21. An embedded system with a UART interface transmits 200 bytes of data. If the baud rate is 9600 bps, how long will it take to transmit the entire data?**

* A) 0.2 seconds
* B) 0.3 seconds
* C) 1 second
* D) 10 milliseconds

**22. An embedded system has a microcontroller running at 48 MHz. How much time will it take to execute 240,000 instructions?**

* A) 5 microseconds
* B) 50 microseconds
* C) 500 microseconds
* D) 5 milliseconds

**23. A microcontroller with an 8-bit ADC has a reference voltage of 3.3V. What is the ADC value for an input voltage of 1.65V?**

* A) 127
* B) 128
* C) 255
* D) 64

**24. An embedded system with a microcontroller clocked at 16 MHz executes 50,000 instructions. If each instruction takes 3 clock cycles, what is the total execution time?**

* A) 3.125 ms
* B) 0.625 ms
* C) 1.25 ms
* D) 5 ms

**25. In an embedded system with a 16-bit ADC, the reference voltage is 5V. What is the output value of the ADC for an input voltage of 3.75V?**

* A) 0.75
* B) 8192
* C) 16384
* D) 25000

**26. A microcontroller with a 16 MHz clock needs to execute 10,000 instructions. If each instruction takes 5 clock cycles, how long will it take to execute these instructions?**

* A) 3.125 milliseconds
* B) 0.625 milliseconds
* C) 6.25 milliseconds
* D) 5 milliseconds

**27. An embedded system uses a 12-bit ADC with a reference voltage of 3.3V. If the input voltage is 2.5V, what is the output of the ADC?**

* A) 2457
* B) 2684
* C) 2048
* D) 3072

**28. An embedded system executes a task requiring 150,000 clock cycles. If the microcontroller runs at 20 MHz, how much time will it take to execute the task?**

* A) 7.5 milliseconds
* B) 7.5 microseconds
* C) 15 microseconds
* D) 0.75 milliseconds

**29. A UART communication system transmits 500 bytes of data. If the baud rate is 9600 bps, how much time will it take to transmit this data?**

* A) 0.5 seconds
* B) 0.4 seconds
* C) 0.1 seconds
* D) 1 second

**30. A microcontroller has a clock speed of 24 MHz. How long will it take to execute 1,000,000 instructions if each instruction takes 3 clock cycles?**

* A) 0.125 milliseconds
* B) 0.25 milliseconds
* C) 0.5 milliseconds
* D) 1 millisecond

**31. A microcontroller has 256KB of flash memory and 32KB of SRAM. If you are designing a system that needs 16-bit data width for both code and data, how many bytes of memory will be required to store a 500-line program with 100 instructions per line?**

* A) 100KB
* B) 200KB
* C) 400KB
* D) 800KB.

**32. If a microcontroller is running at 80 MHz and you need to process an interrupt every 200 microseconds, how many clock cycles will be required between each interrupt?**

* A) 16,000
* B) 16
* C) 400
* D) 1,600

**33. You are designing a real-time system with a processor clocked at 50 MHz. The system needs to perform a task that takes 500,000 clock cycles. How long will it take for the task to complete?**

* A) 10 ms
* B) 50 ms
* C) 100 ms
* D) 200 ms

**34. An embedded system uses a 12-bit ADC (Analog-to-Digital Converter) to measure voltage. If the reference voltage is 3.3V, what is the resolution of the ADC in terms of voltage per bit?**

* A) 0.001V
* B) 0.005V
* C) 0.01V
* D) 0.03V

**35. A sensor in an embedded system produces data at a rate of 100 samples per second. If the system must process data for 2 minutes continuously, how many total samples will be collected during this time?**

* A) 12,000
* B) 10,000
* C) 6,000
* D) 2,000

**36. You are designing an embedded system with a microcontroller running at 40 MHz. The microcontroller has 512MB of flash memory. How long will it take to read the entire memory at a rate of 1 byte per clock cycle?**

* A) 13.7 seconds
* B) 8.5 seconds
* C) 10.24 seconds
* D) 15.5 seconds

**37. In an embedded system with a microcontroller clocked at 80 MHz, how long would it take to execute 500,000 instructions if each instruction takes 1 clock cycle?**

* A) 0.01 seconds
* B) 0.06 seconds
* C) 0.25 seconds
* D) 0.5 seconds

**38. If an embedded system is using a PWM signal with a period of 100 microseconds to control a motor, what is the frequency of the PWM signal?**

* A) 10 kHz
* B) 5 kHz
* C) 100 kHz
* D) 1 kHz

**39. An embedded system's CPU operates at a frequency of 32 MHz. If an interrupt service routine (ISR) takes 2000 clock cycles to complete, how much time is spent for each ISR execution?**

* A) 62.5 microseconds
* B) 100 microseconds
* C) 125 microseconds
* D) 200 microseconds

**40. A microcontroller with a 16-bit ADC is used in an embedded system. The reference voltage is 5V, and you want the ADC to have a resolution of 0.01V per step. What reference voltage would be required for this resolution?**

* A) 2.56V
* B) 5V
* C) 10V
* D) 1V

**41. You are designing an embedded system where a temperature sensor generates 10 readings per second. The data is transmitted over a UART interface at a rate of 115200 baud. What is the data transfer rate required to transmit each reading, assuming each reading is 16-bit data?**

* A) 1.15 Kbps
* B) 4.6 Kbps
* C) 9.2 Kbps
* D) 11.5 Kbps.

**42. An embedded system uses a 256-bit key AES encryption algorithm. How many bits of data can be encrypted in a single encryption operation if the system uses a block size of 128 bits?**

* A) 128 bits
* B) 256 bits
* C) 512 bits
* D) 1024 bits

**43. In an embedded system, the power consumption of a component is 50mW when active and 5mW when idle. If the component spends 70% of its time active, what is the average power consumption over time?**

* A) 25mW
* B) 30mW
* C) 35mW
* D) 40mW

**44. An embedded system is designed to monitor the battery voltage level of a sensor. The ADC is 8-bit and the reference voltage is 3.3V. What will be the ADC value when the input voltage is 2.4V?**

* A) 194
* B) 210
* C) 220
* D) 230

**45. In a microcontroller, the clock speed is 12 MHz. If an instruction takes 4 clock cycles to execute, how long will it take to execute 10,000 instructions?**

* A) 3.33 ms
* B) 4.17 ms
* C) 8.33 ms
* D) 5.56 ms

**46. An embedded system reads data at 100 bytes per second from a sensor. If the data is being transmitted to a host computer using a UART with a baud rate of 9600 bps, how much time will it take to send 1,000 bytes of data?**

* A) 100 seconds
* B) 83.33 seconds
* C) 166.67 seconds
* D) 120 seconds

**47. If a microcontroller executes 300,000 instructions in 0.6 milliseconds, what is the average number of clock cycles per instruction?**

* A) 2
* B) 4
* C) 5
* D) 6

**48. An embedded system has an ADC with a 12-bit resolution. If the reference voltage is 5V, what is the output of the ADC when the input voltage is 3.2V?**

* A) 2589
* B) 3245
* C) 4095
* D) 2560

**49. A microcontroller executes an interrupt service routine (ISR) every 1 ms. The microcontroller runs at a clock speed of 16 MHz. How many clock cycles does the ISR take to execute?**

* A) 16,000
* B) 16
* C) 64,000
* D) 160,000

**50. In an embedded system with a microcontroller running at 100 MHz, an interrupt occurs every 10 microseconds. How many instructions can be executed during the interrupt latency?**

* A) 1000 instructions
* B) 100 instructions
* C) 10 instructions
* D) 10000 instructions

**51. A microcontroller with 16-bit ADC has a resolution of 0.005V per bit. What is the reference voltage of the ADC?**

* A) 2.56V
* B) 5V
* C) 10V
* D) 3.3V

**52. An embedded system is processing a signal with a frequency of 1 kHz. How long will it take for the signal to complete one cycle?**

* A) 1 ms
* B) 0.5 ms
* C) 10 ms
* D) 100 ms

**53. A microcontroller with 32-bit data width and 16-bit instruction width executes 100,000 instructions in 5 ms. What is the clock speed of the microcontroller?**

* A) 50 MHz
* B) 100 MHz
* C) 200 MHz
* D) 400 MHz

**54. If an embedded system is clocked at 50 MHz, how much time will it take to process a task requiring 1,000,000 clock cycles?**

* A) 20 ms
* B) 1 ms
* C) 0.02 ms
* D) 0.1 ms

**55. A system with a microcontroller clocked at 48 MHz needs to read 256 bytes of data. If each byte takes 4 clock cycles to read, how long will it take to read the entire data set?**

* A) 21.33 microseconds
* B) 32 microseconds
* C) 13.33 microseconds
* D) 48 microseconds

**56. A system using a 10-bit ADC with a reference voltage of 5V will produce how many discrete output levels?**

* A) 1024
* B) 512
* C) 2048
* D) 5120

**57. A microcontroller system runs at 12 MHz. How many microseconds will it take to complete 3,000 instructions if each instruction takes 3 clock cycles?**

* A) 0.75 ms
* B) 0.25 ms
* C) 1 ms
* D) 2 ms

**58. An embedded system uses a UART with a baud rate of 9600 bps. How much time will it take to transmit 100 bytes of data?**

* A) 100 milliseconds
* B) 200 milliseconds
* C) 1 second
* D) 10 seconds