# Embedded Systems
# Problems Sheet

1. Provide a brief **definition** of an embedded system.
2. Describe by **sample applications** the difference between the following three types of events: **synchronous**, **asynchronous,** and **isochronous** events.
3. Write a sample **pseudocode** that implements a **non-power-saving super loop** for a sequence of tasks that are performed in an embedded system.
4. Any embedded system requires what is called **firmware as shown in Figure 1**. What is the purpose of such software in any embedded system?
5. Use **Figure 2** to describe the difference between a **hard-real time** and **soft-real time** system.

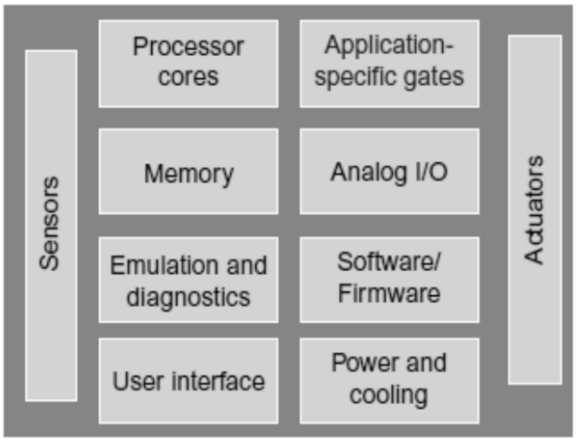


**Figure 1**


**Figure 2**

6. Briefly describe the difference between the following two characteristics of a real-time system: **determinism** and **responsiveness**.
7. Briefly describe how to resolve the **unbounded priority inversion** problem using the **priority ceiling** solution**.**
8. Briefly describe the meaning of **system synthesis** in the context of an embedded system design.
9. Draw a simple diagram that shows the behaviour of an **ATM cash withdrawal** operation with at **least three different states**.
10. When designing an embedded system, the designer might be concerned with optimizing some design criteria like enforcing an average, sustained, and burst throughput. **Answer each of the following questions**:
    (i) What is meant by **system throughput**?
    (ii) Briefly describe the difference between **average**, **sustained** and **burst** throughputs.
11. When designing an **event-driven** embedded system for an air conditioning (AC) system, it is required to implement an interrupt service routine (ISR) for updating the temperature value. One of two design choices can be applied which are follows: (1) include all logic of setting the new temperature value and updating the LCD inside the ISR or (2) only using the ISR code to set a bit in an event array. Which of the two options guarantees that the AC system performs better? **Give reasons.**

12. Briefly describe the difference between **Figure 3** and **Figure 4** when implementing an **event-driven** embedded system for an air conditioning (AC) system.

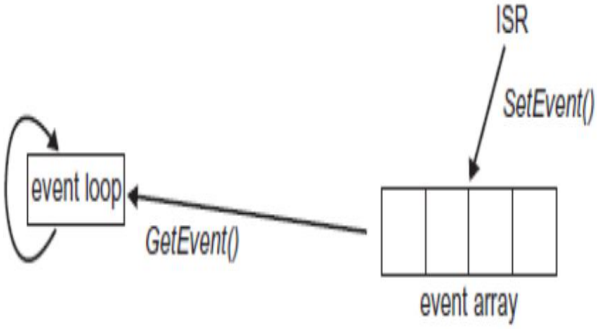


**Figure 3**

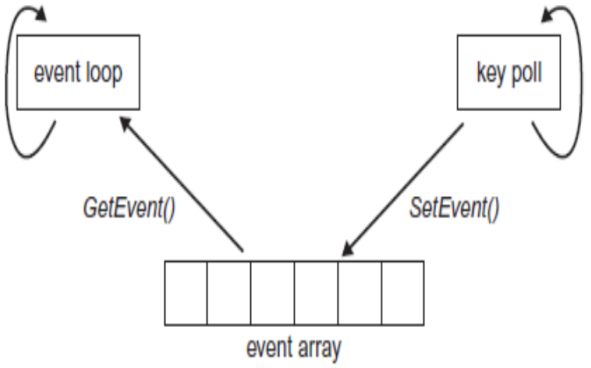


**Figure 4**

13. The following two embedded systems design patterns can handle hardware access in embedded systems design: **Mediator** and **Observer patterns** briefly describe the difference in purpose between the two design patterns. How these two patterns are related to each other

14. The **Cyclic Executive** design pattern for embedded systems can guarantee immediate response to urgent events. Is this assumption valid or not? **Justify with reasons.**

15. Suppose you want to design an embedded system that controls a motor and displays information about the motor **without directly** accessing its hardware. There is an intermediate agent that enables both the motor controller and the motor display client to access the motor hardware. Mention one embedded system design pattern that can be used in your design. **Justify your answer showing how to map the mentioned design pattern to the case study under question.**

16. The **hardware adapter pattern** can be mixed with the **hardware proxy pattern** in some sense. Show how this mix can be done in practice.

17. The following two embedded systems design patterns can handle data collected from sensors but in different manners. The two patterns are **interrupt** and **polling** patterns. Which of the two patterns is more suitable for embedded systems that need an **immediate or near-immediate** reflex action from the system when an urgent event happens? **Justify with reasons**.

*Good Luck*

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