T-106.530 Embedded Systems Exam-8.5.2003
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INSTRUCTIONS:
- <u>Read the **entire** exam before starting</u>
- Stay in the scope of the question
- Answer all questions in any way possible.
- Justifications and explanations are considered
- The total points of the exam is 113. You need 100 points to score 100%

BACKGROUND CASE FOR EXAM QUESTIONS:
Design a simple home alarm system with the following features.
The Front and Back door are monitored and the rooms contain motion detectors.

- The Front and Back door are monitored for being open/closed.
- Motion sensor(s) are in the rooms checking for movement.
  If you wish, you can assume that a joint motion signal shows on, when any of the motion detectors show on.
- 2 pushbutton Keypad (labels "0" and "1")
  - for entering 5 (binary) digit safety code and
  - activation of monitoring on/off
  - After entering the 5 digit code, e.g. 01001 the same pushbuttons are used for the activation/deactivation of the alarm system ("0": off, "1":on)
- Led showing the on/off state of the alarm system
- Alarm Bell or Siren turns on when an intrusion is detected.
  It can be turned off by entering the correct code and then deactiving the alarm system.

A "patience" feature allows a 30 sec delay to enter the Safety Code after opening a door. This enables having the keypad inside the guarded area, further increasing safety, so nobody can stand outside and try all possible code values.

5 unsuccessful code entry attempts trigger the alarm.

A 10 sec delay in entering code resets the input system, so that it again waits for the first digit.

Goals:
- Turn on alarm when intrusion is detected
- Avoid false alarms

- **THE EXAM STARTS BELOW** -

1. Draw a Use Case diagram of the alarm system (10 pt)
   (Hint: Identify Use Cases, Actors, relationships between them,etc.)

2. Identify Classes in the alarm system and show structural relations (association, generalization) among them, i.e. draw diagram (5pt)
   (Hint: for each use case find a set of collaborating objects/classes)

3. Partition the alarm system into subsystems (3 pt)

4. Choose a use case and draw a sequence diagram (5 pt)

5. Draw a state diagram of the whole alarm system and/or a selected subsystem. (5 pt)

6. Does UML specify method/process ? (1 pt)

7. Give examples of some known processes (1 pt/process, max. 4)

8. Kernels
NOTE: NO FAULT TOLERANCE OR REMOTE-CONTROL FEATURES ARE NEEDED FOR THIS QUESTION

8.1. *Draw **simple** flowcharts of the program structure to describe the operation and sequence of operation if the control system for the alarm system was built as a:*

    8.1.1. polling system (5pt)

    8.1.2. interrupt based system (5pt)

    8.1.3. process-based system (5pt)

8.2. *Which of the above is best suited to implement the control system according to the goals listed in the beginning? Explain why? (5pt)*
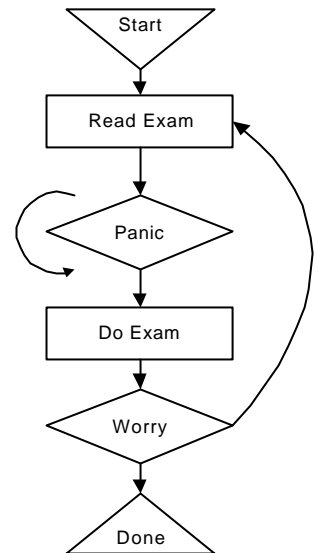
9. How could the above control system be made more fault-tolerant?
NOTE: NO REMOTE-CONTROL FEATURES ARE NEEDED FOR THIS QUESTION

9.1. *Define fault-tolerance in general (5pt)*

9.2. *Briefly describe what changes are necessary to the full system and the system to ensure a basic level fault tolerance in normal operation. (10pt)*

9.3. *Which of the types of systems in Question 8 is best suited for these modifications? Describe and justify. (5pt)*

10. Fault tolerance and prevention
Answer the following questions briefly in the context of fault tolerance and fault prevention. (20pt total, 4pt each)

10.1.   *Watchdog timers*

10.2.   *Self calibration*

10.3.   *Explain Mechanical and Software Interlocks*

10.4.   *What is meant by safe start-up and shutdown*

10.5.   *Testing*

11. Answer the following with **BRIEF** explanations: (20pt total, 5pt each)

11.1.   *What specific improvements to the car would have made your programming tasks easier for the car project?*

11.2.   *Why are the (PI, PD, PID) control system methods useful? i.e. What do they do?*

11.3.   *Explain what went wrong with the Therac-25?*

11.4.   *The requirements change again. What control system or related changes are needed to add remote diagnostics ability to the system in questions 8&9? How does that affect your choice in question 9.3?*

12. Any feedback about this exam or course? (this does not affect your grade)