

T-106.530 Embedded Systems Exam – 21.12.2006

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INSTRUCTIONS:

- Read the entire exam before starting
- Stay in the scope of the question
- Answer all questions in any way possible.
- Justifications and explanations are considered
- The total point value of the exam is 110. You need 100 points to score 100%

BACKGROUND INFORMATION FOR THE QUESTIONS:

(Referred to as 'the system' or '<Exam Problem> system' in later mentions)

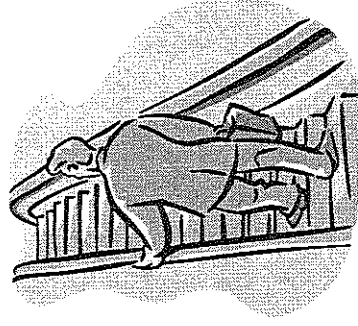
The system is a normal escalator which shuts itself off automatically when there are no passengers, and smoothly restarts when a passenger is approaching the first step.

Known facts:

- Sensors
 - Entering – incoming passenger (0/1, ie. binary output)
 - Exiting – departing passenger (0/1)
 - Speed – current stair speed (meters per second)
 - Emergency Stop button (0/1)
- System is to function smoothly, no sudden starts or stops

Goals:

- Safe transportation
- Avoid unnecessary complexity in the control system



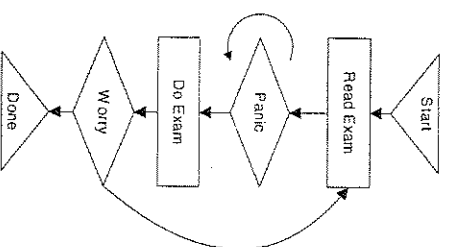
1. **Kernels (40pts total)**

NOTE: No fault tolerance or remote-control features are needed for this question

1.1. *Draw the flowchart of the program structure to describe the operation and sequence of operation if the control system for the device described on the first page was built as a:*

- 1.1.1. polling system (10pt)
- 1.1.2. interrupt based system (10pt)
- 1.1.3. process-based system (10pt)

1.2. *Which of the above is best suited to implement the control system according to the goals listed in the beginning? Explain why? (10pt)*



2. **How could the above control system be made more fault-tolerant? (25pts total)**

NOTE: No remote-control features are needed for this question

- 2.1. *Define fault-tolerance in general (5pt)*
- 2.2. *Briefly describe what changes are necessary to the system described on the first page to ensure a basic level fault tolerance in normal operation. (10pt)*
- 2.3. *Which of the types of systems in Question 1 is best suited for these modifications? Describe and justify. (10pt)*

3. **Fault tolerance and prevention (20pts total)**

Answer the following questions briefly in the context of fault tolerance and fault prevention.

- 3.1. *What is the role of testing in fault tolerance and prevention? (4pt)*
- 3.2. *What does fail-safe mean? (4pt)*
- 3.3. *Explain the use of limits (4pt)*
- 3.4. *Explain the use of sanity checks?(4pt)*
- 3.5. *Explain the use of a watchdog feature in a microcontroller (4pt)*

4. **Answer the following with BRIEF explanations: (25pts total)**

- 4.1. *What specific car hardware improvements would have made your programming tasks easier for the car project? (5pt)*
- 4.2. *Why are control system methods (such as PI, PD, PID) useful? (5pt)*
- 4.3. *Why is the Therac-25 case significant in the embedded systems field? (5pt)*
- 4.4. *The requirements change again:*
 - 4.4.1. *What control system or related changes are needed to add remote diagnostics ability to the system in questions 1&2 (the physical method of remote controlling has been accomplished for you by unspecified means, ie. You have a black box)? (5pt)*
 - 4.4.2. *How does that affect your choice in question 2.3? Describe and justify. (5pt)*

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

----- THE EXAM ENDS HERE -----