T-106.530 Embedded Systems Exam-12.05.2004

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INSTRUCTIONS:

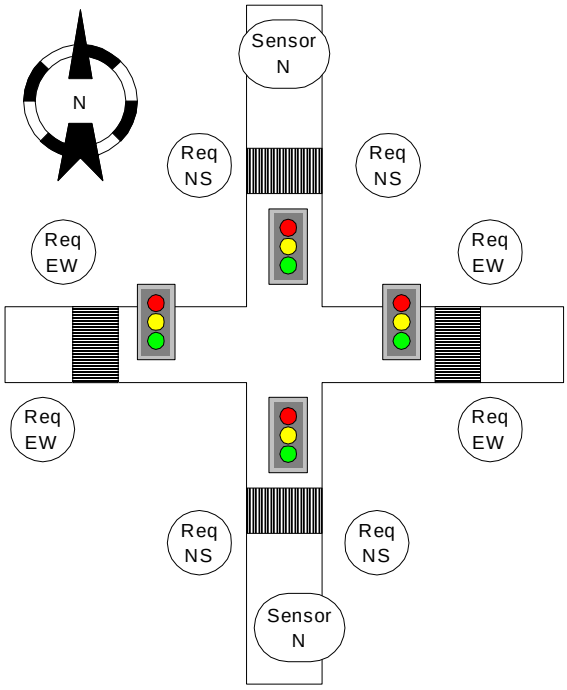
- Read the **entire** exam before starting
- Stay in the scope of the question
- Answer all questions in any way possible.
- Justifications and explanations are considered
- The total point value of the exam is 110. You need 100 points to score 100%

BACKGROUND INFORMATION FOR THE QUESTIONS:
(Referred to as 'the system' or '<Exam Problem> system' in later mentions)
Known facts:

- East-West (EW) road has heavy traffic and needs to flow as well as possible
- North-South (NS) road has less traffic
- NS road has car sensors to indicate when there is a vehicle waiting
  - SensorN for north
  - SensorS for south
- Pedestrians have request buttons to indicate they wish to cross
  - The request buttons are one per road
  - RequestNS to cross NS road
  - RequestEW to cross EW road
  - The lights are always on and operating
  - The lights are only based on demand, there is no schedule

Goals:

- Safe flow of people and vehicles
- Maximum throughput
- Minimum cost to create



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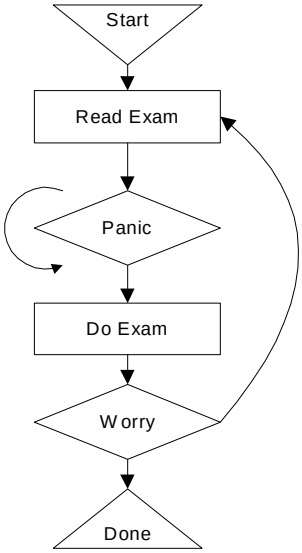
- THE EXAM STARTS BELOW -

1. Draw a Use Case diagram of the <Exam Problem> system (10pt)
   (Hint: Identify Use Cases, Actors, relationships between them, system boundary, etc.)
2. Identify Classes in the <Exam Problem> system (4pt)
   (Hint: for each use case find a set of collaborating objects/classes)
3. Identify the structural relations (association, generalization) among the classes and draw the diagram (4pt)
4. Choose a use case and draw a sequence diagram (5pt)
5. Create a state diagram for the overall system or part of it (5pt)

Kernels

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



5.1. *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:*

5.1.1. polling system (4pt)

5.1.2. interrupt based system (4pt)

5.1.3. process-based system (4pt)

5.2. *Which of the above is best suited to implement the control system according to the goals listed in the beginning? Explain why? (6pt)*

6. How could the above control system be made more fault-tolerant?
NOTE: NO REMOTE-CONTROL FEATURES ARE NEEDED FOR THIS QUESTION

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

6.2. *Briefly describe what changes are necessary to the system described on the first page and the system to ensure a basic level fault tolerance in normal operation. (10pt)*

6.3. *Which of the types of systems in Question 7 is best suited for these modifications? Describe and justify. (5pt)*

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

7.1. *Testing (4pt)*

7.2. *How do sanity checks work? (4pt)*

7.3. *Explain the differences between Mechanical and Software Interlocks (4pt)*

7.4. *What is meant by safe start-up and shutdown (4pt)*

7.5. *What is a watchdog? (4pt)*

8. Answer the following with **BRIEF** explanations: (20pt)

8.1. *What specific car hardware improvements would have made your programming tasks easier for the car project? (5pt)*

8.2. *Why are the (PI, PD, PID) control system methods useful? (5pt)*

8.3. *Explain what went wrong with the Therac-25? (5pt)*

8.4. *The requirements change again. What control system or related changes are needed to add remote diagnostics ability to the system in questions 7&8 (the physical method of remote controlling has been accomplished for you by unspecified means, ie. You have a black box)? How does that affect your choice in question 8.3? (5pt)*

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