EECS 507: Introduction to Embedded Systems Research
Midterm Exam

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25 October 2022

You have 80 minutes for the exam.

Closed book. Closed notes. No communicating with anybody except the teacher about the exam. This remains true even after you have submitted the exam. I'll tell you when it is O.K. to discuss. Someone is taking it late due to COVID-19.

There are answer length limits to control exam duration. For the sake of fairness to students who honor the limits, if you exceed the length limits, I will evaluate only the portion of the answer within the length limit.

Please use × marks for checkboxes.

Skim all the questions before starting so you can budget your time. They have different difficulties, but each is worth similar credit; that's intentional. Do the problems that are easiest for you first if you are concerned about the time limit.

Printed name

Sign below to acknowledge the Engineering Honor Code: "I have neither given nor received aid on this examination, nor have I concealed a violation of the Honor Code."

Signature

10   1. Literature survey: Which one of the following methods is generally least effective for finding research papers during a literature survey? [Lecture]

      ◯ Searching using a research-oriented search engine such as Google Scholar.

      ◯ Searching using a general-purpose search engine.

      ◯ Reading the titles / abstracts of recent research papers in the research area's top venues.

      ◯ Reading the titles / abstracts of papers citing important papers in the field.

      ◯ Reading the titles / abstracts of papers cited by high-quality survey papers in the field.

10   2. Specification and modeling: In the diagram below, at time zero, only A has a token (a small circle), i.e., only A is ready to fire. The numbers near the sources of arcs indicate the number of tokens generated when the arc fires. The numbers near the destinations of arcs indicate the numbers of tokens consumed to fire once. [Jantsch and Sander '05]
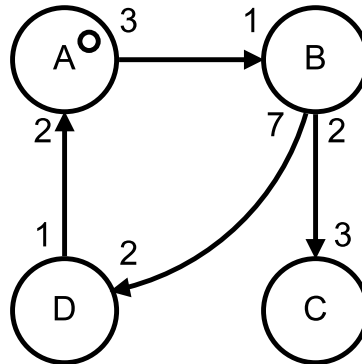
     What is the maximum number of tokens that can ultimately exist in the system?
   ◯ 1,   ◯ 3,   ◯ 4,   ◯ 7, or   ◯ ∞.

10   3. Optimization: If one started from a Parallel Recombinative Simulated Annealing algorithm but replaced Boltzmann trials with trials that always select the solution with lower cost, which (single) optimization approach would this result in? [Lecture]
     ◯ Simulated annealing,   ◯ genetic algorithm,   ◯ tabu search,   ◯ linear programming, or
     ◯ constructive algorithm.

10 4. Power: Voltage scaling is unlikely to bring as much benefit in the future as it has brought in the past and this is largely due to the tightening range of permissible operating voltages. [Lecture]

Use at most one sentence to describe the most important lower bound on the minimum operating voltage.

Use at most one sentence to describe the most important upper bound on the maximum operating voltage.

10 5. Temperature: In the simple thermal model, below, use at most one short phrase to indicate the purpose served by the voltage source. [Lecture, General Reasoning]
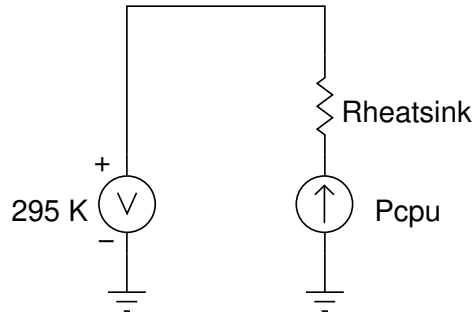
10 6. Sensor networks: Use at most one sentence to indicate why geophones are well suited to the application in this paper? [Bonde et al. '21]

10 7. Wireless communication: Use at most threes phrases to indicate the three most important characteristics of LPWANs that differentiate them from most prior communication technologies. [Raza et al. '17]

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10 8. Reliability: Consider a system containing three software components: A, B, and C. The system functions correctly if C is functioning correctly. A and B are non-essential, but enable some improvement in functionality. A and B communicate with each other to control each other's rates, and therefore computational loads. If either one of these two fails, the other will overload the processing resources of the system and prevent C from executing. This failure mode is in addition to that in which C simply fails on its own. If both A and B fail, the overload problem won't occur. The fault processes for the different components are independent. They have the following fault probabilities A: 0.1, B: 0.2, and C: 0.1. [Lecture]

What is the probability of system failure?

Show your work below.

10 9. Autonomous vehicles: Inference computation, e.g., LiDAR analysis and computer vision, accounts for a substantial percentage of locomotion energy consumption in self-driving cars. What would you expect this percentage to be in scaled-down self-driving vehicles roughly 1/10 the size and mass of a normal automobile? [General reasoning, Dick et al. '22]

Show your work below.

10 10. Memory hierarchy: At most one sentence to indicate why scratchpad memories are more widely used (and presumably easier to use effectively) in embedded applications than in general-purpose computing applications. [Banakar et al. '02]