Name: ____ CS598TAR Midterm

Please answer the following questions in the space provided. This exam is due in class **Friday, April 4th, in hardcopy**. Please staple all pages when you submit your exam. You may use your notes, papers, books, or Internet sources to answer questions. Some questions are designed as learning tools themselves. They encourage you to analyze certain problems more closely and reach your own interesting conclusions about them. Some could benefit from doing a little "research" on the Internet on the topic. Some are open-ended and will be graded based on your argument as opposed to a "ground truth". The exam must be answered individually. You may not discuss the questions and answers with others.

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1. Please answer the following multiple choice questions (10 points)

A. Which of the following statements are consistent with Occam's razor principle? Mark all that apply.

a) The simplest explanation of a phenomenon is most likely to be correct.
b) The explanation of a phenomenon should make as few assumptions as possible.
c) The explanation of a phenomenon is correct only if it includes a small number of assumptions.
d) No phenomenon has a complex explanation.

B. In your opinion, what is the dominant source of discrepancy between real performance and simulated performance of RSSI-based localization algorithms in sensor networks?
(2 points)

a) A highly irregular sensing range
b) A highly irregular radio range
c) Inaccurate simulation of the routing layer
d) Inaccurate simulation of a node's energy consumption

C. Which of the following routing algorithms best describes that used in ZebraNet?
(2 points)

a) Distance vector routing
b) Link state routing
c) Gossiping
d) Multicast routing

D. Which of the following is NOT true of Gopalakrishnan's work on Finite-Horizon Scheduling of Radar Dwells? Check all that apply.

a) The work addresses radars that track targets within a finite horizon in the sense that an admitted target will be tracked until it exits the radars finite sensing range.
b) Energy constraints are considered to prevent the radar front-end from overheating.
c) The authors try to minimize "seek time", or the time it takes to change the orientation of the radar as it moves from observing one target to the next
d) An optimal algorithm is presented that maximizes the number of admitted targets.

E. Which of the following statements most closely describes how delays compose in pipelined execution systems with priority-based scheduling?

a) The end-to-end delay of a task is the sum of the worst-case delays it experiences on each pipeline stage, where a worst case arises at a stage if the task is delayed by all tasks of higher priority at the stage in question.
b) The end-to-end delay of a task is roughly proportional to the number of higher-priority tasks multiplied by the number of stages.
c) The end-to-end delay of a task is upper-bounded by 1.
d) The end-to-end delay of a task is roughly proportional to a single-stage worst-case delay due to higher-priority tasks plus an additive component that grows proportionally to the number of stages.

2. The Time Attribute: Both the Hyperbolic Bound and the Liu & Layland Bound present sufficient conditions for schedulability of independent periodic task sets scheduled in a rate-monotonic fashion. Which bound is more pessimistic for a set of tasks of identical utilization but different periods? Please support your answer by a mathematical proof. **(5 points)**

3. The Time Attribute: A task set is composed of a very large number of independent adaptive periodic tasks executing on a uniprocessor in a deadline-monotonic fashion. The deadline of a task is taken to be the end of the period of its current invocation. An adaptive task is one that can change both its period and execution time from invocation to invocation. What is the lowest upper bound on system utilization for which no task misses its deadline? **(2 points)**

4. Location and Tracking: A set of sensors was deployed at the Sonoran desert to monitor illegal drug traffic. Statistics show that the probability of vehicles passing the sensor line on any given day is 0.1%. The probability of desert animals passing the sensor line that day is 2%. Infrared (motion) and vibration sensors are installed. The probability that the vibration sensor fires when a vehicle is nearby is 90%. The probability that it fires when an animal is nearby is 12%. The probability that it fires for whatever reason on a given day is 2%. For the infrared (motion) sensor, the probability that it fires when a vehicle is nearby is 70%. The probability that it fires when an animal is nearby is 45%. The probability that it fires for whatever reason on a given day is 10%.

On March 27th, 2008, both sensors fired around the same time. What is the most likely reason for sensor firing? To answer, please use naive Bayesian estimation to compute (i) the probability, P(Vehicle), that a vehicle passed by the sensors, and (ii) the probability, P(Animal) that the sensors were tripped by an animal. State both probabilities then your conclusion about the cause of sensor firing. **(3 points)**

P(Vehicle):

P(Animal):

Most likely reason:

5. Location and Tracking: Describe the main idea of particle filtering algorithms. Succinctly, pick a problem of your choice and formulate it as a particle filtering problem.
(3 points)

6. Energy Management: Two identical server machines can operate at full speed or half speed. The energy consumption of a machine is given by the equation:

$$E = E_{max} (f/f_{max})^3 + L$$

Where E_{max} is the maximum energy lost due to switching, and L is the static energy lost due to leakage. If you have enough load to fully utilize one machine, when is it more economical to balance this load across the two machines, and when is it more economical to use one and turn off the other? You may express your answer in terms of conditions on parameters of the above equation. **(4 points)**

7. Distributed Systems: Composition of adaptive components must be done with care. Give an example (other than ones in your slides) where composition of two components, each featuring a stable adaptive loop, yields an unstable system. **(3 points)**