

**Closed book, closed notes, 75 minutes,
closed neighbor, no lifelines.**

Name: _____

ECE 5984 Wearable and Ubiquitous Computing
Midterm exam, March 27, 2003

Grading	
1. _____	/30
2. _____	/15
3. _____	/10
4. _____	/25
5. _____	/20
Total:	/100

Instructions

1. All questions should be answered on this test.
2. Raise your hand if the problem statements are not clear.
3. Students are expected to adhere to all provisions of the Virginia Tech Honor System. Sign the pledge below affirming that you have followed the honor code. By signing the pledge you are stating that you have not discussed any portion of this exam with any other student during the exam period, that you have not used notes or any other unauthorized material while taking the exam, that you have not copied any answers or portions of answers from another student and that you have not allowed anyone to copy yours.

Pledged: _____

1. Short answer questions.

a. (6%) Name and briefly describe Lorch's three categories of energy-related software issues.

1.

2.

3.

b. (5%) Briefly describe Satya's principle for determining the minimum acceptable thickness of a device.

c. (7%) What is the equation for power consumption for digital CMOS circuits? Circle the term that currently dominates the overall power consumption in a well-designed circuit.

d. (6%) Briefly describe why two different power management choices for a system, with each choice having the same average power consumption, could have different battery lives.

e) (6%) What is the mathematical relationship between power and energy? Between current, voltage, and energy?

2. (15%) Name and briefly describe five of the design guidelines for wearability from "Design for Wearability" by Gemperle et. al.

3. (10%) Based upon your reading this semester on the topic of low power software and compilation, if you had the choice between two different subroutines that had the same functionality, but one subroutine had been optimized to reduce program size and the other subroutine had been optimized to increase performance, which would you choose? Defend your answer using examples from the assigned readings.

4. Assume the minimum CPU speed is 25% of the maximum CPU speed (f_{\max}) and that the interval is 100 ms. For the DOH policy, assume that the prediction for the first interval is 100%. Given the trace of periods of activity vs. time below,

(a) (3%) find the average power for the whole trace using Weiser's OPT policy.

(b) (5%) what is s for each interval using Weiser's FUTURE policy?

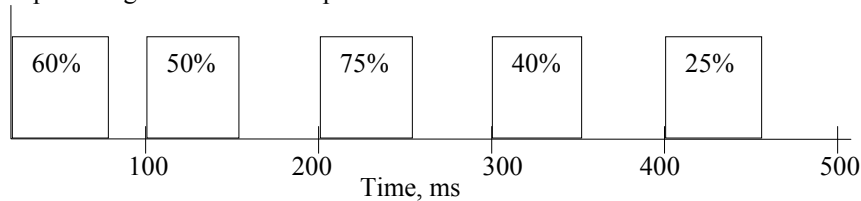
(c) (5%) what is s for each interval using the DOH policy from the example in class?

(d) (4%) how much work, if any, is carried over from the 200-300 ms interval to the 300-400 ms interval using DOH? Give your answer in terms of time of execution at f_{\max} . Assume that no work is carried over from the 100-200 ms interval to the 200-300 ms interval.

(e) (3%) find the average power for the period from 400-500 ms using the DOH policy. Assume that no work is carried over from the 300-400 ms interval.

(f) (5%) Why was Weiser's PAST policy unrealistic?

The percentages in the boxes represent the fraction of time the CPU would be active at f_{\max} .



5. a) (10%) Assume the power of a system while it is active is P_{active} , the power while it is idle is P_{idle} , and that the fraction of the time it is idle is F ($0 \leq F \leq 1$). What is the battery life of the system for a given value of F , normalized to the battery life when the system is never idle, i.e. $F=0$? Assume that the battery energy capacity is constant.
- b) (10%) Assume that the power of a hard drive while it is idle (not reading or writing data, just spinning) is P_{spin} , the power while it is in standby (not spinning) is P_{standby} , and the power while it is spinning up (going from standby to idle) is P_{start} . The time to spin up is T seconds. How long can the drive be allowed to be idle before it is better to be in standby?