Homework 4:

Please work on the homework independently. This homework is due Tuesday, November 7th, in class.

Please choose the best answer to each of the following questions. Please note that in the questions below, the words "power" and "energy" are NOT used interchangeably. (1 point per question)

1) A processor uses 20mW of power when running at full speed and 5mW of power when running at half speed. Approximately what percentage of energy is saved on task execution at half speed compared to full speed, when executing a *compute-intensive* task?

a) 15%

b) 20%

c) 50%

d) 75%

e) 80%

2) In the processor mentioned in Question (1) above, approximately what percentage of energy is saved on task execution at half speed compared to full speed, when executing a *memory-intensive* task?

a) 15%

b) 20%

c) 50%

d) 75%

e) 80%

3) If your processor has a fixed voltage, an adjustable frequency, an efficient sleep mode (in which the power consumed is negligible), and no wakeup cost, which of the following saving policies are energy-optimal (i.e., consume the least energy) if all tasks are *memory-bound* and that the processor will be in sleep mode when not executing a task?

a) Run all tasks at the lowest frequency (that does not overload the processor)

b) Run all tasks at an optimal frequency which is usually somewhere between the maximum and minimum frequency

c) Run all tasks at the maximum frequency

d) Run short tasks at the lowest frequency and long tasks at the maximum frequency.

e) None of the above.

4) For some processor, the energy consumed in executing a task is given by $E = f^2 + 0.25/f$, where f is the normalized frequency (such that f=1 when the processor is running at maximum frequency). At what value of normalized frequency should the processor operate in order to be energy-optimal?

a) f=1

b) f=1/2

c) f=1/3

d) f=1/5

e) Either (a) or (b) depending on whether the voltage is fixed or changes with f, respectively.

5) A processor consumes power at a rate 2.2 W when active, and at a rate of 0.2 W when asleep. The wake-up cost is 0.5 Joules. If this processor goes to sleep, what is the shortest sleep interval such that dropping below it will actually waste more energy compared to not sleeping?

a) 50 ms

b) 100 ms

c) 200 ms

d) 250 ms

e) 1.2 s

Reminder: 1 Joule = 1 Watt Second

6) You are trying to schedule a single 400ms task on the above processor. The task should execute once within each window of 1 seconds. It does not matter where the task executes within the window. Taking wakeup cost into account, when an energy-optimal schedule is used, what amount of energy is spent on average per one period of the above task? If you do not see the correct answer, pick the nearest approximation.

a) 1 Joule

b) 1.25 Joule

c) 1.3 Joule

d) 1.5 Joule

e) 6 Joule

7) Two tasks, A and B, have the same execution time when executed at the maximum frequency of a processor. Task A is CPU-intensive. Task B is memory-intensive. When the processor frequency is dropped in half, the total energy consumption of task B drops by 30%. Which of the following is true of the energy consumption of Task A when processor frequency is dropped in half?

a) The energy consumption of Task A will drop by 30%

b) The energy consumption of Task A will drop by more than 30%

c) The energy consumption of Task A will drop by an amount between 0 and 30%

d) The energy consumption of Task A will increase

e) Either (c) or (d)

8) Use Internet resources to find three contemporary processors that offer power-saving modes. Please name each processor and enumerate its P-states in the tables provided in the answer sheet. Please add a URL reference to the source of your information on each processor. (3 points)

One possible way to search is to start somewhere like:

https://en.wikipedia.org/wiki/Dynamic_frequency_scaling

Click links under "Power Saving Technologies" on the above page and check out the individual processors listed when you click on a particular technology. This, in most cases, leads you to a description of voltage and frequency ranges of multiple processor types. Alternatively, once you find a particular processor listed, you can search for its data sheets for more detailed information. Below are example links that lead to such voltage/frequency ranges or to data sheets.

http://www.cpuheat.wz.cz/html/AXP_multiplier/AXP_Multiplier.htm

https://www.google.nl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwj4wd7R5a_XAhWSFOwKHdXMAuEQFgg5MAE&url=http%3A%2F%2Fdownload.intel.com%2Fdesign%2Fnetwork%2Fpapers%2F30117401.pdf&usg=AOvVaw2bOxGXfuMnSpIJnCW9j3kz

http://en.wikipedia.org/wiki/Sempron

https://en.wikipedia.org/wiki/AMD_K6-2

https://en.wikipedia.org/wiki/Athlon_64