COL862 Major Exam
Low Power Computing
Sem I, 2016-17

Answer all 9 questions   Max. Marks: 72

1. Dynamic Voltage and Frequency Scaling : The Laws of Diminishing Returns

Why are voltage and frequency correlated --- e.g., why does higher frequency require higher voltage? [2]

In Figure 1 of the paper, why is the normalized energy showing up as a U-shaped curve? [3]

2. An analysis of power consumption in a smartphone

What are some high-level conclusions of this paper? [2]

In what scenarios is it justified to consider idle power (padding with idle power), during energy comparisons? In what scenarios, would such padding not make sense? [3]

3. Unlocking Energy

In Figures 13 and 14, why is the performance of the ticket lock mostly higher than Mutex/MutexEE for HamsterDB, Kyoto, Memcached, and RocksDB? [3]

In Figures 13 and 14, why is the performance of the ticket lock so bad for MySQL and SQLite? [3]

Why is the performance of MutexEE better than Mutex? [5]

Why is the energy efficiency of MutexEE better than Mutex? [2]

4. MEANTIME: Achieving both minimal energy and timeliness with approximate computing

What are some examples of applications that can benefit from approximate computing? [2]

What is a safety region, and what is an efficiency region, what what is their respective significance? [2]

Briefly explain Table 5 in the paper. What are the different configurations? What is min. speedup? What is max. acc. loss? What can you infer about the benchmarks from these measurements? [4]

5. Energy Discounted Computing on Multicore Smartphones

The paper uses a non-work-conserving CPU scheduler. Why? [2]

Explain Figure 3 in the paper. Why is the energy-discount ratio for certain tasks (e.g., compress) negative? What are the conclusions of the three plots in the Figure? [4]

6. Automated OS-level Device Runtime Power Management

Why does the software-based inference mechanism entail memory exceptions? How does hardware-assisted inference help? [3]

Explain the tradeoffs associated with the choice of “Threshold time” and the “duration after which a decision to switch mode is taken” in the paper. What are some important factors that decide these values? Explain with some example figures (numbers). [4]

Using an example driver program, that performs MMIO, describe equations (1), (2), (3) ,and (4) in Section 8.2.3 in the paper. Solve these equations for your example. [6]

7. Computational Sprinting on a Hardware/Software Testbed

On what factors does the duration of an unabridged sprint depend? [2]

Sprinting improves responsiveness. But what about energy-efficiency? Does it improve or hurt energy efficiency? Explain. [3]

According to the paper, which one has higher performance: sprint-and-rest scheme vs. sustained-execution scheme. Why? [3]

8. Maximizing Performance Under a Power Cap

Explain how the problem of “maximizing performance under a power cap” maps to the knapsack problem. Describe the mapping mathematically. [4]

9. A simpler, safer programming and execution model for intermittent computing

Consider the following ATM machine program implementing the withdrawal of as many Rs. 100/- notes as possible, as determined by the money in the account.

```
void withdraw 100s(non_volatile account *a)
{
   while (a->money >= 100) {
      dispense_cash(100);  //dispense one Rs. 100/- note
      a->money = a->money - 100;
   }
}
```

Assume that the ATM machine has intermittent power. “Non_volatile” represents a type-specifier indicating that this variable (or structure being pointed to) has been allocated in non-volatile memory.

What are some issues with periodic dynamic checkpointing --- e.g., does it result in a consistent system?   [2]

How would DINO place the task boundaries?   What that result in a consistent system? [5]

What would be your ideal solution to ensure that the system remains as safe/consistent as possible (the solution could involve manual modifications to the code)? [3]