National University of Computer and Emerging Sciences
Karachi Campus

Computer Architecture (EE-3009)

Sessional-I Exam

Date: February 26th 2025

Course Instructor(s)

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Total Time (Hrs): 1
Total Marks: 30
Total Questions: 4

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Roll No Section Student Signature

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INSTRUCTION: Attempt all the questions in-order.

CLO # 1 **Describe the performance evaluation criteria of computers and recognize performance of different computing systems.**

Q1: Logical Reasoning **[3x 2=6 Marks]**

i. According to Flynn's Taxonomy, how parallelism can be achieved in a multi-processor environment.

Data-Level Parallelism (DLP) and Task-Level Parallelism (TLP). They can be implemented through the following techniques:
Single instruction stream, single data stream (SISD)
Single instruction stream, multiple data streams (SIMD)
Multiple instruction streams, single data stream (MISD)
Multiple instruction streams, multiple data streams (MIMD)

How can energy efficiency be improved despite constant clock rates and supply voltages?

Do nothing well.
Dynamic voltage and frequency scaling
Design for the typical case.
Overclocking.
Power gating
Race-to-halt

ii. How the reliability of a system can be improved? Considering metrics like MTTF, MTTR and MTBF.

MTTF has to be increased.
MTTR has to be reduced.
MTBF has to be increased.

***CLO # 1* Describe the performance evaluation criteria of computers and recognize performance of different computing systems.**

Q2: Consider two different machines, with two different instruction sets, both of which have a clock rate of 200 MHz The following measurements are recorded on the two machines running a given set of benchmark programs: **[9+1= 10 Marks]**

Instruction Type	Instruction Count (millions)	Cycles per Instruction
	Machine A	
ALU	8	1
Load and Store	4	3
Branch	2	4
Others	4	3
	Machine B	
ALU	10	1
Load and Store	8	2
Branch	2	4
Others	4	3

a. Determine the effective CPI, MIPS rate, and execution time for each machine.

b. Comment on the results.

Part A

$$CPI_A = \frac{\sum CPI_i \times I_i}{I_c} = \frac{(8\times 1 + 4\times 3 + 2\times 4 + 4\times 3)\times 10^6}{(8+4+2+4)\times 10^6} \approx 2.22$$

$$MIPS_A = \frac{f}{CPI_A \times 10^6} = \frac{200\times 10^6}{2.22\times 10^6} = 90$$

$$CPU_A = \frac{I_c \times CPI_A}{f} = \frac{18\times 10^6 \times 2.2}{200\times 10^6} = 0.2\ \text{s}$$

$$CPI_B = \frac{\sum CPI_i \times I_i}{I_c} = \frac{(10\times 1 + 8\times 2 + 2\times 4 + 4\times 3)\times 10^6}{(10+8+2+4)\times 10^6} \approx 1.92$$

$$MIPS_B = \frac{f}{CPI_B \times 10^6} = \frac{200\times 10^6}{1.92\times 10^6} = 104$$

$$CPU_B = \frac{I_c \times CPI_B}{f} = \frac{24\times 10^6 \times 1.92}{200\times 10^6} = 0.23\ \text{s}$$

Part B

Although machine B has a higher MIPS than machine A, it requires a longer CPU time to execute the same set of benchmark programs.

CLO # 1 **Describe the performance evaluation criteria of computers and recognize performance of different computing systems.**

Q3: When parallelizing an application, the Overall speed is enhanced based on number of processors/core within a system. This is limited by two things: percentage of the application that can be parallelized and the cost of communication. Amdahl's law takes into account the former but not the latter. **[3.5 x2 = 7 Marks]**

a. What is the speedup with N processors if 80% of the application is parallelizable, ignoring the cost of communication?

$$1/(.2 + .8/N)$$

b. Compute the speedup with 8 processors if, for every processor added, the communication overhead is 0.5% of the original execution time.

$$1/(.2 + 8 \times 0.005 + 0.8/8) = 2.94$$

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Q4: Consider an Intel Pentium 4 processor with 2 GHz frequency and 3.3 operating voltage. The processor is designed to have adjustable voltage, so that 12% reduction in voltage may result in 10% reduction in frequency. What would be the impact on dynamic energy and on dynamic power?

[3.5 x2 = 7 Marks]

Q.No: 4

$$\frac{Energy_{new}}{Energy_{old}} = \frac{(3.3 \times 0.88)^2}{(3.3)^2} \Rightarrow \frac{\cancel{1/2}\ \cancel{C}\ V_{new}^2}{\cancel{1/2}\ \cancel{C}\ V_{old}^2}$$

$$\Rightarrow 0.7225$$

Reducing energy to about 72.25% of the original.

$$\frac{Power_{new}}{Power_{old}} = 0.7225 \times \frac{(2 \times 10^9 \times 0.9)}{2 \times 10^9}$$

$$\Rightarrow 0.650$$

Shrinking Power to about 65% of the original.

Correction
Energy = 0.774
Power = 0.696

================== **Good Luck** ==================