Tutorial 2 (21-01-2020)

Q.1) If a computer has a clock cycle time of 5ns, Find the clock rate.

Cycle time= 5ns, clock rate= 1/cycle time.

Q.2) CPU clock rate is 1MHz. Program takes 45 million cycles to execute. What's the CPU time?

Clock rate= 1MHz, cycle count= 45 million
CPU time= 45,000,000/ (1×10^6)= 45 seconds

Q.3) Let's assume that a benchmark has 100 instructions: 25 instructions are loads/stores (each take 2 cycles) 50 instructions are add (each takes 1 cycle) 25 instructions are square root (each takes 50 cycles). What is the CPI for this benchmark?

CPI = ((0.25 * 2) + (0.50 * 1) + (0.25 * 50)) = 13.5

Q.4) Suppose a new CPU has 80% of capacitive load of old CPU and 20% voltage reduction with 10% frequency increment. Compare the power consumption.

$Power_{newCPU} = 0.8 \times old_c \times (0.8 \times old_v)^2 \times old_f + 0.1 \times old_f$
$Power_{oldCPU} = old_c \times (old_v)^2 \times old_f$

$\frac{Power_{newCPU}}{Power_{oldCPU}}$ = 0.5632

Q.5) In a computer floating point square root taking 20% less Execution time as compared to floating point operations. There are two options namely either to improve the FPSQR operations 10 times or FP operations 2 times. Which one is preferred?

$$Speedup_{FPSQR} = \frac{1}{(1 - 0.8FP) + \left(\frac{0.8FP}{10}\right)}$$

$$Speedup_{FP} = \frac{1}{(1 - FP) + \left(\frac{FP}{10}\right)}$$

Assume FP and solve the Speedup to decide which one is preferred.

Questions to discuss:

1. Explain Amdahl's law.
   a. What is Law of diminishing returns
   b. Explain speedup in context of Amdahl's law. Give mathematical expression for the same
2. What is bottleneck in performance improvement as per the Amdahl's law? Justify using mathematical expression.
3. Give expression for CPU power consumption in terms of capacitive load, voltage and frequency.

4. Problems with Arithmetic Mean while calculating SPEC benchmarking?

Problems with Arithmetic Mean

- Applications do not have the same probability of being run
- For example, two machines timed on two benchmarks:

	Machine A	Machine B
Program 1	2 seconds (%20)	6 seconds (20%)
Program 2	12 seconds (%80)	10 seconds (%80)

Average execution $time_A$ = (2 + 12) / 2 = 7 seconds

Average execution $time_B$ = (6 + 10) / 2 = 8 seconds

Weighted average execution $time_A$ = 2*0.2 + 12*0.8 = 10 seconds

Weighted average execution $time_B$ = 6*0.2 + 10*0.8 = 9.2 seconds