Practical Session Week 4

Objectives

1. To understan ughput, CPI, CPU time, clock rate, MIPS and FLOPs
2. To solve CPU xercises

Tasks

1. Given that the tion set has the width of 8 bits:
    - What is the full instruction set size?
    - What would the opcodes of the last 2 instructions be in HEX?

2. Which plane has better performance?

Plane	London to Moscow	Passengers
Airplane 1	6 hours	100
Airplane 2	3 hours	20

- **Response time**: The time between the start and completion of a task. It includes time spent executing on the CPU, accessing disk and memory, waiting for I/O and other processes, and operating system overhead.
- **Throughput**: The total amount of work done in a given time.
- **CPU execution time**: Total time a CPU spends computing on a given task (excludes time for I/O or running other programs).

Airplane 2 is two times faster in terms of flying time, but slower in terms of throughput as throughput1=16.6 passengers/hour and troughput2=6.6 passengers/hour

3. Basic concepts :
    - A given program will require
        - some number of instructions (machine instructions)
        - some number of clock cycles
        - some number of seconds
    - The **clock rate** (cycles per second) is the inverse of the **clock cycle time** (seconds per cycle), for example, if a computer has a clock cycle time of 5 ns, the clock rate is *($1 / 5 \times 10^{-9}$ sec)=200MHz*
    - **CPI** (cycles per instruction). The CPI is the average number of cycles per instruction
    - **CPU time** is the time to execute a given program
    - **Different instructions take different number of CPU cycles**, e.g., division takes more cycles than addition, floating point instructions take more cycles than fixed point, accessing memory takes more than accessing registers etc.
    - **CPU clock cycles** is the number of CPU clock cycles
    - Given the above concepts :
        - CPU time = CPU clock cycles x clock cycle time
        - CPU time = CPU clock cycles / clock rate

- CPU clock cycles = (instructions/program) x (clock cycles/instruction)= Instruction count x CPI

- CPU time = Instruction count x CPI x clock cycle time
- CPU time = Instruction count x CPI / clock rate
- ons/program) x (clock cycles / instruction) x e)

4. Consider that MHz and the Program takes 45 million cycles to execute. Wha

5. A program ha h which 25 instructions are loads (each take 3 cycles), 50 instructions are add (each takes 1 cycle) and 25 instructions are branch (each takes 2 cycles). What is the CPI for this benchmark?

6. Assume a program of 1.000.000 instructions and two implementations of the same instruction set architecture (ISA). CPU.A has a clock cycle time of 10 ns. and a CPI of 2.0, while CPU.B has a clock cycle time of 20 ns. and a CPI of 1.2. Which CPU is faster for this program?

7. Performance Metrics
   - **MIPS** : millions of instructions per second
   - **FLOPS** : floating point operations per second

   Consider a CPU of 500MHz and three different classes of instructions: Class A, Class B, and Class C, which require one, two, and three cycles, respectively. The first code uses 5 billions Class A instructions, 1 billion Class B instructions, and 1 billion Class C instructions. The second compiler's code uses 10 billions Class A instructions, 1 billion Class B instructions, and 1 billion Class C instructions. Which sequence will be faster according to MIPS? Which sequence will be faster according to execution time?

8. Why in 32-bit CPUs we can use only up to 4GBytes of RAM memory?

9. If main memory is of 32Mbyte and every word is of 4 bytes, how many bits do we need to address any single word in memory?

10. Perform the task in slide 38 (week6_a.pdf).