

Tutorial 8 (Practice Problems)  
CSE 112 Computer Organization

**Q1.** A Processor having five stages (Fetch, Decode, Execute, Memory, Writeback) and following Rv32I Isa is designed. We need to answer the below-mentioned questions while concerning the above-mentioned processor. There is no forwarding hardware in the microprocessor to forward the ALU result.

- Draw the pipeline diagram for the below-mentioned assembly programs.
- Point out the Data Hazards in the below-mentioned programs.
- Write the modified code after resolving the data hazards by inserting NOP.
  - You may use **add x0,x0,x0** as a possible NOP instruction.
- Calculate the total number of cycles taken to execute the assembly code.

Assembly Code_A	Assembly Code_B	Assembly Code_C
add x1,x0,x0	add x1,x0,x0	add x1,x0,x0
sub x3,x2,x0	sub x3,x2,x0	sub x3,x2,x0
slt x4,x7,x8	slt x4,x7,x8	slt x4,x7,x1
or x9,x10,x11	sw x1,10(x1)	sw x1,10(x1)
and x12,x13,x14	or x9,x10,x11	or x9,x3,x11
sw x1,10(x1)	and x12,x13,x14	and x12,x9,x14

**Q2. Processor's Qualitative Performance Evaluation**

- Two processors, A and B, are working on the same ISA. The frequency of processor A is higher than the frequency of processor B. For a given program, does it imply that processor A always executes more instructions per second than processor B?
- Two processors, A and B, are working on the same ISA. For a given program, if A executes  $x$  Instructions per second, and B executes  $y$  instructions per second. If  $x > y$ , does this imply processor A is faster than processor B?

**Q3.** What are benchmark programs?

**Q4.** Two Processors (A,B) designed for different ISAs (A,B) respectively are being evaluated against a chosen benchmark. The processor A operates at 5GHz and processor B operates at 4GHz. We need to answer the following.

- What is the performance of both the processors in terms of total execution time?

	Instruction Count (ISA_A)	Processor_A (Execution Time)	Instruction Count (ISA_B)	Processor_B (Execution Time)
Optimization O1	10000		12000	
Optimization O2	8000		4500	
Optimization O3	6000		6200	