CE/CZ3001: Advanced Computer Architecture

Tutorial-3

(Consider the datapath in Figure 1 to find the answers)

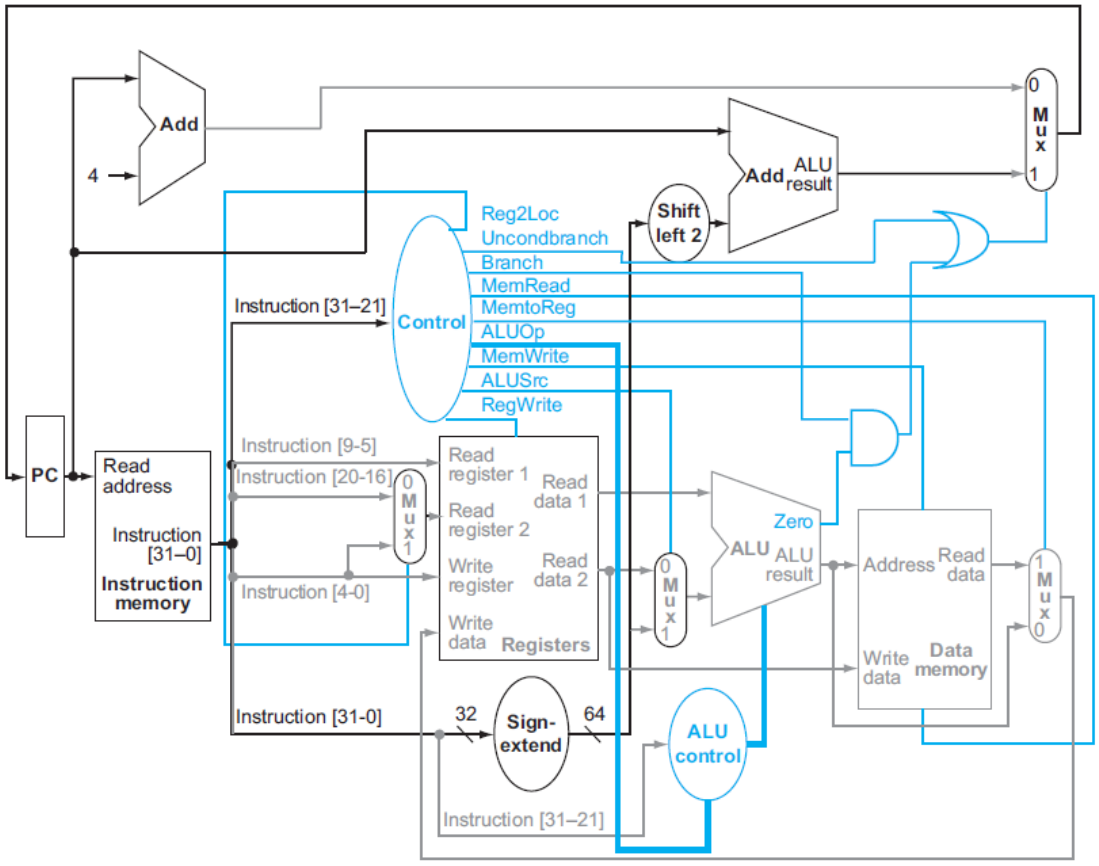

Figure 1: Datapath for R-format, I-format, D-format and B format: for ALU, load/store, conditional branch, and jump instructions.

1. Which types of instructions require the following hardware resources?

   (i) PC increment circuit
   (ii) instruction memory
   (iii) register file
   (iv) ALU
   (v) data memory

   (Answer:

   (i) **PC increment circuit** is used for ALL instructions.
   (ii) **Instruction memory** is used for ALL instructions.
   (iii) **Register file** is used for all instructions except 'unconditional branch'.
   (iv) **ALU** is used for R-type ALU instructions, immediate ALU instructions, load, store and conditional branch instructions.
   (v) **Data memory** is used for load and store instructions.

2. Based on the propagation delay provided in the Table 1, find the execution-time of the following instructions.

   (i) R-format instructions
   (ii) I- format instructions
   (iii) load word (LDUR)
   (iv) store word (STUR)
   (v) conditional branch (CBZ)
   (vi) unconditional branch (B)

Table 1: Propagation Delay of Different Hardware Elements in the Datapath

PC++	PCin→PCout	I-MEM (R)	ADD	MUX	REG (R/W)	ALU	D-MEM (R/W)	Sign-Extend	Shift-Left-2
800 ps	100 ps	500 ps	1500 ps	50 ps	200 ps	2000 ps	2000 ps	25 ps	0

Note: PC++ stands for the delay for PC increment, i.e., time required to add 4 with PC to compute PC+4. I-MEM (R) stands for the time for reading instruction memory, and D-MEM (R/W) stands for the time required for read or write operation on data memory. REG (R/W) stands for the time required for read or write operation on register file.

(Answer: (i) 3050, (ii) 2950, (iii) 4950, (iv) 4700, (vi) 2950, (vii) 2175)

3. Based on the propagation delays listed in Table 1.

   (i) Find the duration of minimum clock period of single-cycle datapath.
   (ii) If we implement the IF, ID, EX, MA, and WB in different clock cycles, then what would be the minimum duration of clock period?

(Answer: (i) 4950 ps, (ii) 2000 ps)