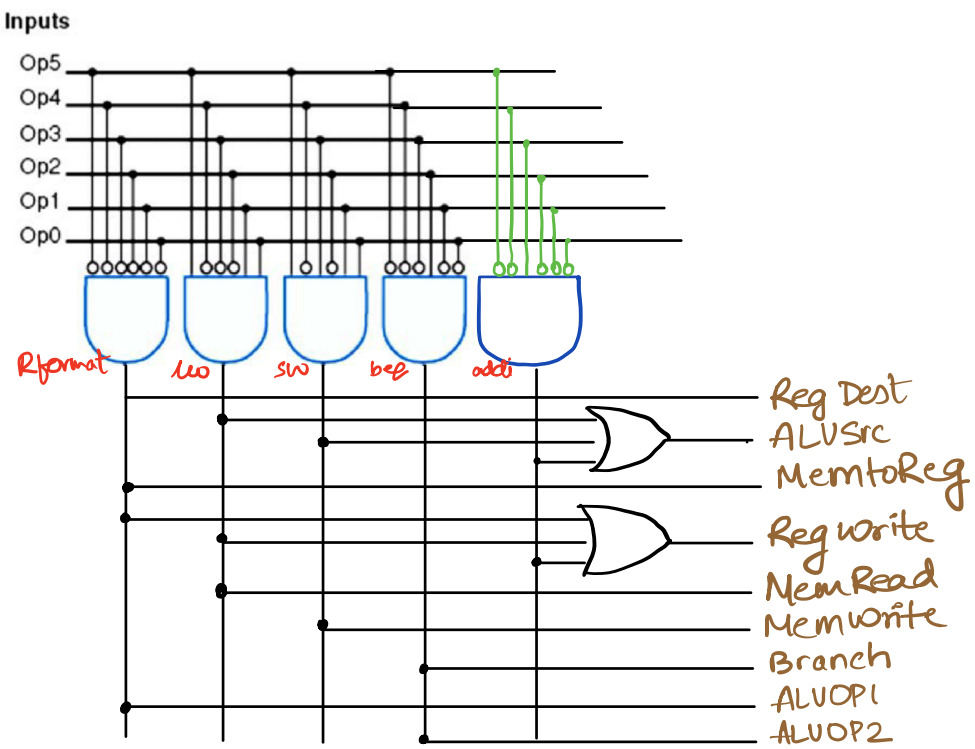
Q1. i) Control signals:-

RegDest = 0 → we require write register to write the result back into
ALUSource = 1 → ALUsource = 1 inorder to get the sign extended bits.
MemtoReg = 0 → we are not accessing memory so, 0
RegWrite = 1 → we are writing back into a reg. so, 1.
MemRead = 0 → (We will block memory reading as well
MemWrite = 0 → as writing as it is not req in addi)
Branch = 0 → we are not branching
ALUOP1 = 0 → Given
ALUOP2 = 0 → Given

ii)

Instruction type	inputs I[31-25] op5	op4	op3	op2	op1	op0	Outputs RegDst	ALUSrc	MemtoReg	RegWrite	MemRead	MemWrite	Branch	ALUOp1	ALUOp0
R-format	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
lw	1	0	0	0	1	1	0	1	1	1	1	0	0	0	0
sw	1	0	1	0	1	1	x	1	x	0	0	1	0	0	0
beq	0	0	0	1	0	0	x	0	x	0	0	0	1	0	1
addi (i format)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0

iii)



Q2.

Processor	Clock Rate	CPI
P1	3 GHz	1.5
P2	2.5 GHz	1.0
P3	4 GHz	2.2

i) Highest Performance (expressed in instructions per sec.)

$$IPS = \frac{\text{Clock Rate}}{CPI}$$

P1: $\frac{3\ GHz}{1.5} \Rightarrow \frac{3\times10^9}{1.5} = 2\times10^9$ instructions/sec

P2: $\frac{2.5\ GHz}{1.0} = \frac{2.5\times10^9}{1} = 2.5\times10^9$ instructions/sec

P3: $\frac{4.0\ GHz}{2.2} = \frac{4\times10^9}{2.2} = 1.82\times10^9$ instructions/sec

ii) # of clock cycles = Clock Rate × CPU Time

P1: $3.0\ GHz \times 10 = 3\times10^{10}$ cycles.

P2: $2.5\ GHz \times 10 = 2.5\times10^{10}$ cycles Ans

P3: $4\ GHz \times 10 = 4\times10^{10}$ cycles.

$$\text{Instruction Count} = \frac{\text{Clock Rate} \times \text{CPU Time}}{CPI}$$

P1: $\frac{3\ GHz \times 10}{1.5} = \frac{3\times10^9\times10}{1.5} = 2\times10^{10}$ instructions

P2: $\frac{2.5\ GHz \times 10}{1} = \frac{2.5\times10^9\times10}{1} = 2.5\times10^{10}$ instructions

P3: $\frac{4\ GHz \times 10}{2.2} = \frac{4\times10^9\times10}{2.2} = 1.82\times10^{10}$ instructions

Ans

(iii)

$$\text{CPU Time} = \frac{\text{Instruction Count} \times \text{CPI}}{\text{clockRate}}$$

CPU time reduced by 30% ⇒ 0.7

CPI increased by 20% ⇒ 1 + 20% ⇒ 1.2

$$\text{Clock Rate} = \frac{\text{Instruction Count} \times \text{CPI}}{\text{CPU Time}}$$

Updated clock rates :-

$$P1 \Rightarrow \frac{2\times10^{10} \times (1.5\times1.2)}{(10\times 0.7)} = 5.14\times10^{9} = 5.14\ \text{GHz}$$

$$P2 \Rightarrow \frac{2.5\times10^{10} \times (1.0\times1.2)}{(10\times0.7)} = 4.285\times10^{9} = 4.285\ \text{GHz}$$

$$P3 \Rightarrow \frac{1.82\times10^{10} \times (2.2\times1.2)}{10\times0.7}$$

$$= 6.86\times10^{9} \Rightarrow 6.86\ \text{GHz}$$ Ans