Mingkuan Pang

1. ca) Add [3ns
6ns + 4ns + 5ns + 4ns = 19ns

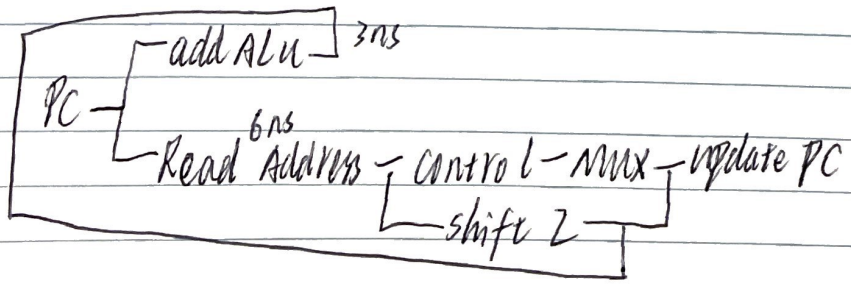
cb) lw [3ns 3ns
6ns + 4ns + 5ns + 6ns + 4ns = 25ns

cc) sw [3ns
6ns + 4ns + 5ns + 6ns = 21ns

cd) beq [3ns + 3ns = 6ns
6ns + 4ns + 5ns = 15ns

(e) The system clock time should be 25 ns, because 25ns is the longest time that instruction consumed.

(f) For j instruction the longest path time should be 6ns



2.a) 6ns is the longest path time. So the system clock time should be 6ns

b) add: $T_{madd} = 6 \times 4 = 24$ ns

lw: $T_{mlw} = 5 \times 6 = 30$ ns

sw: $T_{msw} = 4 \times 6 = 24$ ns

beq: $T_{mbq} = 3 \times 6 = 18$ ns

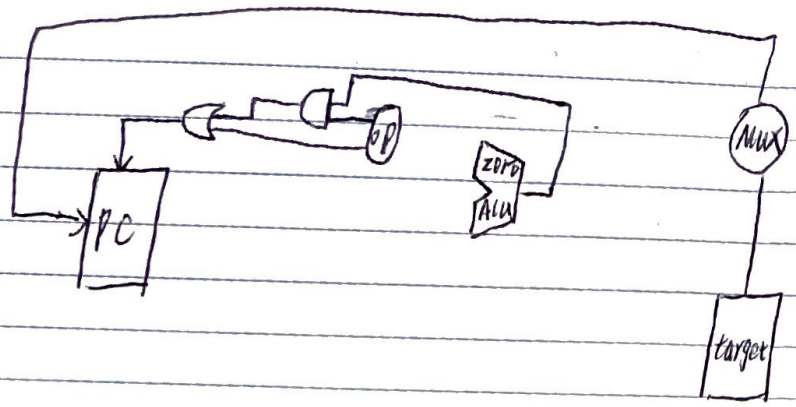
j: $T_{mj} = 3 \times 6 = 18$ ns

$T_m = 24 + 30 + 24 + 18 + 18 = 114$ ns

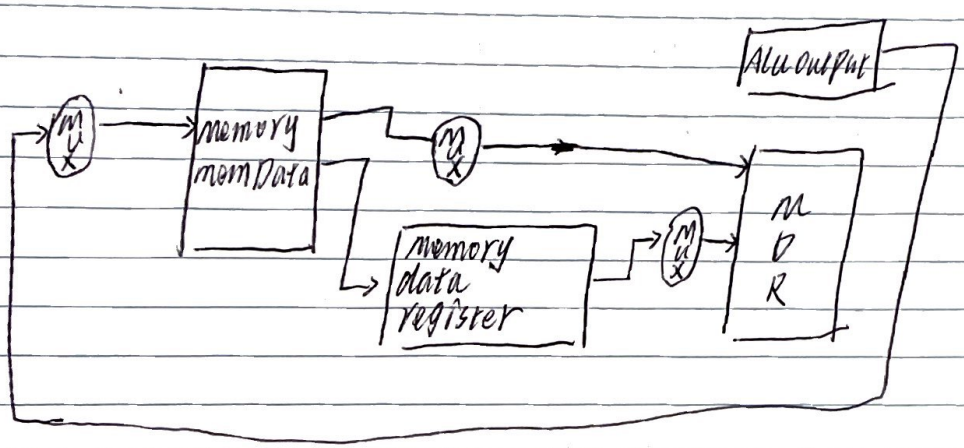
For single cycle: $T = 30 \times 5 = 150$ ns

Therefore: speed up: $\frac{150}{114} \approx 1.32$ times faster

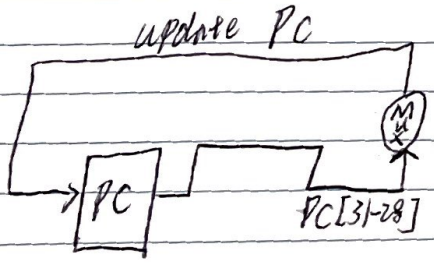
(c)


PC
zero
ALU
MUX
target

(d)


ALU output
memory
memData
memory
data
register
MDR

(e)


update PC
PC
PC[31-28]