Name: Sylvia Le

10 + 79.25 = 89.25

Course: COM219

Homework 2

Question 4

20/20

System	Description	Cycle Time (T)	Clock Frequency (f)	Instruction Completion Time	Processor Bandwidth (BW)
A	No pipeline; instruction latency 20 ns, cycle time 5 ns	5 ns (as it states)	$f = 1/T = 1/(5x10^{-9})$ = 200 MHz	20 ns (as it states)	BW = 1000/latency = 1000/20 = 50 MIPS
B	No pipeline; instruction completion time 25 ns, clock frequency 250 MHz.	$T = 1/f = 1/(2.5x10^{8})$ = 4 ns	250 MHz (as it states)	25 ns (as it states)	BW = 1000/latency = 1000/25 = 40 MIPS
C	7-stage pipeline, instruction completion time 35 ns	Latency = instr. completion time = 35ns = nT = 7T → T = 5 ns	$f = 1/t = 1/(5x10^{-9})$ = 200 MHz	35 ns (as it states)	BW = 1000/T = 1000//5 = 200 MIPS
D	Pipelined design, instruction completion time 10 ns, clock frequency 1 GHz.	$T = 1/f = 1/10^{9}$ = 1 ns (and hence, number of stages = 10/1 = 10 stages)	1 GHz (as it states)	10 ns (as it states)	BW = 1000/T = 1000/1 = 1000 MIPS = 1 BIPS
E	5-stage pipeline, cycle time 5 ns	5 ns (as it states)	$f = 1/T = 1/(5x10^{-9})$ = 200 MHz	Latency = instr. completion time = nT = 5x5 = 25 ns	BW = 1000/T = 1000/5 = 200 MIPS
F	4-stage pipeline, processor bandwidth 250 MIPS.	BW = 1000/T → T = 1000/BW = 1000/250 = 4 ns	$f = 1/T = 1/(4x10^{-9})$ = 250 MHz	Latency = instr. completion time = nT = 4x4 = 16 ns	250 MIPS (as it states)

→ System D is the fastest, since it has the greatest BW = greatest rate of instructions being issued per second

Question 5

14.5 / 15

	01101011	**10011001**
Pure Binary	$1x2^0 + 1x2^1 + 1x2^3 + 1x2^5 + 1x2^6$ = 107	$1x2^0 + 1x2^3 + 1x2^4 + 1x2^7$ = 153
Sign-magnitude	$1x2^0 + 1x2^1 + 1x2^3 + 1x2^5 + 1x2^6$ = 107. The most significant bit is 0 → positive → 107	$1x2^0 + 1x2^3 + 1x2^4$ = 25 The most significant it is 1 → negative → -25
Two's Complement	$0x(-2)^7 + 1x2^0 + 1x2^1 + 1x2^3 + 1x2^5 + 1x2^6$ = 107	$-2^7 + 1x2^0 + 1x2^3 + 1x2^4$ = -103
Excess 128	Unsigned base-10 value: 107 107-128 = -21	Unsigned base-10 value: 153 153-128 = 25
BCD	Use the lookup table First group: 0110 = 6 Second group: 1011 = N.A → N.A	Use the look up table First group = second group = 1001 = 9 → 99
Hexadecimal	Use the lookup table First group: 0110 = 6 Second group: 1011 = B → 6BH -0.25	Use the look up table First group = second group = 1001 = 9 → 99H -0.25

Question 6

14.75 / 21

-3 (-0.25 per correct answer) no work/calculations shown

Original Number	**Binary Number in Register**	**Value as interpreted with the new representation**
11 (Pure Binary, k=4)	1011	3
-14 (Sign-magnitude, k=5)	11110	-2
68 (Pure Binary, k=6)	Number out of range	N.A

-27 (Two's Complement, k=6)	100101	37
-76 (Two's Complement, k=8)	10110100	B4H -0.25
72 (interpret as 2-digit BCD)	01110001 -1.5 01110010	113 -1.5 114
6DH (interpret as 2-digit Hex)	01101101	-19

15/15

Question 2

(a) Average instruction execution time for type A instruction :

Fetch instruction time + execute time = 100 + 10 = 110 cycles

Average instruction execution time for type B instruction :

Fetch instruction time + fetch operand time + execute time = 100 + 100 + 100 = 300 cycles

→ Average instruction execution time : $\frac{110 \times 80 + 300 \times 20}{100}$ = 148 cycles ✓

(b) Cycle time = $\frac{1}{f} = \frac{1}{10^6}$ = 1000 ns = 1 μs (microsec)

→ Average instruction execution time : 148 × 1 = 148 μs

(c) Average instruction execution time in second : 148×10^{-6} s

→ Instruction execution rate = $\frac{1}{148 \times 10^{-6}}$ = 6756 (round down from 6756.756) (ips) ✓

(d) Cycle time = $\frac{1}{f} = \frac{1}{20 \times 10^6}$ = 50 ns

→ Average instruction execution time : 148 × 50 = 7400 ns = 7.4×10^{-6} s

→ Instruction execution rate : $\frac{1}{7.4 \times 10^{-6}}$ = 135 135 (ips) ✓

(e) Program completion time = $M \times t_1$ = 5,000,000 × 7.4×10^{-6}

= 37 (s) ✓

15/15

Question 3

ⓐ Longest ALU operations = 12ns

$\rightarrow T \geq 4 + 12 = 16\,ns$

$\rightarrow f = \frac{1}{T} = \frac{1}{16 \times 10^{-9}} = 62.5$ MHz ✓

Every instruction take 3 cycles to complete

$\rightarrow BW = \frac{1}{3T} = \frac{1}{16 \times 3 \times 10^{-9}} \approx 20.833$ MIPS ✓

ⓑ The loading time and ALU time remain the same

$\rightarrow f$ is the same $= 62.5$ MHz

Since now there is new instruction issued every cycles.

$\rightarrow BW = f = 62.5$ MIPS ✓

$\downarrow$

Since this is number of cycles per sec

ⓒ Program completion time = M × instruction completion time

Part a : $M \times 3T = 0.048\,s$ ✓

Part b : $M \times T = 0.016\,s$ ✓