COMP2300 Set 1 Practice Exam – Answer Key

Part A: Multiple Choice

A1. **B** (ISA)

A2. **C**

A3. **B**

A4. **C**

A5. **C**

A6. **C**

A7. **C**

A8. **C**

A9. **B**

A10. **B**

Part B: Computational Solutions

B1. Information content and encoding
Minimum bits needed for N symbols is $\lceil \log_2 N \rceil$.
(a) $\lceil \log_2 26 \rceil = 5$ bits.
(b) $\lceil \log_2 100 \rceil = 7$ bits.

B2. Base conversion I
$53_{10} = 32 + 16 + 4 + 1 = 2^5 + 2^4 + 2^2 + 2^0$.
Therefore $53_{10} = 110101_2$.

B3. Base conversion II
$11010110_2 = 1 \cdot 128 + 1 \cdot 64 + 0 \cdot 32 + 1 \cdot 16 + 0 \cdot 8 + 1 \cdot 4 + 1 \cdot 2 + 0 \cdot 1$
$= 128 + 64 + 16 + 4 + 2 = 214$.
So $11010110_2 = 214_{10}$.

B4. Binary/hex conversion
(a) $1111\,0111_2 = F7_{16}$.
(b) $D741_{16} = 1101\ 0111\ 0100\ 0001_2$.

B5. Representable ranges, $N = 8$

(a) Unsigned: 0 to $2^8 - 1 = 255$.
(b) Sign/magnitude: -127 to $+127$.
(c) 2's complement: -128 to $+127$.

B6. 2's complement encoding/decoding (8-bit)

(a) $18_{10} = 00010010_2$. Invert: 11101101. Add 1: 11101110.
So -18 is $\boxed{11101110_2}$.
(b) 11101011_2: MSB is 1, so negative.
Invert: 00010100, add 1: $00010101_2 = 21$.
So value is $\boxed{-21}$.

B7. Unsigned addition and overflow (4-bit)

$1111_2 + 1111_2 = 11110_2$.
4-bit stored result is lower 4 bits: $\boxed{1110_2}$.
Carry out is 1, so $\boxed{\text{overflow occurs}}$.

B8. 2's complement addition and overflow (5-bit)

(a) $01001_2 = +9,\ 01011_2 = +11$.
Sum: 10100_2, interpreted as -12.
Two positives produced negative $\Rightarrow$ $\boxed{\text{overflow}}$.
(b) $10100_2 = -12,\ 11010_2 = -6$.
Sum: 01110_2, interpreted as $+14$.
Two negatives produced positive $\Rightarrow$ $\boxed{\text{overflow}}$.

B9. Sign extension

1101_2 (4-bit 2's complement) has MSB = 1, so extend with 1s:
11111101_2.
Decode: invert 00000010, add 1 $\rightarrow$ 00000011, so value is $\boxed{-3}$.

B10. Bitwise operations

$A = 00110110,\ B = 00001111$.
(a) $A \& B = 00000110$.
(b) $A | B = 00111111$.
(c) $A \oplus B = 00111001$.

B11. Bit mask tasks

$X = 10110010_2$.
(a) Lowest 4 bits: use mask 00001111.
$X \& 00001111 = 00000010$.
(b) Clear lowest 2 bits: use mask 11111100.
$X \& 11111100 = 10110000$.
(c) Set highest 2 bits to 1: use mask 11000000.
$X | 11000000 = 11110010$.

B12. Logic/truth table and useful circuits

(a) $Y = (A + B)'$ (NOR):

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(b) 2:1 MUX equation: $Y = \bar{S}I_0 + SI_1$.
With $I_0 = 1, I_1 = 0$: $Y = \bar{S}$.
So $S = 0 \Rightarrow Y = 1,\ S = 1 \Rightarrow Y = 0$.
(c) Half adder: $Sum = A \oplus B,\ Carry = A \cdot B$.
For $A = 1, B = 1$: $\boxed{Sum = 0,\ Carry = 1}$.