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Course: COM219

**Homework 2**

**Question 4**

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| **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/(2.5x108) =  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 = 1/109 = 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**

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|  | **01101011** | **10011001** |
| Pure Binary | 1x20 + 1x21 + 1x23 + 1x25 + 1x26  = 107 | 1x20 + 1x23 + 1x24 + 1x27  = 153 |
| Sign-magnitude | 1x20 + 1x21 + 1x23 + 1x25 + 1x26  = 107.  The most significant bit is 0 → positive → 107 | 1x20 + 1x23 + 1x24  = 25  The most significant it is 1 → negative → -25 |
| Two’s Complement | 0x(-2)7 + 1x20 + 1x21 + 1x23 + 1x25 + 1x26  = 107 | -27 + 1x20 + 1x23 + 1x24  = -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  → 6B | Use the look up table  First group = second group = 1001 = 9  → 99 |

**Question 6**

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| **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 | B4 |
| 72 (interpret as 2-digit BCD) | 01110001 | 113 |
| 6DH (interpret as 2-digit Hex) | 01101101 | -19 |