**Note:**  (Late: -15% Penalty).

1. (5 pts) Fill in the following table to show how the given integers are represented, assuming 16-bits are used to store values and the machine uses 2’s complement notation.

|  |  |  |  |
| --- | --- | --- | --- |
| Integer | Binary | Hex | 4 Byte Little Endian  (hex value as seen in memory) |
| 28 | 11100 | 1C | 0xC1 |
| 2216 | 100010101000 | 8A8 | 0x8A8 |
| -18675 | 1011011100001101 | B70D | 0xD07B |
| -12 | 100 | 4 | 4 |
| 31456 | 111101011100000 | 7AE0 | 0x0EA7 |

1. (5 pts) Convert the following expressions from infix to reverse Polish (postfix) notation.
   1. (8–6)/2

Answer: 86-2/

* 1. (2+3)\*8/10

Answer: 23+8\*10/

* 1. (5×(4+3)×2–6)

Answer: 43+5×2×6-

1. (5 pts) Explain how a stack is used to evaluate the RPN (reverse polish notation) expression 3 5 7 + 2 1 - \* 1 + +

1. (5 pts) Define:
   1. Immediate addressing
   2. Direct addressing
   3. Indirect addressing
   4. Indexed addressing
2. (5 pts) A nonpipelined system takes 200ns to process a task. The same task can be processed in a 5-segment pipeline with a clock cycle of 40ns. Determine the speedup ratio of the pipeline for 200 tasks. What is the maximum speedup that could be achieved with the pipeline unit over the nonpipelined unit?
3. (5 pts) Suppose we have the instruction “Load1000”. Given memory and register R1contain the values below, and assuming R1 is implied in the indexed addressing mode, determine the actual value loaded into the accumulator and fill in the table below:

|  |  |
| --- | --- |
| Memory | |
| Address | Data |
| 0x1000 | 0x1400 |
|  |  |
| 0x1100 | 0x400 |
|  |  |
| 0x1200 | 0x1000 |
|  |  |
| 0x1300 | 0x1100 |
|  |  |
| 0x1400 | 0x1300 |

|  |
| --- |
| R1 |
| 0x200 |

|  |  |
| --- | --- |
| Mode | Value Loaded into AC |
| Immediate |  |
| Direct |  |
| Indirect |  |
| Indexed |  |

1. Assuming the same stages as in Example 5.11, explain the potential pipeline hazards (if any) in each of the following code segments.
   1. X=R2+Y;  R4= R2+X

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time  Period | 1 | 2 | 3 | 4 | 5 | 6 |
| X=R2+Y |  |  |  |  |  |  |
| R4=R2+X |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Answer:

* 1. R1=R2+X; X =R3+Y; Z =R1+X

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Time  Period | 1 | 2 | 3 | 4 | 5 | 6 |
| R1=R2+X |  |  |  |  |  |  |
| X = R3+Y |  |  |  |  |  |  |
| Z=R1+X |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

1. (15 pts) Write working assembly code that successfully executes the following stack reverse Polish (postfix) based code.
   1. Your code must include the use of sub-routines Push, Pop, Subtract, Add

Push A

Push B

Push C

Add

Push D

Push F

Subtract

Subtract

Push E

Add

Add

Pop X

A, 3

B, 5

C, 7

D, 2

E, 4

F, 1

* 1. What is the final value for X?