Solution Exercise L8 ISA

1. The memory unit of a computer has 256K words of 32 bits each. The computer has an instruction format with 4 fields: an opcode field; a mode field to specify 1 of 7 addressing modes; a register address field to specify one of 60 registers; and a memory address field. Assume an instruction is 32 bits long. Answer the following:
a. How large must the mode field be?
b. How large must the register field be?
c. How large must the address field be?
d. How large is the opcode field?

Ans.

a. We need to identify 1 of 7 items, so there must be 3 bits ($2^3 = 8$)
b. 60 registers implies 6 bits ($2^6 = 64$)
c. $256K = 2^8 2^{10} = 2^{18}$, or 18 bits
d. 32 - (3 + 6 + 18) = 5 bits

2. Write code to implement the expression: **A= (B + C) * (D + E)**
on 3-, 2-, 1- and 0-address machines. In accordance with programming language practice, computing the expression should not change the values of its operands.

Ans.

Add R1, B, C
Add R2, D, E
Mult A, R1, R2

3-address machine

Load R1, B
Add R1, C
Load R2, E
Add R2, E
Mult R2, R1
Store A, R2

2-address machine

Load B
Add C
Store Temp
Load D
Add E
Mult Temp
Store A

1-address machine

Push B
Push C
Add
Push D
Push E
Add
Mult
Store A

0-address machine

3. 11. Convert the following expressions from infix to reverse Polish (postfix) notation.

a) (8–6)/2

b) (5×(4+3)×2–6)

Ans.

a) 86–2/

b) 5 4 3 + × 2 × 6 –

4. The first two bytes of a 2M x 16 main memory have the following hex values:
Byte 0 is FE
Byte 1 is 01
If these bytes hold a 16-bit two's complement integer, what is its actual decimal value if:
a. memory is big endian?
b. memory is little endian?

Ans.

a. $FE01_{16} = 1111\ 1110\ 0000\ 0001_2 = -511_{10}$
b. $01FE_{16} = 0000\ 0001\ 1111\ 1110_2 = 510_{10}$