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ECE 242

Exercise #1

1) Can MC68000 read a word beginning at address 5003? Explain your answer.
    - No, the MC68000 cannot read a word beginning at address 5003 as words need to have an even address.

2) Name the 3 internal bus in a microcomputer organization and describe their functionalities.
    - The 3 internal buses in a microcomputer are:
      (1) Address Bus: It is a unidirectional bus that carries location/ memory addresses from processor to other components like the storage and I/O devices.
      (2) Data Bus: It is a bidirectional bus that carries data between processor and other components.
      (3) Control Bus: It is a unidirectional bus that carries control signals from the processor to other components.

3) How many bits (address lines) are necessary to address a memory with:
   Let 'n' be the number of address lines (address bits) and 'a' is the number of locations using the formula $n = \log_2 a$
   a) 256 locations
      - $n = \log_2 256$
        $= 8$

        Thus, 8 bits (address lines) are necessary to address a 256-location memory.

   b) 1,024 locations
      - $n = \log_2 1024$
        $= 10$

        Thus, 10 bits (address lines) are necessary to address a 1,024-location memory.

   c) 16,777,216 locations
      - $n = \log_2 16777216$
        $= 24$

        Thus, 24 bits (address lines) are necessary to address a 16,777,216-location memory.

4) Convert the binary number to decimal: 0100.0110_2
    - $(0100.0110)_2 = (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (0 \times 2^0) + (0 \times 2^{-1}) + (1 \times 2^{-2}) + (1 \times 2^{-3}) + (0 \times 2^{-4})$

      $= (4.375)_{10}$

      Thus, the decimal value is 4.375.

5) Compute the decimal value of the following numbers:
   a) 130_9

- Converting 130_9 to base 10

  $130_9 = (1*9^2) + (3*9^1) + (0*9^0)$

  $= (81 + 27 + 0)_{10}$

  $= (108)_{10}$

  Thus, the decimal value is 108.

b) 120_5

- Converting 120_5 to base 10

  $120_5 = (1*5^2) + (2*5^1) + (0*5^0)$

  $= (25 + 10 + 0)_{10}$

  $= (35)_{10}$

  Thus, the decimal value is 35.

c) 0.7132_8

- Converting 0.7132_8 to base 10

  $0.7132_8 = (0*8^0) + (7*8^{-1}) + (1*8^{-2}) + (3*8^{-3}) + (2*8^{-4})$

  $= (0+\frac{7}{8}+\frac{1}{64}+\frac{3}{512}+\frac{1}{2048})_{10}$

  $= (\frac{1837}{2048})_{10}$

  $= (0.896973)_{10}$

  Thus, the decimal value is 0.896973.

d) $FD5A_{16}$

- Converting $FD5A_{16}$ to base 10

  $FD5A_{16} = (F*16^3) + (D*16^2) + (5*16^1) + (A*16^0)$

  $= (15*4096 + 13*256 + 5*16 + 10*1)_{10}$

  $= (64858)_{10}$

  Thus, the decimal value is 64858.

6) Convert the following numbers as indicated:

a) 1024_{10} to hexadecimal

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Division by 16	Quotient	Reminder (Digit)	Digit Position
(1024) /16	64	0	0
(64) /16	4	0	1
(4) /16	0	4	2

$(1024)_{10} = (400)_{16}$

Thus, the hexadecimal value is 400.

b) 530_{16} to binary

- First convert to binary:

  $(5)_{16} = (0101)_2$

  $(3)_{16} = (0011)_2$

  $(0)_{16} = (0000)_2$

$(530)_{16} = (10100110000)_2$
Thus, the binary value is 10100110000.

c) $FFFFFFFF_{16}$ to octal

- First convert to binary:
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(F)_{16} = (1111)_2$
  $(FFFFFFFF)_{16} = (1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111\ 1111)_2$
  Second break in sets of three and convert it into octal:
  011 111 111 111 111 111 111 111 111 111 111
  3 7 7 7 7 7 7 7 7 7 7
  $(FFFFFFFF)_{16} = (37777777777)_8$
  Thus, the octal value is 37777777777.

d) 35_{10} to base 5

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Division by 5	Quotient	Reminder (Digit)	Digit Position
(35) /5	7	0	0
(7) /5	1	2	1
(1) /5	1	1	2

$(35)_{10} = (120)_5$
Thus, the value to base 5 is 120.

7) Show the machine representation of the number 128 in the following ways:

a) Binary

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Division by 2	Reminder (Digit)	Digit Position
(128) /2	0	0
(64) /2	0	1
(32) /2	0	2
(16) /2	0	3
(8) /2	0	4
(4) /2	0	5
(2) /2	0	6
(1) /2	1	7

Thus, 128 in binary is 10000000.

b) Binary-coded decimal

- To convert spilt each digit to 1, 2 and 8 then convert them to binary
  1 = 0001, 2 = 0010, and 8 = 1000
  Thus, 128 in BCD is 000100101000.

c) ASCII
- Using ASCII Extended character table, the machine representation of 128 is **Ç**.
  Thus, 128 in ASCII is Ç.

8) Answer the following question on floating-point representation:

a) Convert $AD510010_{16}$ to an IEEE single-precision floating-point number
- Sign Bit [S (1)] is 0 since the number is positive.
  Converting AD51001016 to binary:
  $(A)_{16} = (1010)_2$
  $(D)_{16} = (1101)_2$
  $(5)_{16} = (0101)_2$
  $(1)_{16} = (0001)_2$
  $(0)_{16} = (0000)_2$
  $(0)_{16} = (0000)_2$
  $(1)_{16} = (0001)_2$
  $(0)_{16} = (0000)_2$
  $(AD510010)_{16} = (1010\ 1101\ 0101\ 0001\ 0000\ 0000\ 0001\ 0000)_2$
  (Format the above value to $(-1)^S \times (1 + \text{Fraction}\ ) \times 2^e$)
  $= (-1)^0 * (1.0101101010100010000000000010000)_2 * 2^{31}$
  $= (-1)^0 * (1 + 0.0101101010100010000000000010000)_2 * 2^{31}$
  Fraction= 0101 1010 1010 0010 0000 000
  (As IEEE is a 32-bit number, I ignored everything after the 23rd bit)
  Exp = 31+127
  = 158
  $= (10011110)_2$
  IEEE number = S Exp Fraction (Placement)
  = 0 1001 1110 0101 1010 1010 0010 0000 000
  Thus, the IEEE number is 01001111001011010101000100000000.

b) Convert the following IEEE single-precision floating-point number to a decimal number:
10111111110100000000000000000000
- Splitting the IEEE into byte format: 1011 1111 1101 0000 0000 0000 0000 0000

1	0111 1111	1010 0000 0000 0000 0000 000
Sign Bit [S (1)]	Exponent Bit [Exp (8)]	Fraction (23)

I. Since S is 1 it is negative.
II. Exp (8) is 0111 1111
$= 1 \times 2^0 + 1 \times 2^1 + 1 \times 2^2 + 1 \times 2^3 + 1 \times 2^4 + 1 \times 2^5 + 1 \times 2^6 + 0 \times 2^7$
= 127
e = Exp (8) value – 127
= 127- 127

= 0

III. Fraction (23) is 1010 0000 0000 0000 0000 000 (conversion to1.xxx format)

$= 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 0 \times 2^{-4} + \cdots$

= 0.5 + 0.125

=0.625

IV. Decimal form of IEEE single-precision floating-point number

$=(-1)^{S} \times (1 + \text{Fraction}\ ) \times 2^{e}$

$= (-1)^{1} \times (1 + 0.625) \times 2^{0}$

= -1.625

Thus, the decimal number is -1.625.