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CSE 310

Homework 1

1. Explain what a Von Neumann Computer is.

    - A Von Neumann Computer is a fundamental model of a computer for processing computer programs. The model consists of 5 parts:
        i. Memory (MU)
        ii. Processing Unit (CU + ALU)
        iii. Input (Keyboard, Mouse, Disks, etc.)
        iv. Output (Monitor, Printer LED, Disks, etc.)
        v. Control Unit (CU)

2. Convert the binary number **10101.11011011** to octal.
    - $(10101)_2 \Rightarrow (25)_8$
        - $010\ 101 = 25$
    - $(.11011011)_2 \Rightarrow (.333)_8$
        - 011 011 011 = 333

    - $(10101.11011011)_2 \Rightarrow (25.333)_8$

3. Convert the decimal number **2429.625** to octal.
    - $(2429)_{10} \Rightarrow (4575)_8$

        - $\frac{2429}{8} = 303 + 5$

        - $\frac{303}{8} = 37 + 7$

        - $\frac{37}{8} = 4 + 5$

        - $\frac{4}{8} = 0 + 4$

    - $(.625)_{10} \Rightarrow (.5)_{10}$

        - $.625\ * 8 = 5.0$

- $(2429.625)_{10} \Rightarrow (4575.5)_8$

4. Convert the decimal number **532.97** to octal.

    - $(532)_{10} \Rightarrow (1024)_8$

        - $\frac{532}{8} = 66 + 4$

        - $\frac{66}{4} = 8 + 2$

        - $\frac{8}{8} = 1 + 0$

        - $\frac{1}{8} = 1 + 1$

    - $(.97)_{10} \Rightarrow (.76)_8$

        - $.97\, x\, 8 = 7.76$
        - $.76\, x\, 8 = 6.08$

    - $(532.97)_{10} \Rightarrow (1024.76)_8$

5. Convert the binary number **0.0110111** to hexadecimal.

    - $(0.0110111)_2 \Rightarrow (0.4296875)_{10}$

      $= 0 \,*\, 2^0 + 0 \,*\, 2^{-1} + 1 \,*\, 2^{-2} + 1 \,*\, 2^{-3} + 1 \,*\, 2^{-4} + 1 \,*\, 2^{-5} + 1$
      = 0 + 0 + 0.25 + 0.125 + 0.03125 + 0.015625 + 0.0078125
      = $(0.4296875)_{10}$

    - $(.4296875)_{10} \Rightarrow (0.6E)_{16}$

        - $.4296875 \,*\, 16 = 6.875$
        - .875 * 16 = 14.0 = E

6. Determine the value of base x if $(211)_x = (152)_8$

- $(152)_8 = 1 * 8^2 + 5 * 8^1 + 2 \; * 8^0 = 106$
- $(211)_x = 2 \; * x^2 + 1 \; * x^1 + 1 * x^0 = 2x^2 + x + 1$
- $2x^2 + x + 1 = 106$
    - $2x^2 + x \; - 105 = 0$
        - $\frac{-1 \pm \sqrt{1 - 4(2)(-105)}}{2(2)}$
        - $\frac{-1 \pm \sqrt{841}}{4}$
        - $\frac{-1}{4} \pm \frac{29}{4}$
        - $x = 7$
- $(211)_7 = (152)_8$

7. Convert the hexadecimal number **F3A7C2** to octal.

- $(F3A7C2)_{16} \Rightarrow (1111\ 0011\ 1010\ 0111\ 1100\ 0010)_2$
    - $F \; = \; 1111$
    - $3 \; = \; 0011$
    - $A \; = \; 1010$
    - $7 \; = \; 0111$
    - $C \; = 1100$
    - $2 = 0010$
- $(111100111010011111000010)_2 \Rightarrow (74723702)_8$
    - $000\ 111\ 100\ 111\ 010\ 011\ 111\ 000\ 010 = 74723702$

8. Convert the binary number to decimal: **1110101.101**.

- $(1110101)_2 \Rightarrow (117.625)_{10}$

- $= 1 * 2^{6} + 1 * 2^{5} + 1 * 2^{4} + 0 * 2^{3} + 1 * 2^{2} + 0 * 2^{1} + 1 * 2^{0} + 1 * 2^{-1} + 0 * 2^{-2} + 1 * 2^{-3}$
- $= 64 + 32 + 16 + 0 + 4 + 0 + 1 + .5 + 0 + .125$
- $= 117.625$

9. Write a Verilog module that implements the following Boolean equation:

f1 = a * b * c' + a * c + c

Simplify the above expression; write another module to implement it as f2. Write a test bench to check whether f1 and f2 are identical with different values of *a, b,* and *c.*

boolean.v:

```
      // f1 = a * b * c' + a * c + c
     module boolean1( output F1, input A, input B, input C );

          assign F1 = A && B && !C || A  && C || C;

endmodule

    // f2 = ( a * b ) + c
    module boolean2( output F2, input A, input B, input C );

          assign F2 = ( A && B ) || C;

     endmodule
```

boolean_test.v:

```
// 'include "boolean_test.v"
module testBoolean();

reg A, B, C;
wire F1, F2;

// Intialize all variables
initial begin
  $display ("time\t   A   B   C   F1  F2");
  $monitor ("%g\t   %b   %b   %b   %b    %b", $time, A, B, C, F1, F2);
```

```
    A = 0;
    B = 0;
    C = 0;

    #75 $finish;
  end

    always begin
      #5 C = ~C;
    end
    always begin
      #10 B = ~B;
    end
    always begin
      #20 A = ~A;
    end

       boolean1 test1( .F1(F1), .A(A), .B(B), .C(C) );
       boolean2 test2( .F2(F2), .A(A), .B(B), .C(C) );
endmodule
```
~

Sample Inputs:

A = 0
B = 0
C = 0

Sample Output:

```
$ ./boolean_test
time    A  B  C  F1  F2
0       0  0  0  0   0
5       0  0  1  1   1
10      0  1  0  0   0
15      0  1  1  1   1
20      1  0  0  0   0
25      1  0  1  1   1
30      1  1  0  1   1
35      1  1  1  1   1
40      0  0  0  0   0
45      0  0  1  1   1
50      0  1  0  0   0
55      0  1  1  1   1
60      1  0  0  0   0
```

```
65       1  0  1  1   1
70       1  1  0  1   1
75.   1  1  1  1   1
```

Sample Inputs:

A = 1
B = 0
C = 1

Sample Outputs:

```
$ ./boolean_test
time        A  B  C  F1  F2
0           1  0  1  1   1
5           1  0  0  0   0
10          1  1  1  1   1
15          1  1  0  1   1
20          0  0  1  1   1
25          0  0  0  0   0
30          0  1  1  1   1
35          0  1  0  0   0
40          1  0  1  1   1
45          1  0  0  0   0
50          1  1  1  1   1
55          1  1  0  1   1
60          0  0  1  1   1
65          0  0  0  0   0
70          0  1  1  1   1
75.     0  1  0  0   0
```

Discussion: I completed all the questions that were asked and showed my work for each question. I will give myself 50/50.