Introduction to Digital Design ECE 215
Summer 2004 Test 2

1. What number systems could each of the following numbers belong to? Select b (binary) o (octal) d (decimal) h (hexadecimal) (4 points)
   (a) 10111
   (b) 82105
   (c) FE217
   (d) 6745
2. What is the largest unsigned binary number that can be expressed with 10 bits? What is the equivalent decimal and hexadecimal? (3 points)
3. Convert the following numbers with the indicated bases to decimal. (6 points)
   (a) $(2431)_5$
   (b) $(121)_3$
   (c) $(987)_{12}$
4. Perform the following division in binary: $11001 \div 101$ (2 points)
5. Find the twos-complement of 110100_2. (1 point)
6. Convert the decimal number 8.3 to binary (4 points)
7. How many bits are required to encode 27 items? (4 points)
8. Subtract the following 8-bit integers: (4 points)

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 01101101
-00110110
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9. What is encoded in ASCII? (2 points)

10. Simplifiy the following Boolean expressions using K-maps (3 points each)

    (a) $x'y' + yz + x'yz'$

    (b) $B'D + A'BC' + AB'C + ABC'$

11. using a K-map (Karnaugh map), develop a minimized version of f where

$$f(x_1, x_2, x_3, x_4) = \sum(2, 4, 6, 7, 9) + d(10, 11)$$

    (8 points)

12. Determine the decimal value of the arithmetic expression f_{10} where

$$f_{10} = \frac{\left[(01010)_2 + (01010)_{10} - (01010)_8\right](01010)_{16}}{(010100000000)_{BCD}}$$

    (8 points)

13. What is the difference between a *latch* and a *flip-flop*? (4 points)

14. Give truth tables for the following components (3 points each)

    (a) S-R latch

    (b) D latch

    (c) J-K flip-flop

    (d) T flip-flop

15. Draw the circuit diagram for a tri-state inverter (2 points)

16. Design a D-latch using tri-state inverters and ordinary inverters. (4 points)

17. Design a master-slave D flip-flop using two D-latches. (4 points)

18. Write a Verilog module for a full-adder ($S = A + B + C_{in}$). (8 points)

$$S = A \oplus B \oplus C_{in}$$

$$C_{out} = A \cdot B + A \cdot C_{in} + B \cdot C_{in}$$

19. Write a Verilog module for a 4-bit ripple-carry adder using instances of the 1-bit full-adder above. (6 points)

20. Design a 4-bit adder/subtractor using 1-bit full-adders and xor gates. (8 points)