

Binary Number Representation and  
Arithmetic  
Assigned Date: Seventh Week  
Due Date: Oct. 9, 2017

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**P1. (10 points)** Design a logic circuit to meet the following specifications:

- The circuit has 3 inputs (A,B,C) and one output F
  - The circuit outputs a logic 1 for all input combinations that either have a decimal equivalent less than or equal to 2 (i.e.,  $ABC \leq 2$ ) or greater than or equal to 6 (i.e.,  $ABC \geq 6$ ). The circuit outputs a logic 0 for all other input combinations.
- (a) Derive the truth table for the logic circuit  
(b) Use Karnaugh map to derive a minimum SOP expression

**P2. (12 points)** How many bits are required to represent each of the following sets of integers as unsigned numbers in binary?

- (a) The integers 0 and 1  
(b) The integers from 0 to 255 inclusively.  
(c) The integers from 0 to 8191 inclusively.  
(d) The integers from 0 to 4,095 inclusively.  
(e) The integers from 0 to 456789 inclusively.  
(f) The integers from 0 to 1,234,567 inclusively.

**P3. (12 points)** How large a value can be represented by each of the following unsigned binary quantities?

- (a) A 4-bit quantity.  
(b) A 6-bit quantity  
(c) A 10-bit quantity.  
(d) A 12-bit quantity  
(e) A 16-bit quantity  
(f) A 21-bit quantity

**P4. (9 points)** Convert the following unsigned binary numbers to decimal, octal, and hexadecimal:

- (a) 1011010011                      (b) 101011010                      (c) 1000010

**P5. (12 points)** Convert the following decimal numbers to 8-bit 1's complement binary:

- (a)  $113_{10}$                       (b)  $-75_{10}$                       (c)  $-121_{10}$                       (d)  $142_{10}$

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**P6. (9 points)** How many ternary (base 3) digits are required to represent numbers in the following ranges?

- (a) The integer 0 and 1.
- (b) The integers from 0 to 8191 inclusively.
- (c) The integers from 0 to 456789 inclusively.

**P7. (9 points)** What is the value represented by the bit string 110101 if:

- (a) it is in sign-and-magnitude representation?
- (b) it is in 1's complement representation?
- (c) it is in 2's complement representation?

**P8. (9 points)** Negate the following binary numbers in 4-bit 2's complement representation: (Remark: Negate means you find the negative of the number.)

- (a) 0001                                      (b) 1100                                      (c) 0111

**P9. (9 points)** Give the 4-bit 2's complement representation for the following decimal numbers:

- (a) -6    (b) -1    (c) 6

**P10. (9 points)** Answer the following:

- (a) What advantage does 2's complement have over 1's complement?
- (b) If you want to write the number 710 using 10-bit 2's complement representation, what do you need to do?
- (c) If you want to write the number -710 using 11-bit 2's complement representation, what do you need to do?
- (d) Clarify why we can't represent -710 2's complement using only 10-bit.