Homework #1

Assigned: Section 001: February 9th. Section 003: February 12th.
Due: in class by end of lecture on February 16th and 19th, respectively.

1) Number Conversions
Make the following number conversions, showing your work:
(a) 411 decimal to binary
(b) 1001010 binary to decimal
(c) D9E8 hexadecimal to binary
(d) 11001001001001 binary to hexadecimal

2) Problem on Addition/Subtraction
(a) Add the following binary numbers (show the procedure):

00110111 + 00101100

(b) Subtract the following binary numbers (show the procedure):

00110111 – 00100011

(c) Now subtract them again by first taking the two's complement of 00100011 and then adding.

3) Full Subtractor
Design the gate-level circuit for the full subtractor that we covered in class. As a reminder, the difference and borrow are given by the following equations:

$$d_i = (x_i \odot y_i) \odot b_i$$
$$b_{i+1} = (x_i \odot y_i) \, . \, b_i + x_i' \, . \, y_i$$

4) Circuit Design
Design a circuit that takes as inputs two 8-bit numbers, A[7:0] and B[7:0], and generates a single-bit output, EQ, which is 1 when A[7:0] is equal to B[7:0] and 0 otherwise. Provide:
(a) A symbol showing the inputs and output
(b) Logic expression for EQ as a function of the 16 input bits A[7:0] and B[7:0]
(c) The gate-level implementation

Hint: *You can use any of the gates that we covered in class, with as many inputs as you need.*

5) Universal Set of Gates
As we discussed in class, a set of gates is *universal* if any function can be implemented using gates just from that set. For example, we showed that the set S={AND, OR, NOT} is universal since the truth table of any binary function can be expressed using only gates. Is the set S={NAND} universal? Explain your reasoning.

Hint: *To prove that S is universal, you may show that all gates of a known universal set can be implemented using the gates in S. Also, you may connect both inputs of a gate to the same signal.*