CmpSci 201
Homework 2

Numerical Representation and Arithmetic

1. What is the representation of the decimal number 999,
   (a) In binary?
   (b) In Octal?
   (c) In Hexadecimal?
   (d) In Binary Coded Decimal?
2. What is the representation of the binary number 111011110,
   (a) In decimal?
   (b) In Octal?
   (c) In Hexadecimal?
3. What is the representation of the hexadecimal number 0xFEED,
   (a) In decimal?
   (b) In binary?
   (c) In Octal?
4. Perform the following addition. Show your work (including carries). $100001 + 10101$
5. Perform the following addition. Show your work (including carries). $11001101 + 10111011$
6. What is the representation (in binary, with 8 bit wide words) for the values +122 and -122 using,
   - Sign and magnitude (with the MSB as the sign bit)?
   - 1's complement?
   - 2's complement?
7. What is the representation (in binary, with 16 bit wide words) for the values +1152 and -1152 using,
   - Sign and magnitude (with the MSB as the sign bit)?
   - 1's complement?
   - 2's complement?
8. Perform the following subtraction. Show your work. $11000110 - 110001$

- Perform the subtraction longhand (show borrows)
- Perform the subtraction by adding the 1's complement of the second value
- Perform the subtraction by adding the 2's complement of the second value

9. Perform the following subtraction. Show your work. $10101010 - 1010101$

   - Perform the subtraction longhand (show borrows)
   - Perform the subtraction by adding the 1's complement of the second value
   - Perform the subtraction by adding the 2's complement of the second value

10. An Obstreperous ATM

    Years from now, as a successful computer scientist, you are called upon to debug the software for an ATM. The source code is lost in time (or it was all written in assembly from the get go), and so you have to inspect the running code using debugging software. You've narrowed the problem down to either the code that reads the account number off the ATM card, or the software that reads and encodes the PIN number. The code for each operation resides on different chips, and the debugger for the account reader chip outputs the values in hexadecimal, while the debugger for the PIN chip outputs the values in octal. Even worse, the bank expects the values to be transmitted to it in BCD!

    The bank has kindly lent you a demo ATM card, with the card number and PIN stamped on it in decimal. The card's account number is `4276-9937-75`, and the PIN is `7761` (note that these are in decimal). Below are tables with some possible output. The first column is the value output by the account number reading code (in hex). The second column is the value output by the PIN number reading code (in octal). The third column displays the BCD encoding of the PIN value.

    (a) If you swiped the demo card through and saw the following output, which (if any) code is wrong?

Account Output	PIN Reader Output	BCD PIN
`0xF33DBEEF`	`017121`	`0111 0111 0110 0001`

    (b) If you swiped the demo card through and saw the following output, which (if any) code is wrong?

Account Output	PIN Reader Output	BCD PIN
`0xFEEDBEEF`	`017141`	`0111 0111 0111 0111`

    (c) If you swiped the demo card through and saw the following output, which (if any) code is wrong?

Account Output	PIN Reader Output	BCD PIN
`0xFEEDBEEF`	`017121`	`0111 0111 0110 0001`