1. **Two’s Complement Encoding**

Computer X uses (an illogical format of) 3-byte words (i.e., each word consists of 3 bytes) and each byte consists of 8 bits. It uses the 2’s complement number system to represent signed numbers.

(a) (5 points) How many different patterns can be stored in a word?

(b) (10 points) What are the 2’s complement representations for the values $127_{10}$ and $-127_{10}$ in computer X?

(c) What decimal values are represented by the following patterns in computer X?

   i. (3 points) 0011 1010 0011 1101 0011 0000

   ii. (3 points) 1111 1010 1101 0010 1100 1101

(d) (7 points) Give the binary pattern that results from adding the two patterns in c. What decimal value is represented by this pattern?
2. Binary Arithmetic
Do the following arithmetic in binary (representing unsigned integers). Show complete “tail" work (demonstrated in lecture notes) for full credit.

(a) (10 points) $111010_2 \times 1001_2$

(b) (10 points) $10010100_2 / 101_2$

3. (10 points) Base-4 Arithmetic
Do the following arithmetic in base-4. Give complete “tail" multiplication to get full credit.

$2031_4 \times 2231_4$
4. **Octal, Hexadecimal and Other Numbers**
   
   (a) (5 points) Give the representation of the value 240\(_{10}\) in the octal number system.

   (b) (5 points) Give the representation of the value 634\(_{10}\) in the hexadecimal number system.

   (c) (5 points) Give the representation of the value 4800\(_{10}\) in the ”penta number system” (base 5).

5. **Encoding** Show the binary representation (in bits) for the following data items when they are stored in computer memory.

   (a) (5 points) The string “2a?~”. (Assume 8 bit ASCII characters, not 16 bit Unicode.)

   (b) (5 points) The hexadecimal number B73F
(c) (5 points) The signed integer -208 (in 16 bits) in 2’s complement format

(d) (2 points) The signed integer -208 (in 16 bits) in sign magnitude format

(e) (5 points) The single precision floating point number 22.5

(f) (5 points) The single precision float point number -18.75