1. (8 pts) Consider the following Boolean function, which is given as a minterm list.

\[ F(x, y, z) = \overline{m1} + \overline{m2} + \overline{m7} \]

a) Give the canonical sum-of-products Boolean expression for function F.

b) Give the truth table for function F.

c) Draw a two-level circuit diagram of function F using only gates from the set \{NOT, AND, OR\}.
2. (16 pts) Consider the following component-level diagram of a combinational circuit which compares two unsigned two-bit values.

```
+-----+
A-->|     |
B-->|     |
C-->|     |
D-->|     |
+-----+
```

When the two-bit value AB is not equal to the two-bit value CD, the "NE" output signal is asserted (the logical value one). Otherwise, the "NE" output signal is deasserted (the logical value zero). For example, the two-bit value 10 is not equal to the two-bit value 01.

a) Describe the functionality of this circuit using a truth table.

b) Give the Karnaugh map for this circuit.

c) Give the minimized sum-of-products Boolean expression for this circuit.
3. (16 pts) Consider a circuit which functions as a specialized counter: it begins at two and counts up to six (by ones), then starts over. That is, the circuit counts through the sequence <2, 3, 4, 5, 6, 2, 3, 4, 5, 6, ....>. The circuit uses D flip-flops to store the current value, and combinational logic to increment the current value. Assume that the circuit is initialized asynchronously (the initialization is independent of the combinational logic and can be ignored for this problem).

a) Give the truth table for the combinational component of this counter.

b) Give the Karnaugh maps for the combinational component of this counter.

c) Give the minimized sum-of-products Boolean expressions for the combinational component of this counter.
4. (22 pts) Consider the following C program. In the space provided, give the hexadecimal value which will be displayed by each call to "printf".

```c
#include <stdio.h>

int main()
{
    int aaa = 172;
    int bbb = -172;
    int ccc = 0x7c00009d;
    int ddd = 0xb60000a3;

    printf( "%08X\n", aaa );          // ______________________________
    printf( "%08X\n", bbb );          // ______________________________
    printf( "%08X\n", ˜ccc );         // ______________________________
    printf( "%08X\n", ccc | ddd );    // ______________________________
    printf( "%08X\n", ccc ^ ddd );    // ______________________________
    printf( "%08X\n", ccc & ddd );    // ______________________________
    printf( "%08X\n", ccc >> 8 );     // ______________________________
    printf( "%08X\n", ccc << 12 );    // ______________________________
    printf( "%08X\n", ddd >> 16 );    // ______________________________
    printf( "%08X\n", ddd << 20 );    // ______________________________
}
```
5. (12 pts) Suppose that a machine uses eight bits to represent signed integers, uses two's complement arithmetic, and has the integer condition codes discussed at lecture. For each of the problems below, give the result (in binary) of the addition as it would be performed by this machine, and give the value of the indicated condition code bits after the operation is complete.

a) Sum of the eight-bit operands (given in binary).

```
10110011   |   Sum: ________________________
ADD 10011101   |   N: _______   Z: _______   V: _______   C: _______
```

b) Sum of the eight-bit operands (given in binary).

```
00001000   |   Sum: ________________________
ADD 11111000   |   N: _______   Z: _______   V: _______   C: _______
```

c) Sum of the eight-bit operands (given in binary).

```
10100111   |   Sum: ________________________
ADD 11110110   |   N: _______   Z: _______   V: _______   C: _______
```

6. (4 pts) Consider the following list of terms associated with IEEE floating point representation.

Infinity
NaN
Zero
Denormal
Normalized

For each double-precision floating point number shown below (in hexadecimal), state the term from the list above which best describes that number.

```
001f000000000000  ______________________________
ffff000000000000  ______________________________
80000000ffffff   ______________________________
7ff0000000000000  ______________________________
```
7. (12 pts) The following questions refer to IEEE floating point numbers. Show your work for possible partial credit.

a) Give the 64-bit double precision internal representation (in hexadecimal) of the decimal value given below.

-9.625  ________________________________

b) Give the decimal value of the 32-bit single precision floating point number whose internal representation is given below (in hexadecimal).

3f400000  ________________________

c) Give the 32-bit single precision internal representation (in hexadecimal) of the decimal value given below.

+13.375  ________________________________________