CPE201 HW 1 (100 points)

Answer all questions completely. Put a box around the final solution. Put your name on it. Show your work.

All work for this homework must be done by hand.

1.
    a. Find the largest decimal number that you can represent with ten bits?

Unsigned values (don't forget to take out zero)
2^{10}-1 = 1023_{10}

    b. Find is the largest decimal number that you can represent with eighteen bits?

Unsigned values (don't forget to take out zero)
2^{18}-1 = $256k_{10}$ - 1 = 262,143

2. Convert the following numbers to hexadecimal.
    a. 101111001_2

Put in groups of 4 bits starting at the bottom and convert to hex digits
1 0111 1001 = 0x1 0x7 0x9 = 0x179

    b. 1100101001_2

Put in groups of 4 bits starting at the bottom and convert to hex digits
11 0010 1001 = 0x3 0x2 0x9 = 0x329

    c. 646_8

Convert to binary groups of 3 digits
0o6 0o4 0o6 = 110 100 110
Regroup to 4 bit groups and convert to hex digits
1 1010 0110 = 0x1 0xA 0x6 = 0x1A6

    d. 7452_8

Convert to binary groups of 3 digits
0o7 0o4 0o5 0o2 = 111 100 101 010
Regroup to 4 bit groups and convert to hex digits
1111 0010 1010 = 0xF 0x2 0xA = 0xF2A

    e. 1023_{10}

Removing powers of 2

1023 – 512	=	511	2^9
511 – 256	=	255	2^8
255 – 128	=	127	2^7
127 – 64	=	63	2^6
63 – 32	=	31	2^5
31 – 16	=	15	2^4
15 – 8	=	7	2^3
7 – 4	=	3	2^2
3 – 2	=	1	2^1
1 – 1	=	0	2^0

Then the number can be represented as:
111111111_2

f. 743_{10}

Removing powers of 2

743 – 512	=	231	2^9
231 – 128	=	103	2^7
103 – 64	=	39	2^6
39 – 32	=	7	2^5
7 – 4	=	3	2^2
3 – 2	=	1	2^1
1 – 1	=	0	2^0

Then the number can be represented as:
1011100111_2

3. Convert the following numbers to decimal.
   a. 101011101_2

$2^8+2^6+2^4+2^3+2^2+2^0 = 256 + 64 + 16 + 8 + 4 + 1 = 349$

b. 1101101001_2

$2^9+2^8+2^6+2^5+2^3+2^0 = 512 + 256 + 64 + 32 + 8 + 1 = 873$

c. 534_8

Convert to groups of 3 binary bits
0o5 0o3 0o4 = 101 011 100
Convert to decimal
$2^8+2^6+2^4+2^3+2^2 = 256 + 64 + 16 + 8 + 4 = 348$

d. $A6C_{16}$

Convert to groups of 4 binary bits
0xA 0x6 0xC = 1010 0110 1100
Convert to decimal
$2^{11}+2^9+2^6+2^5+2^3+2^2 = 2048 + 512 + 64 + 32 + 8 + 4 = 2668$

4. Do the following binary arithmetic.
   a. 1101 + 10111

Pad to same size, then add down

```
 01101
+10111
------
100100
```

   b. 1001 x 101

```
  1001
  x101
  ----
  1001
   0
+1001
-----
 101101
```

   c. 11010 – 10101

```
 11010
-10101
------
 00101
```

5. Determine the 1's complement and 2's complement of each 8-bit binary number.
   a. 00000000

1's complement (invert all bits)
1111 1111

2's complement (add 1 to 1's complement)
1 0000 0000 = 0000 0000 (Throw away 9th bit, this is only an 8 bit number)

   b. 00011101

1's complement (invert all bits)

1110 0010

2's complement (add 1 to 1's complement)
1110 0011

c. 10101101

1's complement (invert all bits)
0101 0010

2's complement (add 1 to 1's complement)
0101 0011

6. Convert each pair of decimal numbers to 8-bit 2's complement binary form and add the numbers together.
   a. 64 and -42

Removing powers of 2
$64 - 64 = 0 \quad 2^6$

Then the number can be represented as:
$0100\ 0000_2$

Removing powers of 2 (of the positive number)
$42 - 32 = 10 \quad 2^5$
$10 - 8 = 2 \quad 2^3$
$2 - 2 = 0 \quad 2^1$

Then the positive number can be represented as:
$0010\ 1010_2$

Change 42 to -42 by doing 2's complement
$1101\ 0101 + 1 = 1101\ 0110_2$

$$\begin{array}{r} 0100\ 0000 \\ +1101\ 0110 \\ \hline 0001\ 0110 = 24_{10} \end{array}$$

b. -52 and -43

Removing powers of 2 (of the positive number)
$52 - 32 = 20 \quad 2^5$
$20 - 16 = 4 \quad 2^4$
$4 - 4 = 0 \quad 2^2$

Then the positive number can be represented as:
$0011\ 0100_2$

Change 52 to -52 by doing 2's complement
$1100\ 1011 + 1 = 1100\ 1100_2$

Removing powers of 2 (of the positive number)

43 – 32	=	11	2^5
11 – 8	=	3	2^3
3 – 2	=	1	2^1
1 – 1	=	0	2^0

Then the positive number can be represented as:
$0010\ 1011_2$

Change 43 to -43 by doing 2's complement
$1101\ 0100 + 1 = 1101\ 0101_2$

1100 1100
+ 1101 0101
11010 0001 (Throw away 9th bit, this is only an 8 bit number)
$1010\ 0001 = -95_{10}$