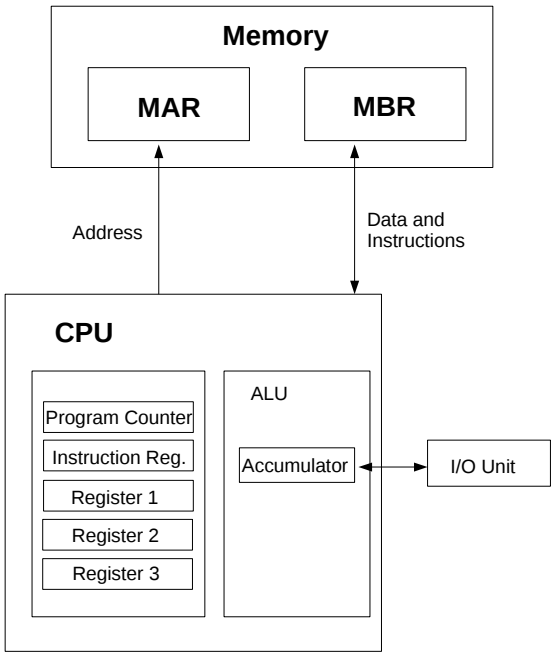
1. (5 Points) Draw a diagram for the von Neumann model of a uniprocessor computer.

   Solution:



2. (5 Points) State Moore's Law and the modified version of Moore's Law.

   Solution: Moore's Law: The density of transistors in an IC will double every year. This was modified to every 18 months.

3. (10 Points) Convert $(12345)_{10}$ to bases, $r = 2$, $r = 5$, $r = 8$, and $r = 16$.

   Solution:

$$(12345)_{10} = (11000000111001)_2 = (343340)_5 = (30071)_8 = (3039)_{16}$$

4. (10 Points) Convert $(123.45)_{10}$ to bases, $r = 2$, $r = 3$, $r = 8$, and $r = 16$.

   Solution:

$$(123.45)_{10} = (1111011.01\overline{1100})_2 = (11120.\overline{1100})_3 = (173.3\overline{4631})_8 = (7B.7\overline{3})_{16}$$

5. (5 Points) Convert the binary number 10010101.00011 to octal and hexadecimal.

   Solution:

$$(10010101.00011)_2 = (225.06)_8 = (95.18)_{16}$$

6. (5 Points) Convert the hexadecimal number FA57.D3 to binary and octal.

   Solution:

$$(FA57.D3)_{16} = (1111101001010111.11010011)_2 = (175127.646)_8$$

7. (10 Points) Take the two binary numbers $a = 100100110$ and $b = 1101100011$ and calculate $a + b$, $b - a$, and $a \cdot b$, using binary arithmetic.

   Solution:

$$\begin{aligned} a + b &= 10010001001 \\ b - a &= 1000111101 \\ a \cdot b &= 111110001110110010 \end{aligned}$$

8. (5 Points) Find the 1's and 2's complement of 123, using byte storage with one sign bit.

   Solution:

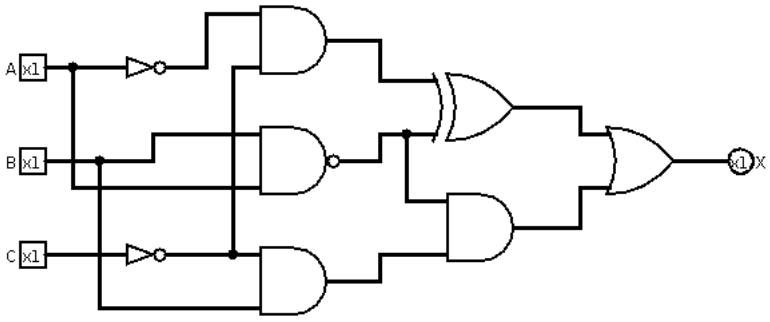
$$(-123)_{10} = 10000101$$

9. (5 Points) Convert 57 to binary and then using the 2's complement of 123 and addition, calculate $57 - 123$ in binary form.

   Solution:

$$\begin{aligned} (57)_{10} &= 00111001 \\ (57 - 123)_{10} &= 10111110 = (-66)_{10} \end{aligned}$$

10. (50 Points) Do the following for the circuit below.



   (a) Construct the truth table for the circuit.

   Solution:

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(b) Write the circuit's logical function in canonical SOP form.
Solution: $X = A'B'C + A'BC' + A'BC + AB'C' + AB'C$

(c) Write the circuit's logical function in canonical POS form.
Solution: $X = (A + B + C)(A' + B' + C)(A' + B' + C')$

(d) Write the circuit in minterm form.
Solution: $X = \Sigma m(1, 2, 3, 4, 5)$

(e) Write the circuit in maxterm form.
Solution: $X = \Pi M(0, 6, 7)$

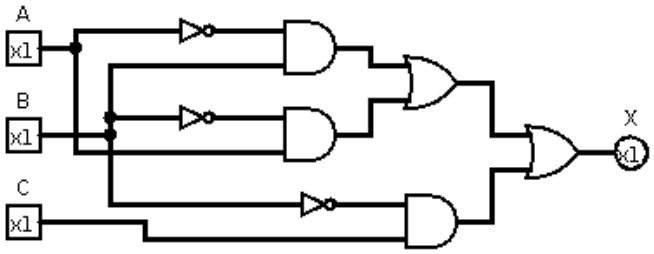
(f) Write the K-Map for the circuit, show the groupings you would use, and then construct the minimized logical circuit function in SOP form.
Solution:

	A B			
C	00	01	11	10
0		1		1
1	1	1		1

Use three groups, column 01, column 10, and the 001/101 cells.

$$X = A'B + AB' + B'C$$

(g) Using the K-Map work, write the circuit diagram of the minimized circuit.
Solution:



(h) Do the Quine-McCluskey procedure on the original circuit, show all steps in the derivation. Construct the minimized logical circuit function in SOP form.
Solution:

001	0–1	(1,3)	PI_1
010	–01	(1,5)	PI_2
<u>100</u>	01–	(2,3)	PI_3
011	10–	(4,5)	PI_4
101			

	1	2	3	4	5
PI_1	×		×		
PI_2	×				×
PI_3		⊗	×		
PI_4				⊗	×

So PI_3 and PI_4 are essential and they can be combined with either PI_1 or PI_2, giving the two possible solutions of $X = A'B+AB'+A'C$ or $X = A'B+AB'+B'C$.