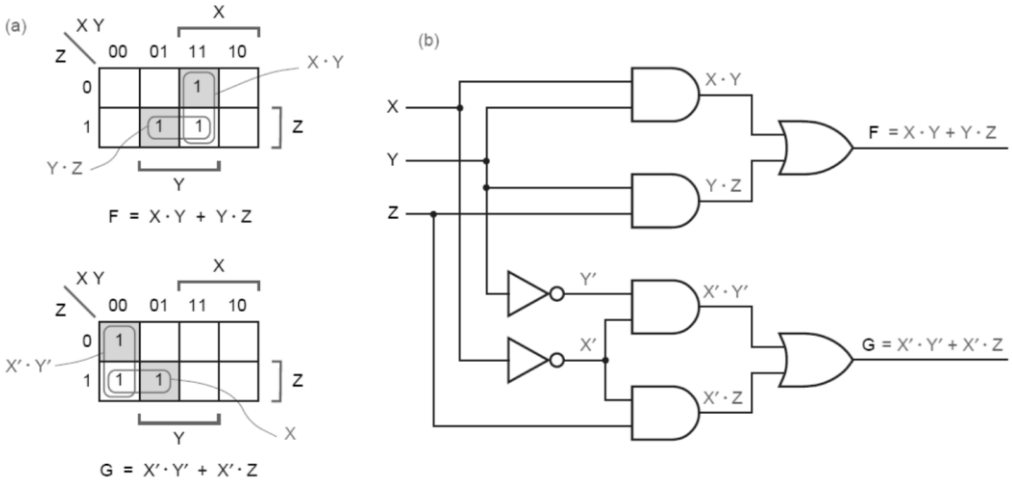
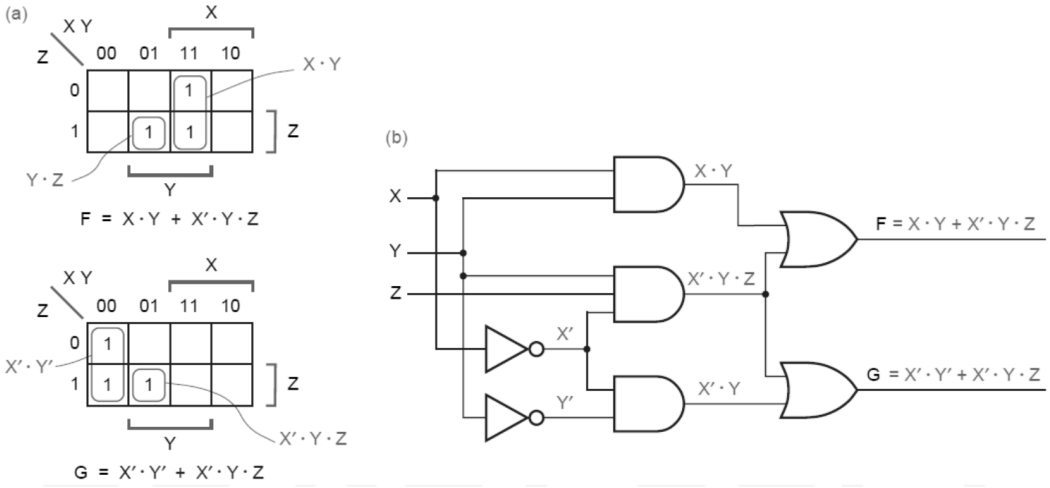
INDRAPRASTHA INSTITUTE OF INFORMATION TWCHNOLOGY DELHI
MID-SEMESTER EXAMINATION
ECE 111 DIGITAL CIRCUITS

Date: February 20, 2022. Max. Marks: 40

Q1. Consider the following logical functions:
F(X, Y, Z) = ∑ m (3, 6, 7) and G(X, Y, Z) = ∑ m (0, 1, 3)
Give the realization of the logic functions F and G using minimum number of total AND, OR and NOT gates to realize the functions. Hint: The realization could have a common minterm for both the functions. (8)



Non minimal solution (2.5 marks for F and 2.5 marks for G)



Minimal solution (4 marks for F and 4 marks for G)

Q2. Determine the base used in each of the following cases for the equation to be correct:

(a) 14/2 = 5, (b) 54/4 = 13 (6)

Solution:

(a) Since the single digit numbers are less than 9, we can conveniently write

$14/2 = 5$ *i.e* $r + 4 = 5 \times 2$ ***(3)***

Writing this in decimal system, $r + 4 = 10$ *or* $r = 6$

(b) Since the single digit numbers are less than 9, we can write

$$54/4 = 13. i.e., \quad 5r + 4 = 4 \times (r + 3)$$

Writing this in decimal system, $5r + 4 = 4r + 12$ $i.e$ $r = 8$ ***(3)***

Q3. Suppose a 8 bit binary number B is represented by a 2-digit hexadecimal number H. Prove that the two's complement of B is represented by the 16's complement of H. Can this be extended to any 4N bit binary number B and N digit hexadecimal number H? (9)

Solution:

Let the 8 bit binary number B be represented by $b_7\ b_6\ b_5\ b_4\ b_3\ b_2\ b_1 b_0$ ***. The twos complement of B will be*** $\overline{b_7}\ \overline{b_6}\ \overline{b_5}\ \overline{b_4}\ \overline{b_3}\ \overline{b_2}\ \overline{b_1}\ \overline{b_0} + 00000001$

Let the two digit hexadecimal number be represented by $h_1 h_0$ ***when represented in binary each will be a 4 bit number with*** h_1 ***represented by*** $b_7\ b_6\ b_5\ b_4$ ***and*** $and\ h_2\ by\ b_3\ b_2\ b_1 b_0$***. 16's complement of*** h_1 ***will be*** $10000 - b_7\ b_6\ b_5\ b_4$***, i.e., 2's complement in binary. Taking the complete number*** $h_1 h_0$ ***its 16's complement will be the 2's complement of*** $b_7\ b_6\ b_5\ b_4\ b_3\ b_2\ b_1 b_0$***.***

If a student establishes it through an example you can give him 8 marks. Anyone who gives the generic solution similar to the above then you give him 9 marks, and let me know the names of students who gets 9 marks for this question.

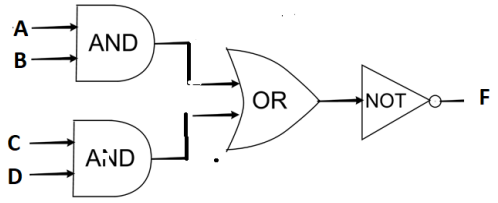
Q4. Logic function of a commercial TTL is given as: F = $\overline{(A\ B + C\ D)}$

Realise this function using AND, OR and NOT gate.

Show that this gate can be used as an Universal gate. (9)

Solution:

To realise F = $\overline{(A\ B + C\ D)}$**, we need two two-inputs AND gate, one two-inputs OR gate and one NOT gate. The realisation is shown below.**



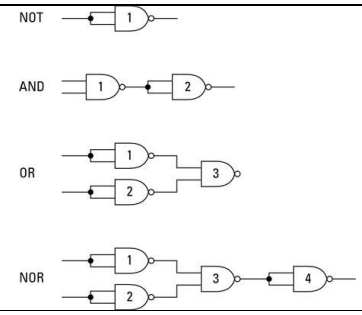
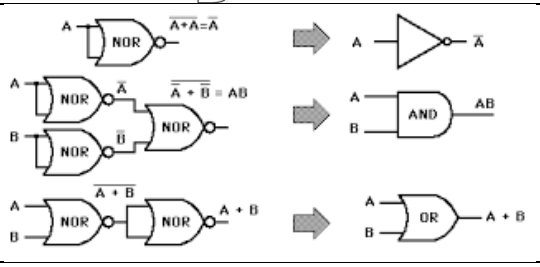
3 Marks

- *We now show a NOR / NAND gate realisation.*

To realise a NOR gate, we make A = B and C = D; then the output F = $\overline{(A + C)}$ *.*
To realise a NAND gate, we make A = C and B = D, the output F = $\overline{(A\,B)}$

Since NOR and NAND are universal gate, so this gate is also Universal gate.
Student should show the AND, OR and NOT gate realisations using either NAND or NOR gate.
Alternate solutions:

1. ***If A, B and D vote for a proposal it will get approved***

FROM	TO		MARKS
AND, OR, INVERT	NAND	• A = A, B=B, C and D EITHER 0 OR 1. • C = A, D=B, A and B EITHER 0 OR 1. • A=B = A/B, C = D = B/A	3
	NOR	• A=B=A, C=D=B OR A=B =B, C=D=A • A=A, B=1 AND C=B, D=1 • A=1, B=A AND D=B. C=1	
NAND	AND, OR, NOT AND NOR		3
NOR	AND, OR, NOT		

3 Marks

Q5. A company has four share-holders A, B, C and D. A owns 20%, B owns 30%, C owns 40% and D owns 10% of total shares. A policy can be passed only if share-holders holding 60% or more of the total shares vote for it. Assuming that **A**, **B**, **C** and **D** denote binary variables indicating whether the corresponding share-holder has supported a particular policy or not, obtain a Boolean expression for the condition (**P** = 1) for a policy to get accepted.

(8)

Solution:

From the problem statement we can write the following

2. ***If A, B, C and D vote for a proposal it will get approved***
3. ***If A and C vote for a proposal it will get approved***
4.
5. ***If B and C vote for a proposal it will get approved***

The condition 1 is included in condition 2 as A and C alone is sufficient and they do not need B and D to join. Similarly condition 1 is included in condition 3 as also condition 4.

Thus we get $\boldsymbol{P = A \cdot C + B \cdot C + A \cdot B \cdot D}$ ***(8)***

Note: The maximum marks is indicated as 40 while in the lecture we announce the mid-sem examination will be for 20%. It will still contribute only 20% to the final total.