SLOT: G1+TG1

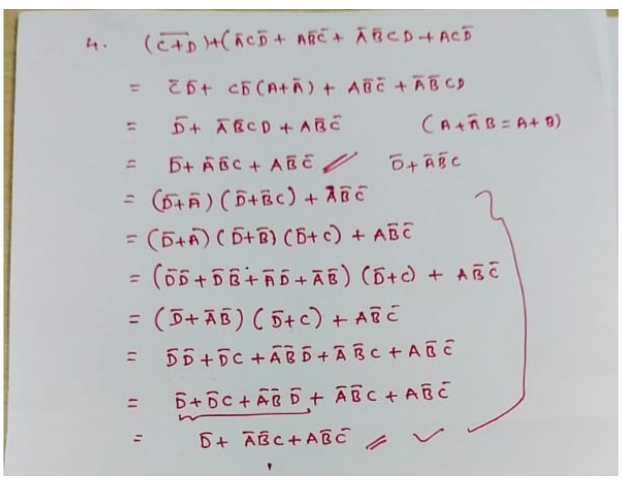
SCHOOL OF ELECTRONICS ENGINEERING

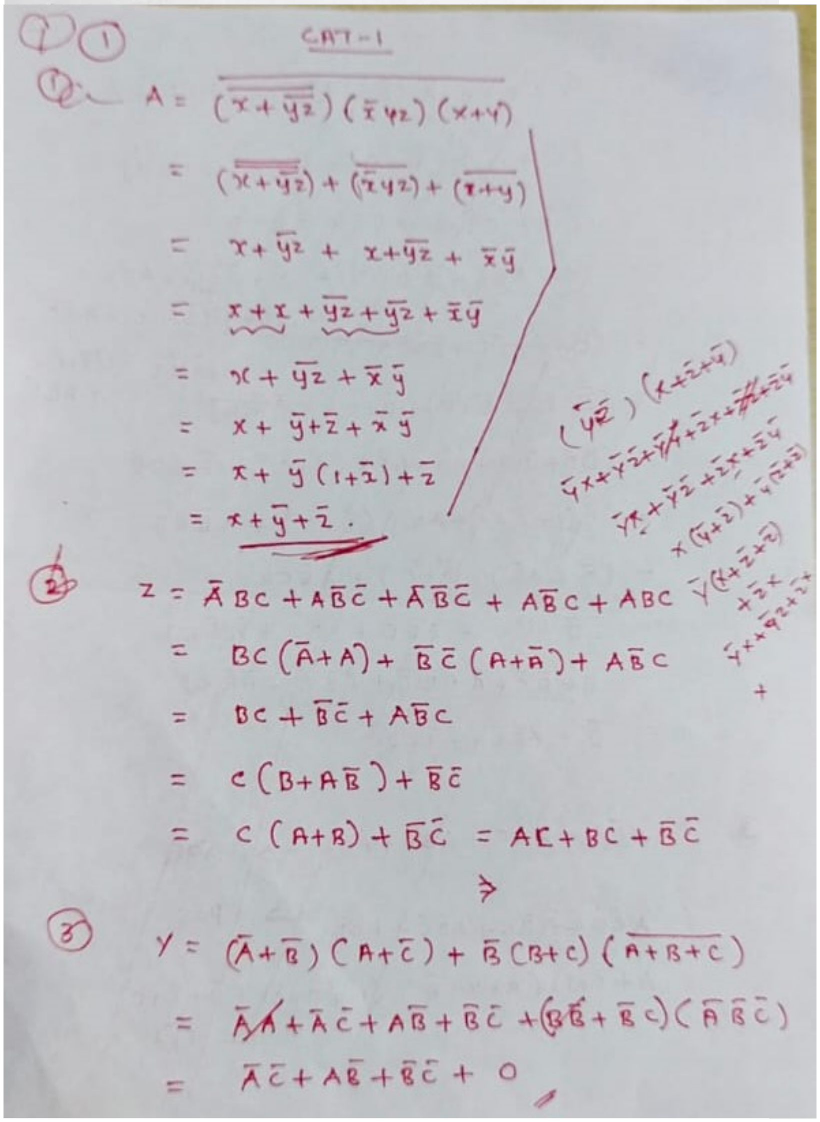
B.Tech CAT I Fall Sem(2022-23)

Course Code : BECE102L **Duration** **:** 90 Minutes.

Course Name : Digital Systems Design **Max. Marks :** 50

Answer all questions

Q.No	Question	Max. Marks	CO	BL
1	Simplify the following Boolean expression to minimum no of literals using the laws of Boolean Algebra a) $A = \overline{(\overline{X + \overline{\overline{YZ}}})(\overline{X}YZ)(X+Y)}$ b) $Z = \overline{A}BC + A\overline{B}\overline{C} + \overline{A}\,\overline{B}\,\overline{C} + A\overline{B}C + ABC$ c) $Y = (A' + B')(A + C') + B'(B + C)\ \overline{(A + B + C)}$ d) $Y = \overline{(C + D)} + \overline{A}C\overline{D} + A\overline{B}\,\overline{C} + \overline{A}\,\overline{B}CD + AC\overline{D}$ 	10	CO1	BL 3



CAT-1

Q ①

① $A = \overline{(\overline{x+\overline{yz}})(\bar{x}yz)(x+y)}$

$= (\overline{\overline{x+\overline{yz}}}) + (\overline{\bar{x}yz}) + (\overline{x+y})$

$= x+\overline{yz} + x+\overline{yz} + \bar{x}\bar{y}$

$= x + x + \overline{yz} + \overline{yz} + \bar{x}\bar{y}$

$= x + \overline{yz} + \bar{x}\bar{y}$

$= x + \bar{y} + \bar{z} + \bar{x}\bar{y}$

$= x + \bar{y}(1+\bar{x}) + \bar{z}$

$= x + \bar{y} + \bar{z}$.

② $Z = \bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + A\bar{B}C + ABC$

$= BC(\bar{A}+A) + \bar{B}\bar{C}(A+\bar{A}) + A\bar{B}C$

$= BC + \bar{B}\bar{C} + A\bar{B}C$

$= C(B + A\bar{B}) + \bar{B}\bar{C}$

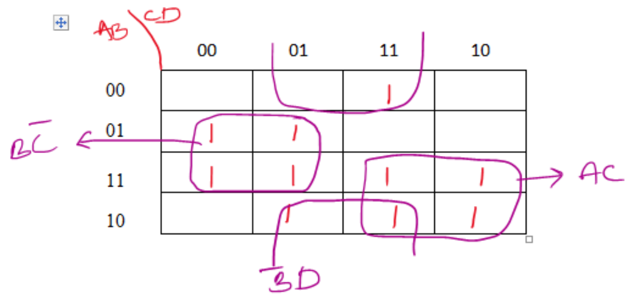
$= C(A+B) + \bar{B}\bar{C} = AC + BC + \bar{B}\bar{C}$

③ $Y = (\bar{A}+\bar{B})(A+\bar{C}) + \bar{B}(B+C)(\overline{A+B+C})$

$= \bar{A}A + \bar{A}\bar{C} + A\bar{B} + \bar{B}\bar{C} + (B\bar{B} + \bar{B}C)(\bar{A}\bar{B}\bar{C})$

$= \bar{A}\bar{C} + A\bar{B} + \bar{B}\bar{C} + 0$

2	a) Find the prime implicants for the following Boolean functions, and determine which are essential: **(4 marks)** $F(A,B,C,D) = \Sigma m(1,3,4,5,9,10,11,12,13,14,15)$	10	CO1	BL3



$Prime = AB, AC, AD, B\bar{C}, \bar{B}D, \bar{C}D$

$Essential = AC, B\bar{C}, \bar{B}D$

b) Using the Karnaugh map method obtain the minimal sum of the products and product of sums expressions for the function **(6 marks)**

$F(A,B,C,D) = \Sigma(1,5,6,7,11,12,13,15)$

	C′D′	C′D	CD	CD′
A′B′		1		
A′B		1	1	1
AB	1	1	1	
AB′			1	

F = A′C′D + A′BC + ABC′ + ACD = B(A′C + AC′) + D(A′C′ + AC)
= B (A ⊕ C) + D(A ⊕ C)′.

To derive the POS expression, the 0s of the Karnaugh map are considered as in Figure.

	C′D′	C′D	CD	CD′
A′B′	0		0	0
A′B	0			
AB				0
AB′	0	0		0

From the Karnaugh map we obtain

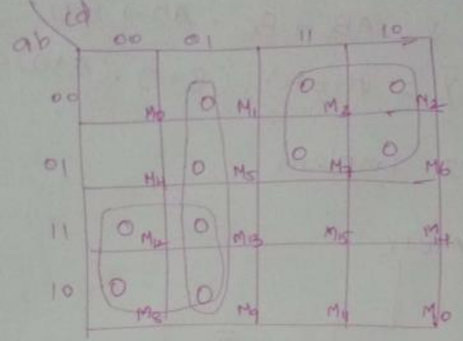
F′ = A′C′D′ + A′B′C + AB′C′ + ACD′.

So the POS expression for the above function is

F = (A + C + D) (A + B + C′) (A′ + B + C) (A′ + C′ + D).

3	Implement the following function using i) NOR logic gate and ii) NAND logic gate f(a, b, c, d) = ΠM (1,2,3,5,6,7,8,9,12,13)	10	CO1	BL2

1) $f(a,b,c,d) = \prod M(1,2,3,5,6,7,8,9,12,$

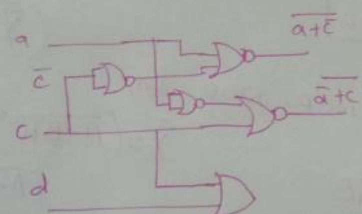


Boolean exp. $f(a,b,c,d) = (a+\bar{c})(\bar{a}+c)(c+\bar{d})$

(i) NOR logic :-

Take double nega. $f(a,b,c,d) = \overline{\overline{(a+\bar{c})(\bar{a}+c)(c+\bar{d})}}$

$= \overline{(\overline{a+\bar{c}}) + (\overline{\bar{a}+c}) + (\overline{c+}}$



(ii) NAND logic gate :

$\bar{f} = \Sigma m(1,2,3,5,6,7,8,9,12,13)$

∴ SOP is obtained by complementing POS simplifying using K-map,

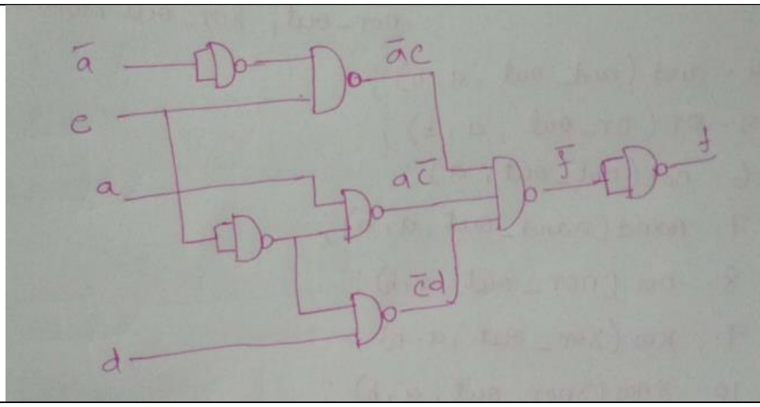
$\bar{f} = \bar{a}c + a\bar{c} + \bar{c}d$

Apply De-Morgan Theorem,

$f = (\overline{\bar{a}c})(\overline{a\bar{c}})(\overline{\bar{c}d})$

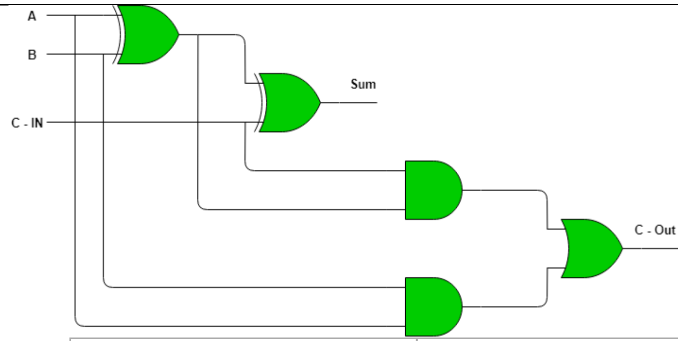
Take double nega,

$f = \overline{\overline{(\overline{\bar{a}c})(\overline{a\bar{c}})(\overline{\bar{c}d})}}$

4	Identify the errors in the following code and find out the logical expression. Also draw the truth table and logical diagram from the logical expression.
	module file(x,y,a,b,bin);
	output (x,y);
	reg (x,y);
	input wire (a,b,bin)
	always (a or b or bin)
	begin
	 case({a,b,bin})
	3’b000:{x,y}=2'b00;
	3’b001:{x,y}=2’b11;
	3’b010:{x,y}=2’b11;
	3’b011:{x,y}=2’b01;
	3’b100:{x,y}=2’b10;
	3’b101:{x,y}=2'b00;
	3’b110:{x,y}=2'b00;
	3’b111:{x,y}=2’b11;
	end case
	end
	end module
	
	Answer:
	Line 1: x=difference, y=borrow.
	Line 2, 3 and 4: No need of open and close () brace.
	Line 4: Semi colon ; missing.
	Line 5: @ missing.
	Line 16 and 18: Space next to the end is not required.
	
	Logical Expression:
	x = $a \oplus b \oplus bin$
	y = $\overline{a}b + ((\overline{a} + b)\ bin)$
		10	CO2	BL4

5	Design the full adder circuit using half adder and OR gate (Write the corresponding expression and truth table). Also, write the behavioral modelling Verilog code using case statements.	10	CO2	BL2, 4



Inputs			**Outputs**	
A	**B**	**C_{in}**	**C_{out} (Carry)**	**S (Sum)**
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

```
module fulladd_be(sum,carry,a,b,c);
  input wire a,b,c;
  output sum,carry;
  reg sum,carry;
  always @(a or b or c)
  begin
     case({a,b,c})
       3'b000:{sum,carry}=2'b00;
       3'b001:{sum,carry}=2'b10;
       3'b010:{sum,carry}=2'b10;
       3'b011:{sum,carry}=2'b01;
       3'b100:{sum,carry}=2'b10;
       3'b101:{sum,carry}=2'b01;
       3'b110:{sum,carry}=2'b01;
       3'b111:{sum,carry}=2'b11;
   endcase
 end
     endmodule
```