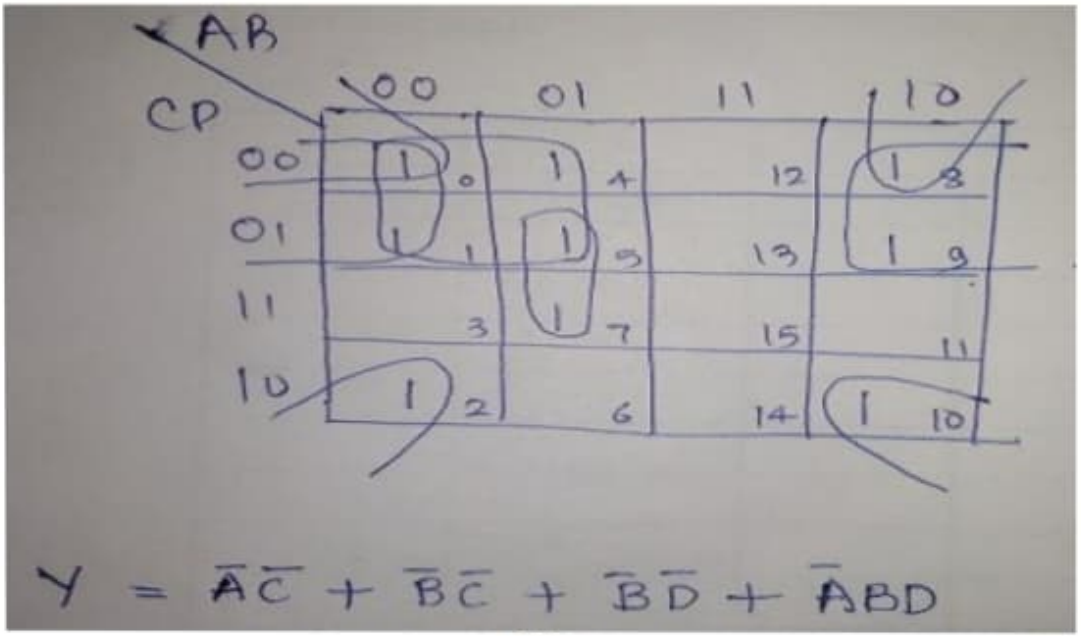
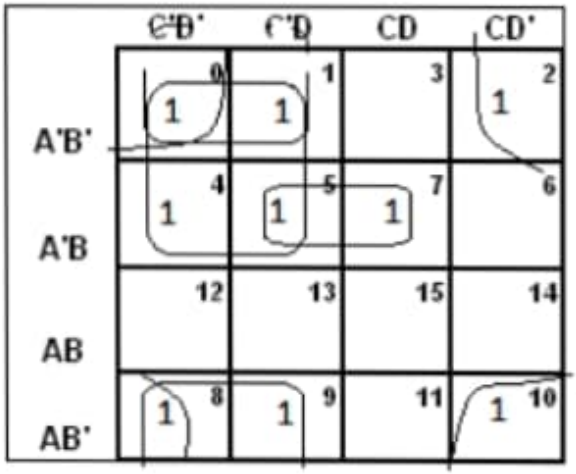
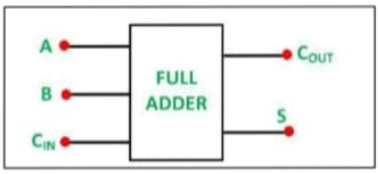
c)	**Write simple example of Boolean expression for SOP and POS.**
Ans:	**SOP form:** $Y = AB + BC + A\overline{C}$ **POS form:** $Y = (A + B)(B + C)(A + \overline{C})$
d)	**State the necessity of multiplexer.**
Ans:	**Necessity of Multiplexer:** • It reduces the number of wires required to pass data from source to destination. • For minimizing the hardware circuit. • For simplifying logic design. • In most digital circuits, many signals or channels are to be transmitted, and then it becomes necessary to send the data on a single line simultaneously. • Reduces the cost as sending many signals separately is expensive and requires more wires to send.

d)	**Minimize the following expression using K-Map.** $f(A, B, C, D) = \sum m\ (0, 1, 2, 4, 5, 7, 8, 9, 10)$	**4M**
Ans:	 OR  $\bar{A}\bar{C} + \bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}BD$	**1 M – drawing k map** **1 M – Representing function in k map** **1 M – Grouping** **1M – Final expression**

b)	**Describe the function of full Adder Circuit using its truth table, K-Map simplification and logic diagram.**	**4M**
Ans:	**(Diagram- 1M,Truth table-1M, K-map- 1M,Logic diagram-1 M)** A full adder is a combinational logic circuit that performs addition between three bits, the two input bits A and B, and carry C from the previous bit. **Block diagram :**  	**1M**
		1M

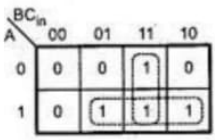
Truth Table :

Input			Output	
A	B	Cin	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

1M

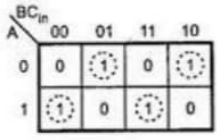
K-Map :-

For Carry (C_{out})



$C_{out} = AB + A C_{in} + B C_{in}$

For Sum

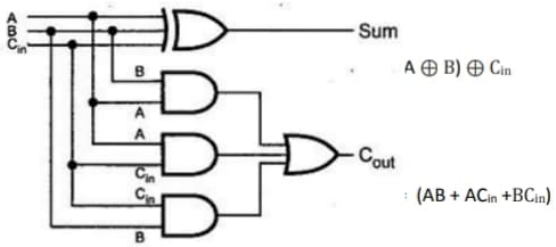


$Sum = \bar{A}\,\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\,\bar{C}_{in} + ABC_{in}$

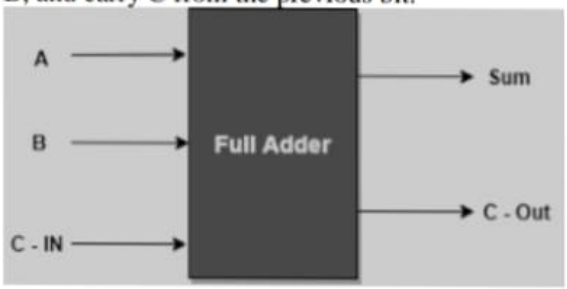
1M

Logic Diagram:

(Note: Logic Diagram using basic or universal gate also can be consider)



	a)	**Design a full Adder using Truth Table and K-map.**	**4M**
	Ans:	A full adder is a combinational logic circuit that performs addition between three bits, the two input bits A and B, and carry C from the previous bit.	



Truth Table:

Input			Output	
A	B	Cin	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Truth table 1½ M

K-map simplification for carry and sum

For Carry (C_{out})

A \ BC_{in}	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$C_{out} = AB + A C_{in} + B C_{in}$

For Sum

A \ BC_{in}	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$

1M

Logical diagram:

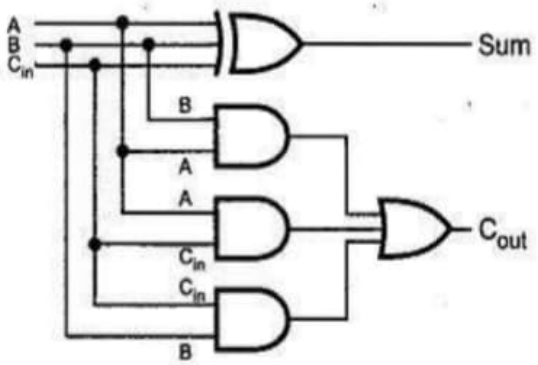
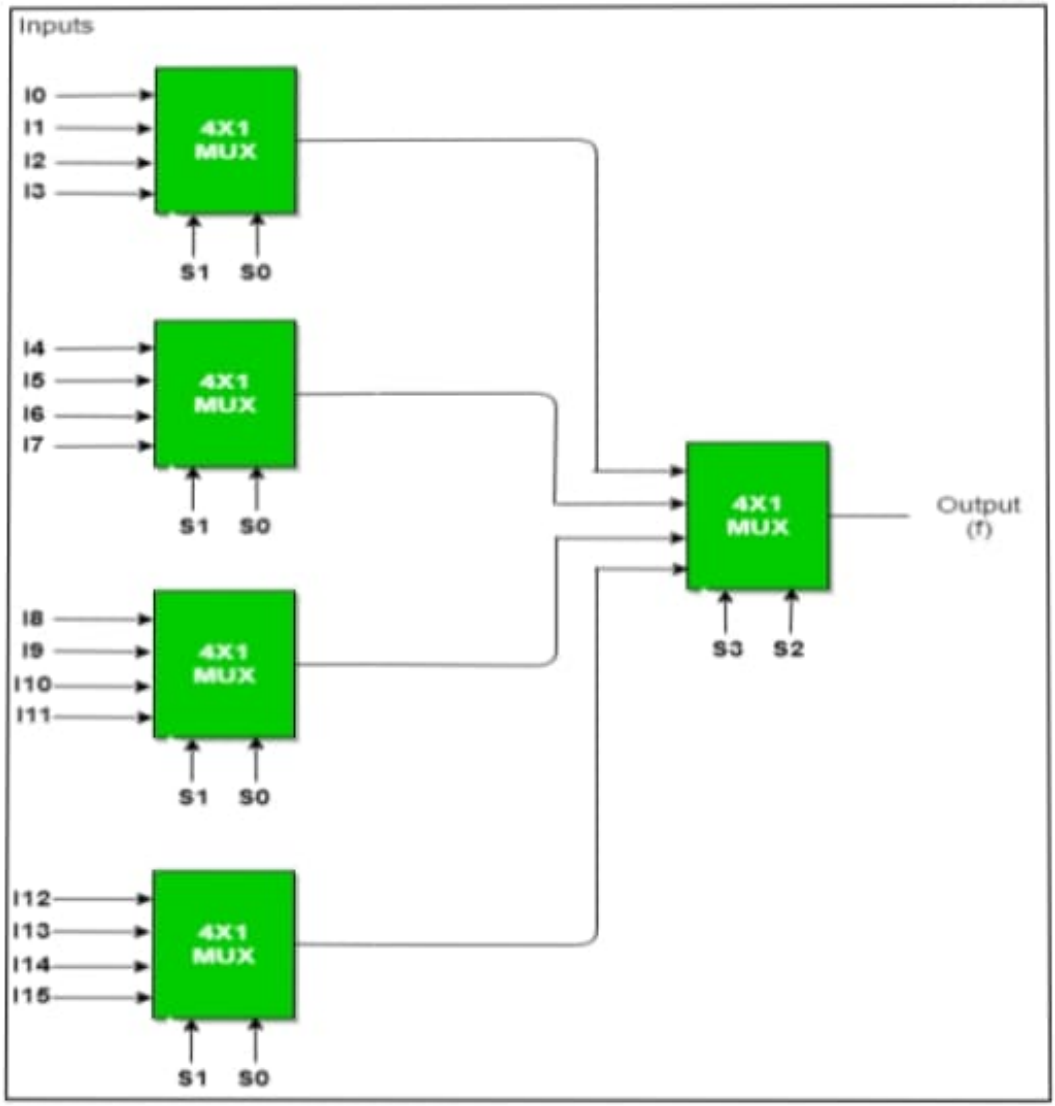


Fig. 3.17 Implementation of full-adder

1½ M

b)	**Draw 16:1 MUX tree using 4:1 MUX.**	**4M**
Ans:	**Diagram :-**	**4M**



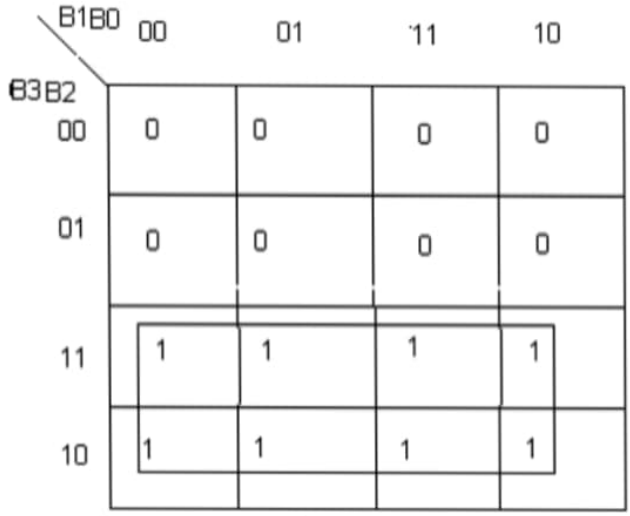
		12
a)	**Design 4 bit Binary to Gray code converter.**	6M

Ans:

Truth Table for 4 bit Binary to Gray code converter

Binary Input				Gray output			
B_3	B_2	B_1	B_0	G_3	G_2	G_1	G_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

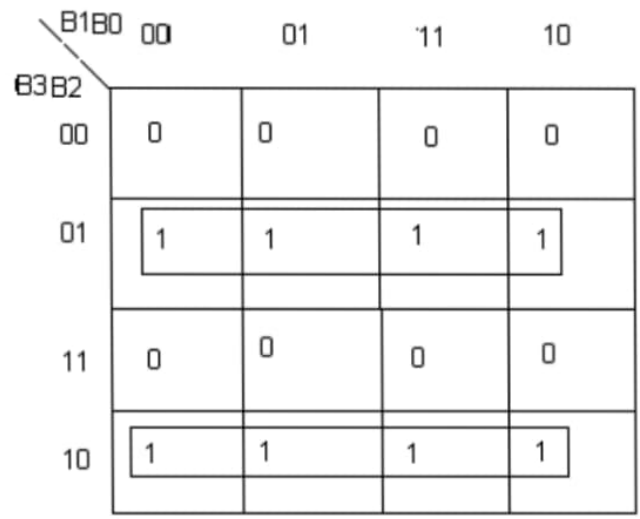
K-MAP FOR G3:



G3=B3

2M for truth table

1/2m for each output equation
2M for realization using gates

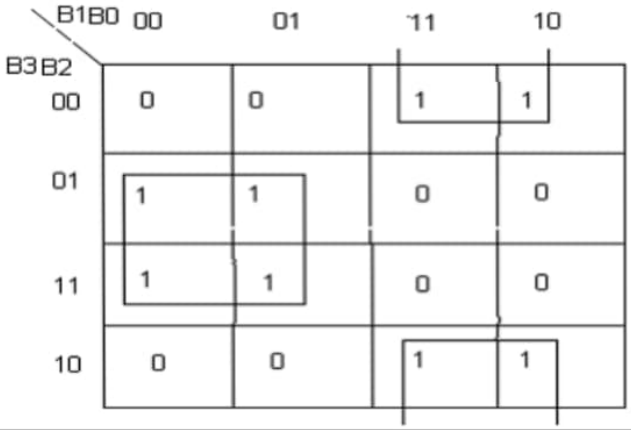


K-MAP FOR G2:

$G2=\overline{B3}\,B2+\overline{B2}\,B3$

= B3 XOR B2

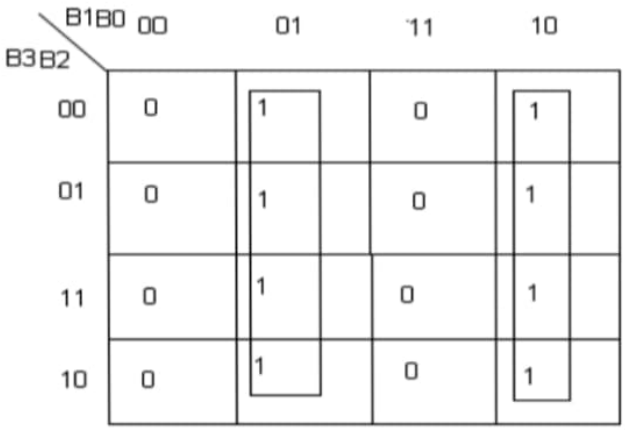
K-MAP FOR G1:



$G1=\overline{B2}\,B1+B2\,\overline{B1}$

= B1 XOR B2

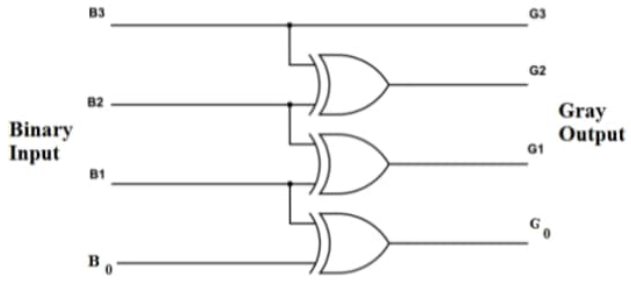
K-MAP FOR G0:



$G0=\overline{B1}B0+B1\overline{B0}$

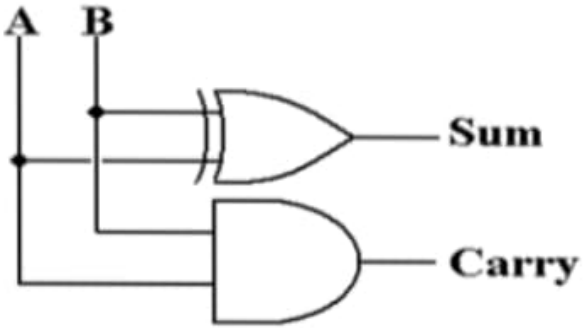
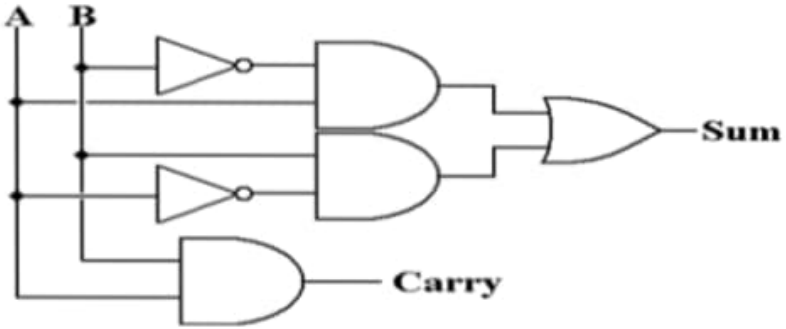
= B1 XOR B0

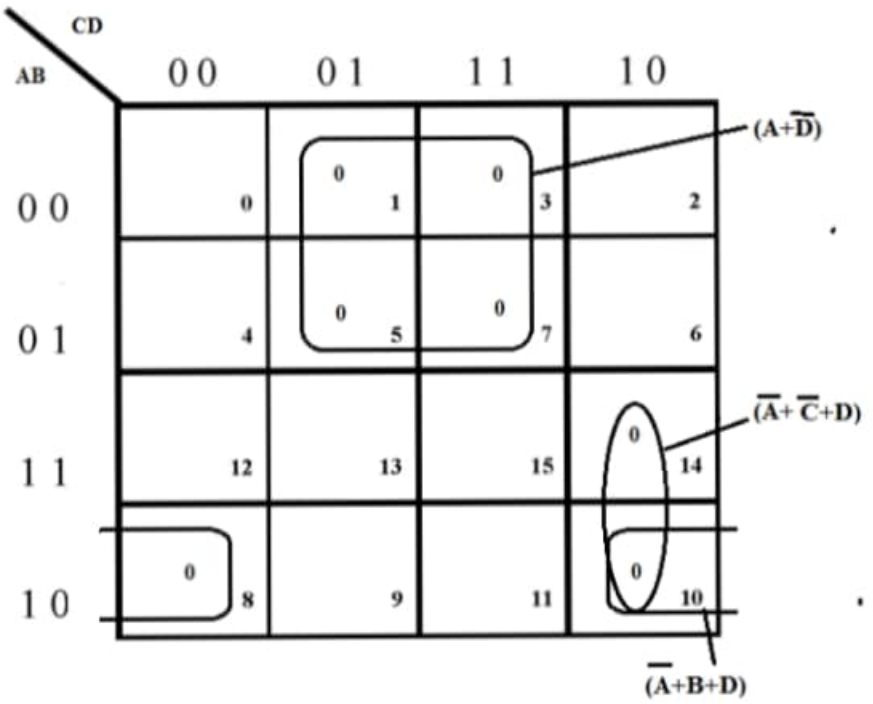
Diagram for 4 bit Binary to Gray code converter:

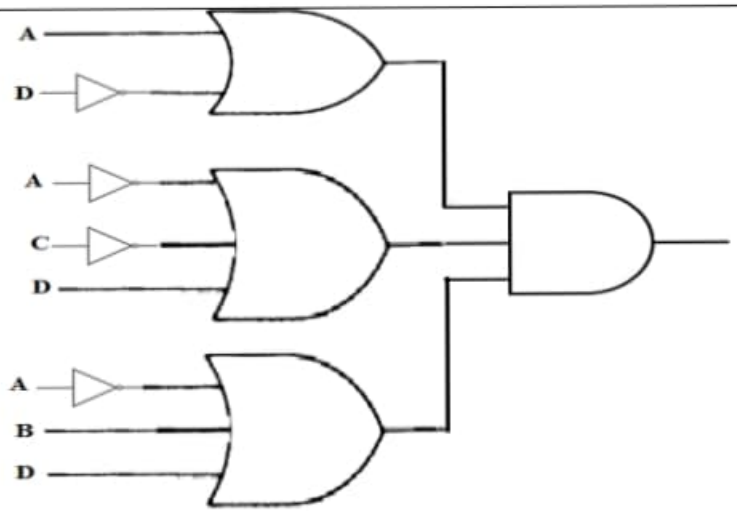


Note: Realization of output equations can be done using Basic or Universal gates

f)	**Define encoder, write the IC number of IC used asdecimal l to BCD encoder.**	**2M**
Ans:	An encoder is a device or circuit that converts information from one format or code to another, for the purpose of standardization, speed or compression. Decimal to BCD encoder IC- 74147	**Definati on-1M** **IC-1M**

d)	**Draw logic diagram of half adder circuit**	**4M**
Ans:	 **OR**  Note: logic diagram using NAND/NOR also can be considered.	**4M**

(d)	Reduce the following expression using K-map and implement it F(A,B,C,D) =ΠM (1,3,5,7,8,10,14)	4M
Ans:	 **F(A,B,C,D)=(A+$\overline{D}$) ($\overline{A}$+$\overline{C}$+D) ($\overline{A}$+B+D)**	Kmap-1M Pairs-1.5M Final Ans-1.5M



	a)	Design BCD to seven segment decoder using IC 7447 with its truth table.	6M

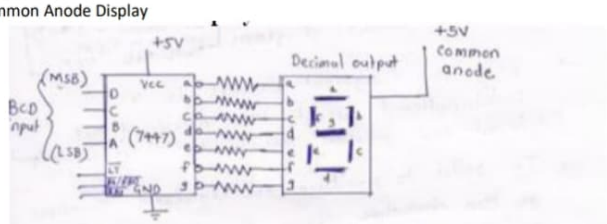
Ans:

Note: Any one type of display shall be considered — **Explaination 2M**

1. BCD to 7 segment decoder is a combinational circuit that accepts 4 bit BCD input and generates appropriate 7 segment output.
2. In order to produce the required numbers from 0 to 9 on the display the correct combination of LED segments need to be illuminated.
3. A standard 7 segment LED display generally has 8 input connections, one from each LED segment & one that acts as a common terminal or connection for all the internal segments
4. Therefore there are 2 types of display 1. Common Anode Display 2. Common Cathode Display :

Circuit Diagram 2M

Common Anode Display

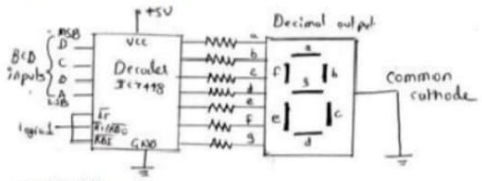


Truth Table — **Truth Table 2M**

For seven segment decoder using common anode display

BCD Inputs				7 segment coded outputs							Display outputs
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	0	0	0	0	0	0	1	
0	0	0	1	1	0	0	1	1	1	1	
0	0	1	0	0	0	1	0	0	1	0	
0	0	1	1	0	0	0	0	1	1	0	
0	1	0	0	1	0	0	1	1	0	0	
0	1	0	1	0	1	0	0	1	0	0	
0	1	1	0	1	1	0	0	0	0	0	
0	1	1	1	0	0	0	1	1	1	1	
1	0	0	0	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	1	0	0	

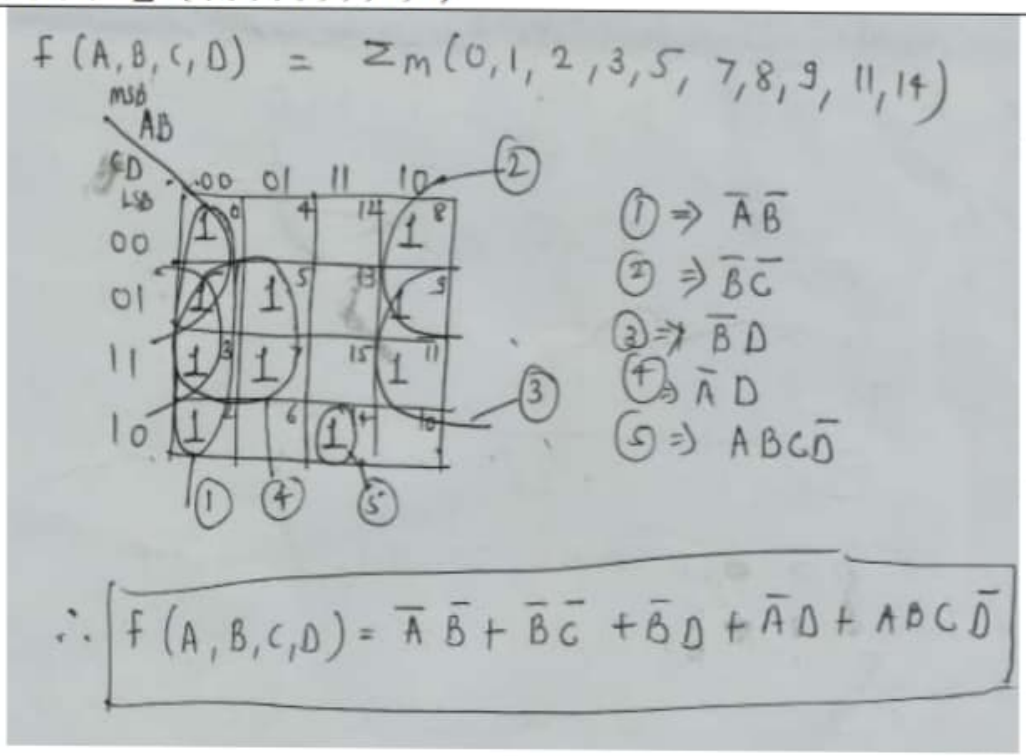
Common Cathode Display:

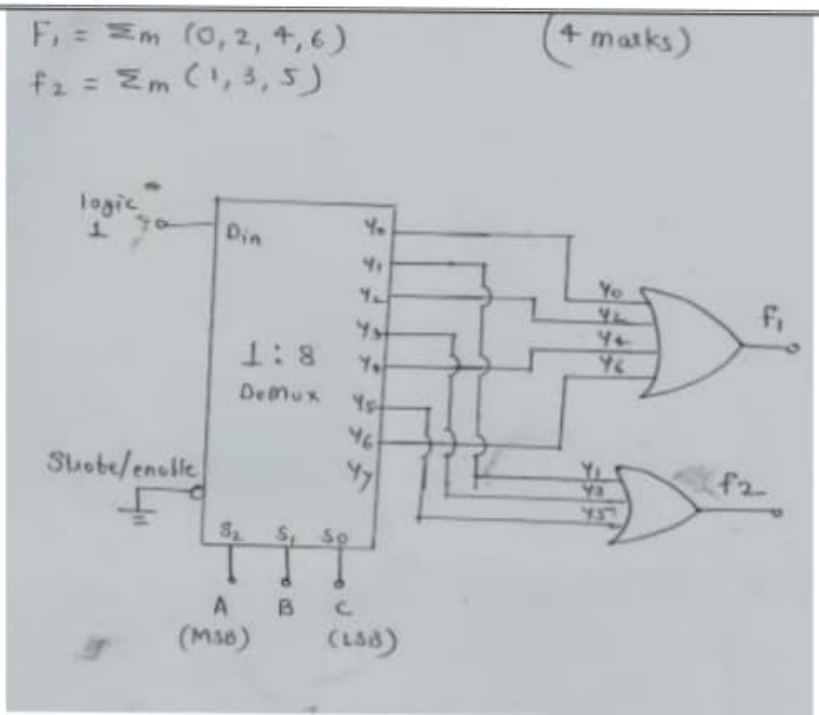


Truth Table

BCD Inputs				7 segment coded outputs							Display outputs
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	
0	0	0	1	0	1	1	0	0	0	0	
0	0	1	0	1	1	0	1	1	0	1	
0	0	1	1	1	1	1	1	0	0	1	
0	1	0	0	0	1	1	0	0	1	1	
0	1	0	1	1	0	1	1	0	1	1	
0	1	1	0	0	0	1	1	1	1	1	
0	1	1	1	1	1	1	0	0	0	0	
1	0	0	0	1	1	1	1	1	1	1	
1	0	0	1	1	1	1	0	0	1	1	

	d)	**Convert the following expression into standard SOP form.** **$Y = AB + A\bar{C} + BC$**	**2M**
	Ans:	$Y = AB + A\bar{C} + BC$ Total variable ABC 1st Product term = AB (C is missing) 2nd Product term = $A\bar{C}$ (B is missing) 3rd Product term = BC (A is missing) $Y = AB \bullet 1 + A\bar{C} \bullet 1 + BC \bullet 1$ $Y = AB(C+\bar{C})\ A\bar{C}(B+\bar{B}) + BC(A+\bar{A})$ $Y = \underline{ABC} + \underline{AB\bar{C}} + \underline{AB\bar{C}} + A\bar{B}\bar{C} + \underline{ABC} + \bar{A}BC$ $(\because A+\bar{A}=A)$ $Y = ABC + AB\bar{C} + A\bar{B}\bar{C} + \bar{A}BC$ Standard SOP Form	**2M**

c)	**Minimize the four variable logic function using K map.** **$F(A,B,C,D) = \sum m(0,1,2,3,5,7,8,9,11,14)$**	**4M**
Ans:		**Kmap with place value-1M** **Pair-1M** **Answer-2M**
d)	**Implement the following function using demultiplexer.** **$f_1 = \sum m(0,2,4,6)$** **$f_2 = \sum m(1,3,5)$**	**4M**

Ans:		**4M**