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Report Topic: Combinational Logic Circuit

Objective:

- Analysis of Truth Table of the following alphanumeric sequence "dr17ZYZ07".
- Analysis equations
- Analysis cost of equations
- Drawing Logisim circuits

List of equipments:

- 7 segment display
- Breadboard
- Wires
- Resistors
- IC 74LS138 (3 to 8 Line Decoder) [TK. 25.04]
- IC 74LS11 (3-Input AND gate) [TK. 30.04]
- IC 74LS~~22~~ (4-Input NAND gate) [TK. 35.04]
- IC 74LS00 (2-input NAND gate) [TK. 20.05]
- IC 74LS153 (4 to 1 Multiplexer) [TK. 30.04]
- IC 74LS04 (Hex Inverter NOT gate) [TK. 20.04]
- IC 74LS02 (2-Input NOR gate) [TK. 25.04]

- IC 74LS27 (3-input NOR gate) [TK 45.09]
- IC 74LS10 (3-input NAND gate) [TK 29.53]
- IC 74LS08 (2-input AND gate) [TK 20.08]
- IC 74LS32 (2-input OR gate) [TK 20.09]

Combinational Logic Circuit Project Report

Chosen Characters:

0 1 2 3 4 5 6 7

Table for the 7 segment display:

Index	x	y	z	A	B	C	D	E	F	G	DISPLAY
0	0	0	0	0	1	1	1	1	0	1	0
1	0	0	1	0	0	0	0	1	0	1	1
2	0	1	0	0	1	1	0	0	0	0	1
3	0	1	1	1	1	0	1	1	0	1	2
4	1	0	0	1	1	0	1	1	0	1	2
5	1	0	1	0	1	1	1	0	1	1	3
6	1	1	0	1	1	1	1	1	1	0	4
7	1	1	1	1	1	1	0	0	0	0	7

Sum of Minterms equations:

$$A(x,y,z) = \sum_m(3,4,6,7) = \bar{x}yz + x\bar{y}\bar{z} + xy\bar{z} + xyz$$

$$B(x,y,z) = \sum_m(0,2,3,4,5,6,7) = \bar{x}\bar{y}\bar{z} + \bar{x}y\bar{z} + \bar{x}yz + x\bar{y}\bar{z} + x\bar{y}z + xy\bar{z} + xyz$$

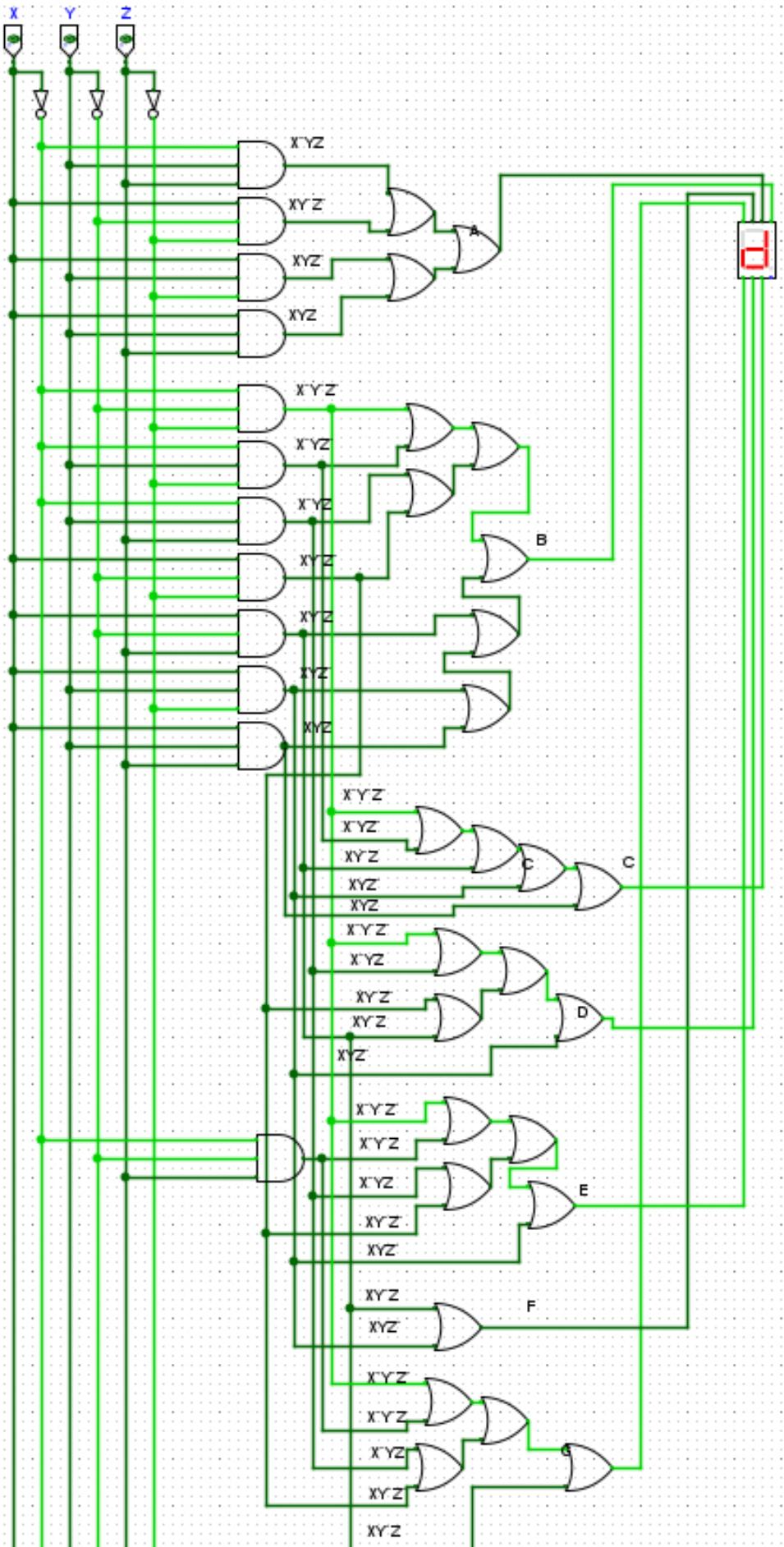
$$C(x,y,z) = \sum_m(0,2,5,6,7) = \bar{x}\bar{y}\bar{z} + \bar{x}y\bar{z} + x\bar{y}z + xy\bar{z} + xyz$$

$$D(x,y,z) = \sum_m(0,3,4,5,6) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + x\bar{y}\bar{z} + x\bar{y}z + xy\bar{z}$$

$$E(x,y,z) = \sum_m(0,1,3,4,6) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xyz$$

$$F(x,y,z) = \sum_m(5,6) = x\bar{y}z + xy\bar{z}$$

$$G(x,y,z) = \sum_m(0,1,3,4,5) = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xy\bar{z}$$



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7 segment display using Sum Of Minterm

□ Cost Analysis:

Required Gate	Gate needed	IC needed	Unit Price	Total Price
NOT gate	03	01	₹0.04	₹0.04
AND gate(3-input)	03 12	04 03 03	30.04	₹0.16
OR gate (3 input)	26	05 07	₹0.04	₹0.28
			Total =	₹80.48TK

□ Product of Maxterm equations:

$$A(x,y,z) = \prod_M (0,1,3,5) = (x+y+z) \cdot (x+y+\bar{z}) \cdot (x+\bar{y}+z) \cdot (\bar{x}+y+\bar{z})$$

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

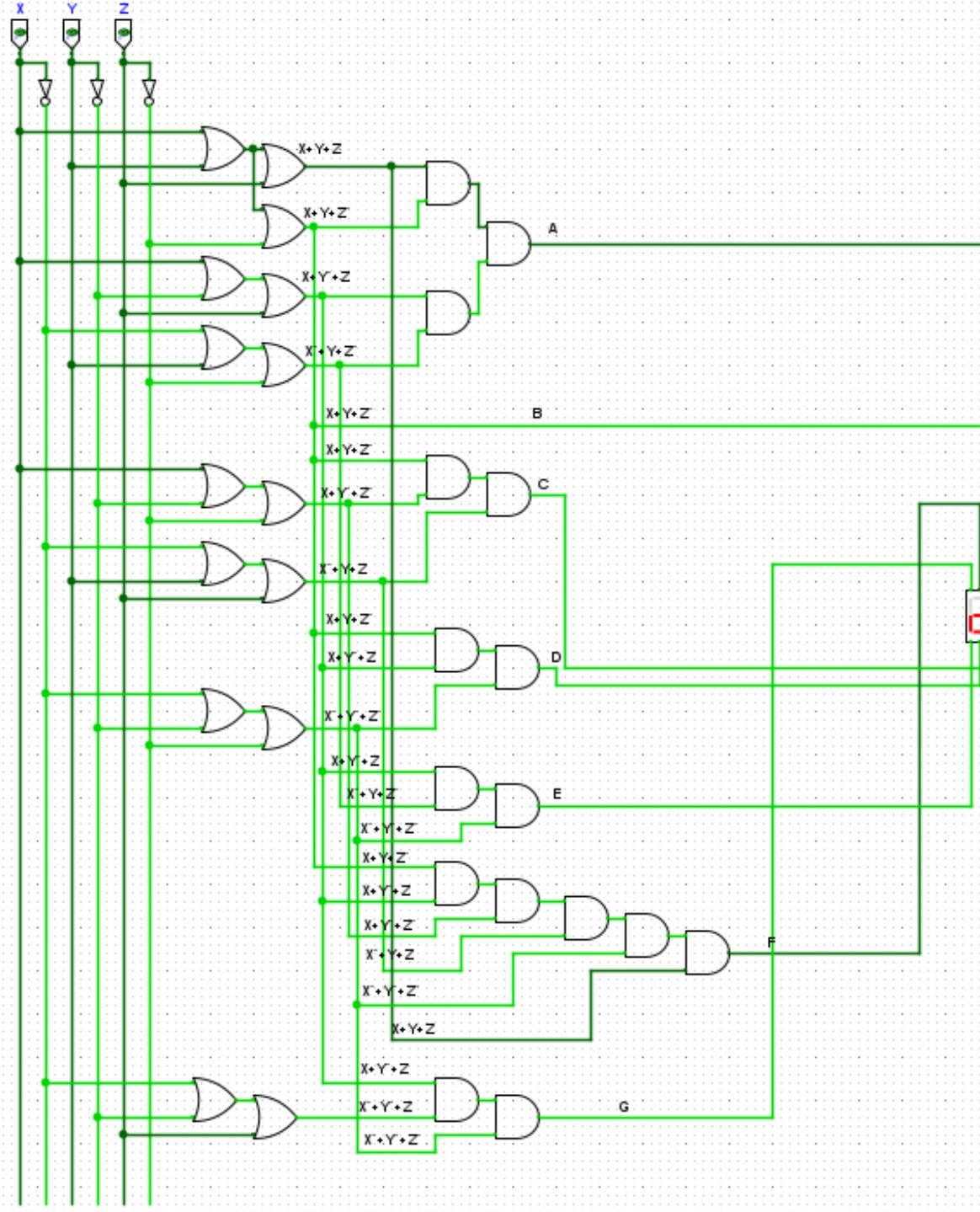
$$C(x,y,z) = \prod_M (1,3,4) = (x+y+\bar{z}) \cdot (x+\bar{y}+\bar{z}) \cdot (\bar{x}+y+z)$$

$$D(x,y,z) = \prod_M (1,2,7) = (x+y+\bar{z}) \cdot (x+\bar{y}+z) \cdot (\bar{x}+\bar{y}+\bar{z})$$

$$E(x,y,z) = \prod_M (2,5,7) = (x+\bar{y}+z) \cdot (\bar{x}+y+\bar{z}) \cdot (\bar{x}+\bar{y}+\bar{z})$$

$$F(x,y,z) = \prod_M (0,1,2,3,4,7) = (x+y+\bar{z}) \cdot (x+\bar{y}+z) \cdot (x+\bar{y}+\bar{z}) \cdot (\bar{x}+y+z) \cdot (\bar{x}+\bar{y}+\bar{z}) \\ (x+y+z)$$

$$G(x,y,z) = \prod_M (2,6,7) = (x+\bar{y}+z) \cdot (\bar{x}+\bar{y}+z) \cdot (\bar{x}+\bar{y}+\bar{z})$$



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7 segment display using Product Of Masterm

■ Cost Analysis:

Required Gate	Gate needed	Ic needed	Unit Price	Total Price
NOT Gate	03	01	20.04	20.04
AND Gate (\leq input)	16	04	20.04	80.16
OR Gate (\leq input)	15	04	20.04	80.16
				Total = TK 180.36

■ Sum of Product equations:

For A(x,y,z)

	\bar{y}		y	
\bar{x}	1		1	
x	1		1	
	\bar{z}	z	\bar{z}	

$$\therefore A(x,y,z) \text{ equation: } yz + x\bar{z}$$

for B(x,y,z)

	\bar{y}		y	
\bar{x}	1		1	
x	1		1	
	\bar{z}	z	\bar{z}	

$$\therefore B(x,y,z) \text{ equation: } x + y + \bar{z}$$

for C(x,y,z)

	\bar{y}		y	
\bar{x}	1		1	
x		1	1	1
	\bar{z}	z	\bar{z}	

$$\therefore C(x,y,z) = \bar{x}\bar{z} + xz + x\bar{y}$$

for D(x,y,z)

	\bar{y}		y	
\bar{x}	1		1	
x	1		1	1
	\bar{z}	z	\bar{z}	

$$\therefore D(x,y,z) = \bar{y}\bar{z} + x\bar{z} + \bar{x}yz + x\bar{y}$$

for E(x,y,z)

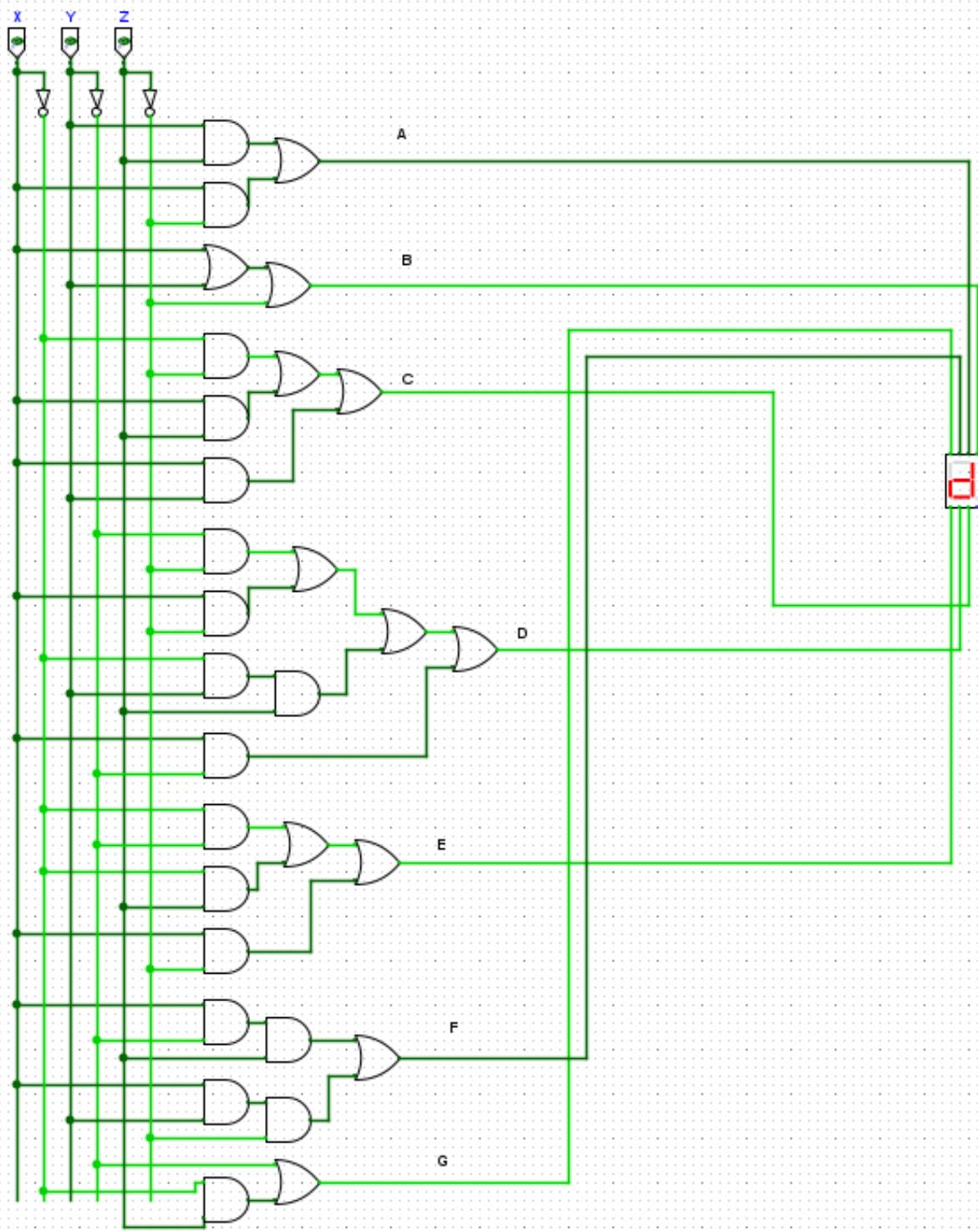
	\bar{y}		y	
\bar{x}	1		1	
x	1		1	
	\bar{z}	z	\bar{z}	

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

for F(s,t)

	\bar{y}		y	
\bar{x}			1	
x			1	
	\bar{z}	z	\bar{z}	

$$F(x,y,z) = x\bar{y}z + xy\bar{z}$$



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7 segment display using SOP

for $n(0,1,3,4,5)$

\bar{x}	\bar{y}	y	
x	1	1	1
\bar{z}	1	1	
z			\bar{z}

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

By Cost Analysis:

Required Gate	Gates Needed	IC Needed	Unit Price	Total Price
NOT gate	03	01	₹0.04	₹0.04
AND gate (3 input)	16	0304	₹0.04	₹0.16
OR gate (3 input)	12	0303	₹0.04	₹0.12
		Total	₹160.32	

Product of Sum equations:

for $A(x,y,z)$:

\bar{x}	\bar{y}	y	
x	0	0	0
\bar{z}	0		
z			\bar{z}

$$A(x,y,z) = \cancel{x}\cancel{y}(x+z)(y+\bar{z})$$

for $B(x,y,z)$:

\bar{x}	\bar{y}	y	
x	0		
\bar{z}			
z			\bar{z}

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

for $C(x,y,z)$:

\bar{x}	x	\bar{y}	y	\bar{z}	z	\bar{z}
0	0	0	0			
0						

$$C(x,y,z) : (x+\bar{z})(\bar{x}+y+z)$$

for $D(x,y,z)$:

\bar{x}	x	\bar{y}	y	\bar{z}	z	\bar{z}
0	0	0	0	0	0	0
0						

$$D(x,y,z) : (x+y+\bar{z})(x+\bar{y}+z)(\bar{x}+\bar{y}+\bar{z})$$

for $E(x,y,z)$:

\bar{x}	x	\bar{y}	y	\bar{z}	z	\bar{z}
0	0	0	0	0	0	0
0						

$$E(x,y,z) : (\bar{x}+\bar{z})(x+\bar{y}+z)$$

for $F(x,y,z)$:

\bar{x}	x	\bar{y}	y	\bar{z}	z	\bar{z}
0	0	0	0	0	0	0
0						

$$F(x,y,z) : (x)(y+z)(\bar{y}+\bar{z})$$

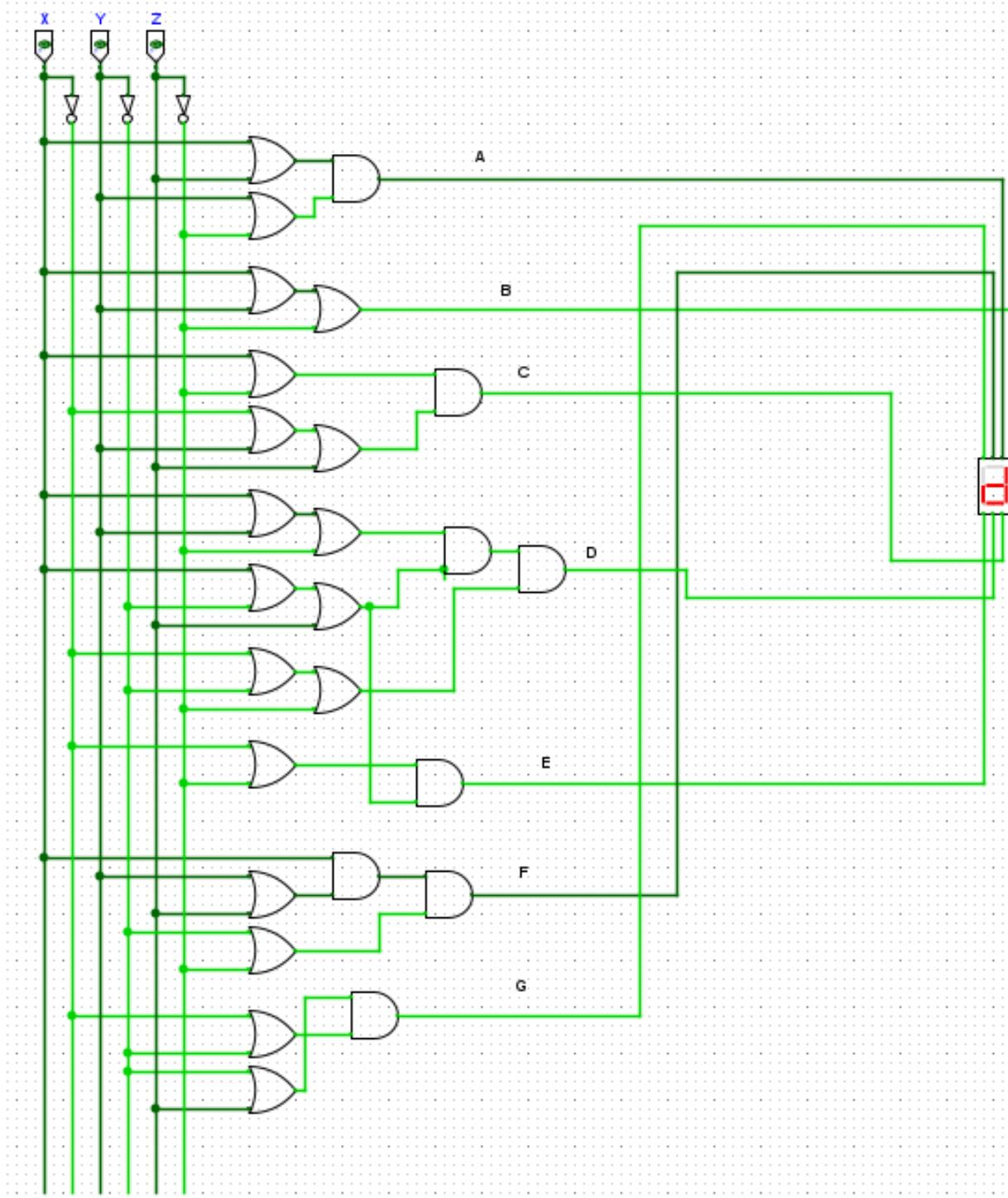
for $G(x,y,z)$:

\bar{x}	x	\bar{y}	y	\bar{z}	z	\bar{z}
0	0	0	0	0	0	0
0						

$$G(x,y,z) : (\bar{y}+\bar{z})(\bar{x}+\bar{y}\bar{z})$$

Cost Analysis:

Required Gate	Gate Needed	IC Needed	Unit Price	Total Price
NOT gate	03	01	₹0.04	₹0.04
AND gate (2 input)	02	02	₹0.04	₹0.08
OR gate (2 input)	01	05	₹0.04	₹0.20
			Total =	160.32



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7 segment display using POS

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▣ NAND gate equations:

$$\text{for } A(x,y,z) = Yz + x\bar{z} \\ = \overline{\overline{Yz} \cdot \overline{x\bar{z}}}$$

$$\text{for } B(x,y,z) = x + y + \bar{z} \\ = \overline{\overline{x}\cdot\overline{y}\cdot\bar{z}}$$

$$\text{for } C(x,y,z) = \bar{x}\bar{z} + xz + xy \\ = \overline{\overline{x}\bar{z} \cdot \overline{xz} \cdot \overline{xy}}$$

$$\text{for } D(x,y,z) = x\bar{z} + \bar{y}\bar{z} + \bar{x}yz + x\bar{y} \\ = \overline{\overline{x}\bar{z} \cdot \overline{\bar{y}\bar{z}} \cdot \overline{\bar{x}yz} \cdot \overline{x\bar{y}}}$$

$$\text{for } E(x,y,z) = \bar{x}\bar{y} + x\bar{z} + \bar{x}z \\ = \overline{\overline{x}\bar{y} \cdot \overline{x\bar{z}} \cdot \overline{\bar{x}z}}$$

$$\text{for } F(x,y,z) = x\bar{y}z + xy\bar{z} \\ = \overline{\overline{x}\bar{y}z \cdot \overline{xy\bar{z}}}$$

$$\text{for } G(x,y,z) = \bar{y} + \bar{x}z \\ = \overline{y \cdot \overline{\bar{x}z}}$$

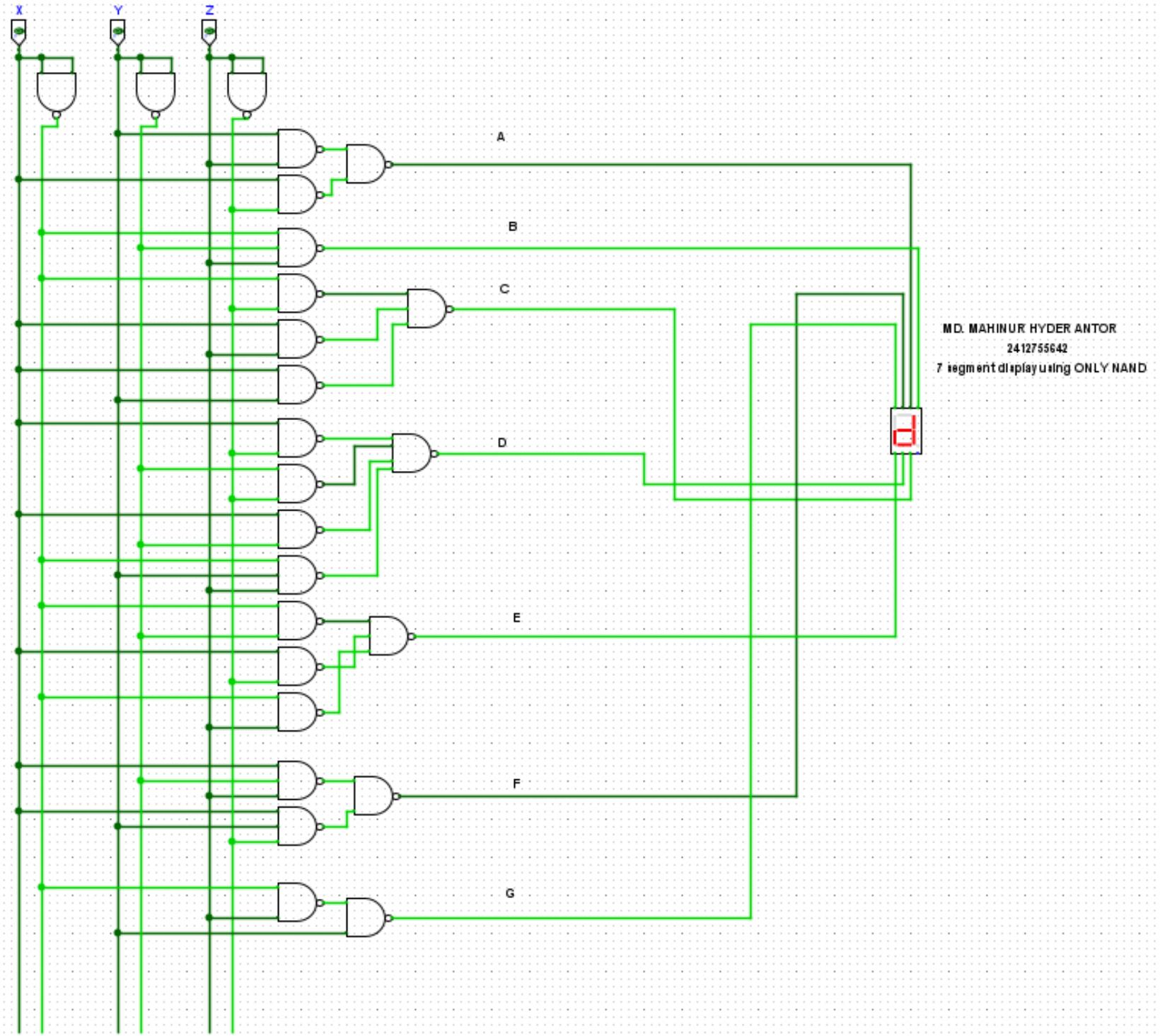
▣ Cost Analysis:

Required Gate	Gates Needed	IC Needed	Unit Price	Total Price
NAND gate(4-input)	01	01	35.04	35.04
NAND gate(3-input)	06	02	29.53	59.06
NAND gate(2-input)	18	05 05	20.05	100.25
		Total = TK		194.35

▣ NOR gate equations:

$$\text{for } A(x,y,z) = (x+z)(\bar{y}+\bar{z}) \\ = \overline{\overline{x+z} + \overline{\bar{y}+\bar{z}}}$$

$$\text{for } B(x,y,z) = \overline{x+y+z}$$



$$\text{for } C(x,y,z) = (x+\bar{z})(\bar{x}+z) \\ = \left(\overline{\overline{x}+\bar{z}} + \overline{\bar{x}+z} \right)$$

$$\text{for } D(x,y,z) = (z+\bar{x})(x+\bar{z}) \\ = \overline{\overline{z+y} + \overline{x+z} + \overline{\bar{x}+\bar{y}}} \\ = \overline{\overline{z+y} + \overline{x+z} + \overline{\bar{x}+\bar{y}}} \\ = \overline{\overline{z+y} + \overline{x+z} + \overline{\bar{x}+\bar{y}}}$$

$$\text{for } E(x,y,z) = (\bar{z}+\bar{x})(\bar{z}+x) \\ = \overline{\overline{\bar{x}+\bar{z}} + \overline{x+\bar{z}}}$$

$$\text{for } F(x,y,z) = x(\bar{z}+\bar{x}) \\ = \overline{\overline{x} + \overline{y+z} + \overline{f+z}}$$

$$\text{for } G(x,y,z) = (y+z)(\bar{x}+\bar{y}) \\ = \overline{\overline{F+z} + \overline{\bar{x}+y}}$$

Cost Analysis:

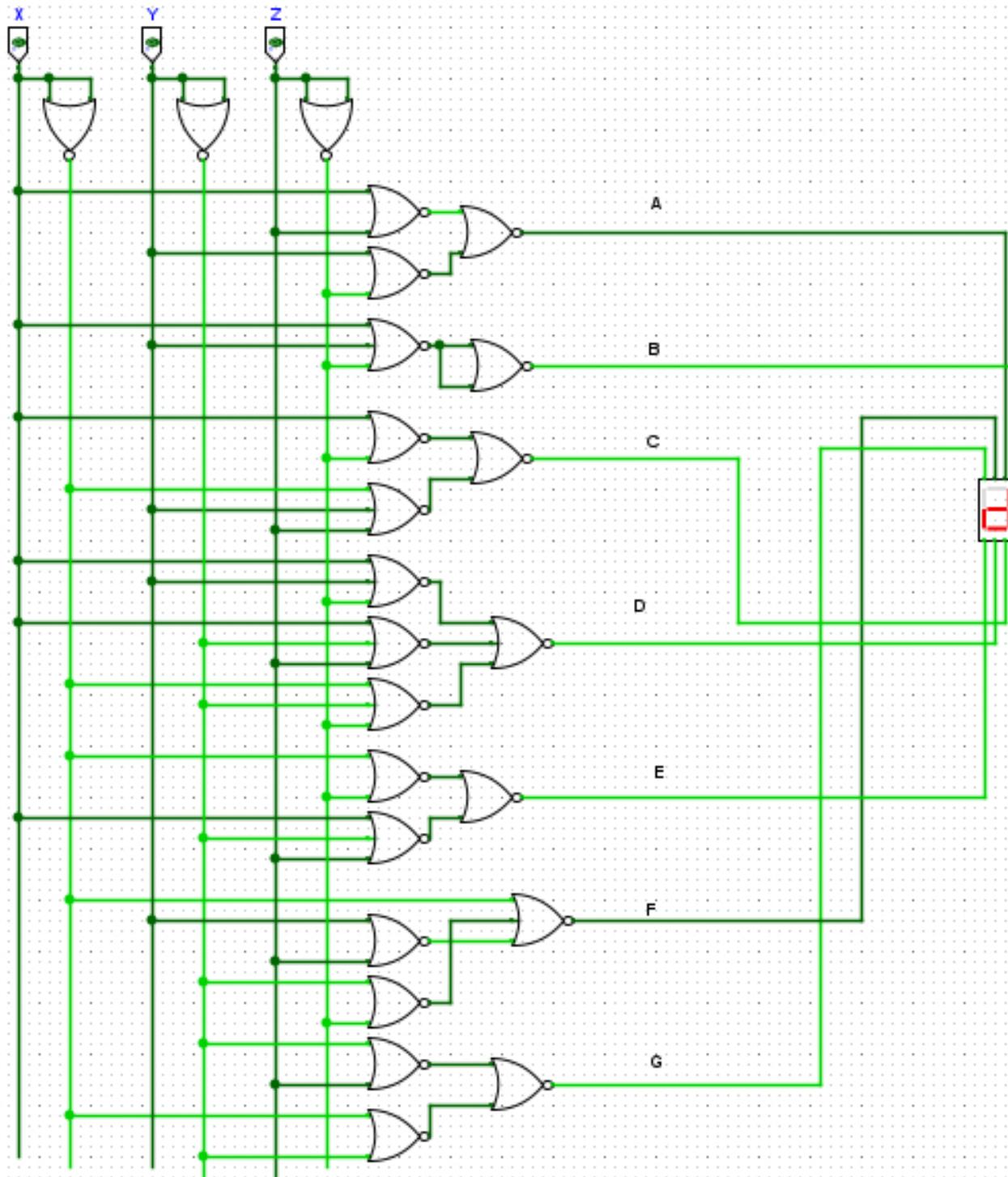
Gate Required	Gate needed	IC Needed	Unit Price	Total Price
NOR gate (4-input)	00	00	0.0	0.0
NOR gate (3-input)	08	03	45.09	135.12
NOR gate (2-input)	13	04	45.09	100.16
		Total = TK		235.28

Multiplexer (MUX) format equation

For, $S_0 = Y, S_1 = X$

$$\text{for } A: \text{equation} = \bar{X}\bar{Y}(0) + \bar{X}Y(2) + X\bar{Y}(2) + XY(1) \\ = \bar{X}YZ + X\bar{Y}\bar{Z} + XY$$

$$\text{for } B: \text{equation} = \bar{X}\bar{Y}(\bar{z}) + \bar{X}Y(1) + X\bar{Y}(1) + XY(1) \\ = \bar{X}\bar{Y}\bar{Z} + \bar{X}Y + X$$



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7 segment display using ONLY NOR

for C: equation = $\bar{X}F(\bar{Z}) + \bar{X}Y(\bar{Z}) + X\bar{Y}(Z) + XY(1)$
 $= \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + X\bar{Y}Z + XY$

for D: equation = $\bar{X}\bar{Y}(\bar{Z}) + \bar{X}Y(Z) + X\bar{Y}(1) + XY(\bar{Z})$
 $= \bar{X}\bar{Y}\bar{Z} + \bar{X}YZ + X\bar{Y} + XY\bar{Z}$

for E: equation = $\bar{X}\bar{Y}(1) + \bar{X}Y(Z) + X\bar{Y}(\bar{Z}) + XY(\bar{Z})$
 $= \bar{X}\bar{Y} + \bar{X}YZ + X\bar{Y}\bar{Z} + XY\bar{Z}$

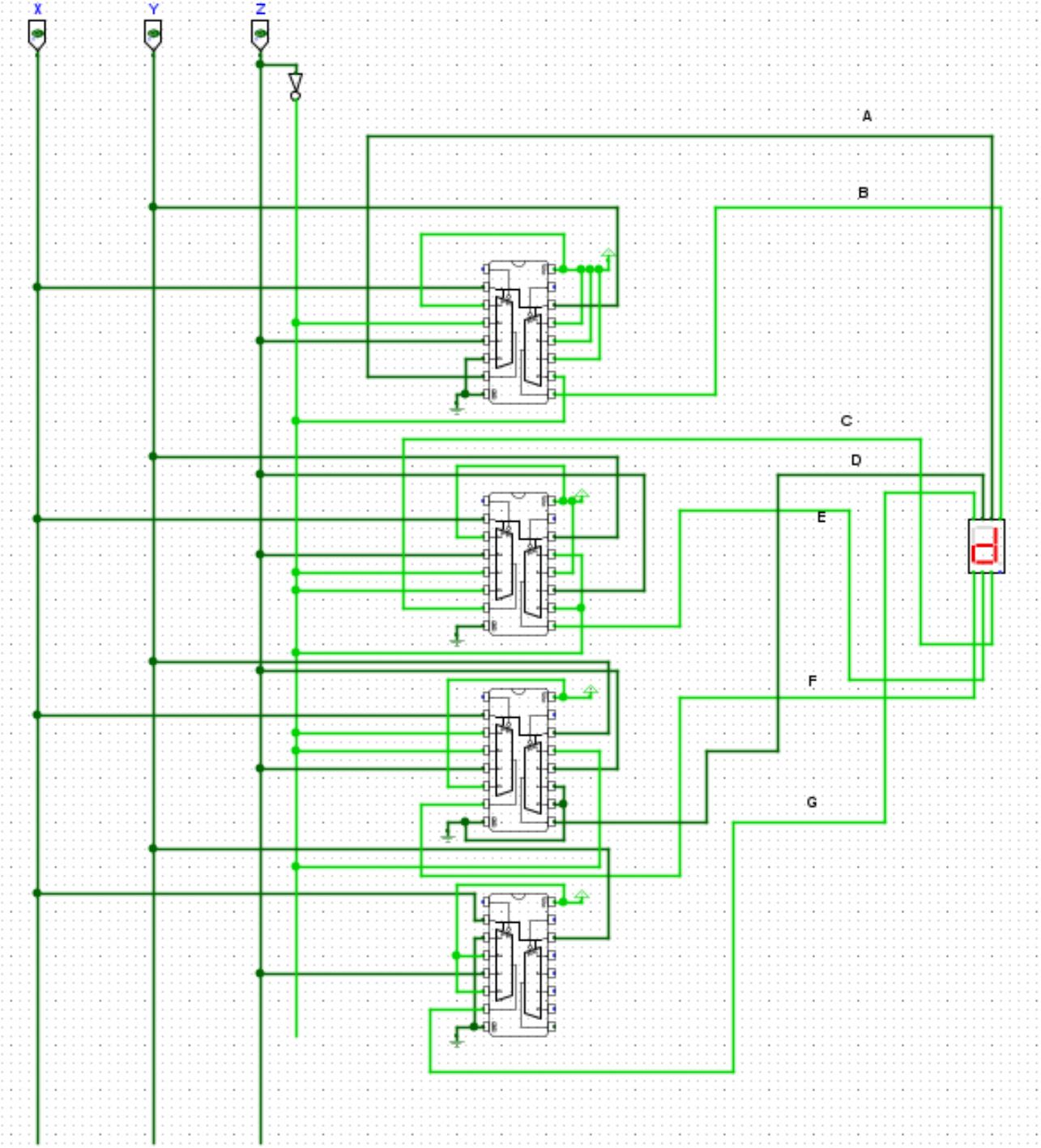
for F: equation = $\bar{X}\bar{Y}(0) + \bar{X}Y(0) + X\bar{Y}(Z) + XY(\bar{Z})$
 $= X\bar{Y}Z + XY\bar{Z}$

for G: equation = $\bar{X}F(1) + \bar{X}Y(Z) + X\bar{Y}(1) + XY(0)$
 $= \bar{X}\bar{Y} + \bar{X}YZ + X\bar{Y}$

Cost Analysis:

Required Gate	Gates Needed	IC Needed	Unit Price	Total Price
Dual 4:1 MUX	04	04	30.04	120.16
NOT gate	03	01	20.04	20.04
			Total = TK	140.20

(1) YK + (1) XY + (1) ZX + (1) YZ



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7 segment display using Multiplexer

Decoder Formal Equation:

for A: equation = $\overline{Y_3.Y_4.Y_6.Y_7}$ [ON state]
= $\overline{\overline{X}YZ}, \overline{X\overline{Y}Z}, \overline{XY\overline{Z}}, \overline{XYZ}$

for B: equation = Y_1
= $\overline{X\overline{Y}Z}$ [off state]

for C: equation = $Y_1.Y_3.Y_4$ [off state]
= $\overline{X\overline{Y}Z}, \overline{X\overline{Y}\overline{Z}}, \overline{XY\overline{Z}}$

for D: equation = $Y_1.Y_2.Y_7$ [off state]
= $\overline{X\overline{Y}Z}, \overline{X\overline{Y}\overline{Z}}, \overline{XY\overline{Z}}$

for E: equation = ~~$Y_2.Y_5.Y_7$~~ [off state]
= $\overline{XY\overline{Z}}, \overline{X\overline{Y}Z}, \overline{XYZ}$

for F: equation = $\overline{Y_5.Y_6}$ [On state]
= $\overline{\overline{X\overline{Y}Z}}, \overline{\overline{XY\overline{Z}}}$

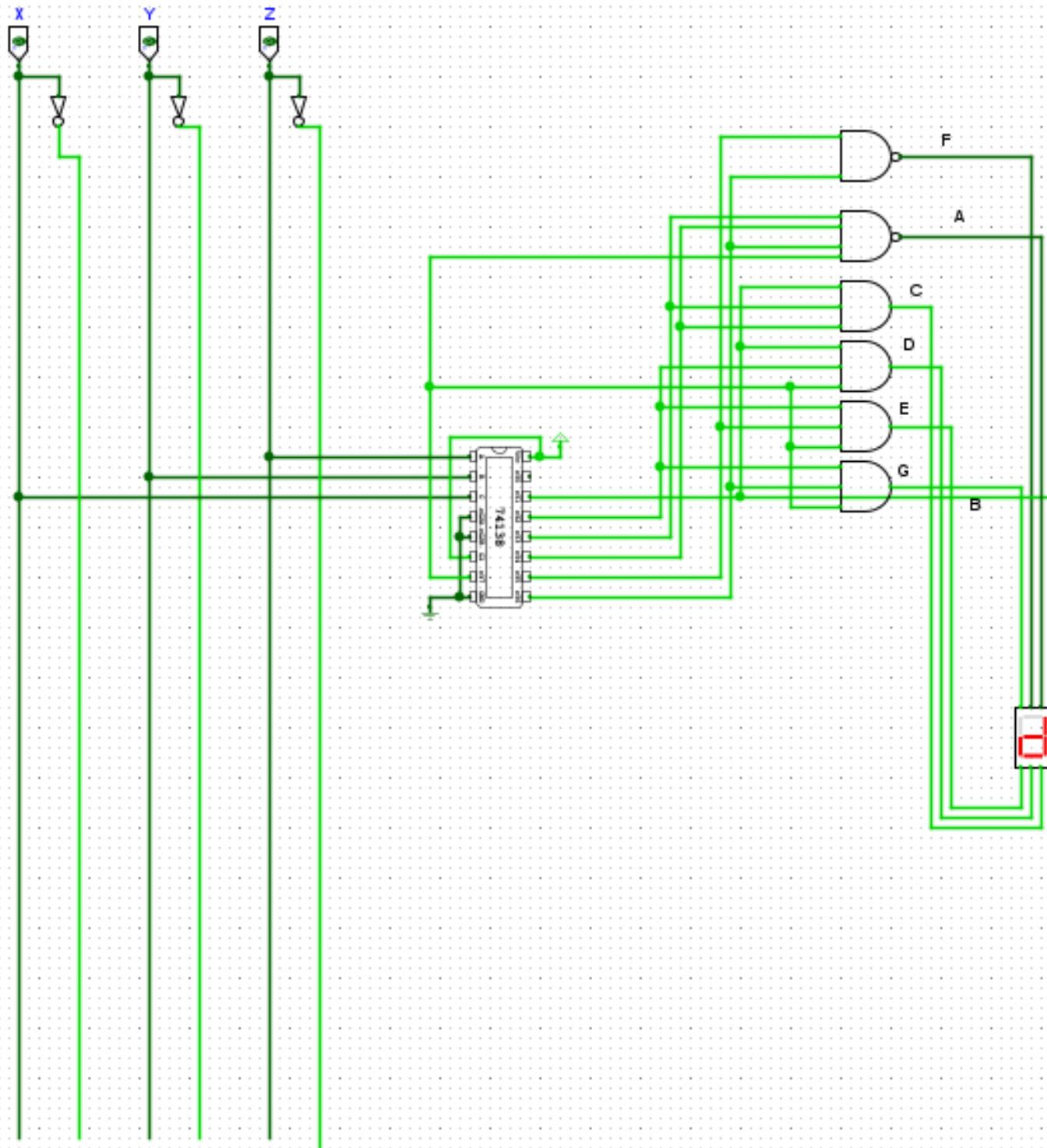
for G: equation = $Y_2.Y_6.Y_7$ [off state]
= $\overline{XY\overline{Z}}, \overline{X\overline{Y}\overline{Z}}, \overline{XYZ}$

Cost Analysis:

Required gate	Gates needed	IC needed	Unit Price	Total Price
Decoder	01	01		
NAND gate (4-input)	01	01		
NAND gate (3-input)	04	02		
NAND gate (2-input)	02	01		

Cost Analysis:

Required Data	Gates Needed	IC needed	Unit Price	Total price
Decoder (3-to-8)	01	01	₹5.04	₹5.04
NOT gate	03	01	₹0.64	₹0.64
NAND gate (3-input)	02	01	₹0.05	₹0.05
AND gate (2-input)	04	01	₹0.08	₹0.08
			Total = TK	85.21



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7 segment display using Decoder