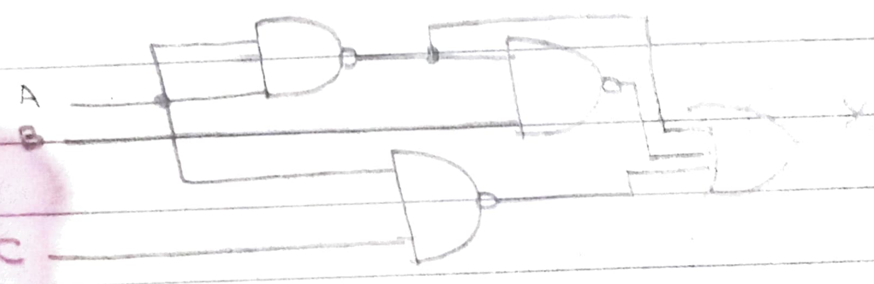
THE UNIVERSAL PROPERTY OF NAND AND NOR GATES:-

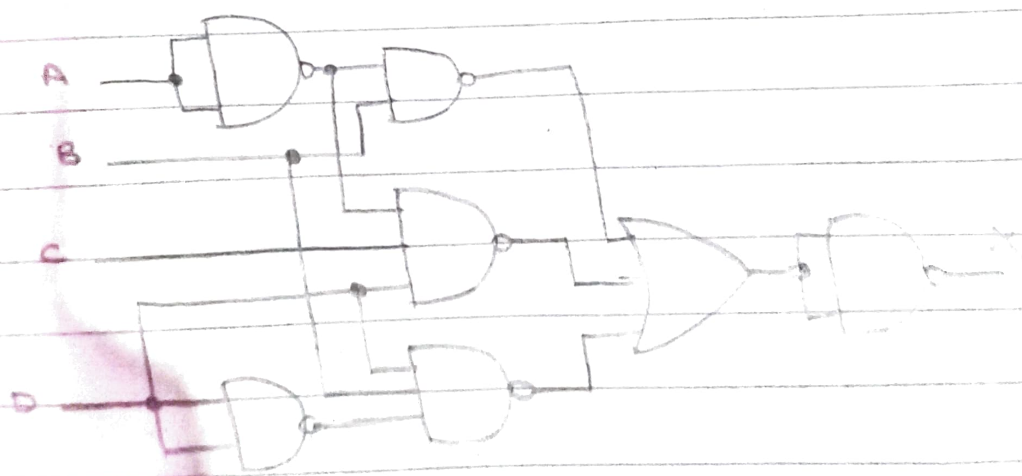
Section 5-3

20. Implement the logic circuits ~~in~~ using only NAND gates.

a)

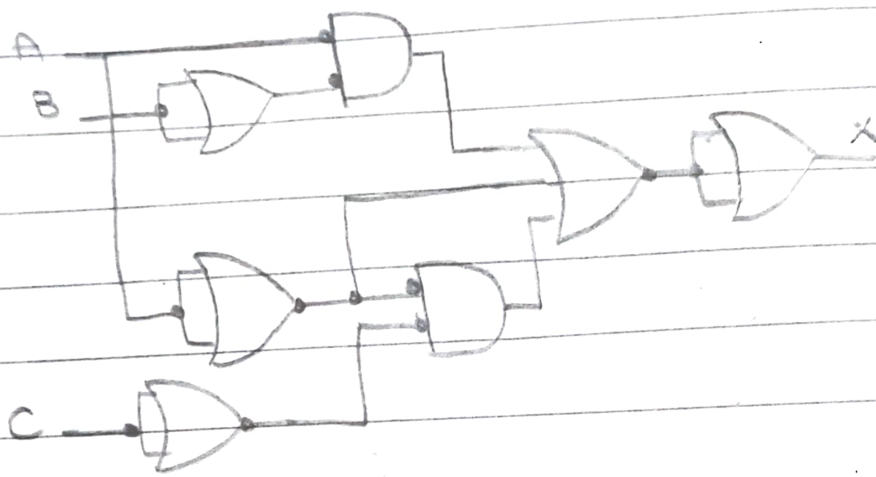


b)

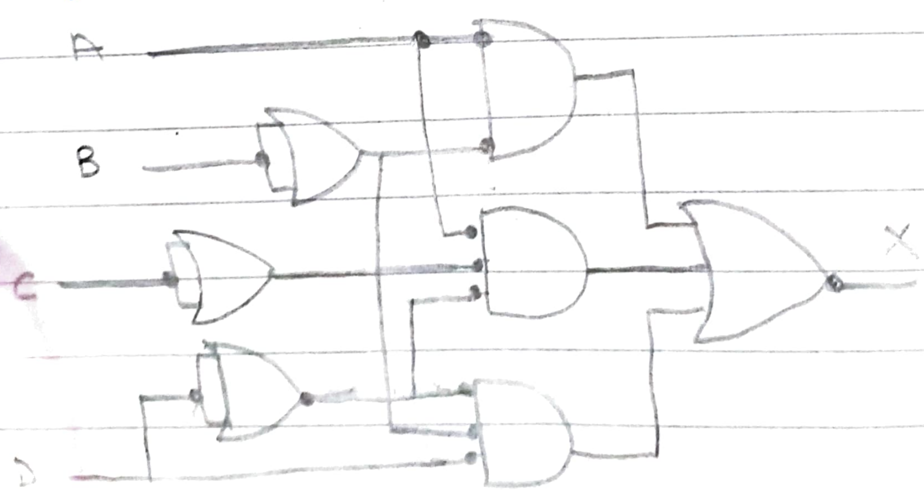


22. Repeat Problem 20 using only NOR gate.

a)



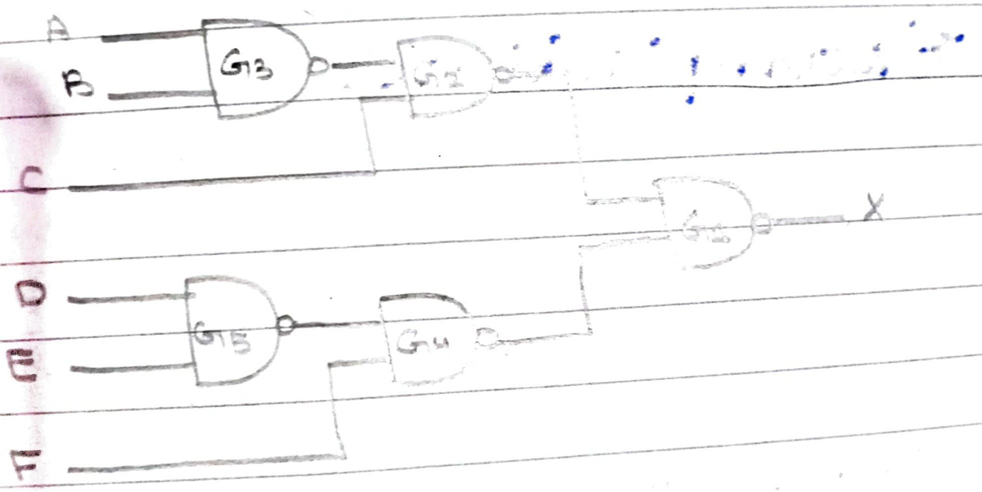
b)



COMBINATIONAL LOGIC USING NAND AND NOR GATES:-

Example 5-9

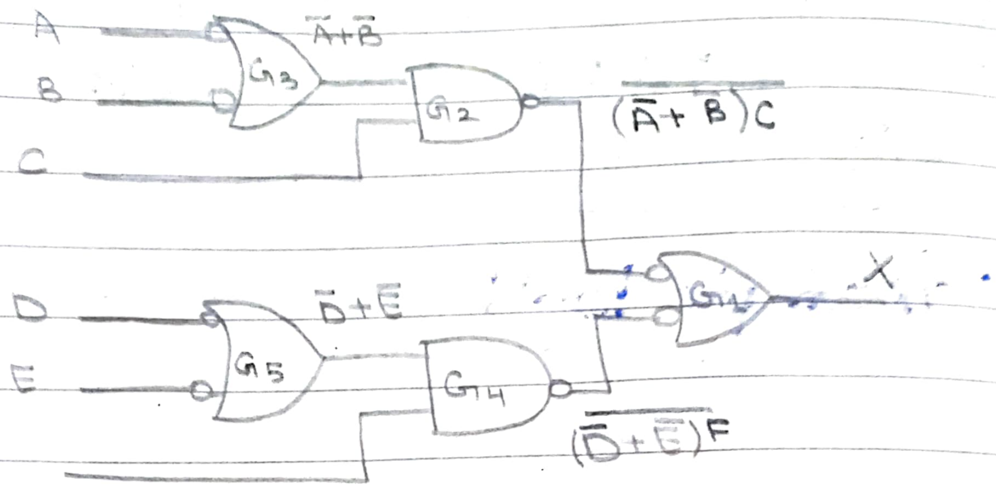
Redraw the logic diagram and develop the output expression for the circuit.



Solution:

Redraw the logic diagram with the use of equivalent negative-OR symbols. Writing the expression for X directly from the indicated logic operation from each gate gives

$$X = (\bar{A}+\bar{B})C + (\bar{D}+\bar{E})F$$

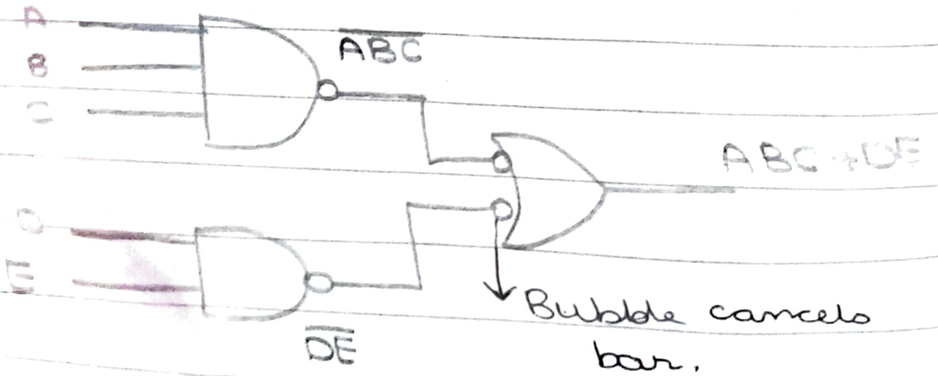


Example 5-10

Implement each expression with NAND logic using appropriate dual symbols.

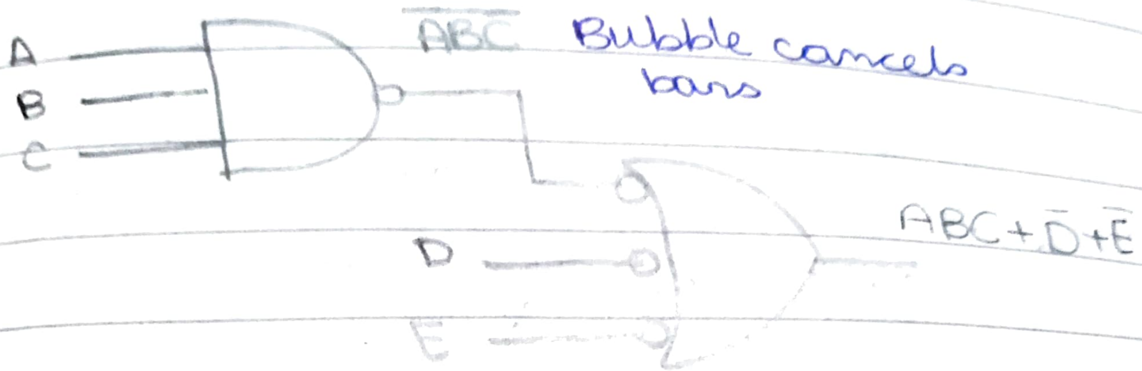
a) ABC+DE

Solution:



b) $ABC + \overline{D} + \overline{E}$

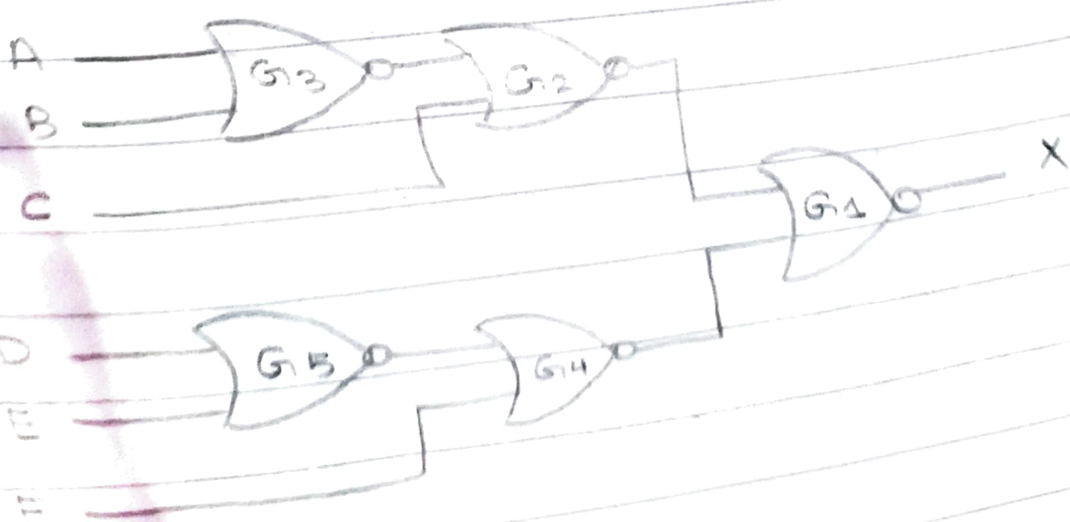
Solution:



Bubbles adds bars to D and E

Example 5-11

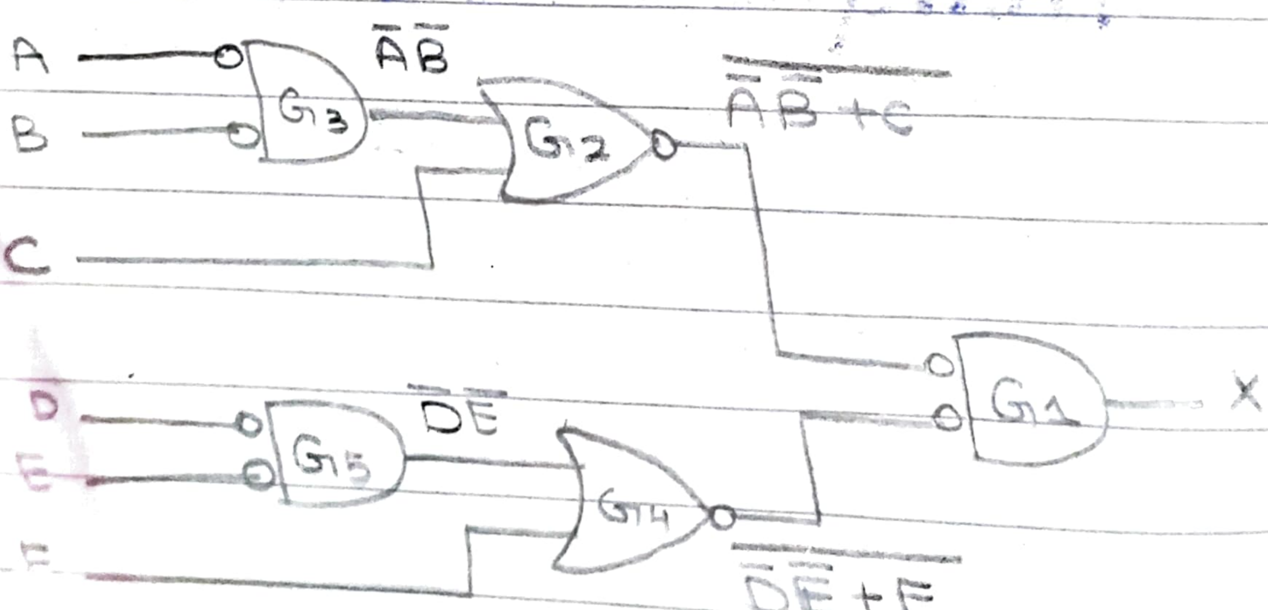
Using appropriate dual symbols, redraw the logic diagram and develop the output expression for the circuit.



Solution:

Redraw the logic diagram with the equivalent negative-AND symbols. Writing the expression for X directly from the indicated operation of each gate.

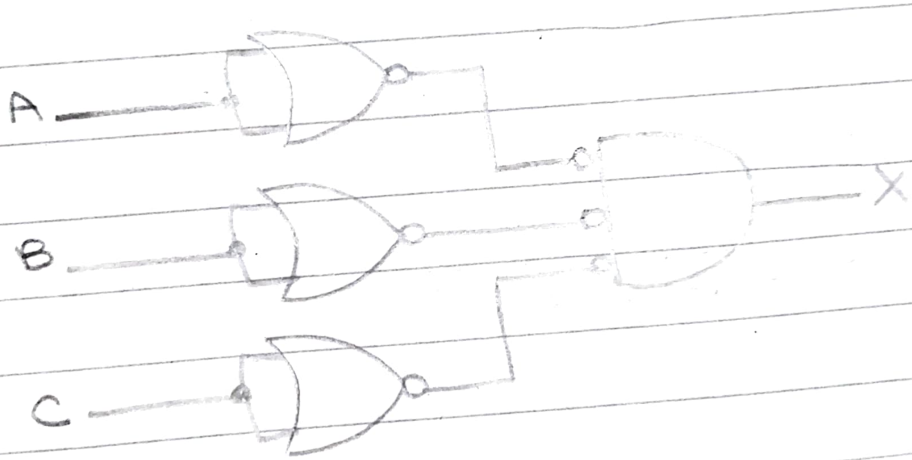
$$X = (\overline{A}\,\overline{B} + C)(\overline{D}\,\overline{E} + F)$$



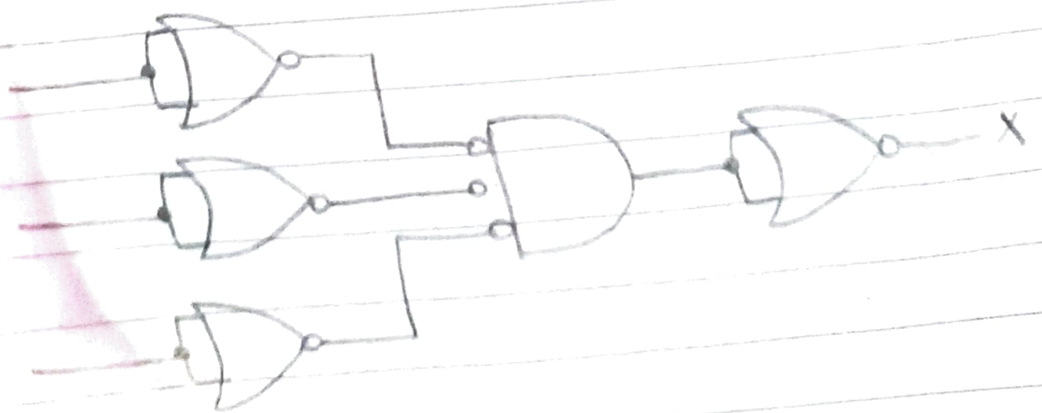
Section 5-4

24. Show how the following expressions can be implemented as stated using only NOR gates.

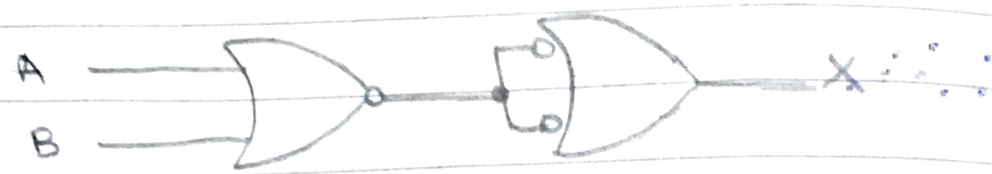
a) $X = ABC$



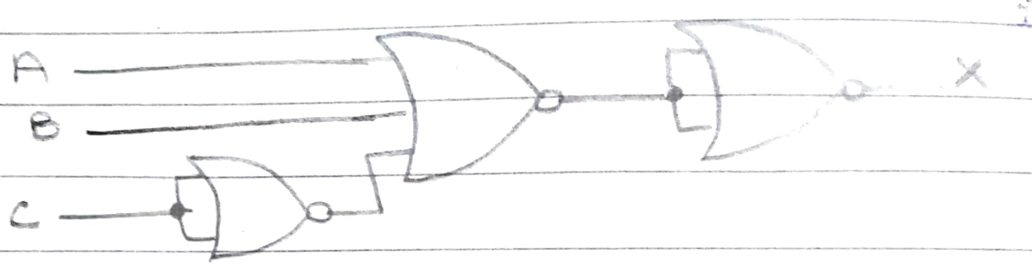
b) $X = \overline{ABC}$



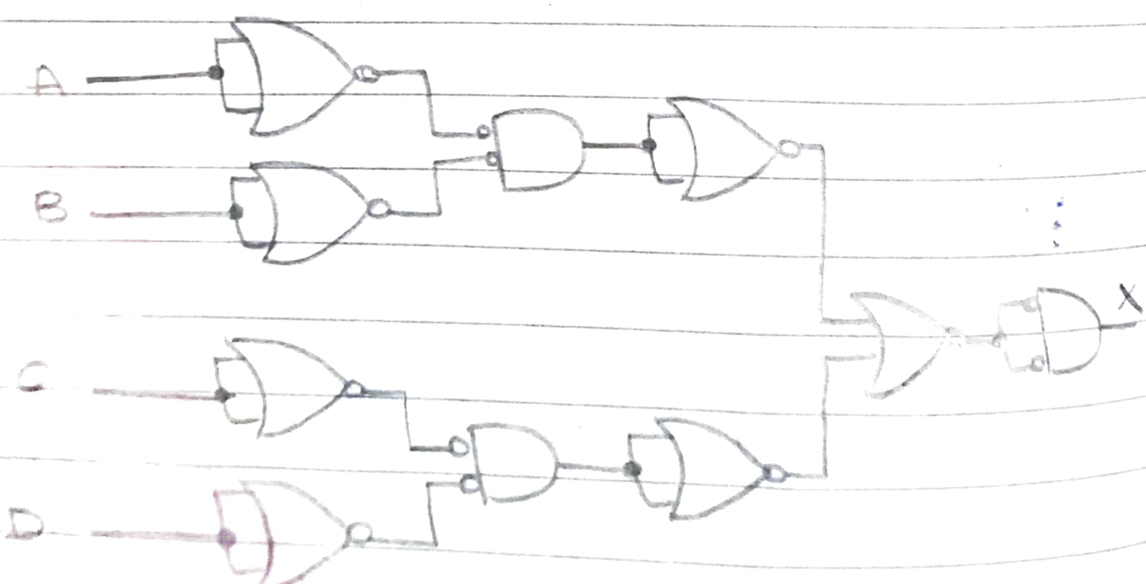
c) $X = A + B$



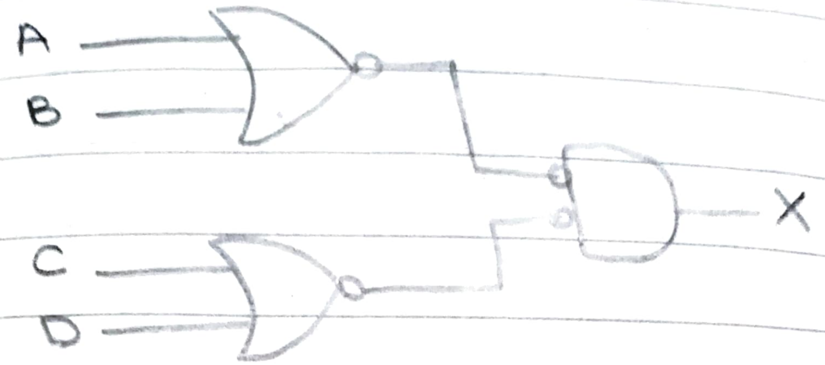
d) $X = A + B + \overline{C}$



e) $X = \overline{AB} + \overline{CD}$

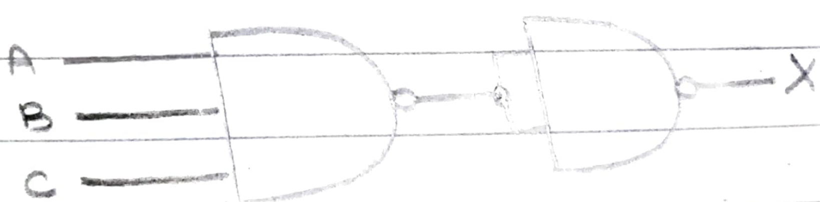


f) $X = (A+B)(C+D)$

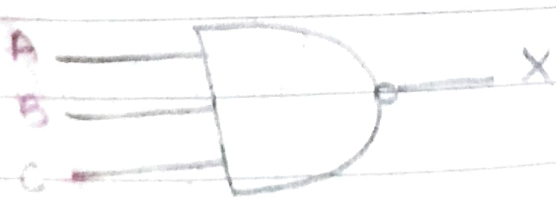


25. Repeat Problem 24 using only NAND gates.

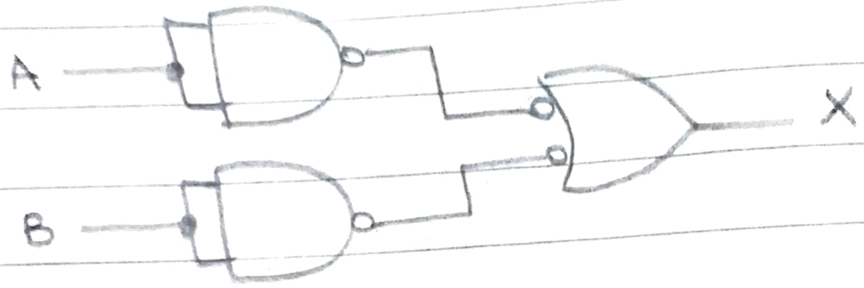
a) $X = ABC$



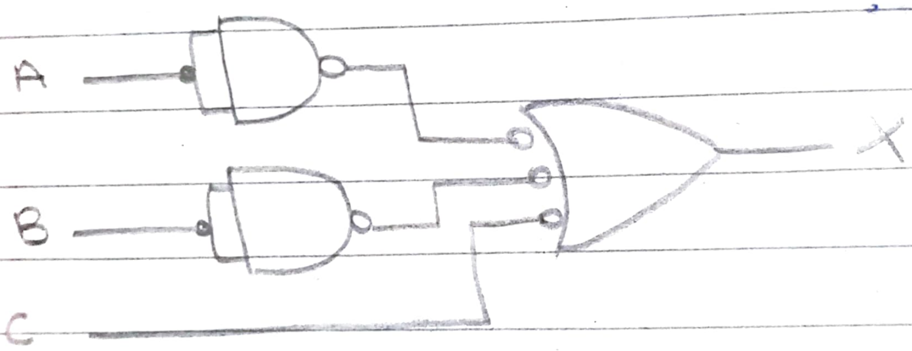
b) $X = \overline{ABC}$



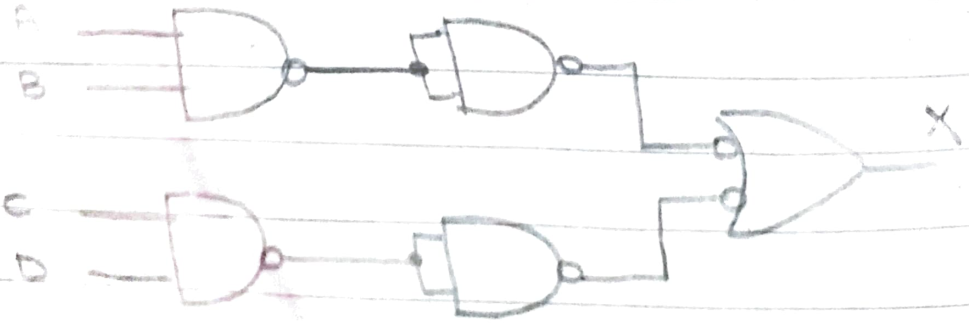
c) $X = A + B$



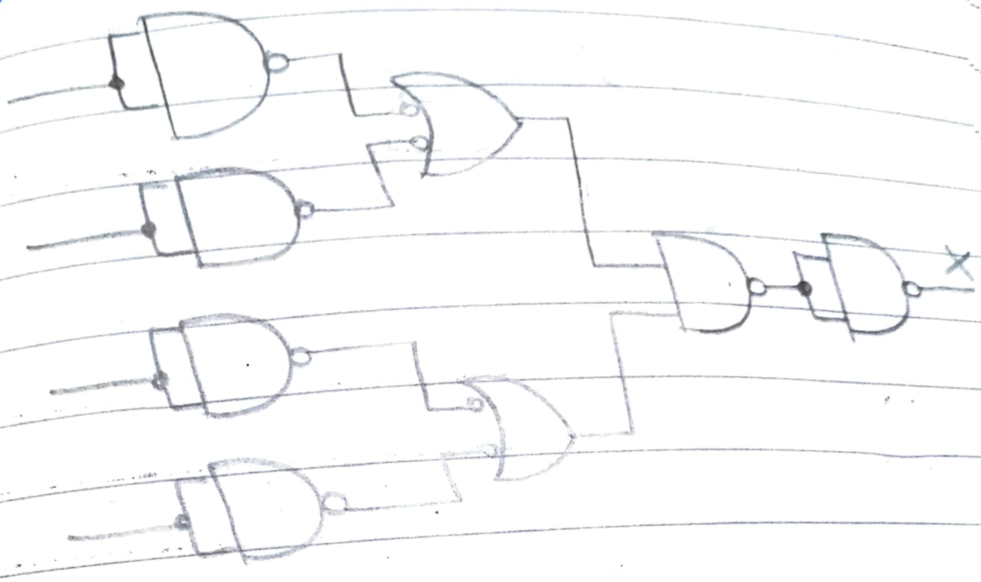
d) $X = A + B + \overline{C}$



e) $X = \overline{AB} + \overline{CD}$



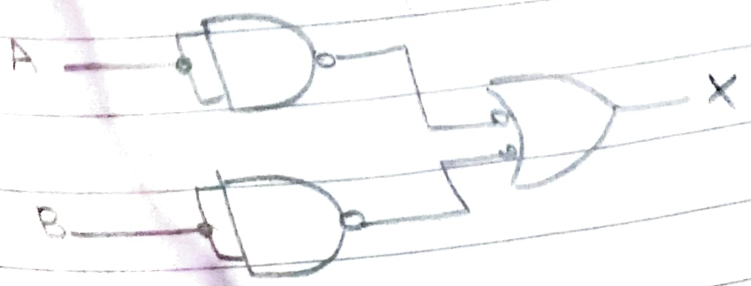
f) $X = (A+B)(C+D)$



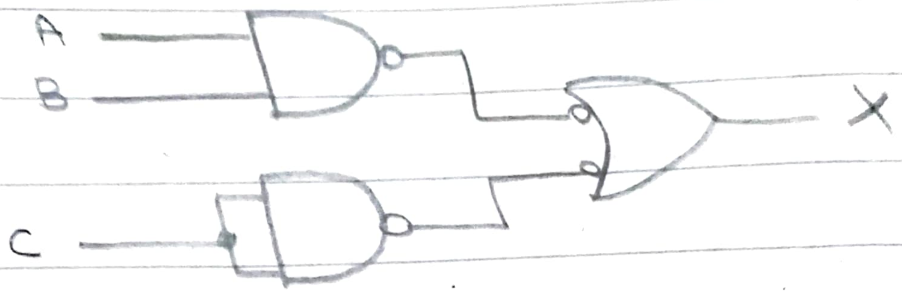
26. Implement each function in Problem 10 by using only NAND gates.

a) $X = AB$

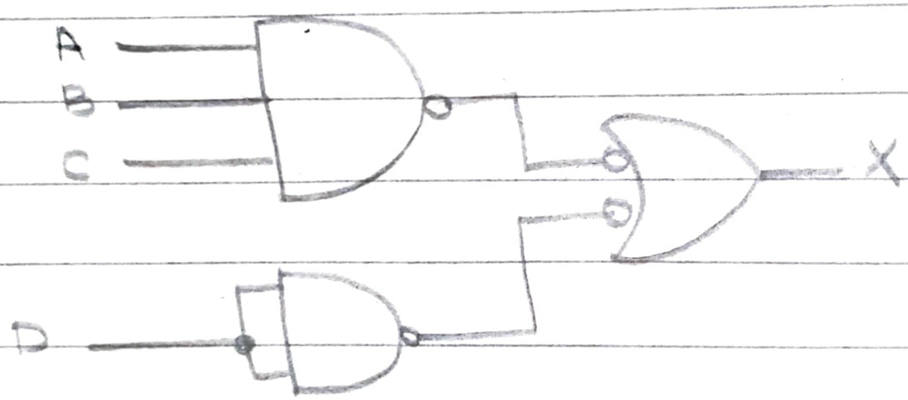
b) $X = A + B$



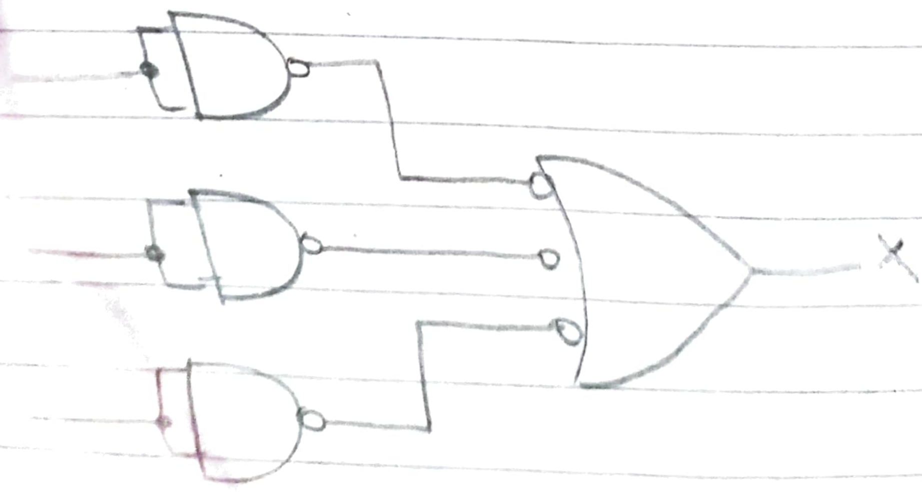
c) $X = AB + C$



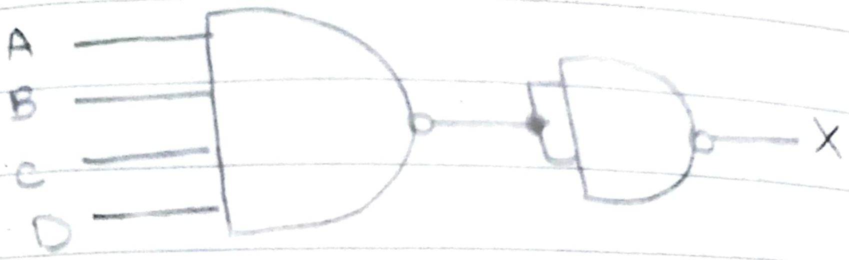
d) $X = ABC + D$



e) $X = A + B + C$

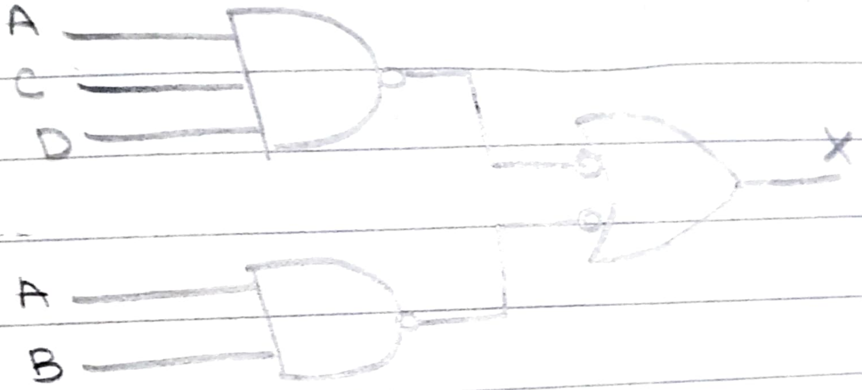


f) $X = ABCD$



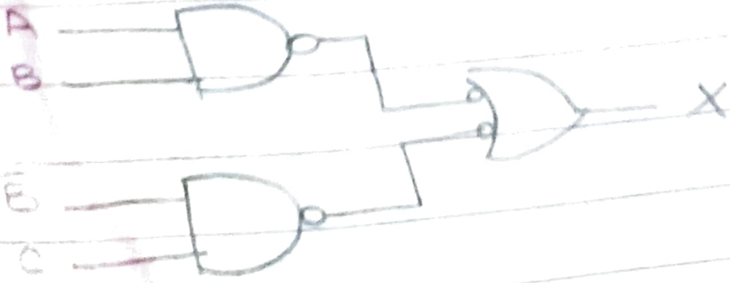
g) $X = A(CD + B)$

$\Rightarrow X = ACD + AB$



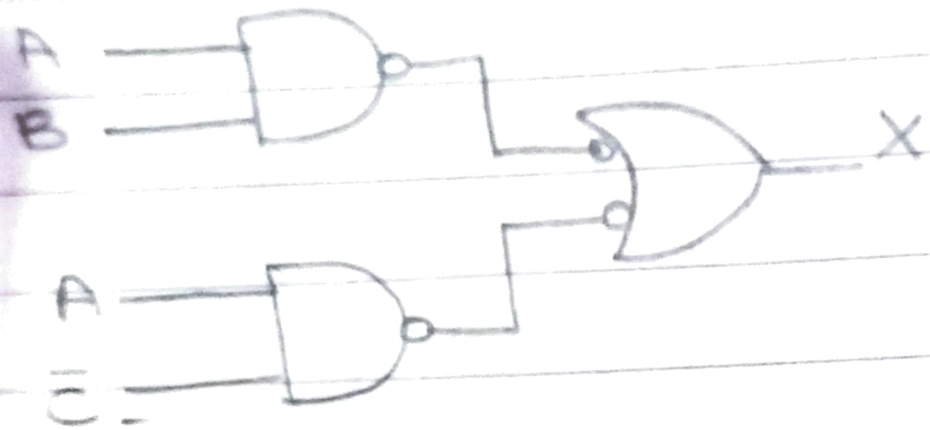
27. Implement each function in Problem 11 by using only NAND gates.

a) $X = AB + \overline{B}C$

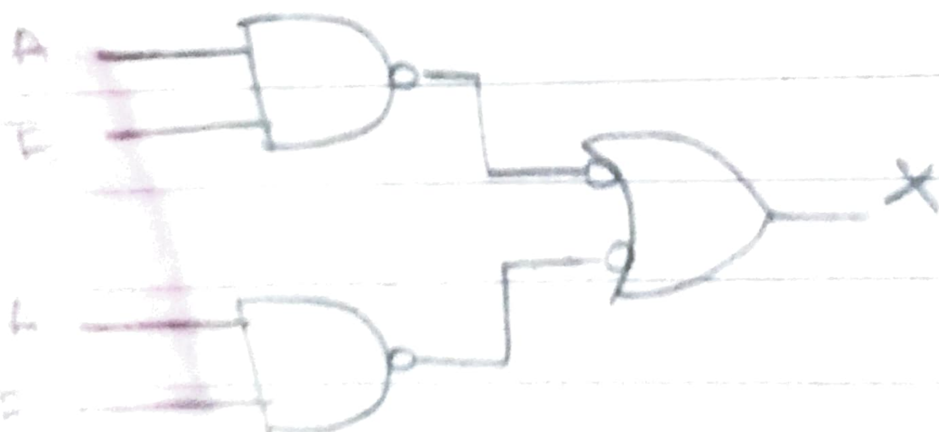


b) $X = A(B + \overline{C})$

$X = AB + A\overline{C}$



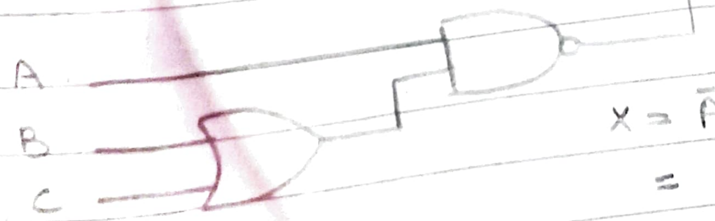
c) $X = A\overline{B} + AB$



PULSE WAVEFORM OPERATION:

Example 5-12

Determine the final output waveform X for the circuit with input waveforms A, B, C.



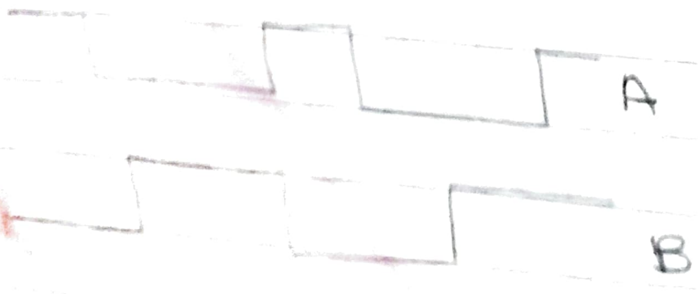
$$X = \overline{A(B+C)}$$

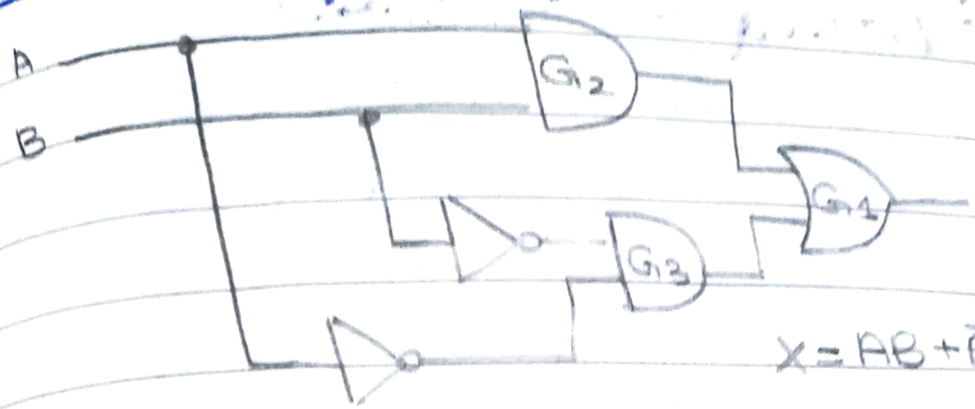
$$= \overline{AB+AC}$$

Solution:
The output expression $\overline{AB+AC}$ indicates the output X is LOW when both A and B are HIGH or when both A and C are HIGH or when all inputs are HIGH. The output waveform X is shown in the timing diagram. The intermediate waveform Y at the output of the OR gate is also shown.

Example 5-13

Draw the timing diagram for the circuit showing the outputs of G_1, G_2 and G_3 with the input waveform A and B as indicated.

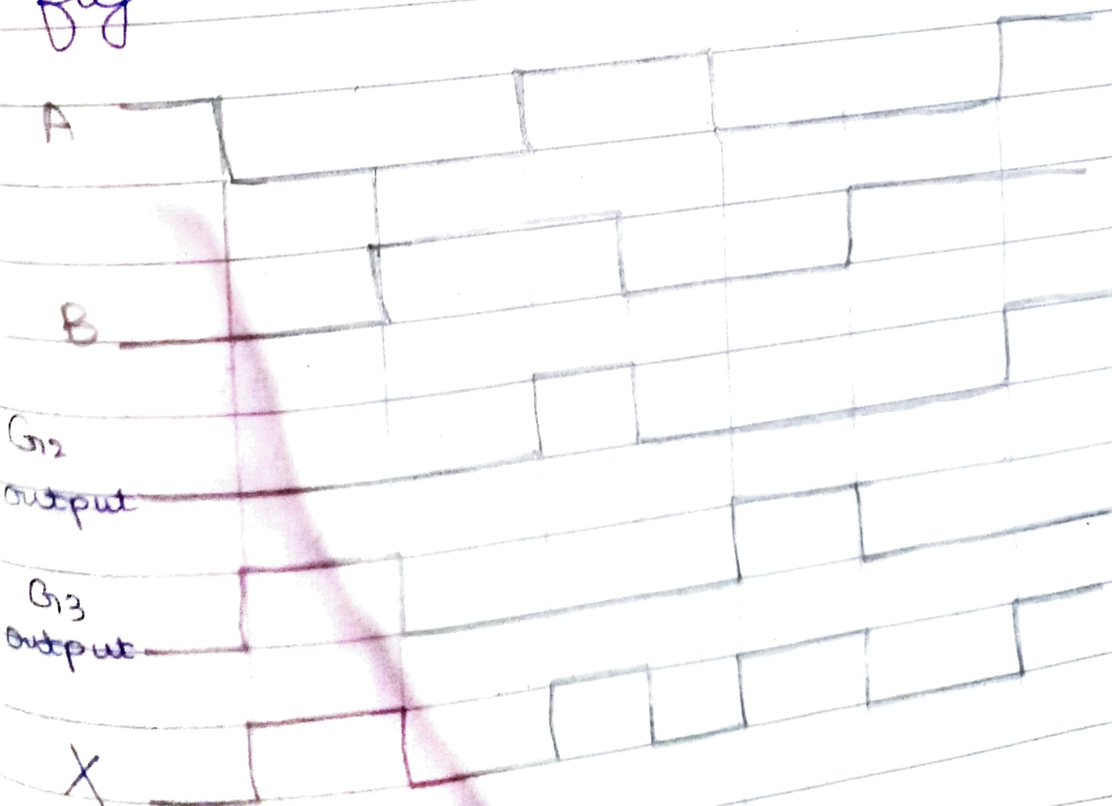




$X = AB + \bar{A}\bar{B}$

Solution:

When both inputs are HIGH or when both inputs are LOW, the output X is HIGH. Notice that this is an exclusive-NOR circuit. The intermediate outputs of gates G2 and G3 are shown in figure.

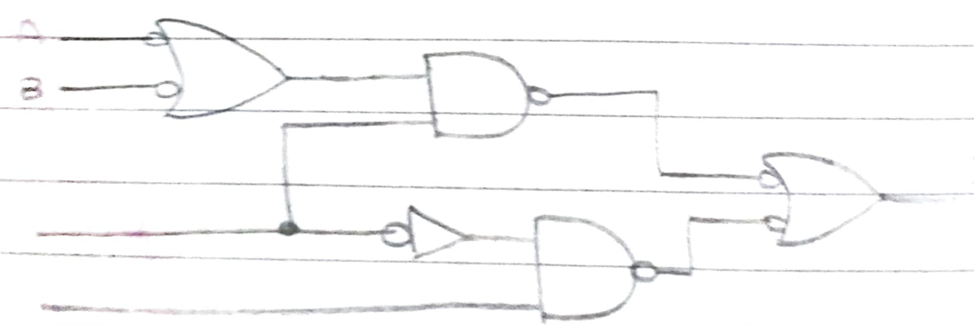


Example 5-15

Determine the output waveform X for the circuit, directly from the output expression.

Solution :

The output expression for the circuit is developed. The SOP form indicates that the output is HIGH when A is LOW and C is HIGH or when B is LOW and C is HIGH or when C is LOW and D is HIGH.

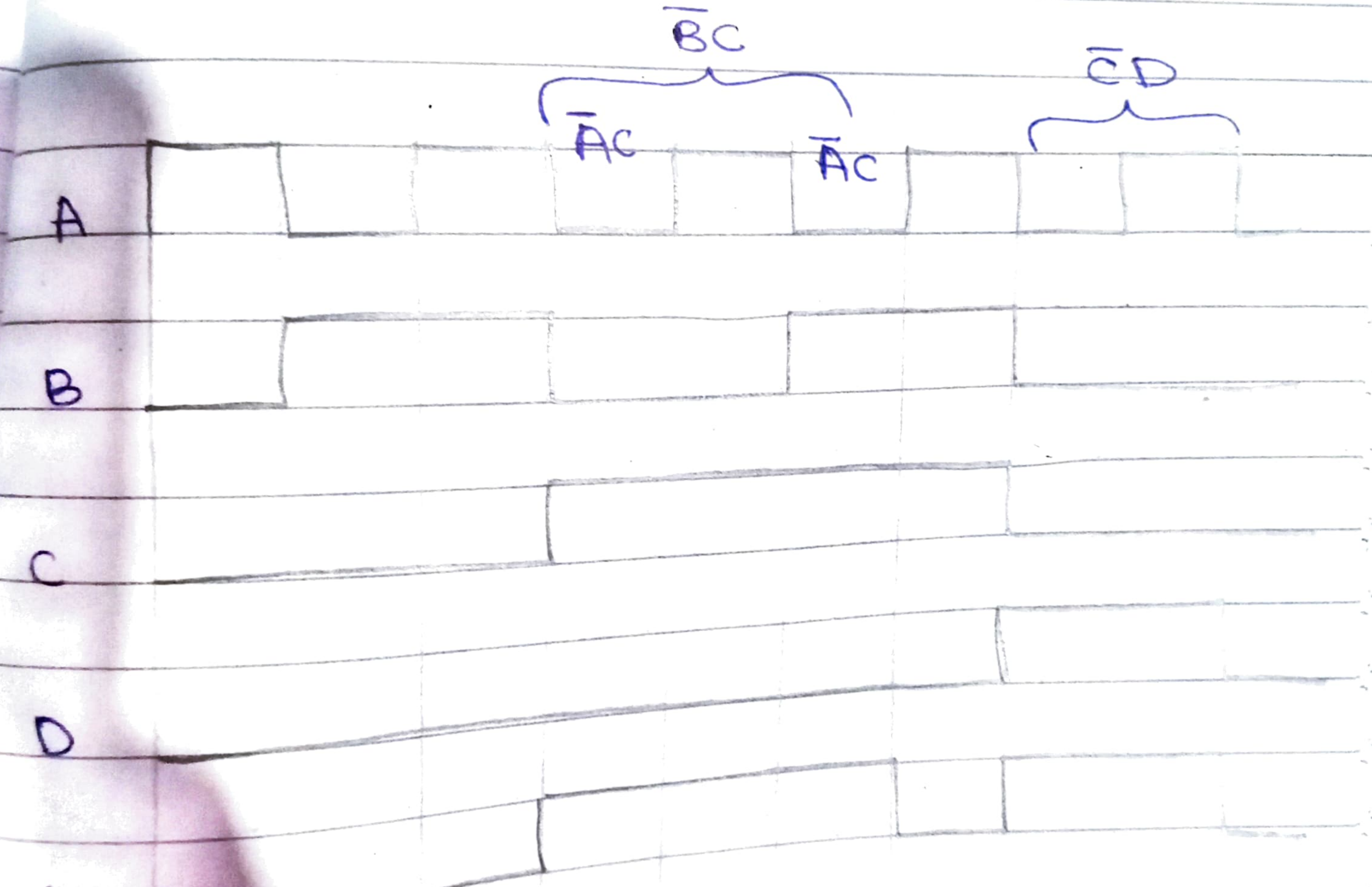


$$X = \overline{\overline{(\bar{A}+\bar{B})C}} + \overline{\overline{\bar{C}D}}$$

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

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

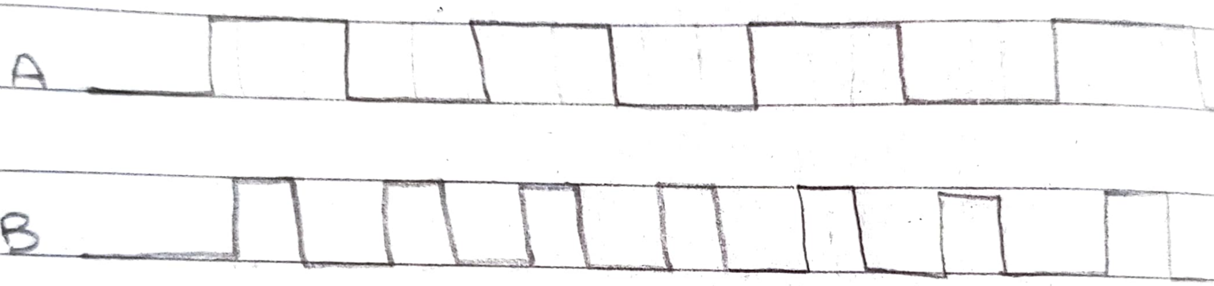
The result is shown in figure and is the same as the one obtained by the intermediate waveform method. The corresponding product terms for each waveform condition that results in a HIGH output are indicated

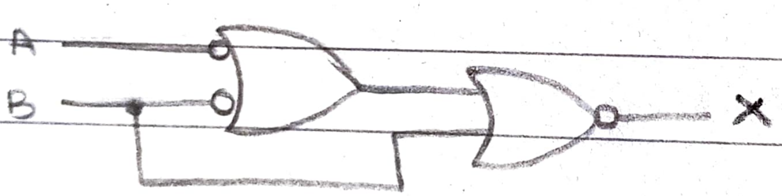


$X = \bar{A}C + \bar{B}C + \bar{C}D$

Section 5-5

28. The output of the logic circuit and input waveforms is passed through an inverter. Draw the output waveforms.





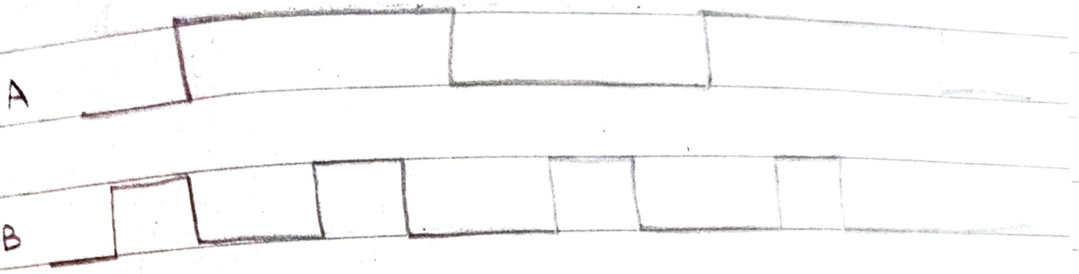
$$\Rightarrow X = \overline{\overline{A} + \overline{B} + B}$$

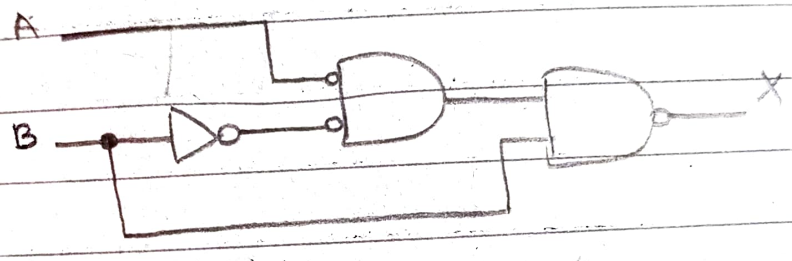
$$= AB\overline{B}$$

$$\Rightarrow X = 0$$

The output X is LOW.

29. For the logic circuit, draw the output waveform in proper relationship to the inputs.

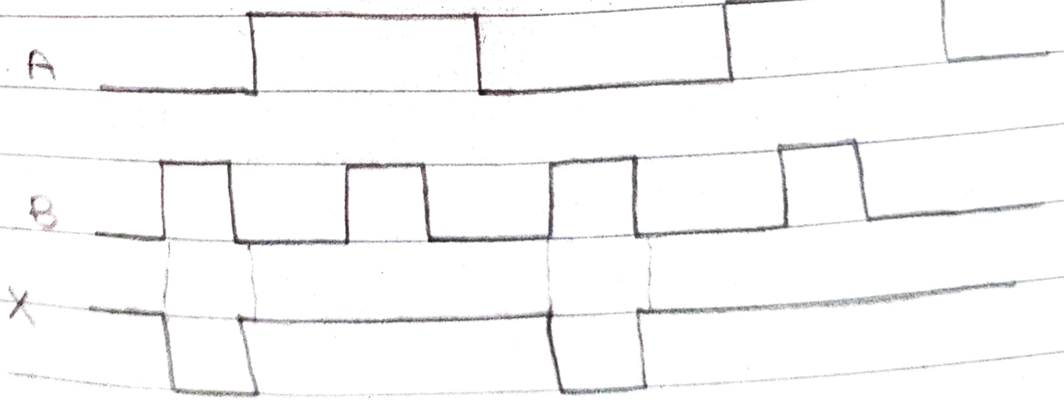


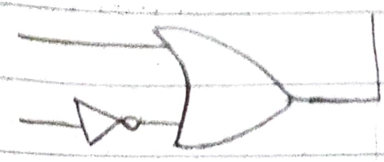


$\Rightarrow X = \overline{(A\overline{B})B}$

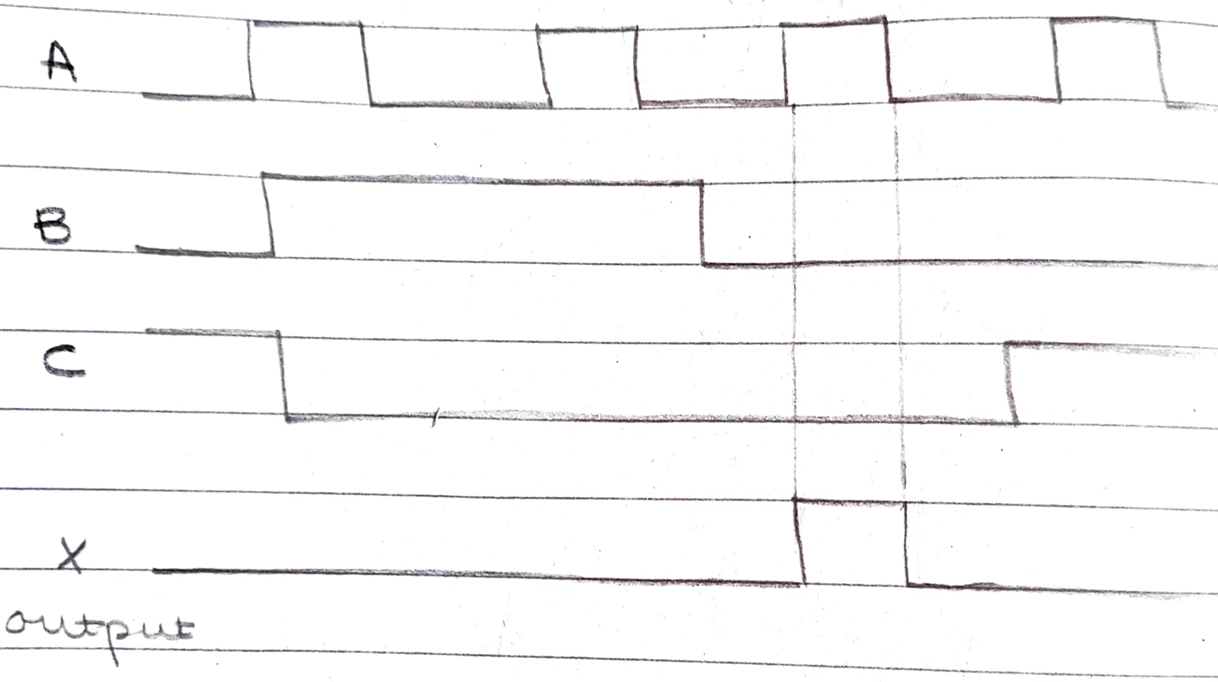
$= A + \overline{B} + \overline{B}$

$= A + \overline{B}$





31. Repeat Problem 30 for the waveforms in figure.



X is HIGH when ~~X~~ A is HIGH, B is LOW and C is LOW

$\Rightarrow X = A\bar{B}\bar{C}$