

## Minor Exam Set-1

$$\textcircled{2} \text{ (a) } y = \underbrace{\underbrace{(a' \cdot b')}_{\text{NAND+NOT}} + \underbrace{(b \cdot c')}_{\text{NAND+NOT}}}_{\text{NOR}} \cdot \underbrace{\underbrace{(a' \cdot c)}_{\text{NAND+NOT}} + \underbrace{(b \cdot c)}_{\text{NAND+NOT}}}_{\text{NOR + NOT}}$$

$\text{NAND + NOT}$

There could be some other ways to implement the circuit. We will check for all such answers and correct answers will get full grades.

$$\begin{aligned} \textcircled{b}. \quad y &= ((a' \cdot b') + (b \cdot c'))' \cdot ((a' \cdot c) + (b \cdot c)) \\ &= \{ (a' \cdot b')' \cdot (b \cdot c')' \cdot (a'c + bc) \} \\ &= (\underline{a+b}) \cdot (\underline{b'+c}) \cdot (\underline{a'c + bc}) \cdot \underline{c} \\ &= (ab' + ac + bc) (a' + b) \cdot c \\ &= (a'bc + abc + bc) \cdot c \\ &= bc \cdot c \\ &= bc. \end{aligned}$$

$\text{NAND + NOT}$

$$\textcircled{3} \quad f(a, b, c, d) = \sum m(0, 1, 3, 9) + \sum d(2, 11, 15)$$

ab \ cd	00	01	11	10
00	1	1	1	X
01				
11			X	
10		1	X	

$$f = a'b' + b'd$$

~~There is~~

$$\textcircled{4} \textcircled{a} \quad f = abcde' + ab'd + ab'ce$$

$$= \{ (abcde' + ab'd + ab'ce)' \}'$$

$$= \{ (abcde')' \cdot (ab'd)' \cdot (ab'ce)' \}'$$

$$= \{ (a' + b' + c' + d' + e) \cdot (a' + b + d') \cdot (a' + b + c' + e)' \}$$

$$= \{ (a' + b' + c' + d' + e) (a' + b + c'd' + d'e') \}'$$

$$= \{ a' + b'c'd' + b'd'e' + bc' + c'd' + c'd'e' + bd' + c'd' + d'e' + be + c'd'e' \}'$$

$$= \{ a' + c'd' + bc' + d'e' + bd' + be \}'$$

$$= a \cdot (c + d) \cdot (b' + c) \cdot (d + e) \cdot (b' + d) \cdot (b' + e)$$

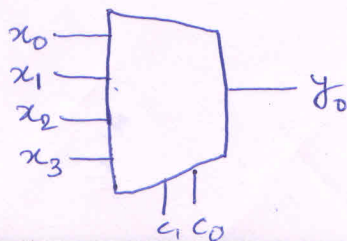
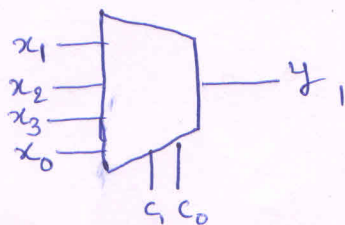
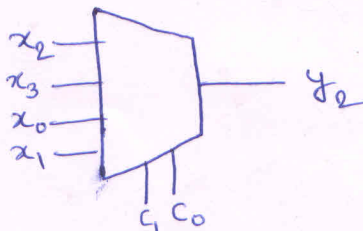
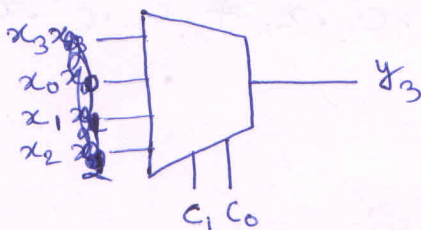
④ ⑥  $f = abcde' + a'b'd + ab'ce$   
 $= \{ (abcde' + a'b'd + ab'ce)' \}'$   
 $= \{ (abcde')' \cdot (a'b'd)' \cdot (ab'ce)' \}'$

$\underbrace{\hspace{10em}}_{NAND} \quad \underbrace{\hspace{10em}}_{NAND} \quad \underbrace{\hspace{10em}}_{NAND}$   
 $\underbrace{\hspace{20em}}_{NAND}$

⑦  $f = abcde' + a'b'd + ab'ce$   
 $= \{ (abcde')' \}' + \{ (a'b'd)' \}' + \{ (ab'ce)' \}'$   
 $= \underbrace{(a' + b' + c' + d' + e)'}_{NOR} + \underbrace{(a' + b' + d)'}_{NOR} + \underbrace{(a' + b' + c' + e)'}_{NOR}$   
 $\underbrace{\hspace{20em}}_{NOR + NOT}$

⑤

①

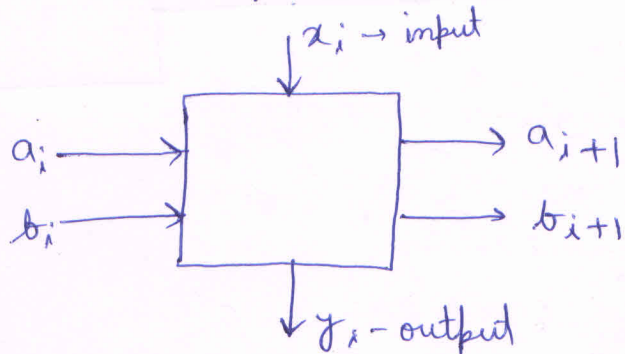


② All paths are equivalent in terms of the delay & hence any path could be selected as the critical path.

	$y_3$	$y_2$	$y_1$	$y_0$
0-shift	$x_3$	$x_2$	$x_1$	$x_0$
1-shift	$x_0$	$x_3$	$x_2$	$x_1$
2-shift	$x_1$	$x_0$	$x_3$	$x_2$
3-shift	$x_2$	$x_1$	$x_0$	$x_3$

⑥ (a) We consider a 2-bit variable  $a_i \cdot b_i$  such that

$$a_i, b_i = \begin{cases} 00, & \# \text{ of matched bits} = 0 \\ 01, & " = 1 \\ 10, & " = 2, \text{ and} \\ 11, & " = 3. \end{cases}$$



$a_i$	$b_i$	$x_i$	$a_{i+1}$	$b_{i+1}$	$y_i$
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	0	0
0	1	1	0	0	0
1	0	0	1	0	0
1	0	1	1	1	0
1	1	0	0	1	1
1	1	1	0	0	0

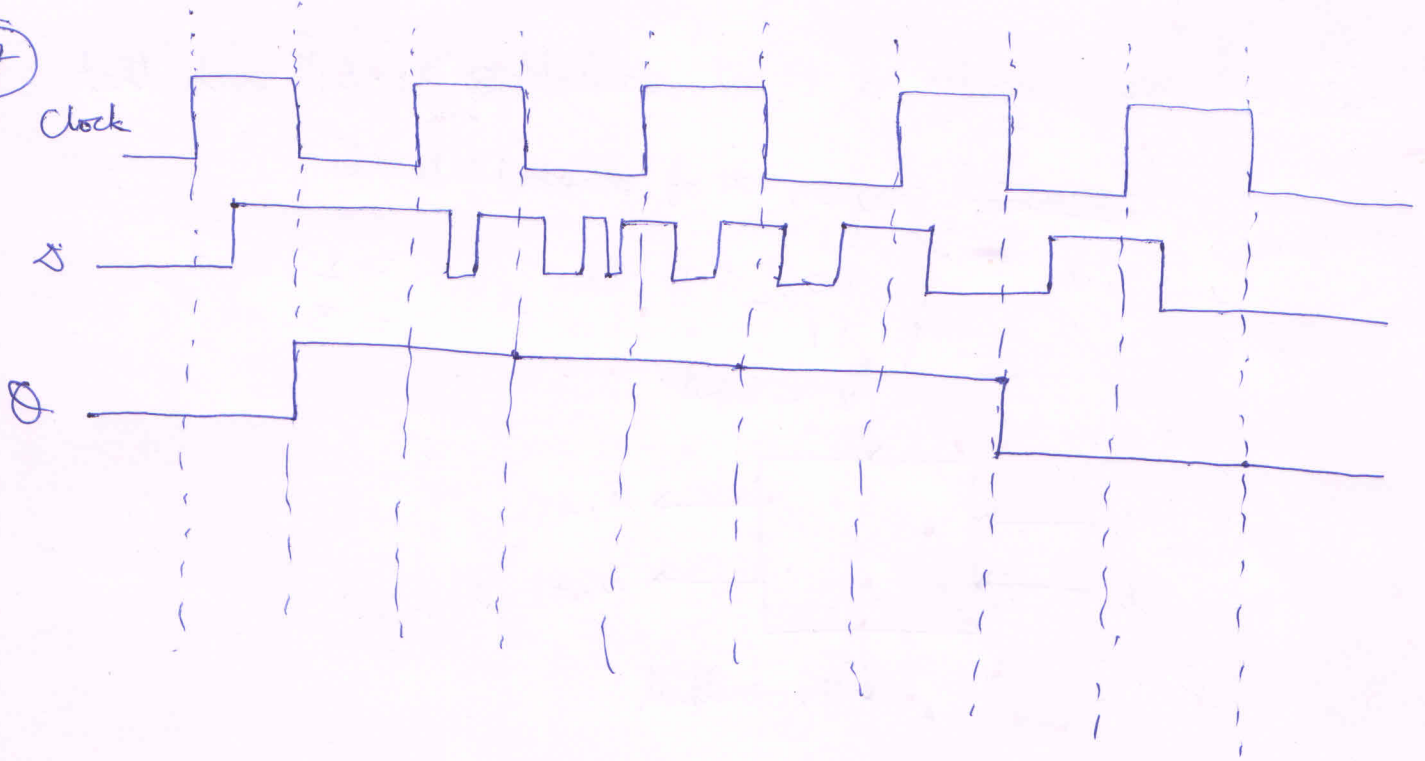
⑦  $a_{i+1} = a_i' \cdot b_i \cdot x_i' + a_i \cdot b_i'$

$b_{i+1} = a_i' \cdot b_i' \cdot x_i' + a_i \cdot b_i' \cdot x_i + a_i \cdot b_i \cdot x_i'$

$y_i = a_i \cdot b_i \cdot x_i'$



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8 (a)

M	N	$Q_{t+1}$
0	0	$Q_t'$
0	1	1
1	0	0
1	1	$Q_t$

$$Q_{t+1} = M' \cdot Q_t' + N \cdot Q_t$$

(b)  $S = M' Q_t' + N \cdot Q_t$

