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18CS10062

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COA LAB TEST 1

1.(a)

$$Z = XYS_3 + X\overline{Y}S_2 + \overline{X}YS_1 + \overline{X}\overline{Y}S_0$$

(b) (a) For $S = 0110$
$S_3S_2S_1S_0$

$\therefore S_3 = 0,\ S_2 = 1,\ S_1 = 1,\ S_0 = 0$

$\therefore Z = XY(0) + X\overline{Y}(1) + \overline{X}Y(1) + \overline{X}\overline{Y}(0)$

$\Rightarrow Z = 0 + X\overline{Y} + \overline{X}Y + 0$

$\Rightarrow \boxed{Z = X\overline{Y} + \overline{X}Y}$

(b) For $S = 0011$
$S_3S_2S_1S_0$

$S_3 = 0,\ S_2 = 0,\ S_1 = 1,\ S_0 = 1$

$\therefore Z = XY(0) + X\overline{Y}(0) + \overline{X}Y(1) + \overline{X}\overline{Y}(1)$

$\Rightarrow Z = 0 + 0 + \overline{X}Y + \overline{X}\overline{Y}$

$\Rightarrow \boxed{Z = \overline{X}Y + \overline{X}\overline{Y}}$

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(c) (a) For XOR function,

$$Z = X\overline{Y} + \overline{X}Y$$
$$= XY(0) + X\overline{Y}(1) + \overline{X}Y(1) + \overline{X}\overline{Y}(0)$$

$\therefore S_3 = 0,\ S_2 = 1,\ S_1 = 1,\ S_0 = 0$

$\therefore \boxed{S = 0110}$

(b) OR function,

$a + \bar{a} = 1$

$$Z = X + Y$$
$$= X(Y + \overline{Y}) + Y(X + \overline{X})$$
$$= XY + X\overline{Y} + XY + \overline{X}Y$$
$$= XY + X\overline{Y} + \overline{X}Y$$
$$= \underset{S_3}{XY(1)} + \underset{S_2}{X\overline{Y}(1)} + \underset{S_1}{\overline{X}Y(1)} + \underset{S_0}{\overline{X}\overline{Y}(0)}$$

$\therefore \boxed{S = 1110}$

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2. $AOI(a,b,c,d) = ((a \wedge b) \vee (c \wedge d))'$
$= ((ab) + (cd))'$

$ITE(v,g,h) = vg + v'h$

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$AOI = (ab+cd)' = (ab)'.(cd)'$
$= (a'+b')(c'+d')$
$= \underline{a'c'} + a'd' + \underline{b'c'} + b'd'$
$\underline{+ a.0 + b.0}$

$ITE(a,0,1) = a.0 + a'1 = a'$
$ITE(b,0,1) \rightarrow b.0 + b'1 = b'$
$ITE(c,0,1) = c.0 + c'1 = c'$
$ITE(d,0,1) = d.0 + d'1 = d'$

$ITE(a, 0, ITE(c,0,1))$
$= a \cdot 0 + a'c'$

$ITE(b, 0, ITE(c,0,1))$
$= b.0 + b'c'$

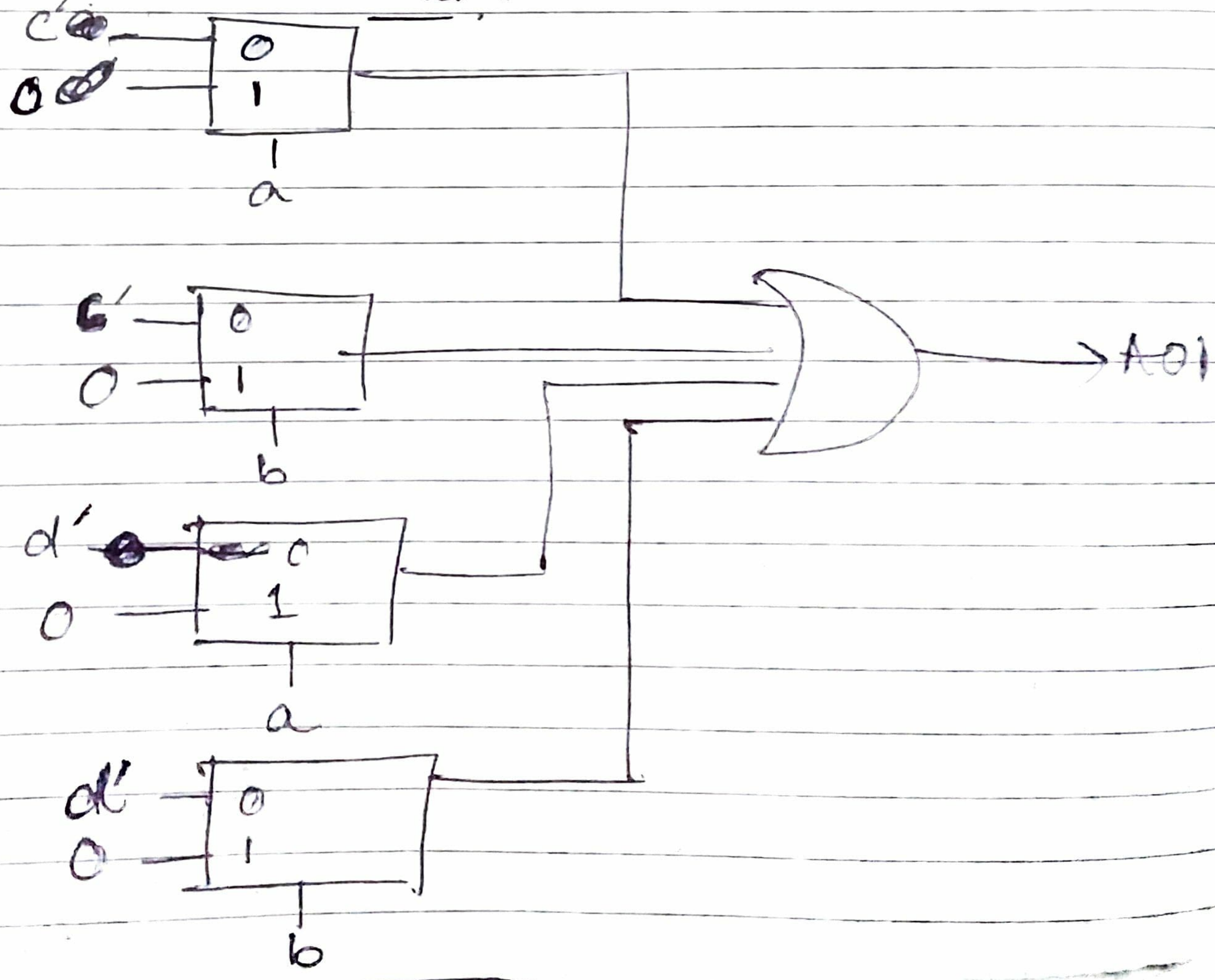
$ITE(a, 0, ITE(d,0,1))$
$= a.0 + a'd'$

$ITE(b, 0, ITE(d,0,1))$
$= b.0 + b'd'$

$$\therefore AOI = ITE(a,0,ITE(c,0,1))$$
$$+\ ITE(b,0,ITE(c,0,1))$$
$$+\ ITE(a,0,ITE(d,0,1))$$
$$+\ ITE(b,0,ITE(d,0,1))$$

$$AOI = (a\cdot 0 + a'c') + (b\cdot 0 + b'c') + (a\cdot 0 + a'd') + (b\cdot 0 + b'd')$$

2:1 MUX.



3. X = n bit unsigned binary no.

Let 2's complement of $X = P$.

Let $X = 0X_{n-2}X_{n-3} \ldots X_1X_0$

$$\therefore P = (\overline{0} \cdot \overline{X_{n-2}} \cdot \overline{X_{n-3}} \ldots \overline{X_1} \cdot \overline{X_0}) + \underbrace{00 \ldots 1}_{n-1 \text{ times}}$$

$$= \underbrace{11111 \ldots 1}_{n \text{ bits}} - 0X_{n-2}X_{n-3} \ldots X_1X_0 + \underbrace{00 \ldots 1}_{n-1 \text{ times}}$$

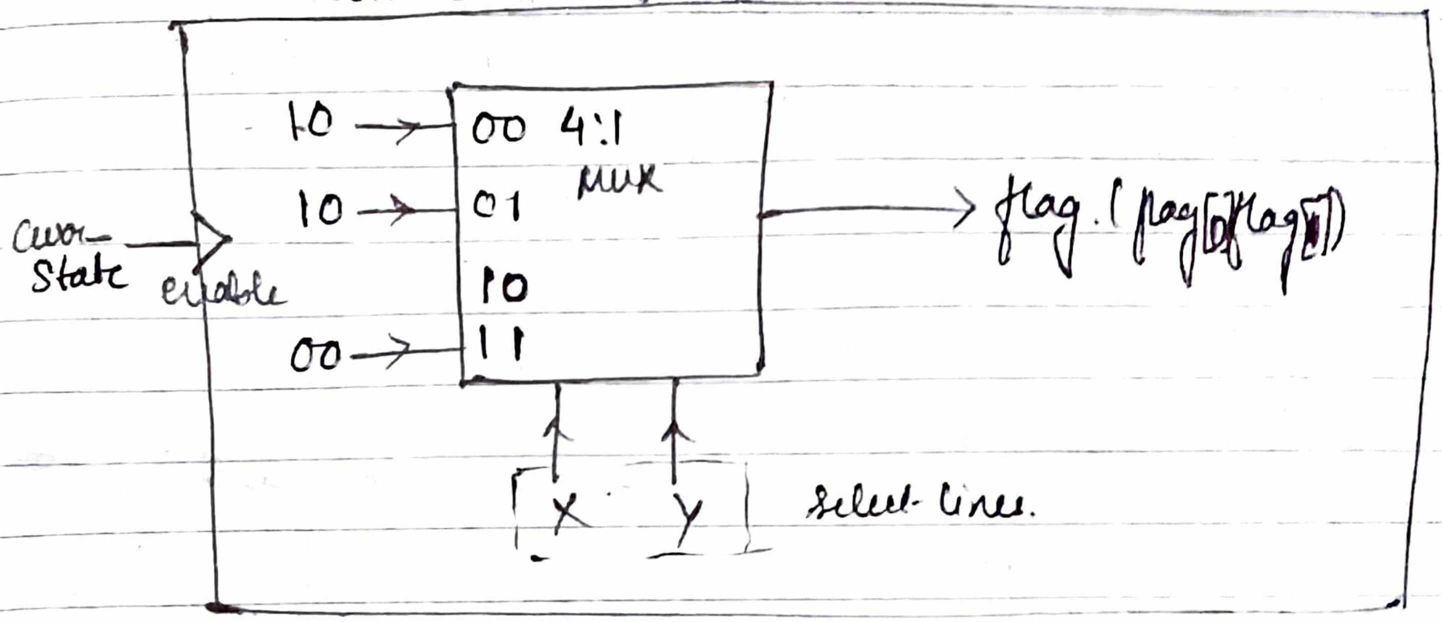
$$= \Big(\underbrace{10000 \ldots}_{n \text{ bits}} - \underbrace{000 \ldots 1}_{n-1 \text{ times}}\Big) - 0X_{n-2}X_{n-3} \ldots X_1X_0 + \underbrace{00 \ldots 1}_{n-1 \text{ times}}$$

$$= (2^n - \cancel{1}) - X + \cancel{1}$$

$$= 2^n - X$$

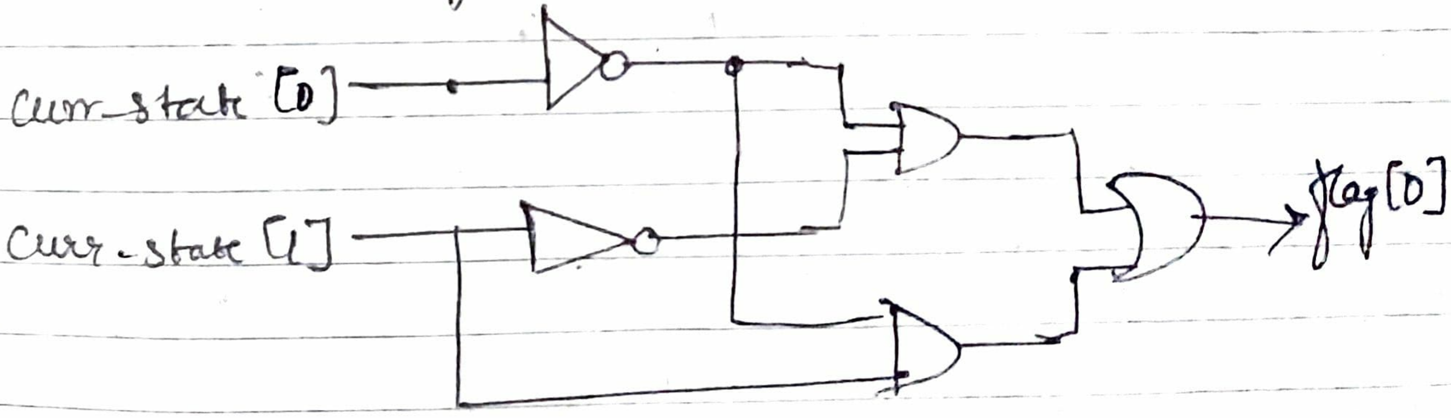
$\therefore P$ = 2's complement of X = $\underline{\underline{2^n - X}}$

5. Let curr_state [0] = X
curr_state [1] = Y



For the mux, $flag[0] = (curr\_state[0])'(curr\_state[1])' + (curr\_state[0])'(curr\_state[1])$

$flag[1] = 0$



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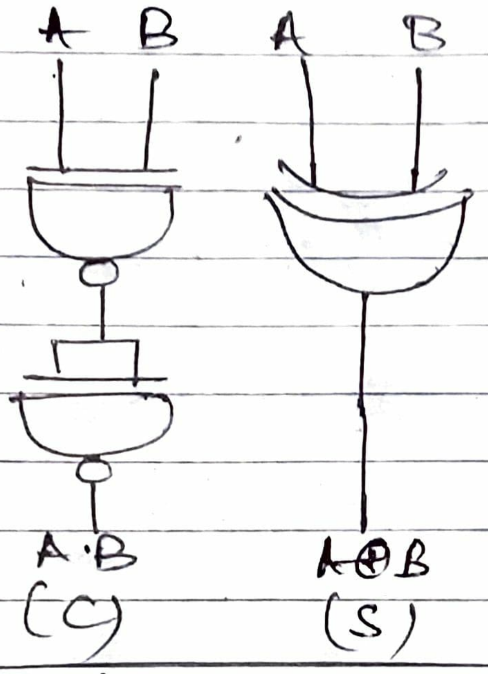
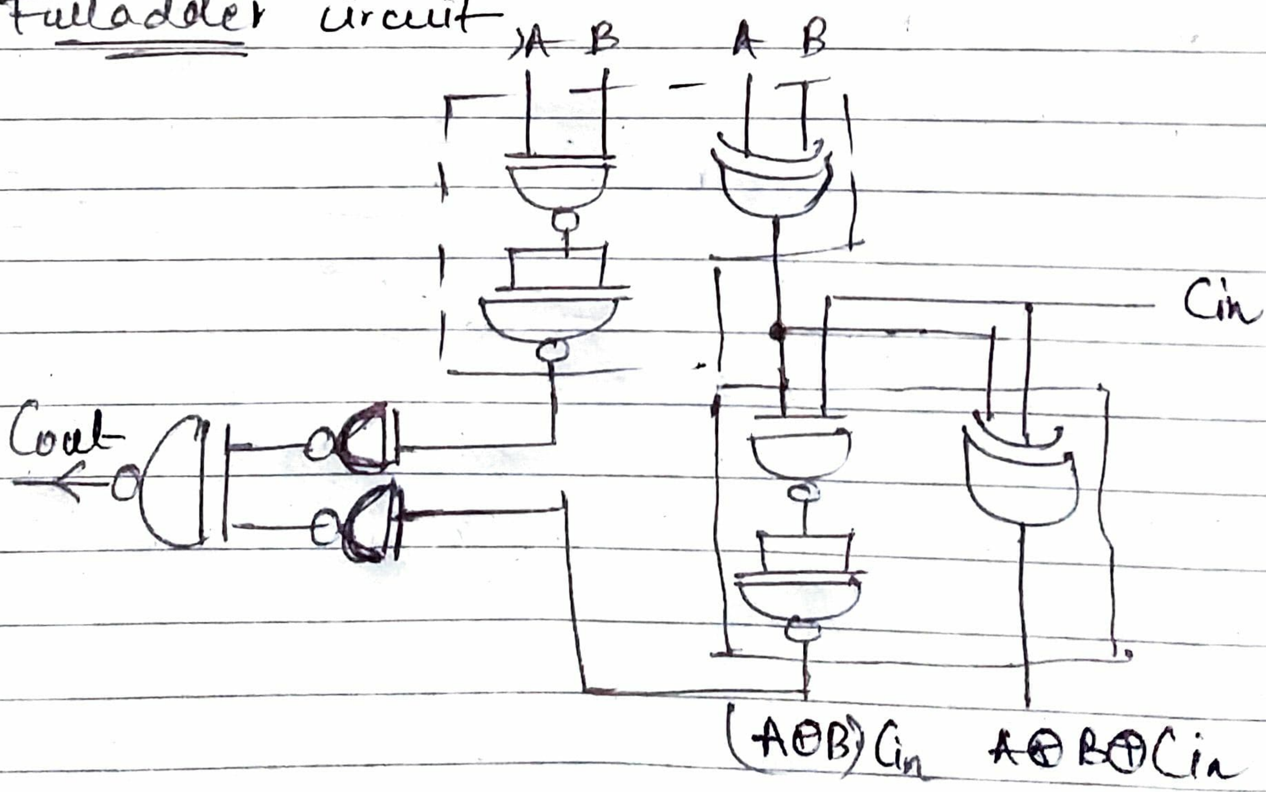
6. Half adder $S = A \oplus B = A \oplus B$
$C = A.B = ((AB)')'$
$= (A'+B')'$

Half adder circuit,



For OR gate
$= ((A+B)')'$
$= (A'B')'$

Fulladder circuit



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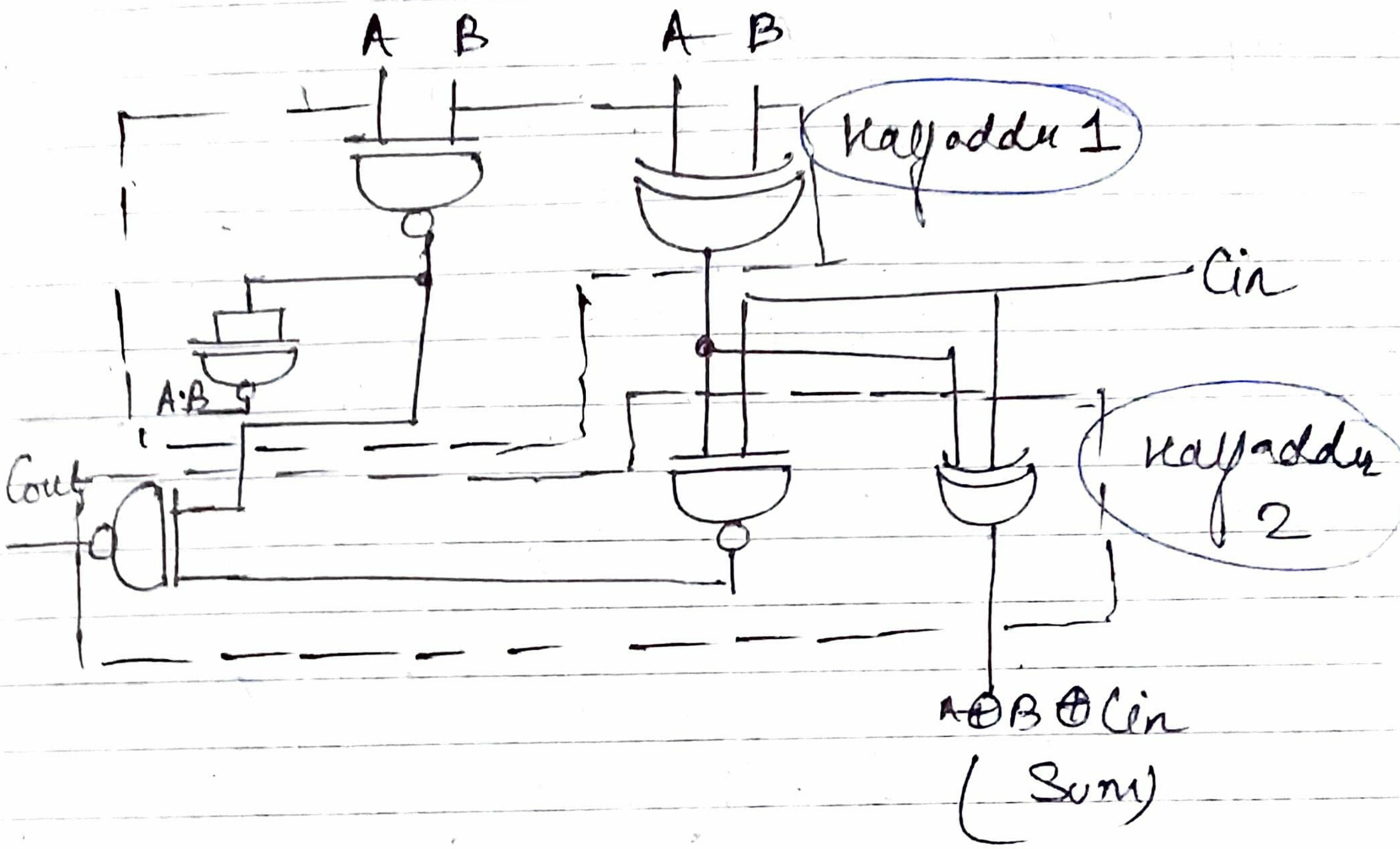
Optimised full adder,



Using 2 half Adder in full adder,

1 full adder has worst case delay

$\Rightarrow \boxed{t_{XOR} + 3t_{NAND}}$

$\therefore$ n bit RCA = n full adders

Total delay = $n(t_{XOR} + 3t_{NAND})$

7. (a)

$$c_{i+1} = g_i + \sum_{j=0}^{i-1} \prod_{k=j+1}^{i} g_j p_k + \left(\prod_{k=0}^{i} p_k\right) c_0$$

$$\boxed{c_{i+1} = g_i + p_i c_i}$$

(b)

$$c_{i+1}' = (g_i + p_i c_i)'$$

$$= (x_i y_i + (x_i \oplus y_i)\, c_i)'$$

$$= (x_i y_i)' \cdot [(x_i \oplus y_i)' + c_i']$$

$$= (x_i y_i)' [(x_i y_i' + x_i' y_i)' + c_i']$$

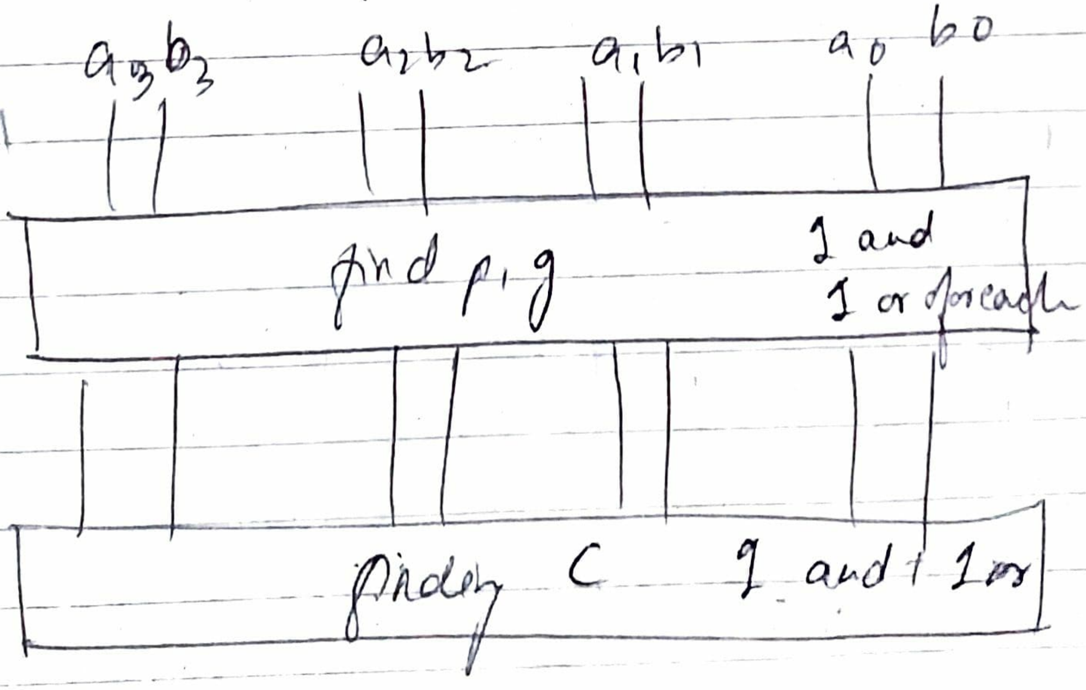
$$=$$

7. (c) $c_{i+1} = g_i + \sum_{j=0}^{i-1} \prod_{k=j+1}^{i} g_j p_k + \left(\prod_{k=0}^{i} p_k\right) c_0$

(d) (a) One OR gate with 3 inputs.

(b) i AND gates

(e)



for carry → 4 $\left(2\, t_{AND,2} + 2\, t_{OR,2}\right)$

7.(b)

$$\overline{C_{i+1}} = \left(x_i c_i + x_i y_i + y_i c_i\right)'$$

$$= (x_i c_i)' \cdot (x_i y_i)' (y_i c_i)'$$

$$= (x_i' + c_i')(x_i' + y_i')(y_i' + c_i')$$

$$= (x_i' + x_i' y_i' + c_i' x_i' + c_i' y_i')(y_i' + c_i')$$

$$= x_i' y_i' + x_i' c_i' + \cancel{x_i' y_i'} + \cancel{x_i' y_i' c_i'}$$
$$+ c_i' x_i' y_i' + \cancel{c_i' x_i'} + c_i' y_i'$$

$$= \underbrace{x_i' y_i'} + x_i' c_i' + x_i' y_i' c_i' + y_i' c_i'$$

$$= (x_i + y_i)' + x_i' c_i' (1 + y_i') + y_i' c_i'$$

$$= (x_i + y_i)' + x_i' c_i' + y_i' c_i'$$

$$= k_i^0 + (x_i' + y_i') c_i'$$

$$x_i \oplus y_i$$

$$= k_i^0 + \Big(x_i' y_i + \underbrace{x_i' y_i'}_{k_i} + y_i x + \overset{k_i}{y_i' x_i'}\Big) \quad c_i'$$

$$= k_i^0 + (k_i^0 + p_i^0)\, c_i'$$

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$$\therefore \boxed{\overline{C_{i+1}} = k_i + (k_i + p_i)\,\overline{C_i}}$$

4. Yes Booth's algo has advantage as

In ordinary add - subtract, Y is multiplied by each bit of X in sequence & the results are summed up so that X's contribution to the product P = XY is

$$\sum_{j=i-k}^{i-1} 2^j Y$$

Now in Booth's algo, it performs addition only on seeing $x_j x_{j-1} = 01$ which contributes to $2^j Y$ to P. It performs a subtraction at $x_{i-k} x_{i-k-1} = 10$ which contributes to $-2^{i-k} Y$ to P. Thus net contribution is

$$2^i Y - 2^{i-k} Y = 2^{i-k} Y (2^k - 1) Y$$

$$= 2^{i-k} \sum_{m=0}^{k-1} 2^m Y$$

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$$= \sum_{m=0}^{k-1} 2^{m+i-k} y$$