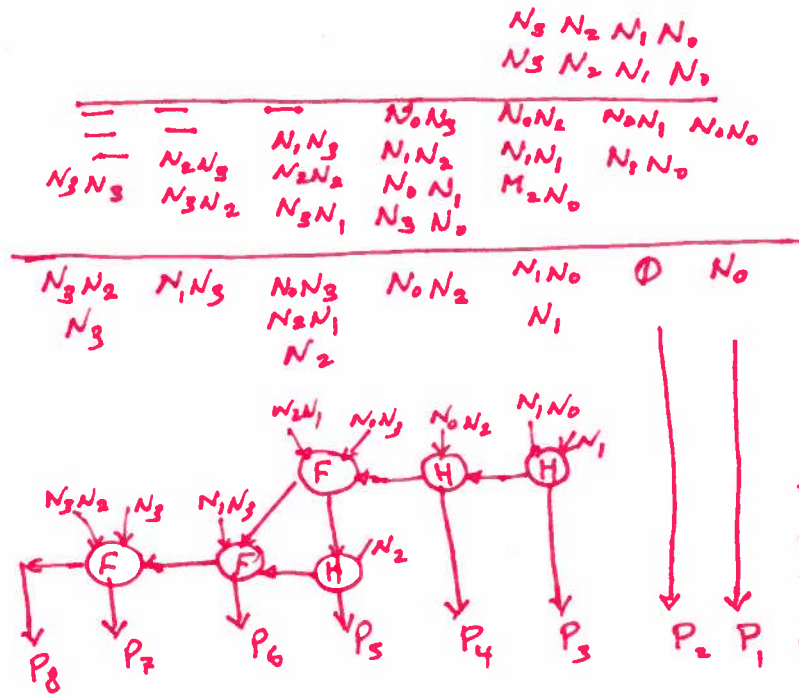


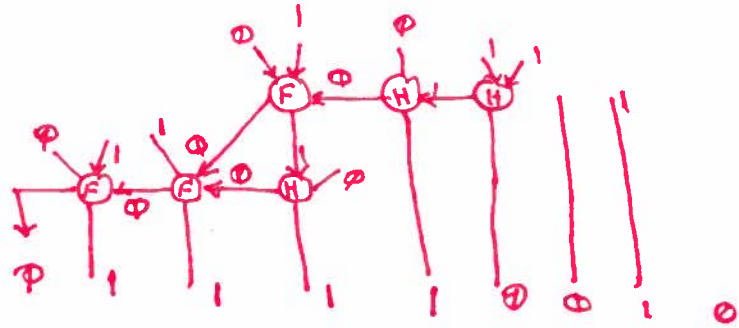
Q1 - $N = N_3 N_2 N_1 N_0$



Area = 3 Half Adders + 3 Full Adders + AND gates

Delay = $3 t_{ha} + 3 t_{fa} + \text{AND gate delay}$

Implementation of 1011



$$P = 011110010_2 = 242_{10}$$

check $11 * 11 = 121 * 2 = 242_{10}$

Q2)

let $P_i = A_i \oplus B_i$



$G_i = A_i \cdot B_i$



$S_i = P_i \oplus C_i$



$C_{i+1} = G_i + P_i \cdot C_i$

$i = 0$

$C_1 = G_0 + P_0 \cdot C_0 = A_0 \cdot B_0 + P_0 \cdot C_0 = G_0 + P_0 \cdot C_0$

$i = 1$

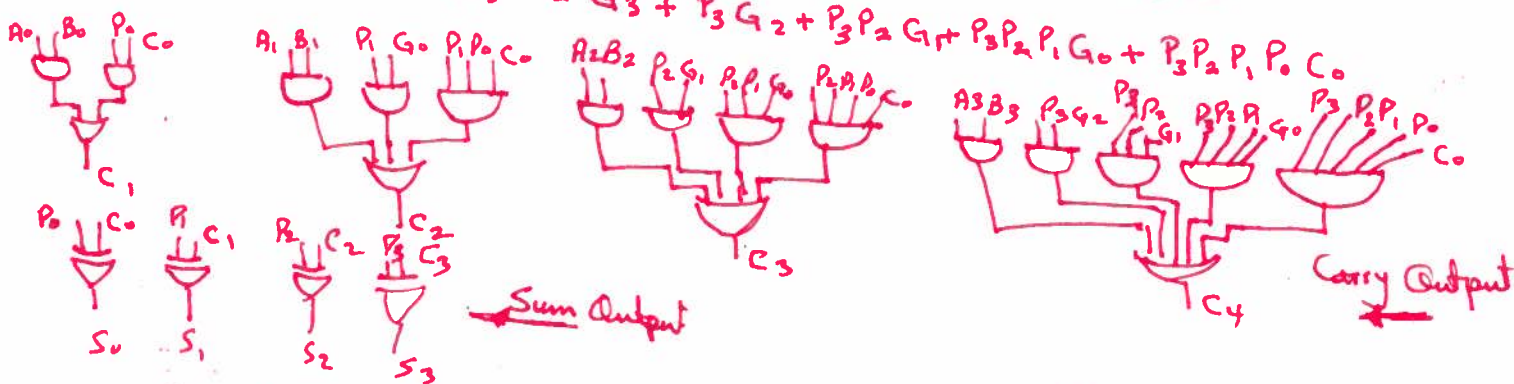
$C_2 = G_1 + P_1 \cdot C_1 = A_1 \cdot B_1 + P_1 \cdot (G_0 + P_0 \cdot C_0) = G_1 + P_1 \cdot G_0 + P_1 \cdot P_0 \cdot C_0$

$i = 2$

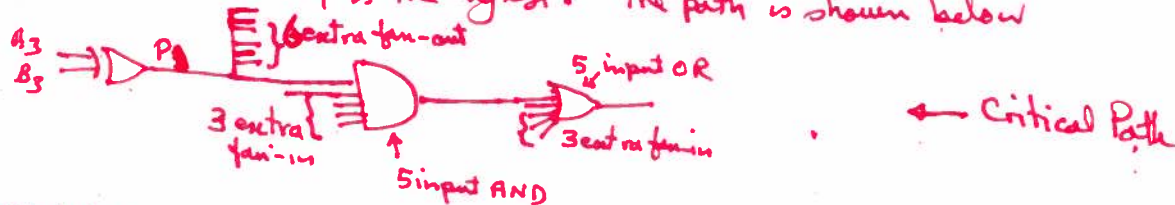
$C_3 = G_2 + P_2 \cdot C_2 = G_2 + P_2 \cdot G_1 + P_2 \cdot P_1 \cdot G_0 + P_2 \cdot P_1 \cdot P_0 \cdot C_0$

$i = 3$

$C_4 = G_3 + P_3 \cdot C_3 = G_3 + P_3 \cdot G_2 + P_3 \cdot P_2 \cdot G_1 + P_3 \cdot P_2 \cdot P_1 \cdot G_0 + P_3 \cdot P_2 \cdot P_1 \cdot P_0 \cdot C_0$



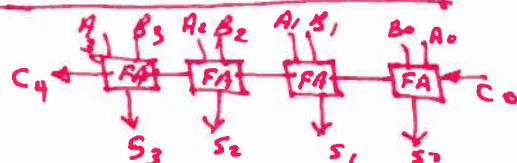
Delay associated with C_4 is the highest. The path is shown below



Total Delay = $\underbrace{3}_{\text{gate}} + \underbrace{5 \times \frac{1}{3}}_{\text{fan-out}} + \underbrace{3 \times \frac{1}{3}}_{\text{fan-in}} + \underbrace{3 \times \frac{1}{3}}_{\text{fan-in}} = 8.0 \tau_g$

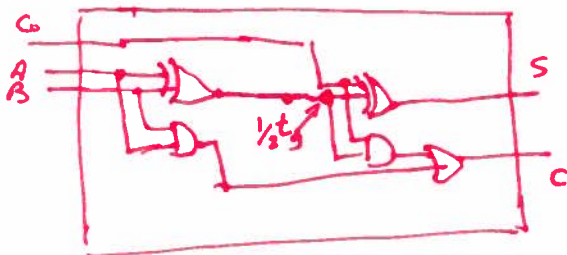
In Comparison the 4-bit Carry Ripple Adder

Total Delay = 4 full Adder



$T_{FA \text{ delay}} = 3 \tau_g + \frac{1}{2} \tau_g = 3.5 \tau_g$

Total Delay = $4 \times 3.5 = 14.0 \tau_g$



Q3 COEN 6501 Midterm 2014

You may design a 8-state FSM with don't cares or go for a 4-state FSM with decoder for the output which is the simplest as we follow:

state diagram



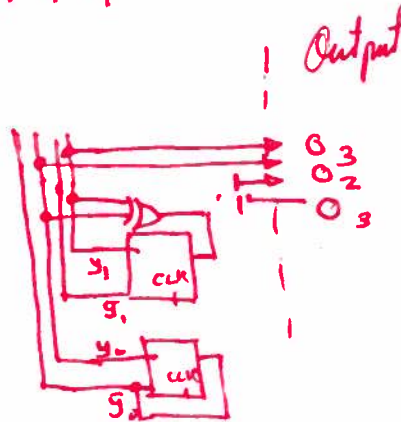
states $y_1 y_0$	Next state $y_1^+ y_0^+$	Output $O_3 O_2 O_1$
00	01	001
01	10	011
10	11	101
11	00	111

From state table directly the next states and the outputs can be read as:

$$y_1^+ = y_1 \oplus y_0 \quad O_3 = y_1$$

$$y_0^+ = \bar{y}_0 \quad O_2 = y_0$$

$$O_1 = 1$$



Alternatively you might want to design a 8-bit FSM with don't care states. Assuming states 000, 010, 100, 110 never happen.

$y_2 y_1 y_0$	$y_2^+ y_1^+ y_0^+$
000	xxx
001	011
010	xxx
011	101
100	xxx
101	111
110	xxx
111	001

Giving $y_2^+ = y_1 \oplus y_0$

$$y_1^+ = \bar{y}_1$$

$$y_0^+ = 1$$

