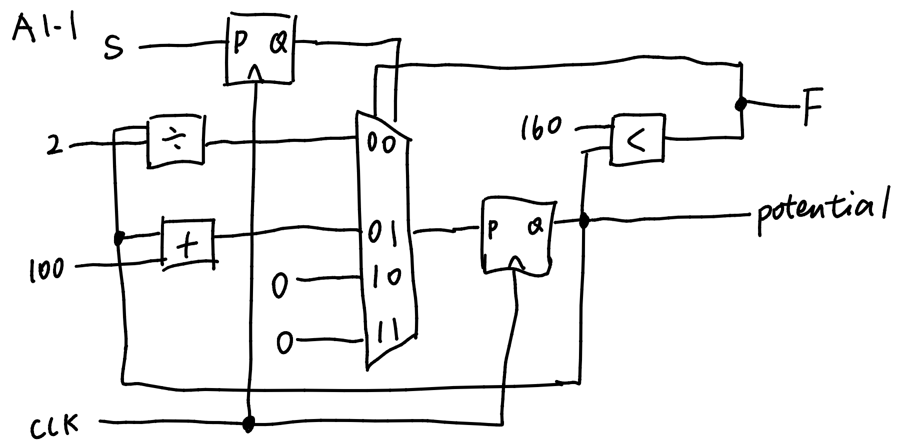
Homework 3 Part A

2022年10月8日 13:46

A1-1



A2.1

(i) $+ / \div$: t_{pd} / t_{cd}.

multiplyer : $5t_{pd} / 5t_{cd}$.

(a) original : $\Sigma t_{pd} = 2t_{pd} + 5t_{pd} = 7t_{pd}$.

$$f_{max} = \frac{1}{t_{pcq} + t_{setup} + \Sigma t_{pd}} = \frac{1}{t_{pcq} + t_{setup} + 7t_{pd}}$$

(b) pipelined : $\Sigma t_{pd} = t_{pd} + 5t_{pd} + t_{pd} = 7t_{pd}$.

$$f_{max} = \frac{1}{t_{pcq} + t_{setup} + \Sigma t_{pd}} = \frac{1}{t_{pcq} + t_{setup} + 7t_{pd}}$$

(ii) (a) infinite slow

(b) infinite slow

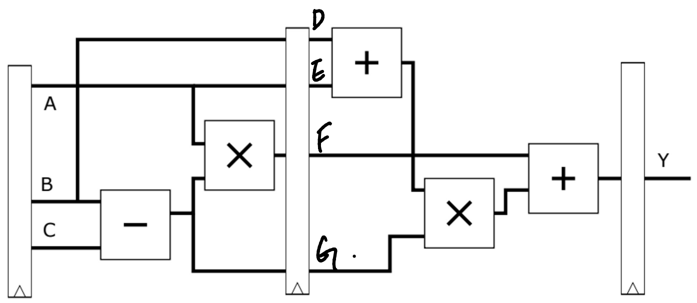
(iii) (a) throughput = $f_{max} = \frac{1}{t_{pcq} + t_{setup} + 7t_{pd}}$

(b) throughput = $f_{max} = \frac{1}{t_{pcq} + t_{setup} + 7t_{pd}}$.

(iv) (a) latency : 1 cycle

(b) latency : 2 cycle.

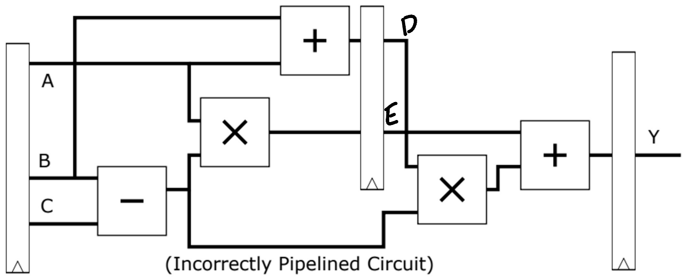
A2.2.



(Pipelined Circuit)

$$Y = [D(n-1) + E(n-1)] \times G(n-1) + F(n-1)$$

$$Y = [B(n-1) + A(n-1)] \times [B(n-1) - C(n-1)] + A(n-1) \times [B(n-1) - C(n-1)]$$



(Incorrectly Pipelined Circuit)

$$Y = D(n-1) \times [B(n) - C(n)] + E(n-1)$$

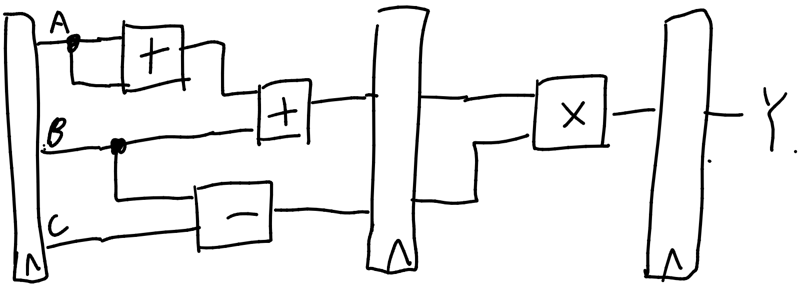
$$Y = [A(n-1) + B(n-1)] \times [B(n) - C(n)] + A(n-1) \times [B(n-1) - C(n-1)]$$

$\Rightarrow$ sequence doesn't match.

A2.3. $Y = A(B-C) + (B-C)(A+B)$

$Y = (B-C)[A+A+B]$

$Y = (B-C)(2A+B)$



$$\text{throughput} = f_{max} = \frac{1}{t_{pcq} + 5t_{pd} + t_{setup}}$$

A3. MTBF = 1 year $\rightarrow$ 50 year

System = 1GHz

$\tau = 100ps$

$T_0 = 110\ ps$

$t_{setup} = 70ps$

new asyn 4 times/sec 0.5 times/sec

$$P(\text{failure})/\text{sec} = N \frac{T_0}{T_c} e^{\frac{T_c - t_{setup}}{\tau}}$$

$$MTBF = \frac{1}{P(\text{failure})/\text{sec}}$$

$$P(\text{failure})/\text{sec} = \frac{1}{MTBF} = \frac{1}{1 \times 365 \times 24 \times 3600 \text{ sec/year}}$$

$$P(\text{failure})/\text{sec} = 3.17 \times 10^{-8}$$

$\therefore$ The required probability of failure satisfy MTBF is 3.17×10^{-8}

The waiting time of P(failure)/sec for one cycle $= N \frac{T_0}{T_c} e^{\frac{T_c - t_{setup}}{\tau}}$

$= 4 \times \frac{110}{1000} \times e^{-\left(\frac{1000-70}{100}\right)}$

$= 4.02 \times 10^{-5}$

TWO cycle: $4 \times \frac{110}{1000} \times \left[e^{-\left(\frac{1000-70}{100}\right)} \right]^2$

$= 3.68 \times 10^{-9}$

$\therefore$ when two cycle, the resut is less than 3.17×10^{-8}, so two cycles are sufficient to gather the MTBF.

A4.1 $\Sigma t_{pd} = 1500 + 3 \times 450 = 2850$ ps

$f_{max} = \frac{1}{\Sigma t_{pd} + t_{pcq} + t_{setup}}$

$= \frac{1}{2850 + 69 + 45}$

$= 3.37 \times 10^8 Hz$

A4.2. $T_c = \frac{1}{300 \times 10^6}$

$T_c \geq t_{pcq} + \Sigma t_{pd} + t_{setup} + t_{skew}$

$\frac{1}{300 \times 10^6} \times 10^{12} \geq 69 + 2850 + 45 + t_{skew}$

$t_{skew} \leq 369.33$ ps

$\therefore t_{skew}$ max $= 369.33$ ps

A4.3. $\Sigma t_{pd} = 450 \times 4 = 1800$ ps

$f_{max} = \frac{1}{\Sigma t_{pd} + t_{pcq} + t_{setup}}$

$= \frac{1}{1800 + 69 + 45} \times 10^{12}$

$= 5.22 \times 10^8$ Hz

A4.4. Connect (1 to 3) $T_c \geq t_{pcq} + \Sigma t_{pd} + t_{setup} + t_{skew}$

$T_c \geq 69 + 1500 + 45 + t_{skew}$

$T_c \geq 1614 + t_{skew}$ ps

Connect (2 to 3) $T_c \geq t_{pcq} + \Sigma t_{pd} + t_{setup} + t_{skew}$

$T_c \geq 69 + 3 \times 450 + 45 + t_{skew}$

$T_c \geq 1464 + t_{skew}$ ps

Connect (2 to 2) $T_c \geq t_{pcq} + \Sigma t_{pd} + t_{setup} + t_{skew}$

$T_c \geq 69 + 4 \times 450 + 45 + t_{skew}$

$T_c \geq 1914$ ps

$\therefore$ Thus, whether connect clk1 or clk2 with clk3 can always maximize the frequency. The skew is between $-100ps \le t \le 100ps$, so either connect 1 to 3 or 2 to 3 will be 1714 ps and 1564 ps both less than 1914 ps with the fmax of $5.22 \times 10^8 Hz$.

A4.5. The maximum ney can be achieved by when the Σtd only contains mutiplier.

$$\therefore f_{max} = \frac{1}{\Sigma t_{pd} + t_{pcq} + t_{se}}$$

$$= \frac{1}{1500 + 69 + 45} \times 10$$

$$= 6.20 \times 10^8 \ Hz.$$