# Free Study Material from All Lab Experiments

## Electronics
## for NET/Gate Physical Sciences
## # Logic Families # Oscillators

# Logic Families

These are the technologies which are used to impliment the logic function.

Logic Families

→ Saturated

→ Non-Saturated

**Saturated**

Those logic familyes in which the devices inters into saturation region.

→ RTL (Resistor Transistor Logic)

→ DCTL (Direct Coupled Transistor Logic)

→ $I^2L$ (Integrated Injected Logic)

→ DTL (Diode Transistor Logic)

→ HTL (High threshold transistor Logic)

→ TTL ( Transistor-Transister Logic)

**Non-Saturated**

Device does not enters in the saturation region.

→ ECL [Emitter Coupled Logic]

→ CMOS [Complementary metal oxide semiconductor technology]

* Characteristic parameters of Logic families :-

① Time propagation delay

② Power dissipation

③ figure of merit (FOM)

④ Fan in

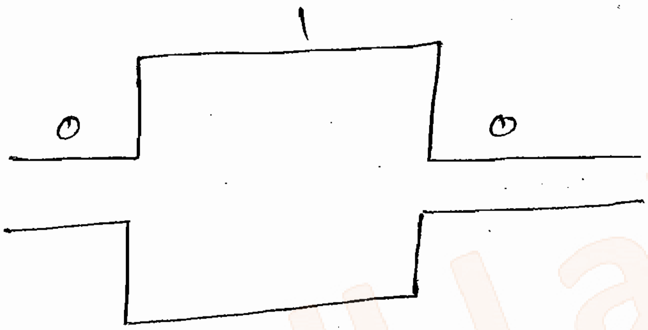
⑤ Fan Out

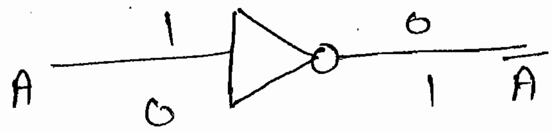
(6) Nois Margin

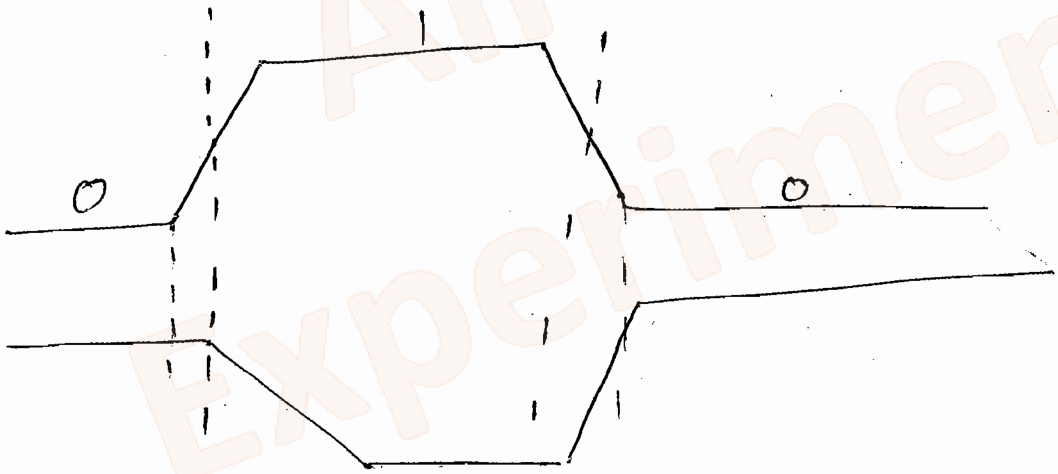
(7) Hised Logic

## (1) Time Propagation Delay :-

It is the delay offered by per logic gate normally measured in nano second.




Delay is offered in the logic gate during the transition from high to low or low to high

Imp. ⇒ Fastest Logic family is ECL, HTL is slowest.

② Power Dissipation :-

Power expenditure inside the logic gate to produce o/p.

CMOS has minimum power dissipation.

ECL has maximum power dissipation.

③ Figure of Merit (FOM) :-

Figure of Merit = Power dissipation (n.s) x power dissipation delay (m.W)

Unit → Pico Joule.

Figure of merit must be as low as possible.

$I^2L$ has best figure of merit

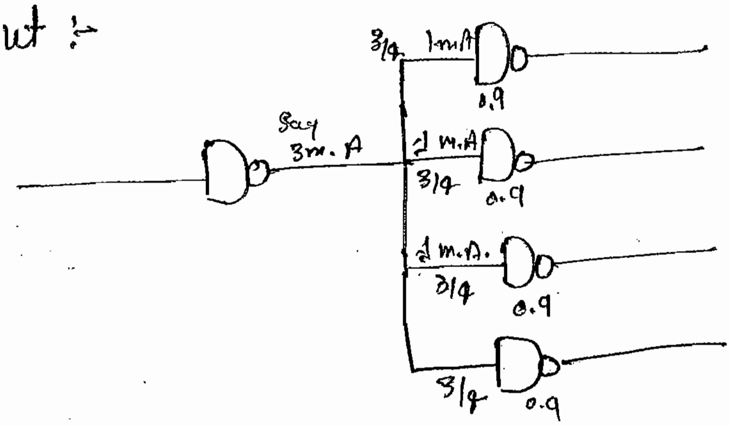
HTL has worst figure of merit.

imp.

④ Fan in :-

Maximum no. of i/p's that can be applied to a logic gate.

⑤ Fan Out :-

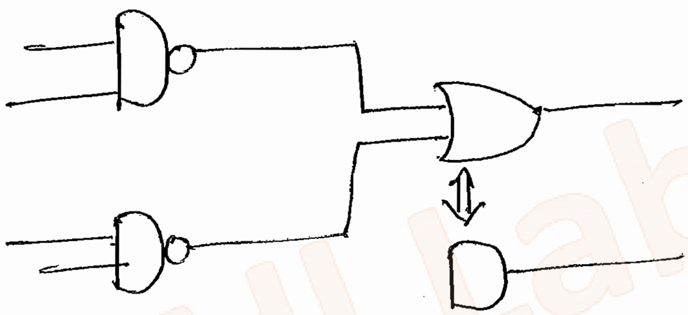


The output of one logic gate can be applied as input to the maximum no. of logic gate of same type is called as Fan Out.

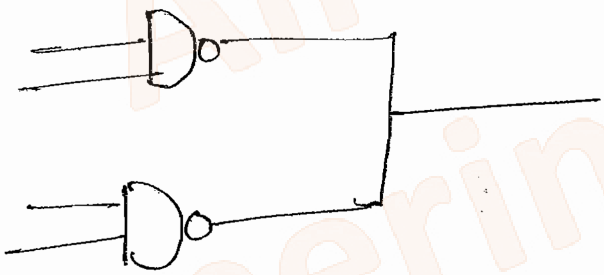
CMOS : Maximum Fan Out

RTL : Minimum Fan Out.

## ⑥ Wired Logic :-



But



The output of two logic gate are joint at a point that point will behave as either OR-gate or AND-gate.

Only ECL behave as wired-OR rest all other logic behave as wired-AND.

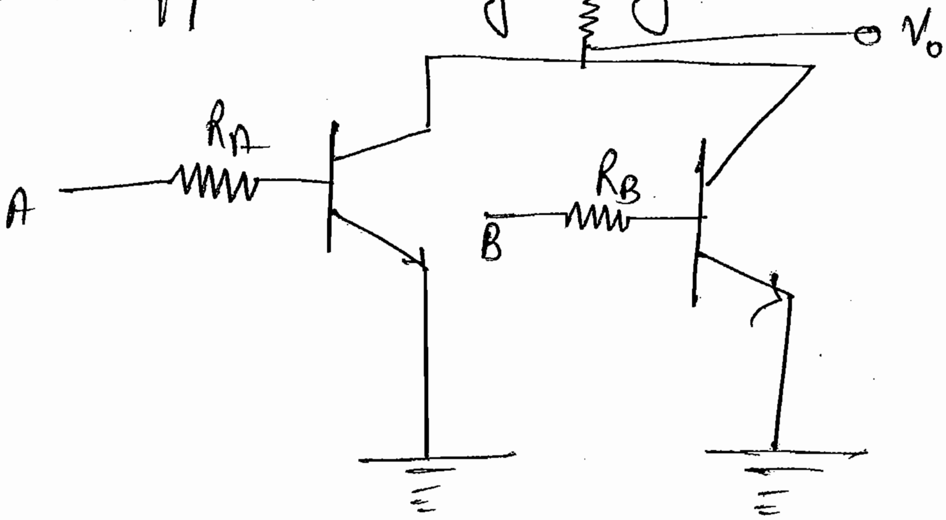
## ⑦ Noise Margin :-

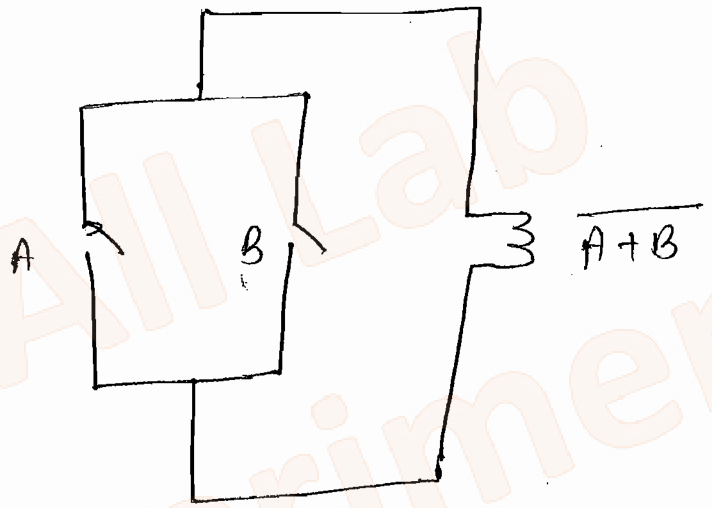
Maximum amount of noise added at the input so that it should not affect the output is called Noise Margin.

HTL ⇒ Best Noise Margin.

RTL ⇒ Worst Noise Margin

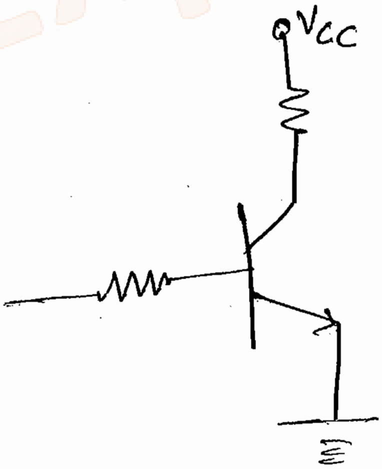
Q. Identify the logic gate.

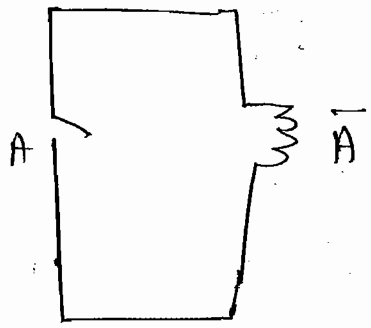



= Not gate.

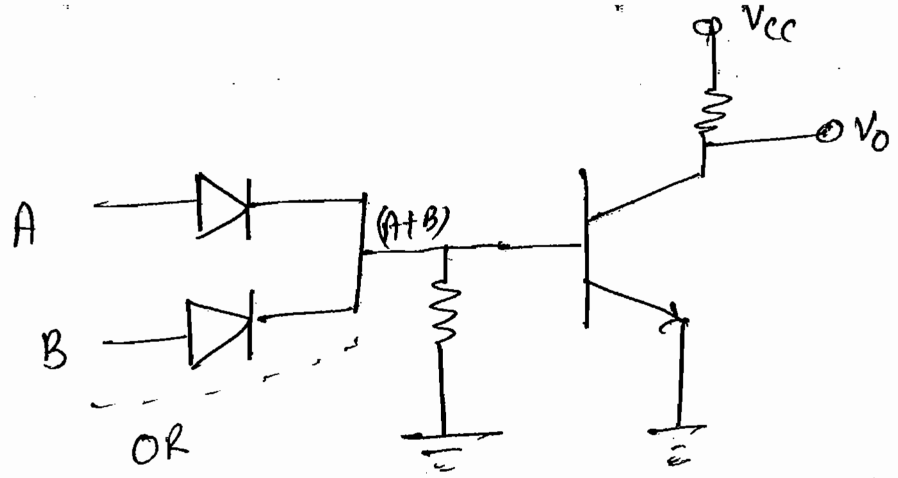
Q. Identify the logic gate.

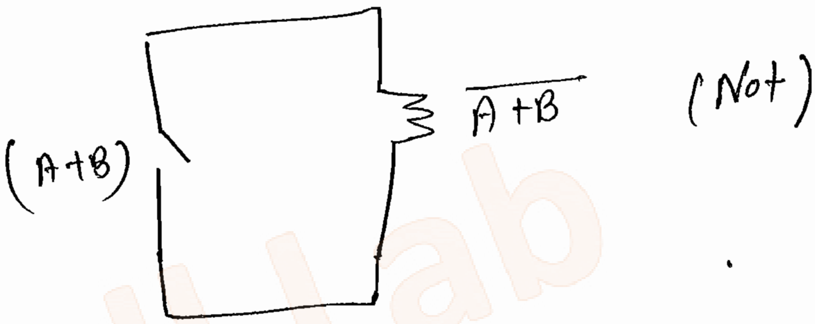


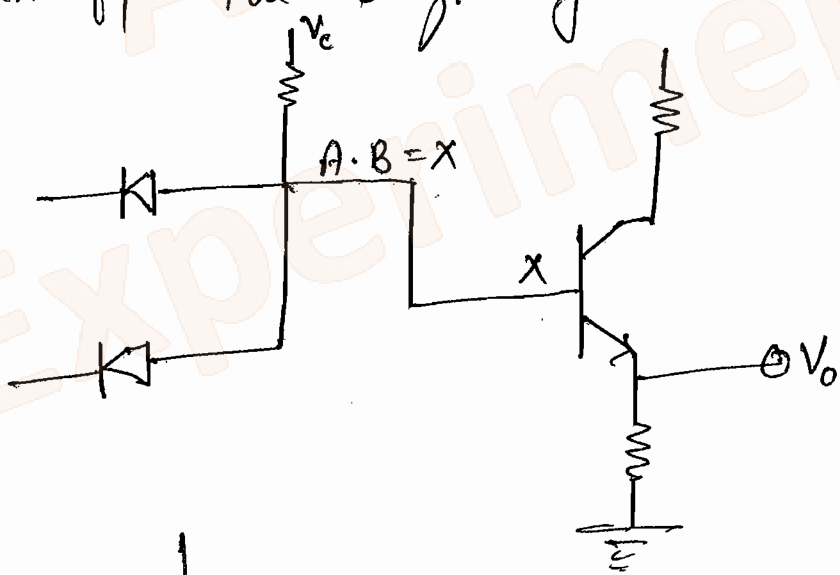

Not.

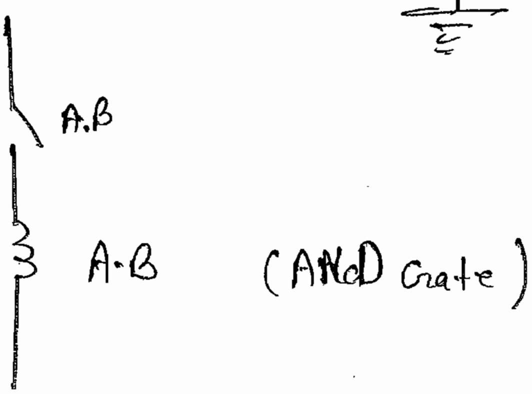
Q.




Q. Identify the logic gate



| Parameters | RTL/DTL | $I^2L$ | DTL | HTL | TTL | ECL | CM |
|---|---|---|---|---|---|---|---|
| Time propagation Delay | | | | Slowest | | fastest | |
| Power Dissipation | | | | | | Max | Min |
| FOM | | | | | | | |
| Fan out | | | | | | | |
| Noise Margin | | | | | | | |
| Wired Logic | | | | | | | |
| Basic gate | | | | | | | |

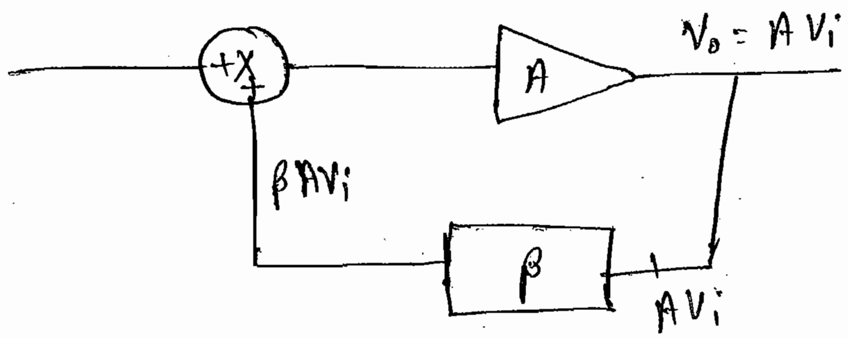
# Oscillators

Those circuit which produces sustained oscillations are called as oscillators.

Oscillators

- Sinusoidal
  - Low freq. Osci. [Audio freq.]
    - → R-C phase shift Oscillator
    - → Wein's Bridge Oscillator
  - High freq. Osci. [Radio freq.]
    - → Heartly Oscillator
    - → Collpits Oscillator
- Relaxation Oscillator

In an oscillator always +ve feedback is used.




$\because \frac{V_o}{V_{in}} = A$

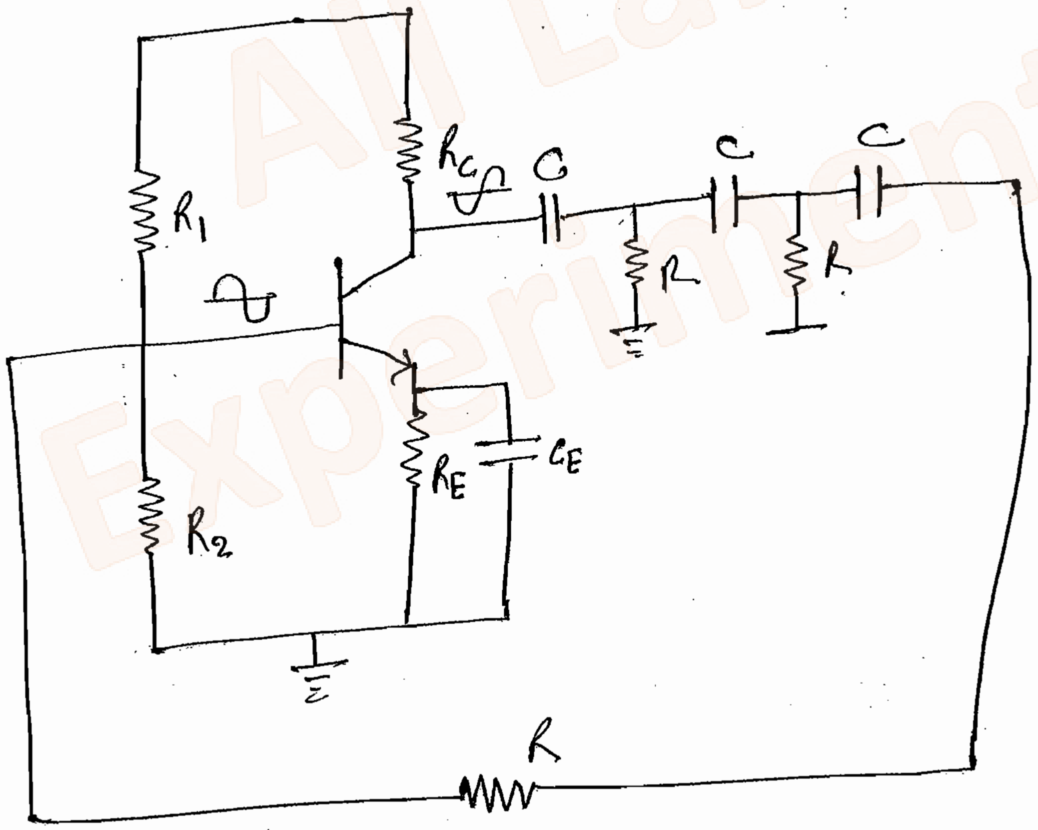
$V_o = AV_i$

Oscillator works without any external applied input.

Any disturbance (Noise) at the input may produce sustained oscillation.

Only if $|A\beta| = 1$ is also called Barkhausen Criteria.

## * R-C Phase Shift Oscillator :-




The output of the common emitter configuration produces the phase shift of 180° the additional 3 R-C stages are used to provide a phase shift of additional 180° so that overall phase shift become 360° (0°).

So each R-C stage will provide 60°. phase shift.

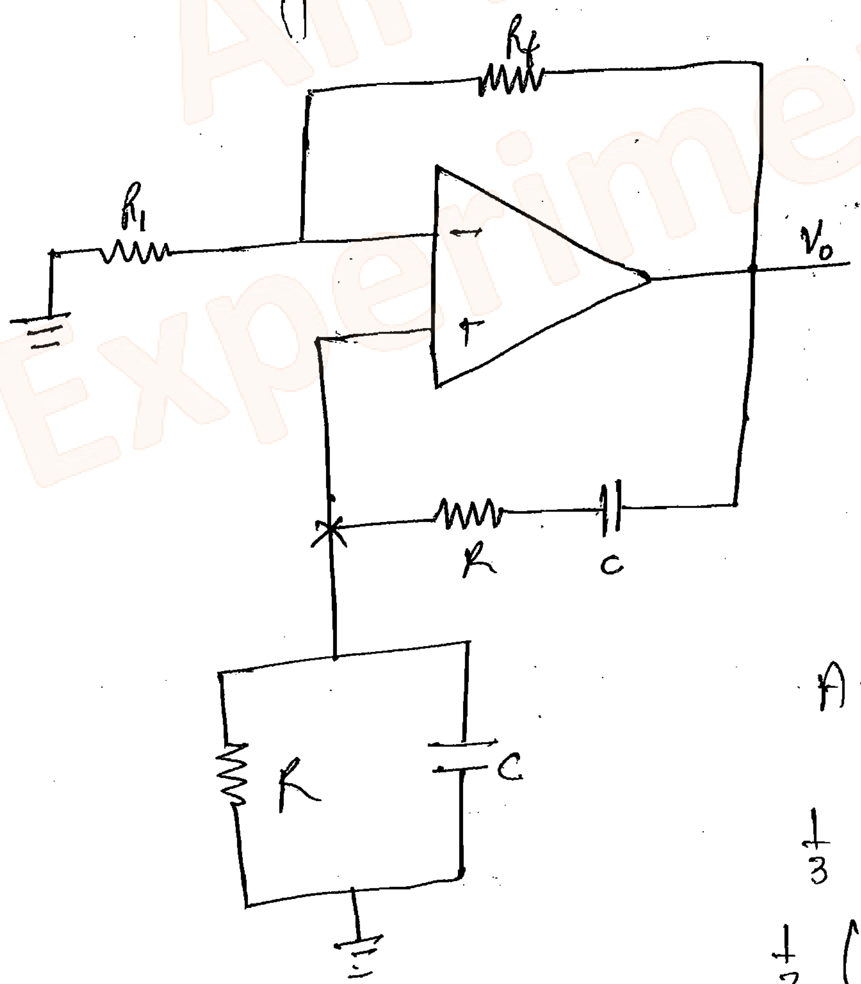
Expression for R-C phase shift:-

$$f_0 = \frac{1}{2\pi RC\sqrt{6 + 4\frac{R_c}{R}}}$$

when we can not use transistor then $R_c = 0$

$$f_0 = \frac{1}{2\pi RC\sqrt{6}}$$

* Wein's Bridge Oscillator:-




$A = 1 + \frac{R_f}{R_1}$

$\frac{1}{3} A \geq 1$

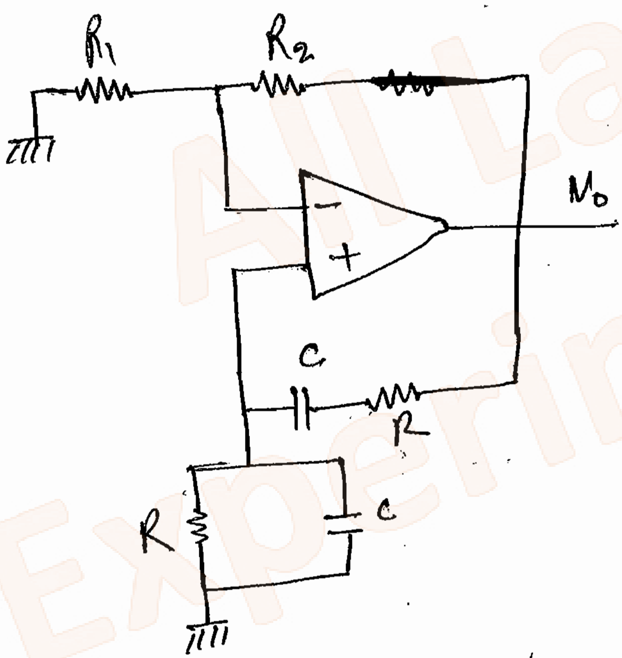
$\frac{1}{3}\left(1 + \frac{R_f}{R_1}\right) \geq 1$

$\omega = \frac{1}{RC}$ , $f = \frac{1}{2\pi RC}$

So $f_0 = \frac{1}{2\pi RC}$

B.A.
Q.59

Sol^n




$C = 0.01 \mu f$

$R_1 = 12 k\Omega$

$f_0 = 300 Hz$

$\because f_0 = \frac{1}{2\pi RC}$

$R = \frac{1}{2\pi f_0 C} = \frac{1}{2\pi \times 300 \times 0.01 \mu F}$

$= \frac{10^8}{300 \times 2\pi} = \frac{10^6}{6\pi}$

$=$ ~~530 kΩ.~~ $53 \times 10^3 \Omega$

$R = 53 k\Omega$

$$\frac{1}{3} A \geq 1$$

$$\frac{1}{3}\left(1+\frac{R_2}{R_1}\right) = 1 \qquad \text{(Worst Case)}$$

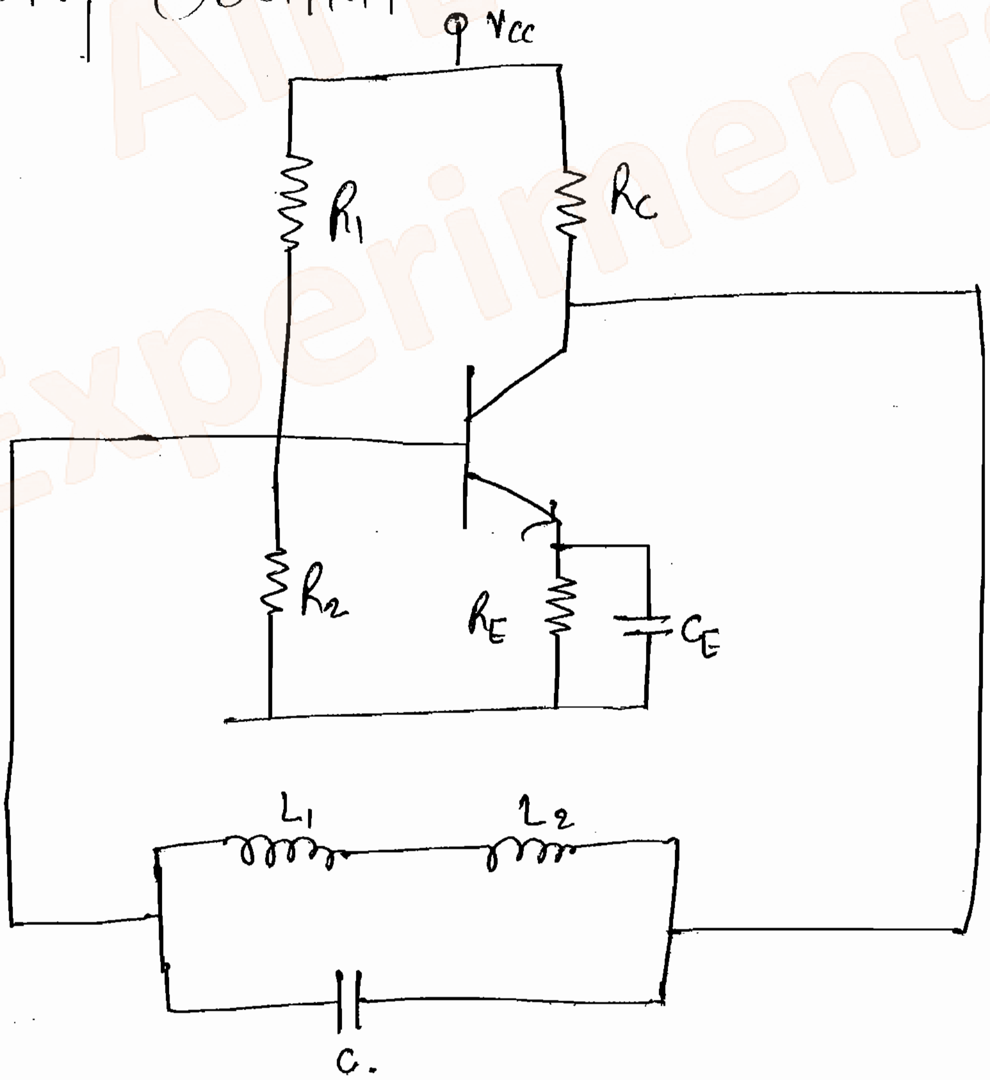
$$1+\frac{R_2}{R_1} = 3$$

$$\frac{R_2}{R_1} = 2$$

$$\frac{R_2}{12} = 2$$

$$\boxed{R_2 = 24} \quad \underline{\text{Ans}}$$

## * Heartly Oscillator :-



The output of C.E. Configuration provides a phase shift of 180° additional ~~phase shift~~ ~~at~~ tank circuit is used so that it can provide a phase shift of 180°. To provide sustained oscillation.

$$X_L = X_C$$

$$\omega L = \frac{1}{\omega C}$$

$$\omega^2 = \frac{1}{L \cdot C}$$

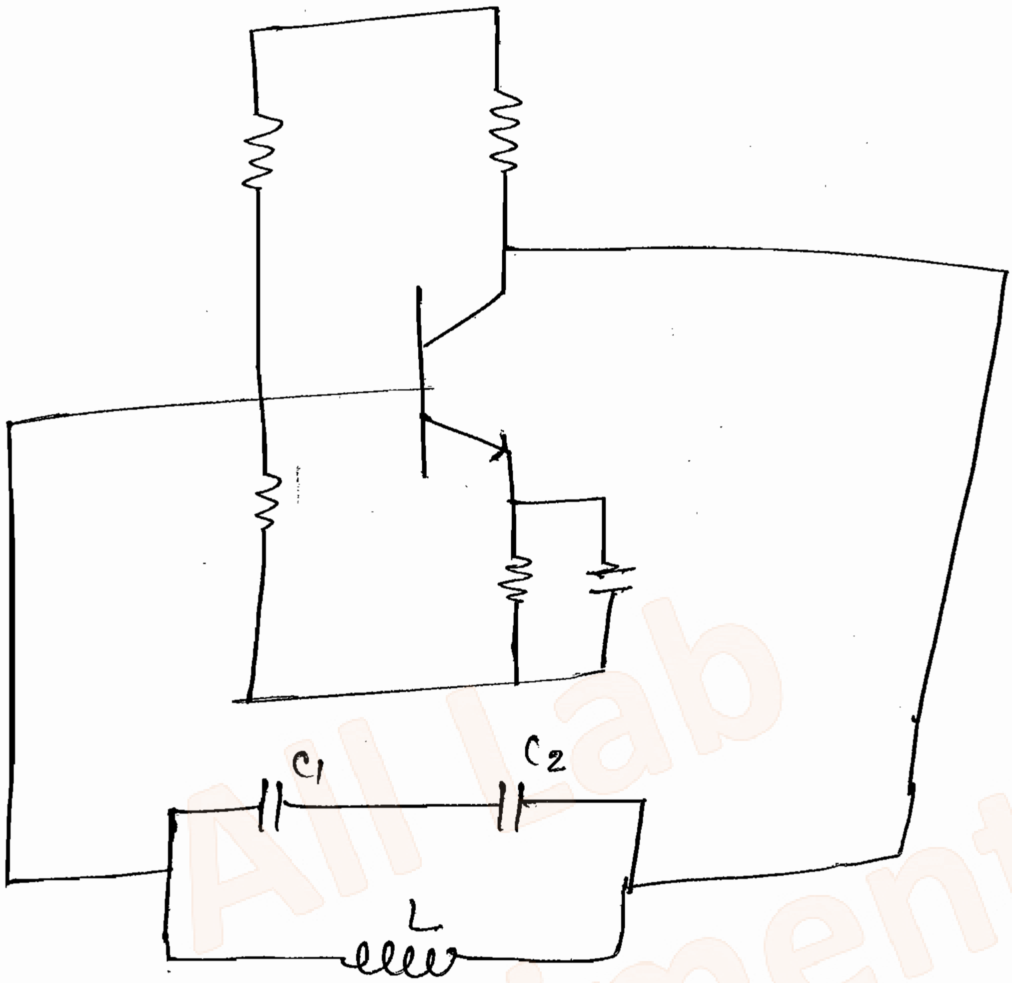
$$\omega = \frac{1}{\sqrt{LC}}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_0 = \frac{1}{2\pi\sqrt{L_{eq} \cdot C_{eq}}}$$

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{(L_1+L_2)C}}}$$

# Collpits Oscillator :-




$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{L_{eq}}\cdot\frac{1}{C}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{L_{eq}}\cdot\frac{1}{C_{eq}}}$$

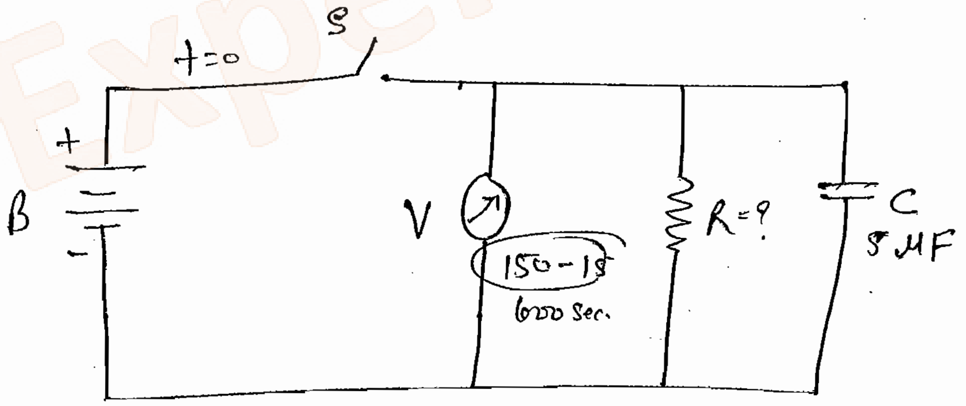
$$\boxed{f_0 = \frac{1}{2\pi}\sqrt{\left(\frac{1}{C_1}+\frac{1}{C_2}\right)\frac{1}{L}}}$$

| | |
|---|---|
| RC phase Shift | $f_0 = \frac{1}{2\pi RC\sqrt{6+4\frac{R_C}{R}}}$ |
| Hein's Bridge | $f_0 = \frac{1}{2\pi RC}$ |
| Heartly | $f_0 = \frac{1}{2\pi\sqrt{(L_1+L_2)C}}$ |
| Collpits | $f_0 = \frac{1}{2\pi\sqrt{\left(\frac{1}{C_1}+\frac{1}{C_2}\right)\frac{1}{L}}}$ |

Net-2013

Q. 85

Sol$^n$




$$\omega = \frac{1}{RC}$$

$$T = \frac{1}{\omega} = RC \quad \left\{ \text{time} \propto \frac{1}{\text{cut-off freq.}} \right\}$$

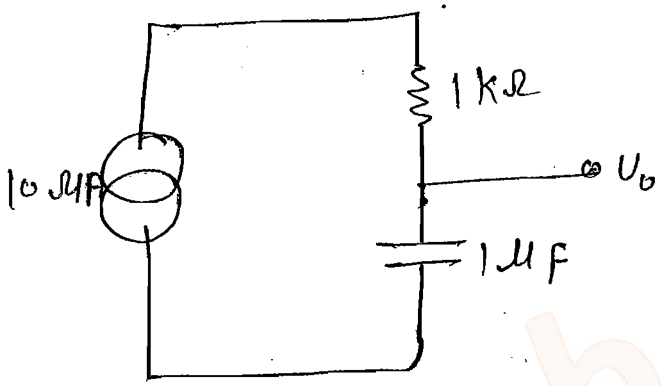
$$\boxed{T = RC}$$

$$R = \frac{1000}{5\mu F} = 2\times10^{8} \approx 10^{8}\,\Omega$$

B.A.

## Q.77

Soln




$T = RC$

$= 1\,k\Omega \times 1\,\mu F = 1 \times 10^{-3} = $ 1 milisecon.

A

B.A.

## Q.85

Second Method

$V = 15$

$T = 1000$

$C = 5\,\mu F$

$R = ?$

$Q = CV$

$Q = 5\,\mu F \times 15$

$= 75\,\mu C$

$Q = it$

$i = \frac{Q}{t} = \frac{75\,\mu C}{1000}$

$I = 75\,m.A.$

$R = \frac{15}{75} \times 10^{9} = 2 \times 10^{8}.$

A

# * Consenses Theorem :-

$$Y = AB + BC + \bar{A}C$$

$$Y = AB + BC(A + \bar{A}) + \bar{A}C$$

$$= AB + ABC + \bar{A}BC + \bar{A}C$$

$$= AB[1 + C] + \bar{A}C[B + 1]$$

$$\boxed{Y = AB + \bar{A}C}$$

Steps:-

1. Total no. of variable in use = 3
2. Every variable must be repeated twice.
3. Select to the term which one is the compliment of other which is ans.

**Q.** Find the minimise expression $Y = AB + \bar{B}C + AC$

**Sol^n**

$$\boxed{Y = AB + \bar{B}C}$$

**Q.** $Y = AB + B\bar{C} + AC$

**Sol^n**

$$\boxed{Y = B\bar{C} + AC}$$

**Q.** $Y = \bar{A}\bar{B} + \bar{B}\bar{C} + A\bar{C}$

**Sol^n**

$$Y = \bar{A}\bar{B} + A\bar{C}$$ Ans

**Q.** $Y = A\bar{B} + \bar{A}\bar{C} + \bar{B}\bar{C}$

**Sol$^n$** $\boxed{Y = A\bar{B} + \bar{A}\bar{C}}$

**Q.** $Y = (A+B)(B+C)(\bar{A}+C)$

**Sol$^n$** $\boxed{Y = (A+B)(\bar{A}+C)}$

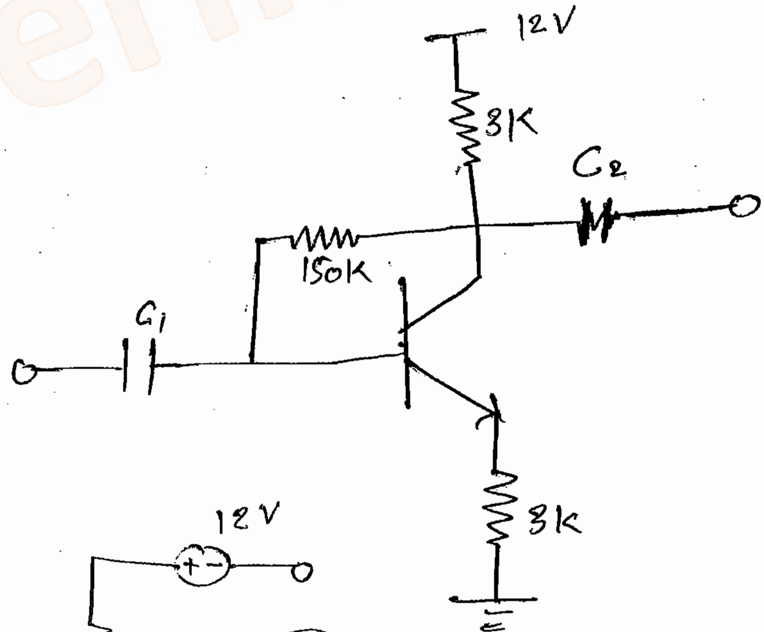
**Q.** $Y = (\bar{x}+\bar{y})(\bar{y}+\bar{z})(x+\bar{z})$

**Sol$^n$** $\boxed{Y = (\bar{x}+\bar{y})(x+\bar{z})}$ Ans

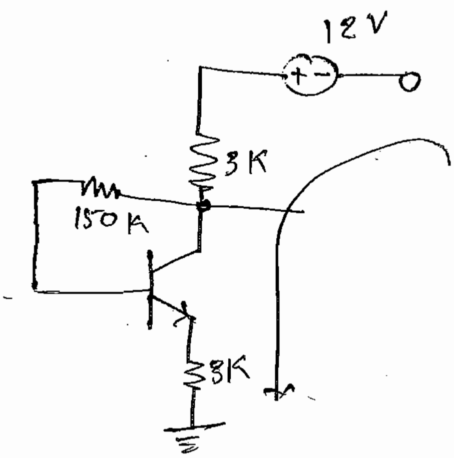
D.U.

**Q.** The current gain in the transistor $\beta = 100$ the value of collector current $I_c$ is ?

(a)




**Sol$^n$**



$-12 + (I_C + I_B) 3K + I_B \times 150K + V_{BE} + I_E \times 3K = 0$

$(I_C + I_B) 3K + I_B 150K + (I_B + I_C) 3K = 11.3$

$I_C 3K + I_B 3K + I_B 150K + I_B 3K + I_C 3K = 11.3$

$I_C 6K + I_B 156K = 11.3$

$\beta I_B 6K + I_B 156K = 11.3$

$100 \times 6K I_B + 156K I_B = 11.3$

$756 I_B = 11.3$

$I_B = \frac{11.3}{756} = 0.014\ m.A.$

$I_C = \beta I_B$

$= 100 \times 0.014\ m.A.$

$= 1.4\ m.A.$ Ans

Q. In order to measure a maximum of 1 V with a resolution of 1 milivolt using n-bit analog to digital converter determine n-bit?

Sol^n

resolution = 1 m.V

$V_r = 1V$

$reso = \frac{V_r}{2^n - 1}$

$\Rightarrow 1 m.V. = \frac{1}{2^n - 1}$

$2^n - 1 = \frac{1}{1 m.V.}$

$2^n - 1 = 1000$

$2^n = 1001$

$2^n \approx 2^{10}$

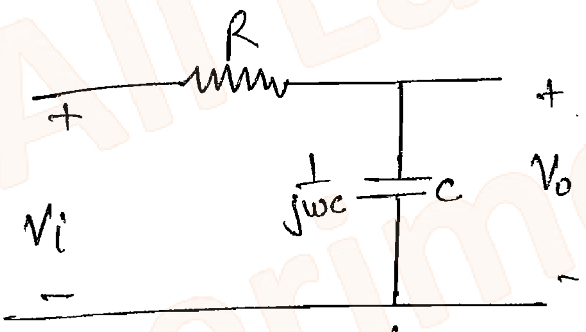
$\boxed{n = 10}$

Q. A low pass filter formed by simble R-C circuit at the cut-off angular frequency. the voltage gain and the phase of output voltage relative to input voltage respectivily are -

(a) $0.71 \angle +45^\circ$ (b) $0.71, -45^\circ$ (c) $0.5 \angle -90$

(d) $0.5 \angle +90^\circ$

Sol^n




Low - pass filter

$$V_o = \frac{V_i \times \frac{1}{j\omega c}}{R + \frac{1}{j\omega c}}$$

$$\frac{V_o}{V_i} = \frac{\frac{1}{j\omega c}}{R + \frac{1}{j\omega c}} = \frac{1}{1 + j\omega RC}$$

$$\left|\frac{V_o}{V_i}\right| = \frac{1}{\sqrt{1 + \omega^2 R^2 C^2}} = \frac{1}{\sqrt{1 + (\omega RC)^2}}$$

$$= \frac{1}{\sqrt{1 + \left(\frac{\omega}{\frac{1}{RC}}\right)^2}} = \frac{1}{\sqrt{1 + \left(\frac{\omega}{\omega_c}\right)^2}}$$

$\omega = \omega_c$

$$\left|\frac{V_o}{V_i}\right| = \frac{1}{\sqrt{1+1}} = \frac{1}{\sqrt{2}} = 0.707$$

$$\frac{V_o}{V_i} = \frac{1}{1+j\omega RC}$$

$$\angle \frac{V_o}{V_i} = -\tan^{-1}(\omega RC) = -\tan^{-1}\left(\frac{\omega}{\frac{1}{RC}}\right)$$

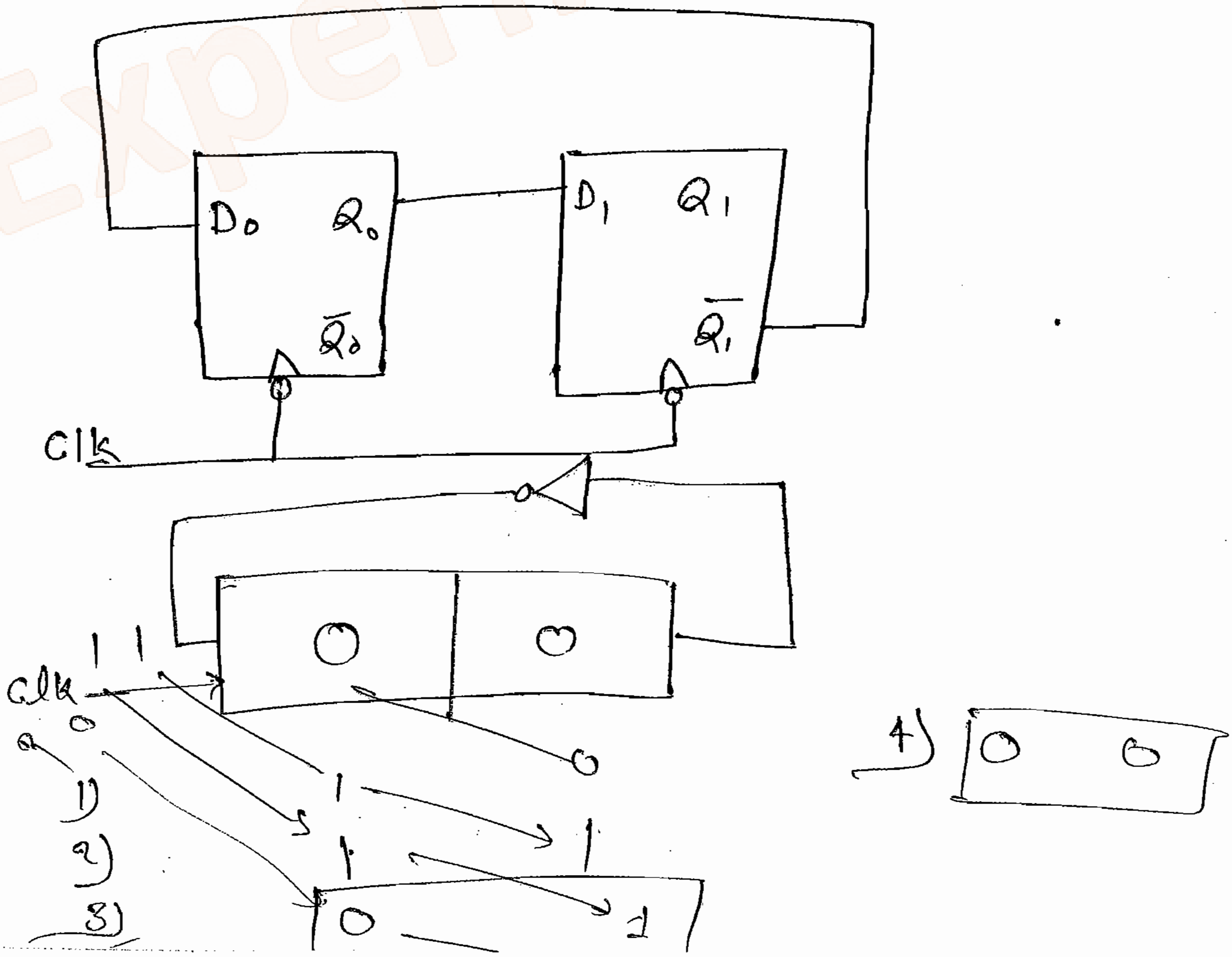
$$= -\tan^{-1}\left(\frac{\omega}{\omega_c}\right) = -\tan^{-1}\left(\frac{\omega}{\omega}\right)$$

$$= -\tan^{-1}(1) = -\tan^{-1}(\tan 45^{\circ})$$

$$= -45^{\circ}$$ Ans

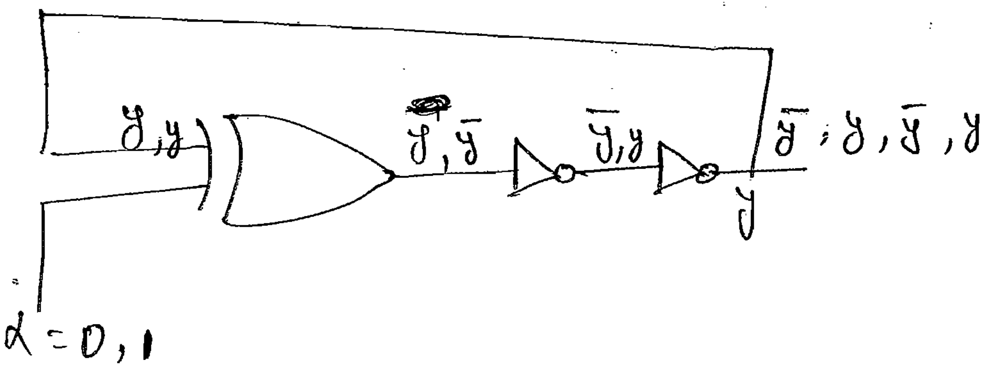
Digital B.A.

(1)



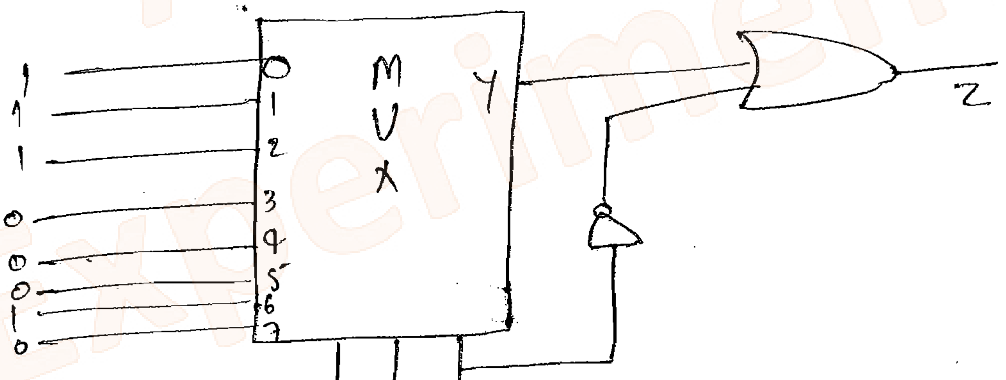
4 ) 335
37
15
12
(3) →

(2)




So $X = 1$

(3)




| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |
| 1 | 1 | 1 |

$\bar A \bar B \bar C.1 + \bar A \bar B C.1 + \bar A B \ldots$

$+ AB\bar C.1 = Z$

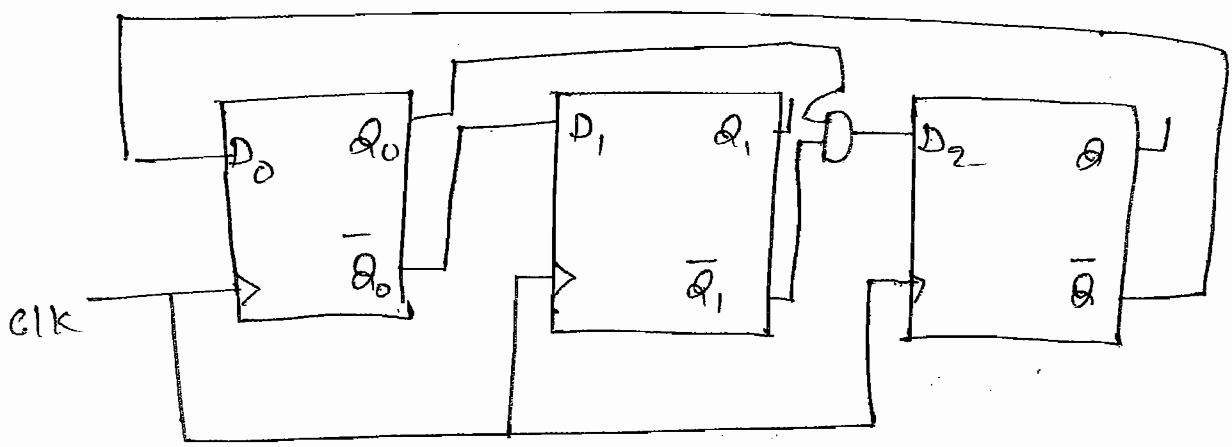
$Z = \bar A \bar B \bar C + \bar A \bar B C + \bar A B \bar C$
$+ AB\bar C + \bar C$

$= \bar A \bar B + \bar A B \bar C + AB\bar C + \ldots$

$= \bar A \bar B + \bar C [1 + AB + \bar A \ldots$

$Z = \bar A \bar B + \bar C$

(4)




$$D_1 = \overline{Q_0}$$

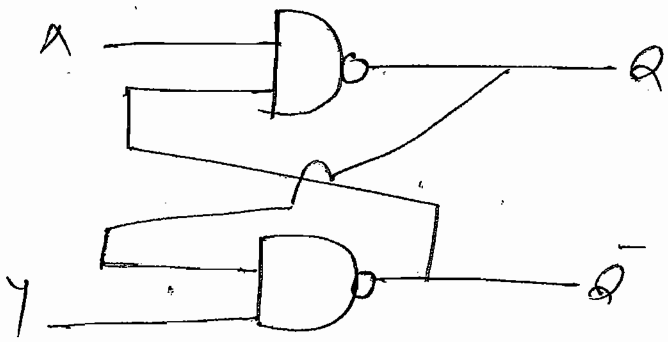
$$D_0 = \overline{Q_2}$$

$$D_2 = \overline{Q_0}\,\overline{Q_1}$$

| | $D_0$ | $D_1$ | $D_2$ | $Q_0$ | $Q_1$ | $Q_2$ |
|---|---|---|---|---|---|---|
| | X | 1 | 1 | 0 | 0 | 0 |
| | | | | 1 | 1 | 0 |
| 1) | 1 | 0 | 0 | 1 | 0 | 0 |
| 2) | 1 | 0 | 1 | 1 | 0 | 1 |
| 3) | 0 | 0 | 1 | 0 | 0 | 1 |
| 4) | 0 | 1 | 0 | | | |
| 5) | 1 | 1 | 0 | 0 | 1 | 0 |
| | | | | 1 | 1 | 0 |

mod - 5

(5)



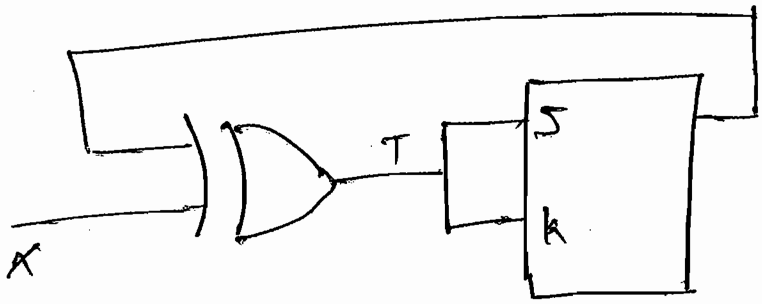

X=0, Y=0 invalid (a)

(6)

| C \ AB | 00 | 01 | 11 | 10 |
| --- | --- | --- | --- | --- |
| 1 | 1 | 1 | x | 0 |
| 0 | 0 | 0 | x | 0 |

$$Y = C\bar{A}$$

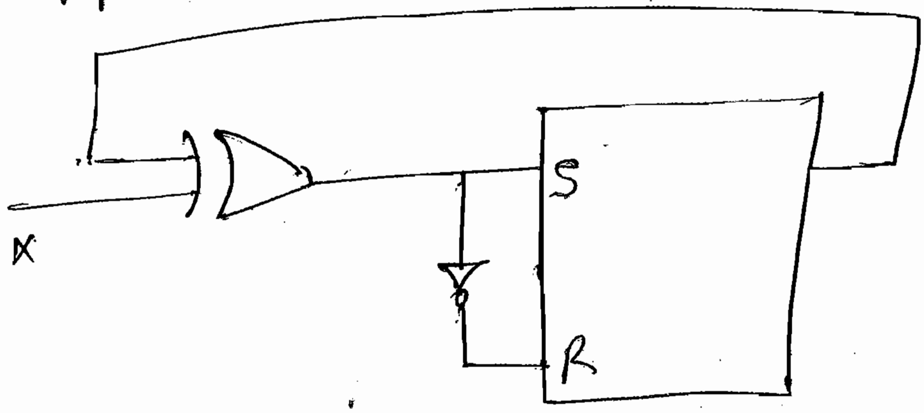
Q: Identify the flip-flop.




$T = x \oplus Q$

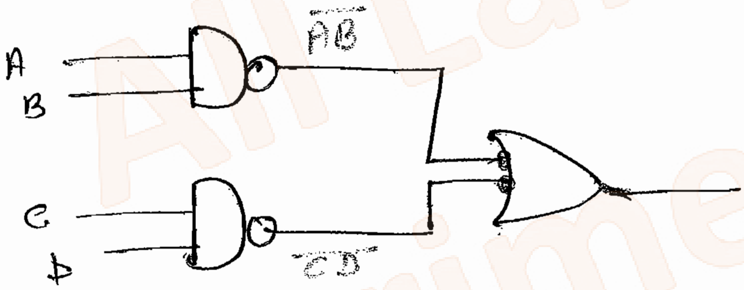
So $x = D$

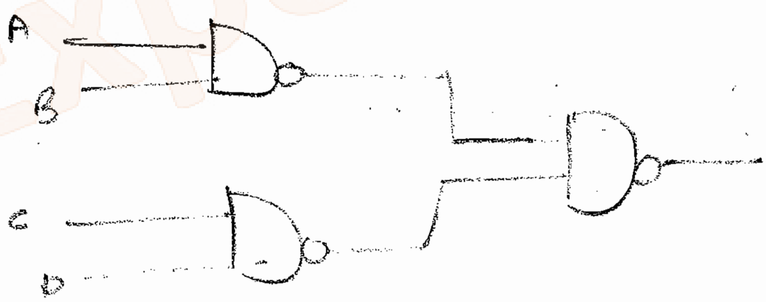
Q. Identify




T-flip-flop.

Q.9




So $min^n$ no. of nand gate required = 3.