*8. Suppose you want to design a street light controller. You have a sensor that gives output as voltage as proportional to the light intensity. You nee [redacted] he sensor output is below the 5V. (You can assume the VH and VL value)

a. **Draw** the voltage transfer characteristics curve (**V_{in} vs V_{out} plot**). Clearly **label** the plot.

b. Draw the circuit diagram that can be perfect for this specification.

[redacted]

9. Suppose you want to design a street light controller. You have a sensor that gives output as voltage as proportional to the light intensity. You need to switch off the light when the output of the sensor is above 5V. You need to switch on the light when the sensor output is below the 5V. There is a noise source of 1V peak-peak. Your instructor has told you to use a schmitt trigger circuit to improve perfor [redacted]

a. What VTH and VTL value can be used for this design to solve the problem of noise?

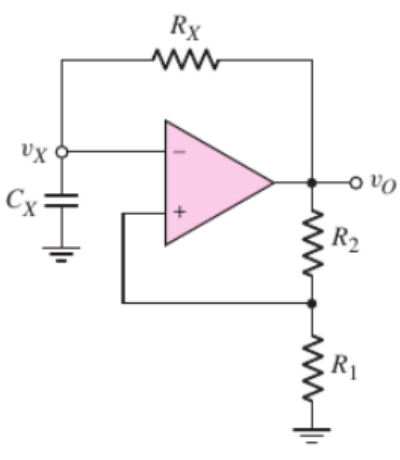
b. **Draw** the voltage transfer characteristics curve (**V_{in} vs V_{out} plot**) and clearly **label** the plot.

[redacted]

d. Find out the parameter value of the circuit.

Square Wave Generator

1.

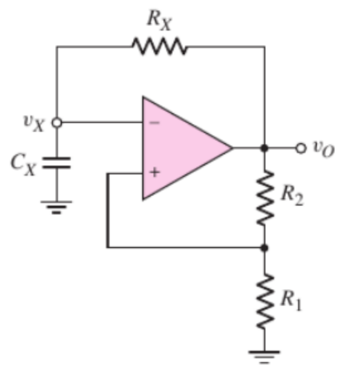


Here suppose R1 = 10k, R2 = 20k, Rx = 1k, Cx = 1 mF, VH= 10V and VL = -10 V

a. Find the period and frequency of the square wave?

b. What will be the value of the duty cycle of the square wave?
c. Draw the output waveform with proper labeling.

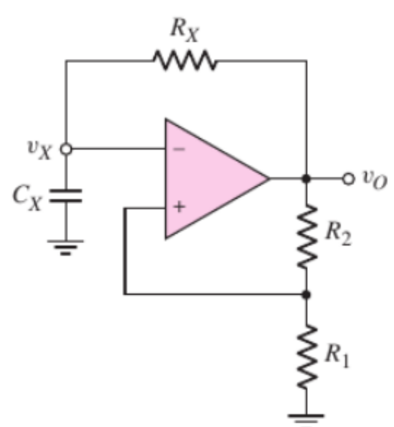
2.



Here VH = 10 V and VL = -10 V

Design the circuit so that it can generate a square wave with 1 kHz frequency and 50% duty cycle.

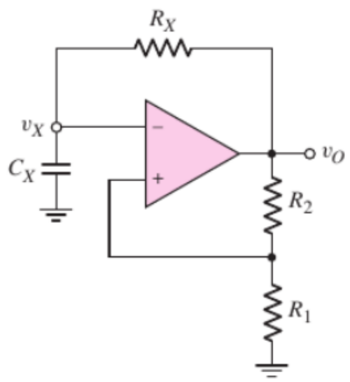
3.



suppose R1 = 10k, R2 = 20k, Rx = 1k, Cx = 1 mF

Design the circuit so that it can generate square wave with a 30% duty cycle. Find the frequency of your designed circuit.

4.

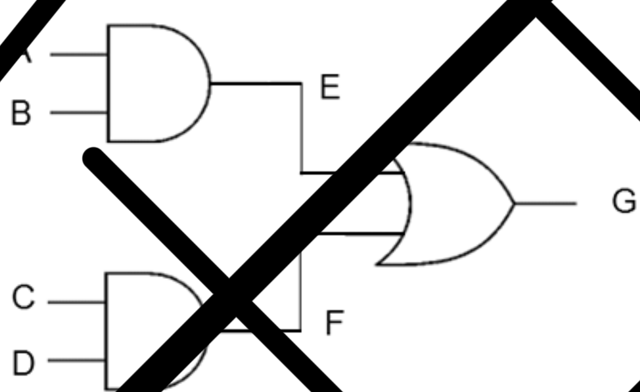


Here suppose R1 = 10k, R2 = 20k, Rx = 1k, Cx = 1 mF, VH = 10V and VL = -5V

Find out the duty cycle of inverted output signal of the above circuit.

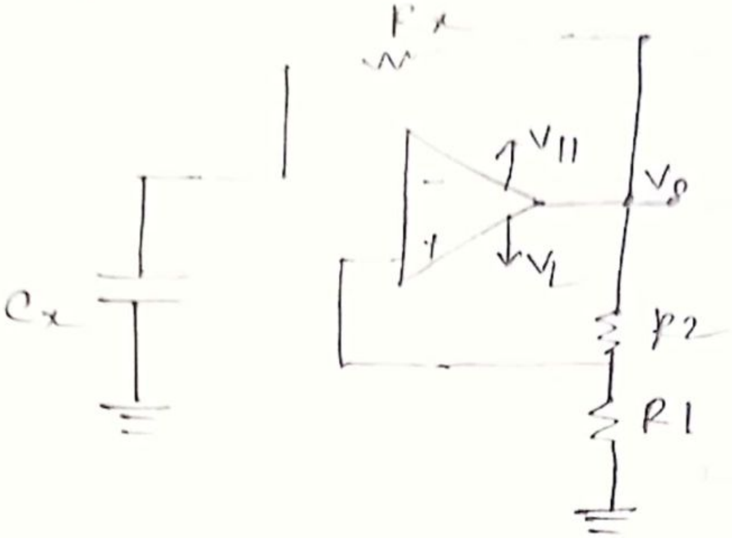
CMOS logic design

1. Design a CMOS logic circuit to implement the given compound gate in Figure below. First derive the logical expression of output Y and then design the CMOS network.



2. a) Design a static CMOS logic circuit that implements the logic function Y= AB
   b) Design a static CMOS logic circuit that implements the logic function Y= (A+B)
   Design a static CMOS logic circuit that will implement the following logic
      a. NAND gate ($Y = \overline{AB}$)
      b. XOR gate ($Y = A\overline{B} + \overline{A}B$)
3. Design a static CMOS logic circuit that will implement the following logic
      a. NOR gate ($Y = \overline{A + B}$)
      b. XNOR gate ($Y = AB + \overline{AB}$)
4. Design static CMOS circuit for the following expression,
      a. Y = AB + CD

Square Wave Generation



$$V_{TH} = V_H \frac{R1}{R1+R2}, \quad V_{TL} = V_L \frac{R1}{R1+R2}$$

$$T_1 = R_x C_x \ln \frac{V_H - V_{TL}}{V_H - V_{TH}}$$

$$T_2 = R_x C_x \ln \frac{V_L - V_{TH}}{V_L - V_{TL}}$$

1. a) $R1 = 10k$, $R2 = 20k$, $Rx = 1k$, $Cx = 1mF$,

$V_H = +10V$, $V_L = -10V$

$$V_{TH} = V_H \times \frac{R1}{R1+R2}$$

$$= 10 \times \frac{10}{10+20} = 3.33$$

$$V_{TL} = V_L \times \frac{R1}{R1+R_2} = -3.33$$

$$\tau = R_x C_x = 1k \times 1m = 1s$$

$$T_1 = \tau \ln \frac{V_H - V_{TL}}{V_H - V_{TH}}$$

$$= 1 \times \ln \frac{10-(-3.33)}{10-3.33}$$

$$= 0.69s$$

$$T_2 = \tau \ln \frac{V_L - V_{TH}}{V_L - V_{TL}}$$

$$= 1 \times \ln \frac{-10-3.33}{-10-(-3.33)}$$

$$= 0.69s.$$

$$T = T_1 + T_2 = 0.69 + 0.69 = 1.38s$$

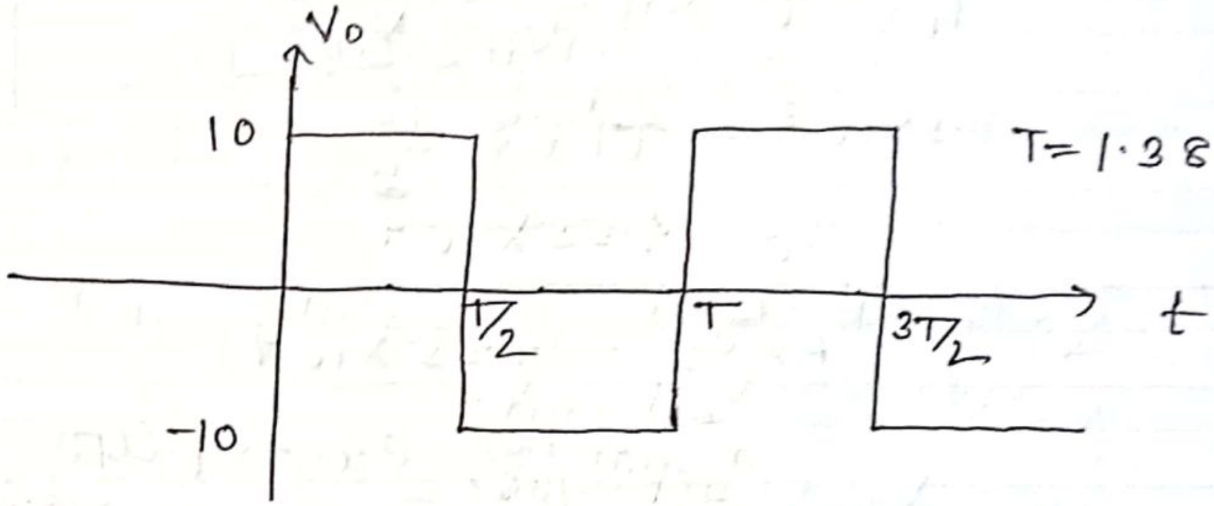
$$f = \frac{1}{T} = 0.72 \text{ Hz}$$

1. b) Duty cycle $= \frac{T_1}{T_1+T_2} \times 100\%$

$= \frac{0.69}{0.69+0.69} \times 100\%$

$= 50\%$

1. c)



$T = 1.38$ sec

2. $V_H = 10V$, $V_L = -10V$

Assuming, $R_1 = R_2 = 10k\Omega$

$V_{TH} = V_H \times \frac{R_1}{R_1+R_2} = 5V$

$V_{TL} = V_L \times \frac{R_1}{R_1+R_2} = -5V$

given, $f = 1kHz$, $T = \frac{1}{f} = 1ms$

Duty cycle $= 50\%$ and, $T = T_1 + T_2$

$$\therefore \frac{T_1}{T_1+T_2} = 0.5, \Rightarrow T_1 = T_2 = T/2$$

$$= 0.5\times10^{-3}$$

$$T_1 = \tau \ln \frac{V_H - V_{TL}}{V_H - V_{TH}}$$

$$0.5\times10^{-3} = \tau \ln \frac{15}{5}$$

$$\tau = 4.55\times10^{-4}$$

$$R_x C_x = 4.55\times10^{-4}$$

assuming, $C_x = 1\mu F$

$$R_x = \frac{4.55\times10^{-4}}{C_x}$$

$$= 455\Omega$$

3. $\tau = R_x C_x = 1k \times 1mF = 1s$

$$\frac{T_1}{T_1+T_2} = 0.3 = \frac{3}{10}$$

$$\frac{T_1}{T_2} = \frac{3}{7}$$

Assuming $R1 = R2 = 10$

$$T_1 = \tau \ln \frac{V_H - V_{TL}}{V_H - V_{TH}}$$

$$T_1 = \tau \ln \frac{V_H - V_L \frac{R1}{R1+R2}}{V_H - V_H \frac{R1}{R1+R2}}$$

$$T_1 = \tau \ln \frac{V_H - V_L/2}{V_H - V_H/2}$$

$$T_1 = \tau \ln \frac{2V_H - V_L}{V_H}$$

$$T_2 = \tau \ln \frac{V_L - V_{TH}}{V_L - V_{TL}}$$

$$= \tau \ln \frac{V_L - V_H/2}{V_L/2}$$

$$T_2 = \tau \ln \frac{2V_L - V_H}{V_L}$$

Now, $7T_1 = 3T_2$

$$\Rightarrow 7 \ln \frac{2V_H - V_L}{V_H} = 3 \ln \frac{2V_L - V_H}{V_L}$$

suppose, $V_H = 10\,V$,

Find $V_L = ?$ -2.24 (use calculator solve eqn)

4. $\tau = R_x C_x = 1s$

$V_H = +10V$, $V_L = -5V$

$$V_{TH} = V_H \frac{R1}{R1+R2} = 10 \times \frac{10}{10+20} = 3.33$$

$$V_{TL} = V_L \frac{R1}{R1+R2} = -5 \times \frac{10}{10+20} = -1.67$$

$$T_1 = \tau \times \ln \frac{V_H - V_{TL}}{V_H - V_{TH}}$$

$$= 1 \times \ln \frac{10 - (-1.67)}{10 - 3.33} = 0.559,$$

$$T_2 = \tau \ln \frac{V_L - V_{TH}}{V_L - V_{TL}} = 1 \times \ln \frac{-5 - 3.33}{-5 - (-1.67)}$$

$$= 0.91\,sec$$

$$\text{Duty cycle} = \frac{T_1}{T_1 + T_2} \times 100\% = 37.9\%$$