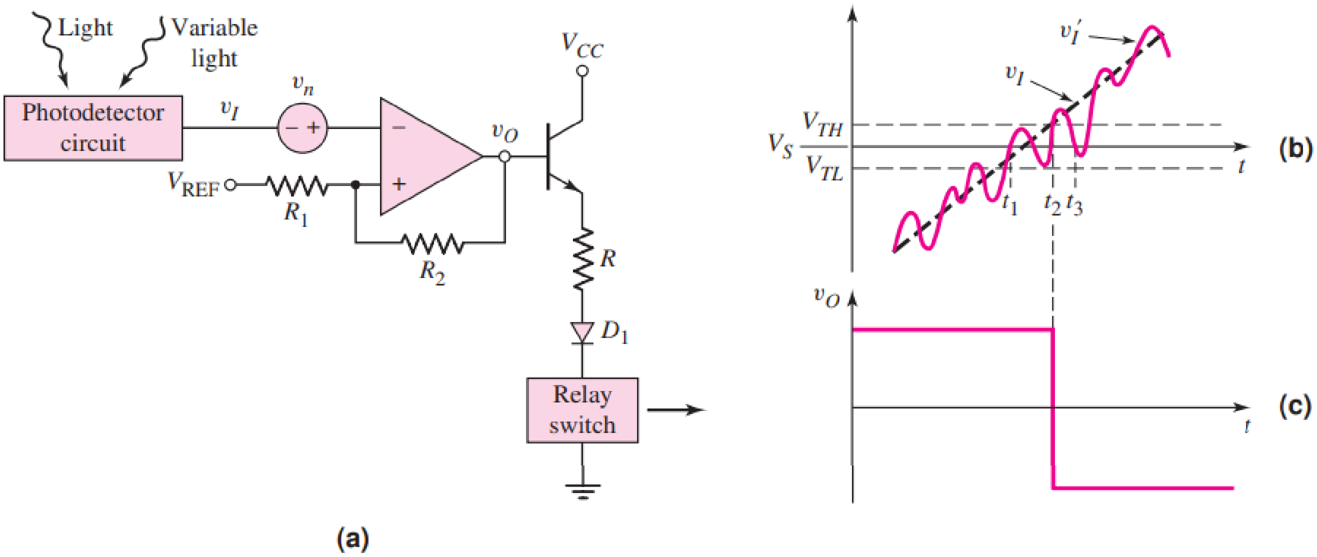
Exercise 1



Design the street light control circuit shown in the above figure such that the switching voltage is $V_s = 2\ V$ and the hysteresis width is $200\ mV$. Assume

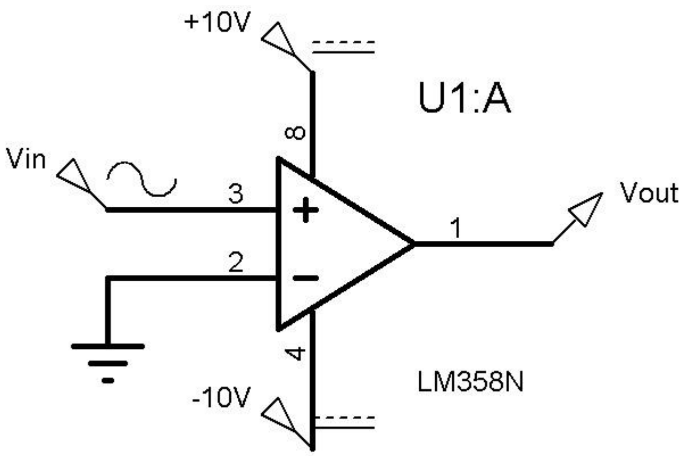
$V_H = 15\ V$ & $V_L = -8\ V$.

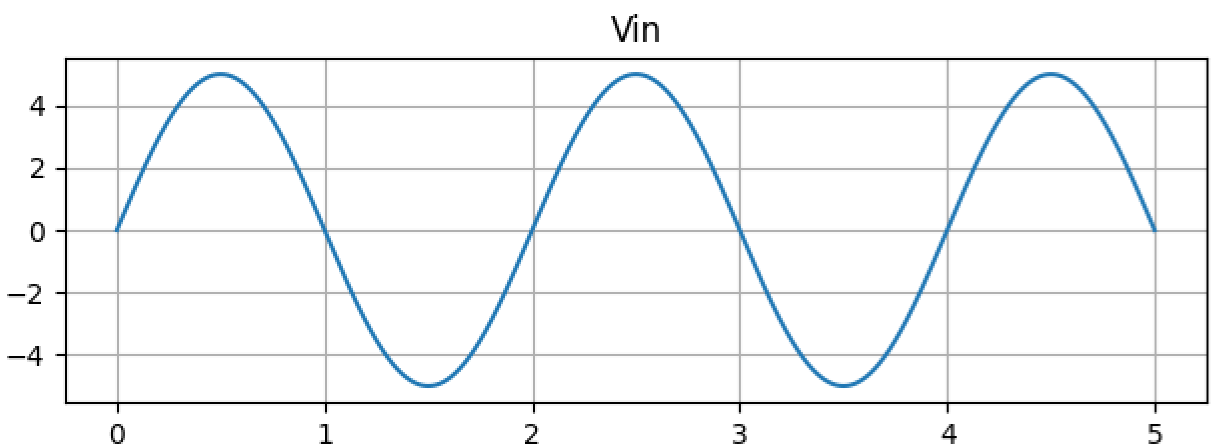
a) Find the resistances in $k\Omega$. You can assume the value of one resistance.
b) Find the value of V_{REF}.
c) Suppose, the current through the resistance R is $250\ \mu A$ when $v_o = V_H$ and relay switch resistance is $330\ \Omega$. Find the value of R.

Ans: a) 10, 1140
b) 2.0175 V
c) 54.07 $k\Omega$

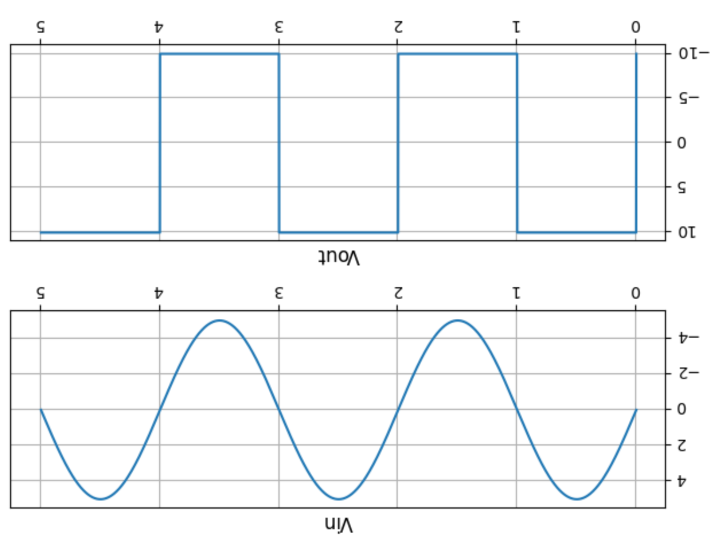
Exercise 2

For the OP-AMP comparator circuit below, V_{in} vs time plot is given. Draw the V_{out} vs time plot for the given input.



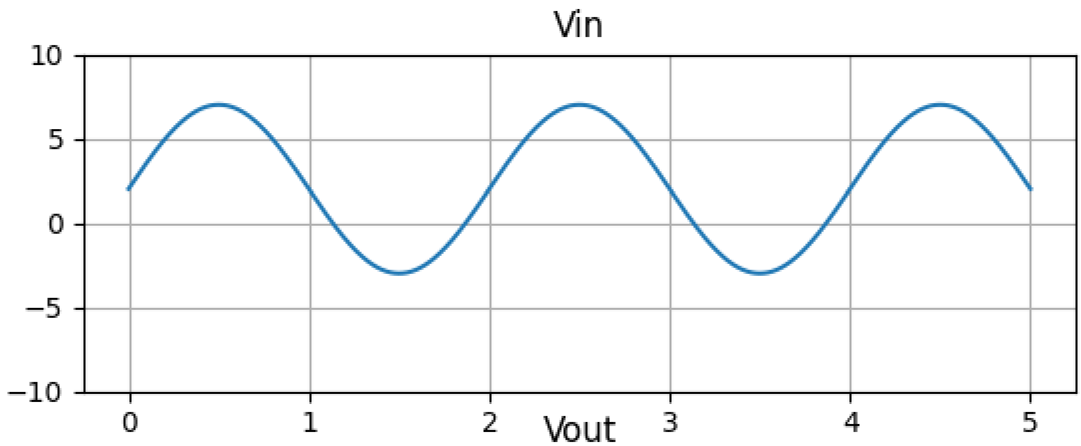


Ans:



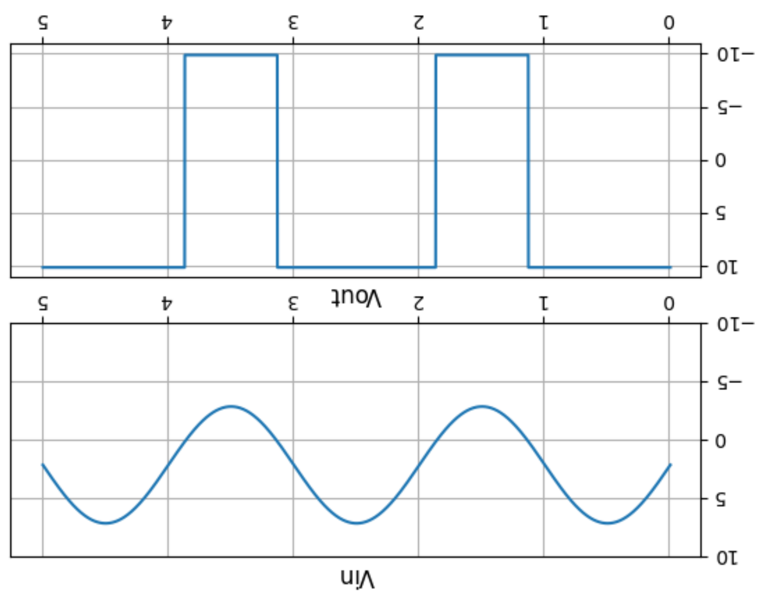
Practice Problem 1:

Do the same as in **Exercise 2** for the following:



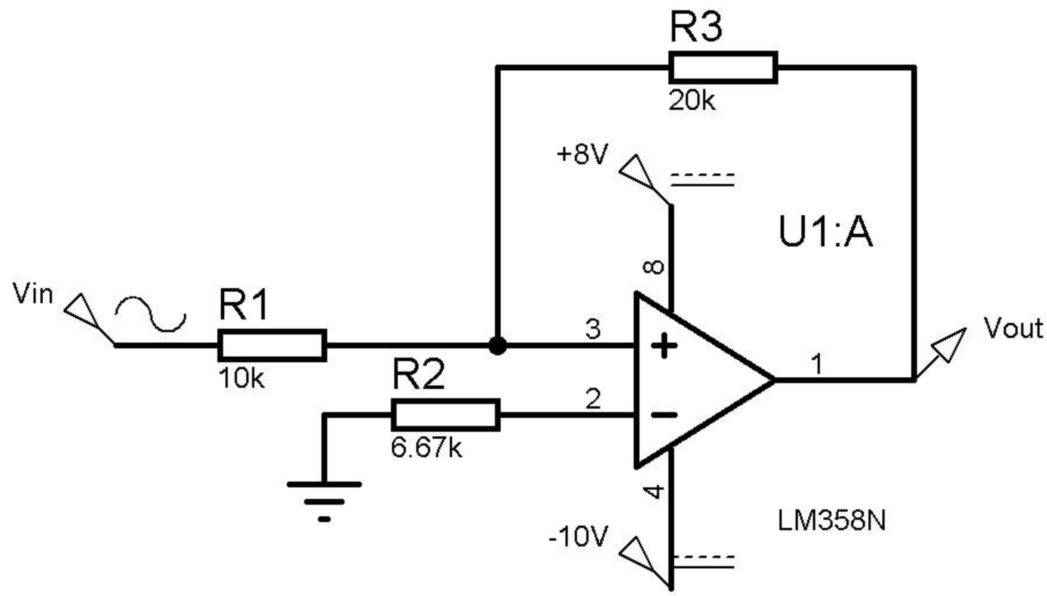
Vout

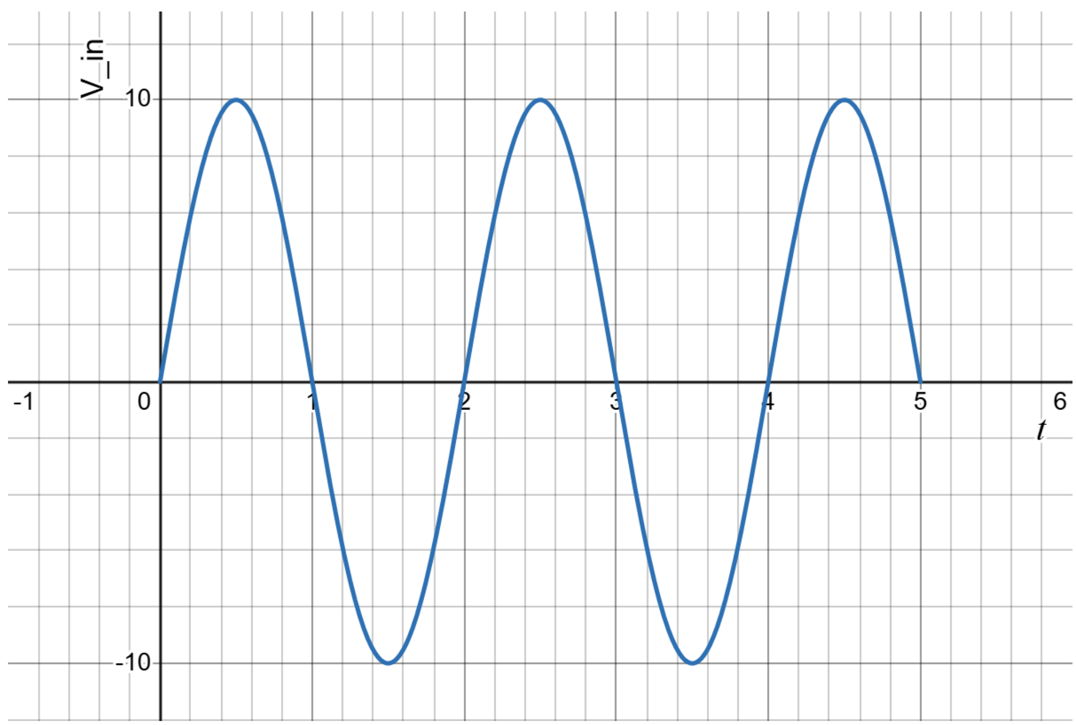
Ans:



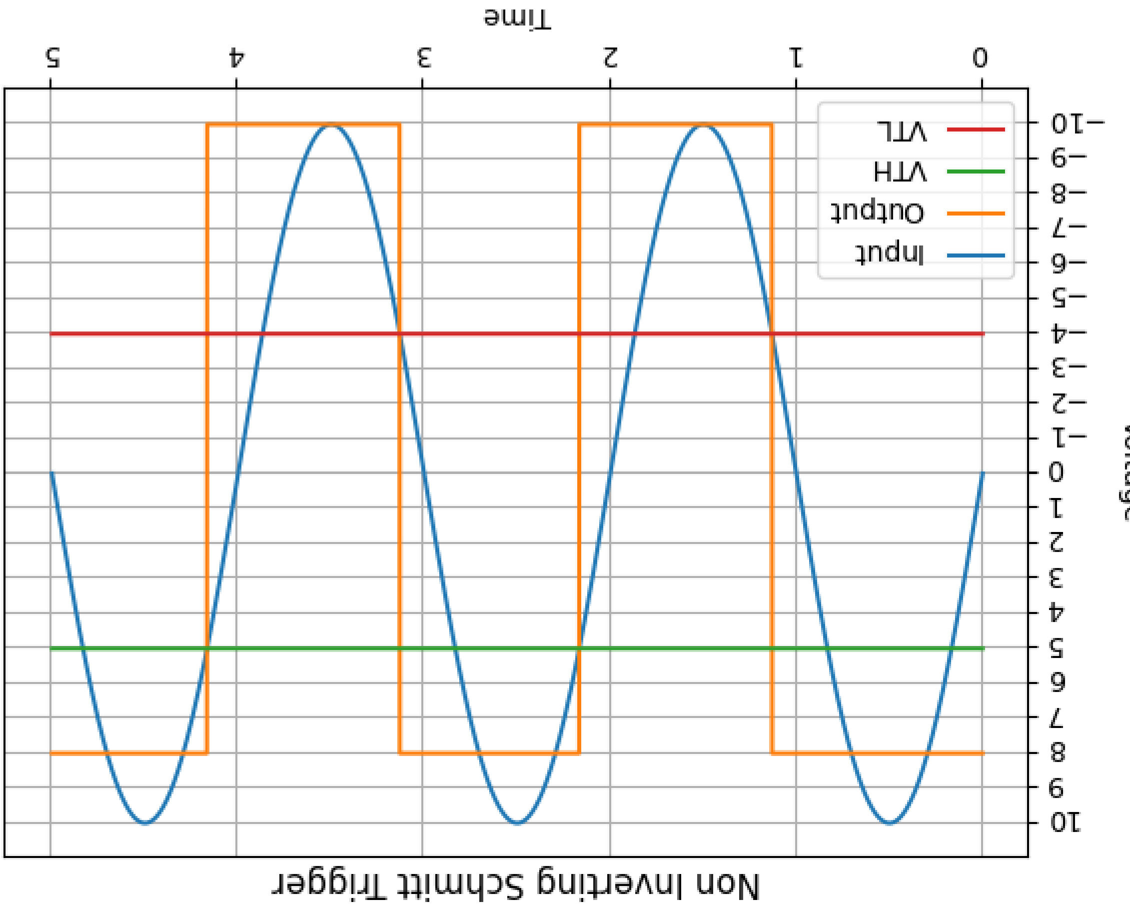
Exercise 3

For the non-inverting Schmitt Trigger circuit below, V_{in} vs time plot is given. Draw the V_{out} vs time plot.



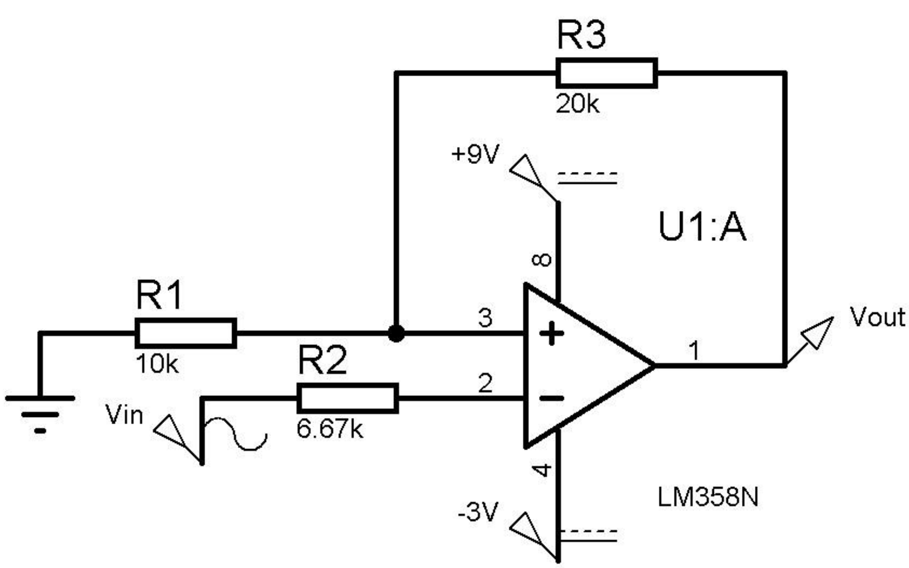


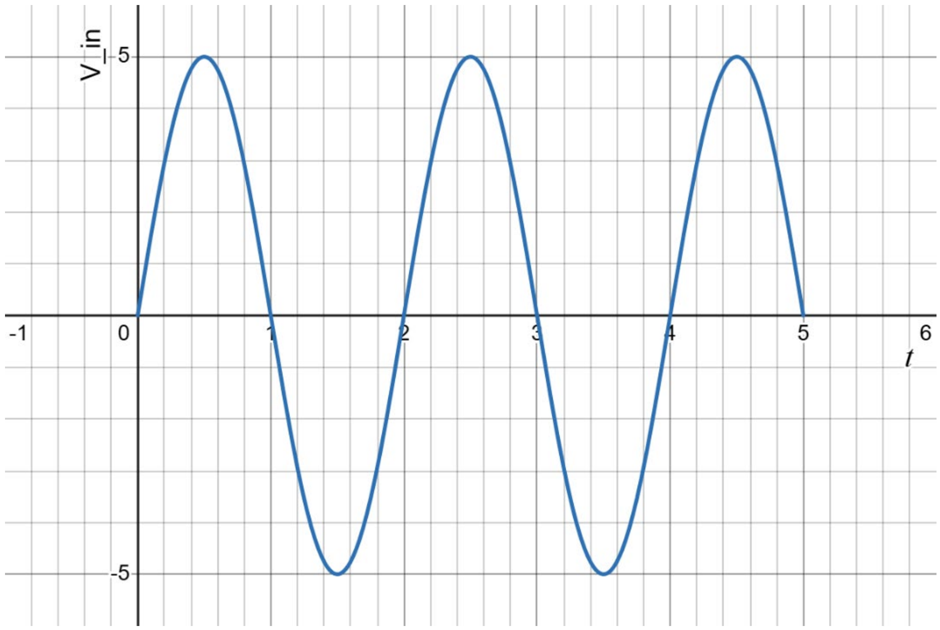
Ans:



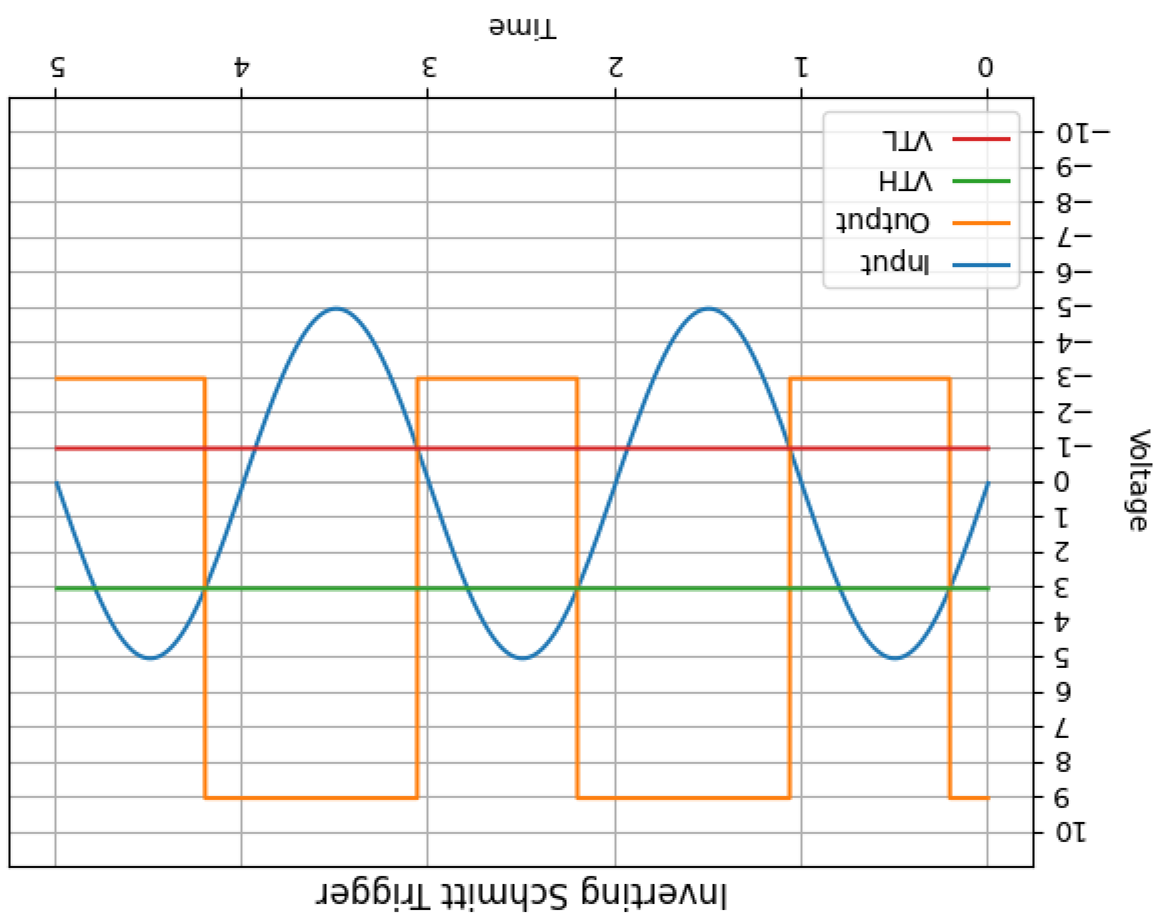
Exercise 4

For the inverting Schmitt Trigger circuit below, V_{in} vs time plot is given. Draw the V_{out} vs time plot for the given input.

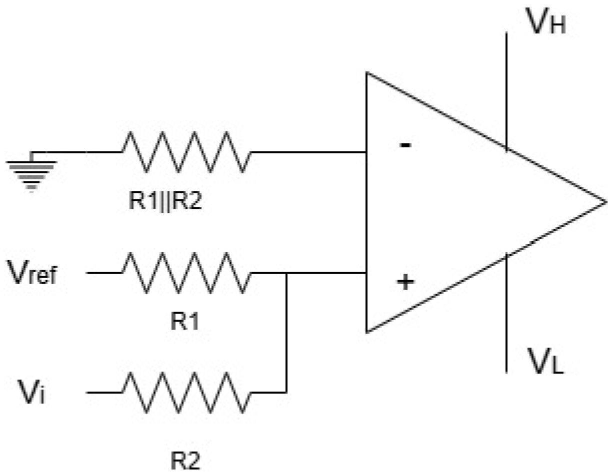



V_in
5
-5
-1
0
1
2
3
4
5
6
t

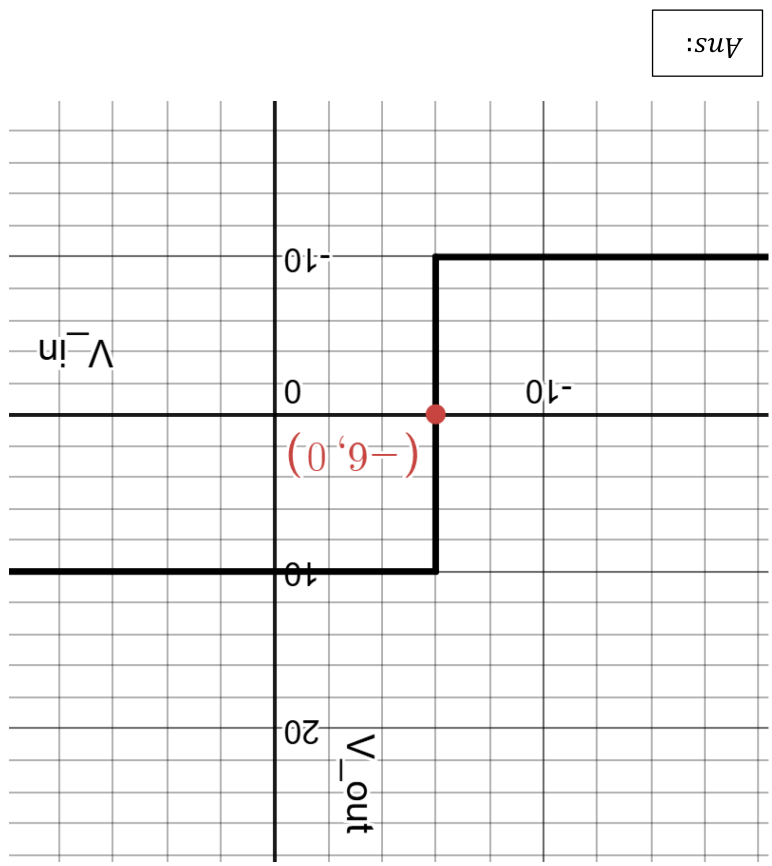
Ans:


Inverting Schmitt Trigger
Voltage
Time
Input
Output
VTH
VTL

Exercise 5

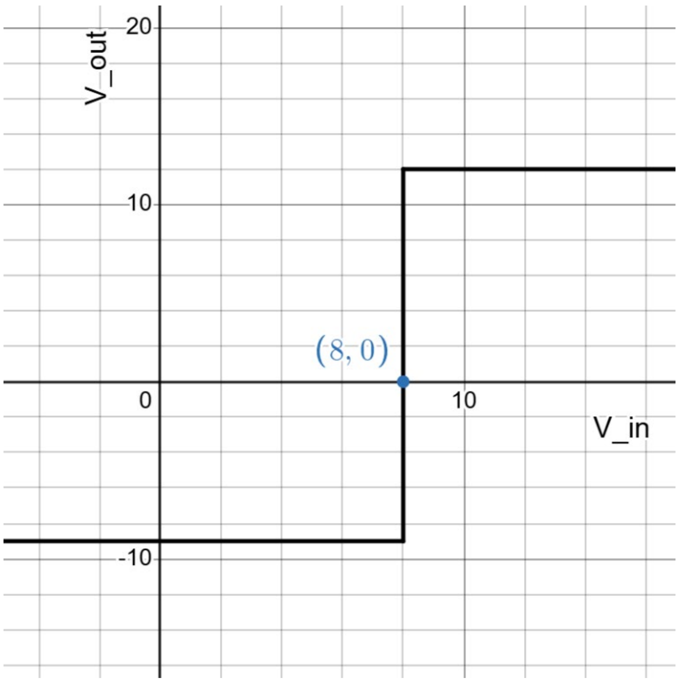


If $R_1 = 10\ k\Omega, R_2 = 20\ k\Omega, \mathrm{V_{ref}} = 3\ \mathrm{V}$
$V_H = 10\ V, V_L = -10\ V$
Draw the VTC of this circuit with proper labeling



Exercise 6

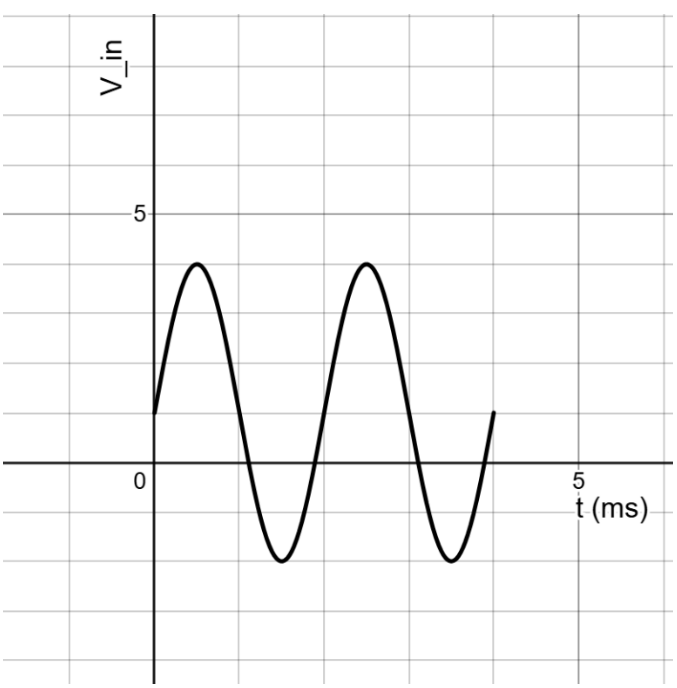
Design a comparator circuit with the following VTC:

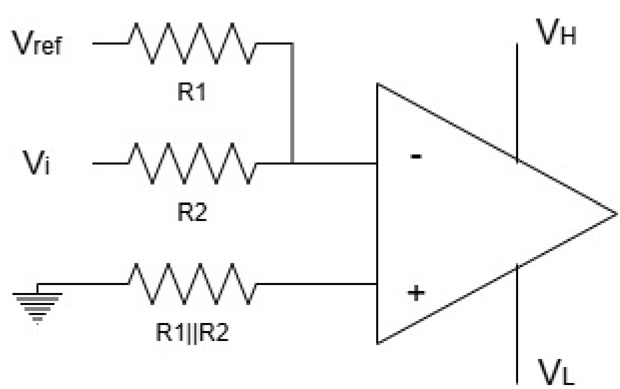


Ans: $R_1 = 5\ k\Omega, R_2 = 10\ k\Omega, V_{ref} = -4\ V, V_H = 11\ V, V_L = -9.5\ V$ (Non − Inverting)

Exercise 7

Draw the V_{out} vs time plot for the given V_{in} vs time plot to the following circuit:

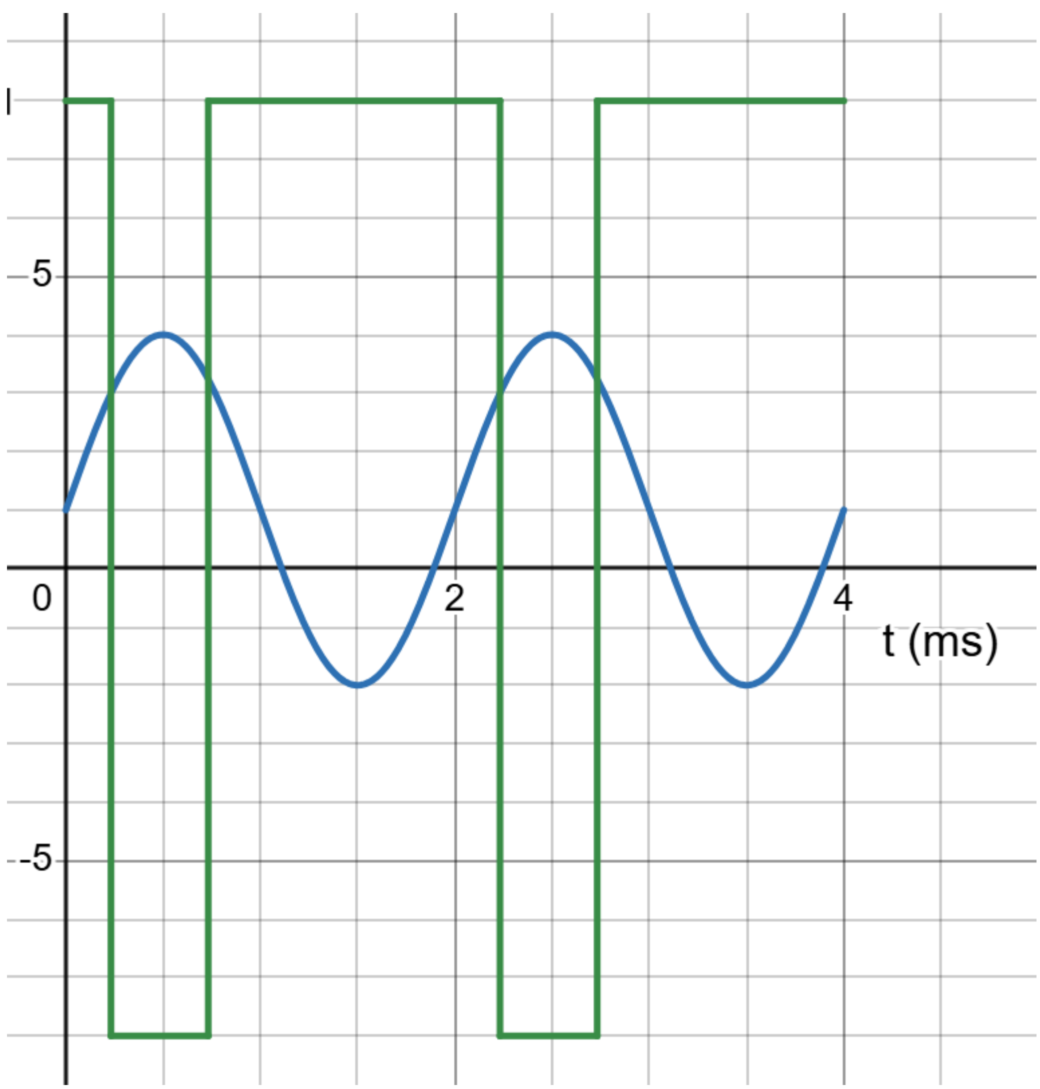




$$V_{ref} = -2\ V$$

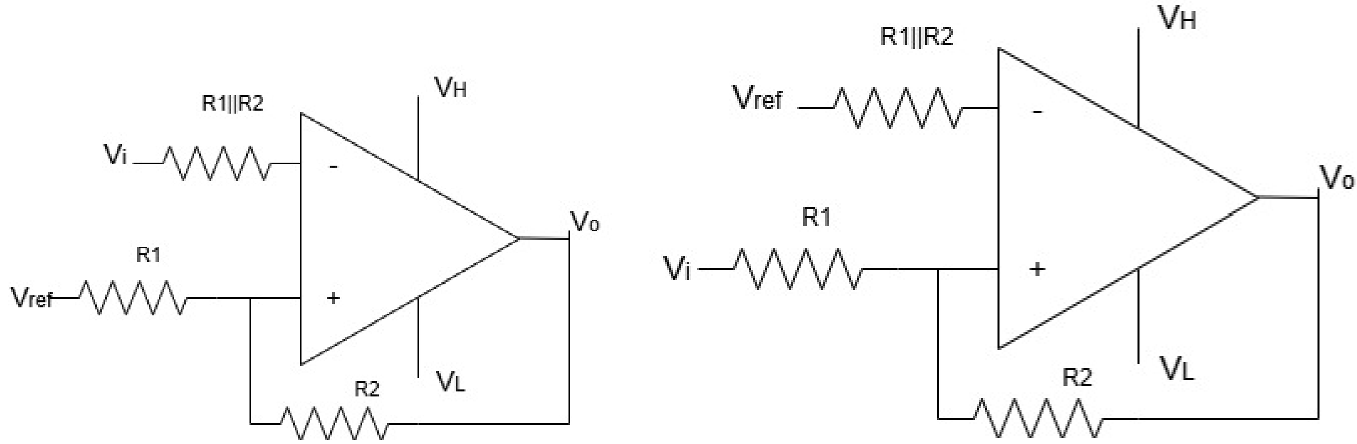
$$R_1 = 10\ k\Omega, R_2 = 15\ k\Omega$$

$$V_H = 8\ V, V_L = -8\ V$$



Ans:

Exercise 8

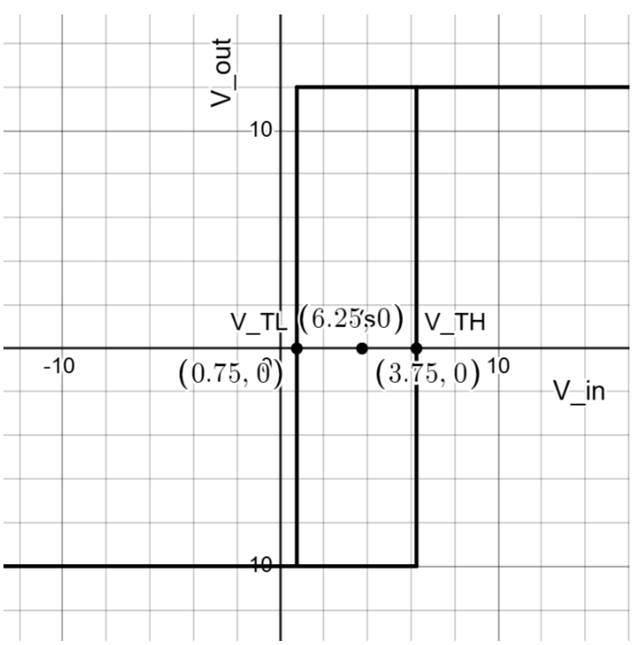


For the above two circuits,

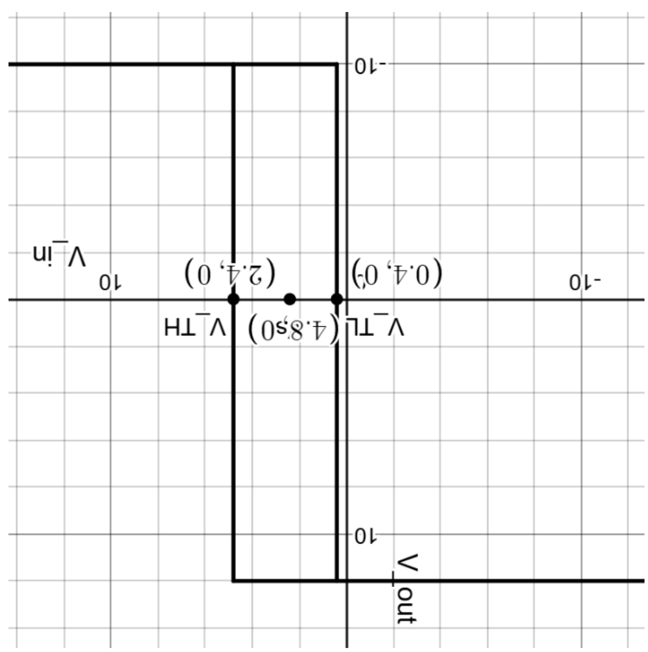
$$R_1 = 5\ k\Omega, R_2 = 20\ k\Omega, \mathrm{V_{ref}} = 3\ \mathrm{V}, V_H = 12\ V, V_L = -10\ V$$

a) Find higher & lower threshold voltages.
b) Find shift voltages & hysteresis widths.
c) Draw their VTCs.

$Ans: a)\ V_{TH} = 4.8\ V\ (Inverting), 6.25\ V\ (Non-Inverting),$
$V_{TL} = 0.4\ V (Inverting), 0.75\ V\ (Non-Inverting)$
$b) 2.4\ V\ (Inverting), 3.75\ V\ (Non-Inverting)$

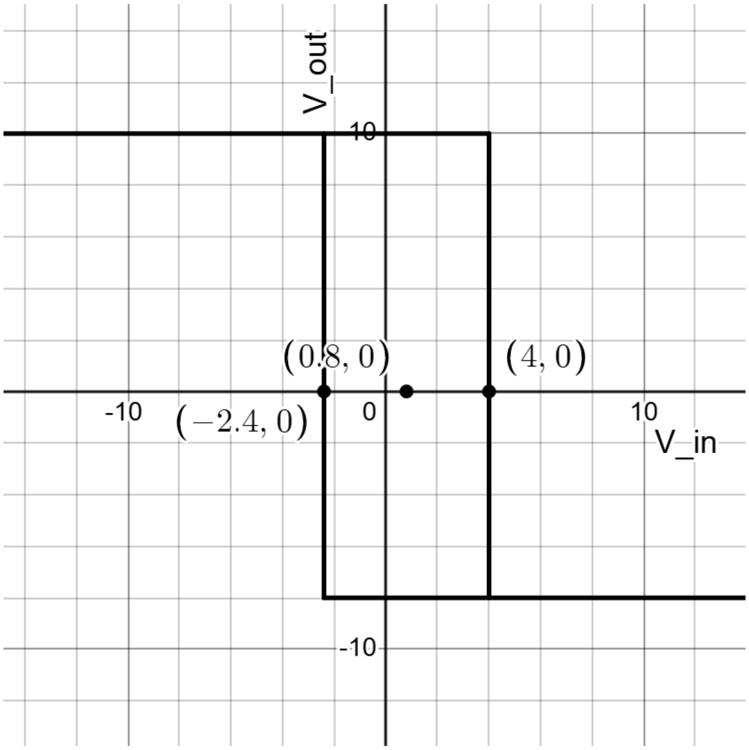


Non-Inverting



Inverting

Exercise 9



If $R_1 = 2\ k\Omega$, design a Schmitt Trigger to achieve the given VTC.

$Ans: R_2 = 4.25\ k\Omega, V_{ref} = 1.17\ V, V_H = 10\ V, V_L = -8\ V$