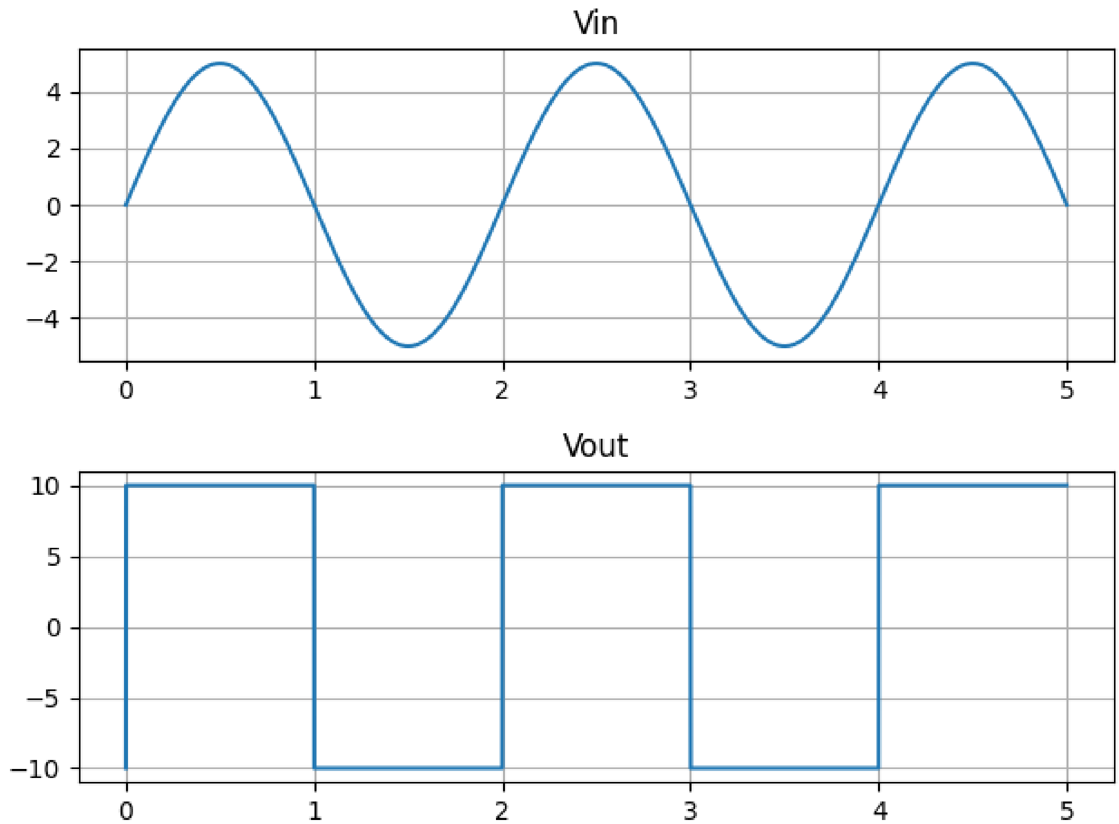
Exercise 2

Solution:

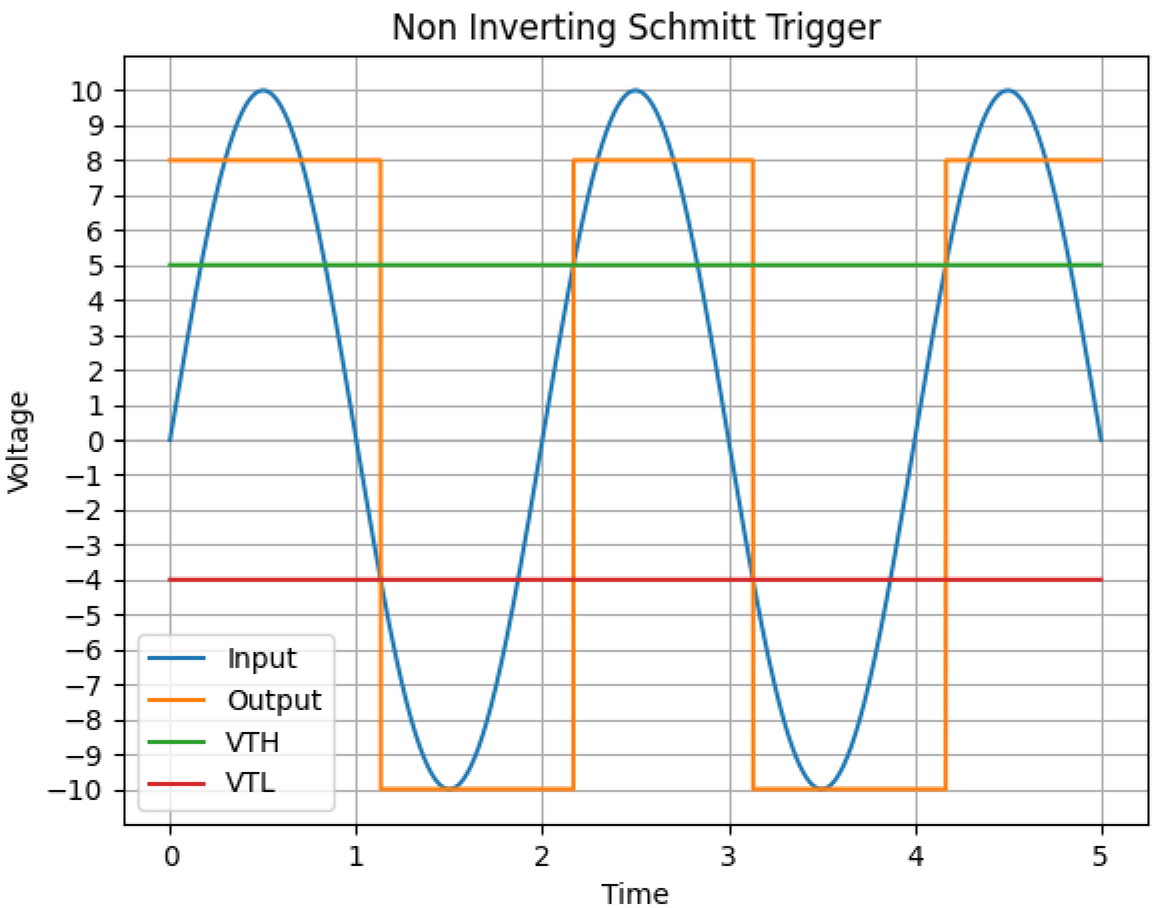


Exercise 3

Solution:

$$V_{TH} = -\frac{R_1}{R_3} \times V_L = -\frac{10}{20} \times -10 = 5\ V$$

$$V_{TL} = -\frac{R_1}{R_3} \times V_L = -\frac{10}{20} \times 8 = -4\ V$$

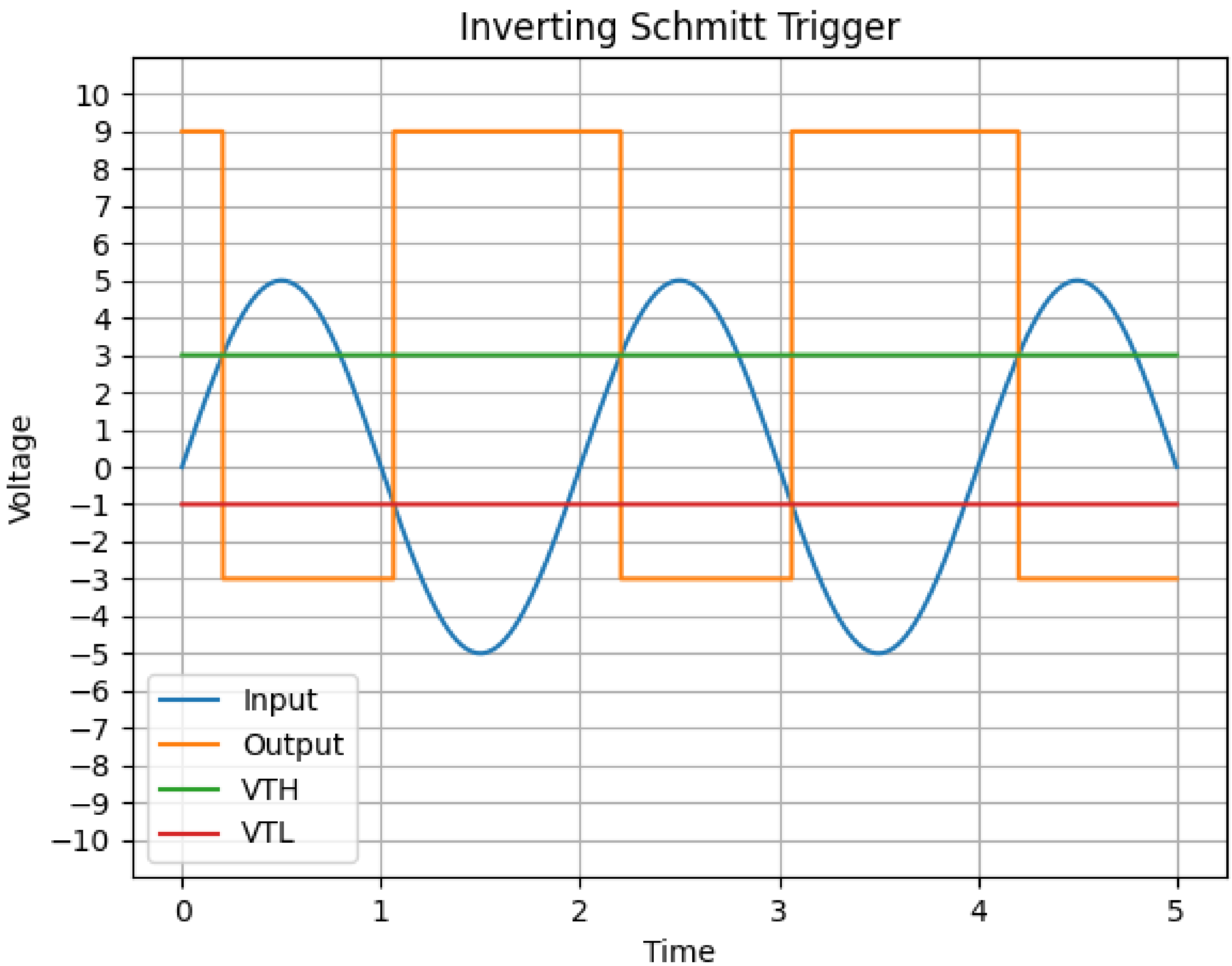


Exercise 4

Solution:

$$V_{TH} = \frac{R_1}{R_1+R_3} \times V_H = \frac{10}{10+20} \times 9 = 3\ V$$

$$V_{TL} = \frac{R_1}{R_1+R_3} \times V_L = \frac{10}{10+20} \times -3 = -1\ V$$



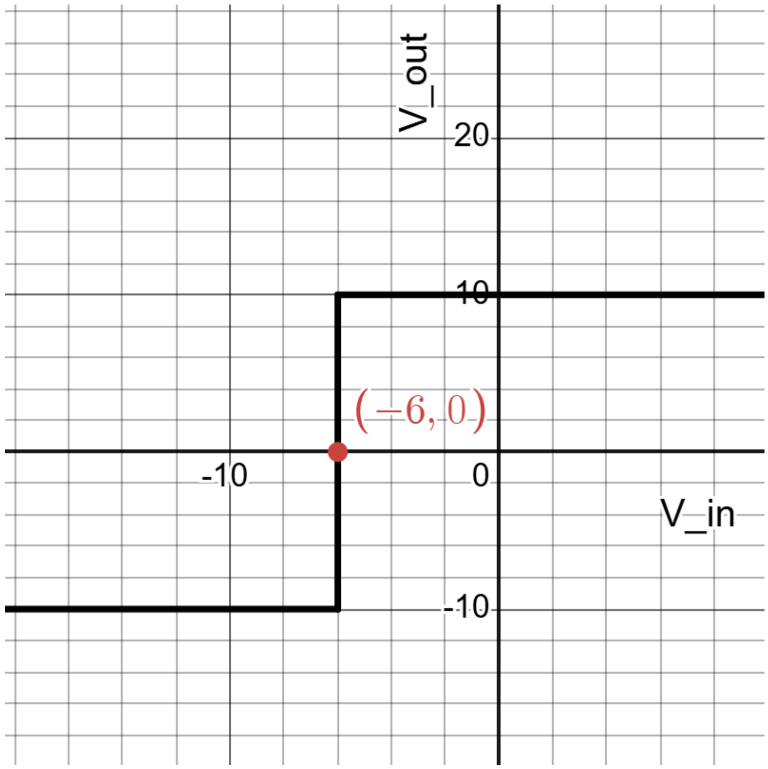
Exercise 5

Solution:

For input & reference voltage both applied to non-inverting terminal.

$$If, V_{in} > -\frac{R_2}{R_1} \times V_{ref} = -\frac{20}{10} \times 3 = -6\,V, then\ V_o = V_H$$

$$If, V_{in} < -\frac{R_2}{R_1} \times V_{ref} = -6\,V, then\ V_o = V_L$$



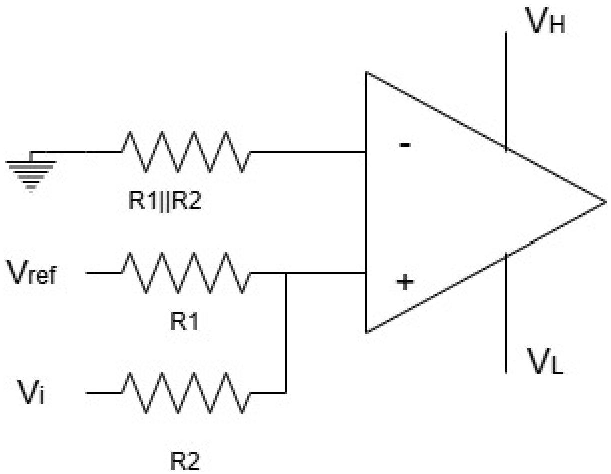
Exercise 6

Solution:

Assuming $R_1 = 5\ k\Omega$ & $R_2 = 10\ k\Omega$,

$$-\frac{R_2}{R_1} \times V_{ref} = 8 \rightarrow V_{ref} = -8 \times \frac{R_1}{R_2} = -8 \times \frac{5}{10} = -4\ V$$

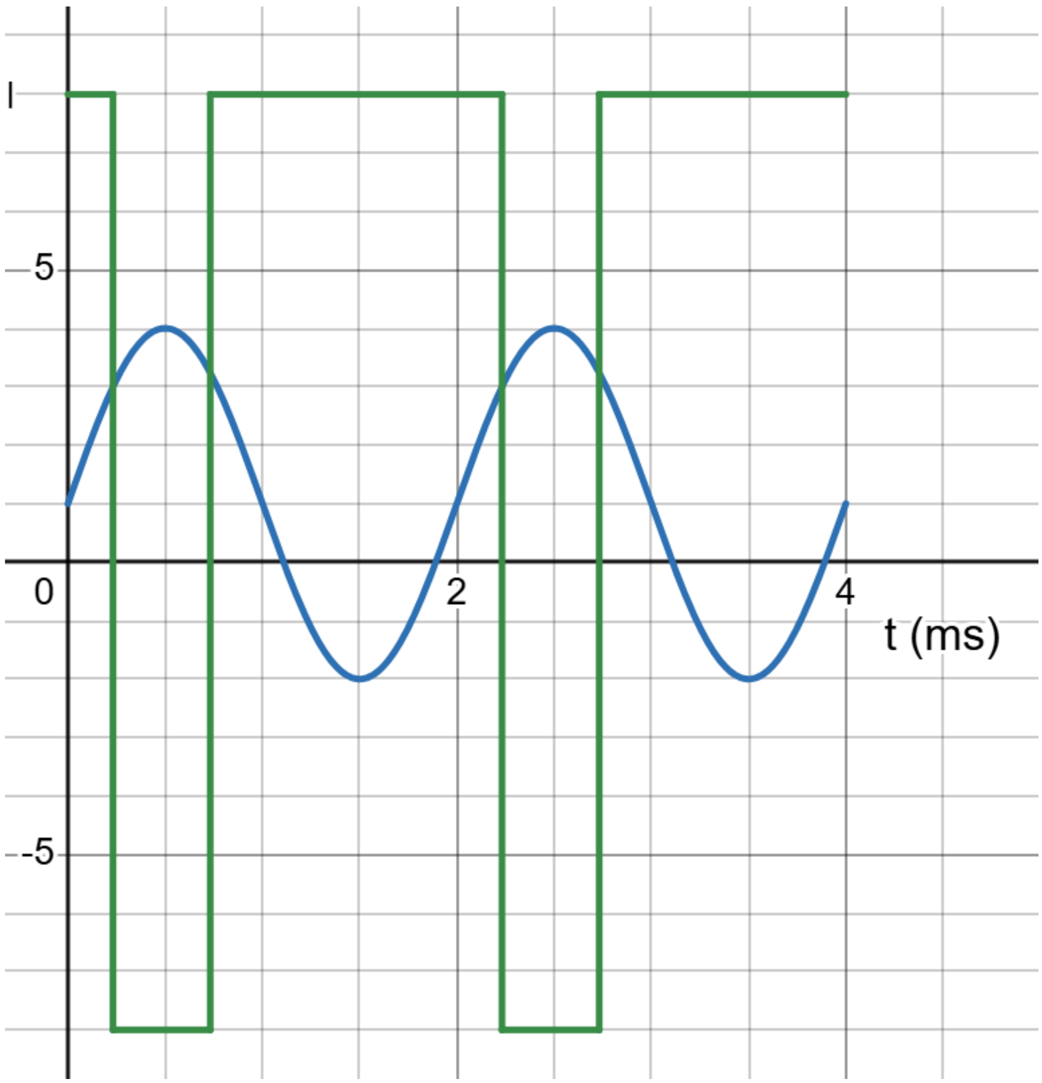
$V_H = 11\ V, V_L = -9.5\ V$



Exercise 7

Solution:

$$V_i < -\frac{R_2}{R_1} \times V_{ref} = -\frac{15}{10} \times -2 = 3\ V$$



The green graph is V_{out} vs time.

Exercise 8

Solution:

Non-Inverting:

$$V_{TH} = \frac{R_1+R_2}{R_2} \times V_{ref} - \frac{R_1}{R_2} \times V_L = \frac{5+20}{20} \times 3 - \frac{5}{20} \times -10 = 6.25\ V$$

$$V_{TL} = \frac{R_1+R_2}{R_2} \times V_{ref} - \frac{R_1}{R_2} \times V_H = \frac{5+20}{20} \times 3 - \frac{5}{20} \times 12 = 0.75\ V$$

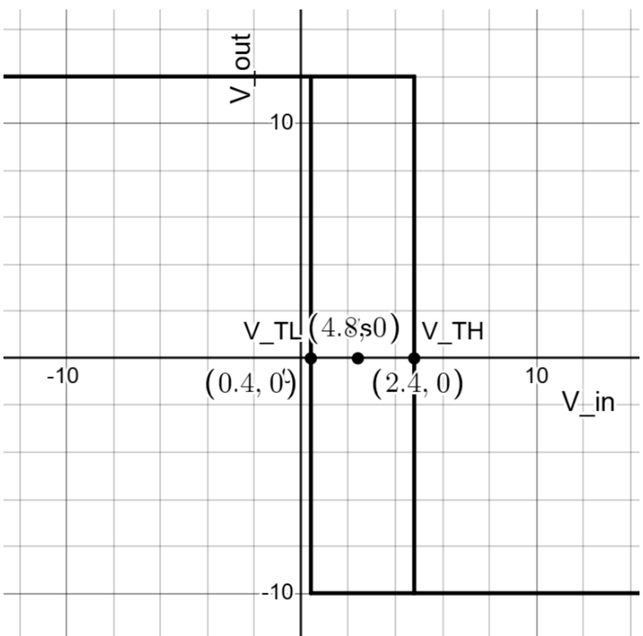
$$V_s = \frac{R_1+R_2}{R_2} V_{ref} = \frac{5+20}{5} \times 3 = 3.75\ V$$

Inverting:

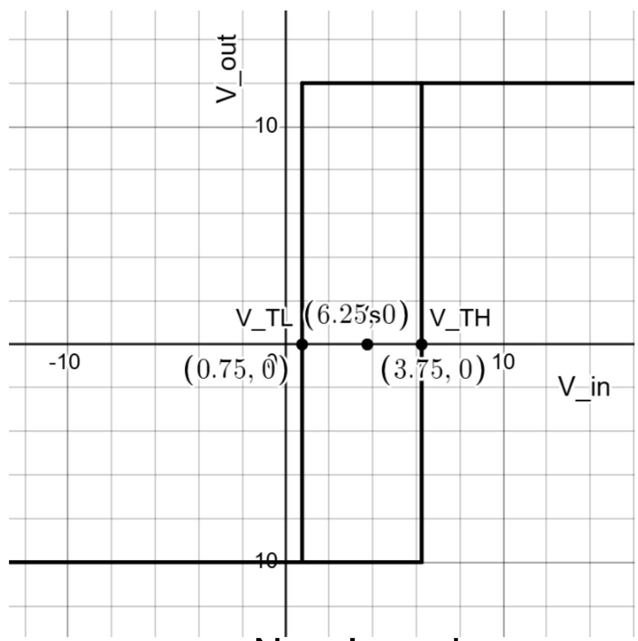
$$V_{TH} = \frac{R_2}{R_1+R_2} \times V_{ref} + \frac{R_1}{R_1+R_2} \times V_H = \frac{5}{5+20} \times 3 + \frac{5}{5+20} \times 12 = 4.8\ V$$

$$V_{TL} = \frac{R_2}{R_1+R_2} \times V_{ref} + \frac{R_1}{R_1+R_2} \times V_L = \frac{5}{5+20} \times 3 + \frac{5}{5+20} \times -10 = 0.4\ V$$

$$V_s = \frac{R_2}{R_1+R_2} = 2.4\ V$$



Inverting



Non-Inverting

Exercise 9

Solution:

The VTC is of an inverting Schmitt Trigger.

$V_S = 0.8 = \frac{R_1}{R_1+R_2} \times V_{ref} = \frac{2}{R_2+2} \times V_{ref} \rightarrow V_{ref} = \frac{0.8(2+R_2)}{2}$

$V_{TH} = V_S + \frac{R_1}{R_1+R_2} \times V_H \rightarrow 4 = 0.8 + \frac{2}{R_2+2} \times 10 \rightarrow \frac{2}{R_2+2} = \frac{3.2}{10} \rightarrow R_2 = 4.25\ k\Omega$

$\therefore V_{ref} = 1.17\ V$