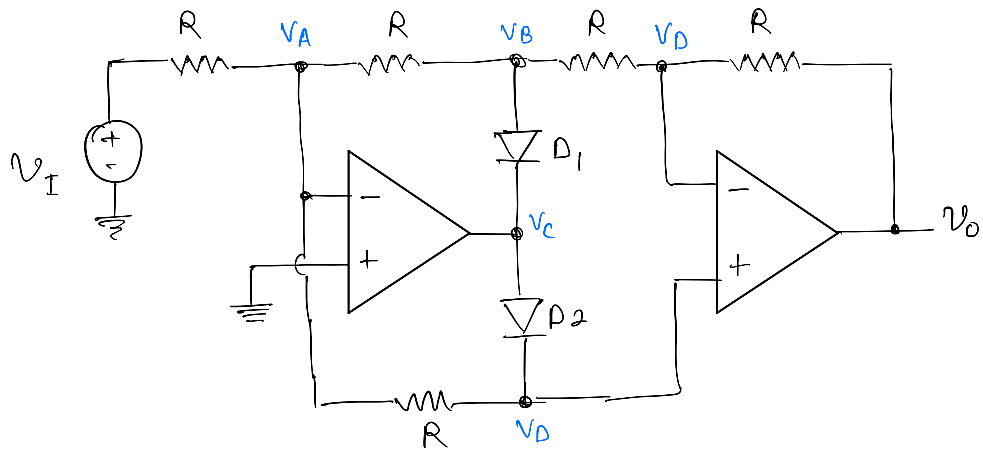
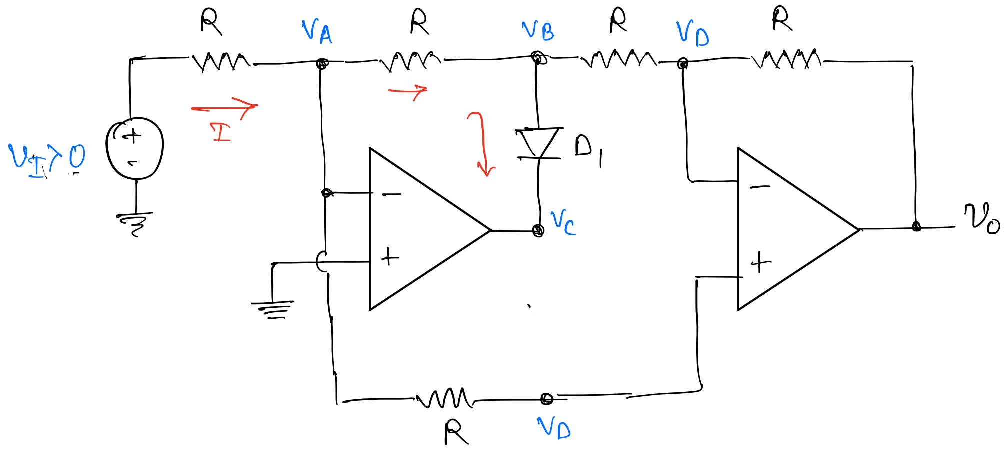
Q1)




a) Case I $v_I > 0 \Rightarrow D_1$ ON & $D_2$ OFF

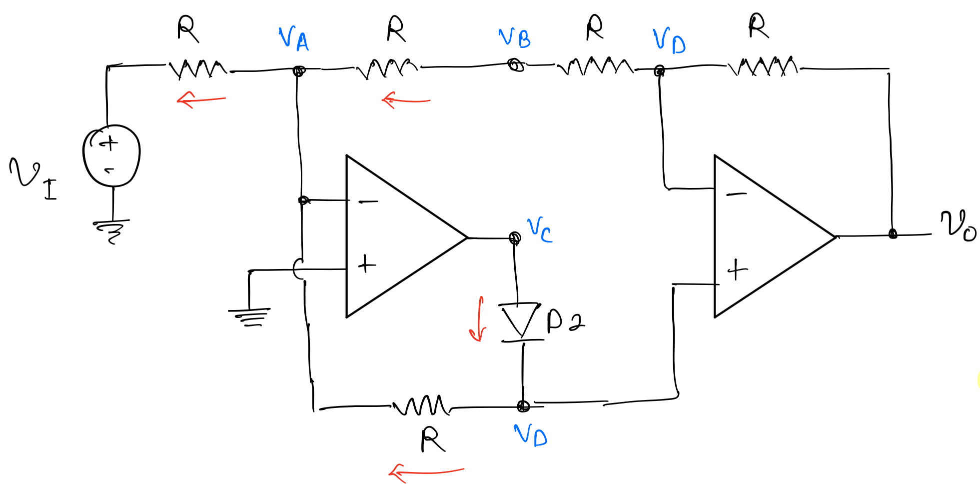



$V_A = 0$ (virtual ground)

$V_B = -v_I$

$v_o = (-R/R) \cdot v_B = v_I$

Case II) $v_I < 0$, D2 ON & D1 OFF




Apply KCL at node A

$V_A = 0$

$$-\frac{v_I}{R} = \frac{v_D}{2R} + \frac{v_D}{R} = v_D\left(\frac{3}{2R}\right)$$

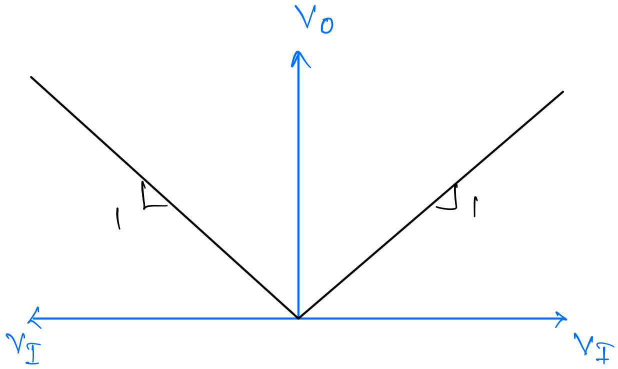
$$\therefore v_I = -\frac{3}{2} v_D$$

& $$v_o = \left(1 + \frac{R}{2R}\right) v_D$$

$$\therefore v_o = \left(\frac{3}{2}\right) v_D$$

$$v_o = -v_I$$

Thus Transfer curve




b) $V_{D_{ON}} = 0.7V$

For $V_I = 1V$

$V_A = 0$ ; $V_C = V_B - V_{D_{ON}} = -1 - 0.7 = -1.7V$

$V_B = -1V$ ;

$V_D = V_A = 0V$

$V_O = 1V$

For $V_I = -3V$

$V_A = 0$

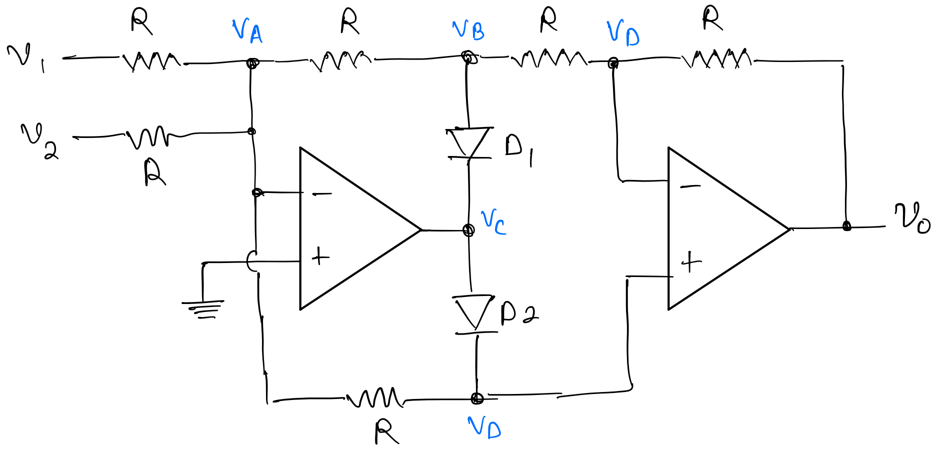
$V_D = -\frac{2}{3}V_I = 2V$

$V_C - V_{D_{ON}} = V_D$

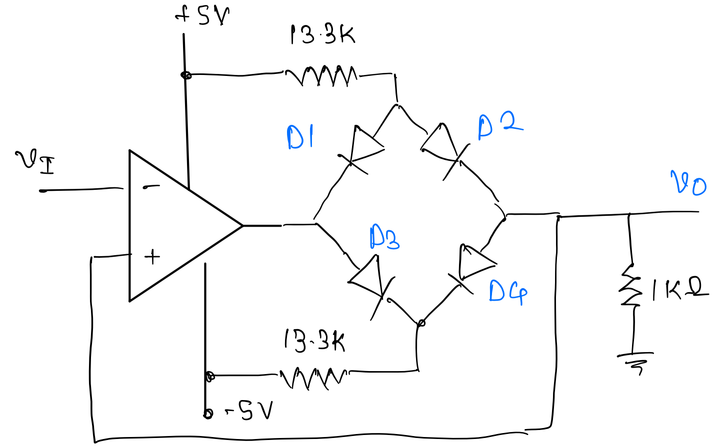
$\therefore V_C = 2.7V$

$V_O = 3V$

c) modefied circuit such that $v_O = |v_1 + v_2|$



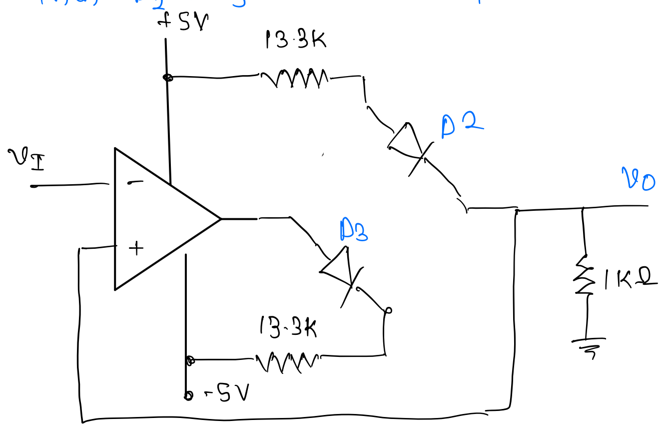
Q2)




The opamp has +ve feedback, Hence opamp o/p saturates at $\pm 4.5V$

when opamp o/p $= +4.5V$

then $D_2$ & $D_3$ are ON & $D_4, D_1$ are OFF



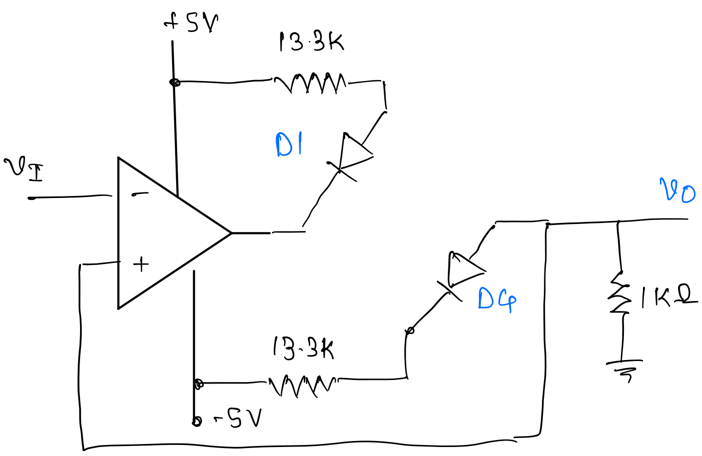

$$V_O = \frac{(5-0.7)\times(1)}{(13.3+1)} = 0.3V$$

($D_4$ cannot turn ON at this $V_O$)

Thus $v^+ = 0.3V$

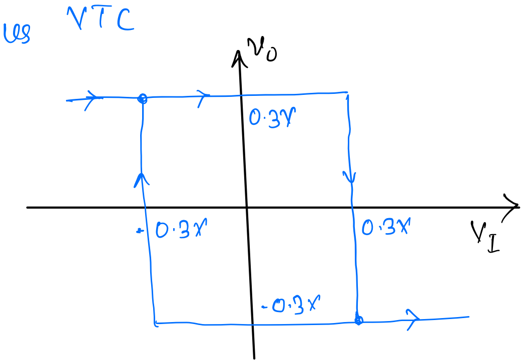
when $V_I > 0.3$

then opamp o/p saturates at $-4.5V$ ; $D_1$ & $D_4$ ON & $D_2, D_3$ are OFF

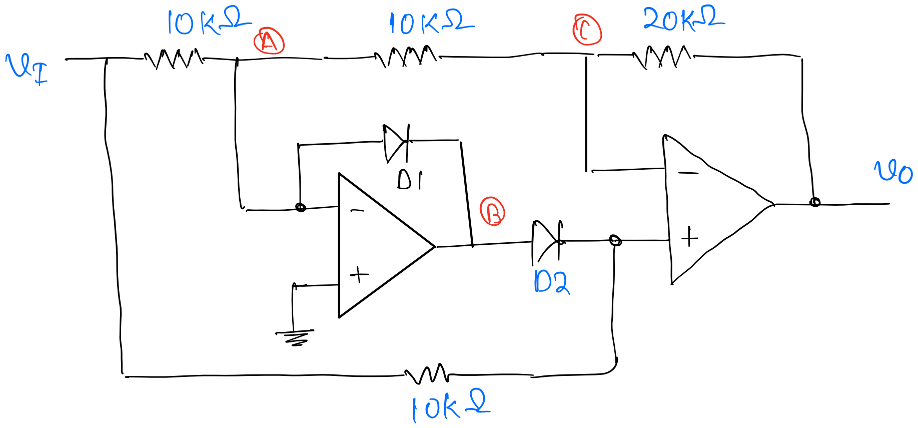



Thus $$V_O = \frac{(-5+0.7)\times 1}{(1+13.3)} = -0.3V$$

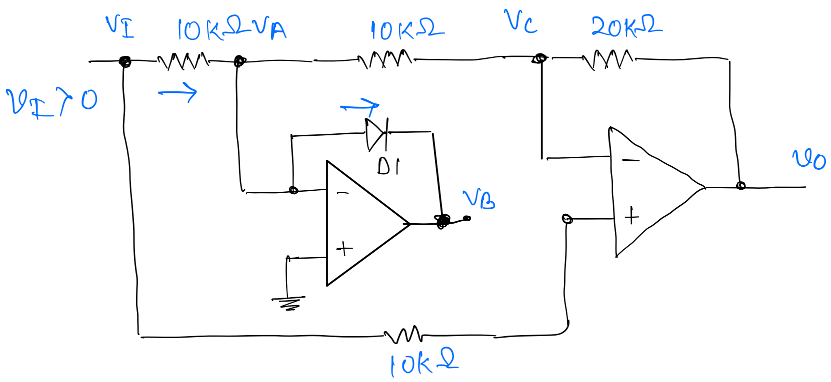
Thus VTC



Q3)




when $v_I > 0$




D1 ON & D2 Off

$V_A = 0$

$V_B = V_A - V_{D_{ON}}$

$V_C = V_I$

$\therefore V_O = V_I\left(\frac{20K}{10K} + 1\right) = 3V_I$

when $v_I = 10mV$

$V_A = 0$

$V_C = 10mV$

$V_O = 3 \times 10mV = 30mV$

$I_{D_1} = \frac{V_C}{10K\Omega} + \frac{V_I}{10K\Omega} = \frac{20mV}{10K\Omega} = 2\mu A$ & $v_{D_{ON}} = 26mV \times \ln\left(\frac{2\mu A}{20fA}\right) = 0.479V$

$\therefore V_B = 0 - 0.479 = -0.479V$

when $v_I = 1V$

$V_A = 0$

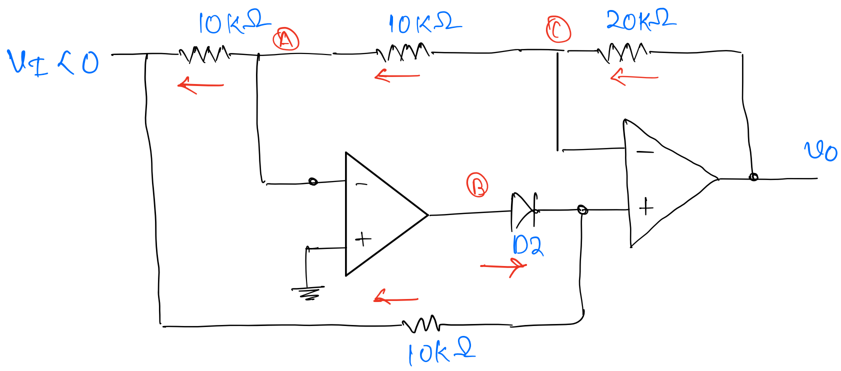
$V_C = 1V$

$V_O = 3V$

$I_{D_1} = \frac{2}{10K\Omega} = 200\mu A$ & $V_{D_{ON}} = 0.599V$

$\therefore V_B = -0.599V$

when $V_I < 0$




$V_A = 0V$

$V_C = -V_I$

$V_O = -3V_I$

when $V_I = -1V$

$V_A = 0$

$V_C = 1V$

$V_O = 3V$

$I_{D2} = \frac{V_2 - V_I}{R_4} = \frac{2}{10k} = 200\mu A \quad \therefore V_{D_{ON}} = 0.599V$

$V_B = V_C + V_{D_{ON}} = 1 + 0.599V = 1.599V$