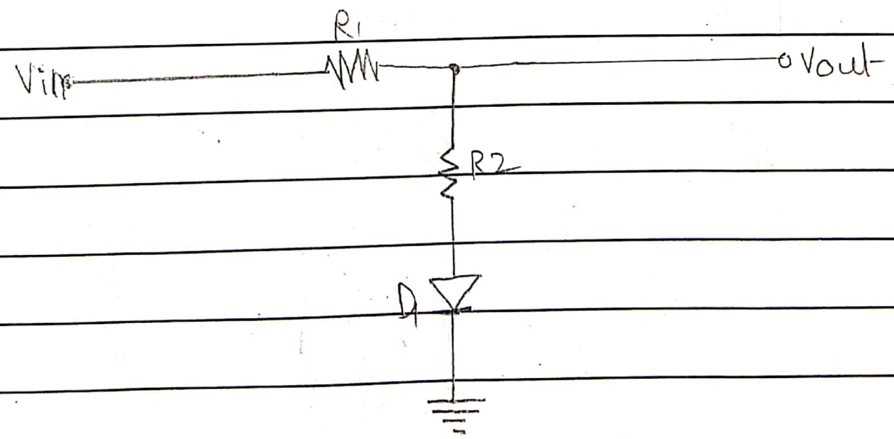
Q.2] Plot the input/output characteristic of the circuit using a) the ideal model b) the constant voltage model



We begin with $V_{in} = -\infty$ recognizing that D_1 is reverse biased. In fact for $V_{in} < 0$; the diode remains off and no current flows through the circuit. Thus, the voltage drop across R_1 is zero and $V_{out} = V_{in}$.

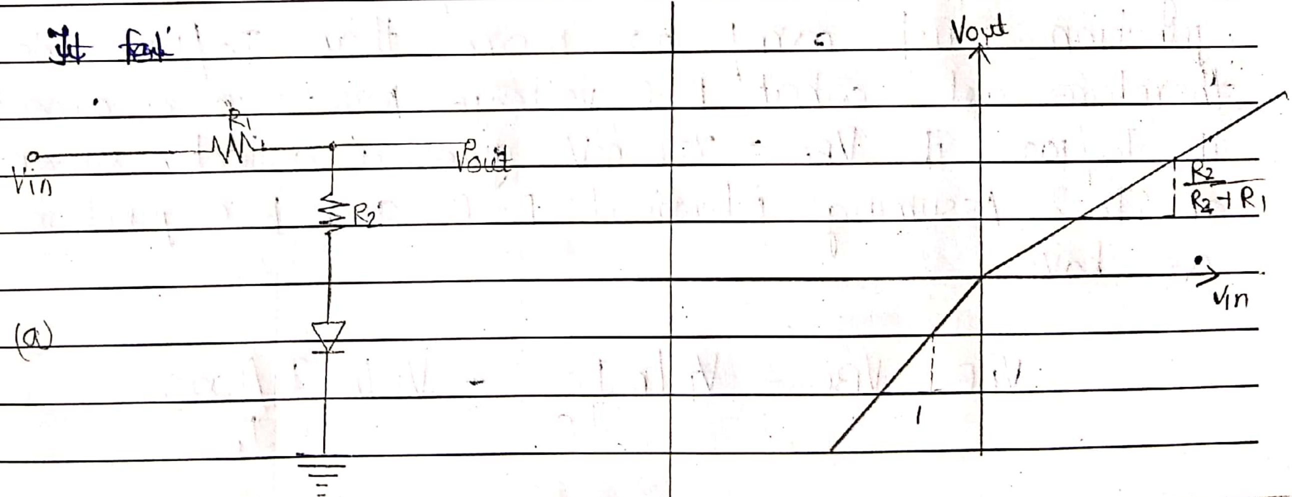
As V_{in} exceeds zero, D_1 turns on, operating as a short and reducing the circuit to a voltage divider. That is,

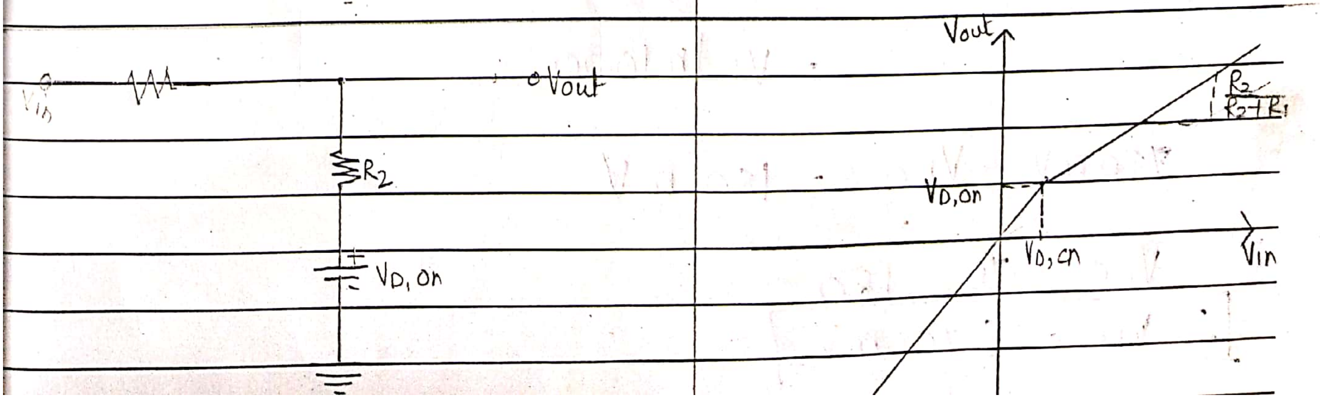
$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in} \quad \text{for } V_{in} > 0$$

Fig (b) plots the overall characteristic, revealing a slope equal to unity for $V_{in} < 0$ and $R_2/(R_2+R_1)$ for $V_{in} > 0$. In other words, the circuit operates as a voltage divider once the diode turns on and loads the output node with R_2. (b) in this case, D_1 is reverse biased for $V_{in} < V_{D,on}$, yielding $V_{out} = V_{in}$. As V_{in} exceeds $V_{D,on}$, D_1 turns on, operating as a constant voltage source with a value $V_{D,on}$ as shown in fig (c). Reducing the circuit to that in fig (c), we apply Kirchoff's current law to the output node:

$$\frac{V_{in} - V_{out}}{R_1} = \frac{V_{out} - V_{D,on}}{R_2}$$

~~It fact~~





It follows that

$$V_{out} = \frac{\frac{R_2}{R_1} V_{in} + V_{D,on}}{1 + \frac{R_2}{R_1}}$$

As expected, $V_{out} = V_{D,on}$ if $V_{in} = V_{D,on}$. Fig (d) plots the resulting characteristic, displaying the same shape as that in fig (b) but with shift in the break point