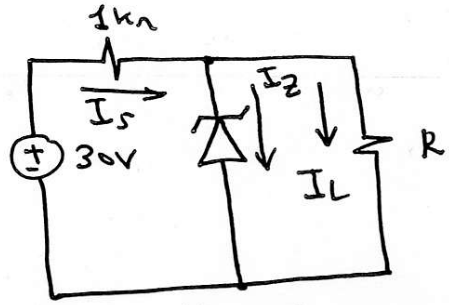


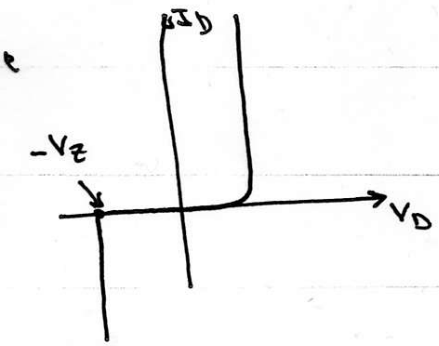
$V_Z = 5V$

$R_Z = 0\Omega$

$V_{D,on} = 0.7$

What is the smallest value of R so that the Zener will function as a voltage regulator?

The smallest possible value of R will make $V_D = -V_Z$ and $I_D = I_Z = 0\,A$.

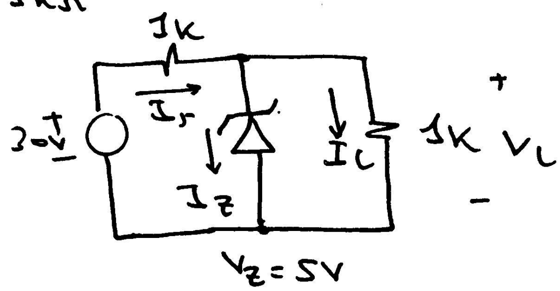


But as $I_S = I_Z + I_L \xrightarrow{\text{at } R_{min}} I_S = I_L$

$$I_S = \frac{30-5}{1K} = 25mA = I_L$$

$$\therefore \ R_{L_{min}} = \frac{5V}{25mA} = 0.2k\Omega$$

If $R_L = 1k\Omega$



* Assume diode is in reverse region

$\therefore \quad I_L = I_s = \frac{30}{2K} = 15\,mA \Longrightarrow V_D = -I_L * R_L$

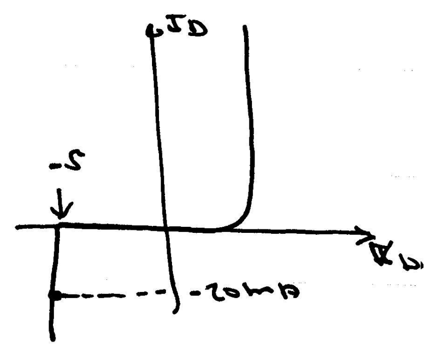
$\therefore \quad V_D = -15V \Longrightarrow$ Contradiction as $V_D < -V_Z$

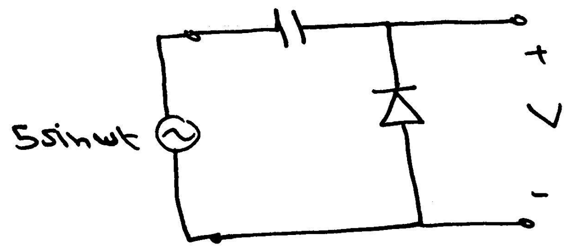
* Zener must be in the breakdown region

$\therefore \quad V_L = 5V \Longrightarrow I_L = \frac{5}{1K} = 5\,mA$

$I_s = \frac{30-5}{1K} = 25\,mA$

$\therefore \quad I_Z = I_s - I_L = 20\,mA$

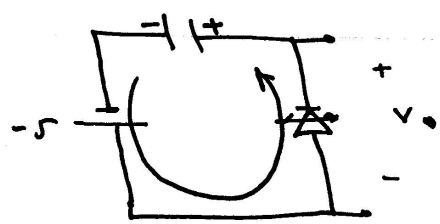




$V_{D,on} = 0$

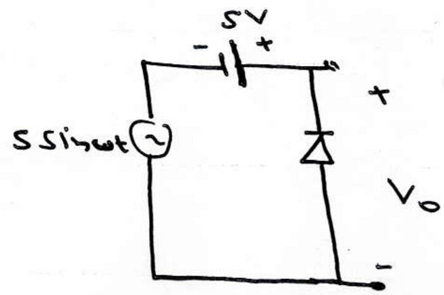
What are the minimum and maximum values of the output voltage V_o?

Transient analysis: At the first negative side of the sin wave, diode is forward bias and Capacitor charges to 5V and $V_o = 0V$

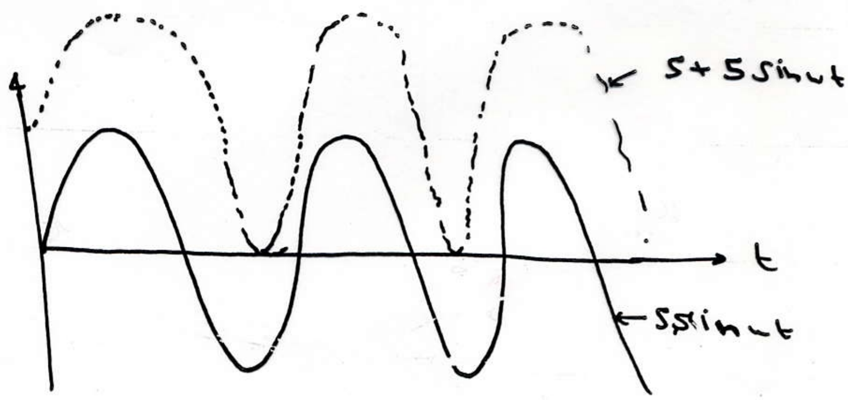


Notice that Capacitor CAN NOT discharge!

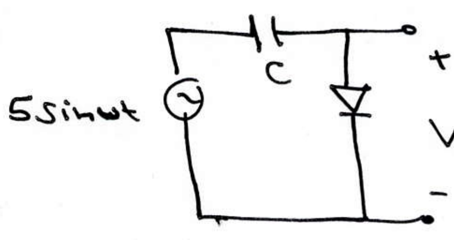
Steady state:

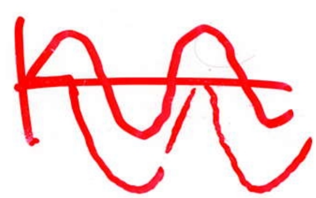


At steady state $V_o = 5\sin\omega t + 5$, diode is always reverse biased and capacitor can no discharge



Try:



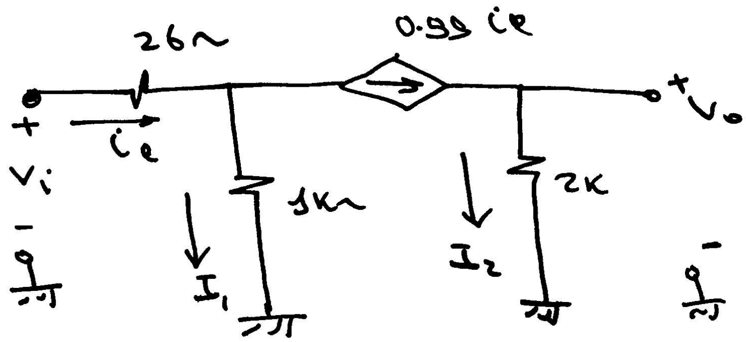


(5)

A pn junction can be approximated by an abrupt Junction with $N_A = 10^{18}$ cm^{-3}, $N_D = 10^{14}$ and $n_i = 10^{10}$ cm^{-3}. If the width of the depletion region in the n region is 3.0 μm. What is the width of the depletion region in the p region?

$$x_p = \frac{3.0 \times 10^{-6}}{10^4} = 3 \times 10^{-10} m = 3 \times 10^{-8} cm$$

(using $N_A x_p = N_D x_n$)



For the shown circuit determine the voltage gain V_o / V_i

$I_1 = i_e - 0.99\, i_e = 0.01\, i_e$

$V_i = 26\, i_e + 1000 \times 0.01\, i_e = 36\, i_e$

$V_o = 0.99\, i_e \times 2000$

$\therefore \dfrac{V_o}{V_i} = \dfrac{0.99 \times 2000}{36} = 55$