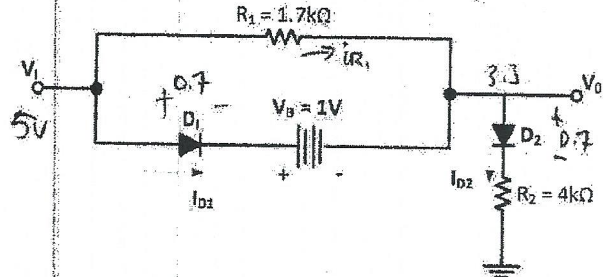
1. Consider the circuit shown below. $V_\gamma = 0.7V$ for each diode. $V_I = 5V$.



$i_{R_1} = \frac{5-3.3}{1.7k} = 1mA$

a. Assume both diodes are conducting. Is this a correct assumption? Prove your answer using the necessary calculations. (10 Points)

$-5V + V_\gamma + V_B + V_o = 0$

$V_o = 3.3V$

$3.3 - 0.7 - i_{D2}(4k) = 0$

$\frac{2.6}{4k} = i_{D2} = 0.65mA$

$i_{D1} + i_{R1} = i_{D2}$

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$i_{D1} + 1.0mA = 0.65mA$

$i_{D1} = -0.35mA$ ← incorrect since I_{D1} is negative.

b. What is the value of I_{R1}, I_{D1}, I_{D2} and V_0 for the correct operating conditions of the diodes? (15 points)

Assume D_1 OFF, D_2 ON

$I_{R1} = I_{D2}$

$-5 + I_{R1}(1.7K) + 0.7 + I_{R1}(4K) = 0$

$\frac{4.3}{5.7K} = I_{R1} = 0.754mA$

$V_o = 5 - I_{R1}(1.7K) = 3.7175V$

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$I_{R1} = I_{D2} = 0.754mA$

$I_{D1} = 0$

$V_o = 3.718V$

2.

a. Consider the simple full-wave battery charging circuit below. Assume $V_B = 6V$, $V_\gamma = 0.6$ and $v_s = 12\sin(\omega t)$ V. Determine the fraction (percent) of time that both diodes is conducting. (15 points)

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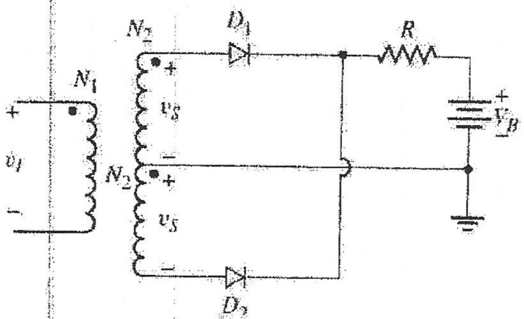


$12\sin(\omega t_1) = 6.6$

$\omega t_1 = \sin^{-1}\left(\frac{6.6}{12}\right) = 33.37°$

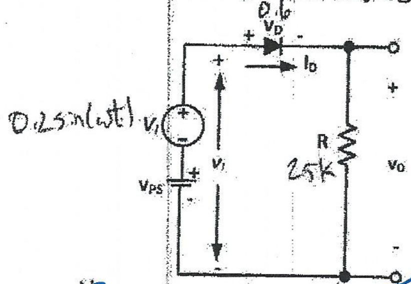
$\omega t_2 = 180 - 33.37 = 146.63°$

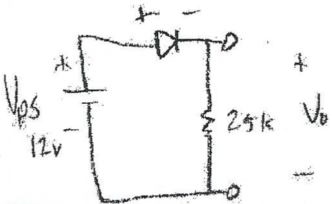
$\% = \frac{\omega t_2 - \omega t_1}{360} \times 100\% = \boxed{31.5\%}$

$\times 2 = 63\%$

b. The circuit and diode parameters for the following circuit are $V_{PS} = 12V$, $R = 25k\Omega$, $V_\gamma = 0.6V$ and $V_i = 0.2\sin(\omega t)V$. Determine the quiescent diode current and the time varying diode current. ($V_T = 26mV$) (10 points)

Find I_{DQ} & I_{tot}

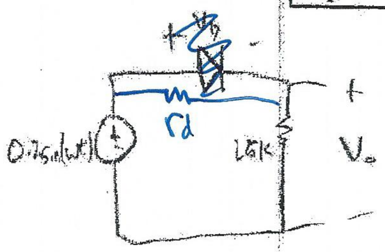




KVL

$-12 + 0.6 + I_{DQ}(25K) = 0$

$\boxed{I_{DQ} = \frac{11.4}{25K} = 0.456mA}$



$r_d = \frac{26mV}{I_{DQ}} = 57.02\Omega$

$-0.2 + 0.6 + I_D(25K)$

$I_D = \frac{-0.4}{25K} = -16\mu A$

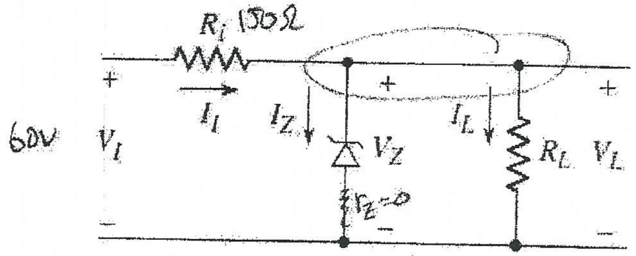
$I_{tot} = I_{DQ} + i_D$

$\boxed{I_{tot} = 0.456 - 0.016\sin(\omega t) \text{ mA}}$

Ac

$-V_i + i(r_d) + i(R) = 0$ $\quad i_d = \frac{V}{r_d + R} = \frac{0.2\sin(\omega t)}{(57.02) + 25k}$

3. Consider the zener diode circuit shown below.



Since $r_Z = 0\Omega$

$V_Z = V_{Z0} = 15.4V$

$P_D = 4w$

$I_{Dmin} = 15mA$

Let $V_I = 60V$, $R_i = 150\Omega$, and $V_{Z0} = 15.4V$. Assume $r_z = 0$. The power rating of the diode is 4W and the minimum diode current is to be 15mA.

Assume $R_L = \infty$ a. Determine the range of Zener diode currents ($I_{Z(max)}$ and $I_{Z(min)}$) (15 points)

$\hookrightarrow P_D = I_{Zmax}(V_Z) \rightarrow 4 = I_{Zmax}(15.4) = 0.2597A = \boxed{259.7mA = I_{Zmax}}$

$\boxed{I_{Zmin} = 15mA}$

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b. Determine the range of load resistance ($R_{L(max)}$ and $R_{L(min)}$) (15 points)

$I_L = \frac{V_Z}{R_L}$ $I_1 = \frac{60}{150} = 0.4A$ $I_{Zmin} = 15mA$

KCL

$I_1 = I_{Z_{min}} + I_L$

$0.4 = 15mA + \frac{15.4}{R_L}$

$\boxed{R_{Lmin} = 40\Omega}$

$I_1 = I_{Zmax} + I_L$

$0.4 = .2597 + \frac{15.4}{R_L} \rightarrow R_L = 109.7961\Omega$

$\boxed{R_{L_{max}} = 110\Omega}$

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$I_1 = \frac{60 - 15.4}{0.15K} = 297.33mA$

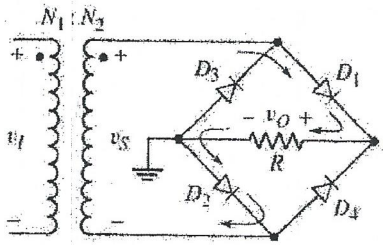
$I_{Lmin} = I - I_{Zmax} = 297.33 - 259.7 = 37.59mA$

$I_{L(max)} = I_1 - I_{Zmin} = 297.33 - 15 = \boxed{282.33mA}$

$\boxed{R_{Lmin} = \frac{15.4}{0.28233} = 54.5\Omega}$

$\boxed{R_{Lmax} = \frac{15.4}{0.03759} = 410\Omega}$

a. The input signal voltage to the full-wave rectifier circuit shown below is $v_I = 160\sin[2\pi(60)t]$ V.



$V_{I\,rms} = \frac{160}{\sqrt{2}} = 113.1V$

$\frac{V_{I\,peak}}{V_{S\,peak}} = \frac{N_1}{N_2}$

Assume $V_\gamma = 0.7V$ for each diode. Determine the required turns-ratio of the transformer to produce a peak output voltage of 100V.
(20 points)

$V_2 = 100V$

$\frac{V_S}{\sqrt{2}} \leftarrow V_S + 2V_\gamma \leftarrow 100$

$\frac{N_1}{N_2} = \frac{V_1}{V_2}$

$\frac{V_{I\,rms}}{(V_S + 2V_\gamma)_{rms}} = \frac{N_1}{N_2}$

$\frac{\frac{160}{\sqrt{2}}}{\frac{101.4}{\sqrt{2}}} = \frac{N_1}{N_2} = \boxed{1.578}$