① PROBLEM 4.63

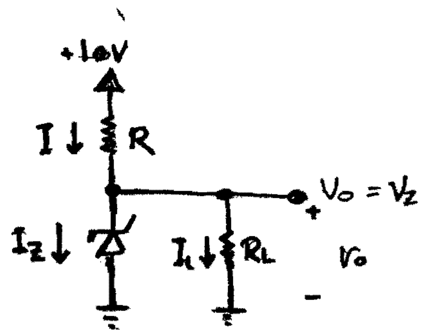
$V_Z = 7.5V$ goo!

Diode 7.5V at 10 mA

$r_z = 30\Omega$, $I_{ZK} = 0.5 mA$

$V_S = 10 \pm\% 10$

$R_L = 1.5 k\Omega$



$I_L = \frac{V_o}{R_L} = \frac{7.5}{1.5} = 5 mA$, $I = I_Z + I_{RL} = 10mA + 5mA = \underline{15 mA}$

$R = \frac{10 - 7.5}{15 \times 10^{-3}} = \underline{166.7\Omega}$

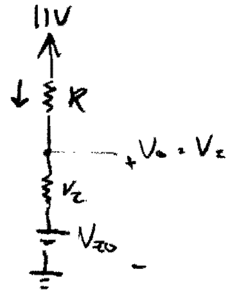
When the supply change ΔV_s, the change in the output voltage ΔV_o can be determine from

$$\frac{\Delta V_o}{\Delta V_s} = \frac{(R_L // r_z)}{(R_L // r_z) + R} = \frac{1.5k \parallel 30}{(1.5k \parallel 30) + 166.7} = 0.15$$

for $V_s = 10 + 1$ (10% high), $V_o = V_o + 0.15V = \underline{7.65V}$

for $V_s = 10 - 1$ (10% less), $V_o = V_o - 0.15V = \underline{7.35V}$

When the Load is removed and $V_s = \underline{11V}$



$V_Z = V_{Z0} + I_{ZT} r_z$

$7.5 = V_{Z0} + 0.01 \times 30$

$V_{Z0} = \underline{7.2V}$

$I = \frac{11 - 7.2}{166.7 + 30} = \underline{19.32 mA}$

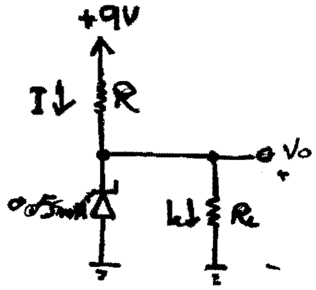
$V_o = V_{Z0} + I \times r_z$

$= 7.2 + (19.32 \times 10^{-3}) \times 30 = \underline{7.78V}$

...

① Cont. PROBLEM 4.63

to determin the smallest allowable value of R_L while $V_S = 9V$



$V_Z = V_{ZK} \approx V_{Z0} = \underline{7.2V}$

$I = \dfrac{9 - 7.2}{166.7} = 10.8\,mA$

$I_L = I - I_Z = \underline{10.3\,mA}$

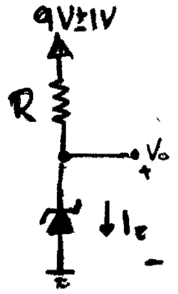
$R_L = \dfrac{V_o}{I_L} = \dfrac{7.2}{10.3} = 666.7\,\Omega$

$V_o = \underline{7.2}V$

② PROBLEM 4.64

$V_Z = 6.8V$, $r_z = 5\Omega$ for $I_Z = 20mA$ ($I_Z \approx I_{ZO}$) , at $I_Z = 0.25 mA$ $r_z = 750\Omega$

for both designs $V = 9V \pm 1V$



1st design

$I_Z = 20 mA$

$R = \frac{9 - 6.8}{0.020} = 110\Omega$

Line Regulation $= \frac{\Delta V}{\Delta V_s} = \frac{r_z}{r_z + R} = \frac{5}{5 + 110} = 43.48 mV/V$

2nd design

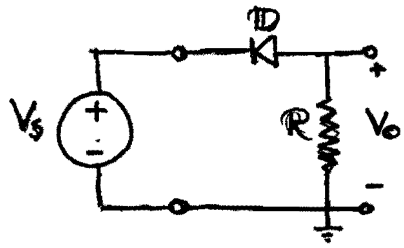
$I_Z = 0.25mA$, $V_Z = V_{ZK} \simeq V_{ZO}$, $V_Z = V_{ZK} + r_z I_Z$ (4.20), (2)

$6.8 = V_{ZO} + 5 \times 0.02 \rightarrow V_{ZO} = 6.7V$

$R = \frac{9 - 6.7}{0.25 mA} = 9.2 k\Omega$

Line Regulation $= \frac{r_z}{r_z + R} = \frac{750}{750 + 9.2k} = 75.38 mV/V$

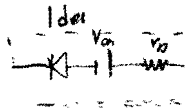
Problem ③ 4.67



$v_s = 10V$ Peak

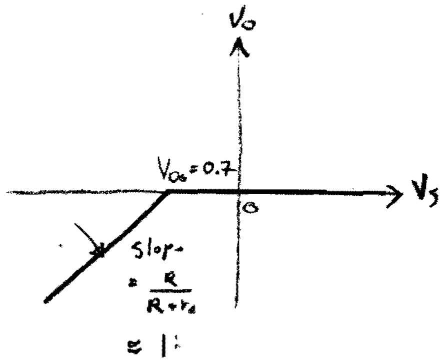
$R = 1k\Omega$

$V_D = 0.7V$

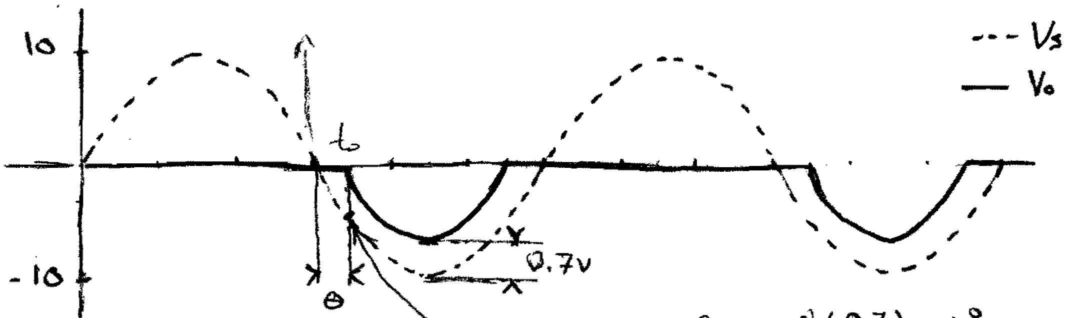


ⓐ Transfer Characteristic

$V_o = 0$ when $V_s \geq -0.7V$



ⓑ V_o waveform



$\theta = \sin^{-1}\left(\frac{0.7}{10}\right) = 4°$

$v_s = -0.7 = -10\sin(\theta)$

$\frac{0.7}{10} = \sin(\theta)$

$\theta = \sin^{-1}\left(\frac{0.7}{10}\right)$

ⓒ Average Value of V_o

V_o Start at $4°$ and stop at $(180° - 4)$

$$V_{avg} = -\frac{1}{2\pi}\int_{\theta}^{180-\theta} (10 * \sin\phi - 0.7)\, d\phi = -2.85V$$

ⓓ Peak current in diode

$$I = \frac{V}{R} = \frac{10 - 0.7}{1k} = 9.3\,mA$$

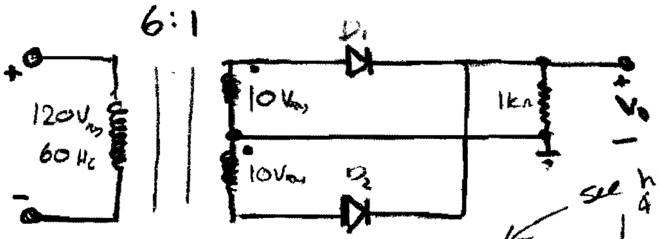
ⓔ PIV of diode

PIV occurs when V_s is in the Peak and $V_o = 0$

PIV = 10V

④ PROBLEM 4.71

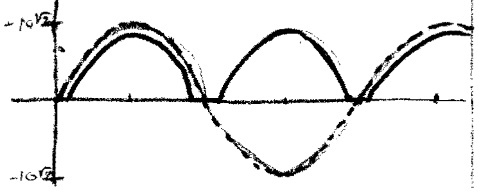
Full-wave rectifier circuit with 1 kΩ load operate from 120 V (RMS) 60 Hz 6 to 1 transformer, with Center-tapped Secondary winding.



120/6 = 20
= 10V + 10
(because of the Center-tap)

$V_0 = +0.7 = +10\sqrt{2}\sin(\theta)$

see hmwk 4.67



$V_0 = 10\cdot\sqrt{2} - V_D$
$= 13.44\,V$

$\theta_{Start} = \sin^{-1}\left(\frac{0.7}{10\sqrt{2}}\right)$
$= 2.84°$

$\theta_{End} = 180° - 2.8$

Conduction angle = $180 - 2\theta = 174.3°$, So the % when one of diodes is Conducting is $\left(100\times\frac{174.3}{180}\right) = 96.8\%$, So each diode is conducting 48.4% of the Cycle.

$V_{o,avg} = \frac{1}{\pi}\int_{\theta}^{180-\theta}(10\sqrt{2}\sin(\phi) - 0.7)\,d\phi = \underline{8.3V}$

$i_{L,avg} = \frac{8.3}{1k\Omega} = \underline{8.3\ mA}$

From text Exercise 4.20,

$$V_O \approx \frac{2}{\pi}V_S - V_D$$

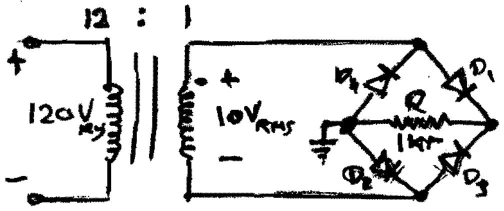
$V_S = 10\cdot\sqrt{2}\ V$ & $V_D = 0.7\ V$

$\therefore\ \underline{V_O} \approx \frac{2}{\pi}\cdot 10\sqrt{2} - 0.7 = \underline{\underline{8.30V}}$

↑

Compares extremely favorably w/ $V_{o,avg}$ calculated above.

(5) Problem 4.72



$V_{R,Peak} = 10\sqrt{2} - 2 \cdot V_D$ $\qquad V_D = 0.7$

$= \underline{12.74\,V}$ $\qquad \theta_s = \sin^{-1}\frac{1.4}{10\sqrt{2}} = 5.68°$

D_1 and D_2 Conduct together, for $\left(100 \times \frac{180-2\theta}{\theta}\right) = 46.8\%$ of the cycle.

D_3 and D_4 Conduct the rest of the cycle.

$$\underline{V_{O,avg}} = \frac{1}{\pi}\int_0^{180-\theta} (10\sqrt{2} \cdot \sin(\phi) - 1.4)\, d\phi = \underline{7.65\,V}$$

$$i_{R,avg} = \frac{V_{O,Avg}}{R} = \frac{7.65}{1k} = \underline{7.65\,mA}$$

From text Exercise 4.21

$$V_O \approx \frac{2}{\pi} V_S - 2V_D$$

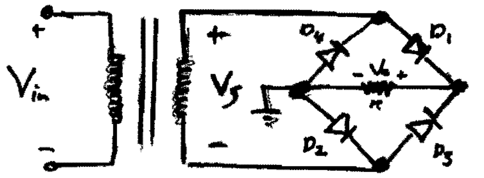
with $V_S = 10 \cdot \sqrt{2}\,V$ & $V_D = 0.7\,V$

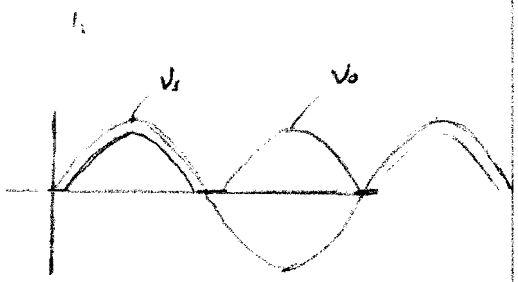
then

$$\underline{V_O} \approx \frac{2}{\pi} \cdot 10\sqrt{2} - 2 \cdot 0.7 = \underline{7.60\,V}$$

↑ Compares very favorably w/ $V_{O,avg}$ calculated above.

⑥ PROBLEM 4.74





$V_{o,avg} = \frac{2}{\pi} V_s - 2V_D$

ⓐ $V_{o,avg} = 10V$

$10 = \frac{2}{\pi} V_s - 1.4$

$V_s = 17.91V$

Turn Ratio $= \frac{120\sqrt{2}}{17.91} = \underline{9.47}$ to 1 ≈ 9

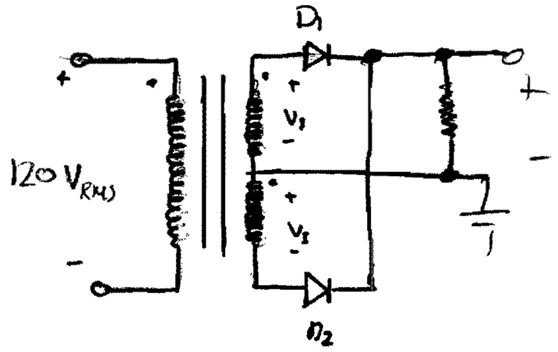
ⓑ $V_{o,avg} = 100V$

$100 = \frac{2}{\pi} V_s - 1.4$

$V_s = 159.3V$

Turn Ratio $= \underline{1.07}$ to 1 ≈ 1

(7) PROBLEM 4.75



$2 \times V_s = 20 V_{rms}$ find PIV of the diode,

$V_s = 10 V_{rms}$

Turn Ratio $120\sqrt{2} \pm 10\%$ to $20\sqrt{2} \pm 10\% \rightarrow \frac{120}{20} = \underline{6 \text{ to } 1}$

$v_s = \frac{20\sqrt{2}}{2} \pm 10\% = 10\sqrt{2} \pm 10\%$ V

$PIV = 2V_s - V_D$

$= 2 \times 10\sqrt{2}\,(1.1) - 0.7 = 30.41$ V

+10%

Using factor of 2 for safety $PIV = \underline{60.83 \text{ V}}$