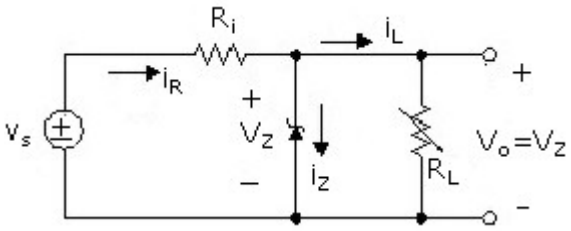
ETEE3211 Fall 2007 Test #1 Name:_____

Show all work. Clearly indicate final answer(s).

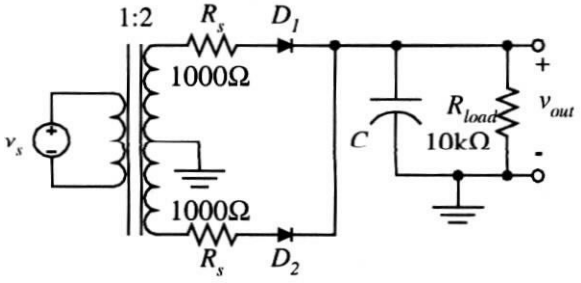
1. (20 pts) A particular diode has a reverse saturation current of 0.2μA and n=1.6. Determine the diode current when the voltage across the diode is 0.4V. Also determine the forward resistance of the diode at this operating point. Use V_T=26mV.

2. (20 pts) A half-wave rectifier output has 50V amplitude at 60Hz. Assuming no forward resistance in the diode, what minimum load could be added to the circuit when using a 50μF capacitor to maintain the voltage above 40V?

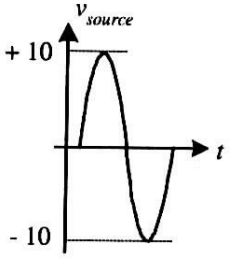
3. (30 pts) A Zener diode regulator circuit has an input whose voltage varies between 10V and 15V, and a load whose current varies between 100mA and 500mA. Find
   a. the values of R_i and I_{Zmax} assuming that a 6-volt Zener is used.
   b. the power ratings for the Zener diode and for the input resistor.

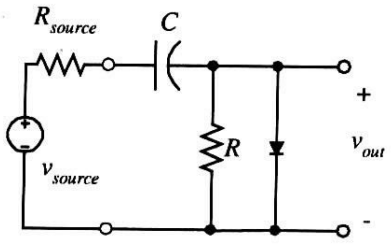


4. (30 pts) If the output load of a full-wave rectifier is 10kΩ, what value of capacitor is required to maintain an output voltage that will not vary more than 10%? The input is 120Vrms at 60Hz. Draw the output waveform. Consider the diodes and transformer idea.



Extra Credit: (25 points max)
The signal shown with a frequency of 5kHz is applied to the circuit given to the right, with the values R_S=0, R=10kΩ, C=0.5μF, R_f=0, $R_r \to \infty$ and V_{ON}=0.
   a. Sketch the output waveform, v_{out}.
   b. Repeat part (a) if R=1kΩ and C=0.001μF





7.17.07

(3.11)

P1) given $I_o = 0.2\mu A$

$n = 1.6$

$V_T = 26mV$

want: I_D when $V_D = 0.4V$

R_f

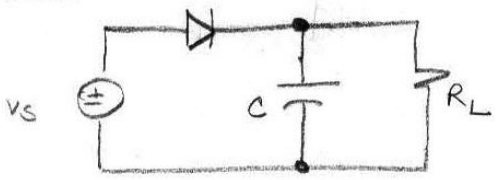
use $I_D = I_o\left(e^{V_D/nV_T} - 1\right)$; $R_f = \frac{nV_T}{I_D}$

$I_D = (0.2\times10^{-6})\left(e^{\frac{0.4}{(1.6)(0.026)}} - 1\right) \cong 3\times10^{-3}A = \underline{3mA}$

$R_f = \frac{(1.6)(0.026)}{0.003} \cong \underline{13.9\Omega}$

P2

E3.4



Want: R_{Lmin}

given: $V_s = 50V$ @ 60Hz ($R_L = R_f = 0$)

$C = 50\mu F$

$V_{min} = 40V$

use (3.52) $C = \dfrac{V_{max}}{\Delta V f_p R_L}$

to obtain: $R_L = \dfrac{V_{max}}{\Delta V f_p C}$

where $V_{max} = 50V$

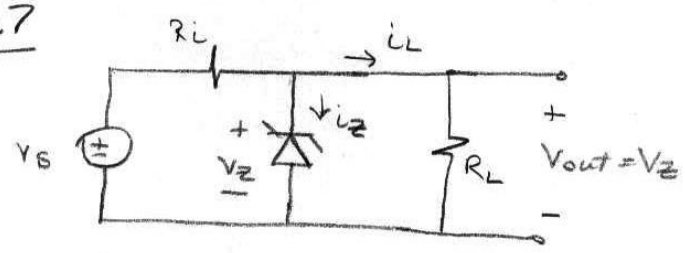
$\Delta V = 50 - 40 = 10V$

$f_p = 60$ Hz (half wave rectifier)

$$R_{Lmin} = \frac{50}{(10)(60)(50\times10^{-6})} \simeq 1.67\times10^{3}\ \Omega$$

$$R_{Lmin} = 1.67k\Omega$$

E3.7



want: $R_i + I_{Zmax}$

given: $V_{Smin} = 10V$ $V_{Smax} = 15V$

$I_{Lmin} = 100mA$ $I_{Lmax} = 500mA$

$V_Z = 6V$

use (3.61): $$I_{Zmax} = \frac{(0.100)(6-10) + (0.500)(15-6)}{10 - (0.9)(6) - (0.1)(15)}$$

$$I_{Zmax} = \frac{-0.4 + 4.5}{10 - 5.4 - 1.5}$$

$$\underline{\underline{I_{Zmax} = 1.32\,A}}$$

use (3.58) $$R_i = \frac{V_{Smax} - V_Z}{I_{Lmin} + I_{Zmax}} = \frac{15-6}{0.100 + 1.32}$$

$$\underline{\underline{R_i = 6.34\,\Omega}}$$

P3 (cont)

E3.8 from E3.7: $V_Z = 6V$, $I_{Zmax} = 1.32A$

$R_i = 6.33\Omega$

$I_{rmax} = I_{Zmax} + I_{Lmin} = 1.42A$

$P_Z = V_Z I_{Zmax} = (6)(1.32) = 7.92W$

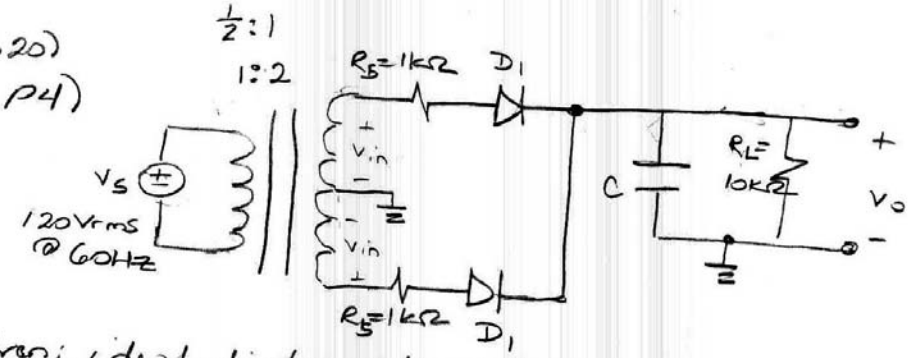
$P_{Ri} = I_{rmax}^2 R_i = (1.42)^2(6.33) = 12.76W$

or

$P_{Ri} = V_{rmax} I_{rmax} = (15-6)(1.42) = 12.78W$ close enough

(3.20)

P4)



given: ideal diodes + transformer

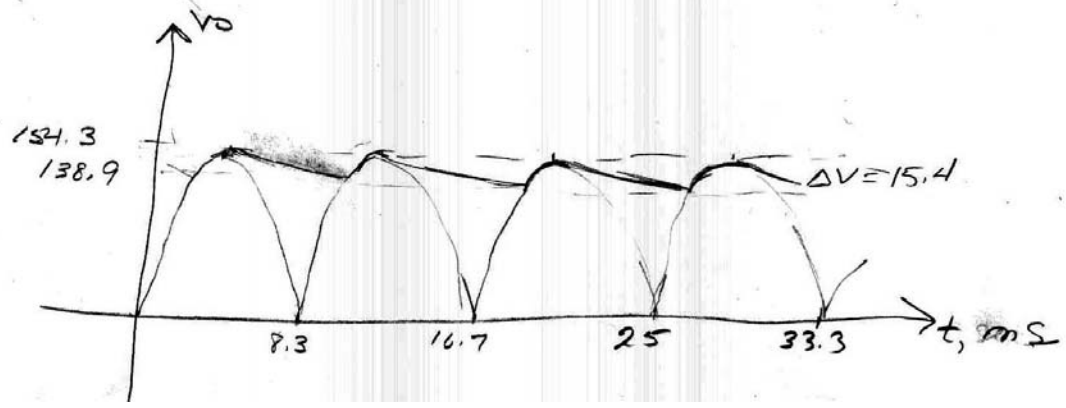
want: C so that $\Delta V_{out} \leq 10\%$

$$V_{in} = \frac{(120\sqrt{2})}{(\frac{1}{2})(2)} = 169.7\,V \quad (max)$$

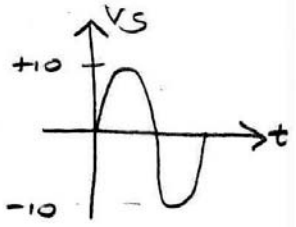
$$V_o = \frac{(10k)V_{in}}{10k+1k} = \frac{(10k)(169.7)}{11k} = 154.3\,V \quad (max) \quad \text{(voltage divider)}$$

(10%) $\Delta V_o = (0.1)(154.3) \simeq 15.4\,V$

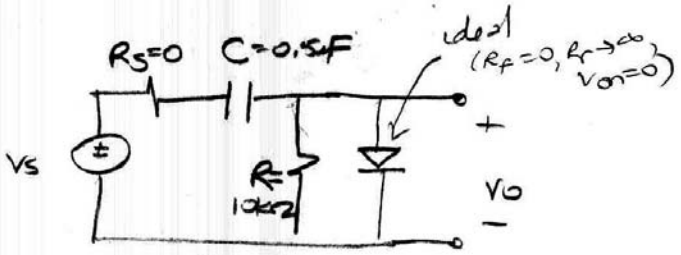
$$C = \frac{V_{max}}{\Delta V \text{ for } R_L} = \frac{154.3}{(15.4)(120)(10k)} = \underline{8.35\mu F}$$



(p3.48)
EC



f = 5kHz



clamper circuit w/ $V_B = 0$

a) $v_o = ?$

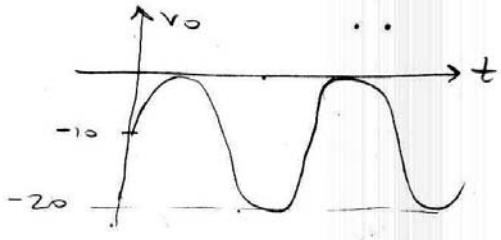
b) $v_o = ?$ if $R = 1k\Omega$ + $C = 0.001\mu F$

Need $\tau \geq \frac{5T}{2}$, $\tau = RC$

$f = 5KHz$, $T = \frac{1}{f} = 200\mu s$

$\tau_{min} = \frac{5(200\mu s)}{2} = 500\mu s$

a) $RC = (10\times10^{3})(0.5\times10^{-6}) = 5000\mu s$ $> 500\mu s$
acts like std clamper



b) $RC = (10^{3})(0.001\times10^{-6}) = 1\mu s$ $< 500\mu sec$
* does not act as clamper, acts as half wave rectifier