1. (50 pts) Assume no resistor, \( R_F \), is used in the circuit below and the transformer is a 4:1 center tapped transformer with a 120Vrms 60Hz input. Assume the minimum voltage allowed at the regulator input is 14V:
   a. What value of \( R_i \) would be needed to maintain 10V across a load whose current varies from 50mA to 200mA?
   b. What value of capacitor is needed in the regulator in order to maintain a minimum voltage of 14V?

2. (30 pts) For the circuit to the right, sketch the output voltage, \( v_o \), when the input voltage \( v_s = 9\sin \omega t \) V. Assume the \( V_{ON} \) of the diode is 0.6V and \( R_f = 0 \).

3. (20 pts) A silicon diode is placed in a circuit and is operating at 85°C. At 25°C, the diode has a 0.68V drop. What is the voltage drop of the diode when in the circuit?

Extra Credit: (20 points max) What type of circuit is needed to obtain the waveforms shown below? Assume the input is 10\( \sin t \) V. Draw the circuits and label them.
want: \( R_i \) for \( V_L = 10V \) (\( = V_2 \))

given: \( I_{\text{imin}} = 50mA \), \( I_{\text{imax}} = 200mA \)
\( V_{\text{min}} = 14V \)

use (3.58) \( R_i = \frac{V_{\text{imax}} - V_2}{I_{\text{imin}} + I_{\text{imax}}} \)

(3.61) \( I_{\text{zmax}} = \frac{I_{\text{imin}} (V_2 - V_{\text{min}}) + I_{\text{imax}} (V_{\text{max}} - V_2)}{V_{\text{min}} - 0.9V_2 - 0.1V_{\text{max}}} \)

\[ V_{\text{max}} = \sqrt{2} \cdot \text{Vrms} = \sqrt{2} \cdot \left( \frac{120}{(1)(2)} \right) = 21.21V \]

\[ I_{\text{zmax}} = \frac{(0.05)(10 - 14) + (0.2)(21.21 - 10)}{14 - (0.9)(10) - (0.1)(21.21)} = 0.709A \]

\[ R_i = \frac{21.21 - 10}{0.05 + 0.709} = 14.58 \Omega \]
$E3.11$ want $C_F$ so that $V_{\text{min}} = 14\text{V}$

from $E3.10$: $R_i = 14.85\text{Ω}$, $V_{\text{max}} = 21.21\text{V}, V_e = 10\text{V}$

use $3.62$: $C_F = \frac{V_{\text{max}} - V_e}{\Delta V f_p R_i}$

$\Delta V = 21.21 - 14 = 7.21\text{V}$

$f_p = 120\text{Hz}$ (full-wave rectifier)

$C_F = \frac{21.21 - 10}{(7.21)(120)(14.8)} = 8.75 \times 10^{-6}\text{F}$

$C_F = 8.75 \times 10^{-6}\text{F}$
Vs < 0: diode open, i = 0, v_o = 0
Vs ≥ 0: forward biased diode, R_f = 0

V_{on} = \frac{(9 - 0.6) \cdot 2k}{2k + 1k} = 5.6 V
output tracks input, but is scaled.
For P3

P3.3

Want: \( V_{on} \) @ \( T = 85^\circ C \)

Given: \( V_{on} = 0.68 \text{V} @ T = 25^\circ C \)

Use (3.32); where

\[ \begin{align*}
T_{new} &= 85^\circ C \\
T_{room} &= 25^\circ C \\
k_T &= -2 \text{mV/}^\circ C \text{ (Si)}
\end{align*} \]

\[ V_{on}(85^\circ C) - V_{on}(25^\circ C) = k_T (85^\circ C - 25^\circ C) \]

\[ V_{on}(85^\circ C) = 0.68 + 0.002(60) \]

\[ V_{on}(85^\circ C) = 0.56 \text{V} \]