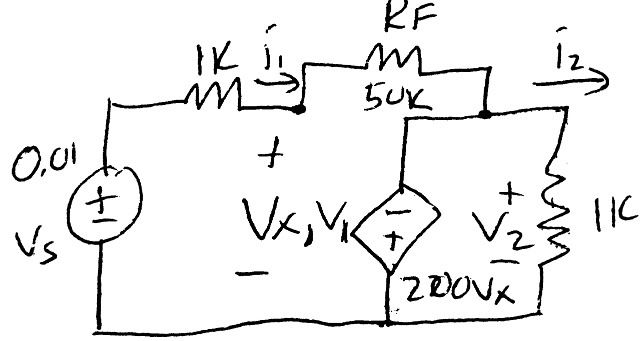
EECS 245 HMWK Solution #2

(4.4) The Key to solving linear-dependent source circuits is writing down all of the device equations.



① $V_2 = -200V_x$ ② $V_x = V_1$

③ $V_s = V_x + i_1(1K)$

④ $i_1 = \frac{V_x - V_2}{R_F}$ ⑤ $i_2 = \frac{V_2}{1K}$

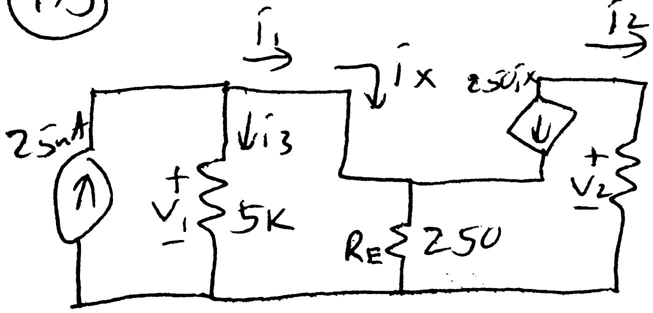
Substituting ① into ④ gives $\frac{V_x + 200V_x}{R_F} = i_1$ By ③, $i_1 = \frac{V_s - V_x}{1K}$ ∴

$\frac{V_x + 200V_x}{R_F} = \frac{V_s - V_x}{1K}$. $V_s = 0.01$, so $V_x = 2mV$ By ②, $V_2 = -0.4V$

By ⑤, $i_2 = -0.4mA$. By ④, $i_1 = 8.04uA$ $\frac{i_2}{i_1} = -49.8$

$\frac{V_1}{i_1} = 249\Omega$

(4.5)



① $i_1 = i_x$ ② $i_2 = -250i_x$

③ $V_1 = 251 i_x R_E$ ④ $i_1 + i_3 = 25uA$

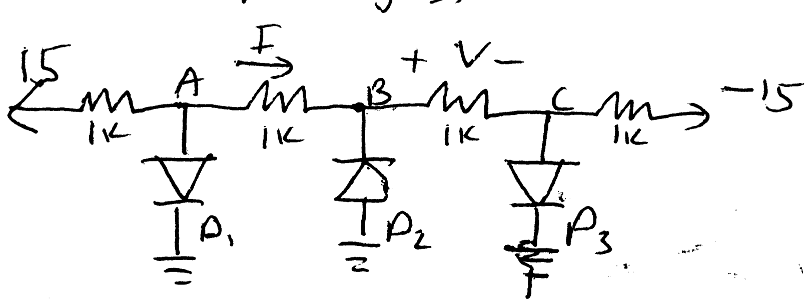
⑤ $V_1 = i_3 \cdot 5K$ ⑥ $V_2 = i_2 \cdot 1K$

Substituting ⑤ & ① into ④ gives $i_x + \frac{V_1}{5K} = 25uA$. Placing ③ into this yields $i_x + 251 i_x \frac{R_E}{5K} = 2uA$ $R_E = 250$ ∴ $i_x = 1.845uA$

By ② $i_2 = -0.461mA$ By ⑥, $V_2 = -.461$ By ③, $V_1 = .11577$ ∴

$\frac{V_2}{V_1} = -3.98$ $\frac{V_1}{i_1} = 62.75K\Omega$

(3.17) Start analysis by assuming all diodes off, then turn on and re adjust

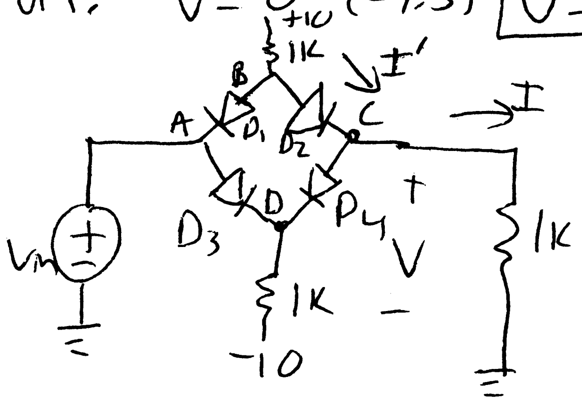


D_1 sees +15 forward bias, it turns on. $V_A = 0$

D_3 sees −15 reverse bias, stays off.

D_2 sees +15 (0−(−15)) fwd bias turns on. $V_B = 0$.

$V_A = V_B = 0 \therefore$ $\boxed{I = 0}$ $V_C = -7.5V$ (voltage divider) D_3 is still off. $V = 0 - (-7.5)$ $\boxed{V = 7.5V}$



$\underline{V_{in} = 0}$ → All diodes on. $V_A = V_B = V_C = V_D = 0$. $\boxed{V = 0, I = 0}$ $I' = 10mA$, but all goes through D_4 to −10.

$\underline{V_{in} = 2}$ → All diodes on. $V_A = V_B = V_C = V_D = 2$. $V = 2, I = 2mA$ $I' = 8mA$, excess goes through D_4. Circuit still works. $\boxed{V = 2, I = 2mA}$

$\underline{V_{in} = 6}$ → All diodes on. $V_A = V_B = V_C = V_D = 6$. $V = 6, I = 6mA$.

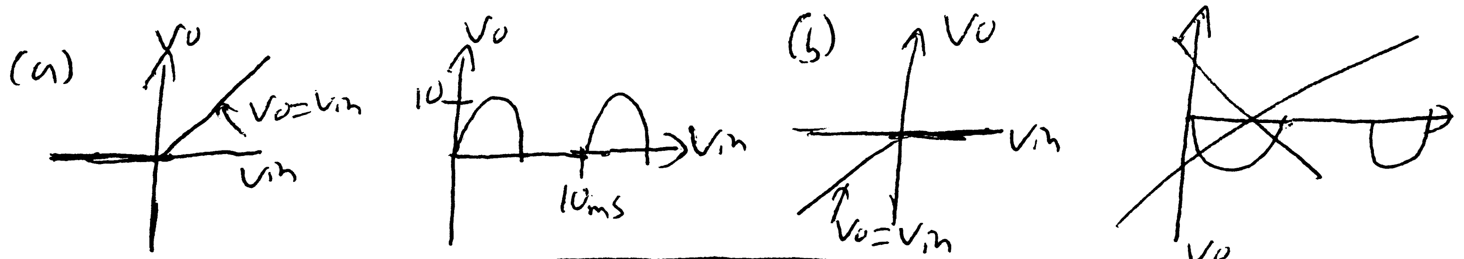
However, $I' = 4mA$. Extra current must come through D_1 or D_4, but can't travel backwards through diode. Therefore, $I \leq I'$

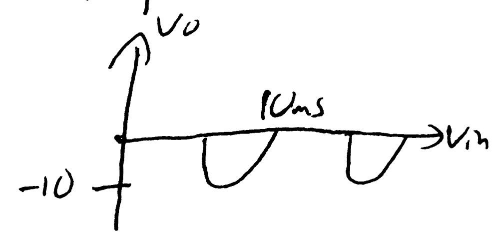
$I = I'$ at 5mA. $V_B = V_C = 5$. However, this turns D_1 + D_4 off.

So, for input voltages greater than 5, output remains at $\boxed{V = 5, I = 5mA}$ and the excess current from the input is shunted to −10.

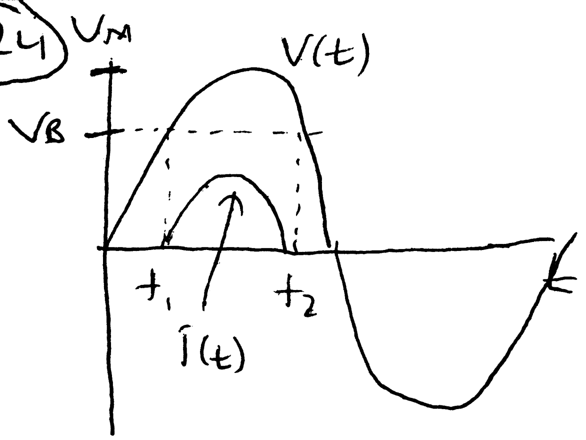
$\underline{V_{in} = 10}$ See above $\boxed{V = 5, I = 5mA}$

(3.20) ideal diode → short when on. In both circuits, diodes conduct for $V_{in} > 0$. In (A) this causes V_{in} to pass to R. In (B) it shorts V_o. For $V_{in} < 0$, in (a) Voltage cannot get to V_o. In (b), all V_{in} will be across V_o since it is an open circuit





(3.24)



$i(t)$ is non-zero only when $V(t) > V_B$
$i(t)$ will peak when $V_s(t)$ peaks at V_m. Thus, $i_{max} = \frac{V_M - V_B}{R}$ $\boxed{i_{max} = 0.6\,A}$

As a function of time, $i(t) = \frac{V_m \sin(\omega t) - V_B}{R}$ setting $i(t) = 0$,

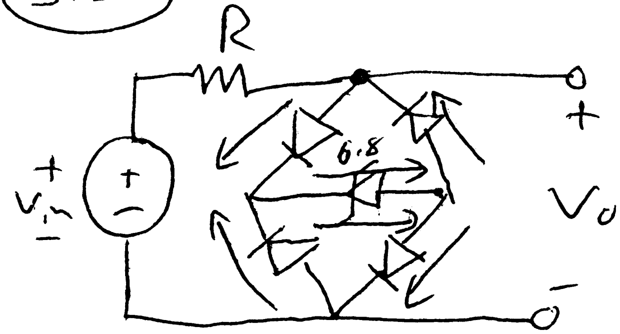
$\sin(\omega t) = \frac{V_B}{V_M}$. We have two solutions: $t_1 = \frac{.775}{\omega}$ $t_2 = \frac{2.37}{\omega}$.
These are marked on the graph. Sine wave period is $T = 2\pi/\omega$ ∴

diode on $= \frac{2.37/\omega - .775/\omega}{2\pi/\omega} = \boxed{25.3\,\%}$

(3.22) The current through the meter is a half-wave rectified sinusoid. Since voltage is 10 V_{RMS}, $V_{P-P} = 10\sqrt{2}$. Thus, current will be $\frac{10\sqrt{2}}{R}$. As given in the problem, the Avg $= \frac{V_{PP}}{\pi}$ ∴

Avg current $= \frac{10\sqrt{2}}{\pi R} = 5\,mA$ $\boxed{R = 900\,\Omega}$

(3.35)

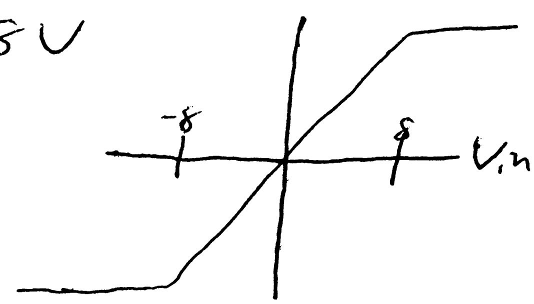


If the bridge is off, $V_o = V_{in}$. Once the bridge turns on, V_o will be held at that voltage. Higher voltages will cause more current over R & the output will be held at the initial "on" voltage.

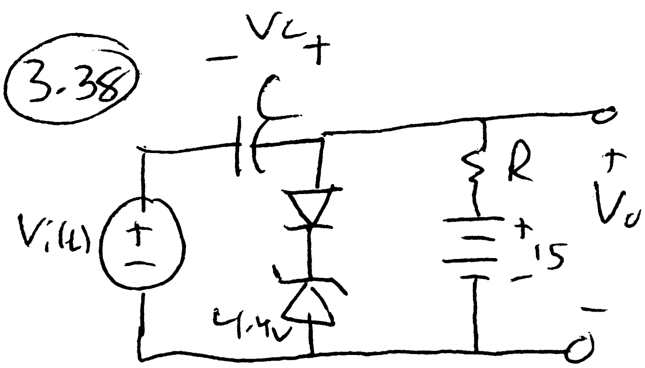
In either direction, to turn the bridge on, we must fwd bias 2 diodes, and reverse-bias the zener into break down.

Thus, On voltage = $0.6 + 6.8 + 0.6 = \pm 8V$

Current paths are labeled above.



(3.38)



Circuit operation: With no input, ($V_i(t) = 0$), Diodes will activate, Charging capacitor until $V_C = V_o = 5V$. Then, diodes shut off. If $RC \gg T$, where T is the period of $V_i(t)$, when $V_i(t)$ is turned on, V_C will remain almost constant. If $V_i(t) < 5V$, this will be passed directly to V_o. If $V_i(t) > 5V$, diodes will conduct, increasing V_C & keeping maximum at 5V. The battery is there to initially charge the capacitor to the 5V bias.