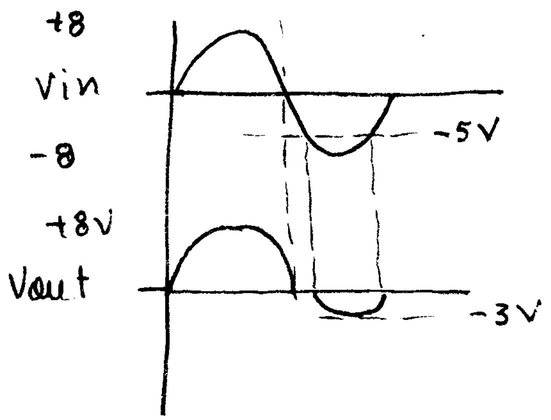
Homework Set #3
Solution

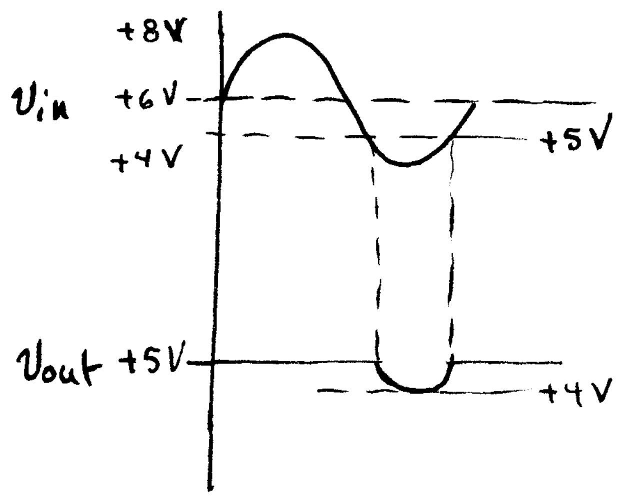
1.) <u>Basic idea</u>: For forward voltages, the diode has no effect on the circuit (or, it behaves like $R=0$). For reverse voltages the diode behaves like $R \to \infty$, and thus has <u>all</u> the voltage across it, until the reverse voltage reaches $V_Z$. Then the diode maintains $V_D = V_Z$, and otherwise acts like $R=0$.

In all cases, $V_{in} = V_D + V_R$ ($V_{in} = V_D + V_C$ for d.)

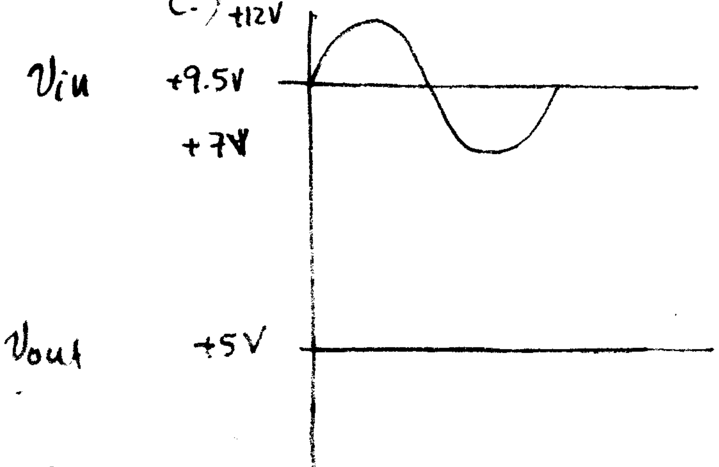
a.)



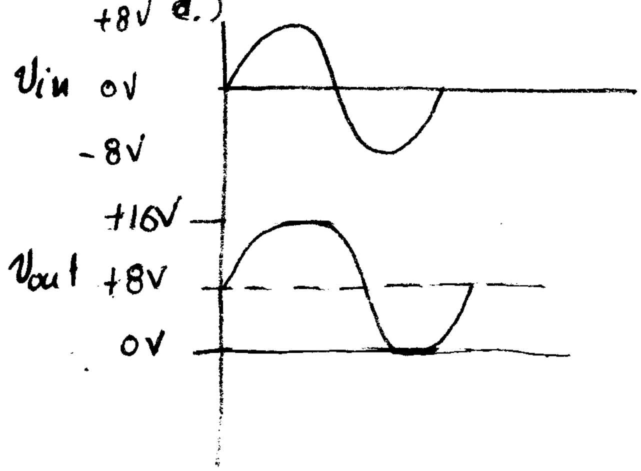

b.)




c.)



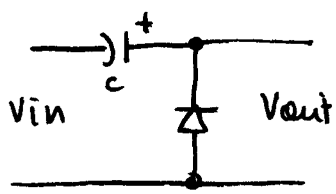

d.)



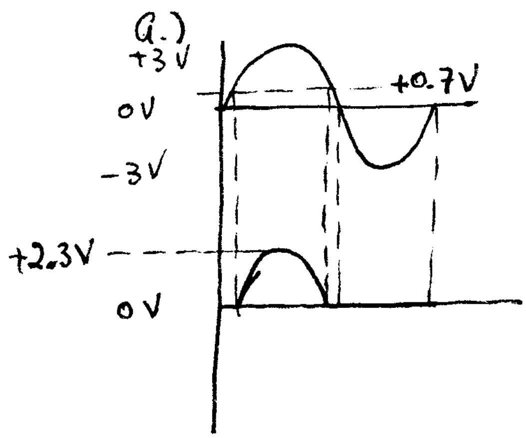
set # 3, cont

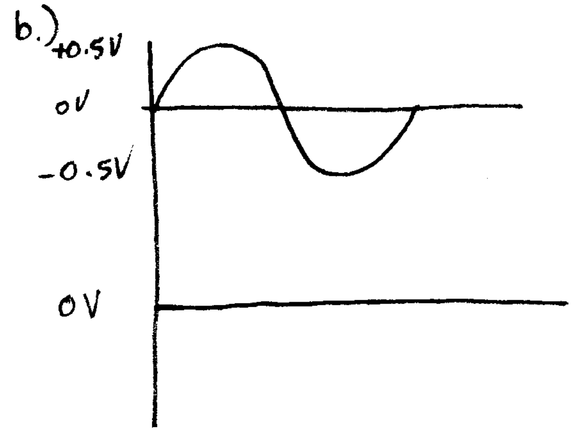
1.) cont

(1d) requires more explanation: During the 1st ~~negative~~ half-cycle, the C charges to $V_{peak}$ (= 8V, in this case). thereafter $V_{out} = V_{in} - V_c$, as shown; thus $V_{out} = V_{in}$ but shifted ~~by~~ down by $V_p$. (This is a "diode clamp")




2.) In this one, the diodes will not conduct in the forward direction until $V = V_{threshold}$ (= 0.7V, for silicon).



Set #3, cont

3.) a.) Ripple = residual a.c. on an otherwise "steady" D.C.

ripple factor = $\frac{\text{r.m.s. a.c. component}}{\text{D.C. component}} \{\times 100\%\}$

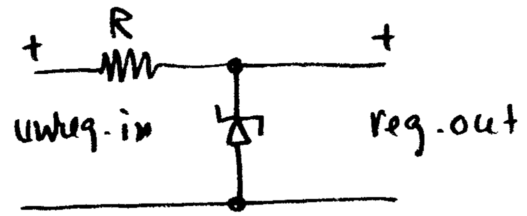
b.) Ripple results from the discharging of the filter capacitor through the load. As the charge is drained off, the voltage across the C drops according to $\Delta V_c = \frac{\Delta Q}{C}$. Since the output is across the C, this is the change in Vout, or the ripple.

as seen above, since ~~the~~ the ripple, or $\Delta V_c = \frac{\Delta Q}{C}$, two factors can reduce it: (1) More C and (2) less $\Delta Q$. Since the current to the load is $\frac{\Delta Q}{\Delta t} = I$, and the $\Delta t$ is related to the period of the unfiltered input, less ~~$\Delta Q$~~ I leads to less $\Delta Q$ during the $\Delta t$, ~~and~~ hence more R + more C → less $\Delta V_c$ or ripple.

c.) a full wave circuit ~~[illegible]~~ has less $\Delta t$ in comparison with a half-wave circuit.

Set #3, cont

4.) (a.)




(b.) "Worst case" $V_R = $ [illegible]$V - 7V = $ [illegible]$V$

- min $I_T = I_D + I_L$ @ min $V_R$ $= (200 + 10)\,ma = 210\,ma$

$\Rightarrow$ $\text{Max } R = \dfrac{\text{min } V_R}{\text{min } I_T} = \dfrac{1V}{210\,ma} = 4.76\,\Omega$

$\boxed{\text{choose } 4.7\,\Omega}$

$$P_R\Big|_{max} = \frac{V_{R,max}^2}{R} = \frac{(10V - 7V)^2}{4.7\,\Omega} = 1.9W; \boxed{\text{choose } 2W}$$

c.) No load: R is taken care of above since all current passes through the ~~B~~ R, load or not. But with No load, the current through the diode includes the 200ma originally sent to the load.

thus

$$P_D = I_T\Big|_{max} V_Z = \left(\frac{10V - 7V}{4.7\,\Omega}\right) 7V = 4.7W$$

$\boxed{\text{is less than } 10W\text{, so O.K}}$

d.) • as a result of (c)'s work, Min $I$ is 0, and is still safe.

- Max load current is $I_L$ such that $I_T\Big|_{min} - I_L < 10\,ma$.

$$I_T\Big|_{min} = \frac{V_{R,min}}{R} = \frac{1V}{4.7\,\Omega} = 212\,ma.$$

so, $I_L > 202\,ma$ will allow less than 10 ma to diode at some times.

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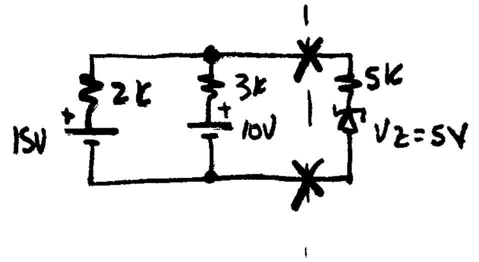
5). Re-draw as shown + use Thevenin's theorem at X's:

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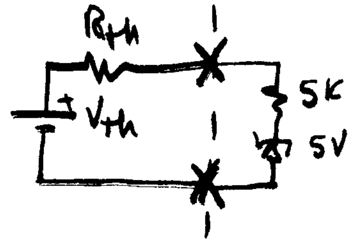


$R_{th} = 3k // 2k = 6k/5 = \underline{1.2k}$

$V_{th} = 15V - 2\left(\frac{15-10}{2+3}\right)V = \left(15 - \frac{10}{5}\right)V = \underline{13V}$

$$\therefore \boxed{I_{5k} = \frac{V_{th} - V_Z}{R_{th} + 5k} = \frac{8V}{6.2k} = 1.29\,ma}$$

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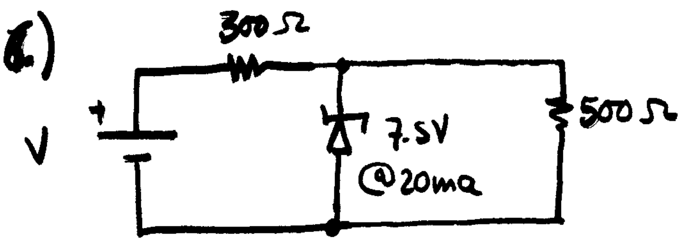
6)




a.) for minimum V,

$I_Z = 20\,ma$

AND $I_{500} = 7.5V/500\,\Omega$

$= 15\,ma$

$\therefore I_{300} = I_Z + I_{500} = 35\,ma$

$+ \; V_{300} = (300)(35\,ma) = \underline{10.5V}$.

thus, $\boxed{V_{min} = V_{300} + 7.5V = 10.5 + 7.5 = 18V}$

b.) $V = 20V \Rightarrow V_{300} = (20 - 7.5)V = \underline{12.5V} \Rightarrow I_{300} = \frac{12.5V}{.3k} = \underline{41.7\,ma}$

$\underline{I_{300} = I_D + I_{500} \; ; \; I_{500} = 7.5V/.5k = \underline{15\,ma}}$

$\therefore \boxed{I_D = I_{300} - I_{500} = 41.7\,ma - 15\,ma = \underline{26.7\,ma}}$