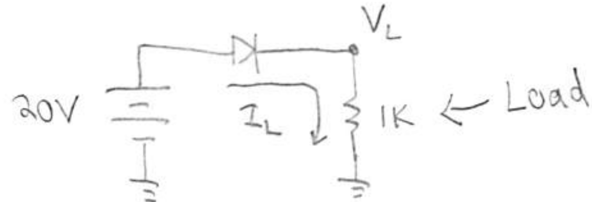
ECE 248
HW 1 Solns

Total = 100 pts

3.9

(+6)

$V_L = 20 - 0.7 = \boxed{19.3V}$



$I_L = \frac{V_L}{1K} = \boxed{19.3\,mA}$

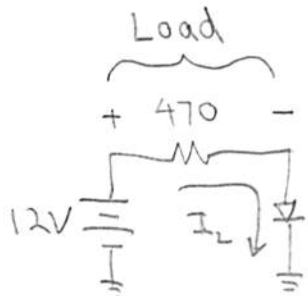
$P_L = I_L V_L = (19.3mA)(19.3V) = \boxed{372.5\,mW}$

$P_D = I_L \times 0.7V = (19.3\,mA)(0.7V) = \boxed{13.5\,mW}$

$P_T = P_L + P_D = \boxed{386\,mW} = I_L \times 20V$

3.11

(+6)



$V_L = 12 - 0.7 = \boxed{11.3V}$

$I_L = \frac{V_L}{470} = \boxed{24\,mA}$

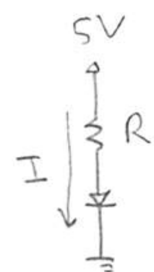
$P_L = I_L V_L = (24\,mA)(11.3V) = \boxed{271.2\,mW}$

$P_D = I_L \times 0.7V = (24\,mA)(0.7V) = \boxed{16.8\,mW}$

$P_T = P_L + P_D = \boxed{288\,mW} = I_L \times 12V$

3.28

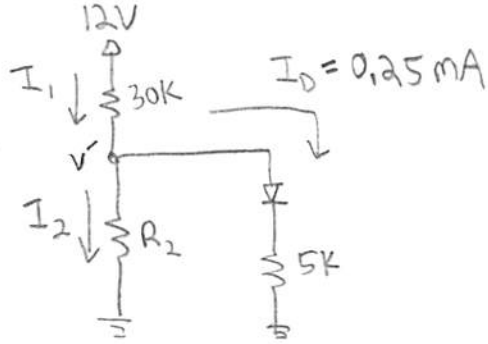
(+5)



$I = \frac{5 - 0.7}{R} = 20\,mA$

$R = \frac{4.3V}{20mA} = 0.215K = \boxed{215\Omega}$

3.29 (+6)



Since we know I_D,

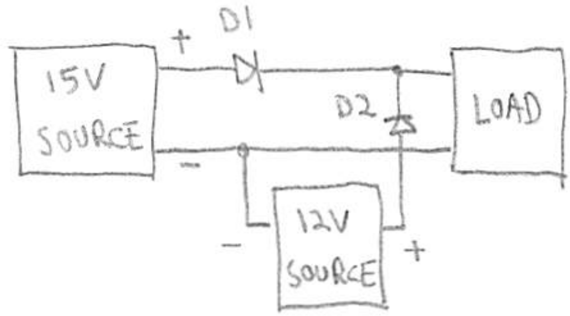
$$V' = I_D \times 5K + 0.7V$$
$$= (0.25\,mA)(5K) + 0.7V = 1.95V$$

By KCL, $I_2 = I_1 - I_D = \frac{12-1.95}{30K} - 0.25mA$

$$= 0.085\,mA = \frac{V'}{R_2} = \frac{1.95V}{R_2} \Rightarrow R_2 = \frac{1.95V}{.085mA} = 22.9K$$

$\sim$ **23K**

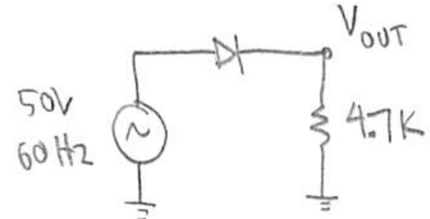
3.33 (+6)



- When 15V source is ON,
  D1 is ON and D2 is OFF
  ⇒ Load sees 14.3V
- When 15V source is OFF,
  D1 is OFF and D2 is ON
  ⇒ Load sees 11.3V

4.3 (+6)

Need peak V_{OUT}, so we need peak V_{IN}

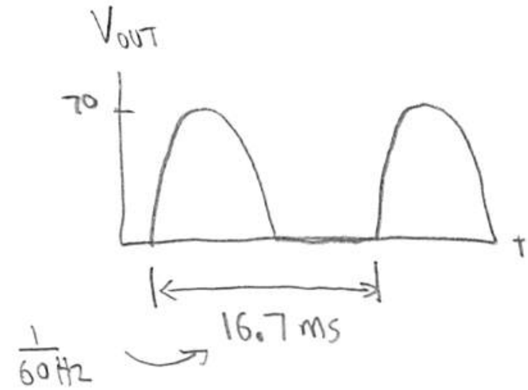


$$50\,V_{rms} = \frac{1}{\sqrt{2}} V_{peak}$$

$$\Rightarrow V_{peak} = 50 \times \sqrt{2} = 70.7V$$

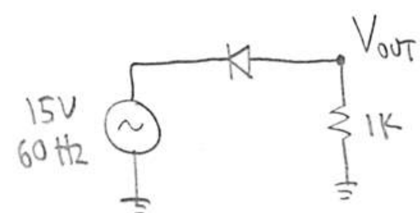
$$\Rightarrow V_{OUT,p} = 70.7 - 0.7 = \boxed{70V}$$

$$V_{AVG} = V_{DC} = \frac{V_{OUT,p}}{\pi} = \boxed{22.3V}$$



4.4 (+6)

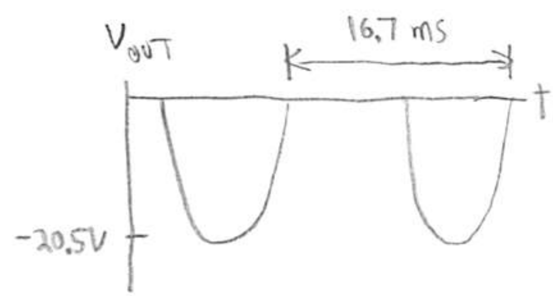
$$V_{peak,IN} = 15 \times \sqrt{2} = 21.2V$$



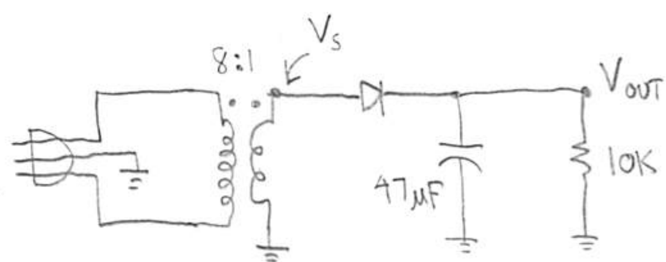
Negative output peak is:

$$V_{OUT,p} = -21.2 + 0.7 = \boxed{-20.5V}$$

$$V_{DC} = \frac{-20.5}{\pi} = \boxed{-6.5V}$$



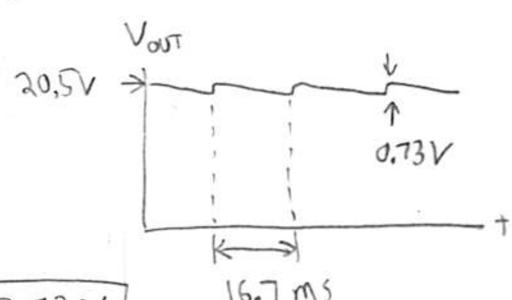
4.17 (+6)



$$V_{s,peak} = \frac{1}{8} \times V_{LINE,p}$$

$$= \frac{1}{8} \times \sqrt{2} \times 120V = 21.2V$$

$$V_{OUT,p} = 21.2 - 0.7 = \boxed{20.5V}$$

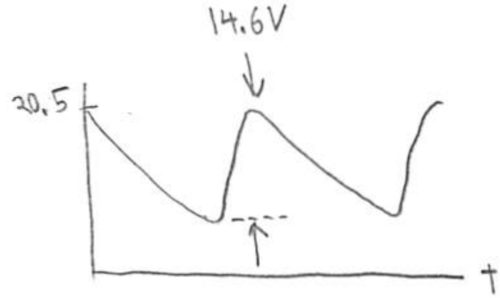


$$V_{ripple} = \frac{V_{OUT,p}}{R_L}\frac{1}{fC} = \frac{20.5V}{10^4\Omega} \times \frac{1}{(60Hz)(47 \times 10^{-6}F)} = \boxed{0.73V}$$

4.20 (+6)

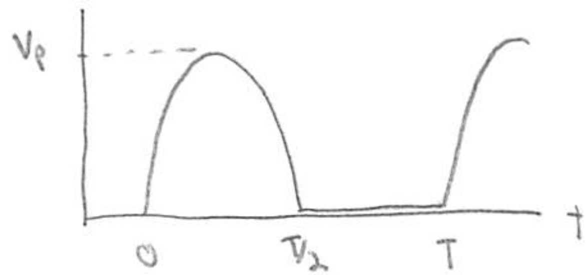
Since $V_{ripple} = \frac{V_{peak}}{R} \frac{1}{fC}$ $\left(\frac{500\Omega}{10000\Omega} = \frac{1}{20}\right)$

↑ If R is reduced by 20, then V_{ripple} increases by 20 due to larger current draw.



$V_{ripple} = 20 \times 0.73V = \boxed{14.6V}$! Not a good DC supply ☹

4.xx (+6)



$$V_{DC} = \frac{1}{T}\int_0^T V_p(t)\,dt$$

$$= \frac{1}{T}\int_0^{T/2} V_p \sin 2\pi f t\,dt + \frac{1}{T}\int_{T/2}^{T} 0 \cdot dt \;\rightarrow 0$$

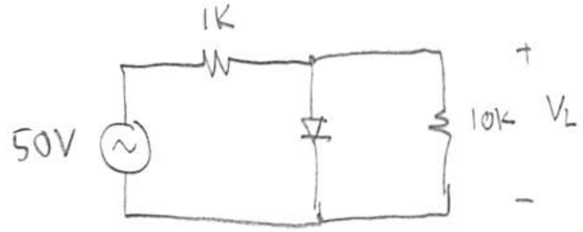
$$= \frac{1}{T} \times \frac{V_p}{-2\pi f} \cos 2\pi f t \Big|_0^{T/2} = \frac{-V_p}{2\pi f T}\left[\cos \pi f T - \cos 0\right]$$

Since $f = \frac{1}{T} \Rightarrow fT = 1 \Rightarrow V_{DC} = \frac{-V_p}{2\pi}\left[\cos\pi - 1\right]$

$$\boxed{V_{DC} = \frac{V_p}{\pi}}$$ ✓

4.33 (+6)

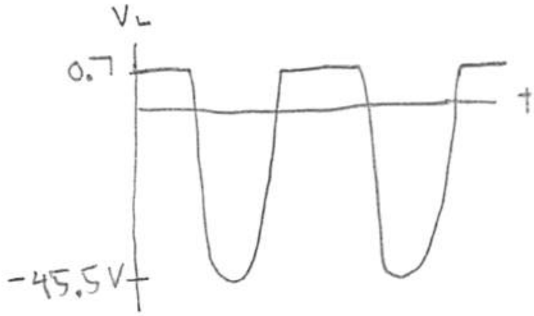
Positive clipper chops off above 0.7V



For $V_{IN} < 0.7V$, diode is OFF

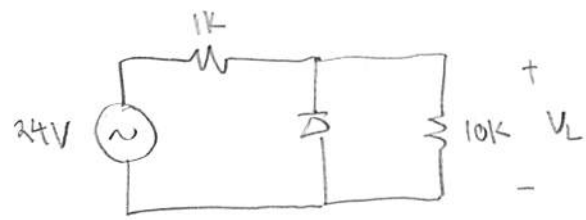
$$V_L = V_{IN} \times \frac{10K}{10K+1K}$$

When $V_{IN} = -50V$, $V_L = -45.5V$



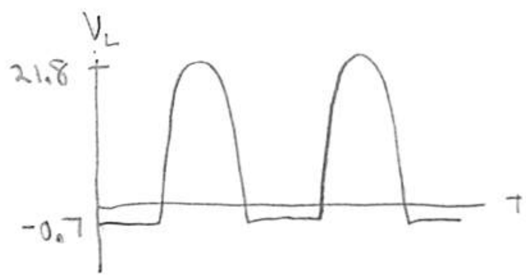
4.34 (+6)

Negative clipper clamps at −0.7V



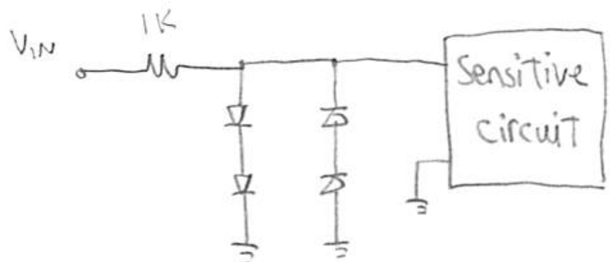
When $V_{IN} > -0.7V$, $V_L = V_{IN} \times \frac{10K}{10K+1K}$

When $V_{IN} = 24V$, $V_L = 24 \times \frac{10}{11} = 21.8V$



4.35 (+5)

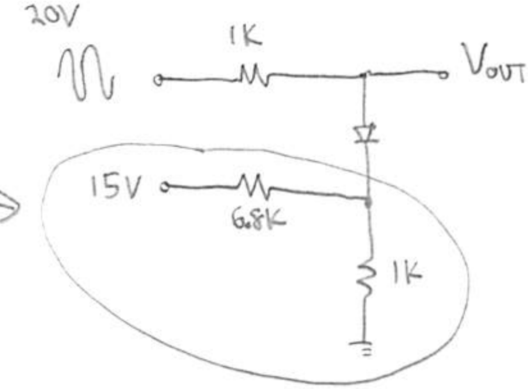
Limiting levels are $\boxed{\pm 1.4V}$



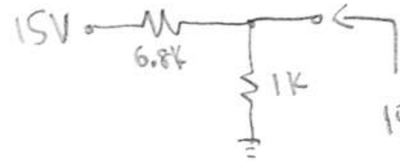
4.36

(+6)

To find max voltage, need to determine Thevenin equivalent of voltage divider →

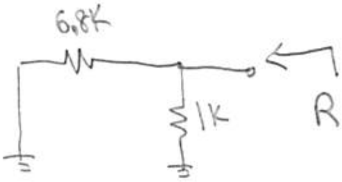


open circuit voltage:



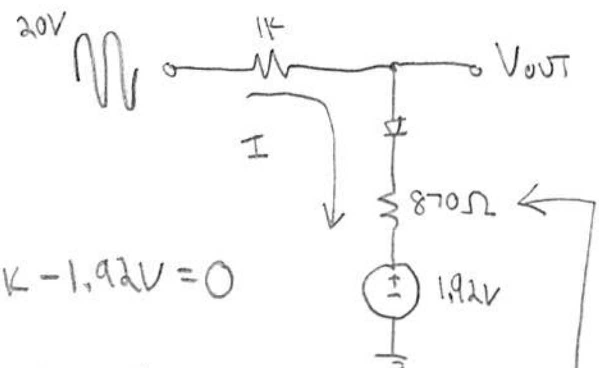
$15 \times \frac{1K}{1K + 6.8K} = \underline{1.92V}$

Equivalent resistance:



$R_{TH} = 6.8K \,//\, 1K = \underline{0.87K}$

New circuit looks like:



use KVL:

$$20V - I \times 1K - 0.7 - I \times .87K - 1.92V = 0$$

$$I = \frac{20 - 0.7 - 1.92V}{1.87K} = \underline{9.3\,mA}$$

$$V_{OUT,MAX} = 20V - (9.3mA)(1K)$$

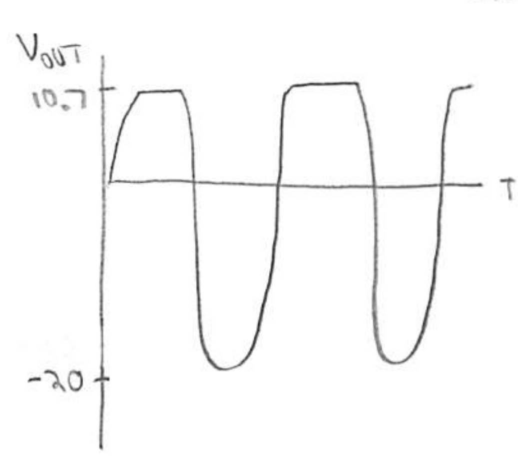
$$= \boxed{10.7V}$$

This resistor causes V_{OUT} to **NOT** be clamped at $1.92 + 0.7 = 2.62V$!

Max negative V_{OUT}?

Diode is OFF

→ $V_{OUT} = V_{IN} = \boxed{-20V}$



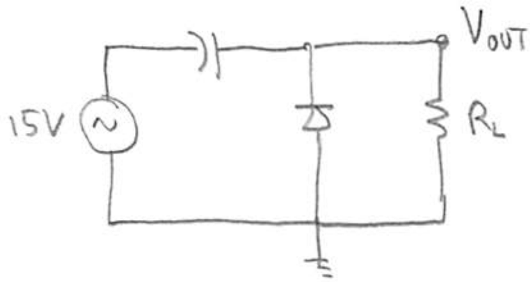
4.38

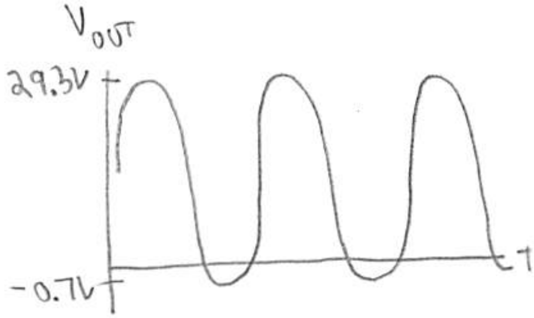
+6

$V_{MAX} = 2V_p - 0.7 = 30 - 0.7$

$= 29.3V$

$V_{MIN} = -0.7V$





4.39

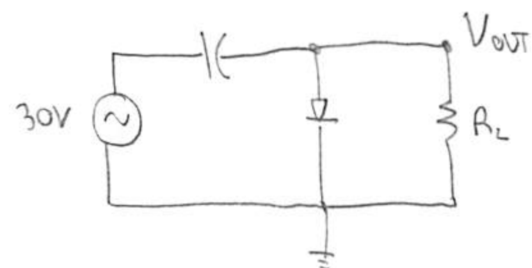
+6

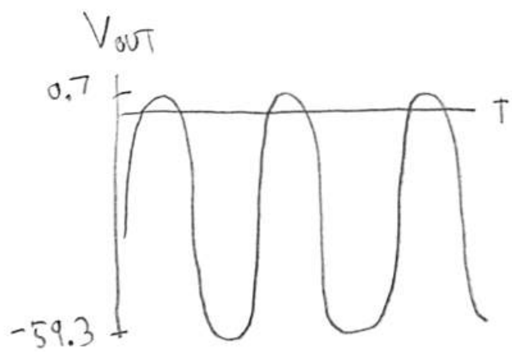
This is a <u>negative</u> clamper!

$V_{MAX} = +0.7V$

$V_{MIN} = -(2V_p - 0.7) = -(60 - 0.7)$

$= -59.3V$

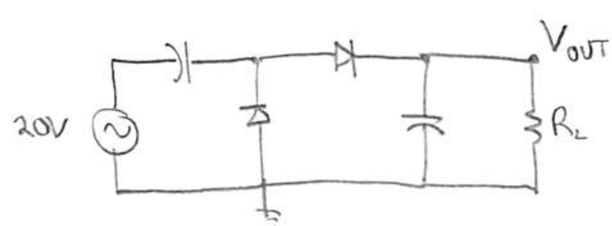




+6

4.40

- Ideal diodes have <u>zero</u> voltage drop



- Second approx includes 0.7V drop