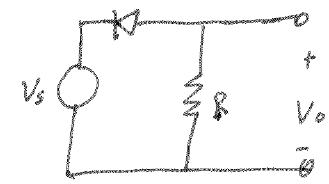
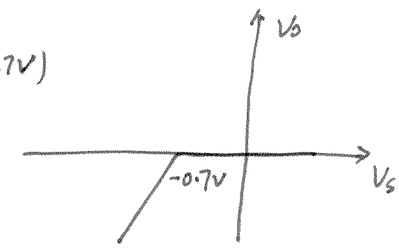
EE 20242 Electronics I HW 5.

4.65

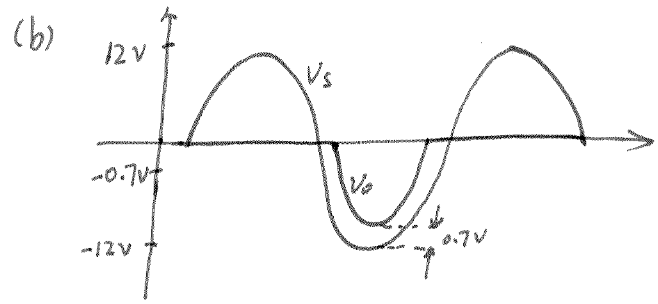


(a) $V_o = V_s + 0.7V \quad (V_s \leq -0.7V)$

$V_o = 0 \quad (V_s \geq -0.7V)$



(b)



(c) $\theta = \sin^{-1}\left(\frac{0.7}{12}\right) = 3.34°$

$\pi - \theta = 176.65°$

} ⇒ The diode conducts (3.34° ~ 176.65°)

⇒ conduction angle is $\pi - 2\theta = 173.31°$ or 3.025 rad

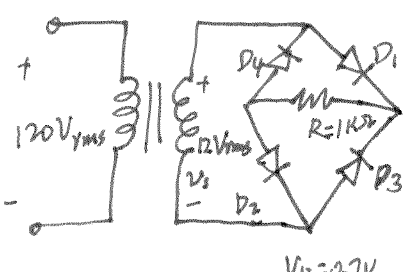
$$V_{o,avg} = \frac{-1}{2\pi} \int_{\theta}^{\pi-\theta} (12 \sin\phi - 0.7)\, d\phi$$

$$= \frac{-1}{2\pi} \left[12 \times 2\cos\theta - 0.7(\pi - 2\theta)\right] = -3.88\,V$$

(d) Peak current in the diode: $\frac{12 - 0.7V}{1.5 \times 10^3 \Omega} = 7.53\,mA$

(e) PIV = 12 V (PIV occurs when v_s is at its peak & $V_o = 0V$)

4.70



Peak voltage across the load $= 12\sqrt{2} - 2V_D = 15.57V$

$\theta = \sin^{-1}\frac{1.4}{12\sqrt{2}} = 0.0826$ rad

Fraction of cycle that D_1 & D_2 conduct:

$\frac{\pi - 2\theta}{2\pi} = 47.4\%$ which is the same as D_3 & D_4

⇒ for each diode, the fraction of cycle ... is 23.7%

The average voltage across the load:

$$v_{o,avg} = \frac{2}{2\pi}\int_{\theta}^{\pi-\theta}(12\sqrt{2}\sin\phi - 2V_D)\,d\phi = \frac{1}{\pi}\left[-12\sqrt{2}\cos\phi - 1.4\phi\right]_{\theta}^{\pi-\theta} = 9.44\,V$$

$$i_{R,avg} = \frac{v_{o,avg}}{R} = \frac{9.44V}{1K\Omega} = 9.44mA$$

4.77 i) $V_r = 0.1\,(V_p - V_{DO}\times 2) = \frac{V_p - 2V_{DO}}{2fCR}$ discharge occurs over $\frac{1}{2}T = \frac{1}{2f}$

$$C = \left(\frac{V_p - 2V_{DO}}{V_p - 2V_{DO}}\right)\frac{1}{2(0.1)fR} = 83.3\,\mu F,\qquad V_{avg} = V_p - \frac{1}{2}V_r = 14.86\,V$$

ii) $$C = \left(\frac{V_p - 2V_{DO}}{V_p - 2V_{DO}}\right)\frac{1}{2(0.01)fR} = 833\,\mu F,$$

$$V_{avg} = V_p - \frac{1}{2}V_r = 15.49\,V$$

(b)(i) Fraction of cycle: $\frac{2\omega\Delta t}{2\pi} = 14.2\%$

(ii) Fraction of cycle: $\frac{2\omega\Delta t}{2\pi} = \sqrt{\frac{2(0.01)}{\pi}} = 4.5\%$

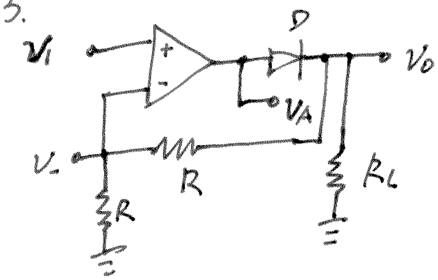
(c) (i) $i_{D,avg} = \frac{14.79}{1}\left(1 + \pi\sqrt{\frac{1}{0.2}}\right) = 119\,mA$

(ii) $i_{D,avg} = \frac{15.49}{1}\left(1 + \pi\sqrt{\frac{1}{0.02}}\right) = 356\,mA$

(d) (i) $\hat{i}_D = \frac{14.79}{1}\left(1 + 2\pi\sqrt{\frac{1}{0.2}}\right) = 223\,mA$

$\hat{i}_D = \frac{15.49}{1}\left(1 + 2\pi\sqrt{\frac{1}{0.02}}\right) = 704\,mA$

4.83.



$$v_O = v_I\left(1+\frac{R}{R}\right) = 2v_I$$

(a) $v_I = +1V$ $v_O = 2V$, $v_A = 2.7V$, $v_- = v_I = 1V$

(b) $v_I = 2V$ $v_O = 4V$, $v_A = 4.7V$, $v_- = 2V$

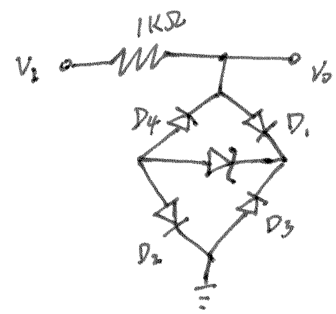
(c) $v_I = -1V$ $v_A = -12V$ diode is cut off

$v_O = 0V$ $v_- = 0V$

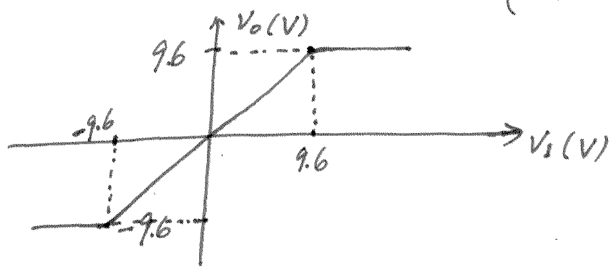
(d) $v_I = -2V$ $v_A = -12V$ diode is cut off

$v_O = 0V$ $v_- = 0V$

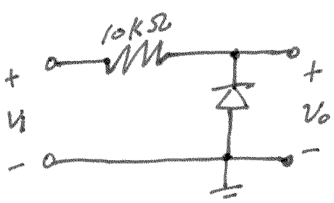
4.88



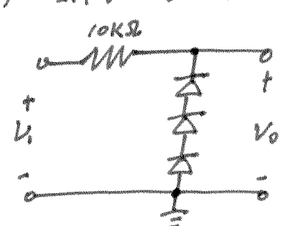
The limiter thresholds are $\pm(0.7\times2+8.2) = \pm9.6V$



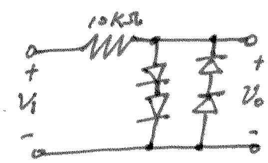
4.90 (a) $-0.7V$ and above



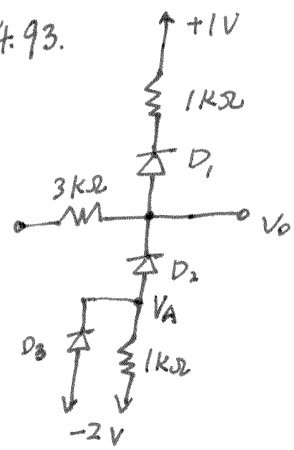
(b) $-2.1V$ and above



(c) $\pm1.4V$



4.93.



For current $i_{D1} > 1mA$

$v_{D1} \cong 0.7v$ let $v_{D1} = 0.71V \Rightarrow v_I > 5.7V$

$v_O = 1.71 + 1K \times i_{D1} = \frac{v_I}{4} + 1.2825$ slope is 1/4.

for $v_I > 5.7V$

v_I (V)	5.8	6	7	8	9	10
v_O (V)	2.7325	2.7825	3.0325	3.2825	3.5326	3.7825

For $-10 \le V_I \le 6$ V, Diode exhibit a 0.7V drop at $i_D = 1$mA

$i_D = I_S e^{V_D/V_T}$ $I_S = \frac{i_D}{V_D/V_T} = \frac{1\times10^{-3}A}{0.7V/0.025V} = 6.91\times10^{-16}A$

when $V_I > 0$, diode D_2 does NOT conduct, so $i_{D2} = 0$

$V_{D1} = V_T \ln\left(\frac{i_{D1}}{I_S}\right)$, $V_O = V_{D1} + 1K \times i_{D1}$, $V_I = (3K + 1K)\, i_{D1} + V_{D1}$

i_{D1} (A)	10^{-10}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	0.2×10^{-2}	0.5×10^{-2}
V_{D1} (V)	0.297	0.527	0.584	0.642	0.7	0.717	0.74
V_O (V)	1.297	1.528	1.595	1.742	2.7	2.717	5.74
V_I (V)	~1.297	1.5313	1.625	2.042	5.7	8.717	20.74

when $V_I < -2.5$

$V_{D3} = V_A + 2$, $i_{D3} = I_S e^{V_{D3}/V_T}$, $i_{D2} = i_{D3} + \frac{V_A + 2}{1K\Omega}$, $V_{D2} = V_T \ln\left(\frac{i_{D2}}{I_S}\right)$

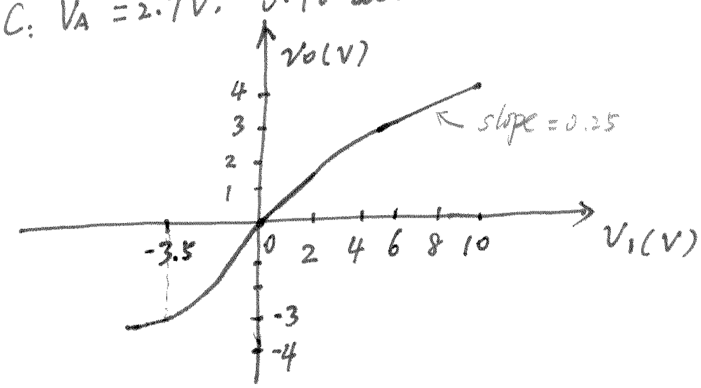
$V_O = V_A - V_{D2}$, $V_I = V_O - 3K\Omega \times i_{D2}$

V_A (V)	-2.001	-2.01	-2.10	-2.2	-2.5	-2.6	-2.7	-2.71
i_{D3} (A)	7.2×10^{-16}	10^{-15}	3.8×10^{-14}	2.1×10^{-12}	33.5×10^{-8}	18×10^{-6}	1×10^{-3}	1.5×10^{-3}
i_{D2} (A)	10×10^{-6}	10^{-5}	10^{-4}	0.2×10^{-3}	0.5×10^{-3}	0.6×10^{-3}	1.7×10^{-3}	$2.2\times10^{-}$
V_{D2} (V)	0.527	0.585	0.642	0.659	0.682	0.687	0.713	0.720
V_O (V)	-2.528	-2.595	-2.724	-2.859	-3.128	-3.287	-3.443	-3.43
V_I (V)	-2.531	-2.625	-3.024	-3.459	-4.628	-5.087	-8.516	-10
	↑ A				↑ B		↑ C	

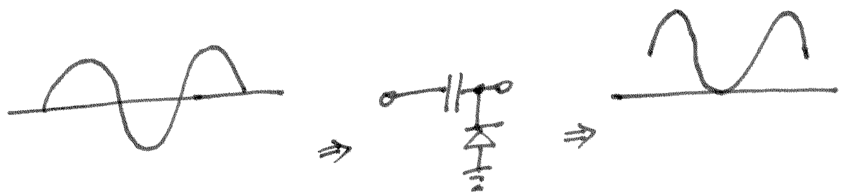
A: for a small i_{D2}, D_3 is off and D_2 is on, i_2 flows through 1KΩ resistor

B: D_3 starts conducting when there's 0.5 V drop across D_3.

C: $V_A = 2.7$V. 0.7V across D_3 and D_3 controls i_{D2}



4.94.



10 Vrms

$10\sqrt{2}$ V, peak

Average (dc) voltage of output : $10\sqrt{2}\,V = 14.14$ V