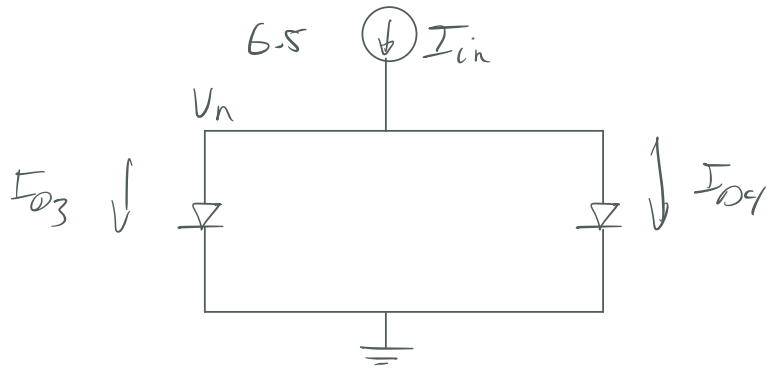
1)



$I_{S3} = 2.45 \times 10^{-13}$ $\quad$ $I_{S4} = 8.37 \times 10^{-13}$

Find : V_n , I_{D3} , I_{D4}

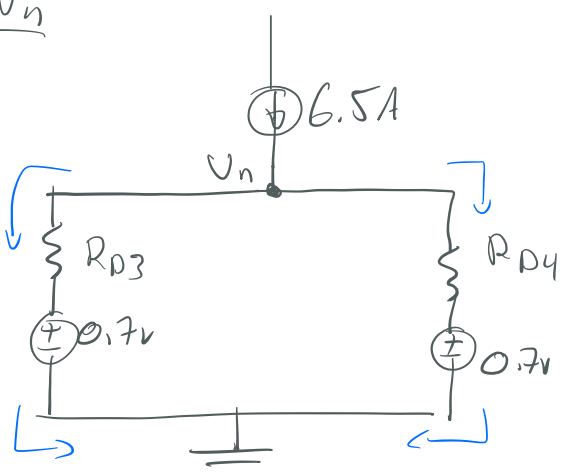
Solution:

$$I_d = I_S e^{V_d/V_t}$$

$V_t = 25\,mV$

$V_d = V_n = ?$

1) Find V_n



$$R_{D3} = \frac{V_T}{I_{D3}}$$

$$R_{D4} = \frac{V_T}{I_{D4}}$$

$$0.7 - V_n + 0.7 - V_n = 6.5$$

$$I_{D3} + I_{D4} = 6.5$$

$$(2.45 \times 10^{-13}) e^{V_D/0.025} + (8.37 \times 10^{-13}) e^{V_D/0.025} = 6.5$$

$$6.5 = (2.45 + 8.37)10^{-13} \cdot e^{V_D/0.025}$$

$$e^{V_D/0.025} = \frac{6.5}{10.82 \times 10^{-13}}$$

$$\ln\left(e^{V_D/0.025}\right) = \left(6.007393715 \times 10^{12}\right)$$

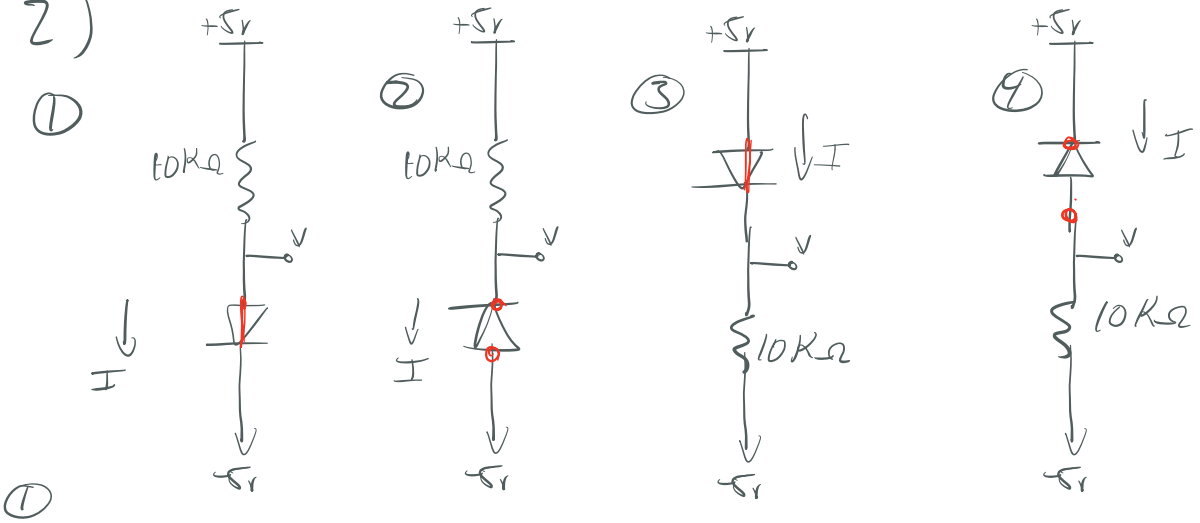
$$V_D = 0.025 \ln(6.007393715 \times 10^{12})$$

① $\boxed{V_D = 0.7356\ V}$ d

② $I_{D3} = (2.45 \times 10^{-13})\, e^{0.7356/0.025} = 1.47179\ A$ c

③ $I_{D4} = (8.37 \times 10^{-13})\, e^{0.7356/0.025} = 5.028127\ A$ b

2)



①

KVL

$5 - I(10K) - 0.67 = -5$

$+I(10K) = +9.33$

$I = \frac{9.33}{10K}$

$V = 0.67 - 5$

$V = -4.33V$

$I = .933mA$

$P = (4.33)(.933mA) = 4.03989\ mW$

② $I = 0$ $V = 5$, $P = (5)^2/10K = 2.5\ mW$

③ $5 - 0.67 - I(10K) = -5$

$I(10K) = 9.33$

$I = .933mA$

$V = 5 - 0.67$

$V = 4.33V$

$P = IV = (.933mA)(4.33) = 4.0389\ mW$

(4) $I = 0$ $V = -5$ $p = (-5)^2 / 10\Omega = 2.5\,mW$

Comeback

3) A shunt regerlator utilizing a zener diode with an incremental resistance of $10\,\Omega$ is fed through a $200\,\Omega$ resistor. What is the regulators output if raw supply changes by 1.4V

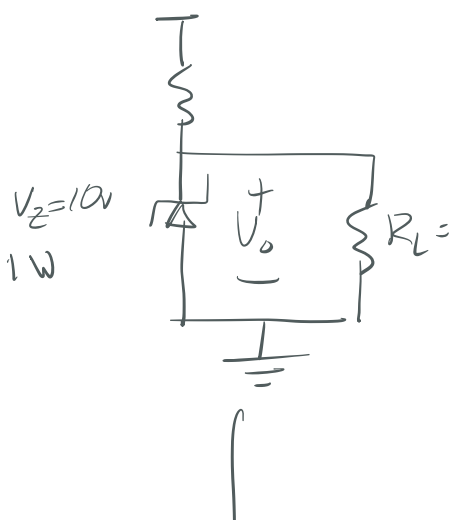
$$\frac{\Delta V_o}{\Delta V_s} = \frac{10}{(10+200)} = 0.047619047\overline{6}$$

$\Delta V_s = 1.4\,V$

$\Delta V_o = 0.047619 \cdot \Delta V \Rightarrow 0.047619 \cdot 1.4 = 66.667\,mV$

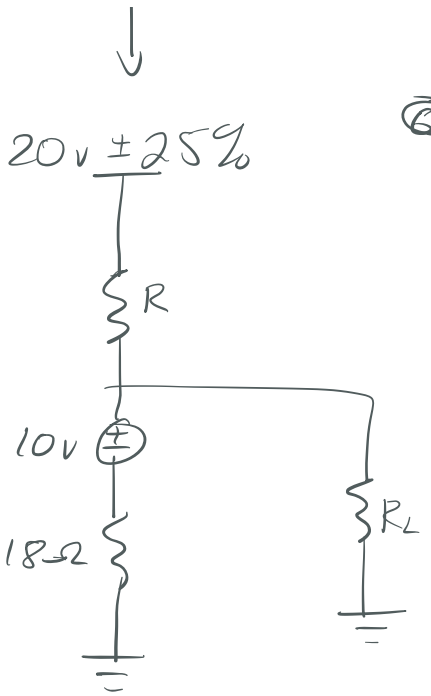
a

4) 20v ± 25%



$I_T = 25\,mA$

$r_z = 18\,\Omega$



⑥

$V_{ZT} = V_{Z0} + r_Z I_{ZT}$

$V_{Z0} = V_{ZT} - r_Z I_{ZT}$

$V_{Z0} = 10 - 18(25\,mA)$

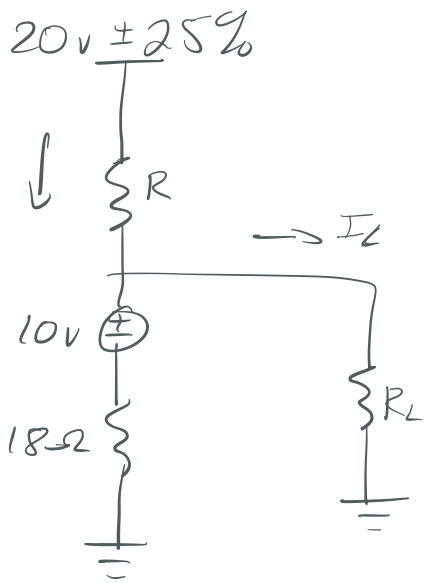
$\boxed{V_{Z0} = 9.55\,V}$ h

⑦

Max current = 20 mA

$I_L(max) = \underline{20\,mA}$, $I_Z(min) = \underline{5\,mA}$

$V_S(min) = 20 - 25\%(20) = \underline{15\,V}$



$I_R = I_Z + I_L$

$I_R = 20\,mA + 5\,mA$

$I_R = 25\,mA$

$I_R = \dfrac{V_S(min) - V_Z}{R}$

$R = \dfrac{V_S - (V_{Z0} + r_Z I_Z)}{I_R}$

$$R = \frac{15 - (9.55 + 18(5\,mA))}{25\,mA} \Rightarrow R = 214.4\ \Omega \text{ h.}$$

(8) $$\frac{\Delta V_o}{\Delta V^+} = \frac{r_z}{R + r_z} = \frac{18}{214.4 + 18} = 0.07745266\ V/V$$

$\times 100\%$

line reg = 7.745266 % (d)

(9) Load regulation

$$\frac{\Delta V_o}{\Delta I_L} = -(r_z // R)$$

$$\frac{\Delta V_o}{\Delta I_L} = -\frac{r_z R}{r_z + R} = \frac{18(214.4)}{18 + 214.4} = -16.605$$

$$\frac{\Delta V_o}{\Delta I_L} = -16.05$$

$$\Delta V_o = -16.05\,\Delta I_L$$

$\Delta V_o = -16.05(25\,mA)$ $\Delta I_L = 20mA - 5mA$

$\Delta V_o = 33.211\,mV$ $V_o = 10V$

$\Delta = 3.3211\%$

(10) Max power in zener diode

$$I_R = \frac{V^+ - V_Z}{R}$$

$$V_Z = V_{Z0} + r_Z I_Z$$

$$V_Z = 9.55v + 18\left(\frac{25v - V_Z}{214.4}\right)$$

$$V_Z = 9.55v + 2.09888 - 0.0839V_Z$$

$$1.0839V_Z = 11.648806$$

$$\boxed{V_Z = 10.7466\,v}$$

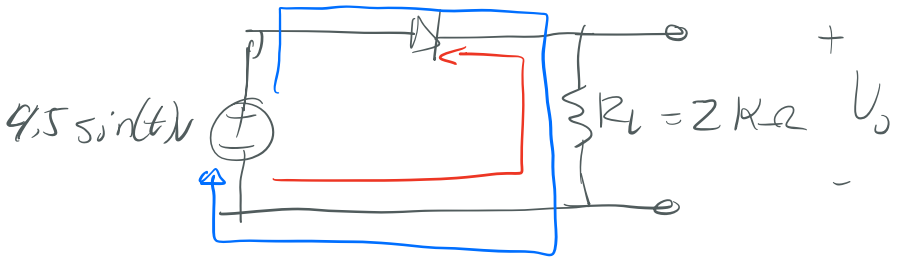
$$I_Z = \frac{25 - 10.7466v}{214.4}$$

$$I_Z = 66.480206\,mA$$

$$P_Z = I_Z V_Z = (66.480206\,mA)(10.7466v)$$

$$P_Z = 0.71443W \quad e$$

5)



$V_D = 0.7V$ find average value of V_o

(1) $V_o = V_S - 0.7V$

$V_o = 4.5 - 0.7V$

$\underline{V_o = 3.8V}$ peak

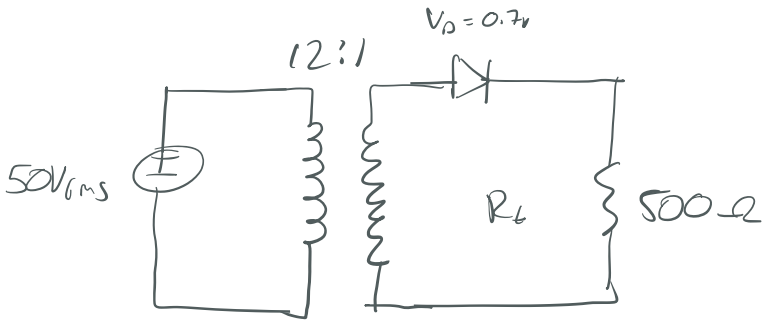
$$V_{o(avg)} = \left(\frac{1}{\pi}\right) V_{S(max)} + \frac{V_D}{2}$$

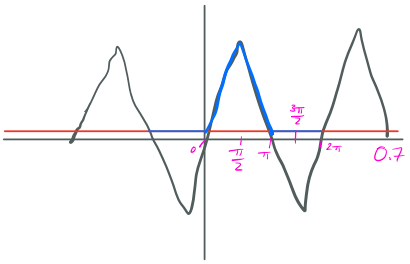
$$V_{o(avg)} = \left(\frac{1}{\pi}\right)(4.5) + \frac{0.7}{2}$$

$$V_{o(avg)} = 1.08239V$$

Comeback

(12)





"For what fraction of a cycle does the diode conduct?"

$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

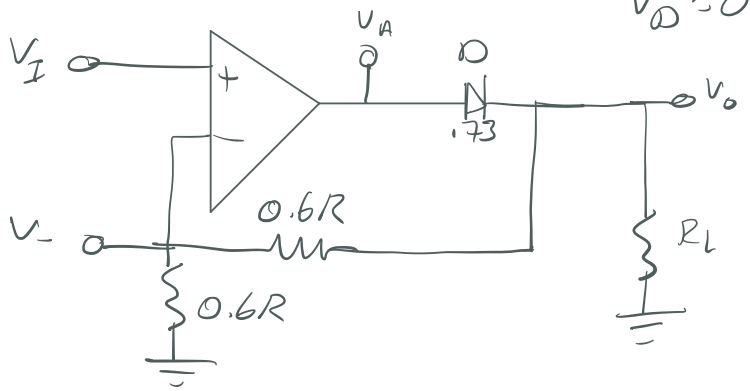
$$(\sqrt{2})\, V_{rms} \cdot V_p = 50 V_{rms}\sqrt{2} \Rightarrow V_p = 70.71 V$$

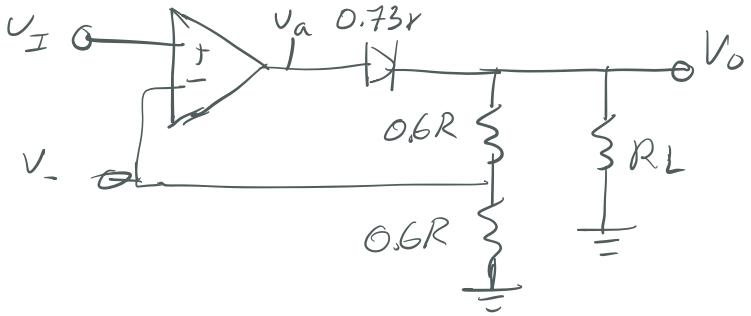
$$V = \begin{cases} \text{triangle wave function}, & 0 < t < \pi \\ 0.7 \ldots\ldots\ldots & \pi < t < 2\pi \end{cases}$$

c) proportional conduction time = 46.06%

7)

$V_D = 0.73v$





13

$V_I = 1.5v$

$$V_A = V_I \left(1 + \frac{R_F}{R_{in}}\right)$$

$$V_A = V_I (2)$$

$$V_A = 1.5(2) = \boxed{3v}$$

$$V_- = V_I = \boxed{1.5v}$$

$$V_o = V_A + 0.73$$

$$V_o = 3 - 0.73$$

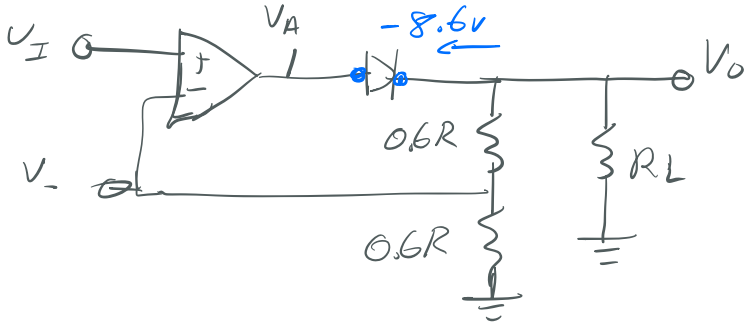
$$\boxed{V_o = 3.73v}$$

2.27

$$V_- + V_A + V_o$$

$$= -1.5 + 3 + 2.27 = \boxed{3.77v}$$ h

(19) $V_I = -4.3\,V$



$V_A = -4.3(2)$

$V_A = -8.6\,V$

$V_o = -8.6v$

$V_- = +4.3v$

$V_- + V_A + V_o = 4.3 - 8.6 - 8.6$

$= -12.9\,b$

8)