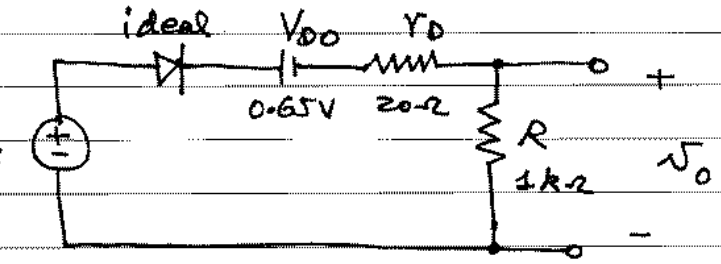
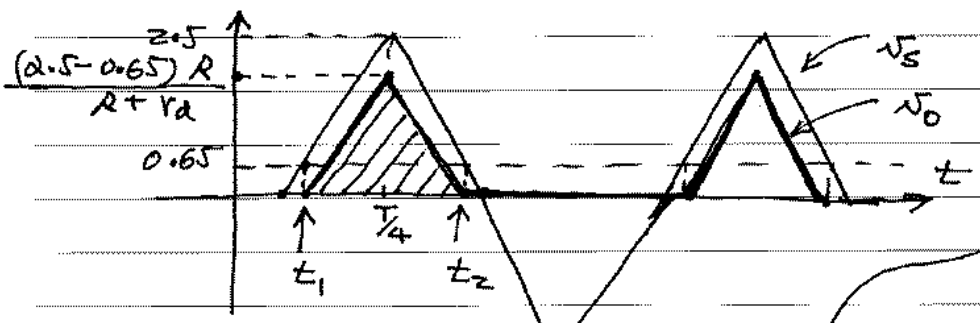
3.74

(20)





$$\frac{2.5}{T/4} = \frac{0.65}{t_1}$$

$$\Rightarrow t_1 = 0.065\,T$$

$$t_2 = \frac{T}{2} - 0.065T = 0.435\,T$$

$$v_{O\,ave} = \frac{1}{T}\int \frac{R}{R+r_d}(v_S - V_{DD})\,dt$$

$$= \frac{1}{T}\cdot(\text{Area of } \triangle)$$

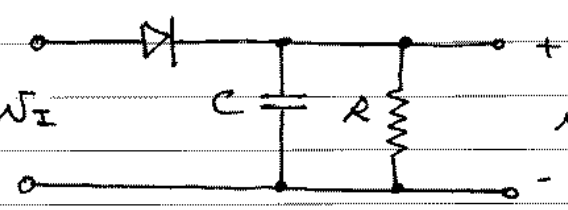
$$= \frac{1}{T}\frac{R}{R+r_d}\cdot\frac{1}{2}(t_2-t_1)\cdot(2.5-0.65)$$

$$= \frac{1}{T}\frac{R}{R+r_d}\cdot\left(\frac{T}{4}-0.065T\right)\cdot(2.5-0.65)$$

$$= \frac{1000}{1020}\cdot 0.342 \simeq \underline{0.335\text{ V}}$$

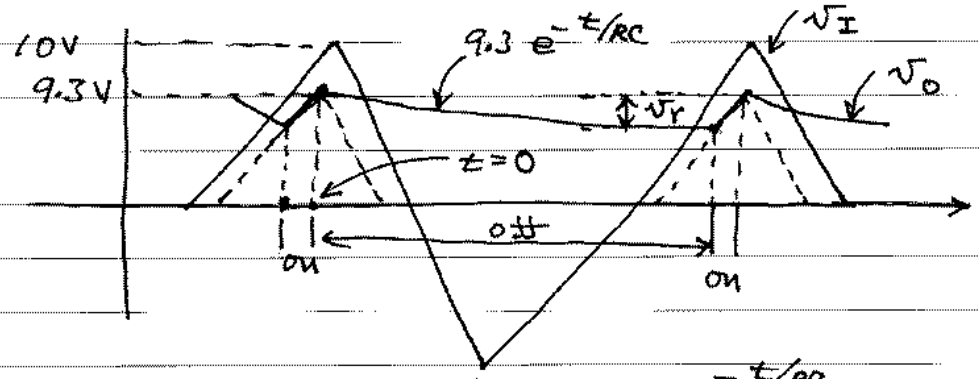
3.89

(40)



$$CR = 100\times10^{-6}\times100 = 10^{-2}\ (s)$$

$$T = 10^{-3}\ (s)$$

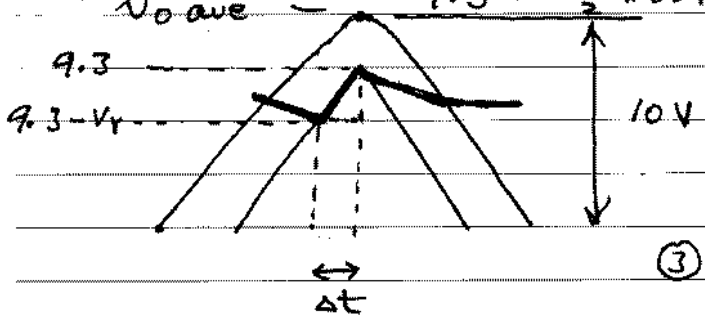


During off period, $v_O = 9.3\,e^{-t/RC} \simeq 9.3\,(1-t/CR)$

$$v_r \simeq 9.3 - 9.3\left(1-\frac{T}{CR}\right) = 9.3\left(\frac{T}{CR}\right) = 0.93\text{ V}$$

(1)

$v_{o\,ave} = 9.3 - \frac{1}{2} \times 0.93 = 8.84\ V$



$\frac{10}{T/4} = \frac{0.93}{\Delta t}$

$\Rightarrow$ (2) $\Delta t = 0.02325\ T$

$= 0.02325\ (ms)$

(3) Charge balance

$i_{c\,ave}\,\Delta t = C V_r$

$\Rightarrow i_{c\,ave} = \frac{C V_r}{\Delta t} = \frac{100 \times 10^{-6} \times 0.93}{0.02325 \times 10^{-3}} = 4.0\ (A)$

$i_{o\,ave} = i_{c\,ave} + \frac{v_{o\,ave}}{R} \doteq 4.0 + \frac{8.84}{100} \doteq 4.09\ (A)$

(4) $i_{c\,max} = C \left.\frac{dv_o}{dt}\right|_{\text{onset of conduction}} = C \cdot \frac{10}{T/4} = 100 \times 10^{-6} \times 40 \times 10^{3}$

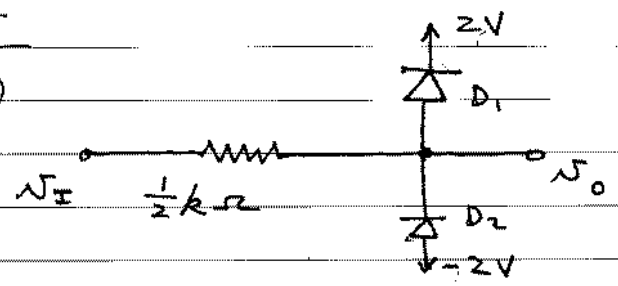
$= 4\ (A)$

$i_{o\,max} = i_{c\,max} + \frac{v_{o\,max}}{100} \simeq 4.09\ (A)$

Note: $i_{o\,ave} \doteq i_{o\,max}$ why?

3.95

(20)



For $-2.5\ V \le v_I \le 2.5\ V$

both diodes are off

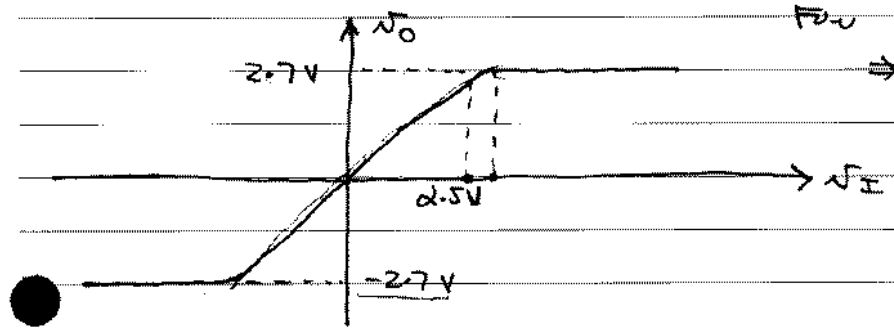
$\Rightarrow v_o = v_I$

For $v_I > 2.5\ V$, D_1 is on

$\Rightarrow v_o \simeq 2.0 + 0.7 = \cancel{3.2\ V}\ 2.7\ V$

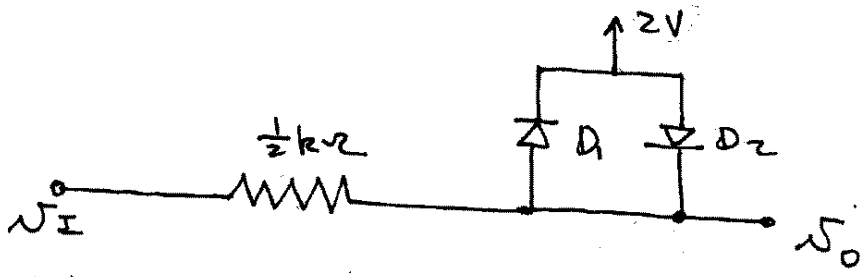
For $v_I < -2.5\ V$ D_2 is on

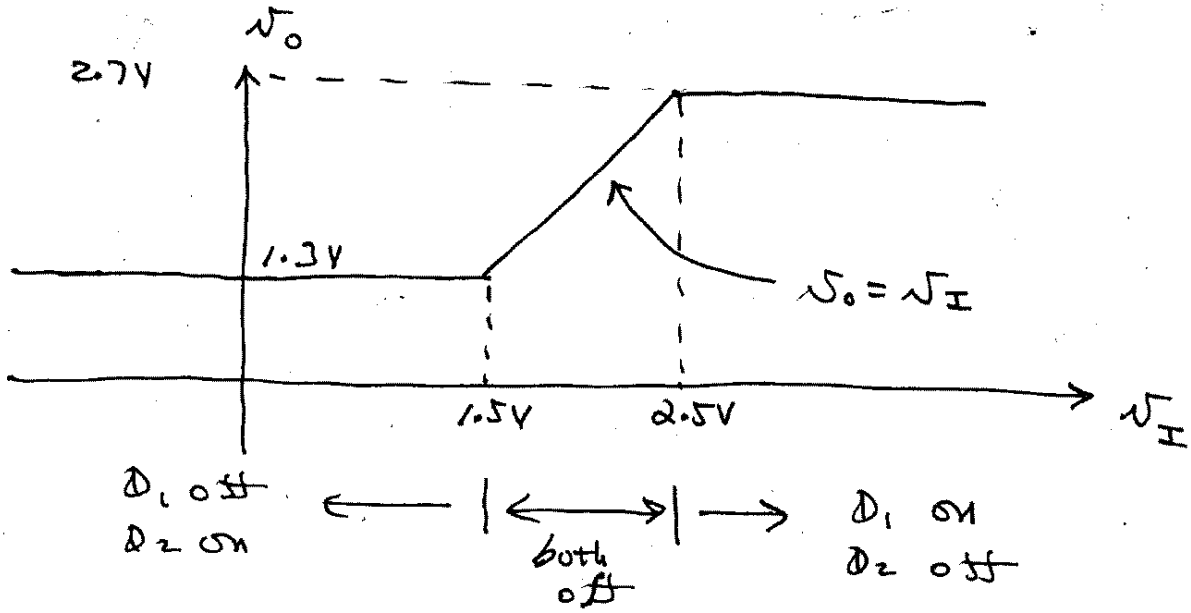
$\Rightarrow v_o \simeq -2.0 - 0.7 = -\cancel{3.2\ V}\ 2.7\ V$



3.96

(20)


2V
½kΩ
D1
D2
vI
vO


vO
2.7V
1.3V
vO = vI
1.5V
2.5V
vI
D1 off
D2 on
both off
D1 on
D2 off