Ex Analyze the cct shown below

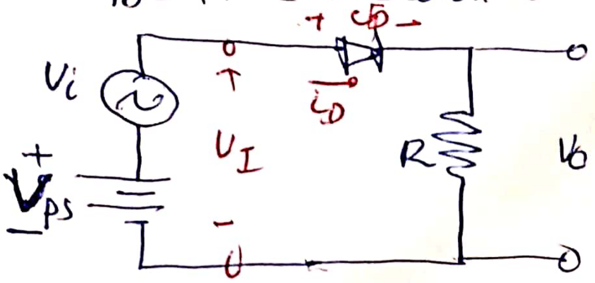


Fig 1

Assume cct & diode parameters of $V_{PS} = 5V$, $R = 5k\Omega$, $V_r = 0.6V$ & $v_i = 0.1 \sin\omega t$ V

Compute i_D & v_0

Soln. DC-Analysis (set $v_i = 0$)

set $v_i = 0$ & determine the DC operating point (Q-point)

dc-current $I_{DQ} = \frac{V_{PS} - V_r}{R} = \frac{5-0.6}{5k\Omega} = \frac{4.4}{5k\Omega} = 0.88 mA$

dc-voltage $V_0 = I_{DQ} R = 0.88 \times 5 = 4.4V$

AC-Analysis (set dc source to zero)

$V_{PS} = 0$ & apply KVL

$v_i = i_d r_d + i_d R = i_d (r_d + R)$

where $r_d = \frac{V_T}{I_{DQ}} = \frac{0.026}{0.88 mA} = 0.0295 k\Omega = 29.5\Omega$

The ac-diode current is

$i_d = \frac{v_i}{r_d + R} = \frac{0.1 \sin\omega t}{5.0295 k\Omega} = 19.88 \sin\omega t \ \mu A$

99.70

The ac component of the o/p voltage is

$v_0 = i_d R = 0.0995 \sin\omega t$ V

Ex The cct & diode parameters for the cct shown in Figure 1 are $V_{PS} = 8V$, $R = 20k\Omega$, $V_r = 0.7V$ & $v_i = 0.25 \sin\omega t$ V.

(a) Determine the quiescent diode current & the time varying diode current (b) Repeat part (a) if R is changed to 10kΩ

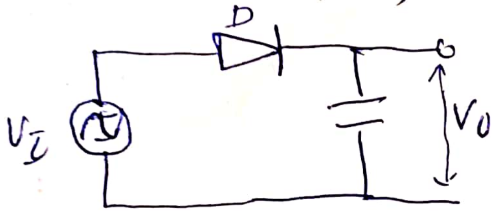
Ans (a) $I_{DQ} = 0.365 mA$, $i_d = 12.5 \sin\omega t \ \mu A$ b) $I_{DQ} = 0.730 mA$

$i_d = 24.95 \sin\omega t \ (\mu A)$

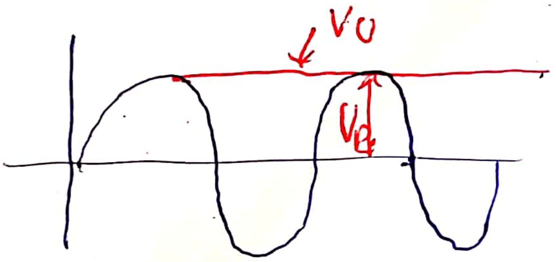
Halfwave Rectifier with capacitor Filter

A HWR with capacitor filter is shown below. If the capacitor C is chosen such that it offers negligible reactance, then the entire ac component or ripple component of the current flows through the capacitor as it practically behaves as a short circuit. In other words, this filter capacitor reduces the variations or ripples in the rectifier output voltage.

To show how a capacitor connected across a load reduces the ripples, consider the following circuit



During a +ve half cycle, the diode conducts and the capacitor is charged so that $V_0 = V_I$. This continues until V_I reaches its peak value V_p. Beyond the peak, as V_I decreases the diode becomes reverse biased & V_0 remains constant at the value of V_p.



Now consider a load R is connected across the capacitor

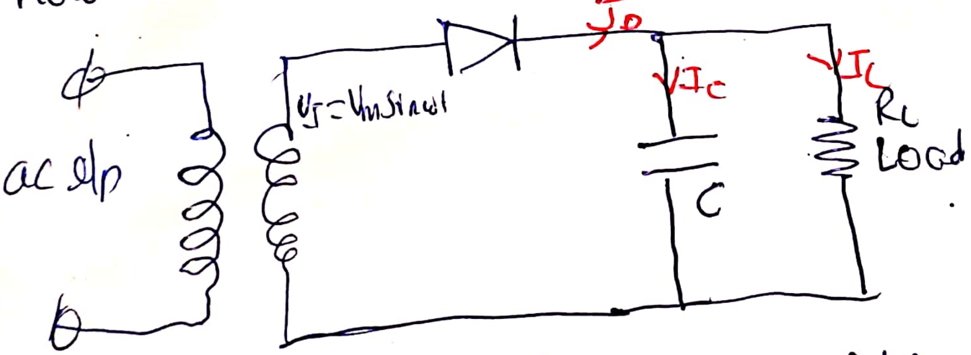


Fig HWR with capacitor filter

+ve half cycle of V_I.

~~D=ON~~

C - charges to the peak when D is ON

during the period D is OFF, C discharges through R_L.

when conducting

$$I_D = I_C + i_L$$

$$= C\frac{dV_I}{dt} + i_L$$

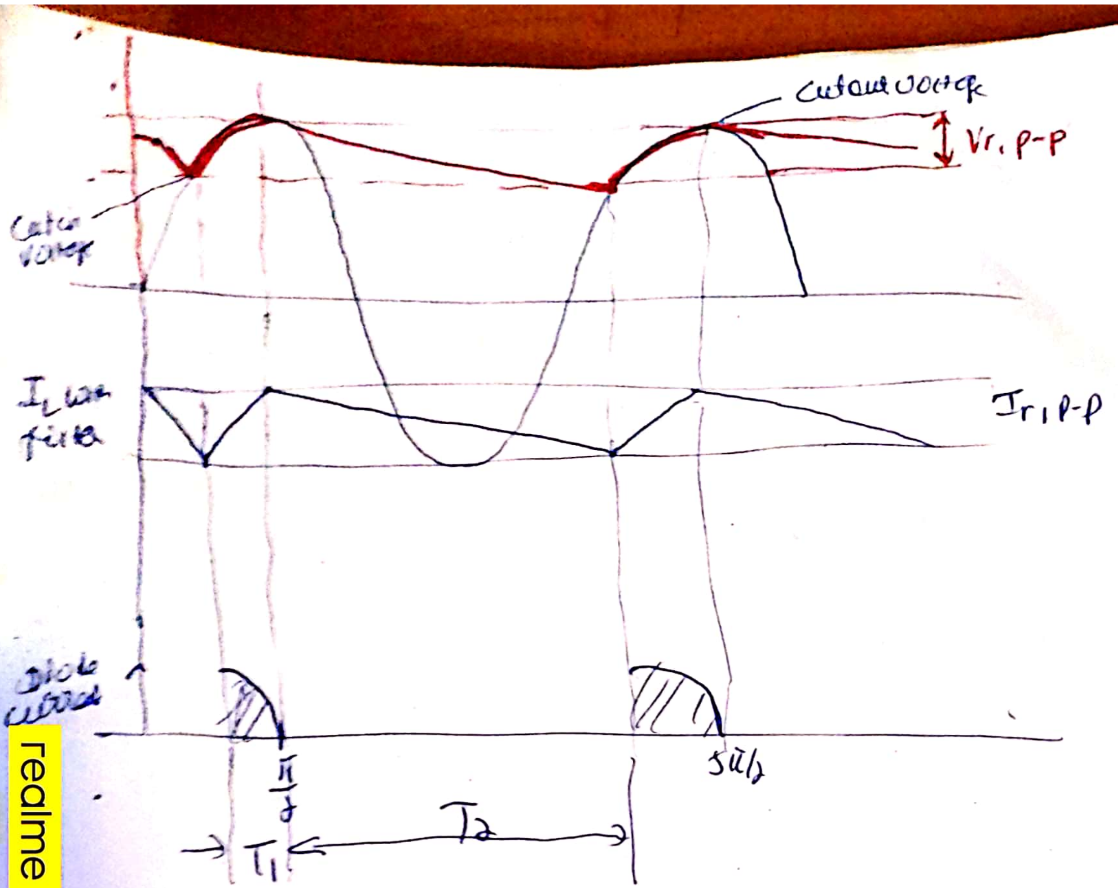


Fig) waveforms of a HWR

The ripple voltage can be assumed as triangular and $T = T_1 + T_2$.
Further, if the time constant $R_L C$ is large $T_2 = T = 1/f$.

During T_1 (D = ON)

~~The charge ont~~
The capacitor acquires charge $= V_{r,p-p} \times C$

During T_2 (D = OFF)

The charge it has lost $= I_{dc} * T_2 = I_{dc} T = \frac{I_{dc}}{f}$

The charge gained by C during T_1 = charge lost by C during T_2

$$V_{r,pp} C = I_{dc} T = \frac{I_{dc}}{f}$$

$$\Rightarrow V_{r,pp} = \frac{I_{dc}}{fC} \text{ or } V_r = \frac{I_{dc}}{fC}$$

* The rms component of the ripple is given by

$$V_{ripple(rms)} = \frac{V_{r,pp}}{2\sqrt{3}} = \frac{I_{dc}}{2\sqrt{3} fC}$$

but $I_{dc} = \frac{V_{dc}}{R_L}$ $V_{dc} = V_m - \frac{V_r}{2}$ $V_r = V_{r,PP}$, $\gamma = \frac{V'_{rms}}{V_{dc}}$

$$V_{r(rms)} = \frac{V_{dc}}{2\sqrt{3}fCR_L}$$

$$\gamma = \frac{V_{r(rms)}}{V_{dc}} = \frac{1}{2\sqrt{3}fCR_L}$$

~~From the graph~~ DC voltage & current

$$V_{dc} = V_m - \frac{V_r}{2}$$

$$= V_m - \frac{I_{dc}}{2fC}$$

$$V_{dc} = V_m - \frac{V_{dc}}{2fCR_L}$$

$$V_{dc}\left(1 + \frac{1}{2fCR_L}\right) = V_m$$

$$V_{dc} = \frac{V_m}{1 + \frac{1}{2fCR_L}}$$

$$I_{dc} = \frac{V_m}{R_L + \frac{1}{2fC}}$$

Ex

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P4.1

4.23 Bridge Rectifier

12V (rms) second f=60Hz

$V_D = 0.8$

$R_L = 100\Omega$

Find C that results in $V_r = 1V$

$V_{dc} = ?$

$I_L = ?$

$PIV = ?$

16.97
1.6
15.37

Soln $V_r = \frac{I_{dc}}{2fC}$ $V_m = \sqrt{2} \cdot 12 = 16.97$

$V_{DC} = V_m - \frac{V_r}{2} = 16.97 - \frac{1}{2} = 16.47 - 0.8$

0.8
15.67
0.8
14.87

$V_{DC} = 14.87$ V

$I_{DC} = \frac{14.87}{100} = 0.1487A = 0.15A$

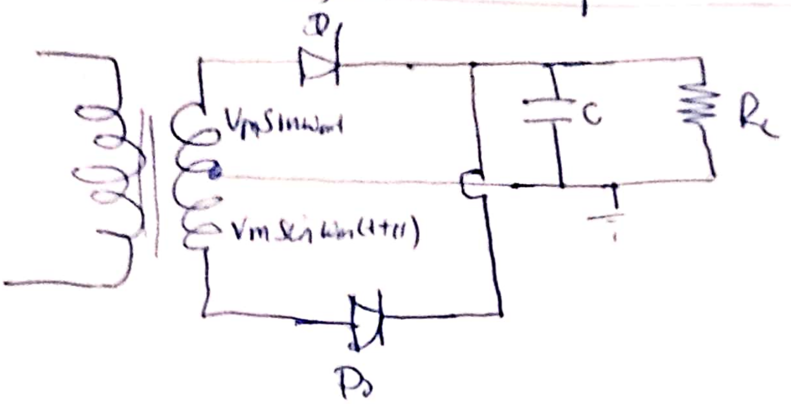
$C = \frac{0.15}{2 \times 60 \times 1} = 0.00125F = 1250\ \mu F$

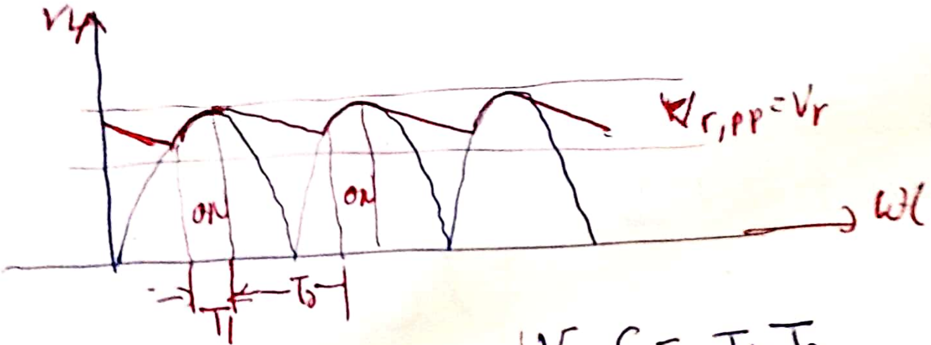
$I_{DC} = \frac{2I_m}{\pi}$

$I_m = \frac{I_r}{\sqrt{2}}$

4.2

Full wave Rectifier with capacitor Filter





$V_r C = I_{dc} T_2$

$= I_{dc} \frac{T}{2}$

$= \frac{I_{dc}}{2f}$

$\Rightarrow V_r = \frac{I_{dc}}{2fC}$

rms of the ripple

$V_{ac} = V_{r(rms)} = \frac{V_r}{2\sqrt{3}}$

$V_{ac} = \frac{I_{dc}}{4\sqrt{3} fC}$

$V_{ac} = \frac{V_{dc}}{4\sqrt{3} fCR_L}$

$\gamma = \frac{V_{ac}}{V_{dc}} = \frac{V_{r,rms}}{V_{dc}} = \frac{1}{4\sqrt{3} fCR_L}$

$V_{dc} = V_m - \frac{V_r}{2} = V_m - \frac{I_{dc}}{2fC} = V_m - \frac{V_{dc}}{4fCR_L}$

$V_{dc} = \frac{V_m}{1 + \frac{1}{4fCR_L}}$

$I_{dc} = \frac{V_m}{R_L + \frac{1}{4fC}}$

$V_{dc} = 10 - 0.1 = 9.9$

$I_{dc} = \frac{9.9}{10k} = 0.99 mA$

$0.2 = \frac{0.99 \times 10^{-3}}{2 \times 60 \times C}$

$C = \frac{0.99 \times 10^{-3}}{24}$

$I_{dc} = 1$ $V_{dc} = 12 - 0.2 = 11.8 V$

$R_L = 2k\Omega$

$I_{dc} = \frac{11.8}{2k\Omega} = 5.9 mA$

$V_r = \frac{I_{dc}}{2fC} = \frac{5.9 mA}{2fC}$

$C = \frac{5.9 \times 10^{-3}}{2 \times 60 \times 0.4}$

$= 122.9$

$V_r = \frac{I_{dc}}{fC}$

$V_r = \frac{V_{dc}}{fCR_L}$

$C = \frac{V_{dc}}{f V_r R_L}$

$= 11.$

$C = \frac{5.9 \times 10^{-3}}{f \times V_r}$

$= \frac{5.9 \times 10^{-3}}{60 \times 0.4}$

$= 245.8 \mu F$

ps. 2

Ex A FWR operating at 50Hz is to provide D.C. current of 50mA at 30V with a 80NF filter is used, calculate

a) The peak secondary voltage of the transformer
b) The ripple factor of the output

Soln

a) $R_L = \frac{V_{DC}}{I_{DC}} = \frac{30V}{50mA} = 600\Omega$

$V_{DC} = \frac{V_m}{1+\frac{1}{4fCR_L}} \Rightarrow V_m = V_{DC}\left(1+\frac{1}{4fCR_L}\right)$

$V_m = V_{DC}\left(1+\frac{1}{4fCR_L}\right)$

$= 30\left(1+\frac{1}{4\times50\times80\times10^{-6}\times600}\right)$

$= 33.125V$

b) $\gamma = \frac{1}{4\sqrt{3}fCR_L} = \frac{1}{4\sqrt{3}\times50\times80\times10^{-6}\times600} = 0.06$

Excer

A FWR cct with C-type filter is to supply a DC current of 20mA at 16V. If frequency is 50Hz & ripple factor is 5%, calculate the

a) Required secondary voltage of the transformer
b) the value of C required (Ans C= 72NF)
$V_m = 17.38V$

Break down Voltage

When a reverse biase voltage is applied to a pn-J^n, the E-field in the space charge region increases. The E-field may become large enough that couvalent bonds are broken and electron-hole pairs are created. Electrons are swept into the n-region and holes are swept into the p-region by the E-field, generating a large reverse bias current. This phenomenon is called breakdown.

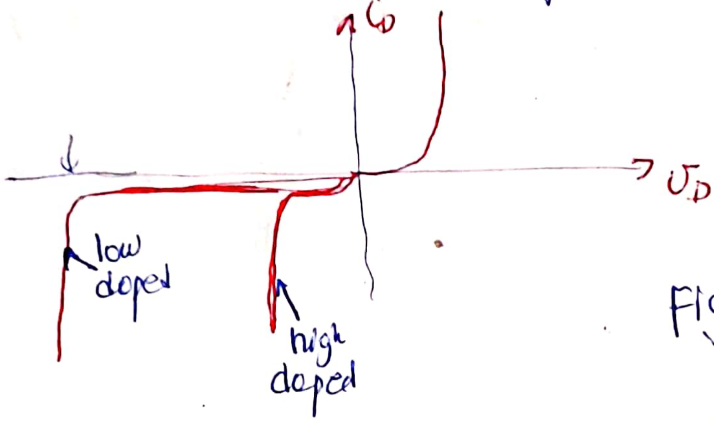


Fig: Reverse break down i-v characteristic

Avalanche breakdown :- It is the most common breakdown mechanism and results in breakdown voltages greater than 5V.

* A thermally generated carrier (part of I_S) falls down the junction barrier and gains sufficient K.E from the high E-field due to the applied reverse bias voltage (potential). This carrier collides with a crystal ion & imparts sufficient energy to disrupt or break a covalent bond. In addition to the original carrier, a new e-h pair is generated. These carriers may also pick up sufficient energy from the applied field, collide with another crystal ion, and create still other electron hole pairs. Thus, each new carrier may, in turn, produce additional carriers through collision. This cumulative process is referred to as avalanche multiplication. It results in a large reverse current, and the diode is said to be in the region of avalanche breakdown. The breakdown voltage is a function of the doping concentrations in the n & p regions.

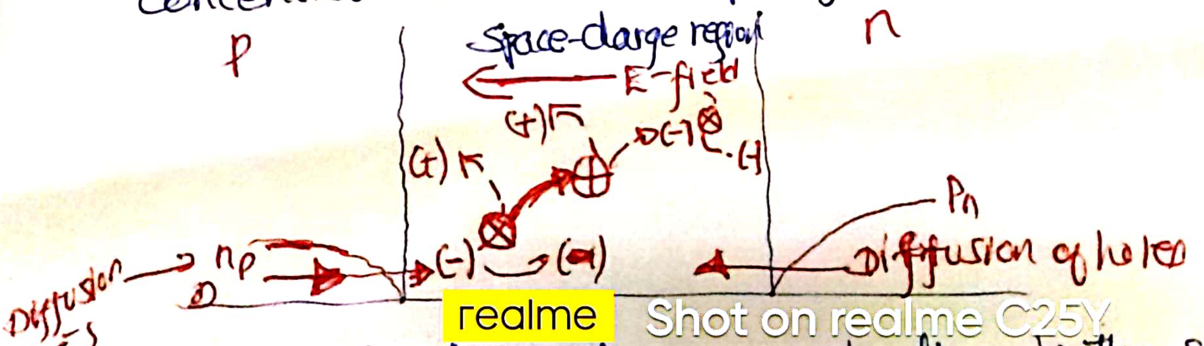


Fig Avalanche multiplication in the space

Zener Diodes

(21)

- A major applic for zener diodes is to provide a stable reference voltage for use in power supplies
- A zener diode is a silicon pn-jc device that is designed for operation in the reverse breakdown region.
- V_Z is controlled by the doping level

Zener Breakdown

- Two types of reverse breakdown
  - avalanche (>5V); it occurs at a sufficiently high reverse voltage
  - zener (<5V)
    - it occurs at low reverse voltages.
    - * It is heavily doped to reduce the breakdown voltage. This causes a very thin depletion region. As a result intense E-field exists within depletion region

* Near the zener breakdown voltage (V_Z), the E-field is intense enough to pull e's from their VB & create current

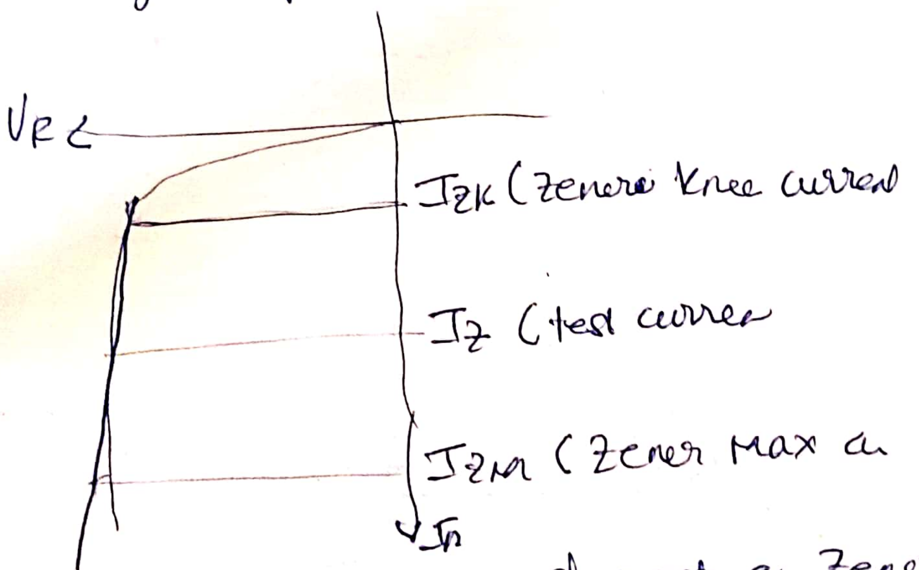


Fig reverse charact. of Zener diod

I_{ZK} - min value of reverse current that must be maintained in order to keep the diode in breakdown for regulation

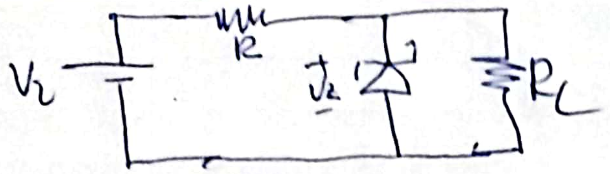
I_{ZM} - max value of current above which the diode may be damaged

Zener diode maintains a nearly constant voltage across its terminals for values of reverse current ranging from I_{ZK} to I_{ZM}

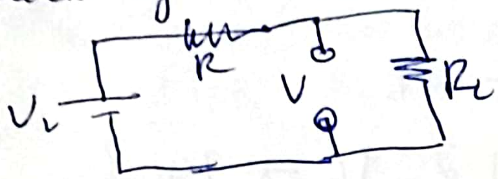
P8 [2]

Three analysis of the basic Zener diodes as a regulator are considered.

V_i & R fixed



1. Determine the state of the Zener diode by finding thevenins Equivalent by removing Z-diode



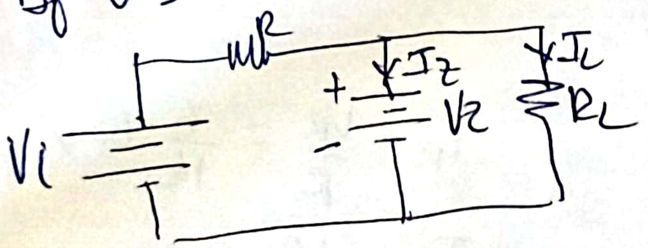
$V = V_L = \frac{R_L V_i}{R+R_L}$

If $V \geq V_Z$, the Zener diode is on, & can be replaced by equivalent cct

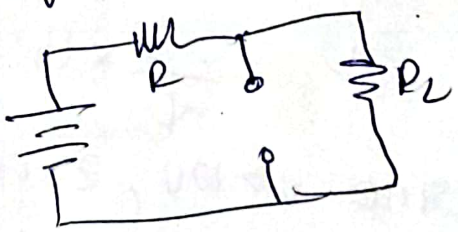
If $V < V_Z$, the diode is off & open cct Equivalent

equivalent cct

If $V \geq V_Z$



If $V < V_Z$



$I_R = I_Z + I_L$

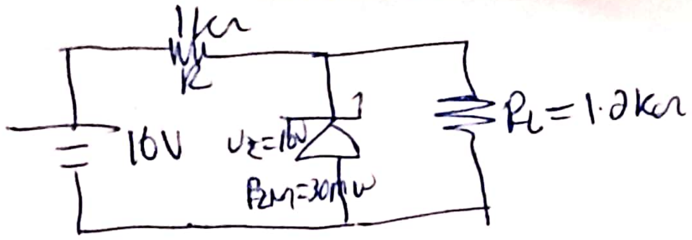
$I_Z = I_R - I_L$

where $I_L = \frac{V_L}{R_L}$ & $I_R = \frac{V_R}{R} = \frac{V_i - V_Z}{R}$

power dissipated by Zener

$P_Z = V_Z I_Z$ must be less than P_{ZM}

Ex



$V_Z = 10V$

determine V_L, V_R, I_Z, P_Z for

a) $R_L = 1.2k\Omega$

b) $R_L = 3k\Omega$

Soln (a)

$$V = \frac{R_L V_i}{R + R_L} = \frac{1.2}{2.2} \times 16 = 8.73V$$

Since $V < V_Z$ → diode = OFF

$$I = \frac{16V}{2.2k\Omega} = \quad V_L = \frac{1.2}{2.2} \times 16 = 8.73V$$

$$V_R = 16 - 8.73 = 7.27$$

$$I_Z = 0$$

$$P_Z = V_Z I_Z = 0$$

(b)

$$V = \frac{3}{4} \times 16 = 12V$$

Since $V > 10V$, Z is ON

$$V_L = V_Z = 10V$$

$$V_R = 16 - 10 = 6V$$

$$I_R = \frac{V_R}{R} = \frac{6}{1k} = 6mA$$

$$I_L = \frac{10}{3} = 3.33mA$$

$$I_Z = I_R - I_L$$

$$= 6 - 3.33 = 2.67mA$$

The power dissipated is

$$P_Z = V_Z I_Z = 10V \times 2.67mA$$

$= 26.7mW$ which is less than the specified $P_{ZM} = 30mW$

realme Shot on realme C25Y

3.2

Fixed V_i, Variable R_L

Due to the offset voltage V_Z, there is a specific range of resistor values that will ensure that the Zener is in the "on" state.

minimum Resistance (R_L)

- Too small R_L will cause V_L to be less than V_Z and the diode will be in "off" state

$$V_L = \frac{R_L V_i}{R_L + R}$$

- The minimum R_L can be obtained by setting $V_L = V_Z$

$$V_L = V_Z = \frac{R_L V_i}{R_L + R}$$

$$\Rightarrow V_Z R_L + R V_Z = R_L V_i \Rightarrow R_{Lmin} = \frac{R V_Z}{V_i - V_Z}$$

* Any load resistance $R_L > R_{Lmin}$ ensures that the zener diode is in the "on" state.

$$I_{LMAX} = \frac{V_L}{R_{Lmin}} = \frac{V_Z}{R_{Lmin}}$$

* Once the diode is in the "on" state,

$$V_R = V_i - V_Z$$
$$I_R = \frac{V_R}{R}$$
} fixed

$$I_Z = I_R - I_L$$

- Since I_Z is limited to I_{ZM}, it affects the Range of R_L & therefore I_L. I_{ZM} establishes the minimum I_L

$$I_{Lmin} = I_R - I_{ZM}$$

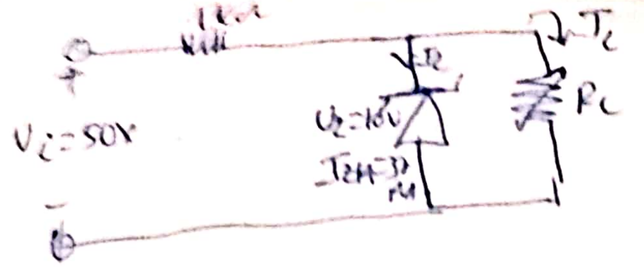
& the maximum load resistance as

$$R_{Lmax} = \frac{V_Z}{I_{Lmin}}$$

Ex for the n/w shown, determine the range of R_L & I_L that result in V_{RL} being maintained at 10V.

(b) Determine the max voltage ratings of the diode

4



Soln

$V = \frac{R_L V_i}{R_L + 1} \Rightarrow \frac{50 R_L}{R_L + 1} \geq 10V$

$\Rightarrow 50 R_L \geq 10 R_L + 10$

$40 R_L \geq 10$

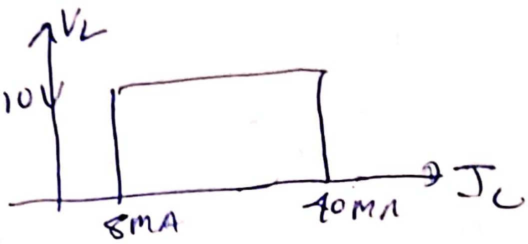
$R_L \geq \frac{1}{4} = 250\Omega$

$R_{Lmin} = 250\Omega$

$I_{LMAX} = \frac{V_L}{R_{Lmin}} = \frac{10}{250} = 40mA$

$I_{Lmin} = I_R - I_{ZM}$
$= 40 - 32$
$= 8mA$

$R_{Lmax} = \frac{10}{8mA} = 1.25k\Omega$



b) $P_{max} = V_Z I_{ZM}$
$= 10 \times 32 mA = 320 mW$

Fixed R_L, Variable V_i

$$V = \frac{R_L}{R_L + R} V_i$$

minimum V_i

$$\frac{R_L}{R_L + R} V_i \geq V_Z$$

$$\Rightarrow V_{imin} \geq \left(\frac{R + R_L}{R_L}\right) V_Z$$

$$\Rightarrow V_{imin} = \left(\frac{R + R_L}{R_L}\right) V_Z$$

maximum V_i

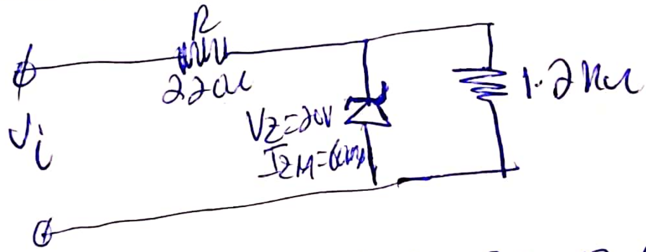
- I_L is limited by I_{ZM}

$$I_{Rmax} = I_{ZM} + I_L$$

$$V_{imax} = V_{Rmax} + V_Z$$

$$\boxed{V_{imax} = I_{Rmax} R + V_Z}$$

Ex: Determine the range of values of V_i that will maintain the zener diode in the on state



Soln

$$V_{imin} = \frac{R + R_L}{R_L} V_Z = \frac{1.4}{1.2} \times 20 = 23.67V$$

$$I_L = \frac{V_L}{R_L} = \frac{20V}{1.2k\Omega} = 16.67mA$$

$$I_{Rmax} = I_{ZM} + I_L = 60mA + 16.67mA = 76.67mA$$

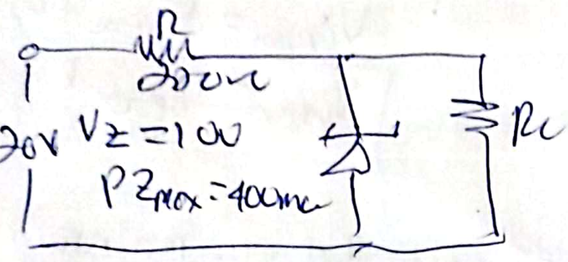
$$V_{imax} = I_{Rmax} R + V_Z = 76.67 \times 0.22 + 20 = 16.87 + 20 = 36.87V$$

Ex: (a) Determine V_L, I_L, I_Z & I_R for the n/w shown if $R_L = 180\Omega$

(b) Repeat (a) if $R_L = 470\Omega$

c) Determine the value of R_L that will establish max power conditions for the Zener diode

d) Determine the min value of R_L to ensure that Z is on



Soln: (a)

$$V = \frac{180}{400} \times 20V = 9V$$

Since $V < 10$, diode is OFF

$V_L = 9V$, $I_Z = 0$, $I_R = \frac{20-9}{220} = \frac{11}{220} = 0.05A$

(b) $$V = \frac{470}{690} \times 20 = 13.62V$$

Since $V > V_Z$, Z is ON

$V_L = V_Z = 10V$

$$I_R = \frac{10}{220} = 0.0454A = 45.4mA$$

$$I_L = \frac{10V}{470} = 0.0213A = 21.3m$$

$$I_Z = 0.0454 - 0.0213$$
0.0213
$= 24.1mA$

c) $I_{Zmax} = 40mA$

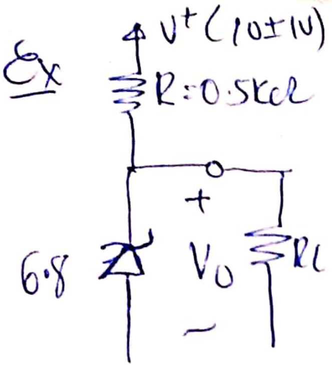
$I_{RL} = 45.4 - 40mA$ $\quad R_L = \frac{10}{5.4} = 1.85k\Omega$

$= 5.4mA$

d) $R_{Lmin} = 880\Omega$

p11.2

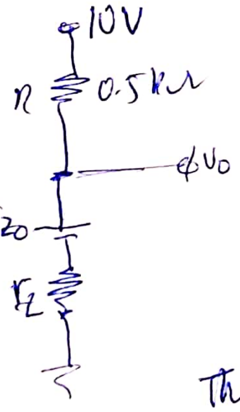
Ex



VZ = 6.8V at
IZ = 5mA
rZ = 20Ω, &
IZK = 0.2mA

a) Find V_0 with no-load & V^+ at its nominal value
b) Find Δ in V_0 resulting from the ±1V change in V^+
c) Find the Δ in V_0 resulting from connecting a load R_L that draws a current $I_L = 1mA$, & find load regulation $(\Delta V_0/\Delta I_L)$ in mV/mA
d) Find the change in V_0 when $R_L = 2k$
e) Find the value of V_0 when $R_L = 0.5k\Omega$
f) What is the minimum value of R_L for which the diode still operates in the breakdown region?

Soln



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

$V_{Z0} = 6.8 - 5 \times 20$
$= 6.7V$

$I_Z = I = \frac{10 - 6.7}{520}$
$= 6.35mA$

Thus $V_0 = V_{Z0} + I_Z r_Z$
$= 6.7 + 6.35mA \times 0.02$
$= 6.83$

b) $\Delta V_0 = \Delta V^+ \frac{r_Z}{R + r_Z} = \pm 1 \times \frac{20}{520} = \pm 38.5mV$

Line regulation = 38.5mV/V

c) $\Delta V_0 = r_Z \Delta I_Z = 20 \times (-1) = -20mV$

Load regulation = $\frac{\Delta V_0}{\Delta I_L} = -20mV/mA$

d) $R_L = 2k\Omega$

$I_L = \frac{6.8}{2k} = 3.4mA$

$\Delta I_Z = -3.4mA$

$\Delta V_0 = r_Z \Delta I_Z = 20 \times -3.4$
$= -68mV$

e) $V_0 = V^+ \frac{R_L}{R + R_L} = \frac{10 \times 0.5}{0.5 + 0.5} = 5V$

f) $I_Z = I_{ZK} = 0.2mA$ & $V_Z = V_{ZK} = 6.7V$

$I_{max} = \frac{9 - 6.7}{0.5} = 4.6mA$

$R_L = \frac{6.7}{4.4}$

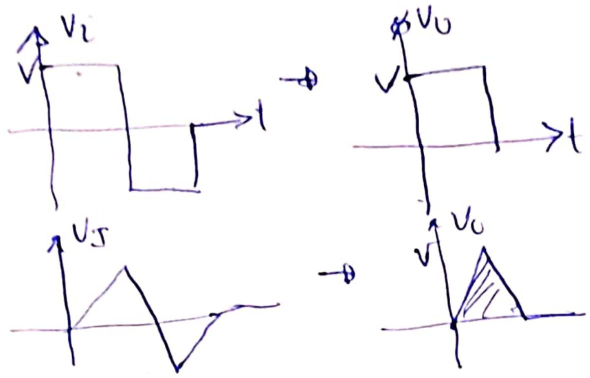
P.12

6

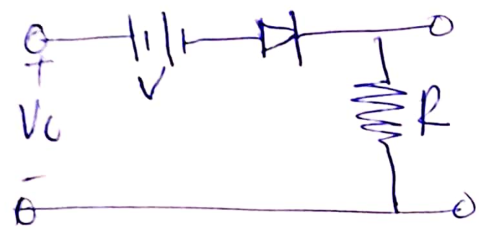
G1

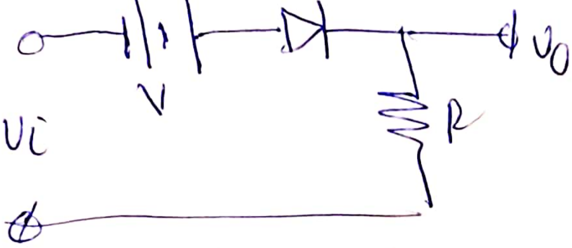
CLIPPERS: are networks that employ diodes to "clip" away a portion of an input signal without distorting the remaining part of the applied voltage waveform

Series clippers: the diode is in series with the load

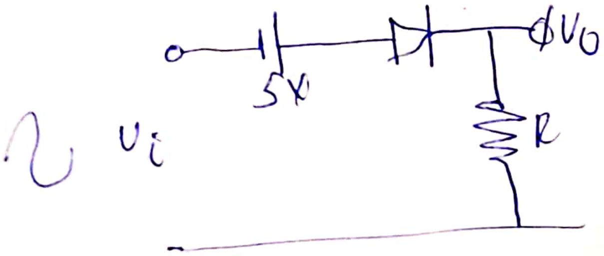


Series clippers with Bias





Ex Determine the o/p waveform for the network shown when $V_i = 20\sin\omega t$ a) Repeat 'a' for V_i = 20V, -10V, T/2



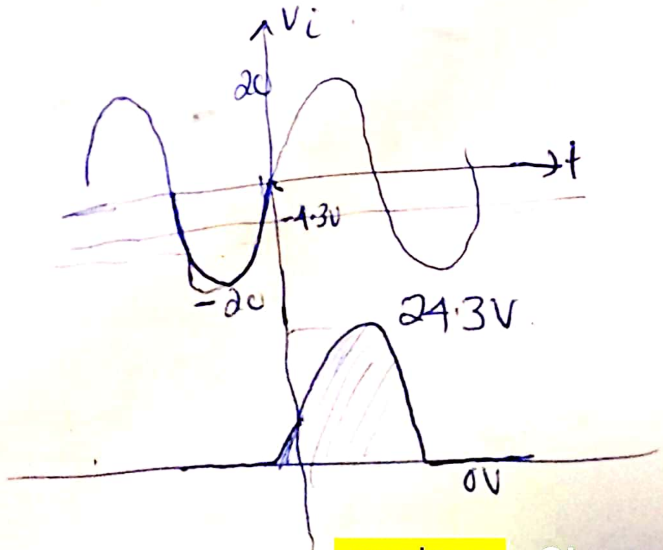
In order to make the diode ON,

$$V_i + 5V \geq 0.7V$$

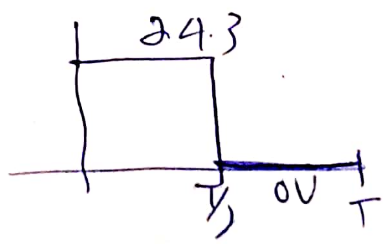
$$V_i \geq -4.3V$$

with this condition

$$V_o = V_i + 5 - 0.7$$
$$= V_i + 4.3$$



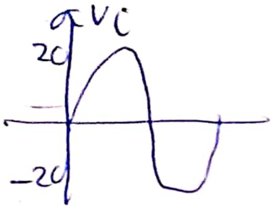
b)



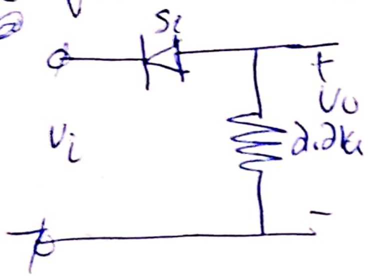
P13

7

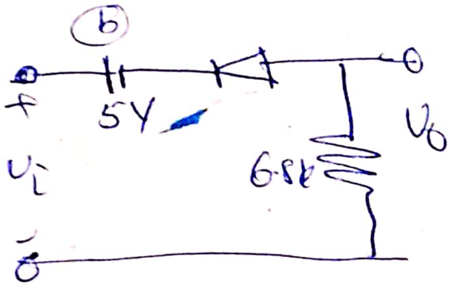
Ex Determine V_o for each n/w



ⓐ



ⓑ



Soln

ⓐ $V_i \leq -0.7$ to make the diode on ie $-20V < V_i \leq -0.7V$

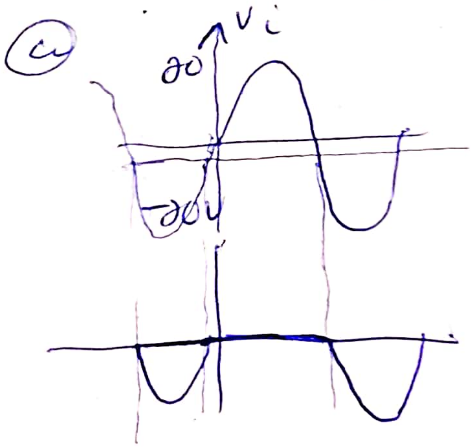
$V_o - V_i = 0.7$

$V_o = V_i + 0.7$

For $V_i = -20V$
$V_o = -19.3V$

For $V_i = -0.7V$
$V_o = 0V$

ⓐ



b) $V_i - 5V < -0.7$

$V_i < 4.3$

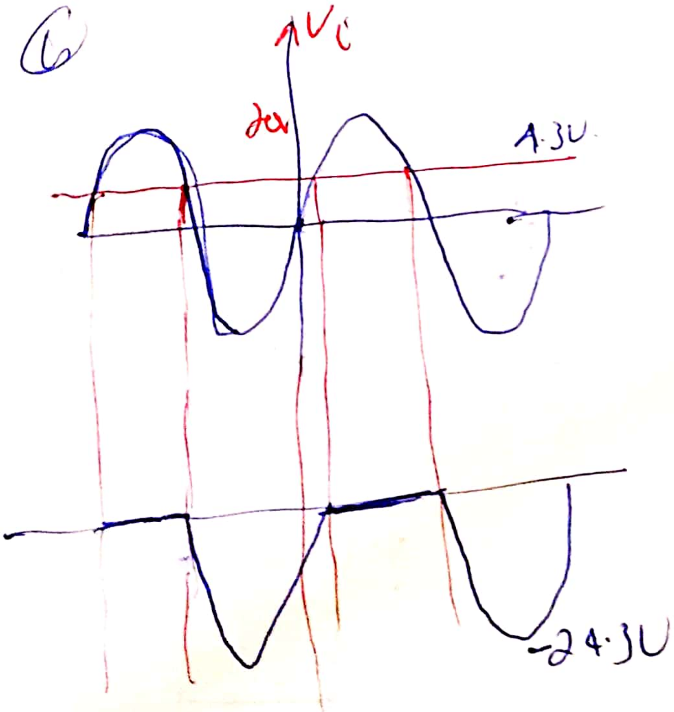
$V_o - 0.7 + 5 - V_i = 0$

$V_o = V_i + 0.7 - 5V = V_i - 4.3$

For $V_i = -20V$
$V_o = -24.3V$

For $V_i = 4.3$
$V_o = 0V$

ⓑ



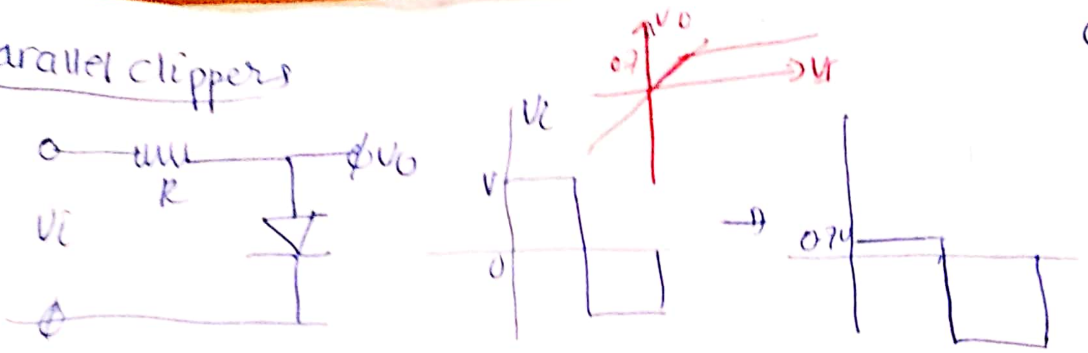
$-V_i - 0.7 + 5 > 0$

$V_i > -4.3$

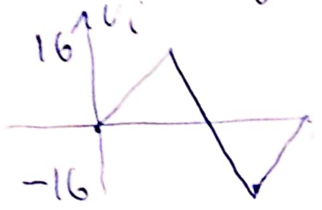
$V_i \leq 4.3$

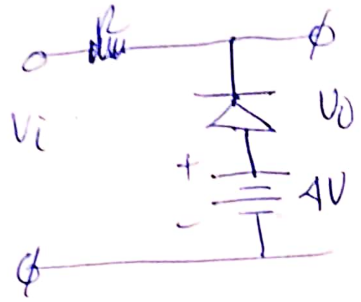
P13.2

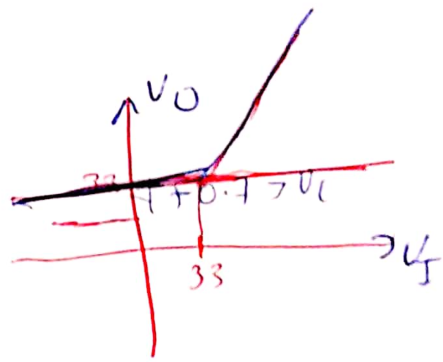
Parallel clippers



Ex Determine V_o for the n/w shown







Soln Transition

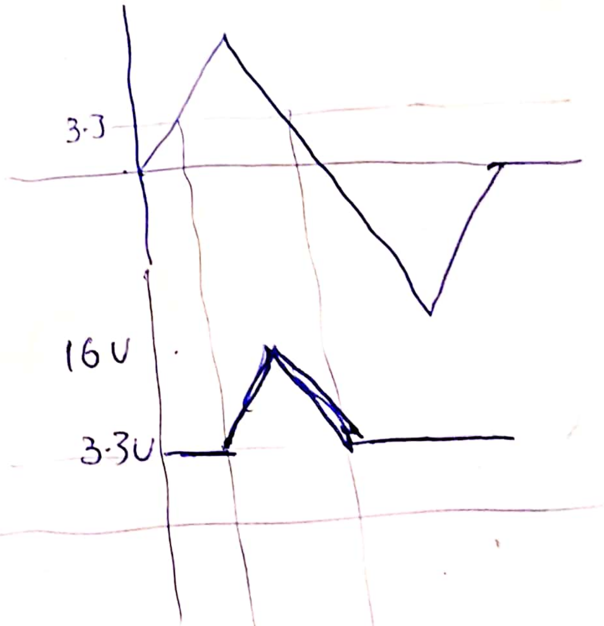
$V_i + 0.7 - 4V < 0$

$V_i <$ ~~4.7V~~ $3.3V$

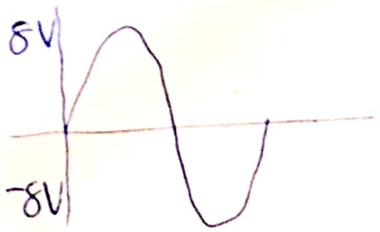
$V_o = -0.7 + 4 = 3.3V$

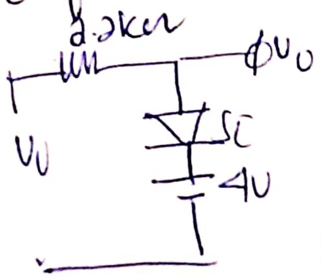
For $V_i \geq 3.3V$, D = OFF

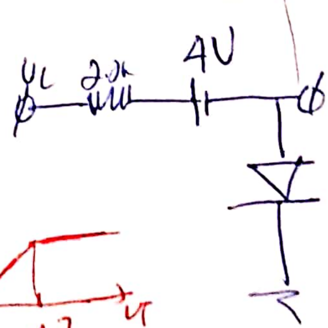
$V_o = V_i$

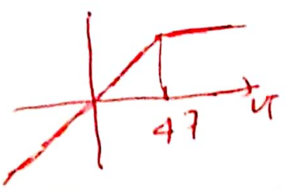


Ex Determine V_o for each n/w shown









8

Soln

$V_i \geq 4.7V$

$V_o = 4.7V$

V_i realme , $V_o = V_i$

$V_i - 4 > 0.7$

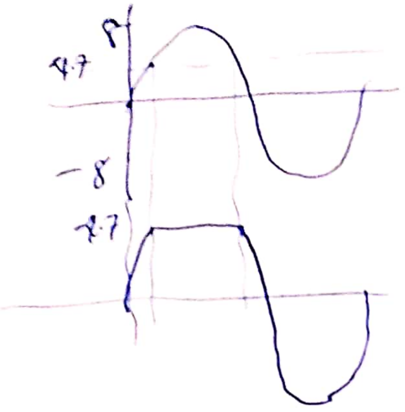
$V_i > 4.7$

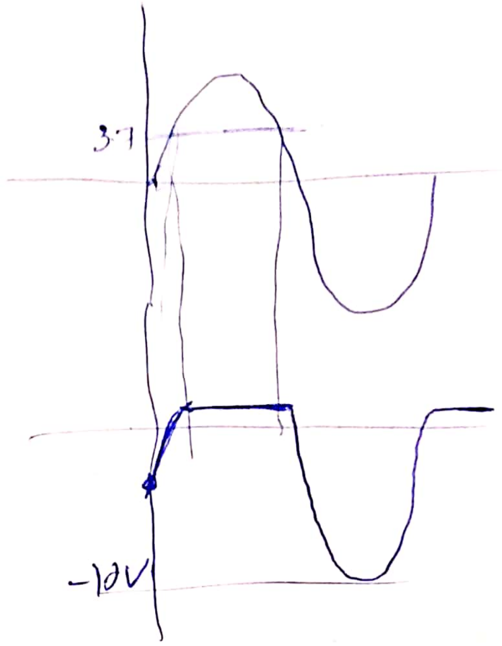
$V_o = 0.7$

For $V_i < 4.7$

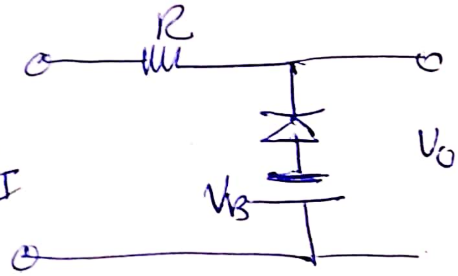
$V_o = V_i$

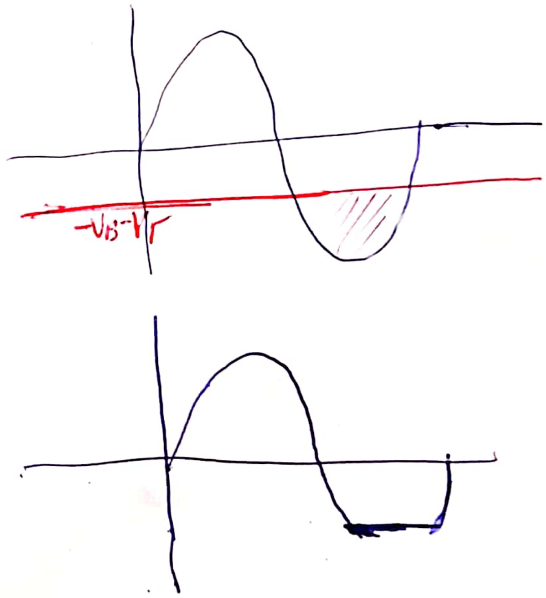
(4/14)





Ex





$$-V_I - V_B - V_\gamma - iR \geq 0$$

$$-V_I \geq V_B + V_\gamma$$

$$V_I \leq -(V_B + V_\gamma)$$

$$V_O = -V_B - V_\gamma$$

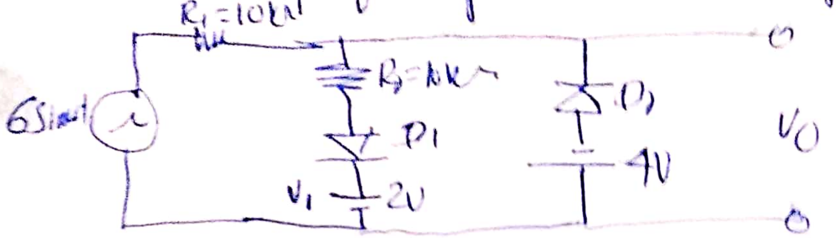
For $V_I \geq -(V_B + V_\gamma)$

$$V_O = V_I$$

p14.2

(C3)

Ex Find the o/p of the parallel based clipper shown below



Soln

D_1 ON when $V_I \geq 2 + V_\gamma = 2.7V$

D_2 OFF $\quad I = \left(\frac{V_I - 2.7}{20}\right) mA$

V_O

$V_O = \frac{V_I - 2.7}{2} + 2.7$

$= \frac{1}{2}(V_I + 2.7)$

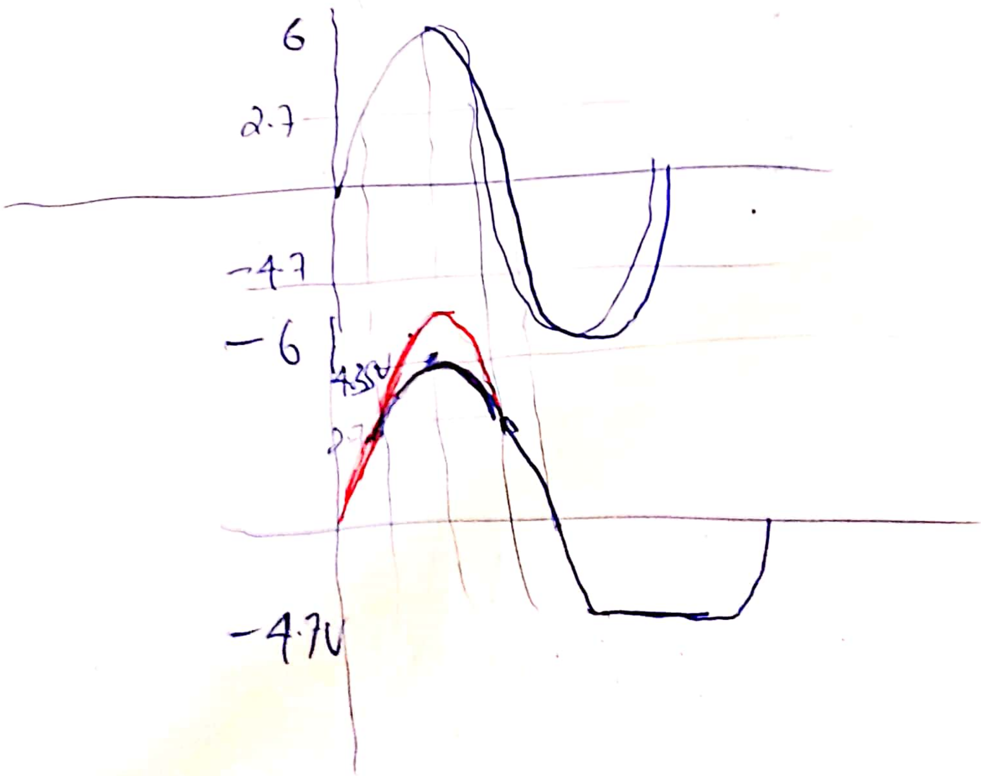
D_2 ON when

$V_I \leq -(4 + 0.7)$

$V_O = -4.7V$

D_1 & D_2 OFF when $-4.7 \leq V_I \leq 2.7$

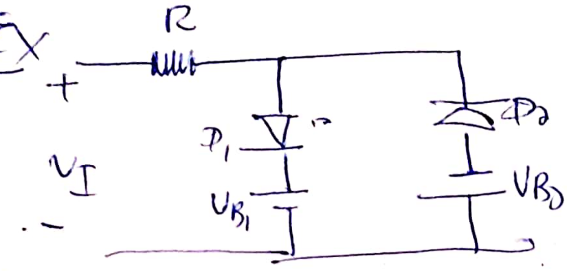
$V_O = V_I$

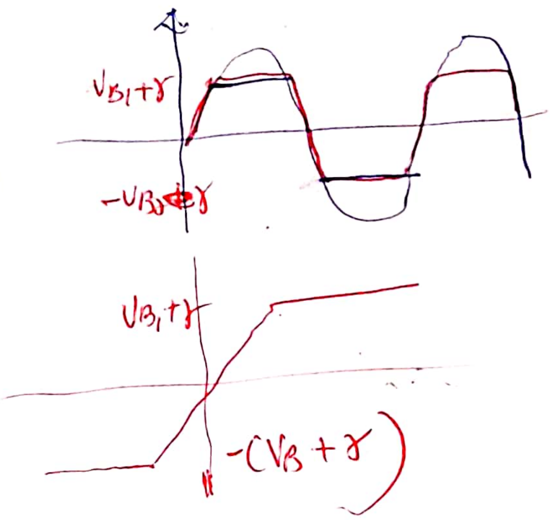


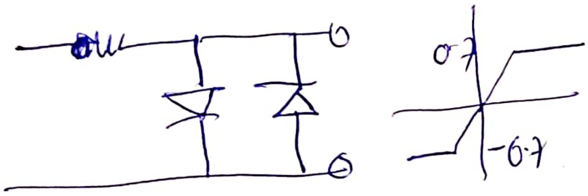
9

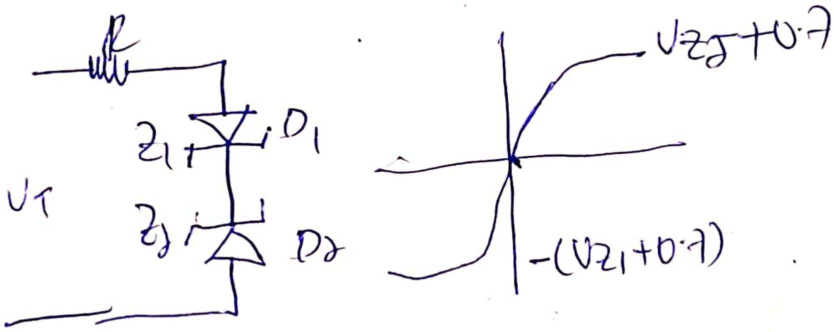
P15

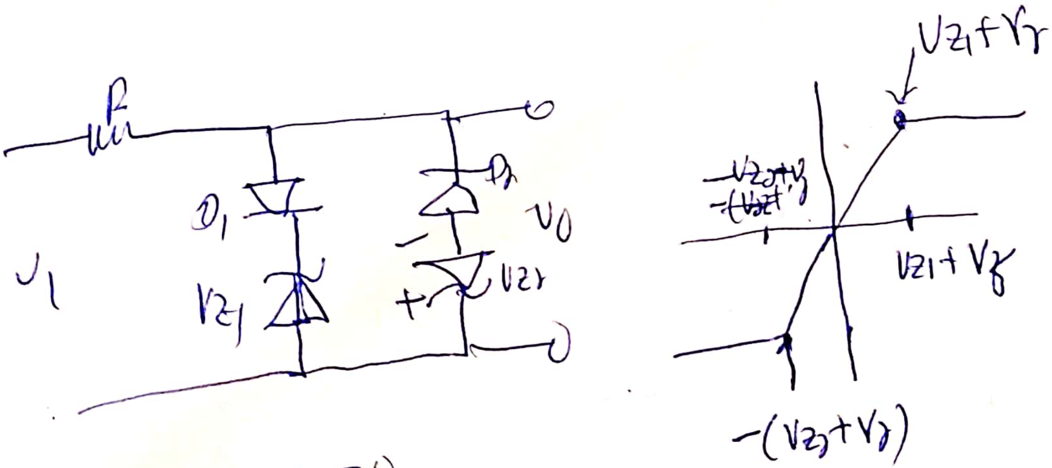
Ex









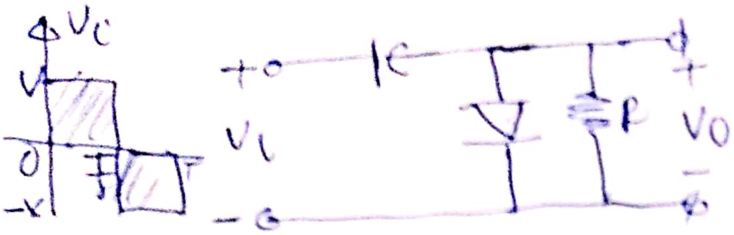


$V_I - 0.7 - V_{Z_1} = 0$

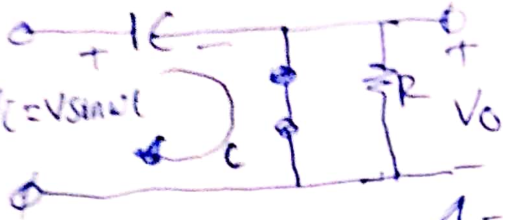
$V_I = V_{Z_1} + 0.7$

P152

Clampers :- dc shifter



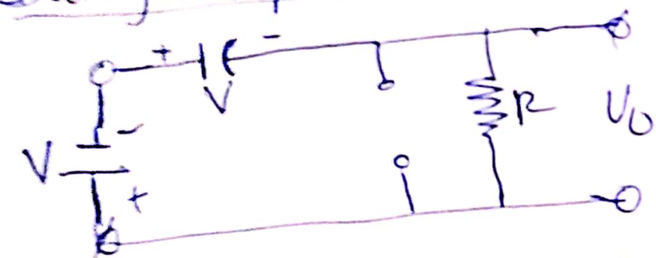
During ON period



$V_c = V$

$\tau = RC$ very small

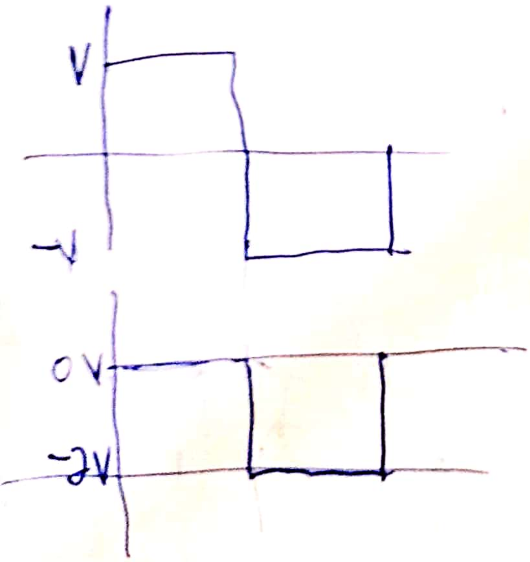
During OFF period

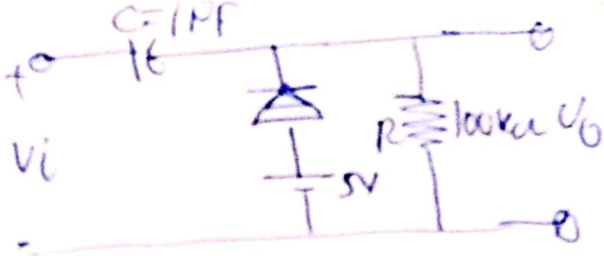


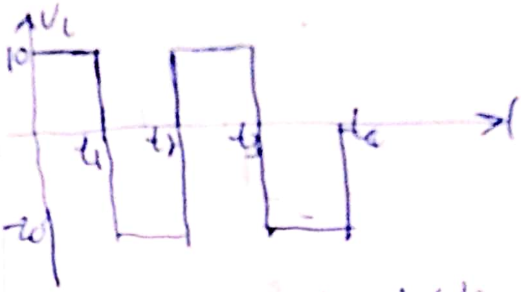
$\tau = RC$ Very large

$\tau = 5\tau > T/2$

$V_o = -2V$

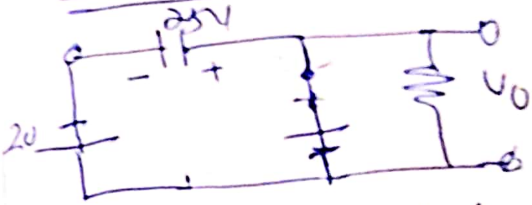




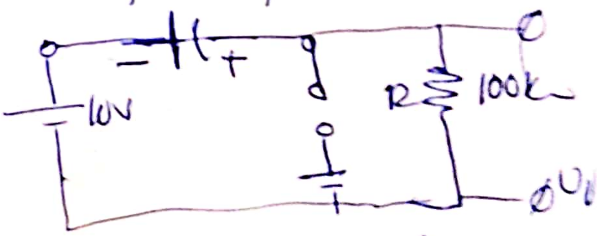


During "on", $t_1 < t < t_2$

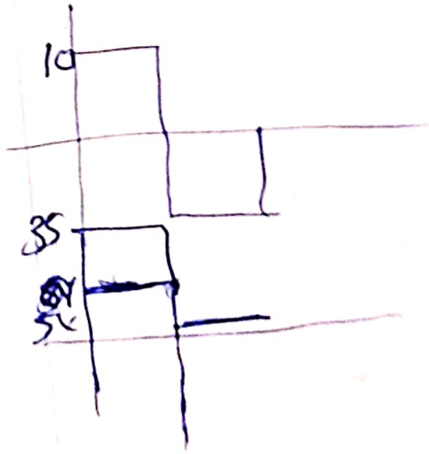
$V_c = 25V - 0.7$, $V_o = 5V - V_d$

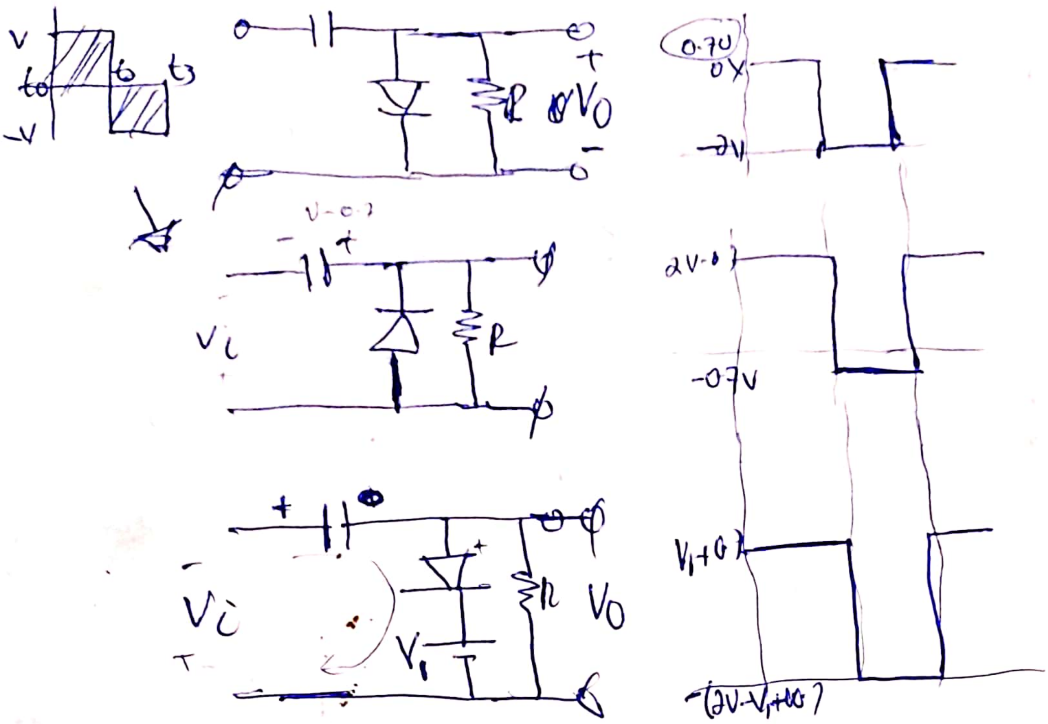


During "OFF", $t_2 < t < t_3$



$V_o = 35V$ (34.3V





ON ⇒ $V_O = V_1 + 0.7$

$V_C = V - (V_1 + 0.7)$

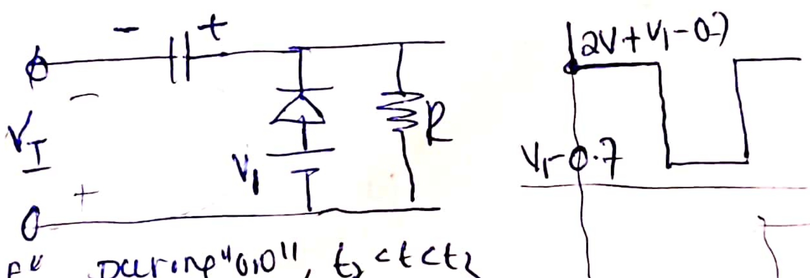
OFF ⇒ $-V_C - V_O - V = 0$

$V_O = -(V_C + V)$

$= -(V - V_1 - 0.7 + V)$

~~$= V_1 + 0.7$~~

$= -(2V - V_1 - 0.7)$



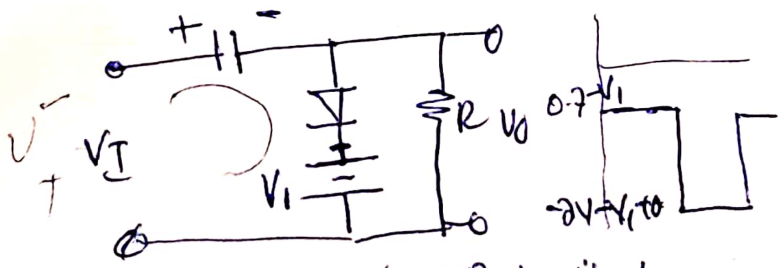
During "OFF" $t_0 < t < t_1$

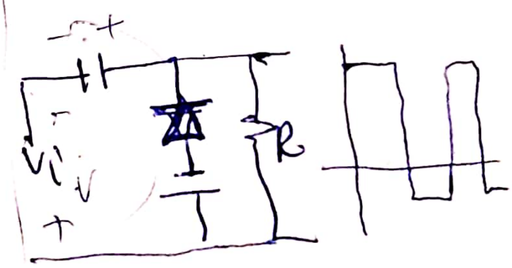
$V_O = 2V + V_1 - 0.7$

During "ON", $t_2 < t < t_3$

$V_O = V_1 - 0.7$

$V_C = V + V_1 - 0.7$





During "On", $t_0 < t < t_1$

$V_C = V + V_1 - 0.7$

$V_O = 0.7 - V_1$

OFF, $t_2 < t < t_3$

$V_O = -V_C - V$

$= -V - V_1 + 0.7 - V$

$= -2V - V_1 + 0.7$

ON=

$V_O = -(0.7 + V_1)$

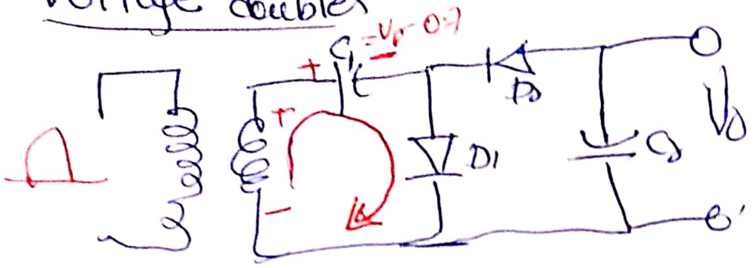
$V_C = V - V_1 - 0.7$

OFF

$V_O = V_C + V = 2V - V_1 - 0.7$

P16.2

Voltage doubler



+ve half cycle

D_1 = Conducts

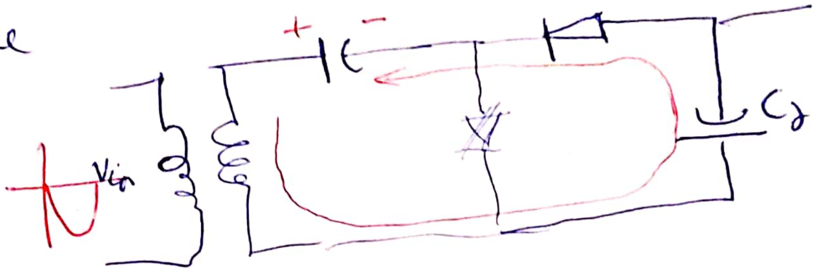
D_2 = OFF

C_1 is charged to the peak of secondary voltage (V_p) less the diode drop

During -ve half cycle

D_2 = Conducts

D_1 = OFF



using KVL

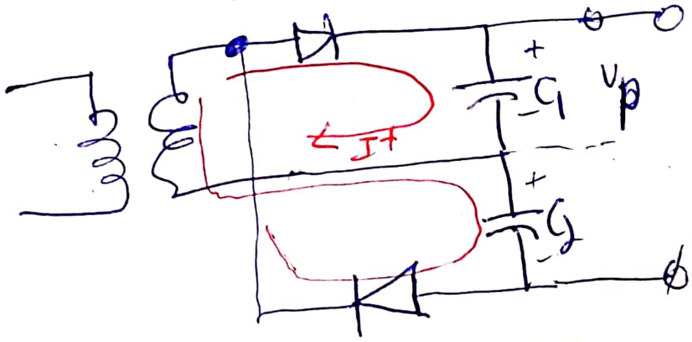
$$V_p - V_{C2} + V_{C1} = 0$$

$$V_{C2} = V_p + V_{C1}$$

$$= V_p + V_p - V_d$$

$$V_o = 2V_p - V_d$$

Full wave voltage doubler



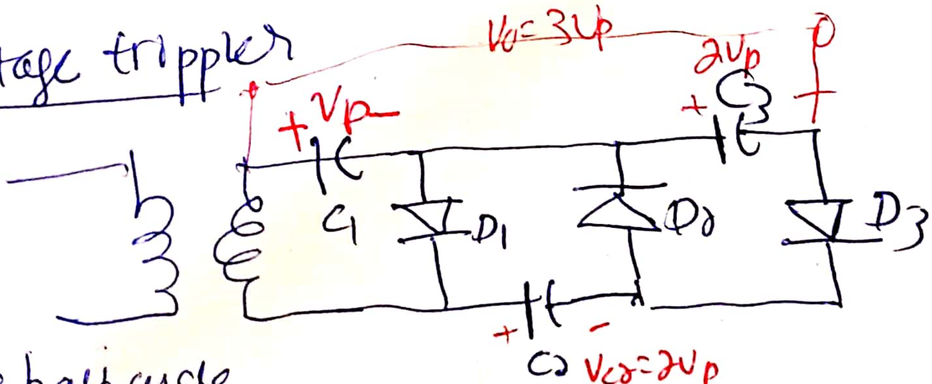
+ve cycle

$$V_{C1} = V_p - 0.7$$

$$V_{C2} = V_p - 0.7$$

$$V_o = 2V_p - 1.4$$

Voltage trippler



+ve half cycle

C_1 charges to V_p through D_1

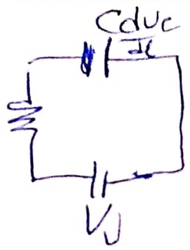
$V_{C1} = V_p - V_d$

-ve half cycle

C_2 charges to $2V_p - V_d$ through D_2

during next +ve cycle

C_3 charges to $2V_p$ through D_3



$V_0 - CR\frac{dV_c}{dt} - V_c = 0$

$V_0 - \frac{CR}{C}\frac{dQ}{dt} - \frac{Q}{C} = 0$

$R\frac{dQ}{dt} + \frac{Q}{C} = V$

$q = Ae^{\lambda t}$

$\frac{dq}{dt} = A\lambda e^{\lambda t}$

$AR\lambda e^{\lambda t} + \frac{Ae^{\lambda t}}{C} = 0$

$\lambda R + \frac{1}{C} = 0$

$\lambda = -1/RC$

Step-1

$R\frac{dq}{dt} + q/C = 0$

$q = Ae^{-t/RC}$

particular solⁿ

$q = a$, $a = V_0 C$

$\frac{-R}{RC}Ae^{-t/RC} + \frac{Ae^{-t/RC}}{C} = V$

$q = Ae^{-t/RC} + CV_0$

$A = -CV_0$

$q = -CV_0e^{-t/RC} + CV_0$

$q = CV_0(1 - e^{-t/RC})$

$V_C = V_0(1 - e^{-t/RC})$

$\frac{a}{s(s+a)}$

$a\left\{\frac{1/a}{s} + \right.$

$V_0(s) = SCR\,V_c(s) + V_c(s)$

$= V_c(s)\{1 + SCR)$

$V_c(s) = \frac{V_0(s)}{1+SCR} = \frac{1}{CR}\left(\frac{V_0(s)}{s+\frac{1}{CR}}\right)$

$= \frac{1}{CR}\left(\frac{1}{s(s+\frac{1}{CR})}\right)$

$= \frac{1}{CR}\left\{\frac{CR}{s} - \frac{CR}{s+1/CR}\right\}$

$= \frac{1}{s} - \frac{1}{s+1/CR}$

$= A(1 - e^{-t/CR})$

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Diode capacitances:

There are two types of capacitive effects in a pn-jn

1) Space charge capacitance (C_T)
2) Diffusion capacitance (C_D)

$C_T = \frac{dQ}{dV} = \frac{\varepsilon A}{d}$ - Its effect is reduced in forward biased diode

Diffusion capacitance (C_D)

* The capacitance offered by the jn diode when forward biased is the diffusion capacitance, C_D.
* There will be a large concentration of holes on the N-side of the jn & the concentration of holes decreases exponentially on the N-side as we move away from the junction
* A +ve charge is injected from the p-side into the n-side. The injected charge is proportional to the forward bias voltage V. The rate of change of Q with V is the diffusion capacitance

$$C_D = \frac{dQ}{dV}$$

* The amount of Q stored in the diode is proportional to the diode current I.

$Q = I\tau$, τ - mean life time of charge carriers

$$I = I_s e^{V/\eta V_T} \Rightarrow Q = (I_s e^{V/\eta V_T})\tau$$

$$C_D = \tau \frac{d}{dV}(I_s e^{V/\eta V_T}) = (I_s e^{V/\eta V_T})\left(\frac{\tau}{\eta V_T}\right)$$

$$= \frac{\tau}{\eta V_T}(I + I_s)$$

$$C_D \simeq \frac{\tau I}{\eta V_T}$$

$C_T = \frac{dQ}{dV} =$ P & N regions can be considered as a parallel plate in reverse biased diod

$$C_T = \frac{dQ}{dV} = \frac{q N_D A E}{q N_D W} = \frac{\varepsilon A}{W}$$

W - width of depletion region

A - Jn area

Shotcky diode & LED
Read Ass
Tunnel diode
step-recovery diode
Varactor

} Reading Assignment.

p18-2 End