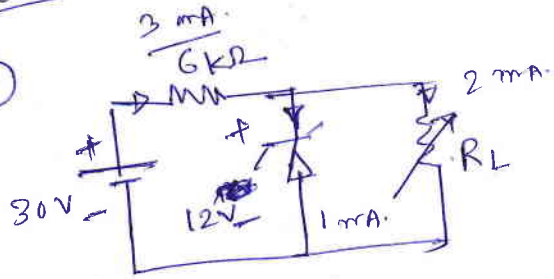
Set-A

① 

6 kΩ

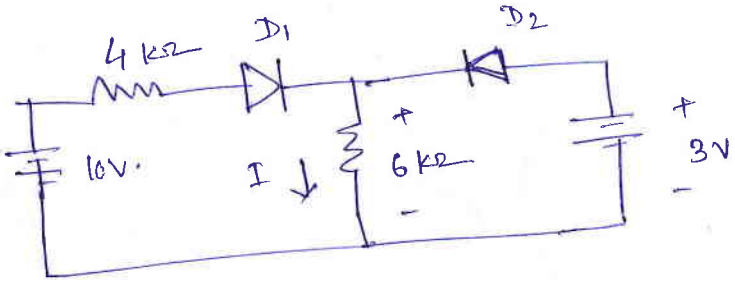
Current through 6kΩ resistor $= \frac{30-12}{6\ k\Omega} = 3$ mA.

min. 1 mA current through Zener., So, 2 mA current through R_L.

min. value of R_L should be such that drop across it should be 12 V.

So, min. value = 6 kΩ

Range 5.7 kΩ to 6.1 kΩ.

② 

Diodes are ideal

So, $I_S = 0$. (Reverse bias current),

$V_\gamma = 0$

assume, D_1 is ON, D_2 is OFF

$I = 1$ mA.

Drop across 6kΩ = 6V.

D_2 reverse bias., as assumed.

check other possibilities, D_1 & D_2 both ON.

Not possible.

D_2 ON, D_2 OFF

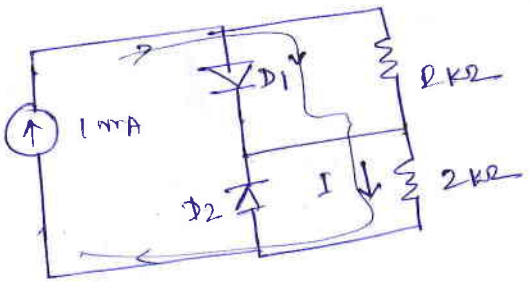
not possible.

Some of you have considered

$V_\gamma = 0.7$ V.

0.93 mA.

Range 0.9 to 1.05 mA

③ 

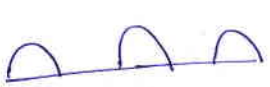
D_1 forward bias, current through D_1 = 1 mA, Voltage drop = 0 as cut-in voltage = 0.

D_2 can't conduct 1 mA current the current will flow through 2 kΩ resistor.

So, I = 1 mA.

Range 0.95 to 1.05 mA

④ 200 Sin 300t V i.e. V_m Sin ωt

o/p  H-wave

Average value $= \frac{V_m}{\pi} = \frac{200}{3.14} = 63.69$ V.

Range 61 V to 65 V.

Set-A

SET-A PAGE-2

(5) $f = 60\,Hz$.

$R_L = 10\,k\Omega$.

$V_r = 0.2\,V$.

peak output voltage $= 10\,V$. $= V_{m\_out}$.

$$V_r = \frac{V_m}{2fRC} \quad ; \quad C = \frac{V_m}{2fRV_r} = \frac{10}{2\times 60\times 10\times 10^3\times 0.2}$$

$$\approx 41.6\,\mu F.$$

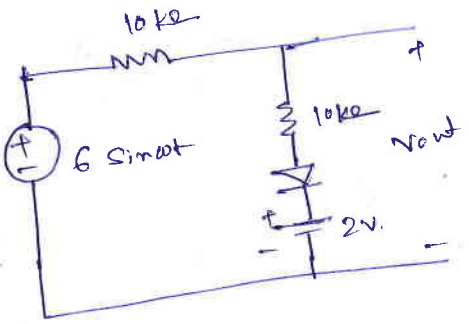
Range: 40 μF to 43 μF

(6) Every 10°C rise in temp., I_s doubles.

$$\frac{I_s'}{I_s} = 2^{\frac{\Delta T}{10}} = 100, \text{ find } \Delta T, \quad \Delta T = 66.67^\circ C.$$

Range: 65 – 68 °C

(7)



Diode is ON, for positive half-cycle of input.

Max. input = 6V.

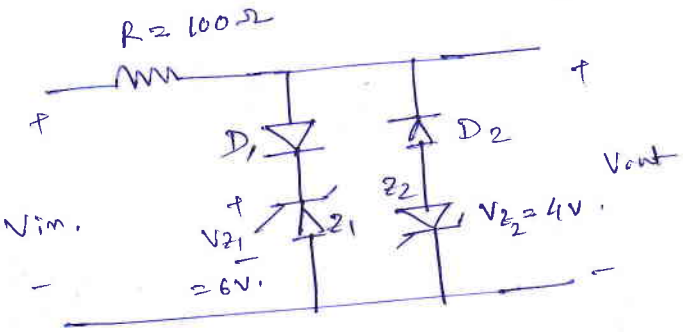
$$\text{Current} = \frac{(6-2)V}{(10+10)k} = 0.2\,mA.$$

Max. $V_{out} = 10\,k\Omega \times 0.2\,mA + 2V.$

$= 4\,V.$

Range: 3.5 V to 4.5 V.

(8)



$V_{in} = 5\,V$.

D_1 ON, D_2 OFF

Z_1 is not in break down

So, $V_{out} = V_{in}$.

$= 5\,V$.

Range: 4.8 V to 5.2 V.

(9) F.W. bias $V_{in} = 0.15\,V$.

$$I_F = I_s \exp\left(\frac{0.15}{0.026}\right); \; n=1$$

Reverse bias

$$I_R = -I_s$$

$$\frac{I_F}{I_R} = \frac{I_s \exp\left(\frac{0.15}{0.026}\right)}{-I_s} = -320.29,$$

Range: 310 to 330

both '+' and '−'

Set - A

SET-A PAGE-3

(10)

Conductivity (σ) = $nq\mu$

Resistivity (ρ) = $\frac{1}{\sigma} = \frac{1}{nq\mu}$

$= \frac{1}{2.3 \times 10^{15} \times 1.6 \times 10^{-19} \times 1350}$

$= 2$ Ω-cm.

1.9 to 2.1 Ω-cm Range.

(11)

Voltage applied = 5V.

Distance = 2 cm.

Field = $\frac{5}{2}$ = 2.5 V/cm.

(E)

$n = 10^{16}$ cm^{-3}

$\mu_n = 2500$ cm^2/V-s.

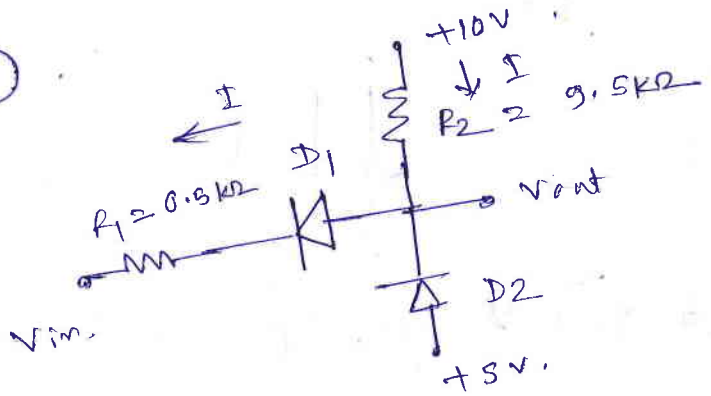
$J_n = nq\mu_n E$

$= 10^{16} \times 1.6 \times 10^{-19} \times 2500 \times 2.5$

$= 10$ A/cm^2

Range 9 A/cm^2 – 11 A/cm^2

(12)



When, Vin = 10 V.

D_2 is OFF

Vout = $10 - 9.5 \times I$

$10 = 9.5I - 0.6 - 0.5I - V_{in} = 0$

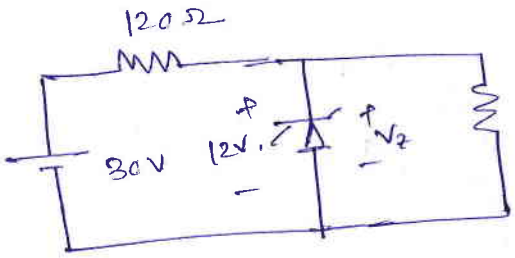
$\therefore I = \frac{9.4 - V_{in}}{10}$.

Vout = $10 - 9.5 \times \frac{9.4 - V_{in}}{10}$.

for Vin ≥ 9.4 V., Vout = 10 V.

Range 9.5V to 10.5 V.

(13)



Voltage drop across R_L = 10 V. < V_Z. Zener is not on.

No current through zener.

power dissipation across zener = 0.

power dissipation "Zero"

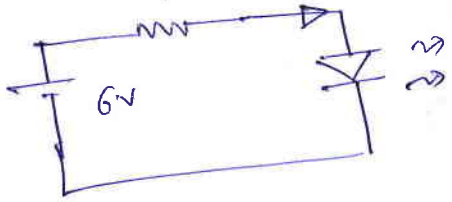
(14) Voltage at transformer secondary $V_m \sin \omega t$ V

$10 \sin 377t$ V.

Full wave rectifier, $V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.07$ V.

Range 6.95 V to 7.2 V.

(15)



Cut-in voltage = 1V.

~~Voltage drop across LED = 6 − 700 × 5~~

Voltage drop across LED

= 6 V − 5 mA × 700 Ω

= 2.5 V.

power dissipation = 2.5 V × 5 mA.

= 12.5 mW.

= 2.5 V.

power dissipation = 2.5 V × 5 mA

= 12.5 mW.

Range

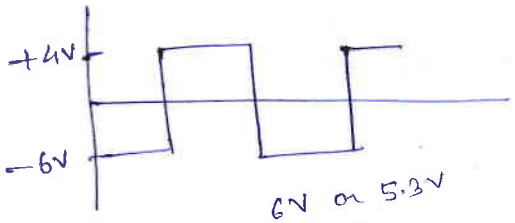
12 to 13 mW

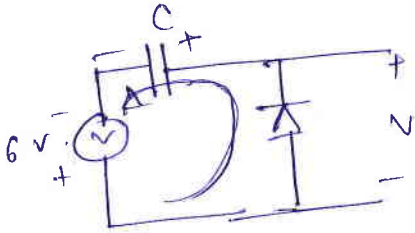
Set-B

Range (31-32)

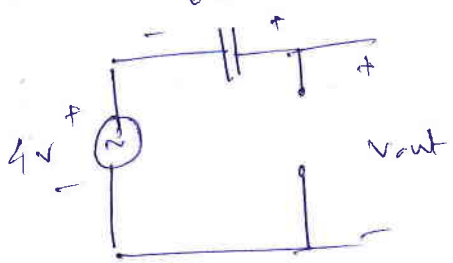
(1) Avg. value $= \frac{V_m}{\pi} = \frac{100}{3.14} = 31.84$ V. (B-4 in Set-A)

(2)





During (-) half., capacitor charged with 6 V on 5.3 V. (Considering $V_\gamma = 0.7$V)



$V_{out(max)}$ = 10 V on 9.3 V.

Range (9 to 10 V.)

(3) (B-5 in Set-A)

$C_r = \frac{V_m}{2fRV_r} = \frac{10\text{ V}}{2 \times 50 \times 10 \times 10^3 \times 0.3}$

= 33.36 μF.

Range (31 - 35) μF

(4) $N_D = 10^{15}$ cm^{-3} $\quad n_i = 1.5 \times 10^{10}$ cm^{-3}.

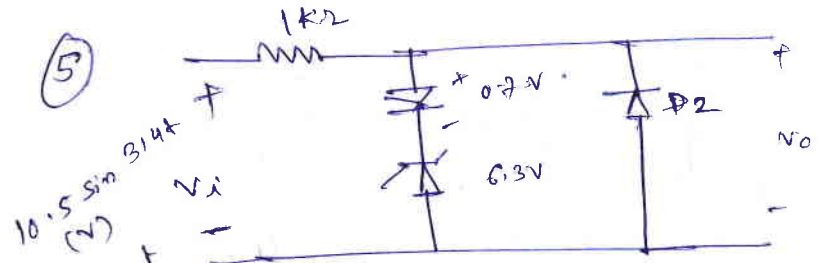
additional doping $N_A = 1 \times 10^{18}$ cm^{-3}. $\gg N_D$

$P = 1 \times 10^{18}$ cm^{-3}

$n = \frac{n_i^2}{P} = \frac{2.25 \times 10^{20}}{1 \times 10^{18}} = 2.25 \times 10^2 = 225$ cm^{-3}

Range (220 to 230)

(5)



Max. input = ±10.5 V.

$V_{out-max} = 0.7\text{V} + 6.3\text{V} = 7$V.

Range (6.5 to 7.5 V.)

(6) 1 mA (B-3 in Set-A)

Range (0.9 to 1.1 mA)

Set-B

(7) (B-6 in Set-A)

$$\frac{I_s'}{I_s} = 2^{\Delta T/10} = 200$$

$$\frac{\Delta T}{10}\log 2 = 2.30$$

$$\Delta T = \frac{2.30 \times 10}{\log 2}$$

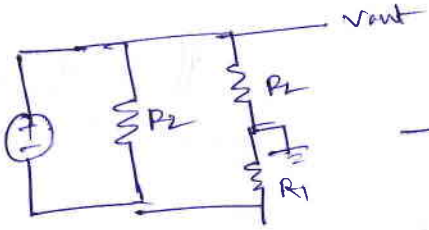
$$\Delta T = 76.40$$

range (75 to 78)

(8) $I = 1\ mA$. (B-2 in Set-A) range (0.9 to 1.1)

(9) $V_{out} = 5.5\ V$. (B-8 in Set A) ~~(5.2 to 6.6)~~ (5.2 to 5.7)

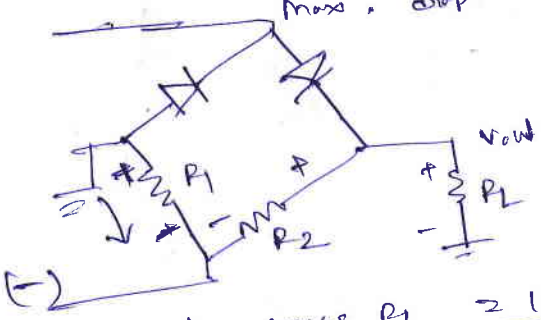
(10) the circuit can be redrawn as (in forward bias)



Max. 20

max. voltage drop across $R_2 = R_1$

$= 10\ V$.

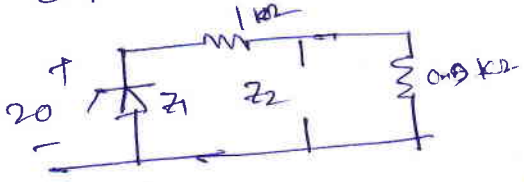


range (9.5 to 10.5)

PIV = drop across R_2 − drop across R_1 $= 10\ V$.

(11) Remove zener diodes, find current $= \frac{35}{0.5+1+0.9} = 14.58\ mA$.

drop across (1K + 900Ω) is ~~so~~ more than 20V, & 20 V zener is in breakdown.



drop across 0.9 kΩ resistor

$= 9.47 < 10V$.

Z_2 is not in breakdown

Ans. 9.47 V. (9.2 to 9.6) V.

(12) $D_p = 15\ cm^2/s$.

$$\frac{D_n}{\mu_n} = \frac{D_p}{\mu_p} = V_T = 0.0259\ V.$$

$$\mu_p = \frac{D_p}{0.0259} = \frac{15}{0.0259} = 579.15\ cm^2/V\text{-}s.$$

(560 to 590)

range

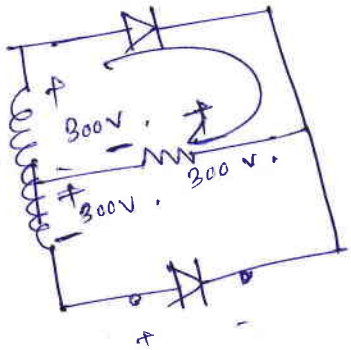
(13) D_1 and D_2 is in parallel, so, D_2 will turn on as $V_\gamma = 0.3\,V$.

$$I_R = \frac{10 - 0.3}{330\,\Omega}\ A.$$

$$= 29.39\ mA$$

Range 29 to 30

(14)



$PIV = 2V_s - V_\gamma$

$= 599.3\,V.$ / 600 V.

Range (599 to 600V)

(15) $10 \sin(377t)$ in V.

$V_m \sin \omega t$

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.07\ V.$$

Range (7.0 to 7.15)

Set-C

SET-C PAGE-8

(1) $N_D = 10^{15}\ cm^{-3}$, $n_i = 1.5\times10^{10}\ cm^{-3}$

additional doping $N_A = 2\times10^{18}\ cm^{-3}$. >> N_D and n_i

So, $P = 2\times10^{18}\ cm^{-3}$.

$$n = \frac{n_i^2}{P} = \frac{2.25\times10^{20}}{2\times10^{18}} = 1.125\times10^{2} = 112.5\ cm^{-3}.$$

Range 105 – 125 cm^{-3}.

(2) Drop across $R_L = \frac{60}{60+120}\times30 = 10\ V$, $V_Z = 11\ V$.

So, Zener is not in breakdown.

↓

no current through Zener.

Power dissipation = 0

'0'

(3) $V_i = 12.5 \sin\omega t$

$V_m = 12.5\ V$.

$V_\gamma = 0.6\ V$, $V_Z = 6.3\ V$.

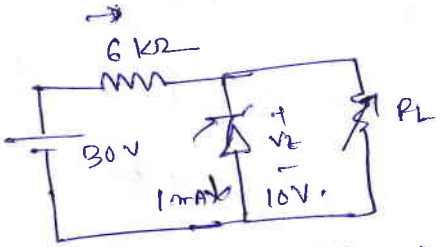
Max. voltage drop = $6.3 + 0.6 = 6.9\ V$.

Range (6.5 to 7.5 V.)

(4) Same as B-7 Set-A

Ans 4V Range 3.5 V to 4.5 V.

(5)



Current through 6 kΩ = $\frac{30-10}{6\ k\Omega} = 3.33$ mA

Current " $R_L = (3.33 - 1) = 2.33$ mA.

Min. value of R_L should be such that $2.33\times R_L = 10\ V$.

$R_L = 4.29\ k\Omega$

Range 4.1 to 4.45 kΩ.

(6) Only Ge diode is ON.

$$I_R = \frac{10 - 0.35}{330\ \Omega} = 29.24\ mA.$$

Range 29 to 30 mA

SET-E PAGE-9

(7) $\mu_n = 1500\ cm^2/V\text{-}s$. $n = 10^{16}\ cm^{-3}$.

$E = 5/2 = 2.5\ V/cm$. $J = nq\mu_n E$

$= 10^{16} \times 1.6 \times 10^{-19} \times 1500 \times 2.5$

$= 6\ A/cm^2$.

Range 5 - 7 A/cm^2.

(8) $\frac{I_{Forward}}{I_{Reverse}} = \frac{I_S \exp\left(\frac{0.2}{0.026}\right)}{I_S}$

$= 2191$

Range 2100 - 2300

(9) $V_{out} = 10V$ (Please See Q-12, Set-A)

Range 9.5 to 10.5 V.

(10) $V_{in} = V_m \sin \omega t$, $V_m = 30V$. (max. input voltage).

PIV = 15V. (for details pls. see Q-10 Set-B)

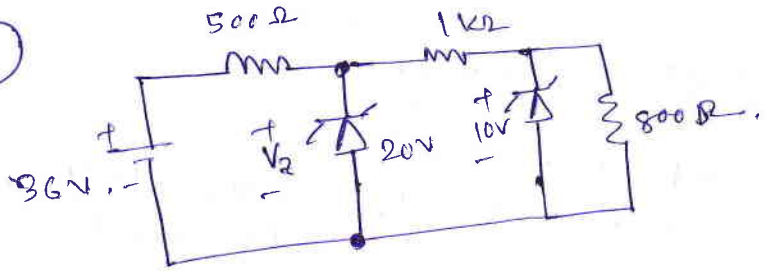
Range. 14.5V to 15.5V.

(11) $\mu_n = 1250\ cm^2/V\text{-}s$. $N_D = n = 4.3 \times 10^{15}\ cm^{-3}$

$\rho = \frac{1}{\sigma} = \frac{1}{nq\mu_n} = \frac{1}{4.3 \times 10^{15} \times 1.6 \times 10^{-19} \times 1250} = 1.16\ \Omega\text{-cm}$

Range 1 to 1.3 Ω-cm

(12)



Remove all Zener diodes

Find current $= \frac{36}{0.5+1+0.8}$

$= 15.65\ mA$.

drop across $(1+0.8)\ K\Omega$

$= 28\ V. > 20V$.

20 V Zener is in breakdown

So, current through 800 Ω. = 11.11 mA.

drop across " $= 11.11 \times 0.8 = 8.88\ V < 10V$, 10V Zener not in breakdown

Range 8.3 V. to 9.3V.

SET-C PAGE-10

(13) (14) Please See B-2, Set-A

Ans 1 mA Range 0.9 to 1.05 mA

(15) LED cut-in voltage = 1 V.

Current through LED = 5 mA.

Voltage drop across LED = 6 V − 0.7 × 5 mA.

= 6 − 3.5 = 2.5 V.

power dissipation = 2.5 V × 5 mA = 12.5 mW

Range 12 to 13 mW