

02)

2017

MONDAY ♦ OCTOBER

41st Week • 275-090

SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
35						1 2	40	1 2 3 4 5 6 7				
36	3 4	5 6	7 8	9	10 11	12 13 14 15 16	41	8 9 10 11 12 13 14				
37	10 11	12 13	14 15	16	17 18	19 20 21 22 23	42	15 16 17 18 19 20 21				
38	17 18	19 20	21 22	23	24 25	26 27 28 29 30	43	22 23 24 25 26 27 28				
39	24 25	26 27	28 29	30	44	29 30 31						

ELECTRONICS

Electronic Fundamental & Application
by D. Chatterjee & P.C. Rayshit

Rajib Ranjan Pal (9432164216)

Formation of Energy band in Solid.

An isolated atom of any substance should have discrete energy levels and it is verified by Bohr's atomic model.

We look into the energy band diagram of a solid formed by periodic arrangement of similar atoms.

Let us take there N no. of atoms are forming a solid $3D$ crystal.

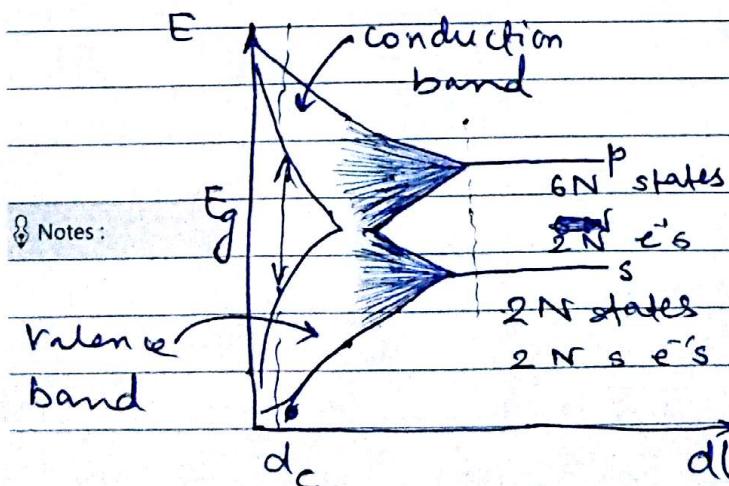
In the crystal the spacing between atoms are very small, so interaction between them will be very high.

(14)

(32)

Let us consider silicon or germanium specimen.

$$Si_{14} = 1s^2 2s^2 2p^6 (3s^2 3p^2)$$



d_c = inter atomic spacing of a crystal at a particular temp.

d (Inter atomic space)

NOVEMBER		DECEMBER 2017					JANUARY	
S	M	T	W	T	F	S	S	M
1	2	3	4	5	6	7	1	2
8	9	10	11	12	13	14	3	4
15	16	17	18	19	20	21	5	6
22	23	24	25	26	27	28	7	8
29	30			29	30		9	10
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				4	5	6	13	14
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OCTOBER • TUESDAY

2017

03

41st Week • 276 days

The sample has $2s$ e's and $2p$ e's in a distinct shell. There are $2N$ s states and 100% are occupied and $6N$ p states and only $2N$ are occupied. As the inter atomic space is decreased the p and s shell will split as shown in fig. And if the space is decreased then p and s will merge together. When p and s subshells merge together, then we have a total of $8N$ states and only $4N$ e's are available. If we further decrease it, then the $4N$ e's will form a band containing $4N$ states and remaining $4N$ states will be empty. The filled $4N$ states are called valence band. And empty $4N$ states together form conduction band.

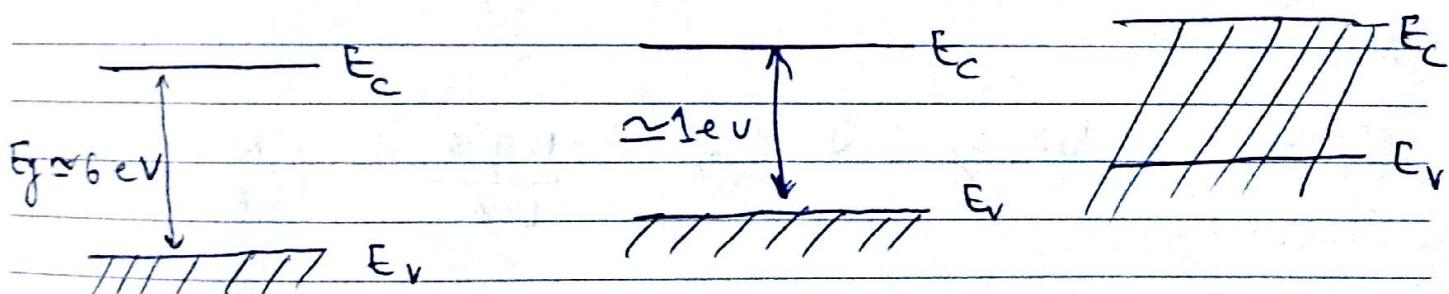
Depending upon the value of E_g (Energy gap) we can classify the solid as:-

Insulator

Semiconductor

Metal.

$$KT = 0.026 \text{ eV}$$



The band gap is $\approx 1 \text{ eV}$

If there is sufficient

KT i.e. thermal energy

$\text{Si} \rightarrow 1.1 \text{ eV}$ hence e's can jump to the conduction band.

$\text{Ge} \rightarrow 0.785 \text{ eV}$ at 0°K

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2017

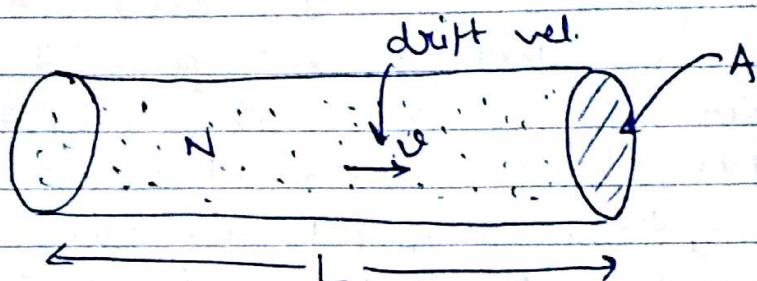
WEDNESDAY ♦ OCTOBER

41st Week • 277-088

SEPTEMBER						2017 OCTOBER					2017				
WK	S	M	T	W	F	S	WK	S	M	T	W	F	S	WK	S
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36	3	4 5	6 7	8 9		41	8 9 10 11 12 13 14								
37	10 11	12 13	14 15	16		42	15 16 17 18 19 20 21								
38	17 18	19 20	21 22	23		43	22 23 24 25 26 27 28								
39	24 25	26 27	28 29	30		44	29 30 31								

At room temperature i.e. 300K $E_g = 1.1 \text{ eV}$ for Si
 $= 0.72 \text{ eV}$ for Ge.

Conduction Phenomenon in solid



There are 2 processes by which conduction takes place in a solid (conductor or semiconductor)

Drift phenomenon - occurs due to the application of voltage across the specimen.

An e^- takes a time τ to move a dist ' L '.

\therefore Total no. of e^- passing through any cross sections of the solid in unit time is N/τ .

$$\therefore \text{The current } I = \frac{Nq}{\tau} = \frac{Nq\tau}{L}$$

$$\text{Current density } J = \frac{I}{A} = \frac{Nq\tau}{LA} = \left(\frac{N}{LA}\right) q\tau$$

$$= nq\tau$$

Notes:

\rightarrow e^- density

$$= nq\mu E$$

\rightarrow mobility

$$= \sigma E$$

\rightarrow conductivity

NOVEMBER					DECEMBER						2017						
WEEK	S	M	T	F	S	W	S	M	T	W	F	S	W	S	M	T	F
44		1	2	3	4	48	31	1	2								
45	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
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47	19	20	21	22	23	24	25	26	27	28	29	30	31	17	18	19	20
48	26	27	28	29	30		32	24	25	26	27	28	29	30			

OCTOBER ♦ THURSDAY

2017

05

41st Week - 27A-087

$$\text{Now } J_{ndrift} = nqM_nE ; J_{pdrift} = pqM_pE \quad \left\{ \begin{array}{l} \text{P hole case} \\ n = \text{electron con} \end{array} \right.$$

If we consider it as a semiconductor, then current will be contributed by both the carriers. Therefore the total drift current density will be equal to :-

$$J_{drift} = J_{ndrift} + J_{pdrift}$$

$$\Rightarrow J_{drift} = (nM_n + pM_p) qV E$$

$$\Rightarrow J_{drift} = \sigma_{total} \cdot E. \quad (\sigma_{total} = nM_n + pM_p)$$

Diffusion phenomenon :-

Let us consider the system in which hole concentration decreases in positive x-direction as shown in the figure at $x=0$

at $x=0$, the concentration of carriers is $P(0)$ and that at $x=x$ is $P(x)$.

The diffusion current density

$$J_{p(x)} \underset{\text{diffusion}}{\propto} \frac{dP(x)}{dx} = -q_p D_p \frac{dP(x)}{dx}$$

D_p is also diffusivity of holes. J_{pdift} and $\frac{dP(x)}{dx}$ is opposite directed. So negative sign is introduced.

$$\text{Similarly, } J_{n(x)} \underset{\text{diffusion}}{\propto} q_n D_n \frac{dn(x)}{dx}$$

Then, for electrons in semiconductor

Notes:

$$J_{n^+} = J_{ndrift} + J_{ndiffusion}$$

$$\therefore J_{n^+} = nqM_nE + q_n D_n \frac{dn(x)}{dx}$$

$$\text{Similarly } J_p^+ = pqM_pE + q_p D_p \frac{dp(x)}{dx}$$

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41st Week • 279-086

SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
35				1	2	3	40	1	2	3	4	5
36	3	4	5	6	7	8	9	41	8	9	10	11
37	10	11	12	13	14	15	16	42	15	16	17	18
38	17	18	19	20	21	22	23	43	22	23	24	25
39	24	25	26	27	28	29	30	44	29	30	31	

Semiconductor

- (i) Intrinsic (ii) Extrinsic

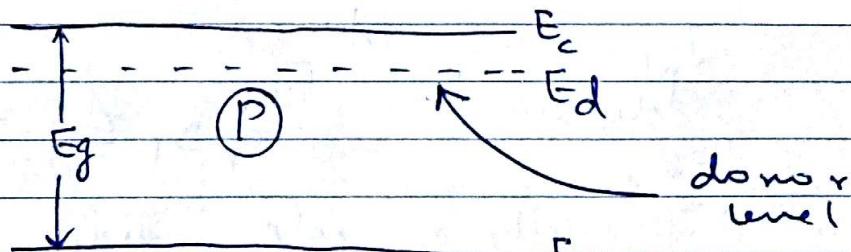
In intrinsic semiconductor, there is no doping i.e. within the crystal intentional defects are not introduced.

But in extrinsic semiconductor, we dope some foreign atoms inside the crystal. So, in this case we are intentionally introducing some defect inside the crystal.

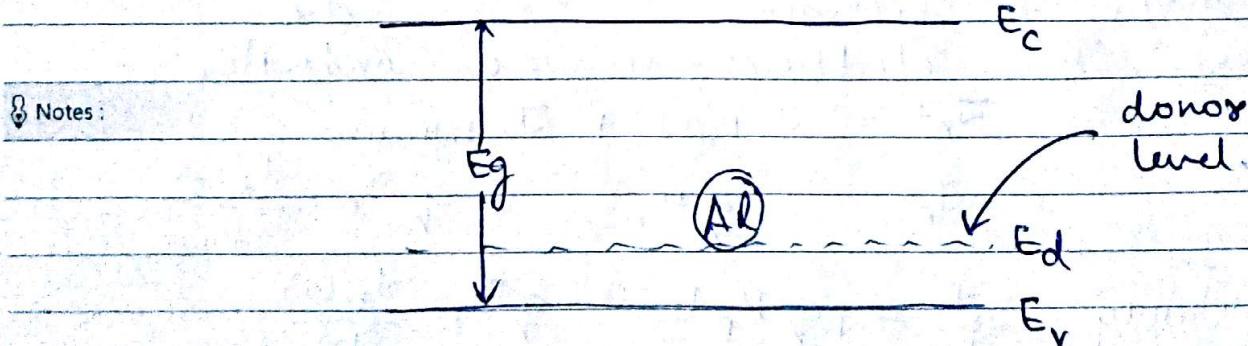
There are two types of extrinsic semiconductors:-

- (i) N-type (pentavalent atoms are doped to create excess free e^- concentration inside the crystal).

The band diagram is as shown below!:-



- (ii) P-type (trivalent atoms are doped to create excess holes)



Notes:

NOVEMBER	2017	DECEMBER	2017				
WEEK	S	M	T	W	T	F	S
44	1	2	3	4	5	6	7
45	8	9	10	11	12	13	14
46	15	16	17	18	19	20	21
47	22	23	24	25	26	27	28
48	29	30		31			
	32	24	25	26	27	28	29
	30						

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41st Week • 253-285

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The concentration of n-types or p-types dopants are very less, so the interaction between dopants is very less. Therefore we get discrete energy level for dopant. As the donor level is just below E_c and for n-type and just above E_v for p-type, then at thermal equilibrium ~~each~~ the dopant atoms will contribute a single free electron to the crystal. (For n-type).

$$E_c - E_d = 0.01 \text{ eV Ge}$$

$$= 0.05 \text{ eV Si}$$

Mass Action Law :-

The addition of n-type and p-type impurities decreases the no. of holes. and vice versa.

Under thermal equilibrium, the product of negative and positive charge concentration is constant and equal to n_i^2 .

$$np = n_i^2$$

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n = Free electron conc. in extrinsic semiconductor
 p = Free hole conc.

n_i = intrinsic carrier concentration.

Notes:

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42nd Week • 282-083

SEPTEMBER 2017							OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F	S
35				1	2	3	40	1	2	3	4	5	6
36	3	4	5	6	7	8	41	8	9	10	11	12	13
37	10	11	12	13	14	15	42	15	16	17	18	19	20
38	17	18	19	20	21	22	43	22	23	24	25	26	27
39	24	25	26	27	28	29	30	44	29	30	31		

Charge density in semiconductor :-

Let the semiconductor is doped with both type of impurities. Under equilibrium the free electron concentration is given by n and that of free hole is given by p . If we consider complete ionisation then concentration of positive ions will be equal to donor conc. N_D , similarly a negative ion conc. will be equal to app acceptor conc. N_A . Due to charge neutrality, total +ve charge conc. will be equal to total -ve charge conc.

$$n + N_A = p + N_D$$

For n type material, $N_A \rightarrow 0$

$$\therefore n = p + N_D$$

$\approx N_D$ (\because in n type semiconductor free e^- conc. \ggg free hole conc.)

$$n_n = N_D$$

$$p_n = ?$$

$$n_n \cdot p_n = n_i^2$$

$$\therefore p_n = \frac{n_i^2}{n_n}$$

$$p_n = \frac{n_i^2}{N_D}$$

Notes :

NOVEMBER 2017					DECEMBER 2017									
WEEK	S	M	T	W	T	F	S	WEEK	S	M	T	W	T	F
44		1	2	3	4		48	31		1	2			
45	5	6	7	8	9	10	11	49	3	4	5	6	7	8
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47	19	20	21	22	23	24	25	51	17	18	19	20	21	22
48	26	27	28	29	30			52	24	25	26	27	28	29

OCTOBER ♦ TUESDAY

2017

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42nd Week • 281 082

For p-type material; $N_D \rightarrow 0$.

$$\therefore P = n + N_A \quad [\because \text{hole conc} \ggg e^- \text{conc.}] \\ \approx N_A$$

$$\therefore P_p = N_A$$

$$n_p \cdot P_p = n_i^2$$

$$n_p = ?$$

$$\Rightarrow n_p = \frac{n_i^2}{N_A}$$

$$n_p = \frac{n_i^2}{N_A}$$

Fermilevel in semiconductor

$$f(E) = \frac{1}{1 + e^{\frac{(E-E_f)}{kT}}}$$

Electrons inside the crystal obey Fermi-Dirac statistics and the distribution function in a particular energy level E is given by the function f(E).

where, E_f is the fermi energy level

$f(E)$ denotes the occupancy factor for a particular energy level E.

Let us first consider intrinsic semiconductor is at absolute 0 K.

$$\text{At } T=0K; f(E) = \frac{1}{1+e^{\infty}} = 0; (E > E_f)$$

Notes: $T=0K; f(E) = \frac{1}{1+e^{-\infty}} = 1; (E_f > E)$

i.e. at $T=0K$; the available energy level upper the fermi level is vacant and at $T=0K$, the

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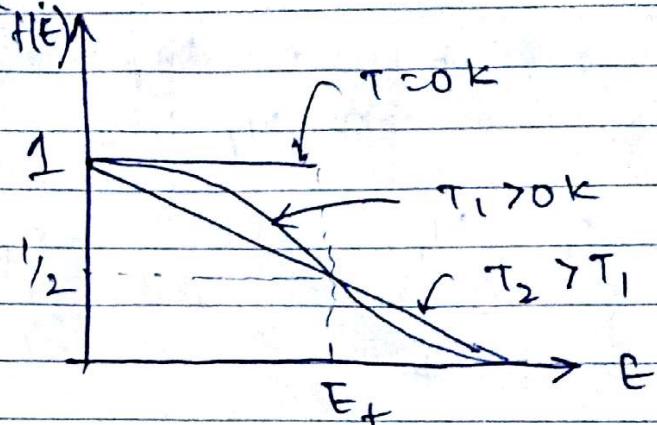
2017

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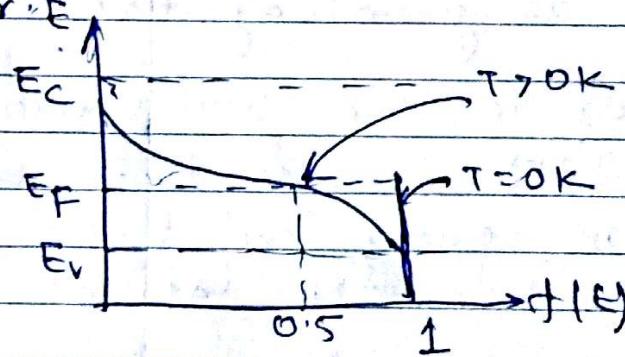
SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
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38	17	18	19	20	21	22	43	22	23	24	25	26
39	24	25	26	27	28	29	30	44	29	30	31	

available energy level and at $T = 0K$; the available energy level below the Fermi level is completely occupied.

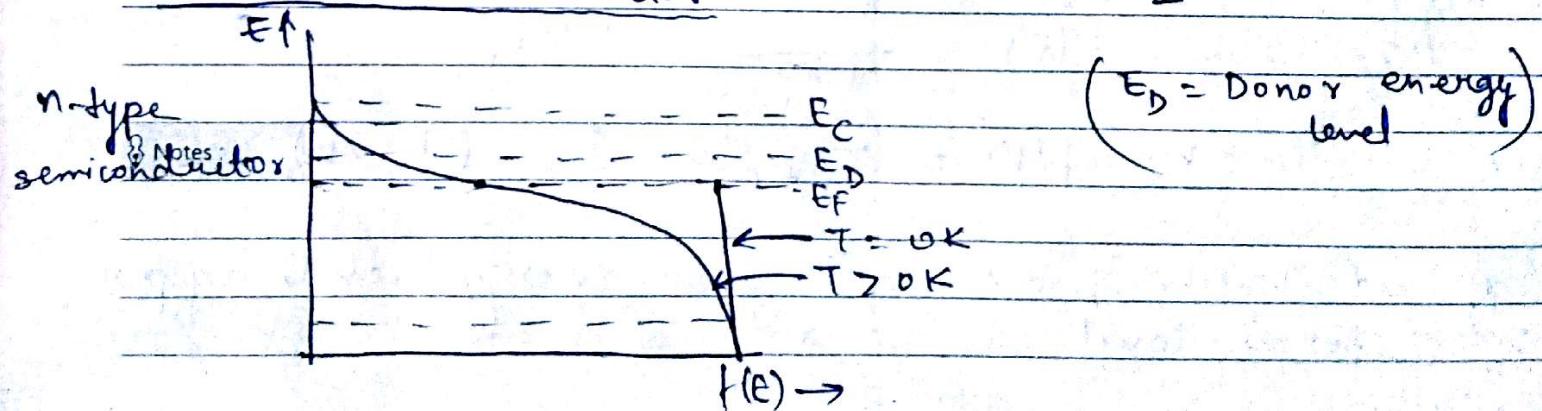


If we increase temperature, we find that some of the valence electrons will move to the conduction band. i.e. occupancy factor above E_F will be non-zero for $T > 0K$. At any temperature the occupancy factor at $E = E_F$ will be $1/2$.

If we consider n type semiconductor than the band diagram along with the occupancy. For n type, the following figure indicates the band diagram and occupancy factor $f(E)$.



Intrinsic semiconductor



NOVEMBER 2017					DECEMBER 2017										
WEEK	S	M	T	W	F	S	W	S	M	T	W	F	S		
44		1	2	3	4	45	31		1	2					
45	5	6	7	8	9	10	11	49	1	4	5	6	7	8	9
46	12	13	14	15	16	17	18	50	10	11	12	13	14	15	16
47	19	20	21	22	23	24	25	51	17	18	19	20	21	22	23
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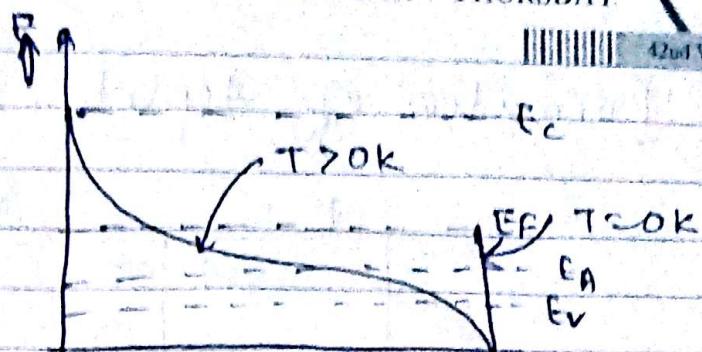
OCTOBER ♦ THURSDAY

2017

(12)

42nd Pg. L-223 (R)

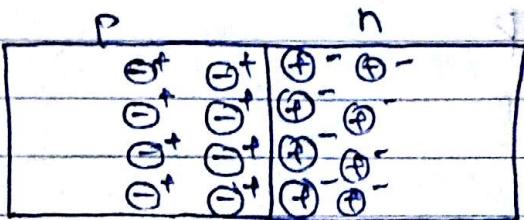
Similarly for the
p-type semiconductor



Effect of temperature on doped semiconductor $f(E) \rightarrow$

If we increase the temperature ; say for n-type semiconductor to high value then huge number of e-h pair will be generated . So the electron concentration of the thermally generated carrier will be very large compared to that of generated from donor atoms . Therefore the total electron concentration will be dominated by thermal generation and electron-hole concentration will be same at high temperature ; i.e. they will act as intrinsic semiconductor .

p-n junction diode :-



To form a p-n junction diode ,

We first take a series of semiconductor bar . Now this bar is placed in a doping chamber containing n-type dopant . So some portion of the bar becomes n-type semiconductor and this region is controlled by proper environment within the chamber (temp, pressure, condition of dopant) . After that the n type dopant is removed from the chamber and p type dopant is introduced . So the remaining portion of the silicon bar will be doped .

Notes :

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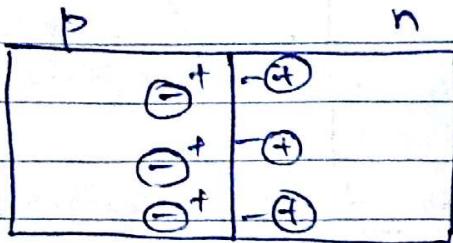
2017

FRIDAY ♦ OCTOBER

42nd Week • 286-079

SEPTEMBER 2017						OCTOBER 2017						
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37	10	11	12	13	14	15	42	15	16	17	18	19
38	17	18	19	20	21	22	43	22	23	24	25	26
39	24	25	26	27	28	29	30	44	29	30	31	

Formation of depletion layer



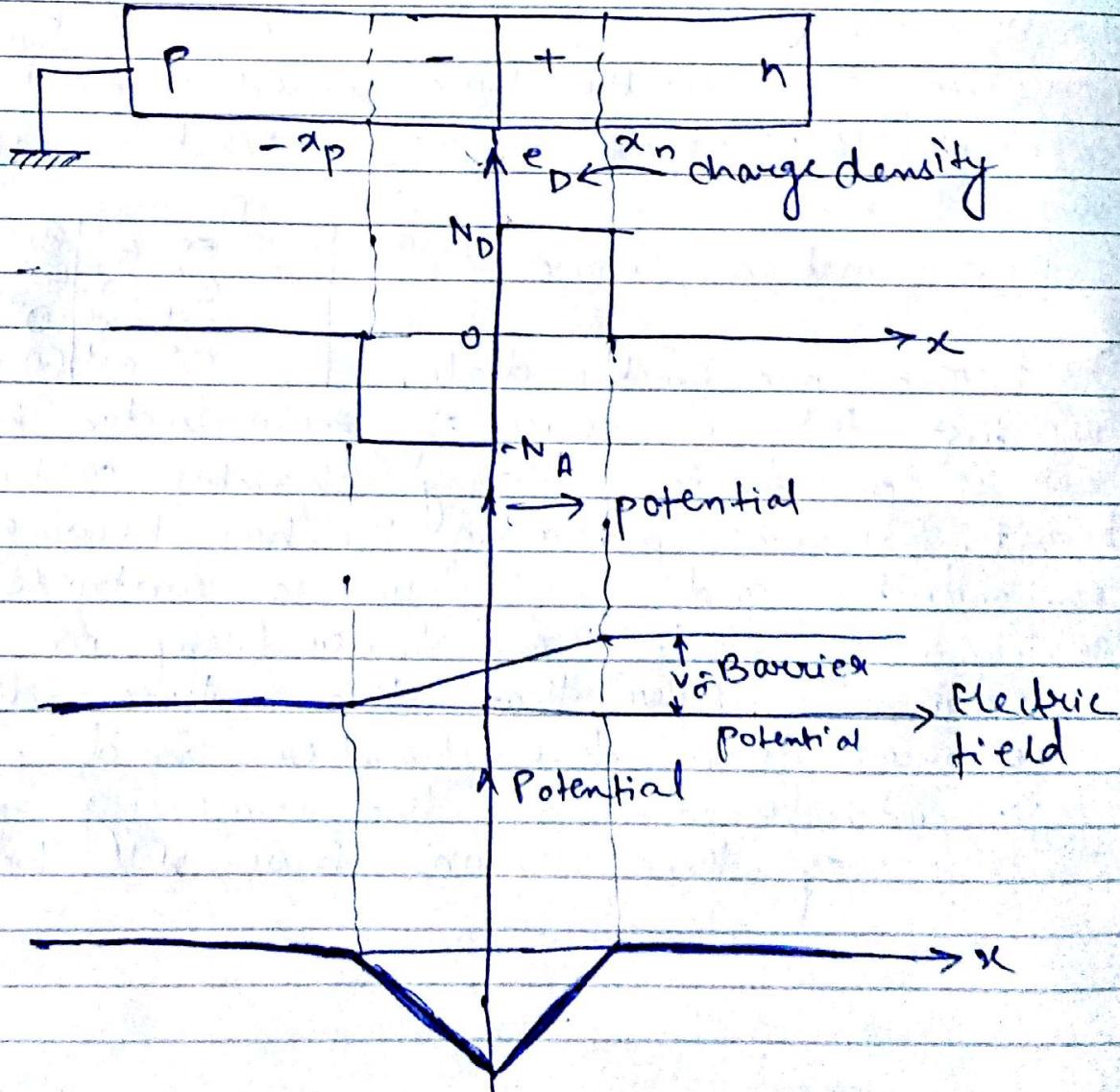
Depletion region is also called space charge region.

Charge | Potential & Electric field profile

$$N = x_n + x_p$$

$$N_A = N_D$$

$$\therefore x_n = x_p$$



Notes:

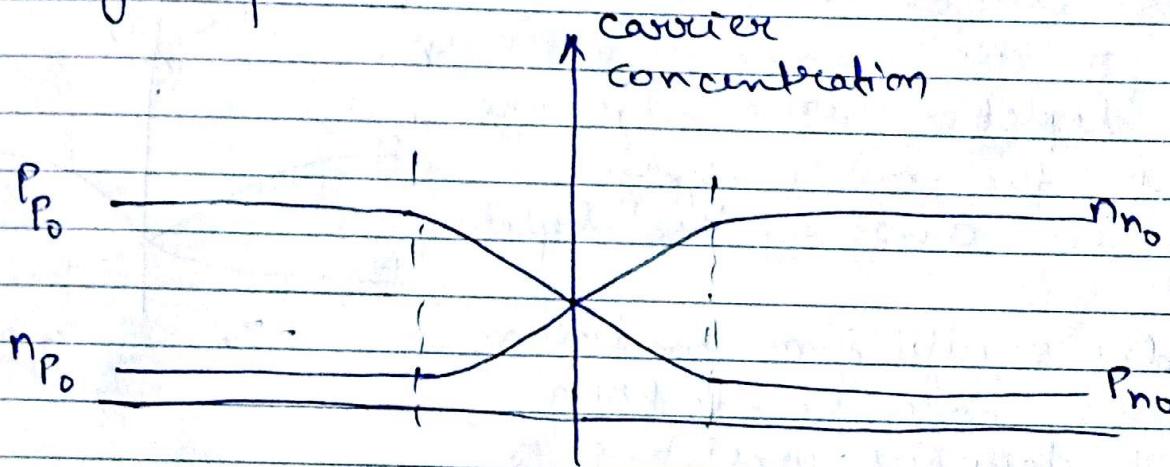
NOVEMBER 2017						DECEMBER 2017						
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47	19	20	21	22	23	24	51	17	18	19	20	21
48	26	27	28	29	30		52	24	25	26	27	28

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If we consider abrupt junction on step graded junction then the p-n junction will be strictly defined.



$$n = N_D = n_{n_0}$$

$$P = \frac{N_i^2}{N_D} = P_{n_0}$$

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Notes:

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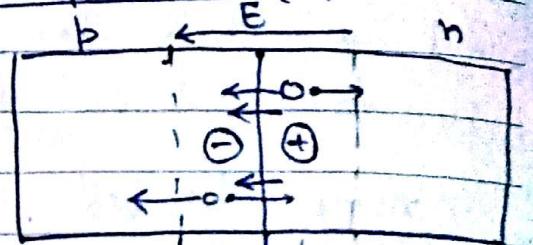
2017

MONDAY ♦ OCTOBER

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SEPTEMBER 2017						OCTOBER 2017						
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38	17	18	19	20	21	22	43	22	23	24	25	26
39	24	25	26	27	28	29	30	44	29	30	31	

Calculation of built-in barrier potential (V_0):



To calculate the barrier potential (V_0), we should consider:

(i) The junction is abrupt or sharp.

(ii) The depletion region edges are sharp i.e. the mobile charge density are 0 within the depletion layer.

(iii) Under equilibrium condition, the total hole or electron current densities consisting of drift and diffusion is equal to zero.

$$\text{Therefore, } J_p(x) = J_{p\text{drift}}(x) + J_{p\text{diffusion}}(x) = 0$$

$$= p(x) q \mu_p E(x) + \left(-q D_p \frac{dp(x)}{dx} \right) = 0$$

$$E(x) = \frac{D_p}{\mu_p} \frac{1}{p(x)} \frac{dp(x)}{dx}$$

$$= \frac{kT}{q} \cdot \frac{1}{p(x)} \cdot \frac{dp(x)}{dx}$$

$$\frac{D_p}{\mu_p} = \frac{D_p}{M_p} = \frac{kT}{q}$$

einstein's relation.

$$V_0 = \int_{-x_p}^{x_n} E(x) dx = - \frac{kT}{q} \int_{-x_p}^{x_n} \frac{dp(x)}{p(x)}$$

$$= - \frac{kT}{q} \left[\ln \{ p(x=x_n) \} - \ln \{ p(x=-x_p) \} \right]$$

$$= - \frac{kT}{q} \left[\ln p_{n0} - \ln p_{p0} \right]$$

Q Notes:

NOVEMBER	2017	DECEMBER	2017								
WK	S	M	T	F	S	WK	S	M	T	F	S
44		1	2	3	4	48	31		1	2	
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46	12	13	14	15	16	50	10	11	12	13	14
47	19	20	21	22	23	51	17	18	19	20	21
48	26	27	28	29	30	52	24	25	26	27	28

2017
OCTOBER ♦ TUESDAY

43rd Week • 299-075

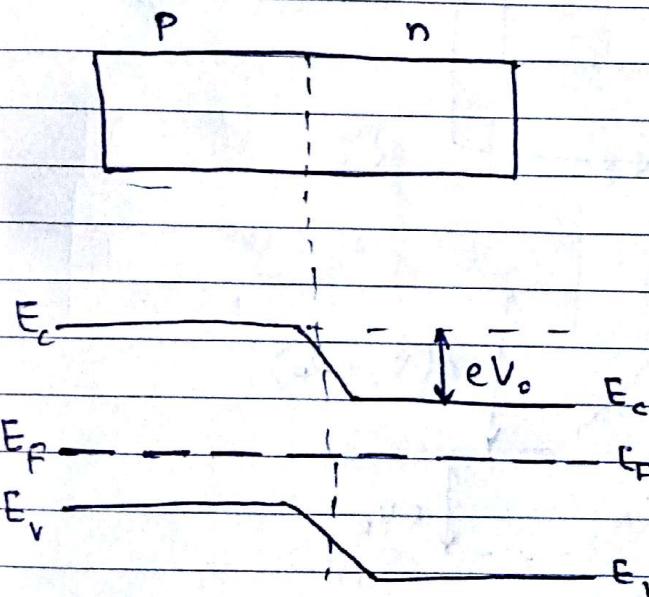
(17)

$$= \frac{kT}{q} \ln \left(\frac{P_{po}}{P_{no}} \right)$$

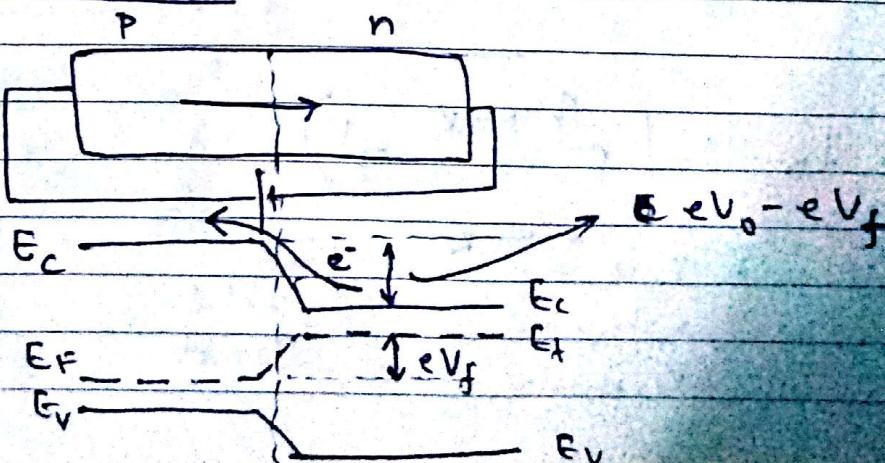
$$= \frac{kT}{q} \ln \left(\frac{N_A}{n_i^2 / N_D} \right)$$

$$= V_T \ln \left(\frac{N_A N_D}{n_i^2} \right)$$

Energy band diagram of p-n diode under no bias :-



Under forward biased :-



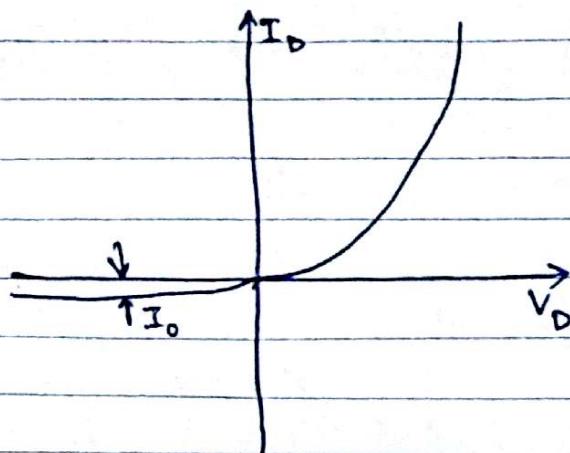
18)

2017

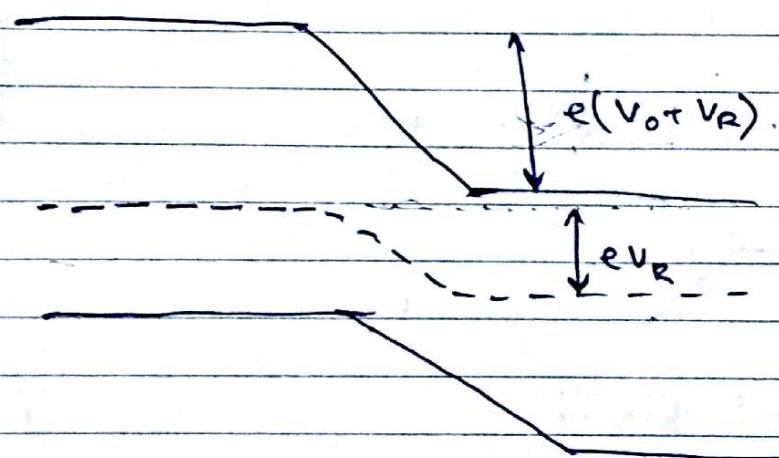
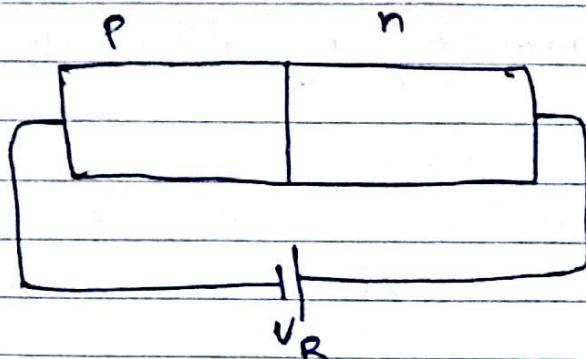
WEDNESDAY ♦ OCTOBER

43rd Week • 291-074

SEPTEMBER 2017						OCTOBER 2017						
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38	17	18	19	20	21	22	23	43	22	23	24	25
39	24	25	26	27	28	29	30	44	29	30	31	



Reverse bias :-



$$I_D = I_0 \left(e^{\frac{qV_D}{nKT}} - 1 \right)$$

Notes :

$$= I_0 e^{\frac{qV_D}{nKT}} - I_0$$

$\underbrace{\hspace{2cm}}$ Diffusion $\underbrace{\hspace{2cm}}$ Drift

NOVEMBER 2017					DECEMBER 2017									
WEEK	S	M	T	W	T	F	S	WEEK	S	M	T	W	F	S
44		1	2	3	4	5	6	48	31		1	2		
45	5	6	7	8	9	10	11	49	3	4	5	6	7	8
46	12	13	14	15	16	17	18	50	10	11	12	13	14	15
47	19	20	21	22	23	24	25	51	17	18	19	20	21	22
48	26	27	28	29	30			52	24	25	26	27	28	29

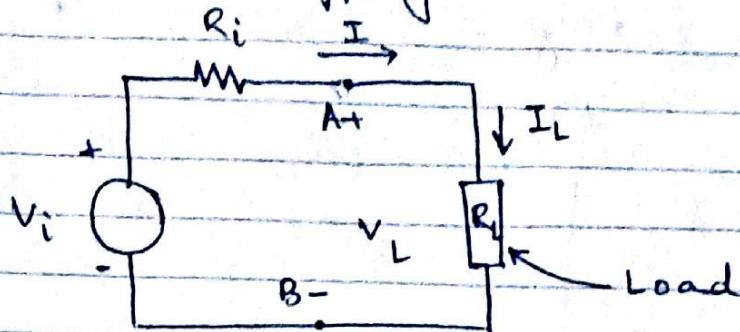
OCTOBER ♦ THURSDAY

2017

19

43rd Week • 293 073

Regulated Power Supply



$$I_L = \frac{V_i}{R_i + R_L}$$

V_{NL} = No load voltage

$$= V_{AB} = V_i - V_L$$

$$= V_i \quad (\because V_L = 0)$$

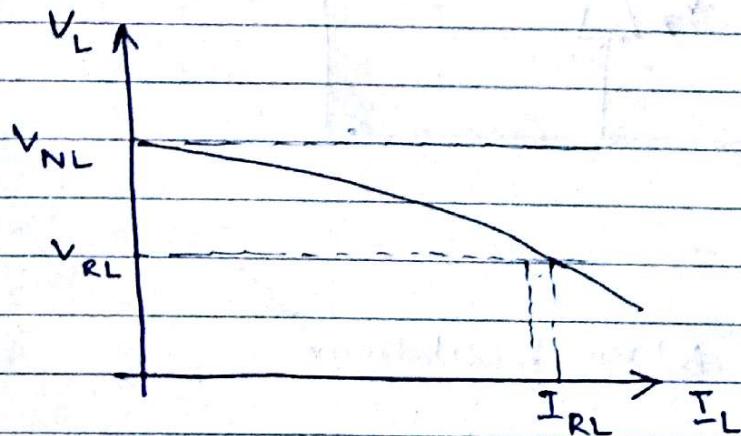
$$\therefore V_L = I_L R_L$$

$$= \frac{V_i R_L}{R_i + R_L}$$

$$R_i + R_L$$

V_{RL} = Rated load voltage

$$= \frac{V_i R_L}{R_i + R_L} < V_i \text{ i.e. } V_{NL}$$



For ideal voltage source

$$R_i = 0$$

internal impedance = 0.

$$\% \text{ Regulation} = \frac{V_{NL} - V_{RL}}{V_{RL}} \times 100\%$$

Notes:

20)

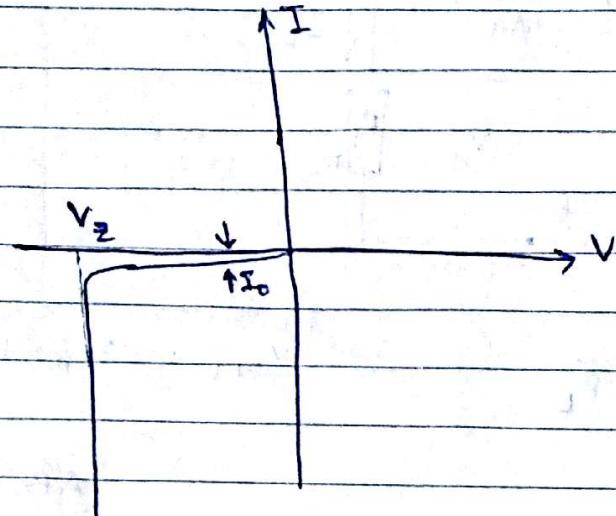
2017

FRIDAY ♦ OCTOBER

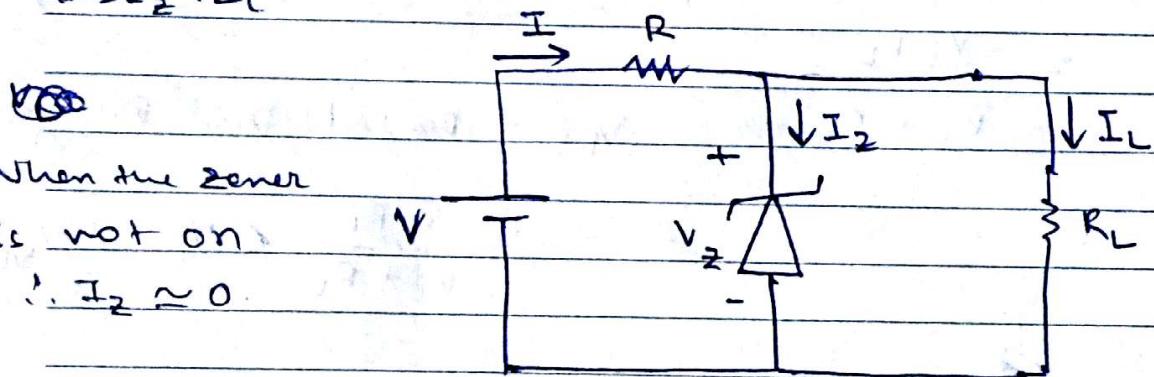
43rd Week • 293-072

SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
35				1	2	3	40	1	2	3	4	5
36	3	4	5	6	7	8	9	41	8	9	10	11
37	10	11	12	13	14	15	16	42	15	16	17	18
38	17	18	19	20	21	22	23	43	22	23	24	25
39	24	25	26	27	28	29	30	44	29	30	31	

Use of zener diode as reference voltage source or regulated power supply.



$$I = I_z + I_L$$



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

After breakdown

Breakdown condition $V_L \geq V_z$

$$I = \frac{V - V_z}{R}$$

$$I_L = \frac{V_L}{R_L} = \frac{V_z}{R_L}$$

$$I_z = I - I_L$$

8 Notes:

NOVEMBER 2017					DECEMBER 2017								
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F	S
44		1	2	3	4		48	31		1	2		
45	5	6	7	8	9	10	49	3	4	5	6	7	8
46	12	13	14	15	16	17	50	10	11	12	13	14	15
47	19	20	21	22	23	24	51	17	18	19	20	21	22
48	26	27	28	29	30		52	24	25	26	27	28	29

2017
OCTOBER ♦ SATURDAY

43rd Week • 294 071

21

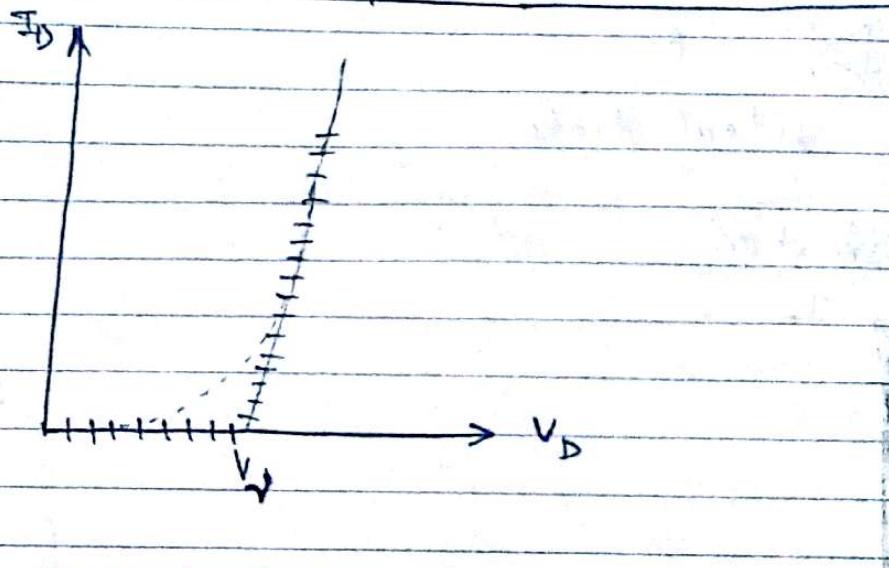
Case - I ! Let the supply voltage V is kept constant and R_L is changed.

$$\Delta I = 0 \quad \Delta I_L \neq 0$$

$$\Delta I = \Delta I_Z + \Delta I_L$$

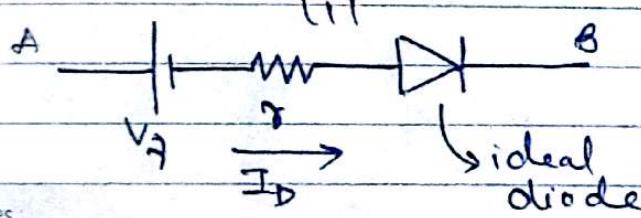
$$\Rightarrow V = \Delta I_Z + \Delta I_L \Rightarrow \Delta I_L = -\Delta I_Z$$

Piecewise linear approximate diode model:



1st approximation.

SUNDAY 22



Notes:

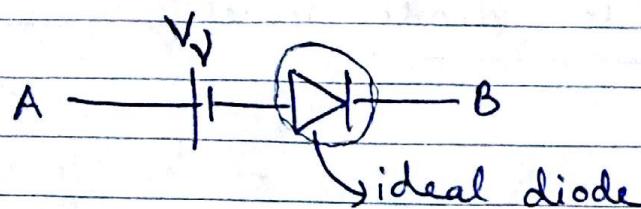
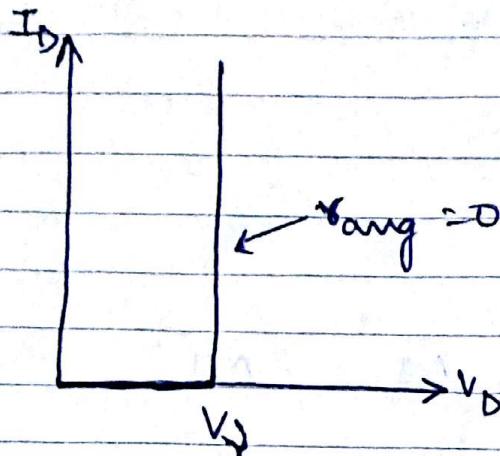
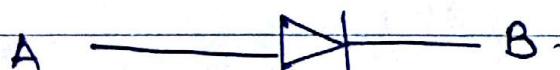
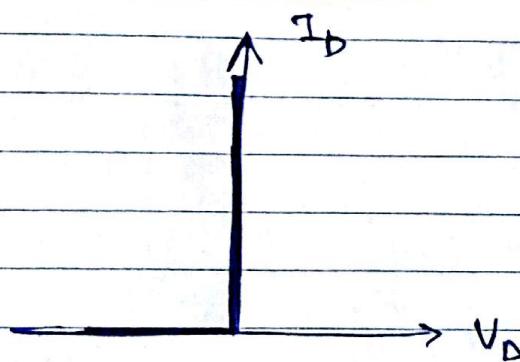
23)

2017

MONDAY ♦ OCTOBER

44th Week • 296-069

SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
35				1	2	3	40	1	2	3	4	5
36	3	4	5	6	7	8	41	8	9	10	11	12
37	10	11	12	13	14	15	42	15	16	17	18	19
38	17	18	19	20	21	22	23	22	23	24	25	26
39	24	25	26	27	28	29	30	29	30	31	27	28

2nd approximation3rd approximation

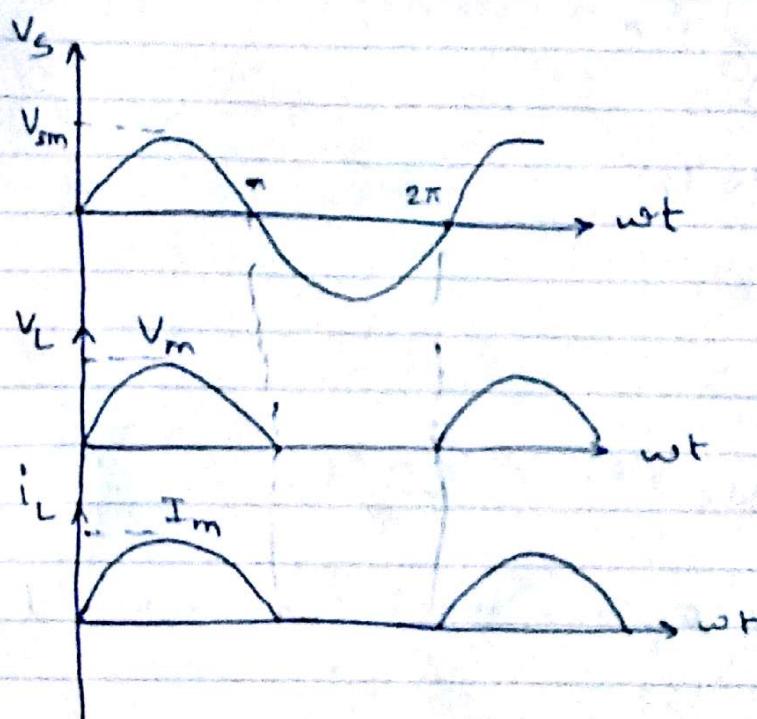
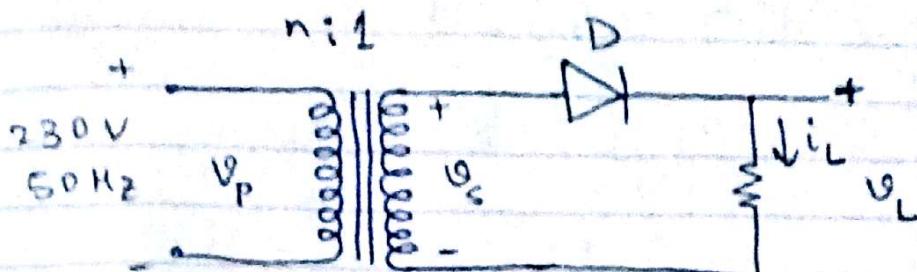
Notes :

NOVEMBER	2017	DECEMBER	2017												
WEEK 5	S	M	T	W	T	F	S	WEEK 6	S	M	T	W	T	F	S
1	2	3	4	5	6	7	8	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
4	5	6	7	8	9	10	11	18	19	20	21	22	23	24	25
12	13	14	15	16	17	18	19	26	27	28	29	30	31	1	2
19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3
26	27	28	29	30	31	1	2	9	10	11	12	13	14	15	16

2017
OCTOBER • TUESDAY

(24)

Half Wave Rectifier:



Let $V_S = V_{Sm}$ sin wt.

V_{Sm} = secondary max. voltage

$$i_L = \frac{V_S}{R_f + R_L} \quad ; \quad R_f \text{ is the resistance of diode}$$

$$\Rightarrow \frac{V_{Sm} \sin wt}{R_f + R_L}, \quad 0 \leq wt \leq \pi$$

$$= I_m \sin wt \quad \text{where, } I_m = \frac{V_{Sm}}{R_f + R_L}$$

$$\equiv 0, \quad \pi \leq wt \leq 2\pi$$

Notes:

25)

2017

WEDNESDAY ♦ OCTOBER

4th week • 2017 002

SEPTEMBER							OCTOBER							
WEEK	S	M	T	W	T	F	S	WEEK	S	M	T	W	F	S
35				1	2		40	1	2	3	4	5	6	7
36	1	4	5	6	7	8	9	41	8	9	10	11	12	13
37	10	11	12	13	14	15	16	42	15	16	17	18	19	20
38	17	18	19	20	21	22	23	43	22	23	24	25	26	27
39	24	25	26	27	28	29	30	44	29	30	31			

Therefore the d.c load current,

$$I_{dc} = \frac{1}{2\pi} \int_0^{2\pi} i_L d(\omega t)$$

$$= \frac{1}{2\pi} \int_0^{\pi} I_m \sin \omega t d(\omega t)$$

$$= \frac{1}{2\pi} I_m (2)$$

$$= \frac{I_m}{\pi}$$

$$\text{IV} V_{dc} = I_{dc} \times R_L = \frac{I_m R_L}{\pi} = \frac{V_m}{\pi}$$

The rms value of the total load current, i_L is given by

$$I_{rms} = \left[\frac{1}{2\pi} \int_0^{2\pi} i_L^2 d(\omega t) \right]^{1/2}$$

$$= \left[\frac{1}{2\pi} \int_0^{\pi} I_m^2 \sin^2 \omega t d(\omega t) \right]^{1/2}$$

$$= \left[\frac{I_m^2}{4R} \int_0^{\pi} (1 - \cos 2\omega t) d(\omega t) \right]^{1/2}$$

$$= \left(\frac{I_m^2}{4} \right)^{1/2} = \frac{I_m}{2}$$

Notes:

NOVEMBER 2017							DECEMBER 2017								
WEEK	S	M	T	W	T	F	S	WEEK	S	M	T	W	T	F	S
44		1	2	3	4		5	45	31		1	2			
45	5	6	7	8	9	10	11	46	3	4	5	6	7	8	9
46	12	13	14	15	16	17	18	47	10	11	12	13	14	15	16
47	19	20	21	22	23	24	25	48	17	18	19	20	21	22	23
48	26	27	28	29	30			52	24	25	26	27	28	29	30

OCTOBER ♦ THURSDAY

2017

44th Week • 299 066

(26)

$$V_{rms} = I_{rms} \cdot R_L$$

$$= \frac{Im R_L}{2} = \frac{N_m}{2}$$

The total load current i_L consists of two components :-

(i) dc component (I_{dc})

(ii) AC or repel component (i')

$$i_L = I_{dc} + i'$$

The rms com value of the repel component is given by :-

$$\begin{aligned} I'_{rms} &= \left[\frac{1}{2\pi} \int_0^{2\pi} (i')^2 d(\omega t) \right]^{1/2} \\ &= \left[\frac{1}{2\pi} \int_0^{2\pi} (i_L - I_{dc})^2 d(\omega t) \right]^{1/2} \\ &= \left[\frac{1}{2\pi} \int_0^{2\pi} (i_L^2 + I_{dc}^2 - 2i_L I_{dc}) d(\omega t) \right]^{1/2} \\ &= \left[I_{rms}^2 + I_{dc}^2 - \frac{2I_{dc}}{2\pi} \int_0^{2\pi} i_L d(\omega t) \right]^{1/2} \\ &\approx \left[I_{rms}^2 + I_{dc}^2 - 2I_{dc} \frac{Im}{R} \right]^{1/2} \end{aligned}$$

Notes :

27)

2017

FRIDAY ♦ OCTOBER

44th Week • 300-065

SEPTEMBER 2017						OCTOBER 2017						
WEEK	S	M	T	W	F	S	WEEK	S	M	T	W	F
35				1	2	3	40	1	2	3	4	5
36	3	4	5	6	7	8	9	41	8	9	10	11
37	10	11	12	13	14	15	16	42	15	16	17	18
38	17	18	19	20	21	22	23	43	22	23	24	25
39	24	25	26	27	28	29	30	44	29	30	31	

$$= \left[I_{rms}^2 + I_{dc}^2 - 2I_{dc}^2 \right]^{1/2}$$

$$= \left[I_{rms}^2 - I_{dc}^2 \right]^{1/2}$$

Therefore the ripple factor is defined as

$\Rightarrow \frac{\text{rms value of the ripple comp. of the load current}}{\text{avg. value or dc value of load current}}$

$$\Rightarrow = \frac{I_{rms}}{I_{dc}}$$

$$= \frac{\left[I_{rms}^2 - I_{dc}^2 \right]^{1/2}}{I_{dc}}$$

$$= \left[\left(\frac{I_{rms}}{I_{dc}} \right)^2 - 1 \right]^{1/2}$$

$$= \sqrt{\left(\frac{Im/2}{Im/\pi} \right)^2 - 1} = \sqrt{\left(\frac{\pi}{2} \right)^2 - 1}$$

$$= 1.21$$

Notes :

Rectification efficiency is defined as the ratio of

NOVEMBER 2017							DECEMBER 2017								
WEEK	S	M	T	W	T	F	S	WEEK	S	M	T	W	T	F	S
44		1	2	3	4		48	31		1	2				
45	5	6	7	8	9	10	11	49	3	4	5	6	7	8	9
46	12	13	14	15	16	17	18	50	10	11	12	13	14	15	16
47	19	20	21	22	23	24	25	51	17	18	19	20	21	22	23
48	26	27	28	29	30			52	24	25	26	27	28	29	30

OCTOBER ♦ SATURDAY

2017

423 Web 2 - 301-064

28

dc output power to the ac input power.

$$\eta = \frac{P_{dc}}{P_{in(ac)}} \times 100\% = \frac{I_{dc}^2 \cdot R_L}{(R_f + R_L) I_{rms}^2} \times 100\%$$

$$P_{in(ac)} = \frac{1}{2\pi} \int_0^{2\pi} v_s i_L d(\omega t)$$

$$= \frac{40.6}{1 + R_f/R_L} \%$$

$$= \frac{1}{2\pi} \int_0^{2\pi} \left\{ (R_f + R_L) i_L \right\} i_L d(\omega t)$$

$$= \frac{R_f + R_L}{2\pi} \int_0^{2\pi} i_L^2 d(\omega t)$$

$$= (R_f + R_L) I_{rms}^2$$

Q max. efficiency = 40.6% (considering $R_f = 0$ SUNDAY 29)

Notes:

30)

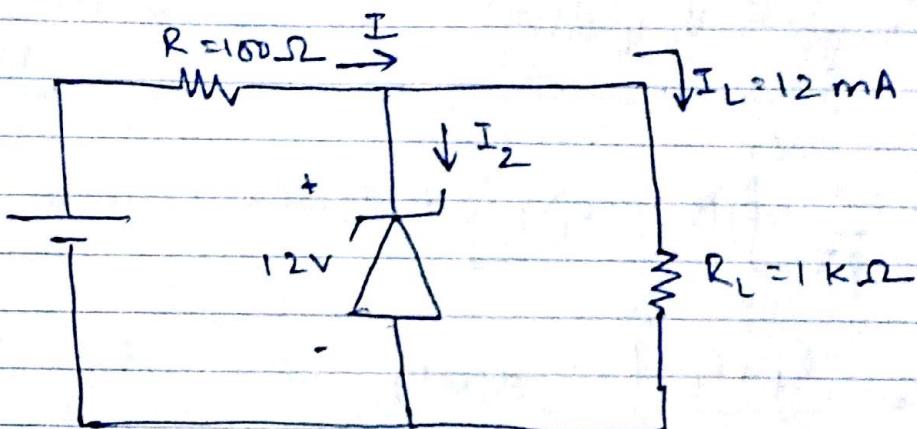
2017

MONDAY ♦ OCTOBER

45th Week • 303-062

SEPTEMBER 2017							OCTOBER						
W	S	M	T	W	F	S	W	S	M	T	W	F	S
35				1	2	3	49	1	2	3	4	5	6
36	3	4	5	6	7	8	48	8	9	10	11	12	13
37	10	11	12	13	14	15	16	42	15	16	17	18	19
38	17	18	19	20	21	22	23	43	22	23	24	25	26
39	24	25	26	27	28	29	30	44	29	30	31		

Q] In a zener regulator, a 12 V, 0.36 W zener diode operates at a min. diode current of 2 mA. The value of R (series resistance) is 100 Ω and load resistance $R_L = 1 \text{ k}\Omega$. Determine the limits between which the supply voltage V can vary without loss of regulation in the circuit.



$$P = V_Z I_Z$$

zener \Rightarrow 2 mA - 30 mA
current

$$\begin{aligned} P_{\min} &= 12 \times 2 \text{ mW} \\ &= 24 \text{ mW} \end{aligned}$$

$$P_{\max} = 0.36 \text{ W}$$

$$\Rightarrow V_Z I_{Z(\max)} = 0.36 \text{ W}$$

$$\Rightarrow I_{Z(\max)} = 0.03 \text{ A} = 30 \text{ mA}$$

$$I_L = \frac{V_Z}{R_L} = \frac{12}{1 \times 10^3} = 12 \text{ mA}$$

Notes:

$$I_{\min} = (2 + 12) \text{ mA} = 14 \text{ mA}$$

$$\begin{aligned} V_{\min} &= V_{R_{\min}} + V_Z = (14 \text{ mA} \times 100 \Omega) + 12 \text{ V} \\ &\approx 13.4 \text{ V} \end{aligned}$$

NOVEMBER 2017					DECEMBER 2017							
WEEK	S	M	T	F	S	WEEK	S	M	T	W	F	S
44		1	2	3	4	48	31		1	2		
45	5	6	7	8	9	49	3	4	5	6	7	8
46	12	13	14	15	16	50	10	11	12	13	14	15
47	19	20	21	22	23	51	17	18	19	20	21	22
48	26	27	28	29	30	52	24	25	26	27	28	29

2017
OCTOBER • TUESDAY

(31)

453 Week - 314 - 021

$$V_{max} = V_{R_{max}} + V_2$$

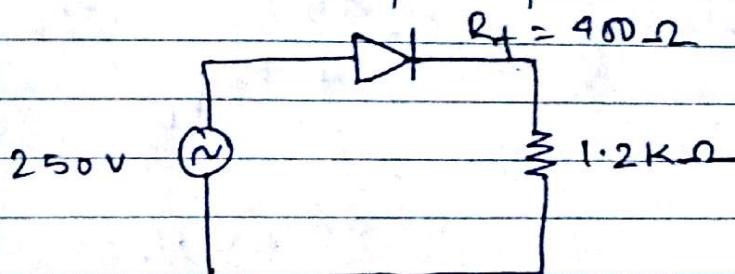
$$= ① (I_{max} \times 100) + 12$$

$$= (4.2 \times 10^3 \times 100) + 12$$

$$= (4.2 + 12) V$$

$$= 16.2 V$$

- Q] A diode having forward resistance (R_F) of 400Ω supplies power to a load resistance of 1200Ω from a $250V$ (rms) mains. Calculate (i) dc load current (ii) ac load current (iii) dc voltage across the diode. (iv) dc output power (v) conversion efficiency.



$$\text{dc peak} \quad \text{The peak load current, } I_m = \frac{V_{om}}{R_F + R_L}$$

$$= \frac{250 \times \sqrt{2}}{1.6 \times 1000}$$

$$= 0.221 A$$

$$\text{The dc. load current} = \frac{I_m}{\pi} = 0.073$$

Notes :

01)

2017

WEDNESDAY ♦ NOVEMBER

45th Week • 305-060

OCTOBER 2017							NOVEMBER 2017								
WK	S	M	T	W	T	F	S	WK	S	M	T	W	T	F	S
40	1	2	3	4	5	6	7	44		1	2	3	4		
41	8	9	10	11	12	13	14	45	5	6	7	8	9	10	11
42	15	16	17	18	19	20	21	46	12	13	14	15	16	17	18
43	22	23	24	25	26	27	28	47	19	20	21	22	23	24	25
44	29	30	31					48	26	27	28	29	30		

$$\overline{I_{rms}} = \sqrt{I_{rms}^2 + I_{dc}^2}$$

$$\Rightarrow \overline{I_{rms}} = \sqrt{\overline{I_{rms}}^2 - I_{dc}^2}$$

$$\sqrt{\left(\frac{Im}{2}\right)^2 - \left(\frac{Im}{\pi}\right)^2}$$

$$= 0.0852 \text{ A}$$

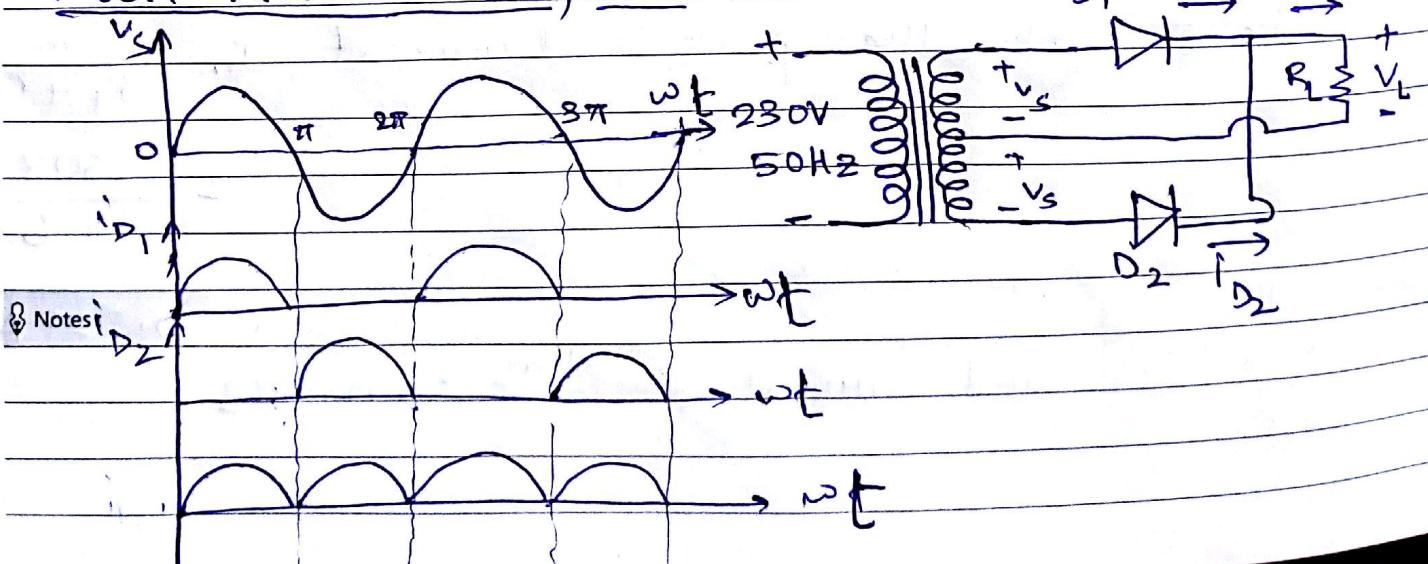
$$\text{D.C voltage across the diode} = I_{dc} \times R_f$$

$$\text{D.C output power} = I_{dc}^2 \times R_L$$

$$\text{The conversion efficiency } \eta = \frac{90.6}{1 + R_f/R_L} \%$$

$$= 30.45 \%$$

Full Wave Rectifier



DECEMBER				2017				JANUARY				2018			
Wk	S	M	T	W	T	F	S	Wk	S	M	T	W	T	F	S
48	11			1	2	3	4	1	2	3	4	5	6	7	8
49	3	4	5	6	7	8	9	2	3	4	5	6	7	8	9
50	10	11	12	13	14	15	16	3	4	5	6	7	8	9	10
51	17	18	19	20	21	22	23	4	5	6	7	8	9	10	11
52	24	25	26	27	28	29	30	5	6	7	8	9	10	11	12

NOVEMBER ♦ THURSDAY

2017

45th Week • 306/059

$$i_L = \frac{V_s}{R_f + R_L} = \frac{V_m \sin \omega t}{R_f + R_L}$$

$\Rightarrow I_m \sin \omega t, 0 \leq \omega t \leq \pi$

$\Rightarrow I_m \sin \omega t < \theta < \omega t \leq 2\pi$

Therefore a.c. d.c. load current $I_{dc} = \frac{1}{2\pi} \int_0^\pi I_m \sin \omega t d(\omega t)$

$$I_{rms} = \sqrt{\frac{1}{\pi} \int_0^\pi I_m^2 \sin^2 \omega t d(\omega t)} = \frac{2I_m}{\pi}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \times 2} = \frac{I_m}{\sqrt{2}}$$

$$\text{Ripple factor, } \gamma = \frac{I_{rms}}{I_{dc}} = \sqrt{\frac{I_{rms}^2 - I_{dc}^2}{I_{dc}^2}}$$

≈ 0.482

$$\text{efficiency, } \eta = \frac{81.2}{1 + R_f/R_L} \%$$

(Q) A full wave rectifier uses a double diode like forward resistance of each diode is 200Ω .

The rectifier supplies current to a load resistance of 1500Ω . The primary to secondary turns ratio of the centre tapped transformer is $1:3$. The primary is fed from a supply of $240 V$ rms. Find (i) I_{dc} (ii) dc power output

03)

2017

FRIDAY ♦ NOVEMBER

45th Week • 307-058

OCTOBER 2017							NOVEMBER 2017								
WK	S	M	T	W	T	F	S	WK	S	M	T	W	T	F	S
40	1	2	3	4	5	6	7	44		1	2	3	4		
41	8	9	10	11	12	13	14	45	5	6	7	8	9	10	11
42	15	16	17	18	19	20	21	46	12	13	14	15	16	17	18
43	22	23	24	25	26	27	28	47	19	20	21	22	23	24	25
44	29	30	31					48	26	27	28	29	30		

(iii) direct current supplied by each diode

(iv) Ripple factor (v) efficiency.

$$\text{Total secondary voltage} = (240 \times 3)V = 720V \text{ rms}$$

\therefore The peak value of the secondary voltage = $720\sqrt{2}$

$$\text{Here } V_{sm} = \frac{720\sqrt{2}}{2} = \frac{720}{\sqrt{2}}$$

$$I_{dc} = \frac{2I_m}{\pi} = \frac{2}{\pi} \frac{V_{sm}}{R_f + R_L}$$

$$\text{The dc current in each diode} = \frac{I_{dc}}{2}$$

$$\text{dc. Power} = I_{dc}^2 \times R_L$$

$$\text{Ripple voltage, } V_{rms} = I_{rms} \times R_L$$

$$= \sqrt{I_{rms}^2 - I_{dc}^2} \times R_L$$

Efficiency =

Notes :