PART - A CIE (F)

M-3

(1) A 25KW, 250V DC shunt Generator has armature field resistance of 0.06 Ω and 100 ohms respectively; Determine the total armature power delivered when working

(i) As generator delivering 25 KW output.

$P_L = 25\ KW$
$V = 250V$
$R_a = 0.06\ \Omega$
$R_{sh} = 100\ \Omega$

Sol: Armature current; $I_a = I_L + I_{sh}$

load current; $I_L = P_L / V$

$$I_L = \frac{25000}{250}$$

$$I_L = 100A.$$

Shunt field current; $I_{sh} = \frac{V}{R_{sh}} = \frac{250}{100}$

$$= 2.5A$$

$$\therefore I_a = I_L + I_{sh} = 100 + 2.5$$

$$= 102.5A$$

Induced voltage in armature $(E_g) = V + I_a R_a$

$$E_g = 250 + 102.5(0.06)$$

$$E_g = 256.15V$$

Power delivered; $P = E_g I_a = 256.15 \times 102.5$

$$\boxed{P = 26.25\ KW}$$

(2) A 8 pole DC shunt generator with 778 wave armature conductors and running at 500 rpm. supplies a load of 12.5 ohm resistance at terminal voltage of 250 volts. The armature resistance is 0.24 Ω and the field resistance is 250 Ω. Find the (i) armature current (ii) Induced EMF (iii) flux per pole.

Sol: $Z = 778$; $N = 500 rpm$; $R_a = 0.24\,\Omega$; $R_L = 12.5\,\Omega$.

$R_{sh} = 250\,\Omega$

(i) $I_a = ?$; $I_L = V/R_{sh} = \frac{250}{250} = 1A$;

$$I_L = V/R_L = \frac{250}{12.5} = 20A$$

$$I_a = I_L + I_{sh} = 20 + 1 \Rightarrow \boxed{I_a = 21A}$$

(ii) $E_g = ?$; $E_g = V + I_a R_a$.

$$E_g = 250 + 21(0.24)$$

$$\boxed{E_g = 255.04\ V}$$

$A = 2$ (wave winding)

(iii) ϕ/pole = ? ; $E_g = \frac{\phi P Z N}{60 A} \Rightarrow \phi = \frac{E_g \times 60 \times A}{P \times Z \times N}$

$$\phi = \frac{255.04 \times 60 \times 2}{8 \times 778 \times 500}$$

$$\boxed{\phi = 0.00983\ Wb = 9.83\ mWb}$$

(3) A 4 pole DC generator having wave wound armature has 50 slots and 25 conductors per slot. Find the generated EMF, if it is driven at 25 rpm & useful flux per pole in the machine is 0.03 Wb?

Sol: $P = 4$; $\phi = 0.03$ Wb; $A = 2$ (wave winding); $N = 25$

Total conductors = No. of slots × conductors per slot

$Z = 50 \times 25$

$Z = 1250$; $E_g = ?$

$$E_g = \frac{\phi P Z N}{60 A} = \frac{0.03 \times 1250 \times 4 \times 25}{60 \times 2}$$

$$\boxed{E_g = 31.25\ V}$$

(4) A 220V DC machine supplies 20A at 200V as a Generator the armature resistance is 0.2 ohms. If the machine is now operated as a motor at the same terminal voltage and current but with flux increased by 10 percentage, calculate the ratio of motor speed to generator speed.

Given;

Sol (i) DC Generator; $R_a = 0.2$

$V = 200V$

(ii) DC Motor; $R_a = 0.2$

$V = 200V$

Find $\frac{N_2}{N_1} = ?$

Flux increased in motor by 10% compared to Generator

$\phi_2 = 1.1 \phi_1$

How? Flux of Generator Assume = 100%

Flux of Motor = 110%

$\phi_2 = 1.1 \phi_1$

→ In Case of Generator,

E_g = Terminal voltage + voltage drop

$E_g = V_t + I_a R_a$

$E_g = 200 + 20(0.2) = 204\,V$

→ In Case of motor,

$E_b = V_t - I_a R_a$

$E_b = 200 - (0.2)\,20 = 196\,V$

Turns ratio : $\frac{N_2}{N_1} = \frac{E_2}{E_1} \times \frac{\phi_2}{\phi_1}$ $[E = N\phi]$

$\frac{N_2}{N_1} = \frac{196}{204} \times \frac{1.1\phi_1}{\phi_1}$

$\boxed{\frac{N_2}{N_1} = 0.87}$

(5) A 440V DC shunt motor takes a no load current of 2.5A. The resistance of shunt field and the armature are 550 Ω and 1.2 Ω respectively. The full load line current is 32 A. Find the full load output and the efficiency of the motor.

Sol

440V; $I_{No\ load} = 2.5A$; $R_{sh} = 550\Omega$; $R_a = 1.2\Omega$

$I_{Full\ load} = 32A$; o/p & Efficiency = ?

Input power = Voltage x $I_{full\ load}$

$\Rightarrow 440 \times 32 = 14080\ W$

Output power = Voltage x $I_{full\ load}$

$\Rightarrow 440 \times 32 = 14080\ W$

$$\text{Efficiency} = \frac{\text{output power}}{\text{Input power}} \times 100$$

$$\eta = \frac{14080}{14080} \times 100$$

$$\boxed{\eta = 100\%}$$

(6) A three - phase, 20 hp, 208 V, 60 Hz, six pole, wye connected induction motor delivers 15 kW at a slip of 5 percentage. Calculate (i) synchronous speed (ii) Rotor Speed (iii) Frequency of rotor speed

Sol: Given; poles = 6; frequency = 60; slip = 5 %
= 0.05

(i) $n_s = \frac{120f}{P} = \frac{120 \times 60}{6} = 1200$ rpm

$\boxed{n_s = 1200 \text{ rpm}}$

(ii) $n_r = (1-s)\, n_s = (1-0.05) \times 1200$

$\boxed{n_r = 1140 \text{ rpm}}$

(iii) $f_r = s f_s$

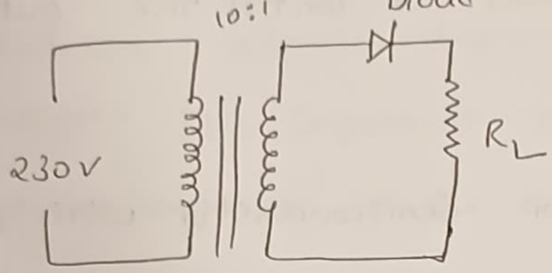
$f_r = 0.05\,(60)$

$\boxed{f_r = 3 \text{ Hz}}$

CIE - II PART - A

Q1) An AC Supply of 230V is applied to a half wave rectifier circuit through a transformer of turn ratio 10:1. Find (i) The output dc voltage.

(ii) The Peak inverse voltage (Assume the diode to be ideal).



Sol Given data ; $V_{rms} = 230V$ (ac supply)

Turns ratio $= \frac{N_1}{N_2} = 10$.

To find (i) $V_{dc} = ?$

(ii) Peak inverse voltage.

primary to Secondary turns ratio is.

RMS primary voltage = 230V

max. primary voltage is $V_{pm} = (\sqrt{2}) \times V_p(rms)$.

Note: $V_{rms} = \frac{V_m}{\sqrt{2}}$

$V_p(max) = \sqrt{2} \times 230 = \cancel{325.3V}$ 460V

$V_m = \sqrt{2}\, V_{rms}$

Max. Secondary voltage is

$V_s(max) = V_p(max) \times \frac{N_2}{N_1}$ $\left(\frac{V_1}{V_2} = \frac{N_1}{N_2}\right)$

$\Rightarrow \cancel{325.3}$ 460 $\times \frac{1}{10} = \cancel{32.53V}$ 46V

(i) the output d.c voltage

$$I_{d.c} = \frac{I_m}{\pi}$$

$$V_{d.c} = \frac{I_m}{\pi} \times R_L = \frac{V_s(max)}{\pi}$$

$$\Rightarrow \frac{\cancel{32.53}\ 46}{\pi} = \cancel{10.36V}\ 14.64V$$

$$\boxed{V_{d.c} = \cancel{10.36V}\ 14.64V}$$

(ii) During the negative half cycle of a.c supply the reverse biased and hence conducts no current the secondary voltage appears across the diode.

$$\boxed{\therefore \text{Peak Inverse voltage} = \cancel{32.53V}\ 46V.}$$

Note:
$PI_V = V_m$

Q2) A half wave rectifier is used to supply 50V dc to a resistive load of 800 Ω. The diode has a resistance of 25 Ω. Calculate a.c voltage required.

Ans Given data:

Output dc voltage $(V_{dc}) = 50V$.

Diode resistance $r_f = 25\ \Omega$

Load resistance $= 800\ \Omega$

$$\left[I_m = \frac{V_m}{r_f + R_L} \right]$$

solution:

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

$$= \frac{V_m}{\pi (r_f + R_L)} \times R_L$$

$$50 = \frac{V_m}{\pi(25+800)} \times 800$$

$$V_m = \frac{\pi \times 825 \times 50}{800} = 162\,V$$

Hence a.c voltage of maximum value 162 V is required

Q3) A full wave rectifier uses two diodes, the Internal resistance of each diode may be assumed constant at 20 Ω. The transformer rms secondary voltage from centre tap to each end of secondary is 50 V and load resistance is 980 Ω. Find.

(i) the mean load current

(ii) the rms value of load current.

Sol Given data:

diode resistance, $r_f = 20\,\Omega$; $R_L = 980\,\Omega$, $V_{rms} = 50\,V$

Max. AC voltage $V_m = 50 \times \sqrt{2}$

$= 70.7\,V$

Max. load current $I_m = \frac{V_m}{r_f + R_L} = \frac{70.7}{(20+980)}$

$= 70.7\,mA$

(i) Mean load current $I_{d.c} = \frac{2 I_m}{\pi} = \frac{2 \times 70.7}{\pi}$

$= 45\,mA$

$$\boxed{I_{d.c} = 45\,mA}$$

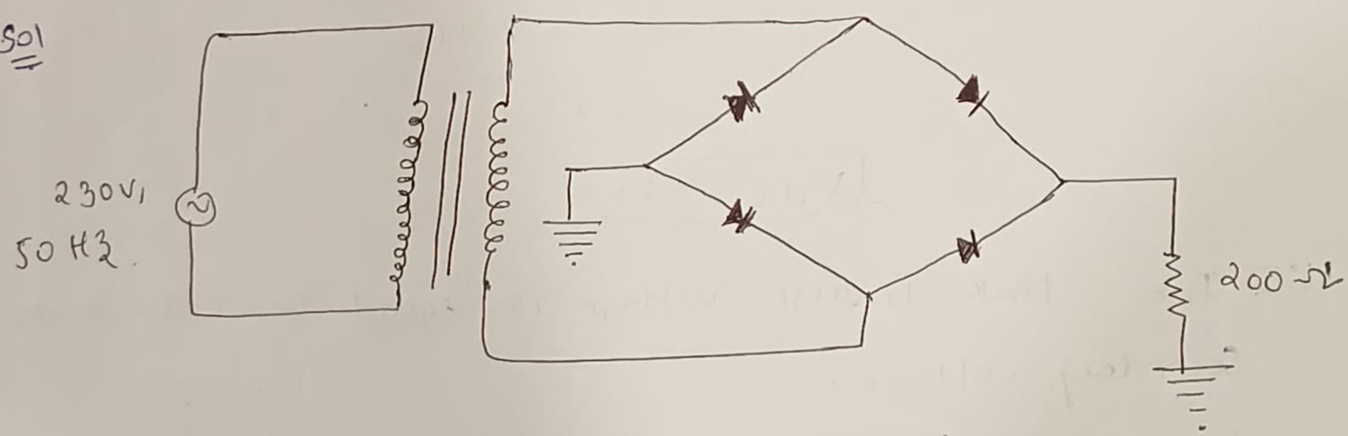
(ii) RMS value of load current is

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{70.7}{\sqrt{2}} = 50\,mA$$

$$\boxed{I_{rms} = 50\,mA}$$

Q4). An a.c supply of 230v is applied to a bridge type Rectifier circuit through a transformer of turns ratio 4:1. Find (i) d.c out voltage.
(ii) peak inverse voltage.
(iii) Output frequency. Assume the diodes are ideal.

Sol



Turns ratio $\frac{N_1}{N_2} = \frac{4}{1}$

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

RMS Primary voltage = 230 v

RMS Secondary voltage $= 230 \times \frac{N_2}{N_1}$

$= 230 \times 1/4$

$= 57.5\,V$

Maximum voltage across secondary is

$$V_{max} = 57.5 \times \sqrt{2}$$

$$= 81.3V.$$

$$\boxed{V_{max} = 81.3 V.}$$

Note

$V_{max} = \sqrt{2} \times V_{rms}$

(i) Average current $I_{dc} = \frac{2V_m}{\pi R_L}$

Note

$I_{d.c} = \frac{2I_m}{\pi}$

$I_m = \frac{V_m}{R_L}$

$$I_{d.c} = \frac{2 \times 81.3}{\pi \times 200} = 0.26A$$

d.c output voltage $V_{d.c} = I_{d.c} \times R_L$

$$= 0.26 \times 200$$

$$= 52V.$$

$$\boxed{V_{d.c} = 52V}$$

(ii). The Peak Inverse Voltage is equal to maximum Secondary voltage.

Note;

$PIV = V_{max}$

$$\boxed{PIV = 81.3V}$$

(iii) In full wave rectification, there are two output pulses for each complete cycle of the input a.c voltage.

$$f_{out} = 2 \times f_{in}$$

$$= 2 \times 50$$

$$= 100 \, Hz$$

$$\boxed{f_{out} = 100 \, HZ}$$

5) An Half wave rectifier has a load of 3.5 KΩ. If the diode resistance and secondary coil resistance together have a resistance of 800 Ω and the input voltage has a signal voltage of peak value 240. Calculate (11)

(a) Peak, average and rms values of current flowing.

(b) dc power output.

(c) a.c power input.

(d) efficiency of the rectifier.

Ans Given data : $R_L = 3.5 K\Omega$

$R_s + R_f = 800\Omega$ and $V_m = 240V$.

(a) Peak value of current $I_m = \dfrac{V_m}{R_f + R_s + R_L}$

$$= \frac{240}{800 + 3{*}500}$$

$$\boxed{I_m = 55.81 mA}$$

Average value of current $I_{dc} = \dfrac{I_m}{\pi} = \dfrac{55.81}{\pi}$

$$\boxed{I_{dc} = 17.77 mA}$$

Rms value of current $I_{rms} = I_m/2$

$$= \frac{55.81 \times 10^{-3}}{2}$$

$$= 27.9 mA$$

$$\boxed{I_{rms} = 27.9 mA}$$

(b) d.c power output $P_{dc} = I^2_{dc} R_L$

$$= (17.77 \times 10^{-3})^2 \times 3500$$

$$= 1.105 W$$

$$\boxed{P_{dc} = 1.105 W}$$

(c) A.c Input power $P_{AC} = I^2_{rms} \times (R_f + R_L + R_s)$

$$= (27.905 \times 10^{-3})^2 \times (3500 + 800)$$

$$= (27.9 \times 10^{-3})^2 \times 4300$$

$$\boxed{P_{AC} = 3.348 W}$$

(d) Efficiency $(\eta) = \dfrac{P_{d.c}}{P_{a.c}}$

$$\eta = \frac{1.105}{3.348} \times 100$$

$$\boxed{\eta = 33\%}$$

— THE

END —

PART - B

① State the principle of DC generator. Explain the working of DC generators with neat diagrams.

Ans: * DC generators primary function is to convert mechanical energy into electrical energy. DC generators generate electricity using the principle of "Faraday's law of electromagnetic Induction"

* According to Faraday's law of electromagnetic induction, whenever a conductor is placed in a varying magnetic field, an emf (electromotive force) gets induced in the conductor.

* The magnitude of induced emf can be calculated from the emf equation of dc generator.

* If the conductor is provided with the closed path, the induced current will circulate within the path. In a DC generator, field coils produce an electromagnetic field and the armature conductors are rotated into the field.

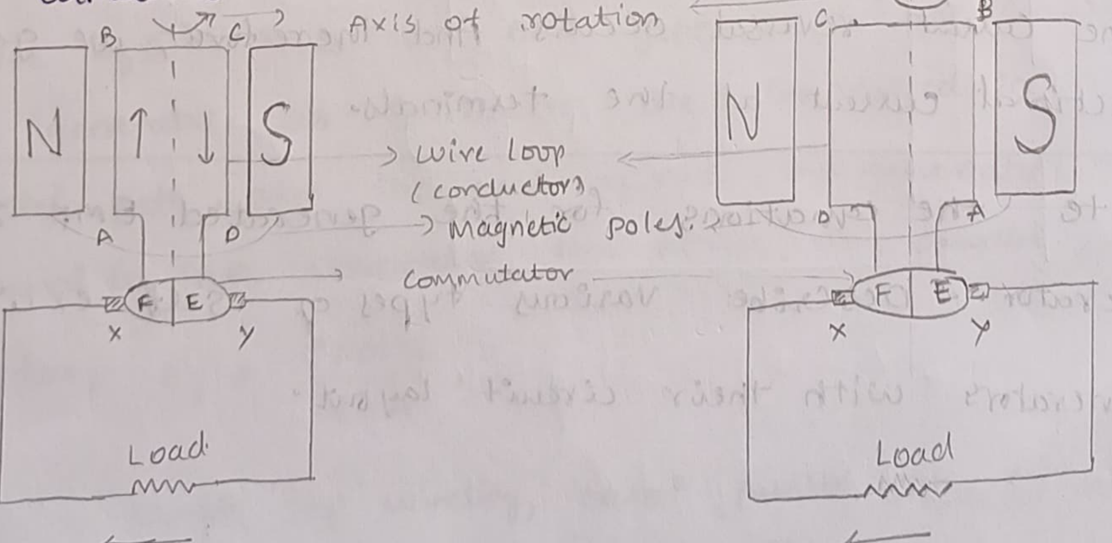


Fig : Principle of DC generator.

* Thus an, electromagnetically induced emf is generated in the armature conductors. The direction of induced current is given by "Fleming's right hand rule."

* According to the Fleming's right hand rule, the direction of induced current changes whenever the direction of motion of the conductor changes.

* Let's consider an armature rotating clockwise and a conductor at the left is moving upward.

* When the armature completes a half rotation, the direction of ~~current in every~~ motion of that particular conductor will be reversed to downward.

* Hence, the direction of current in every armature conductor will be alternating.

* If you look at the above figure, you will know how the direction of the induced current is alternating in an armature conductor. But with a split ring commutator, connections of the armature conductors also gets reversed when the current reversal occurs. And therefore, we get unidirectional current at the terminals.

---

(2) Write the equations for the generated EMF in a DC generator. Describe various types of self excited DC generators with their circuit layout.

Ans Consider a DC generator with the following parameters,

P = No. of poles

ϕ = flux produced per pole in Wb.

Z = Total no. of armature Conductors.

A = No. of parallel paths in armature.

N = rotational Speed of armature in revolution per min (rpm)

Now; According to Faradays law of Electromagnetic Induction,

Average emf generated per conductor $(E_g) = \frac{d\phi}{dt}$ V — ①

Flux cut by one conductor in one revolution $= d\phi = P\phi$ (Wb).

No. of revolutions per second (speed in RPS) $= N/60$

Time for one revolution $\Rightarrow dt = 60/N$ (seconds).

from ①

$$E_g = \frac{d\phi}{dt}$$

$$E_g = \frac{P\phi}{\left(\frac{60}{N}\right)} \Rightarrow E_g = \frac{NP\phi}{60} \quad \text{— ②}$$

Above eq ② gives the emf generated in one conductor of the generator. The Conductors are Connected in Series per parallel path, and the emf across the generator terminals is equal to the generated emf across any parallel path.

Therefore; $E_g = \frac{\phi P N Z}{60 A}$.

a) For a simple lap winding, no. of parallel paths is equal to the no. of poles i.e, $P = A$ (or) $A = P$. Therefore,

$$E_g = \frac{\phi N \cancel{P} Z}{60 \cancel{A}} \quad (\text{or}) \quad \frac{\phi N P Z}{60 P}$$

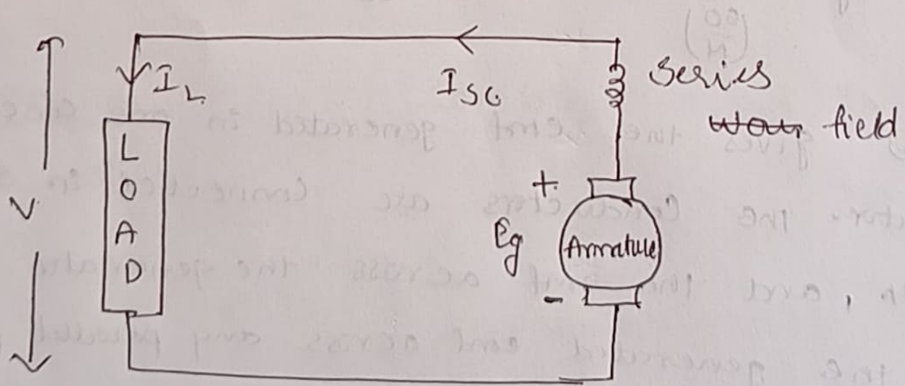
b) For a simple wave winding, no. of parallel paths is equal to 2 i.e ($A = 2$). Therefore,

$$E_g = \frac{\phi N P Z}{120}$$

Self Excited DC generators: In this type, field coils are energized from the current produced by the generator itself. Initial emf generation is due to residual magnetism in field poles. The generated emf causes a part of current to flow in the field coils, thus strengthening the field flux and thereby increasing emf generation.

Self excited dc generators can further be divided into three types.

(a) Series wound: field winding in series with armature winding



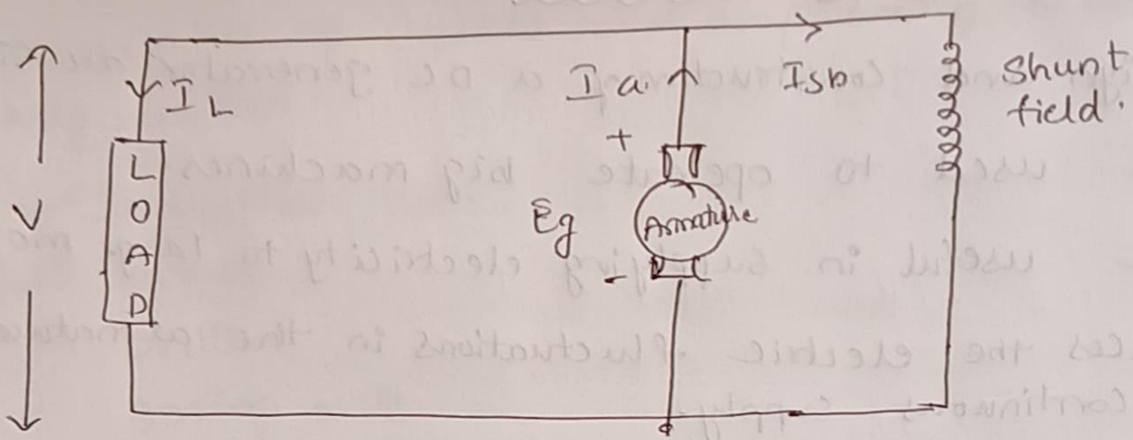
$$* \; V = E_g - I_a (R_a + R_{se})$$

$$* \; I_a = I_L = I$$

$$* \; P_{developed/generated} = E_g . I$$

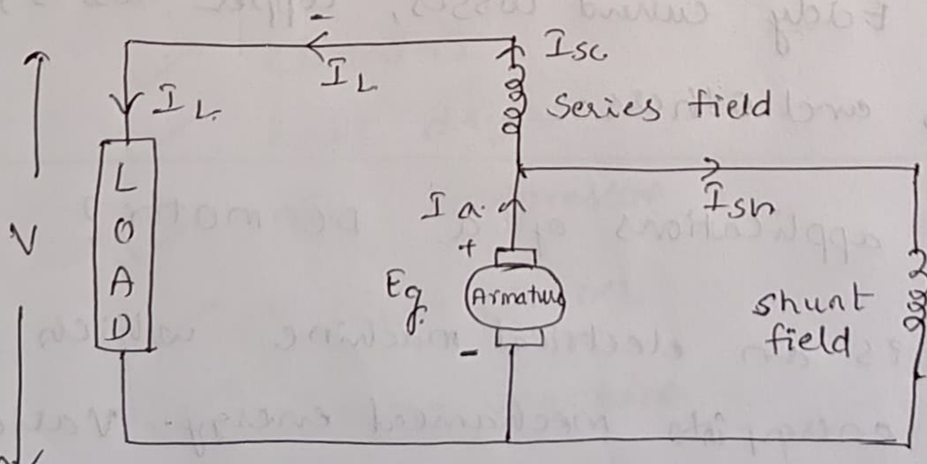
$$* \; P_{delivered} = V . I$$

(b) Shunt wound: field winding in parallel with armature winding.



* $V = E_g - I_a R_a$
* $I_a = I_{sh} + I_L$.
* $I_{sh} = V/R_{sh}$
* $P_{developed/generated} = E_g \cdot I_a$.
* $P_{delivered} = V \cdot I_L$;

(c) Compound wound: Combination of series and shunt winding.



4. What are the advantages and disadvantages of DC generators?

Ans

Advantages of DC generators:

→ The design and construction of a DC generator are simple.

→ They are used to operate big machines.

→ They are useful in supplying electricity to large motors.

→ It reduces the electric fluctuations in the armature and gives a continuous supply.

→ They are used to supply electricity for heavy electric devices.

Disadvantages of DC generators:

→ The efficiency of a DC generator is very low.

→ It cannot be used with a transformer.

→ They are placed at a long distance may experience major voltage drops.

→ The current flowing in DC generator experiences various losses such as Eddy current losses, Copper losses, mechanical losses and others.

5. What are the applications of a DC motor?

Ans A DC motor is an electrical machine which converts electrical energy into mechanical energy. Various DC motors are used for various applications, which are mentioned as follows:

1. DC Shunt motors: It is a constant speed motor where the speed is required to remain almost constant from no load to full load, where the load has to be driven at a number of speeds and any one of which is nearly constant.

Industrial use:

- ✓ Lathes
- ✓ Drills
- ✓ Boring mills
- ✓ Shapers
- ✓ Spinning and weaving machines

2. DC Series motor: It is a variable speed motor. The speed is low at high page on torque at light or no load, the motor speed attains dangerously high speed. The motor has a high starting torque. (elevators, electric traction).

Industrial use:

- ✓ electric traction
- ✓ Cranes
- ✓ elevators
- ✓ hair dryer
- ✓ air compressor
- ✓ vaccum cleaner
- ✓ Sewing machine.

3. DC Compound motor: Differential compound motors are rarely used ~~before~~ because of its poor torque characteristics

Industrial uses:

✓ presses shears.

✓ Reciprocating machine.

③ Classify the types of DC generators and explain in detail the various losses of DC generator.

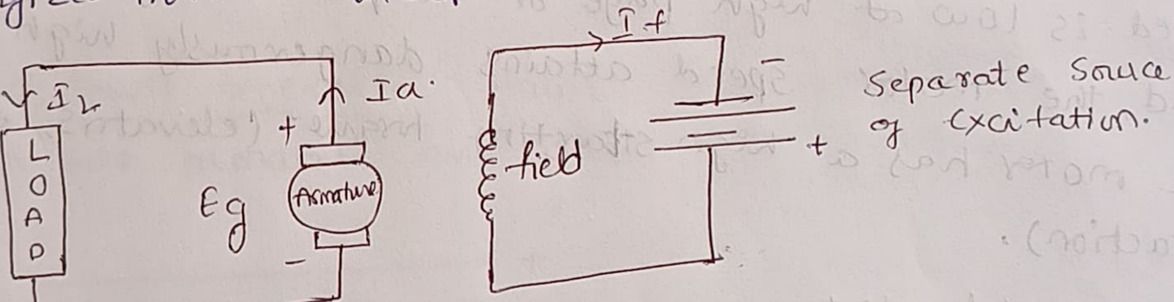
(10) describe the different types of losses occured in DC motors.

Ans DC generators can be classified in two main categories, viz, (i) Separately excited

(ii) Self-excited.

For flow chart, refer notes.

(i) Separately excited: In this type, field coils are energized from an independent external DC source.



* $V = E_g - I_a R_a \Rightarrow \boxed{E_g = V + I_a R_a}$

* $I_a = I_L = I$

* $P_{developed / generated} = E_g \cdot I$

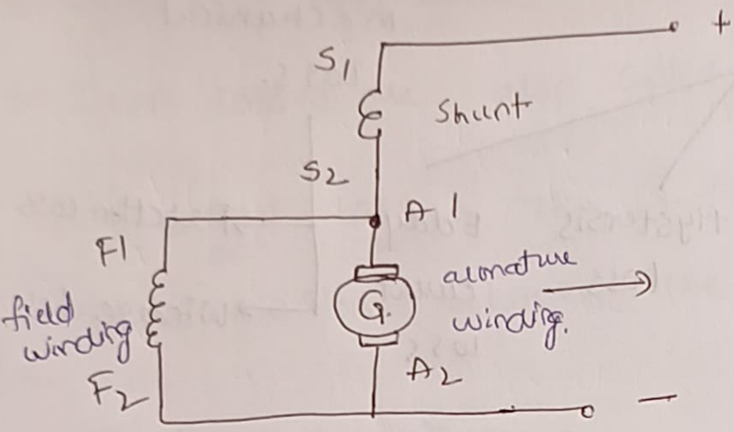
* $P_{delivered} = V \cdot I$

(ii) Self-excited:

Refer 2Q, and continue after compound generator the following part.

compound generator classified into two types

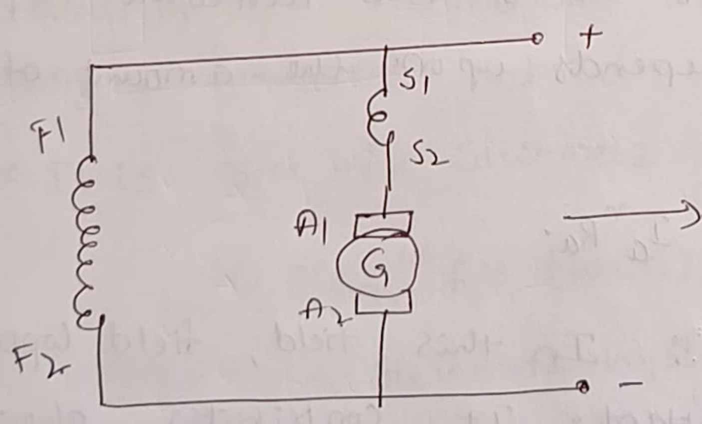
a) Short shunt generator: Shunt field winding is in parallel with armature winding.



* Terminal Voltage = $E_g - I_a R_a - I_{se} R_{se}$.

* Power developed ⇒ $P = V \cdot I_L$.

b) long shunt generator: Shunt field winding is in parallel with both armature and series field winding.



* $I_{se} = I_a = I_L + I_{sh}$

* $I_{sh} = V/R_{sh}$.

* $V = E_g - I_a (R_a + R_{se})$

* P delivered $= V \cdot I_L$.

Losses in a DC generator and DC motor:

Losses in a DC machine

- Copper loss
  - Armature cu loss
  - Shunt field cu loss
  - Series field cu loss
- Iron loss
  - Hysteresis loss
  - Eddy current loss
- Mechanical loss.
  - Friction loss
  - Windage loss

a) Copper loss: These losses occur in armature and field copper windings. Copper loss consist of Armature Copper Loss, Shunt field Copper loss and series field Copper loss due to brush contact resistance.

i) Armature Copper Loss: This loss contributes about 30 to 40 % to full load losses. The armature copper loss is variable and depends upon the amount of loading of the machine.

$$\text{Armature copper loss} = I_a^2 R_a.$$

ii) Shunt wounded field: In this field, field copper loss is practically constant. It contributes about 20 to 30 % to full load losses.

iii) Brush contact resistance: Brush contact resistance also contributes to the copper losses. Generally, this loss is included into armature copper loss.

... the Constructional details of a.

b) Iron loss : As the armature core is made of iron & it rotates in a magnetic field, a small current gets induced in the core itself too. Due to this current, eddy current & Hystersis loss occur.

→ Iron losses are also called as core losses / magnetic losses

Eddy current loss : The loss occur because of the relative motion between the core and the magnetic flux.

* $P_e = k_e v_f^2 t^2 B_m^2$.

* It is occured because of the interaction of the magnetic flux & conductor and it can be minimised by making the core of thin lamination.

Hysterisis loss: The losses which occur because of the reversal of the magnetism. It can be minimised by using silicon steel material.

* It is given by, Steinmetz formula,

$$h = \eta B_{max}^{1.6} f V \text{ (watts)}$$

where; η = Steinmetz hysteresis constant

V = volume of the core in m^3

f = frequency of magnetic reversal.

$= \frac{P \cdot N}{120}$ (P - no of poles; N = speed in rpm).

c) mechanical loss: It consist of the losses due to friction in bearings and commutator. Air friction loss of rotating armature also contributes to these. These losses are about 10 to 20% of full load losses.

Stray losses: In addition to the losses stated above, there may be small losses present which are called as stray losses or miscellaneous losses. These losses are difficult to account. They are usually due to inaccuracies in the designing & modeling of the machine. Most of the times, stray losses are assumed to be 1% of the full load.

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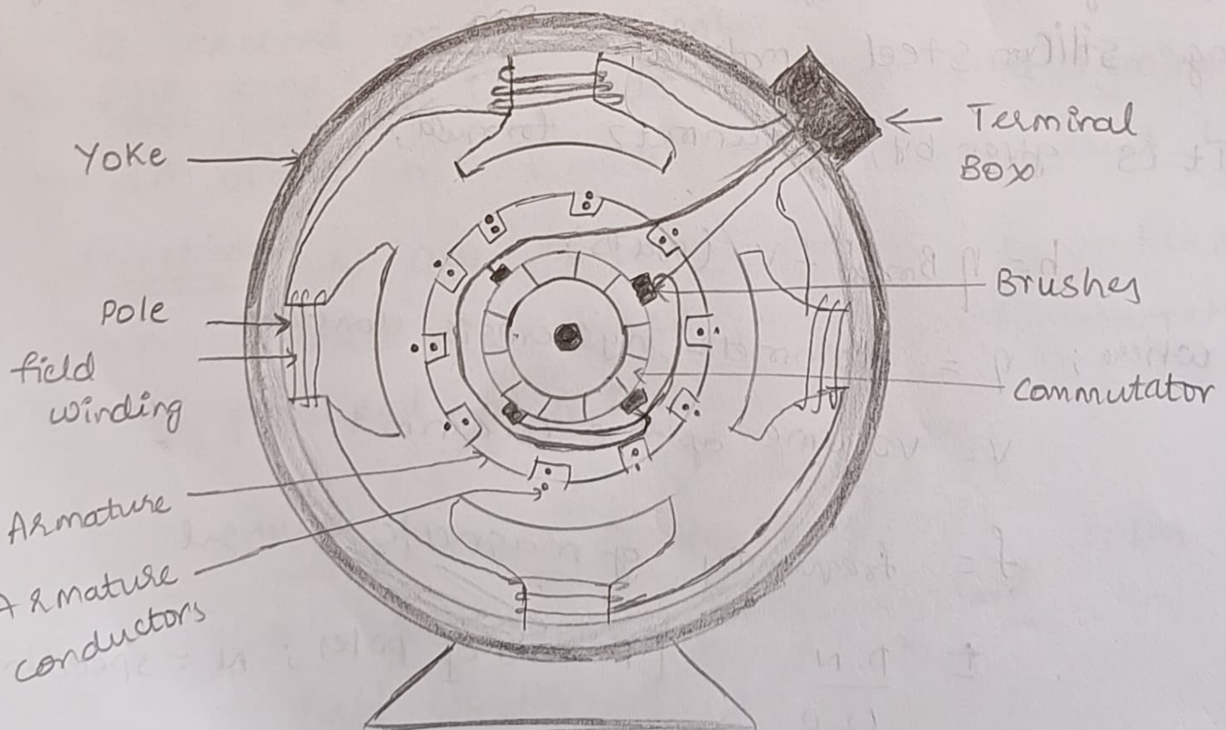
⑥ Interpret the constructional features of a DC machine with the help of neat sketches.



DC Machine Construction.

The above figure shows the constructional details of a simple 4 pole DC machine. A DC machine consists of two basic parts; stator and rotor. Basic constructional parts of a DC machine are described below.

① **Yoke:** Yoke is made up of caste iron for small DC machines and caste steel for large DC machines.

Functions: ① It ~~proctects~~ acts as a protecting cover for entire machine.

② It provides mechanical support for field poles.

③ It provides return path to the main field.

② **Field poles:**

a) **pole core:** It is made with solid cast steel.

Functions: a). carries the field winding.

b). It acts as electromagnet, when field winding is excited with DC supply.

b) **pole shoe:** It is made of cast steel laminations

→ In order to reduce the eddy current losses

Functions: a) Due to its enlarged area, flux per pole increase, induced emf & electromagnetic torque produced also increases.

③ **Field winding:** It is made with the copper wire

→ It is of two types

a) Shunt field winding.

b) Series field winding.

④ Rotar:

a) Armature pole: It is made with silicon steel laminations to minimize both eddy current losses and Hysteresis losses.

Function: It provides low reluctance path to the main field.

⑤ Commutator: It consists of no. of Commutator Segments

- These segments are insulated each other by mica Insulation.

→ Commutator segments are made with hard drewan copper.

→ No. of commutator segments are required equal to the no. of armature points.

Functions: → It converts AC voltages into DC voltages

⑥ Brushes: They are made with Copper / Carbon for small DC machines.

→ Electrographite is used for general purpose.

Functions: → It collects current from armature points through commutator segments.

→ It sends the current into armature via commutator segments.

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⑧ Describe the different types of motors with equivalent circuits.

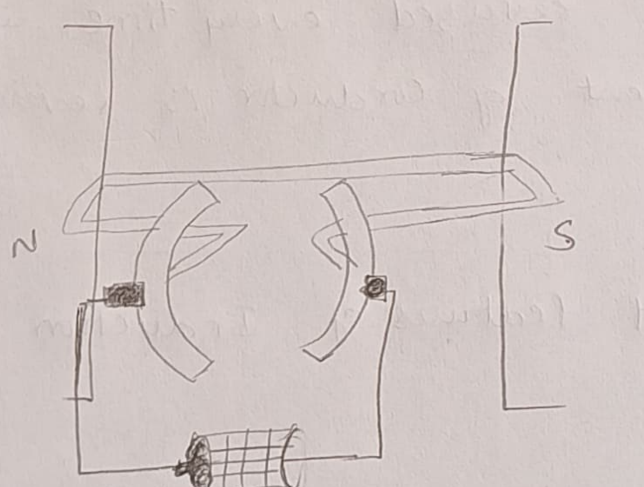
Ans Refer 2Q & 3Q & change the terms (Exclude : Losses).

7. Interpret the principle operation of DC motors.

Ans

A motor is an electrical machine which converts electrical energy into mechanical energy. The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force." The direction of this force is given by Flemings left hand rule & its magnitude is given by $F = BIL$. where, B = magnetic flux density,

I = current ; L = length of conductor within the magnetic field.



Working of DC motor.

Fleming's left hand rule: If we stretch the 1st finger, 2nd finger and thumb of our left hand to be perpendicular to each other and direction of magnetic field is represented by the first finger, direction of the current is represented by the second finger then the thumb represents the direction of the force experienced by the current carrying conductor.

When armature windings are connected to a DC supply, currents sets up in the winding. Magnetic field may be provided by field winding (electromagnetism) or by using permanent magnets. In this case, current carrying armature conductors experience force due to the magnetic field, according to the principal stated above.

Commutator is made segmented to achieve unidirectional torque. Otherwise, the direction of force would have reversed every time when the direction of movement of conductor is reversed the magnetic field.

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(9) What are salient features of Induction machines?

Ans Refer 6Q

CIE – II

PART – B

1) Define below terms:

(i) P-type Semiconductor : P type Semiconductors are the Semiconductors formed when a trivalent impurity like B, Al, Ga, In are doped with pure form of Semiconductor (intrisinic semiconductor).

* The majority carriers are holes and the minority carriers are electrons.

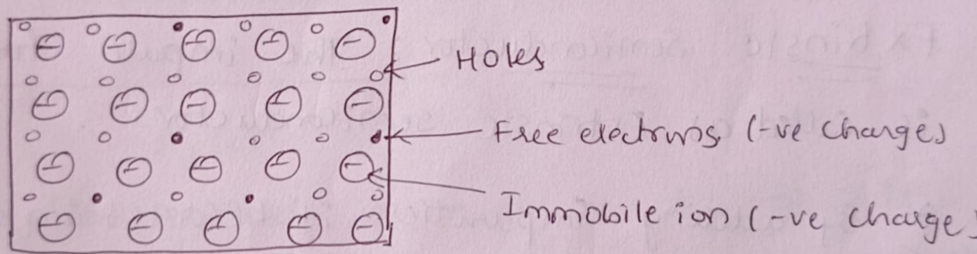


Fig: P-type Semi conductor.

(ii). N-type semiconductor : N type semiconductors are the semiconductors formed when a pentavalent impurity like P, As, Sb, etc.. are doped with pure form of the Semiconductor (intrisinic semiconductor).

* The majority carriers are electrons and the minority carriers are holes.

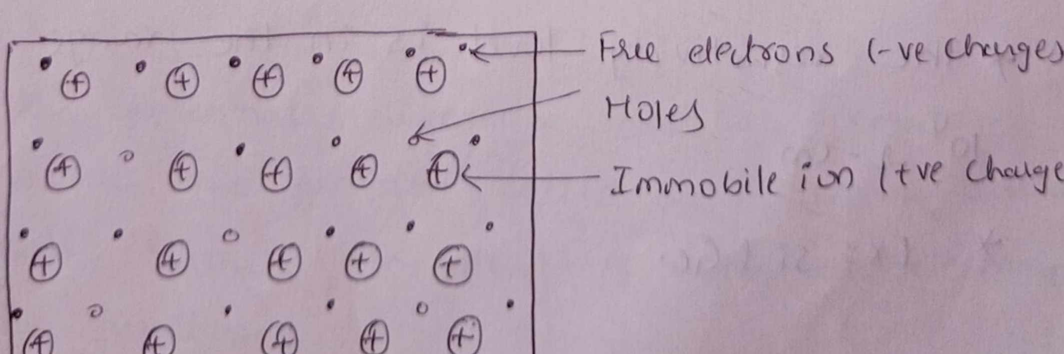


Fig: N-type Semiconductor

(iii) Doping : The process of adding impurities to the intrinsic semiconductor is called as doping.

(iv) Intrinsic Semiconductor : A pure form of semiconductor is called as Intrinsic semiconductor.

Ex : Si and Ge

* The conduction in Intrinsic semiconductor is either due to thermal excitation or crystal defects.

(v) Extrinsic Semiconductor : The impure form of semiconductor is called as Extrinsic semiconductor.

* By adding impurities. it becomes impure and hence intrinsic semiconductor is converted to Extrinsic semiconductor.

(2) What are semiconductors ? Give the Energy band structure of the semiconductor.

Ans A semiconductor is a material that has its conductivity lies between the insulator and conductor

* The resistivity level is in the range of 10 and 10^4 Ω-cm

* Ex : Si & Ge.

Energy band structure of Semiconductors:

In case of semiconductors, the valence band is almost filled and conduction band is empty. But the forbidden energy gap is very small (1eV) as shown in below figure.

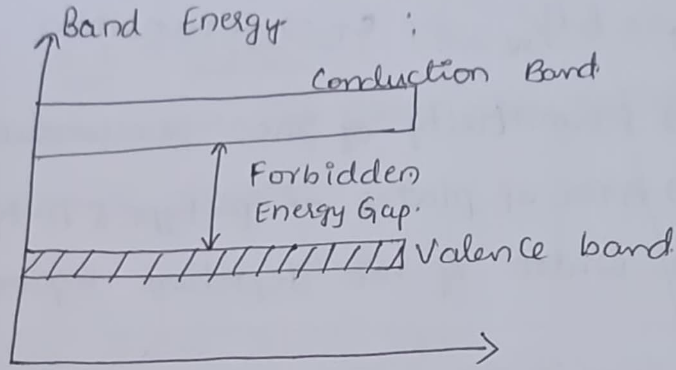


Fig (c).

Therefore, comparatively a smaller electric field is required to lift the valence electrons to the conduction band. Thus, the conductivity of semiconductor lies between a conductor and insulator.

---

(3) Define terms:

(i) Potential Barrier: The Barrier which prevents the further movement of holes and electrons through the junction is called as the potential barrier.

(or).

The potential difference due to formation of ions, across the junction called as Potential barrier as it prevents further movement of holes and electrons through the junction.

(ii) Transition Capacitance : The amount of Capacitance changed with increase in voltage is called as the transition Capacitance.

* Also known as Depletion region capacitance, Junction capacitance or barrier capacitance.

$$C_T = \varepsilon A/W \quad ; \; C_T \rightarrow \text{Transition capacitance}$$

where; $\varepsilon \rightarrow$ permittivity of the semiconductor.

$A \rightarrow$ Area of plates of p-type & n-type regions.

$W \rightarrow$ width of the depletion region.

(iii) Diffusion Capacitance: The amount diffusion Capacitance in a forward biased P-n junction diode. Diffusion Capacitance is also sometimes referred as storage Capacitance.

$$C_D = dQ/dv.$$

where; $C_D \rightarrow$ Diffusion Capacitance.

$dQ \rightarrow$ Change in no. of minority carriers store outside the depletion region.

$dv \rightarrow$ Change in voltage applied across diode

(iv) Forbidden energy gap : The difference in energy levels between the conduction band and valence band is known as the forbidden energy gap.

(v) **Diffusion** : Suppose the two pieces are suitably treated to form PN junction, then there is a tendancy for the free electrons from n-type to diffuse over to the p-side and holes from p-type to the n-side. This process is called Diffusion.

(vi) **Static or D.C Resistance** : The resistance of a diode at a particular operating point is called the dc or static resistance diode.

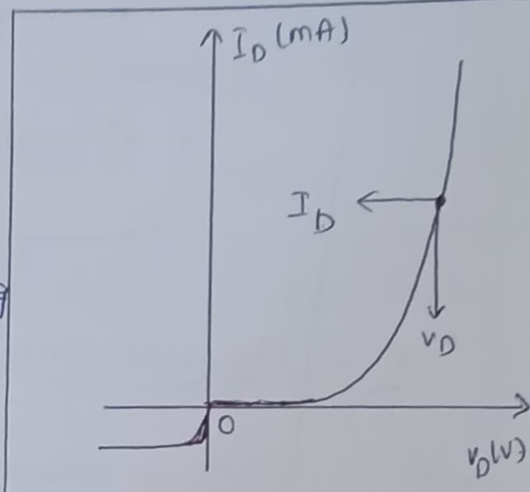


Fig: Static resistance curve.

* The resistance of the diode at the operating point can be found simply by finding the corresponding levels of V_D and I_D.
* It can be determined by using equation ; $\boxed{R_D = V_D / I_D}$
* lower the current through a diode, the higher the dc resistance level.

(vii) **Dynamic or AC Resistance** : Static resistance is using dc input. If the input is sinusoidal, the scenario will be change.

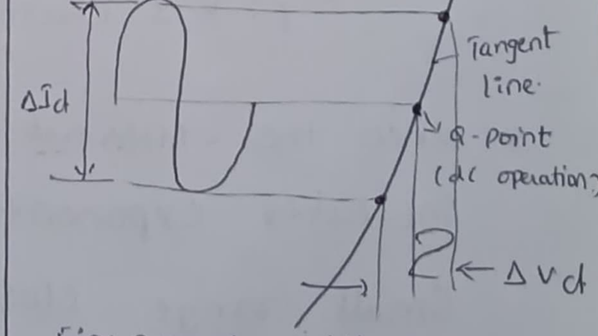
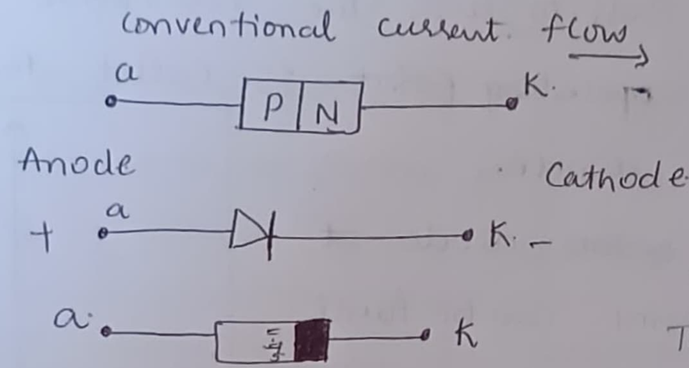


Fig: Dynamic resistance curve

* The AC resistance is determined by a straight line drawn between the two intersections of the maximum and minimum values of input voltage.
* Thus, the specific changes in current and voltage is obtained. It can be determined using $\boxed{r_d = \frac{\Delta V_D}{\Delta I_D}}$

4) What is a PN junction diode? Explain V-I characteristic-s of the PN junction diode.

Ans = A PN junction is a device formed by joining p-type with n-type semiconductors and separated by a thin junction is called PN junction diode or junction diode.



(If for LAQ) - 7M

Theory of PN junction diode can be included

V-I Characteristics of the PN junction diode:

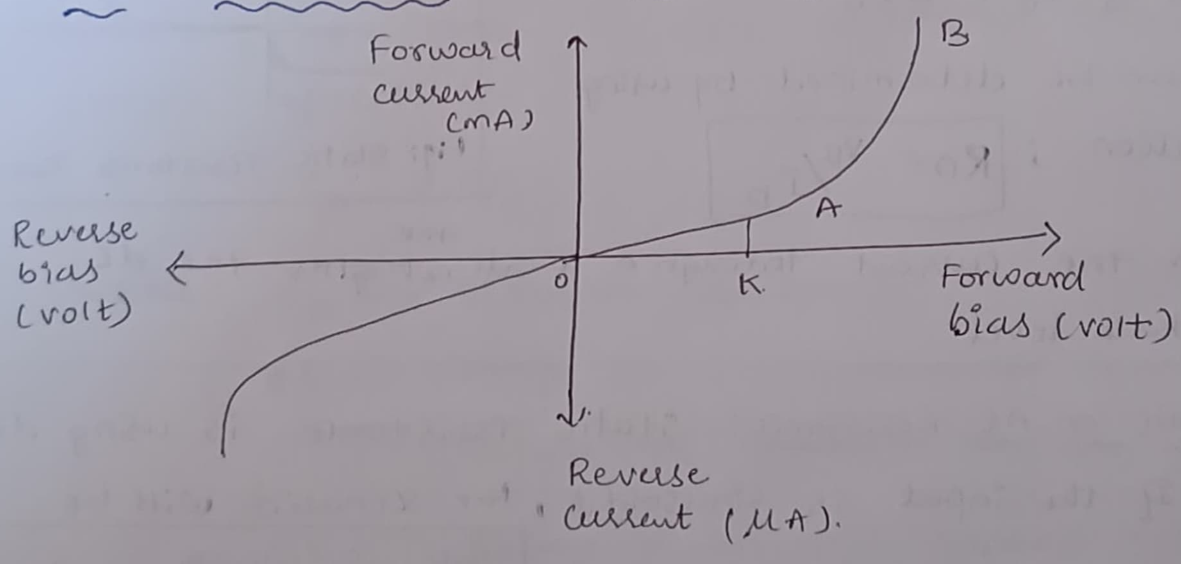


Fig: V-I Characteristics of PN junction diode

* When the current is Forward - biased, the current increases exponentially with voltage except for a small range close to the origin.

* When the diode is reverse biased, the reverse current (4)
is constant and independent of the applied reverse bias.

* Turn-on or cut-in (threshold) voltage V_γ: for a Forward bias diode it is the voltage when the current increases appreciably from zero.

* It is roughly equal to the barrier potential difference.

* For Ge; $V_\gamma \sim 0.2 - 0.4\,V$ (at room temp.)

  For Si; $V_\gamma \sim 0.6 - 0.8\,V$ (at room temp.).

---

5) What is a Rectifier? What are the types of Rectifiers. Draw circuit diagrams of Rectifiers.

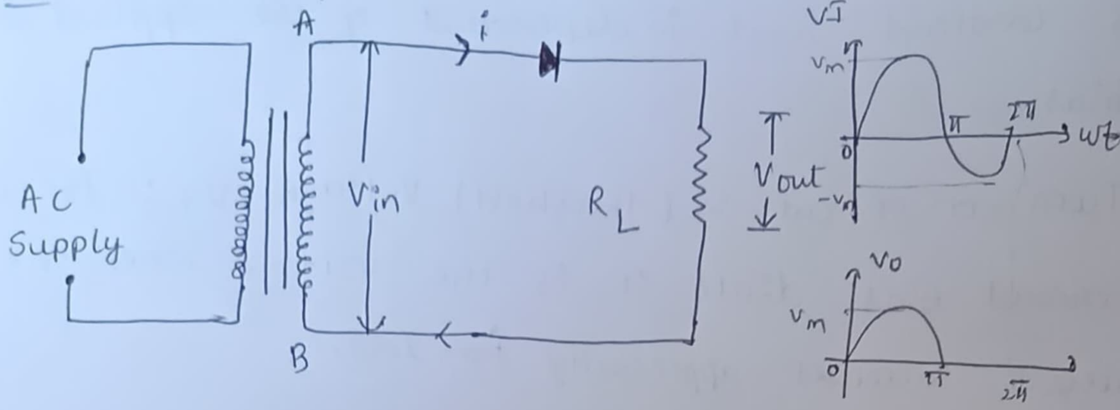
Ans: * A circuit that converts ac voltage of main supply into pulsating dc voltage using one or more PN junction diodes is called as a rectifier.

Types of Rectifiers:

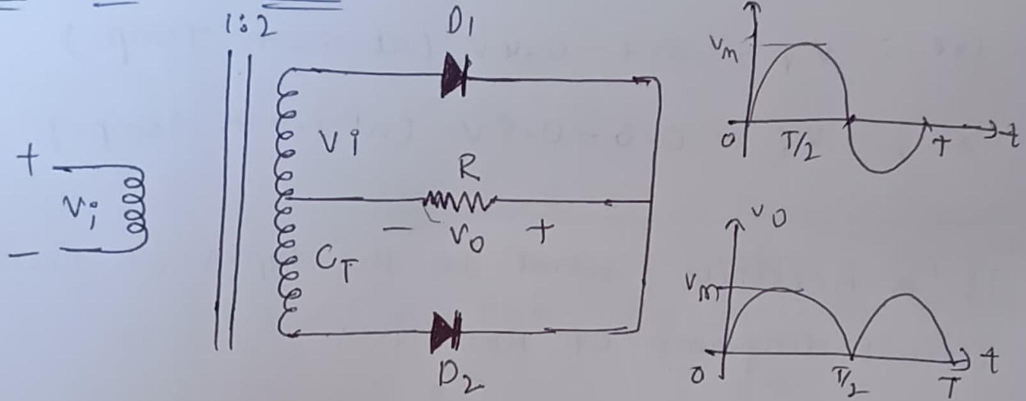
1) Half wave Rectifier
2) Full wave Rectifier
3) Bridge wave Rectifier

The circuit diagrams of

a) Half wave Rectifier

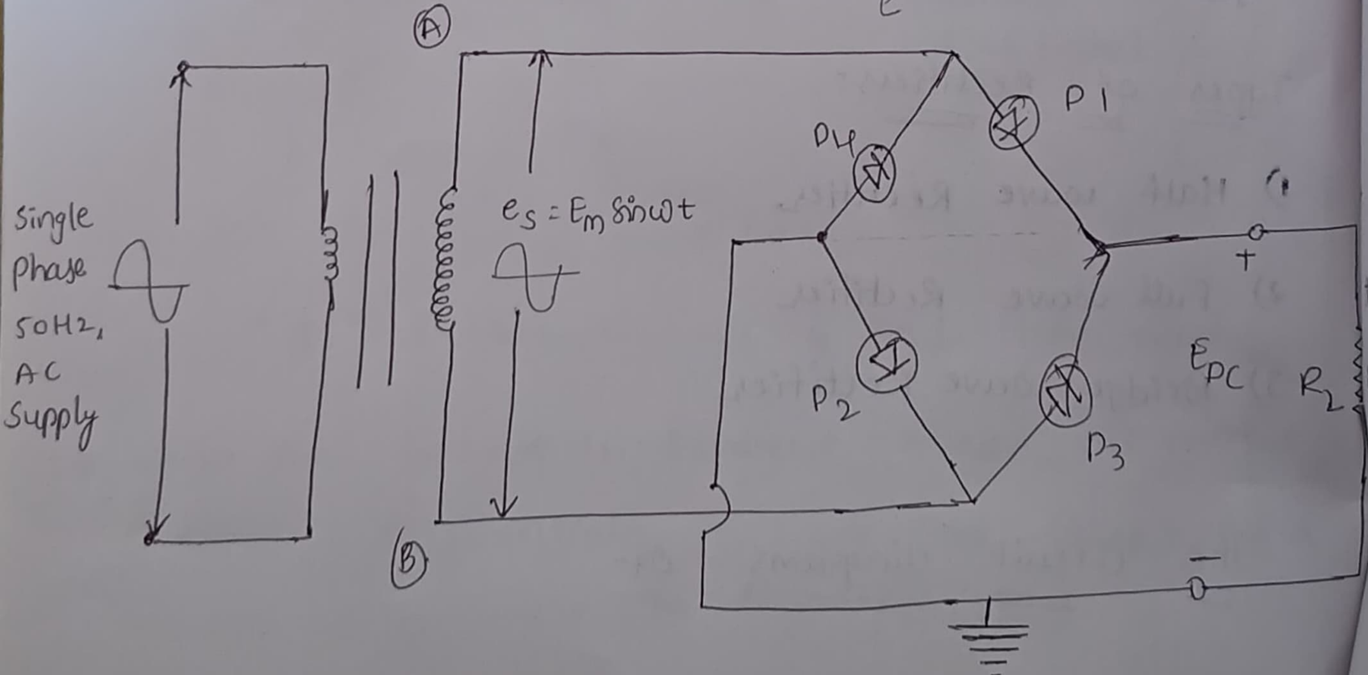


b) Full wave Rectifier



(output forms also to be mentioned)

c) Bridge Rectifier :

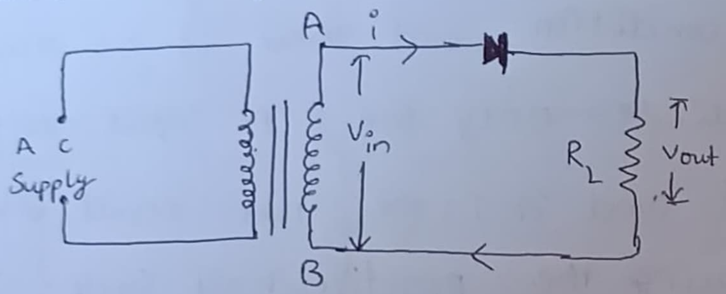


Explain the half-wave Rectifier with circuit diagram and draw its output wave forms? (5)

* The process of removing one-half of the input signal to establish a dc level is called "Half-wave Rectification.

* In half wave rectification, the rectifiers conducts current during positive half cycle of input ac signal only.

* Negative half cycle is suppressed.



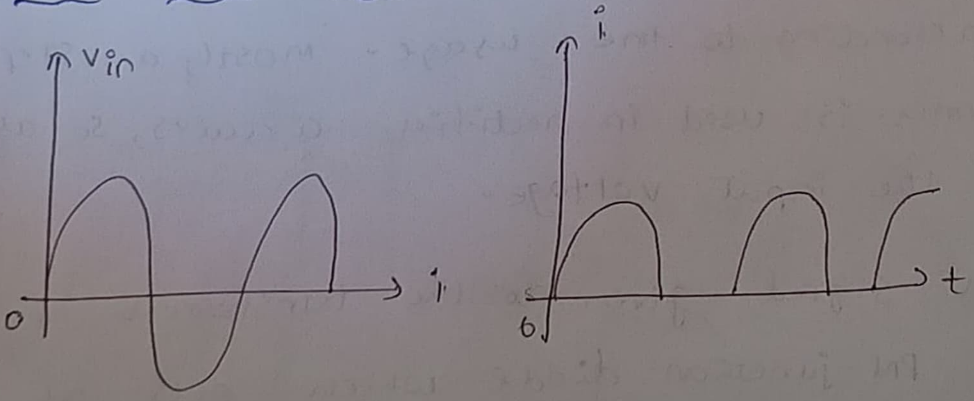
* The name of half wave rectifier itself states that the is done only for half of the cycle. The AC signal is given through an input transformer which steps up or down according to the usage. mostly a step down transformer. is used in rectifier circuits, so as to reduce the input voltage.

* The input signal given to the transformer is passed through a PN junction diode. which acts as a rectifier. This diode converts the AC voltage into pulsating dc for only the positive half cycles of the input. A load resistor is connected at the end of the circuit.

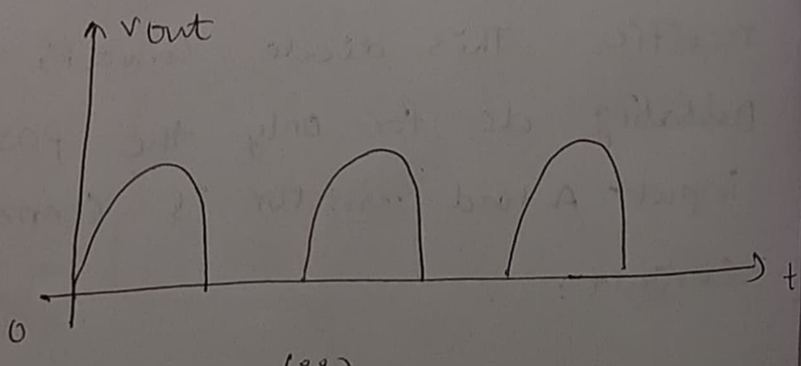
* During the positive half cycle, the diode is under forw[ard] bias condition and it conducts current to R_L (load resistance). A voltage is developed across the load, which is same as the input AC signal of the positive half cycle.

* During the negative half cycle, the diode is under reverse bias condition and there is no current flo[w] through the diode. Only the AC input voltage appea[rs] across the load and it is the net result which is possible during the positive half cycle. The outpu[t] voltage pulsates the DC voltage.

Output wave forms:



(i).



(ii)

Explain working of Diode as switch with circuit diagram? ⑥

A diode is a two terminal p-n junction. The p-n junction when forward biased, acts as a closed circuit and when reversed biased, acts as a open circuit. Hence, change in state from forward biased to reversed biated makes the diode works as a switch.

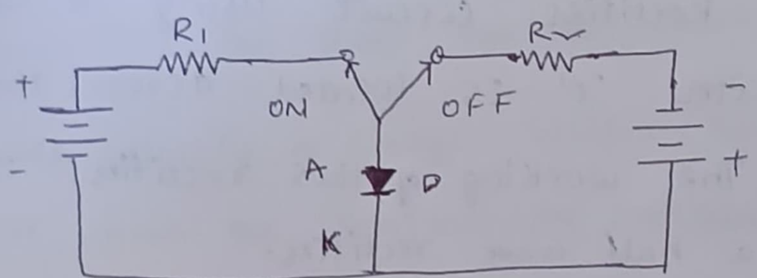


Fig (1): Diode as a switch.

* The forward being ON and the reverse being OFF

* Whenever a specified voltage is exceeded the diode resistance gets increased marking the diode reverse biased and it acts as OPEN SWITCH.

* Whenever a voltage is applied below the reference voltage, the diode resistance gets decreased making the diode forward biased and itt acts as an CLOSED SWITCH.

*. Hence diode can act as a SWITCH.

8) Explain Full wave Rectifier with Capacitive Filter?

Ans

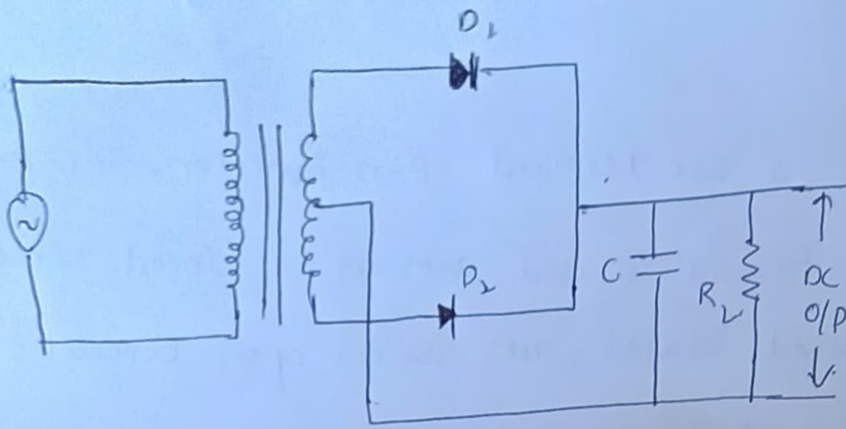
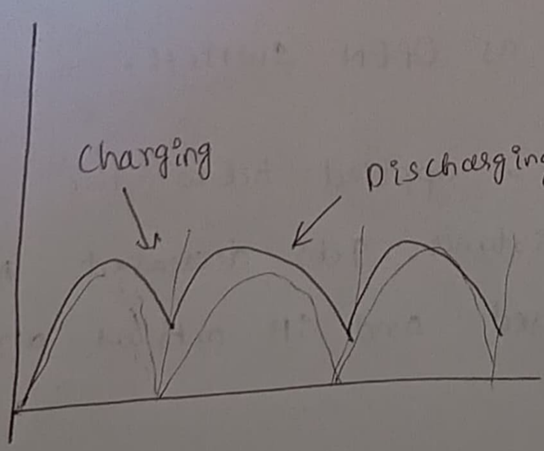


Fig: Full wave Rectifier with Capacitive filter.

* In full wave Rectifier circuit using a capacitor filter, the capacitor 'c' is located across the 'RL' load resistor. The working of this rectifier is almost the same as a half wave rectifier.

* Once the i/p AC voltage is applied throughout the positive half cycle, then the D1 diode gets forward biased and permits flow of current while D2 diode gets reverse biased and blocks the flow of current.



Full wave Rectifier output

Generally, Capacitive filter uses a Capacitor to improve the waveform quality coming from the rectifier circuit. The capacitor itself is frequently referred to as a smoothing Capacitor. (7)

* Filters are commonly used after rectification in order to improve the quality ~~coming~~ of the output signal.

) Define terms of Bridge Rectifier:

(i) $V_{(rms)}$: The term V_{rms} is defined as the root mean square velocity of charge carriers, such as electrons or holes, within the semiconductor material.

* For a bridge rectifier; $V_{rms} = V_m/\sqrt{2}$

(ii) V_{dc} : V_{dc} typically refers to direct current voltage. "V" stands for volts, which is the unit of measurement for electric potential, and "DC" stands for direct current. Direct current is a type of electrical current that flows in one direction continuously.

* For a bridge rectifier; $V_{dc} = 2V_m/\pi$.

(iii) Ripple factor: It is a measure used to quantify the amount of AC component present in the output of a rectifier circuit. Rectifiers are electronic circuits that converts AC To dc.

* For a bridge rectifier; Ripple factor = 0.48.

(iv) Peak inverse voltage (PIV) : PIV is the maximum voltage that occurs across the diode when it is reverse-biased.

* For a bridge rectifier ; PIV = $2 V_m$.

(v) Output frequency : The term output frequency can refer to different aspects depending on the specific application. It's important that it depends on the type of semiconductor device and its intended application.

* For a bridge rectifier ; Output frequency = $2f$.

(vi) Form factor : It can be defined as the ratio of the RMS value to the average value.

$$\text{Form factor} = \frac{I_{rms}}{I_{avg}}$$

* For a bridge Rectifier ; form factor = 1.11.

(vii) Efficiency : It can be defined as the ratio of output power to the input power.

$$\text{Efficiency} (\eta) = \frac{\text{o/p power}}{\text{i/p power}} \times 100.$$

* For a bridge Rectifier ; Efficiency = 81.2 %.

(viii) Peak factor : It is the ratio Peak Maximum value to the RMS value ~~to~~ of a.c

$$\text{Peak (value) factor} = \frac{I_m}{I_{rms}}.$$

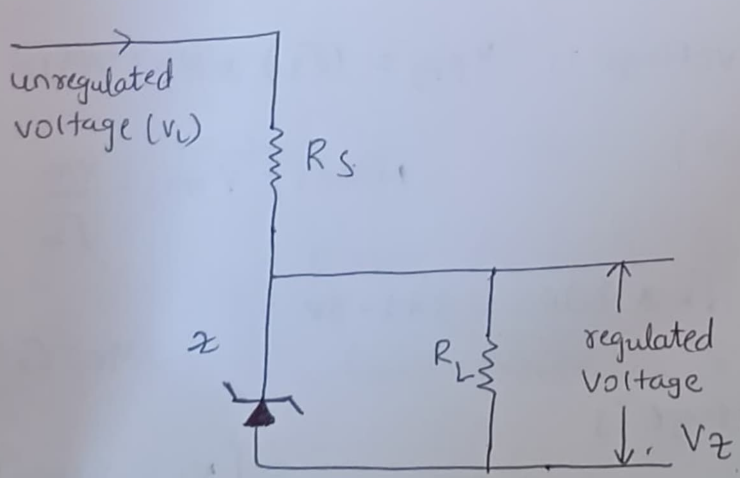
* For a bridge rectifier ; Peak factor = $\sqrt{2}$

) Define voltage regulator? Explain how Zener diode works as voltage regulator. (8)

A voltage regulator is a device that regulates the voltage level. Voltage regulators are used in computers, power generation, alternators to control the output of the plant.

Zener diode is a silicon semiconductor with p-n junction i.e specially designed to work in the reversed biased condition. When forward biased, it behaves like a normal single diode. But when reverse voltage ~~remains~~ is applied to it, the voltage remains constant for a wide range of currents. Due to this feature, It is (Zener diode) is used as a voltage regulator.

* Symbol of Zener diode -



(Whatsapp pics also include).