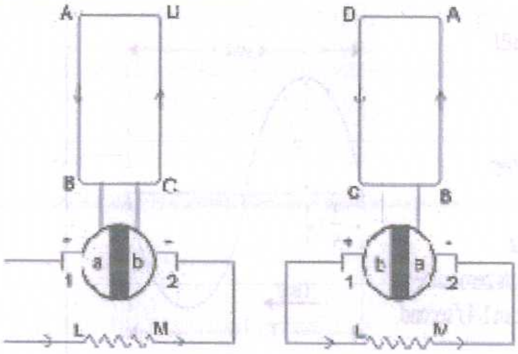
SCHEME OF VALUATION

(Scoring Indicators)

Revision (2015) Course Title : ELECTRICAL & ELECTRONONICS ENGINEERING				Course Code 3021
Qt No	Scoring Indicator	Split Up Score	Sub Total	Total
I	PART A			
1	Ohm's Law: It states that under constant temperature current through a conductor is directly proportional to potential difference between its ends. V=IR V- Potential difference across the points I – current through the conductor R- Resistance	2	2	2x5=10
2	The working of DC motor is based on the principle that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force. The direction of the mechanical force is given by **Fleming's Left-hand Rule** and its magnitude is given by **F = BIL** Newton.	1+1	2	
3	pasteurization and sterilization of food, drying processes , Temperature control unit (TCU)	1+1	2	
4	DC quantities : PMMC (Permanent Magnet Moving coil)Instrument Both DC and AC quantities: MI (Moving Iron) Instrument	1+1	2	
5	Active Component : BJT, SCR Passive Component : Resistor , Capacitor	1+1	2	

II	**PART B**			
1.	Series Combination: In series combination, resisters are connected end to end and current has a single path through the circuit but the potential difference varies across each resistor. Thus we can write as, $V = V1 + V2 + V3$ according to Ohm's law $V = IR$ So, $V1 = I R1, V2 = I R2, V3 = I R3$ $V = I R1 + I R2 + I R3$ $V = I(R1+R2+R3)$ $V = IRe$ All the individual resistances become equal to the equivalent resistance. or $Re = R1 + R2 + R3......Rn$	3		
	Parallel Combination: In parallel combination, each resistor is connected to the positive terminal while the other end is connected to a negative terminal. The potential difference across each resistance is the same and the current passing through them is different. $V = V1 = V2 = V3$ $I = I1 + I2 + I3$ Current through each resistor will be: $I1 = V/R1 , I2 = V/R2 = I3 = V/R3$ $I = V (1/R1 + 1/R2 + 1/R3)$ In case of equivalent resistance $I = V/Re$ $V/Re = V (1/R1 + 1/R2 + 1/R3)$ So the equivalent resistance is the sum of all resistances $1/Re = 1/R1 + 1/R2 + 1/R3$	3	6	
2	Principle of DC Generator : Faradays law states that whenever a conductor cuts the magnetic flux or magnetic flux cuts the conductor, an EMF is induced in the conductor.			

	 As the coil rotates, electromagnetic induction causes emf to be induced into the coil. As a result current produced is an alternating current. However, it is possible to convert the alternating current that is induced into the armature into a form of direct current. This conversion of AC into DC is accomplished through the use of a split ring or commutator. The conductors of the armature of a DC generator are connected to commutator segments.	3 3	6	
3	• Shunt motor: Shunt motor is a motor in which the field winding is connected in parallel with the armature. • Series motor: Series motor is a motor in which the field winding is connected in series with the armature. • Compound-wound motor : Compound motor has two field windings; one connected in parallel with the armature and the other in series with it. There are two types of compound motor connections. When the shunt field winding is directly connected across the armature terminals, it is called short shunt connection when the shunt field winding is so connected that it shunts the series combination of armature and series fields, it is called long shunt connection.	2 2 2	6	

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32.6. E.M.F. Equation of a Transformer

Let N_1 = No. of turns in primary

N_2 = No. of turns in secondary

Φ_m = Maximum flux in core in webers

$= B_m \times A$

f = Frequency of a.c. input in Hz

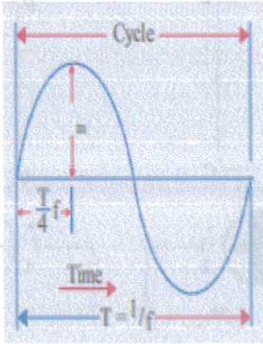

Fig. 32.14

As shown in Fig. 32.14, flux increases from its zero value to maximum value Φ_m in one quarter of the cycle *i.e.* in $1/4f$ second.

$$\therefore \text{ Average rate of change of flux} = \frac{\Phi_m}{1/4f}$$

$$= 4f\Phi_m \text{ Wb/s or volt}$$

Now, rate of change of flux per turn means induced e.m.f. in volts. 2

$$\therefore \quad \text{Average e.m.f./turn} = 4f\Phi_m \text{ volt}$$

If flux Φ varies *sinusoidally*, then r.m.s. value of induced e.m.f. is obtained by multiplying the average value with form factor.

$$\text{Form factor} = \frac{\text{r.m.s. value}}{\text{average value}} = 1.11$$ 6

$$\therefore \quad \text{r.m.s. value of e.m.f./turn} = 1.11 \times 4f\Phi_m = 4.44 f\Phi_m \text{ volt}$$

Now, r.m.s. value of the induced e.m.f. in the whole of primary winding

$$= (\text{induced e.m.f/turn}) \times \text{No. of primary turns}$$

$$E_1 = 4.44 f N_1 \Phi_m = 4.44 f N_1 B_m A \quad ...(i)$$ 4

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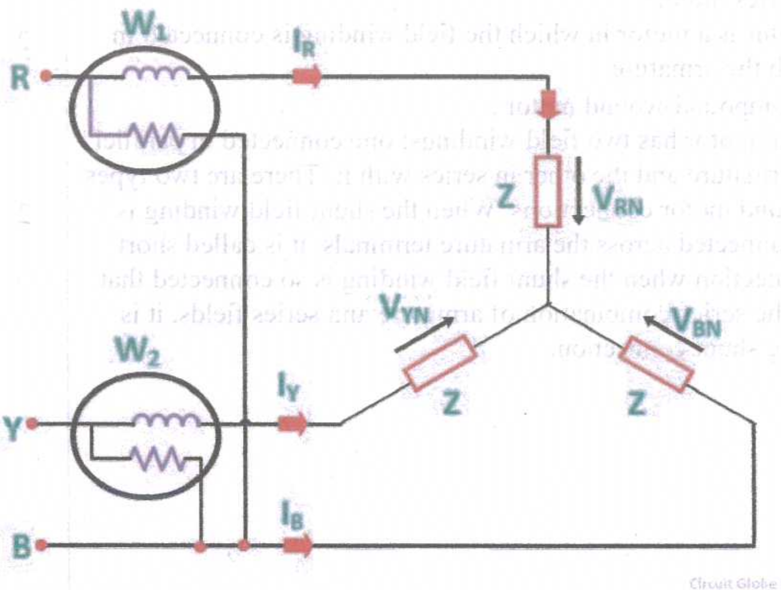
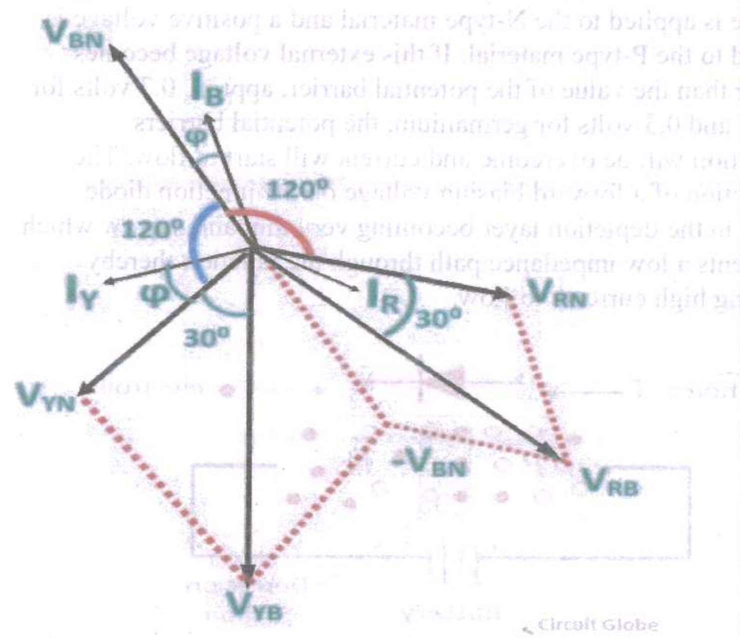


The three voltages VRN, VYN and VBN, are displaced by an angle of 120 degrees electrical as shown in the phasor diagram. The phase current lag behind their respective phase voltages by an angle ϕ.

power measured by the Wattmeter, W1 is



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$$W_1 = V_{RB} I_R \cos(30^\circ - \varphi)$$

power measured by the Wattmeter, W2 is

$$W_2 = V_{YB} I_Y \cos(30^\circ + \varphi)$$

Since, the load is in balanced condition, hence,

$$I_R = I_Y = I_B = I_L \quad \text{and}$$

$$V_{RY} = V_{YB} = V_{BR} = V_L$$

Therefore, the wattmeter readings will be

$$W_1 = V_L I_L \cos(30^\circ - \varphi) \quad \text{and}$$

$$W_2 = V_L I_L \cos(30^\circ + \varphi)$$

$$W_1 + W_2 = V_L I_L \cos(30^\circ - \varphi) + V_L I_L \cos(30^\circ + \varphi)$$

$$W_1 + W_2 = V_L I_L [\cos(30^\circ - \varphi) + \cos(30^\circ + \varphi)] \quad \text{or}$$

3

$$W_1 + W_2 = V_L I_L [\cos 30^\circ \cos\varphi + \sin 30^\circ \sin\varphi + \cos 30^\circ \cos\varphi - \sin 30^\circ \sin\varphi] \text{ or}$$

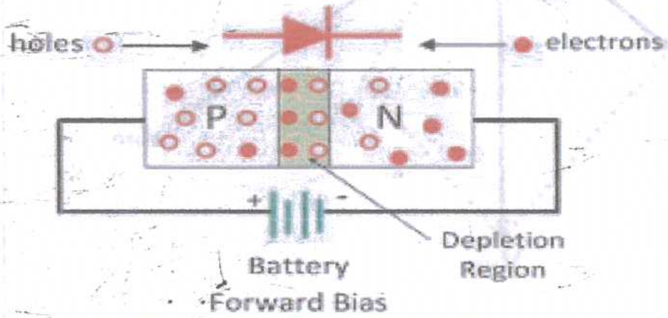
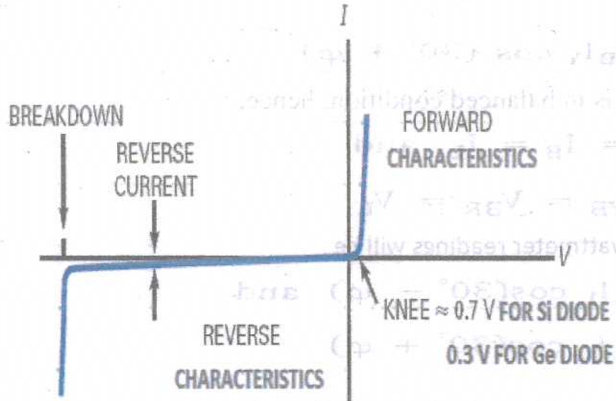
$$W_1 + W_2 = V_L I_L (2 \cos 30^\circ \cos\varphi) \quad \text{or}$$

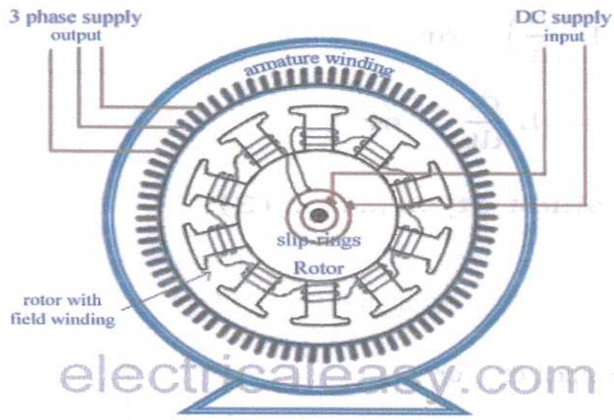
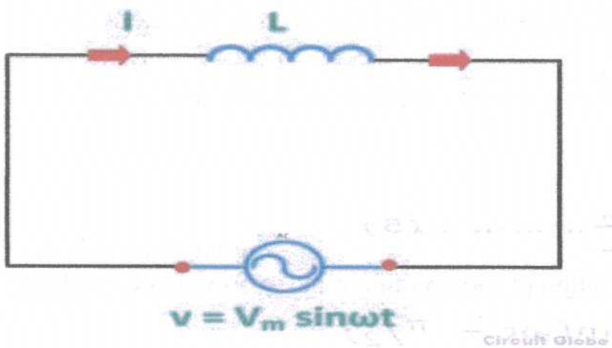
$$W_1 + W_2 = V_L I_L \left(2 \frac{\sqrt{3}}{2} \cos\varphi \right)$$

6

$$W_1 + W_2 = \sqrt{3}\, V_L I_L \cos\varphi$$

$$W_1 + W_2 = P \; \ldots\ldots (1)$$

6	When a diode is connected in a Forward Bias condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material. If this external voltage becomes greater than the value of the potential barrier, approx. 0.7 volts for silicon and 0.3 volts for germanium, the potential barriers opposition will be overcome and current will start to flow. The application of a forward biasing voltage on the junction diode results in the depletion layer becoming very thin and narrow which represents a low impedance path through the junction thereby allowing high currents to flow.			
	 PN Junction Diode in Forward Bias	3		
		3	6	
7	• Time saving • Reduces cost of production • Reduces wastage of material • Higher production rate • Improved safety • improves quality of product	1x6	6	
				6x5=30

III (i)	An alternator has 3,-phase winding on the stator and a d.c. field winding on the rotor. Stator: It is the stationary part of the machine and is built up of silicon steel laminations having slots on its inner periphery. A 3-phase winding is placed in these slots and serves as the armature winding of the alternator. The armature winding is always connected in star and the neutral is connected to ground. Rotor : The rotor carries a field winding which is supplied with direct current through two slip rings by a separate d.c. source. This d.c. source (called exciter) is generally a small d.c. shunt or compound generator mounted on the shaft of the alternator. Rotor construction is of two types, namely; 1. Salient (or projecting) pole type 2. Non-salient (or cylindrical) pole type  	5 3	8	
III (ii)	 Let the alternating voltage applied to the circuit is given by the equation	1		

	$v = V_m Sin\omega t$ ....(1) As a result, an alternating current i flows through the inductance which induces an emf in it. The equation is shown below $e = -L\frac{di}{dt}$	1		
	The emf which is induced in the circuit is equal and opposite to the applied voltage. Hence, the equation becomes $v = -e$ ....(2) Putting the value of e in equation (2) we will get the equation as $v = -\left(-L\frac{di}{dt}\right)$ or $V_m Sin\omega t = L\frac{di}{dt}$ or $di = \frac{V_m}{L} sin\omega t\ dt$ ... ... (3)	1		
	Integrating both sides of the equation (3), we will get $\int di = \int \frac{V_m}{L} sin\omega t\ dt$ or $i = \frac{V_m}{\omega L}(-\cos\omega t)$ or $i = \frac{V_m}{\omega L} sin(\omega t - \pi/2) = \frac{V_m}{X_L} sin(\omega t - \pi/2)$ ... ... (4) where, XL = ω L is the opposition offered to the flow of alternating current by a pure inductance and is called inductive reactance. The value of current will be maximum when sin (ωt – π/2) = 1	3	7	
	Therefore, $I_m = \frac{V_m}{X_L}$ ... ... (5) Substituting this value in Im from the equation (5) and putting it in equation (4) we will get $i = I_m sin(\omega t - \pi/2)$	1		

IV (i)

Lead acid cell uses sponge lead and lead peroxide for the conversion of the chemical energy into electrical power.

Construction of Lead Acid Battery :

1. Container – The container of the lead acid battery is made of glass, lead lined wood, ebonite, the hard rubber of bituminous compound, ceramic materials or moulded plastics and are seated at the top to avoid the discharge of electrolyte.

2. Plate – The plate of the lead-acid cell is of diverse design and they all consist some form of a grid which is made up of lead and the active material. The grids are made up of an alloy of lead and antimony.

3. Active Material – The material in a cell which takes active participation in a chemical reaction (absorption or evolution of electrical energy) during charging or discharging is called the active material of the cell. The active elements of the lead acid are

- Lead peroxide (PbO2) – It forms the positive active material. The PbO2 are dark chocolate broom in colour.
- Sponge lead – Its form the negative active material. It is grey in colour.
- Dilute Sulfuric Acid (H2SO4) – It is used as an electrolyte. It contains 31% of sulfuric acid.

4. Separators – The separators are thin sheets of non-conducting material made up of chemically treated leadwood, porous rubbers, or mats of glass fibre and are placed between the positive and negative to insulate them from each other.

5. Battery Terminals – A battery has two terminals the positive and the negative.

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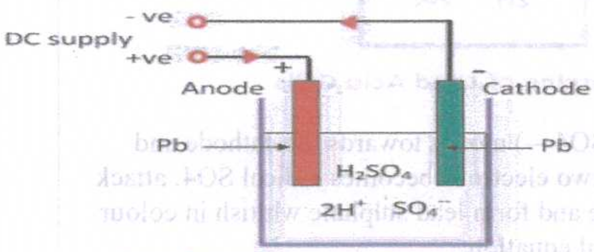
Working Principle of Lead Acid Battery :

When the sulfuric acid dissolves, its molecules break up into positive hydrogen ions (2H+) and sulphate negative ions (SO4—) and move freely. If the two electrodes are immersed in solutions and connected to DC supply then the hydrogen ions being positively charged and moved towards the electrodes and connected to the negative terminal of the supply. The SO4— ions being negatively charged moved towards the electrodes connected to the positive terminal of the supply main (i.e., anode).



Charging of Lead Acid Cells

Each hydrogen ion takes one electron from the cathode, and each sulphates ions takes the two negative ions from the anodes and react with water and form sulfuric and hydrogen acid.The oxygen, which produced from the above equation react with lead oxide and form lead peroxide (PbO2.) Thus, during charging the lead cathode remain as lead, but lead anode gets converted into lead peroxide, chocolate in colour.If the DC source of supply is disconnected and if the voltmeter connects between the electrodes, it will show the potential difference between them. If wire connects the electrodes, then current will flow from the positive plate to the negative plate through external circuit i.e. the cell is capable of supplying electrical energy.

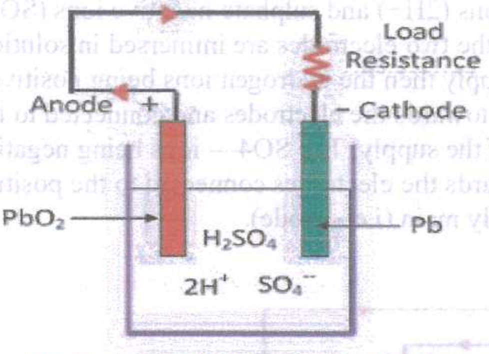
Chemical Action During Discharging :

When the cell is full discharge, then the anode is of lead peroxide (PbO2) and a cathode is of metallic sponge lead (Pb). When the electrodes are connected through a resistance, the cell discharge and electrons flow in a direction opposite to that during charging.The hydrogen ions move to the anode and reaching the anodes receive one electron from the anode and become hydrogen atom. The hydrogen atom comes in contacts with a PbO2, so it attacks and forms lead sulphate (PbSO4), whitish in colour and water according to the chemical equation.

$$PbSO_4 + 2H = PbO + H_2O$$

$$PbO + H_2SO_4 = PbSO_4 + 2H_2O$$

$$PbO_2 + H_2SO_4 + 2H = PbSO_4 + 2H_2O$$



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Discharging of Lead Acid Cells

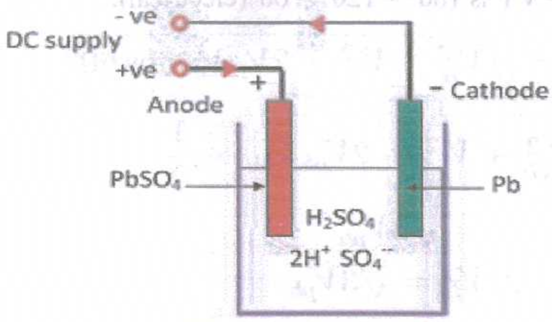
Circuit Globe

The each sulphate ion (SO4—) moves towards the cathode and reaching there gives up two electrons becomes radical SO4, attack the metallic lead cathode and form lead sulphate whitish in colour according to the chemical equation.

Chemical Action During Recharging :

For recharging, the anode and cathode are connected to the positive and the negative terminal of the DC supply mains. The molecules of the sulfuric acid break up into ions of 2H+ and SO4—. The hydrogen ions being positively charged moved towards the cathodes and receive two electrons from there and form a hydrogen atom. The hydrogen atom reacts with lead sulphate cathode forming lead and sulfuric acid according to the chemical equation.

$$PbSO_4 + 2H_2O + 2H = PbSO_4 + 2H_2SO_4$$

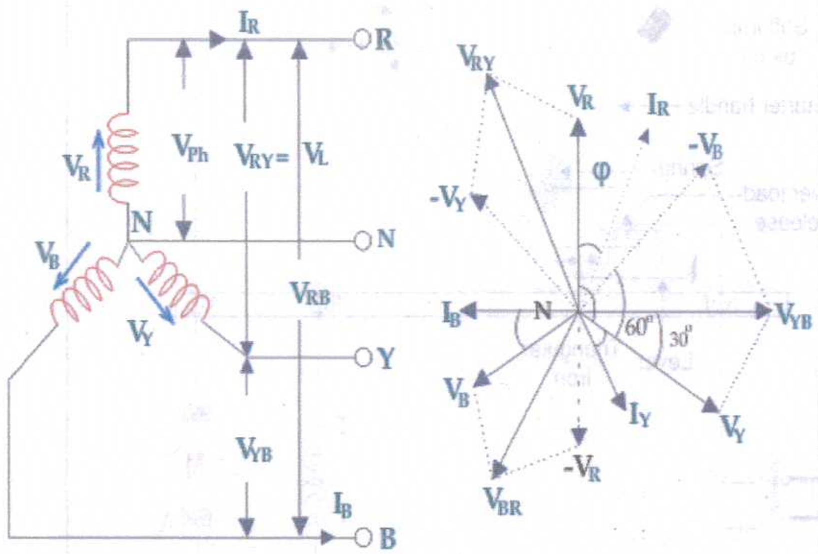


Recharging of Lead Acid Cell

SO4— ion moves to the anode, gives up its two additional electrons becomes radical SO4, react with the lead sulphate anode and form leads peroxide and lead sulphuric acid according to the chemical equation. 8

$$PbSO_4 + 2H = H_2SO_4 + Pb$$

IV (ii)



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In the balanced star system, magnitude of phase voltage in each phase is Vph.

∴ VR = VY = VB = Vph

Now, let us say, the voltage across R and Y terminal of the star connected circuit is VRY.
The voltage across Y and B terminal of the star connected circuit is VYB The voltage across B and R terminal of the star connected circuit is VBR.
VRY = VR + (– VY)
Similarly, VYB = VY + (– VB)
And, VBR = VB + (– VR)
Now, as angle between VR and VY is 120° (electrical), the angle between VR and – VY is 180° – 120° = 60°(electrical).

$$V_L = |V_{RY}| = \sqrt{V_R^2 + V_Y^2 + 2V_R V_Y \cos 60^o}$$

$$= \sqrt{V_{ph}^2 + V_{ph}^2 + 2V_{ph}V_{ph} \times \frac{1}{2}}$$

$$= \sqrt{3}V_{ph}$$

$$\therefore V_L = \sqrt{3}V_{ph}$$

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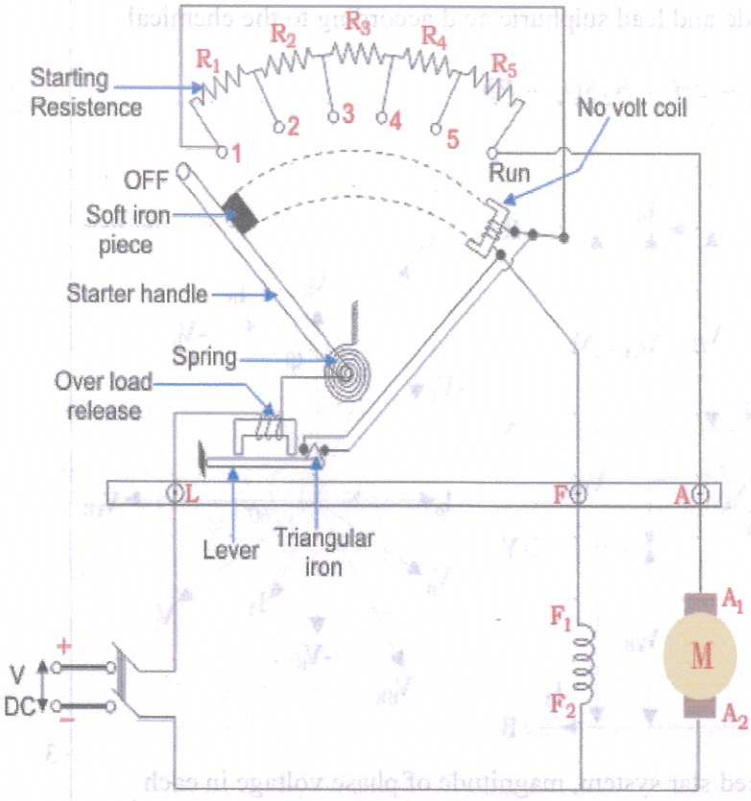
V (i)



Three Point Starter

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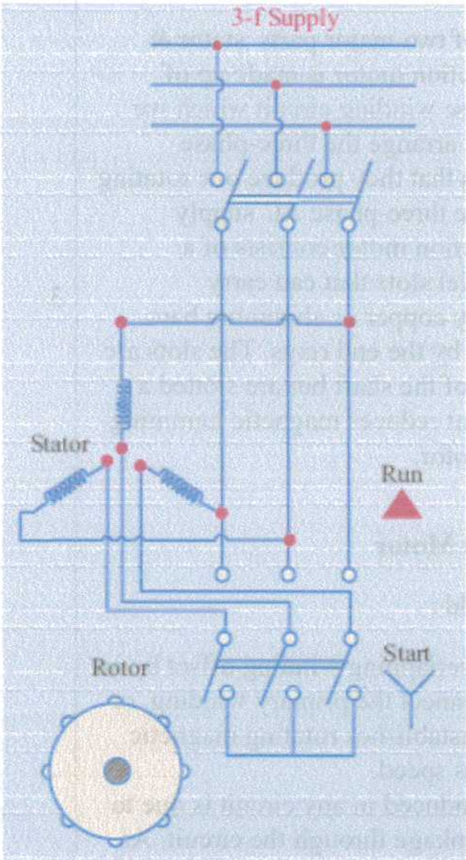
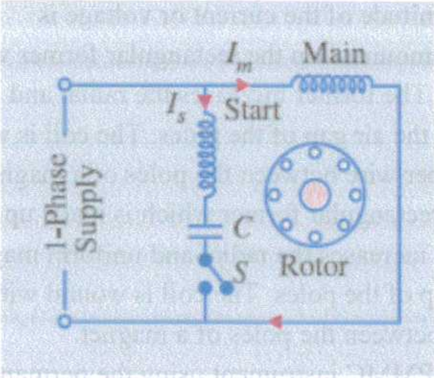
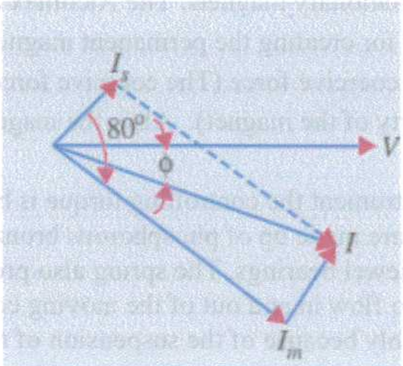
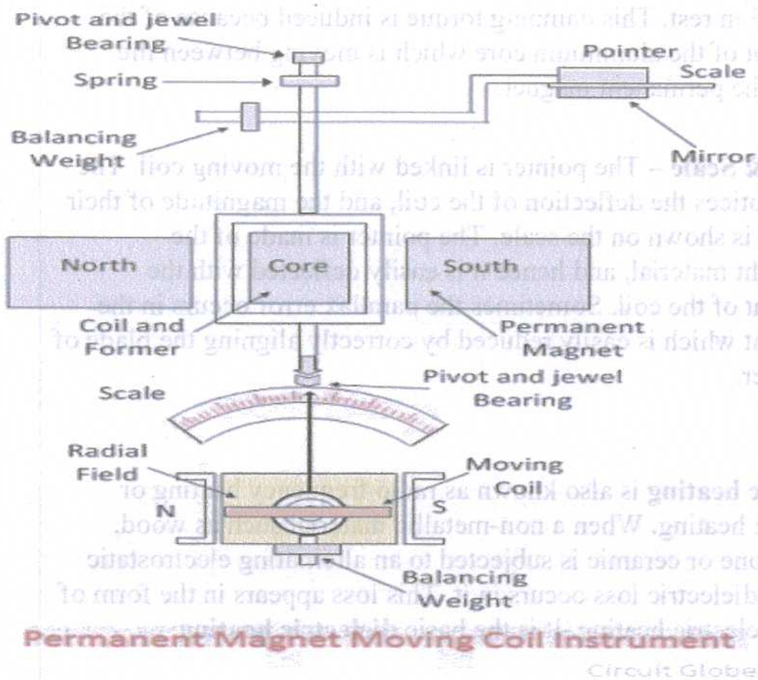
	To start with the handle is in the OFF position when the supply to the DC motor is switched on. Then handle is slowly moved against the spring force to make contact with stud No. 1. At this point, field winding of the shunt or the compound motor gets supply through the parallel path provided to starting the resistance, through No Voltage Coil. While entire starting resistance comes in series with the armature. The high starting armature current thus gets limited. As the handle is moved further, it goes on making contact with studs 2, 3, 4, etc., thus gradually cutting off the series resistance from the armature circuit as the motor gathers speed. Finally, when the starter handle is in 'RUN' position, the entire starting resistance is eliminated, and the motor runs with normal speed.	3	8	
V (ii)	A 3 phase induction motor consists of two major parts :stator & rotor . The stator of three phase induction motor is made up of numbers of slots to construct a 3 phase winding circuit which we connect with 3 phase AC source. We arrange the three-phase winding in such a manner in the slots that they produce one rotating magnetic field when we switch on the three-phase AC supply source.The rotor of three phase induction motor consists of a cylindrical laminated core with parallel slots that can carry conductors. The conductors are heavy copper or aluminum bars fitted in each slot and short-circuited by the end rings. The slots are not exactly made parallel to the axis of the shaft but are slotted a little skewed because this arrangement reduces magnetic humming noise and can avoid stalling of the motor.	3		
	Working of Three Phase Induction Motor Production of Rotating Magnetic Field : The stator of the motor consists of overlapping winding offset by an electrical angle of 120°. When we connect the primary winding, or the stator to a 3 phase AC source, it establishes rotating magnetic field which rotates at the synchronous speed. According to Faraday's law an emf induced in any circuit is due to the rate of change of magnetic flux linkage through the circuit. As the rotor winding in an induction motor are either closed through an external resistance or directly shorted by end ring, and cut the stator rotating magnetic field, an emf is induced in the rotor copper bar and due to this emf a current flows through the rotor conductor. Here the relative speed between the rotating flux and static rotor conductor is the cause of current generation; hence as per Lenz's law, the rotor will rotate in the same direction to reduce the cause, i.e., the relative velocity.	4	7	

VI (i)	This method is used in the case of motors which are built to run normally with a delta-connected stator winding. It consists of a two-way switch which connects the motor in star for starting and then in delta for normal running. When star-connected, the applied voltage over each motor phase is reduced by a factor of 1/ √3 and hence the torque developed becomes 1/3 of that which would have been developed if motor were directly connected in delta. The line current is reduced to 1/3. Hence, during starting period when motor is Y -connected, it takes 1/3rd as much starting current and develops 1/3rd as much torque as would have been developed were it directly connected in delta.	4		
		4	8	
VI (ii)	**Capacitor-start Induction-run motor :** The main winding has low resistance but high reactance whereas the starting winding has a high resistance, but low reactance. In these motors, the necessary phase difference between Is and Im is produced by connecting a capacitor in series with the starting winding. The capacitor is designed for extremely short-duty service and is guaranteed for not more than 20 periods of operation per hour, each period not to exceed 3 seconds. When the motor reaches			

	about 75 per cent of full speed, the centrifugal switch S opens and cuts out both the starting winding and the capacitor from the supply, thus leaving only the running winding across the lines.	3		
	 	4	7	
VII (i)		4		

Moving Coil – The coil is the current carrying part of the instruments which is freely moved between the stationary field of the permanent magnet. The current passes through the coil deflects it due to which the magnitude of the current or voltage is determined. The coil is mounted on the rectangular former which is made up of aluminium. The former increases the radial and uniform magnetic field between the air gap of the poles. The coil is wound with the silk cover copper wire between the poles of a magnet.The coil is mounted on the rectangular former which is made up of aluminium. The former increases the radial and uniform magnetic field between the air gap of the poles. The coil is wound with the silk cover copper wire between the poles of a magnet.

Magnet System – The PMMC instrument using the permanent magnet for creating the stationary magnets. The Alcomax and Alnico material are used for creating the permanent magnet because this magnet has the high coercive force (The coercive force changes the magnetisation property of the magnet). Also, the magnet has high field intensities.

Control – In PMMC instrument the controlling torque is because of the springs. The springs are made up of phosphorous bronze and placed between the two jewel bearings. The spring also provides the path to the lead current to flow in and out of the moving coil. The controlling torque is mainly because of the suspension of the ribbon.

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Damping – The damping torque is used for keeping the movement of the coil in rest. This damping torque is induced because of the movement of the aluminium core which is moving between the poles of the permanent magnet.

Pointer & Scale – The pointer is linked with the moving coil. The pointer notices the deflection of the coil, and the magnitude of their deviation is shown on the scale. The pointer is made of the lightweight material, and hence it is easily deflected with the movement of the coil. Sometimes the parallax error occurs in the instrument which is easily reduced by correctly aligning the blade of the pointer.

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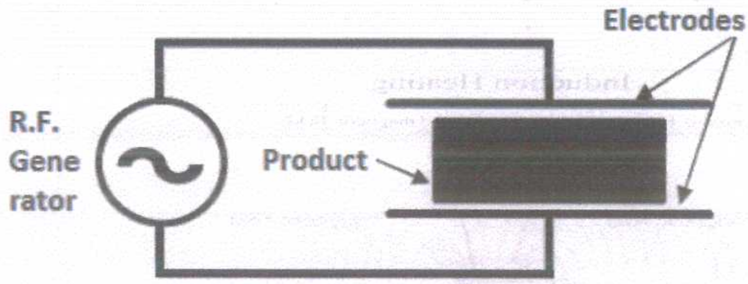
VII (ii)

Dielectric heating is also known as radio frequency heating or electronic heating. When a non-metallic material such as wood, plastic, bone or ceramic is subjected to an alternating electrostatic field, the dielectric loss occurs in it. This loss appears in the form of heat in dielectric heating. It is the basic **dielectric heating principle**.



Capacitive Heating

3

The material to be heated is placed as a slab between two metallic electrodes across which high-frequency voltage is applied. To ensure sufficient loss and to give an adequate amount of heating, frequencies between 10 to 20 MHz must be used. The voltage varies from 10 to 20 kV. The necessary high-frequency supply voltage is obtained from a valve oscillator. The current drawn by the capacitor, when an a.c. supply voltage is applied across its two plates, does not lead the supply voltage by 90° exactly. It means that there is a certain component of the current which is in phase with the voltage. Due to this component of current, heat is produced in dielectric material placed in between the two plates of the capacitor. This electric energy, dissipated in the form of heat energy in the dielectric material is known as the **dielectric loss**. The dielectric loss is directly proportional to V 2f. That is why high-frequency voltage is used in dielectric heating. Generally, a.c. voltage of about 20 kV at a frequency of 10-30 MHz is used. Dielectric heating is also employed for drying of textiles, manufacture of plywood, paper etc. The overall efficiency in case of dielectric heating is about 50%.

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VIII (i)

Induction heating is the process of heating an electrically conducting object (usually a metal) by electromagnetic induction, where eddy currents (also called Foucault currents) are generated within the metal and resistance leads to Joule heating of the metal.Induction heating is a form of non-contact heating for conductive materials, when alternating current flows in the induced coil, varying electromagnetic field is set up around the coil, circulating current(induced, current, eddy current) is generated in the workpiece(conductive material), heat is produced as the eddy current flows against the resitivity of the material.

An induction heater (for any process) consists of an induction coil (or electromagnet), through which a high-frequency alternating current (AC) is passed. Heat may also be generated by magnetic hysteresis losses in materials that have significant relative permeability.The frequency of AC used depends on the object size,

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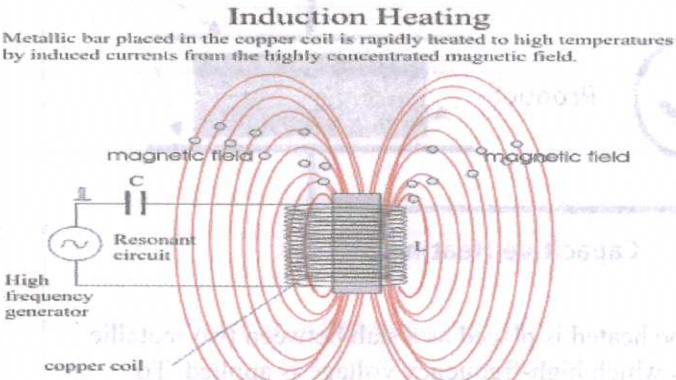
material type, coupling (between the work coil and the object to be heated) and the penetration depth.



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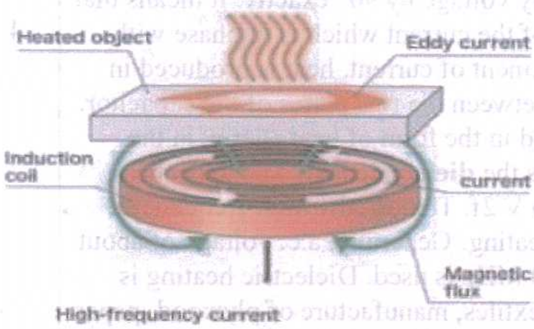

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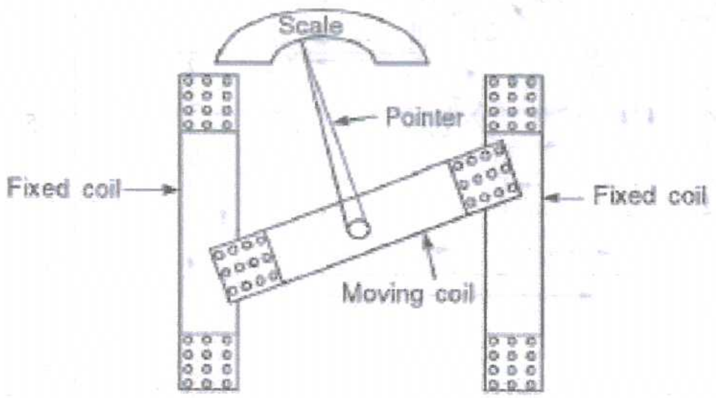
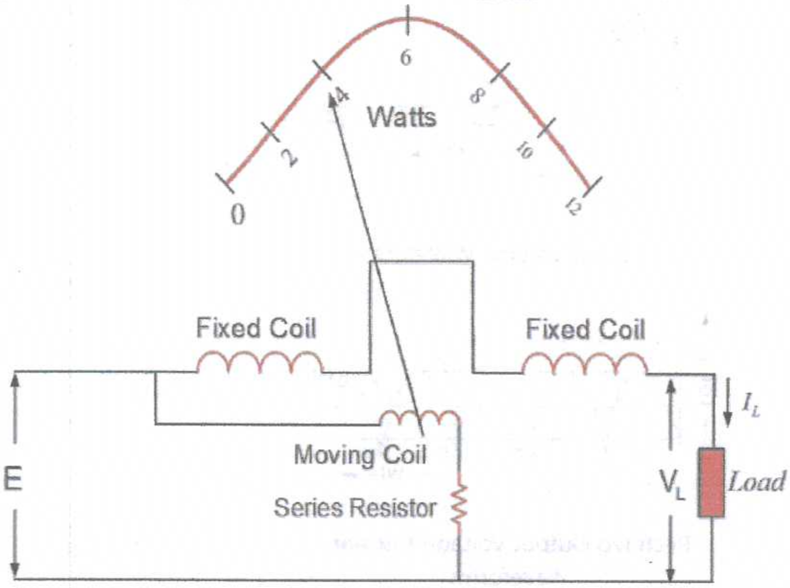
VIII (ii)

Dynamometer type wattmeter working principle is that when a current carrying moving coil is placed in the magnetic field produced by the current carrying fixed coil, a force is exerted on the coil sides of the moving coil and deflection takes place.

A dynamometer type wattmeter essentially consists of two coils called fixed coil and moving coil. The fixed coil is splitted into two equal parts which are placed parallel to each other. The two fixed coils are air-cored to avoid hysteresis effects when used on AC. The fixed coil is connected in series with the load and carries the circuit current. It is, therefore, called current coil. The moving coil is pivoted between the two parts of the fixed coil and is mounted on the spindle. A pointer is attached to the spindle which gives deflection. The moving coil is connected in parallel with the load and carries the current proportional to the voltage. It is, therefore, called potential coil. Generally, a high resistance is connected in series with the moving coil to limit the current through it. By limiting the current, the moving coil is made of light weight which in turn increases the sensitivity of the instrument. The controlling torque is provided by springs. Air friction damping is employed in such instruments. When power is to be measured in a circuit, the wattmeter is connected in the circuit. The current coil is connected in series with the load, carries the load current and the potential coil, connected in parallel with the load, carries the current proportional to the voltage across the load. The pointer attached to the spindle of the moving coil deflects. The deflection is controlled by the controlling torque produced by the springs. 4



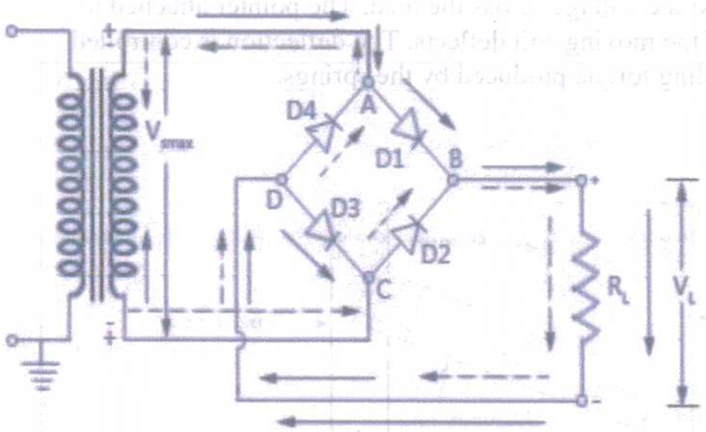


3

7

IX (i)

During the first half cycle of the input voltage, the upper end of the transformer secondary winding is positive with respect to the lower end. Thus during the first half cycle diodes D1 and D3 are forward biased and current flows through arm AB, enters the load resistance RL, and returns back flowing through arm DC. During this half of each input cycle, the diodes D2 and D4 are reverse biased and current is not allowed to flow in arms AD and BC. During the second half cycle of the input voltage, the lower end of the 3 transformer secondary winding is positive with respect to the upper end. Thus diodes D2 and D4 become forward biased and current flows through arm CB, enters the load resistance RL, and returns back to the source flowing through arm DA.



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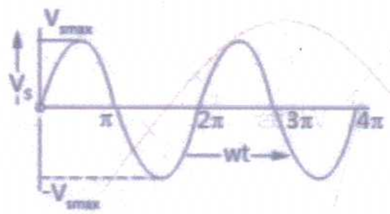
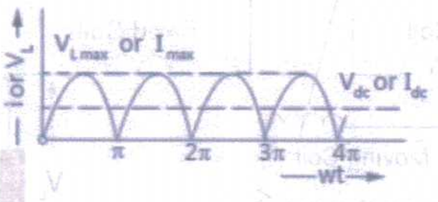


Input Voltage Waveform



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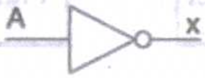
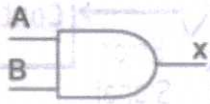
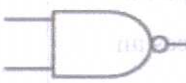
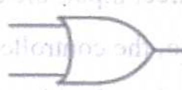
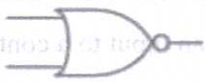
Rectified Output Voltage/Current Waveforms

IX (ii)

Name	NOT	AND
Alg. Expr.	$\overline{A}$	AB
Symbol		
Truth Table	A | X: 0 | 1; 1 | 0	B A | X: 0 0 | 0; 0 1 | 0; 1 0 | 0; 1 1 | 1

NAND	OR	NOR
$\overline{AB}$	$A+B$	$\overline{A+B}$
		

NAND:

B	A	X
0	0	1
0	1	1
1	0	1
1	1	0

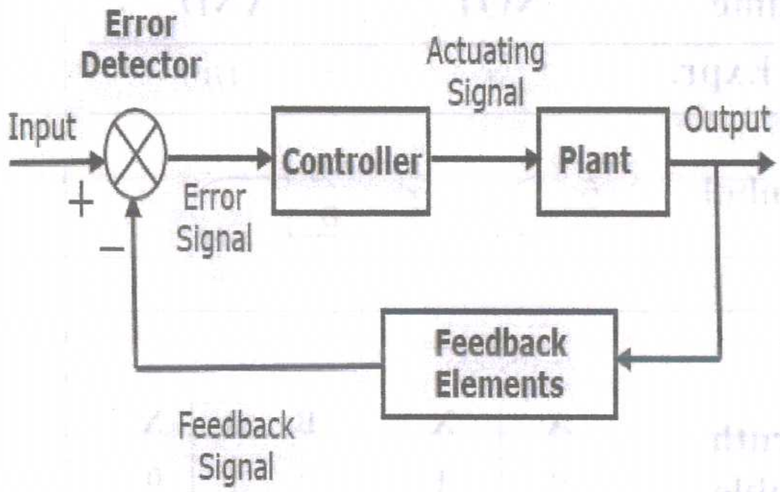
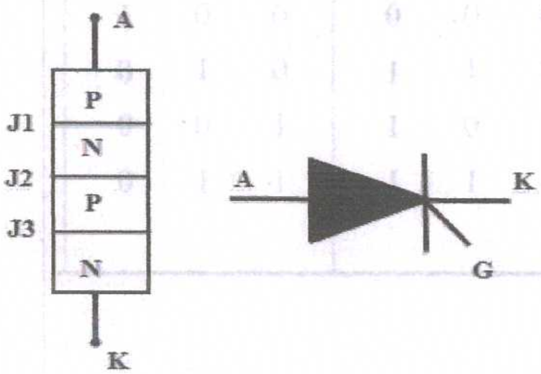
OR:

B	A	X
0	0	0
0	1	1
1	0	1
1	1	1

NOR:

B	A	X
0	0	1
0	1	0
1	0	0
1	1	0

7

X (i)		4		
	An input is applied to a controller and it produces an actuating signal or controlling signal. This signal is given as an input to a plant or process which is to be controlled. So, the plant produces an output, which is controlled. The error detector produces an error signal, which is the difference between the input and the feedback signal. This feedback signal is obtained from the block (feedback elements) by considering the output of the overall system as an input to this block. Instead of the direct input, the error signal is applied as an input to a controller.So, the controller produces an actuating signal which controls the plant. In this combination, the output of the control system is adjusted automatically till we get the desired response. Hence, the closed loop control systems are also called the automatic control systems.	4	8	
X (ii)				

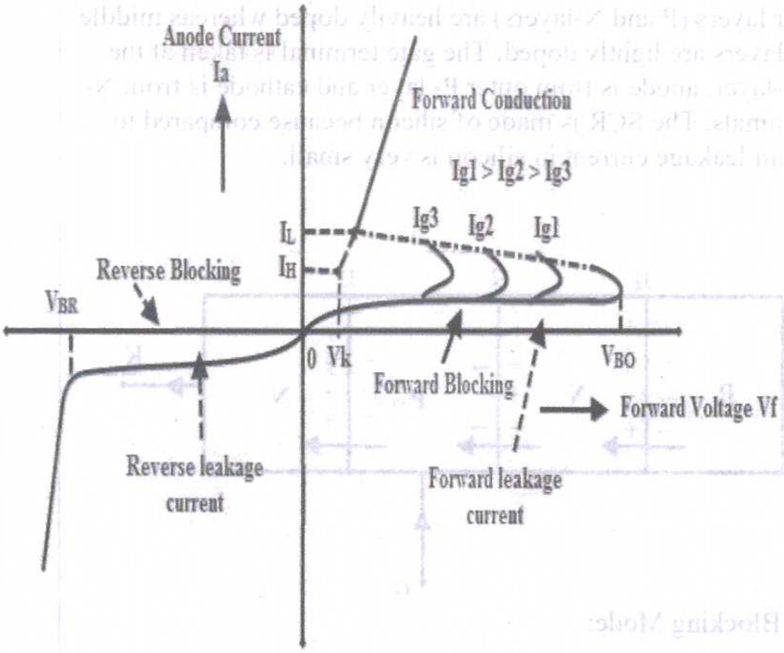
through the SCR as shown in the VI characteristics curve of the SCR.

Forward Conduction Mode:

In this mode, SCR or thyristor comes into the conduction mode from blocking mode. It can be done in two ways as either by applying positive pulse to gate terminal or by increasing the forward voltage (or voltage across the anode and cathode) beyond the break over voltage of the SCR. Once any one of these methods is applied, the avalanche breakdown occurs at junction J2. Therefore the SCR turns into conduction mode and acts as a closed switch thereby current starts flowing through it. 3

Reverse Blocking Mode :

In this mode of operation, cathode is made positive with respect to anode. Then the junctions J1 and J3 are reverse biased and J2 is forward biased. This reverse voltage drives the SCR into reverse blocking region results to flow a small leakage current through it and acts as an open switch.

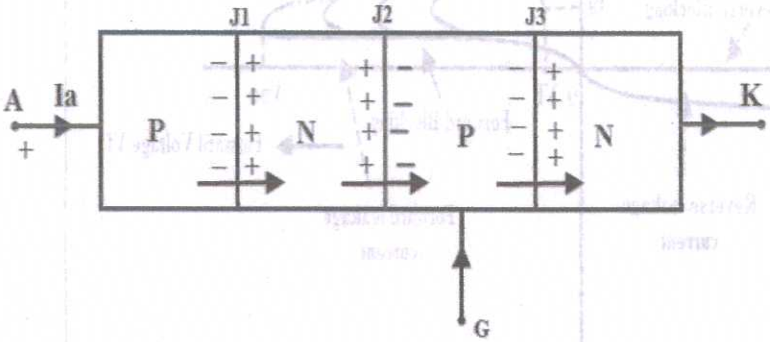


7

During the first half cycle of the input voltage, the upper end of the transformer secondary winding is positive with respect to the lower end. Thus during the first half cycle diodes D1 and D3 are forward biased and current flows through arm AB, enters the load resistance RL, and returns back flowing through arm DC. During this half of each input cycle, the diodes D2 and D4 are reverse biased and current is not allowed to flow in arms AD and BC. During the second half cycle of the input voltage, the lower end of the transformer secondary winding is positive with respect to the upper end. Thus diodes D2 and D4 become forward biased and current flows through arm CB, enters the load resistance RL, and returns back to the source flowing through arm DA. 4

SCR is a unidirectional device that allows the current in one direction and opposes in another direction. SCR is a three terminal device; anode, cathode and gate . SCR has built in feature to turn ON or OFF and its switching is controlled by biasing conditions and gate input terminal.

The SCR is a four layer and three terminal device. The four layers made of P and N layers, are arranged alternately such that they form three junctions J1, J2 and J3.
The outer layers (P and N-layers) are heavily doped whereas middle P and N-layers are lightly doped. The gate terminal is taken at the middle P-layer, anode is from outer P- layer and cathode is from N-layer terminals. The SCR is made of silicon because compared to germanium leakage current in silicon is very small.



Forward Blocking Mode:

Silicon Controlled Rectifier is connected such that the anode terminal is made positive with respect to cathode while the gate terminal kept open. In this state junctions J1 and J3 are forward biased and the junction J2 reverse biased. Due to this, a small leakage current flows through the SCR. Until the voltage applied across the SCR is more than the break over voltage of it, SCR offers a very high resistance to the current flow. Therefore, the SCR acts as a open switch in this mode by blocking forward current flowing