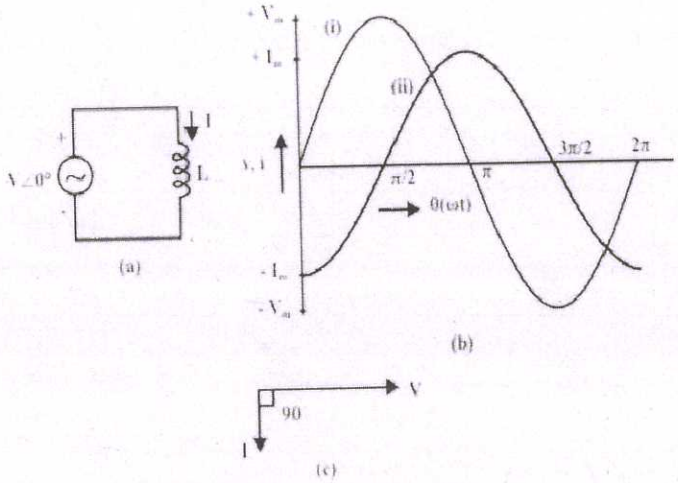
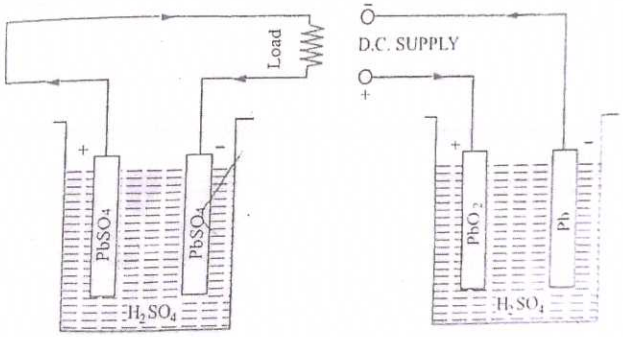
REVISION : 2015 COURSE CODE : 3021

COURSE TITLE: ELECTRICAL AND ELECTRONICS ENGINEERING

Question no	Scoring indicators	Split up score	Sub total	Total
	PART -- A			
I 1.	frequency= no. of cycles per second of an AC wave f=1/T	1 1	2	
2.	$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$ K is the transformation ratio	2	2	
3.	Induction heating is the process of heating an electrically conducting object by electromagnetic induction, through heat generated in the object by eddy currents.	2	2	10
4.	Deflecting torque deflects the pointer according to value of measured quantity	2	2	
5.	Rectifier is a device which converts AC to DC	2	2	
	PART – B			
II . 1	AC through pure inductor  Fig. 14.2: Circuit with Inductance (L) (a) Circuit diagram (b) Waveforms: (i) Voltage (ii) Current (c) Phasor diagram	3	6	

	For the circuit the current i, is obtained by – As $v=V_m \sin(\omega t)=L\, di/dt$ Integrating, $i = -\frac{Vm\cos(\omega t)}{\omega L} = I_m \sin(\omega t - 90^\circ)$ therefore, current lags voltage by 90°. inductive reactance $=X_L=\omega * L$	3		
2	**active materials** **PbO2** lead peroxide is positive plate--dark brown colour and is brittle sponge lead **Pb** is negative plate dilute H2SO4 having 3 parts water and 1 part acid. It has specific gravity 1.21 **Discharging** When cell is fully charge, anode is PbO2 and cathode is Pb. When cell discharges, it sends current through external load, H2SO4 is dissociated into H2 and SO4 ions.H2 ions move to anode and SO4 ions move to cathode. At anode, H2 combines with oxygen of PbO2 and H2SO4 attacks Pb to form PbSO4 LEAD sulphate, which is grey in colour. During discharging, cell gives out energy. voltage of cell decreases. specific gravity decreases due to formation of water. **Charging** During charging ,H2 ions move to cathode and SO4 ions go to anode to form PbO2 and Pb at anode and cathode. Due to consumption of water, specific gravity increases. voltage rises. energy is absorbed by the cell Positive electrode: $PbO_2 + H_2SO_4 + 2H^+ + 2e^- \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} PbsO_4 + 2H_2O$ Negative electrode: $Pb + H_2SO_4 \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} PbSO_4 + 2H^+ + 2e^-$ Overall cell reaction: $PbO_2 + pb + 2H_2SO_4 \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$	3	6	



3

3. **Capacitor-start Motor**

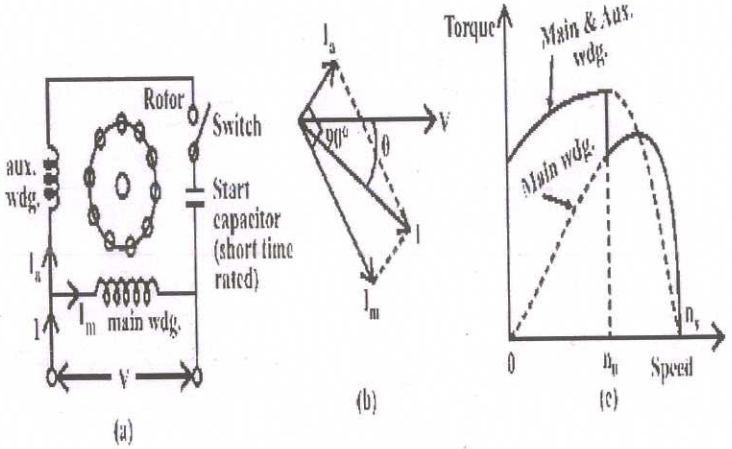


Fig. 34.5: Capacitor-Start Induction Motor
(a) Schematic Diagram
(b) Phasor Diagram
(c) Torque-Speed characteristic

3

3

6

To make the single phase induction motor self starting, an auxiliary winding is connected in parallel with main winding. In capacitor start induction motor, a capacitor is connected in series with main winding. Ia leads applied voltage and Im lags V. The angle between Ia and Im is made almost 90° to make two phase supply and a rotating magnetic field. currents are induced in the rotor by induction and force acts on rotor conductors to move the rotor in same direction as field. Thus, motor is made self starting. Centrifugal switch disconnects auxiliary winding when motor reaches 75% speed.

30

4.

Sl No	Power transformer	Welding transformer
1	May be step up or step down	Step down
2	Used in generating and substations	Used for arc welding
3	Secondary may not have tappings	Secondary has tappings
4	Large size	Small size
5	Oil cooled	Air cooled
6	Carry current for entire period of working	Secondary carry high current for short duration only

6 6

5.

Dielectric heating

the process of heating up material by causing dielectric motion in its molecules using alternating electric fields

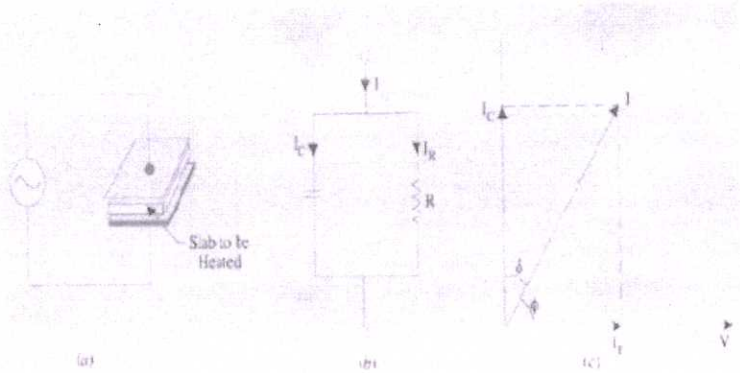
Polar molecules contain electric dipole moments. When such molecules are exposed to the electric field, they try to align themselves in the direction of the field. When the applied field oscillates, these molecules of the material undergo dipole rotations. The molecules collide with other molecules distributing the energy to adjacent molecules and atoms in the material , so agitating the molecules in this way increases the temperature of the material.

3

When a practical capacitor is connected across an a.c. supply, it draws a current which leads the voltage by an angle , which is a little less than 90° or falls short of 90° by an angle δ. It means that there is a certain component of the current which is in phase with the voltage and hence produces some loss called dielectric loss, this produces heat and is proportional to frequency.

6

3



6	Capacitors classification • **Fixed** — **variable** • **Non polarised** — Trimmer type, Rotor-stator type • Paper • Ceramic • Polyester • **polarised** • Aluminium • tantalum	6	6	
7	**Any 6** 1.automobile-For bulk production of vehicles, sensors 2. electrical- governor, power and voltage control 3. mechanical- water level , HVAC systems 4. chemical process -temperature, 5. space - satellite , 6. radar and navigation 7. household-AC, washing machine ,oven 8. Missile launching systems	6	6	
	PART -- C			
III a i)	Voltage The voltage or potential energy difference between two points in an electric circuit is the amount of energy required to move a unit charge between the two points.	2		
ii)	Form factor $=\frac{rms\ value}{average\ value}$ form factor of sine wave =1.11	2	8	
iii)	Powerfactor = cosΦ or $\frac{active\ power}{apparent\ power}$ of an AC circuit	2		15
iv)	rms value of AC is the effective dc value that will transfer same amount of heat to a circuit as transferred by AC wave.	2		

III b)

Alternator or synchronous generator converts mechanical energy from turbine to electrical energy. Armature is stator and field is rotor. It works on principle of faraday's law of electromagnetic induction. Stator has three phase windings.

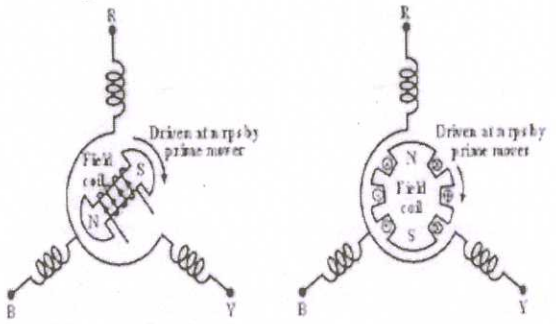
Rotor is excited by dc to produce flux in the air gap. As rotor is rotated by prime mover, the stator conductors are cut by flux in the air gap. The induced emfs are alternating in nature . they are of same magnitude and phase displaced by 120°.

4

Frequency of induced emf f=PN/120 .where P is the no. of poles and N is the rpm.

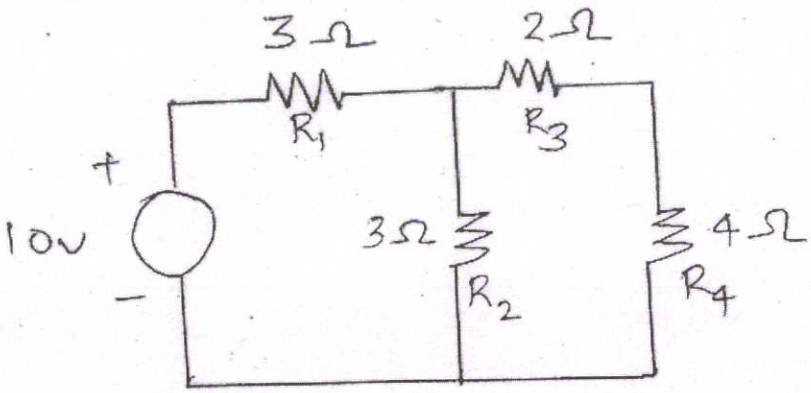
3

7



(a) Salient pole generator (b) Non salient pole generator

IV (a)



R_3 and R_4 are in series. 2+4= 6Ω

6Ω and 3Ω are in parallel. $\frac{6*3}{6+3} = 2\Omega$

This 2 Ω is in series with 3 Ω .

Effective resistance= 5 Ω

4

Current through R1, $I_{R1} = \frac{10}{5} = 2A$ — 1

$V_{R1} = 3*2 = 6V$

$V_{R2} = 10\text{-}6 = 4V$ — 1

$I_{R3} = I_{R4} = \frac{4}{2+4} = \frac{2}{3}\ A.$ — 1

$V_{R3} = \frac{2}{3} * 2 = \frac{4}{3}\ V$

$V_{R4} = \frac{2}{3} * 4 = \frac{8}{3}\ V$ — 1

8

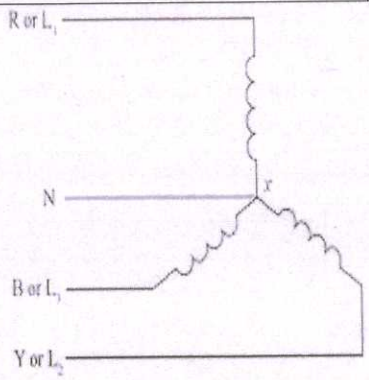
15

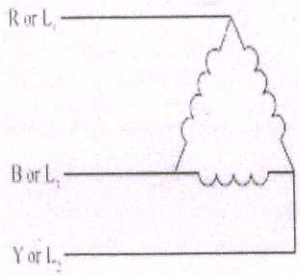
IV b)

STAR CONNECTION	DELTA CONNECTION
The terminals of the three branches are connected to a common point.	The three branches of the network are connected in such a way that it forms a closed loop
The starting and the finishing point coils are connected together	The end of each coil is connected to the starting point of the other coil
Neutral or the star point exists in the star connection.	Neutral point does not exist in the delta connection.
Line current = Phase current.	Line current = $\sqrt{3}$ *Phase Current.
Line voltage = $\sqrt{3}$ * Phase Voltage	Line voltage = Phase voltage
Insulation required is low.	High insulation is required.

7

7





V a)

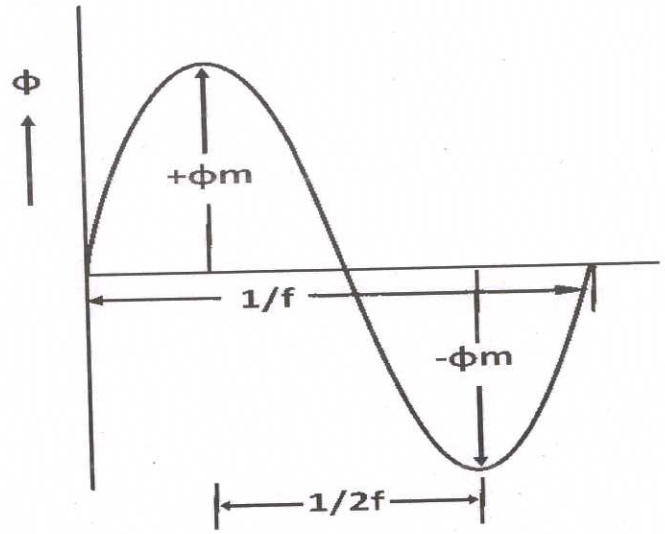
Emf equation of transformer

When a sinusoidal voltage is applied to the primary winding of a transformer, alternating flux ϕ_m sets up in the iron core of the transformer. This sinusoidal flux links with both primary and secondary winding. The function of flux is a sine function. The rate of change of flux with respect to time is derived mathematically.

The derivation of **EMF Equation** of the transformer is shown below. Let

- ϕ_m be the maximum value of flux in Weber
- f be the supply frequency in Hz
- N_1 is the number of turns in the primary winding

N_2 is the number of turns in the secondary winding Φ is the flux per turn in Weber



3

7

As shown in the above figure that the flux changes from + ϕ_m to – ϕ_m in half a cycle of 1/2f seconds.

By Faraday's Law

Let E_1 is the emf induced in the primary winding

$$E_1 = -\frac{d\psi}{dt} \dots\dots\dots (1)$$

Where $\Psi = N_1\phi$

$$\text{Therefore, } E_1 = -N_1 \frac{d\varphi}{dt} \quad \ldots\ldots\ldots(2)$$

Since ϕ is due to AC supply $\phi = \phi_m \text{ Sinwt}$

$$E_1 = -N_1 \frac{d}{dt}(\varphi_m \text{ Sinwt})$$

$$E_1 = -N_1 w\varphi_m \text{ Coswt}$$

$$E_1 = N_1 w\varphi_m \text{ Sin}(wt - \pi/2) \ldots\ldots\ldots(3)$$

So the induced emf lags flux by 90 degrees.

Maximum valve of emf

$$E_1 max = N_1 w\varphi_m \ldots\ldots\ldots(4)$$

4

But $w = 2\pi f$

$$E_1 max = 2\pi f N_1 \varphi_m \ldots\ldots\ldots(5)$$

Root mean square RMS value is

$$E_1 = \frac{E_{1max}}{\sqrt{2}} \ldots\ldots\ldots(6)$$

Putting the value of E_1max in equation (6) we get

$$E_1 = \sqrt{2}\pi f N_1 \varphi_m \ldots\ldots\ldots(7)$$

Putting the value of $\pi = 3.14$ in the equation (7) we will get the value of E_1 as

$$E_1 = 4.44 f N_1 \varphi_m \ldots\ldots\ldots(8)$$

Similarly

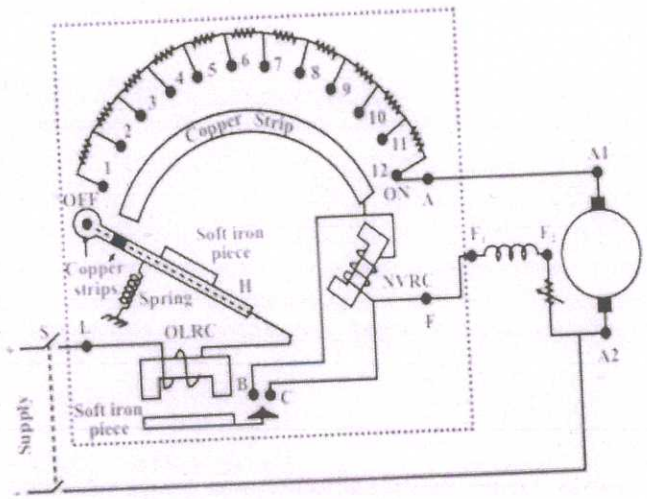
$$E_2 = \sqrt{2}\pi f N_2 \varphi_m$$

Or

$$E_2 = 4.44 f N_2 \varphi_m \ldots\ldots\ldots (9)$$

3 Point Starter

V (b)



there are 3 points on this starter

1. 'L' Line terminal (Connected to positive of supply)
2. 'A' Armature terminal (Connected to the armature winding)
3. 'F' Field terminal (Connected to the field winding)

The point 'L' is connected to an electromagnet called overload release (OLR) . The other end of OLR is connected to the lower end of starter handle where spring is attached with it. The starter handle contains a soft iron piece fixed on it. The main function of spring is to brings back the handle to its original OFF position by its restoring force. The No Volt Coil (NVC)or holding coil is used to hold handle while motor is running. The OLR protects the starter under overload condition.

Working of Three Point Starter

Keep handle is in the OFF position when the supply to the DC motor is switched on. Then handle is slowly moved to make contact with stud No. 1. At this point, entire starting resistance comes in series with the armature. Thus 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

15

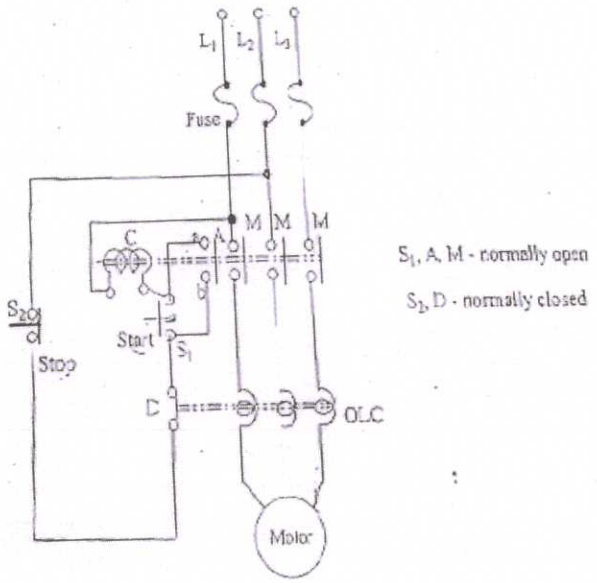
4

8

4

resistance is eliminated, and the motor runs with normal speed
The NVC(No volt coil) holds the handle in 'RUN' position against the restoring force given by spring. When supply to the motor is off, then NVC is de-energised. So the handle of the starter move back to off position due to the restoring force of spring
OLR(Over load release) cuts the supply to motor under overload condition

VI (a)



4

DOL starter is used for starting of 3 phase induction motors having capacity less than 5hp. It consists of
1. 2 No of push button switches. one is Start button switch which is normally open and other is Stop button switch, which is normally closed.
2. holding coil used for holding contacts
3. overload coil is used to disconnect motor supply when motor is overloaded.
4. main contact- 3 nos of main contacts are present. When it is closed, supply will come to motor terminal and remaining contact is called auxiliary contact.
5. Auxiliary contact-it help to keep holding coil energised while motor is running
When start button is pressed (which is normally open), the current flows through holding coil. This energises Holding coil. This energised holding coil closes the three main contact. Now the supply will come across motor winding terminals. The auxiliary contact helps to energizes the hold on coil after the start button is released.

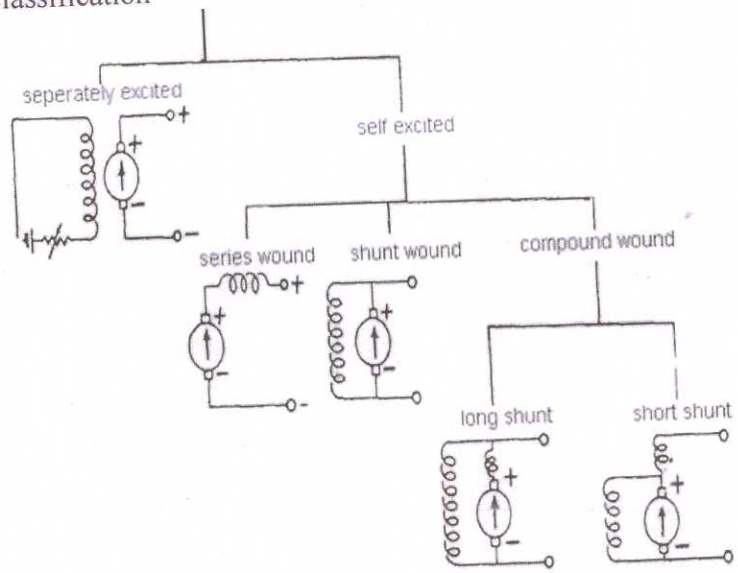
8

4

When stop button (which is normally closed) is pressed, supply through holding coil is braked. So holding coil is de-energised. So main contact will open. So the supply to motor winding terminal is disconnected.

When overload is happened during motor working condition, OLC operates and switch D opens and makes main contacts to open. Thus, the supply to motor winding terminal is disconnected.

VI (b) Classification



3

Separately Excited DC Motor

In Separately Excited DC Motor, a separate DC source is utilized for activating the field coils.

Self excited Motors

Shunt Wound DC Motor

In Shunt wound DC Machines, the field coils are allied in parallel through the armature. As the shunt field gets the complete o/p voltage of a generator otherwise a motor supply voltage, it is normally made of a huge number of fine wire

Series Wound DC Motor

In series wound D.C. Machines, the field coils are in series through the armature. As series field winding gets the armature current, as well as the armature current is huge, due to this the series field winding includes few turns of wire of big cross-sectional region.

4

7

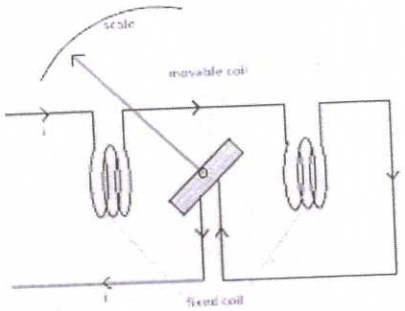
15

Compound Wound DC Motor

A compound machine includes both the series as well as shunt fields. The two windings are carried-out with every machine pole. The series winding of the machine includes few turns of a huge cross-sectional region, as well as the shunt windings, include several fine wire turns.

The connection of the compound machine can be done in two ways. If the shunt-field is allied in parallel by the armature only, then the machine can be named as the 'short shunt compound machine' & if the shunt-field is allied in parallel by both the armature as well as series field, then the machine is named as the 'long shunt compound motor'.

VII a)



Electrodynamic type instruments are similar to the PMMC-type elements except that the magnet is replaced by two serially connected fixed coils that produce the magnetic field when energized. The fixed coils are spaced far enough apart to allow passage of the shaft of the movable coil. The movable coil carries a pointer, which is balanced by counter weights. Its rotation is controlled by springs. **The motor torque is proportional to the product of the currents in the moving and fixed coils.**

If the control is due to spiral springs, the controlling torque is proportional to the angle of deflection θ.

Controlling torque $Tc=k\theta$

deflecting torque Td= Controlling torque Tc at steady deflection

$$I_f I_m \frac{dM}{d\theta} = k_c\theta$$

$$\theta = \frac{I_f I_m}{k_c}\left(\frac{dM}{d\theta}\right)$$

5 9

$$\theta \propto i_f i_m \frac{dM}{d\theta}$$

or $$\theta \propto I_L \frac{V}{R} \frac{dM}{d\theta}$$

$$\propto \text{power} \left(\text{if} \frac{dM}{d\theta} \text{is nearly constant} \right).$$

4

M is the mutual inductance between coils.

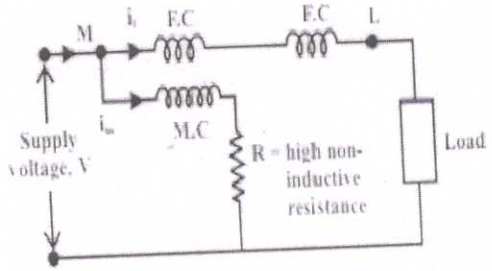


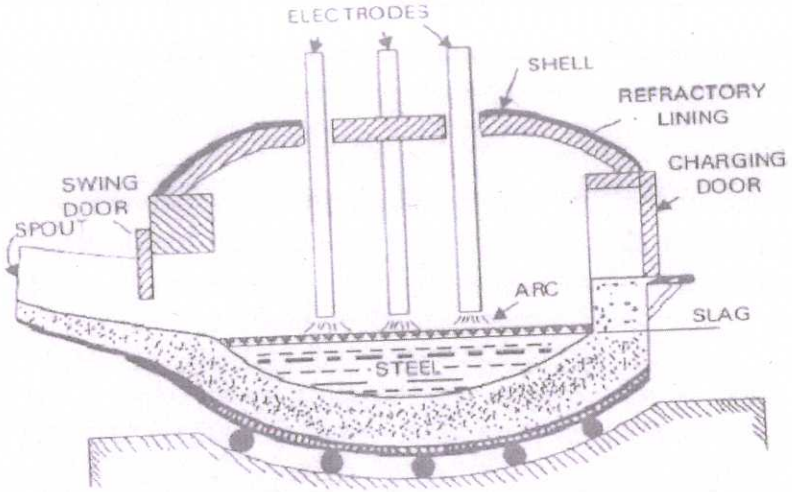
Fig. 43.6: Wattmeter Connection

If the current is reversed, the field polarity and the polarity of the moving coil reverse at the same time, and the turning force continues in the original direction. Since the reversing the current direction does not reverse the turning force, this type of instruments can be used to measure AC or DC current, voltage, or power. For power measurement, one of the coils (usually the fixed coils) passes the load current and other coil passes a current proportional to the load voltage.

VII (b) **Any six** 6 6 15

Used for welding and brazing of metals
Used for sterilisation of surgical instruments
Surface hardening of metals
food processing
Welding of PVC
Drying of tobacco, paper and wood
Used in the production of artificial fibres
Wood gluing

VIII (a) **Arc furnace**



3

3phase arc furnace
It consists of steel shell with refractory clay lining. It has a hearth with silica lining, walls and roof. The electric current is delivered through electrodes inserted into furnace.
The material to be melted is known as charge. It is fed through charging door. Electrodes are lowered until arc is struck. The metal is melted gradually and impurities are removed.
used in larger foundries and mini-mill steelmaking operations 3

6

In **direct arc furnace**, the arc is in direct contact with charge and thus produces high temperature. It produces uniform heating without stirring. It is mainly used for production of steel.

indirect arc furnace which is cylindrical in shape. The arc is struck by short-circuiting the electrodes manually or automatically for a moment and then, withdrawing them apart. The heat from the arc and the hot refractory lining is transferred to the top layer of the charge by radiation

15

VIII (b) **Repulsion type MI instrument consist of following major components**

Fixed coil
It is made up of copper. It has many numbers of turns. Quantity to be measured is applied to this coil. When current flows though this coil it produces magnetic field

Vane
Two number of iron vanes are present. Which is placed inside the fixed coil. One is movable vane which is attached to spindle carrying pointer and the other is fixed

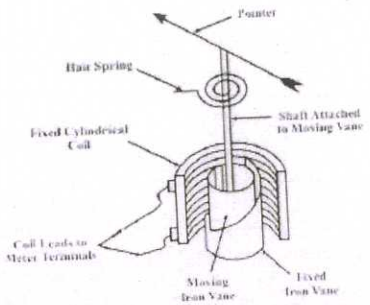
control torque system
Control torque is given by spring control using spring made of phosphor bronze. But in vertical mounted instruments gravity control method is used to provide control torque Damping system

Damping system
Air friction damping is provided in this instrument with the help of light aluminium piston is attached with moving system. 5

Pointer
Pointer used is light in weigh. Pointer moves on the non uniform scale to show the value of measured quantity. the end of the pointer has a shape of an arrow.

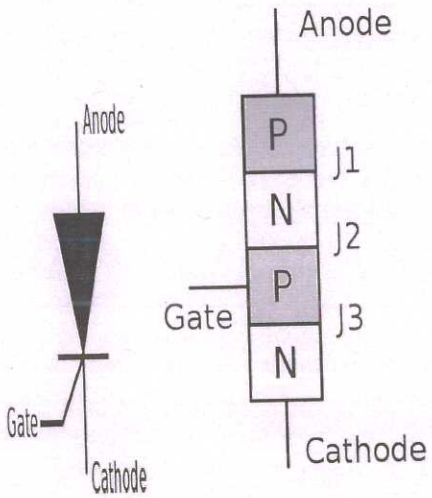
Scale
Scale used in this instrument is non uniform type. Scale normally printed with black marking on white background. Sometime a mirror is also present along with scale to avoid parallax error while taking reading from this instrument 9

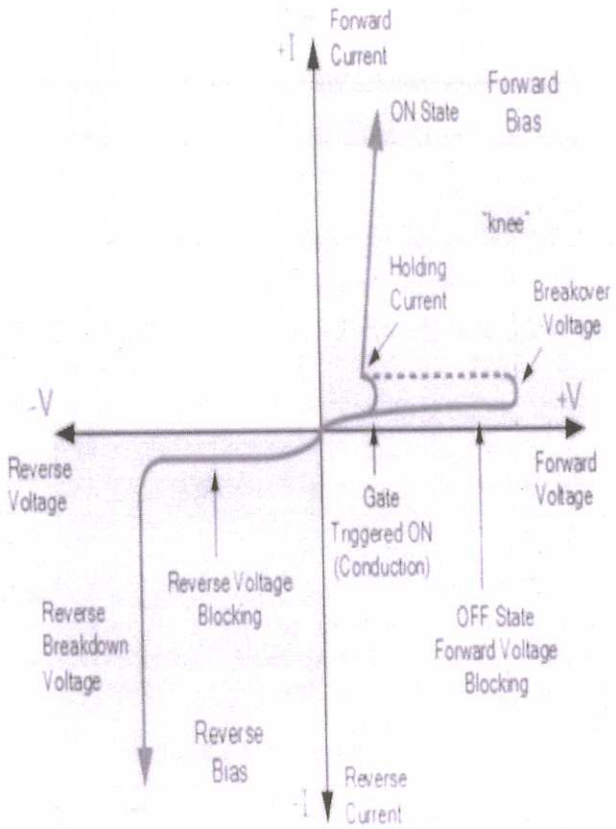
Bearing
Jewel bearing is used in this instrument



4

Working Current in the coil induces both vanes to become magnetized and repulsion between the similarly magnetized vanes produces a proportional rotation.
Due to this repulsive force moving vane mounted on spindle carrying pointer moves.
The deflecting torque is proportional to the square of the current in the coil, making the instrument reading is a true 'RMS' quantity Rotation is opposed by a hairspring that produces the restoring torque.

IX (a)	**Need for automation** 1. reduces the number of labours needed for a work 2. saves time- increases the speed of a process 3. increase the efficiency of a work 4.economy- reduce overall running cost for a process 5. safety- replace humans from work done from dangerous environment such as fire chance area, electric shock area etc. 6. performance- increase the accuracy, precision and quality of a work	6	6	15
IX (b)	**SCR**  SCR -silicon controlled rectifier is 3 terminal ,4 layer device. It has 3 junctions J1,J2,J3 It is used to control ouput voltage of a rectifier. It is a used as a switch in power electronic circuits.	3		



3

9

Modes of operation

Forward blocking mode

A positive voltage is applied across Anode and cathode. J1 and J3 are forward biased and J2 is reverse biased. so, current will not flow.

3

Forward conducting mode

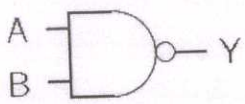
As voltage is further increased, junction J2 breaks down and device starts conducting. Device can also be turned ON by applying a positive gate pulse as that will supply carriers to junction.

Reverse blocking mode

a negative voltage is applied across anode and cathode. As junctions J1 and J3 are reverse biased, device is in off condition.

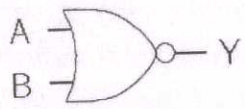
X (a) NAND and NOR are called universal gates. 2

NAND



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

NOR



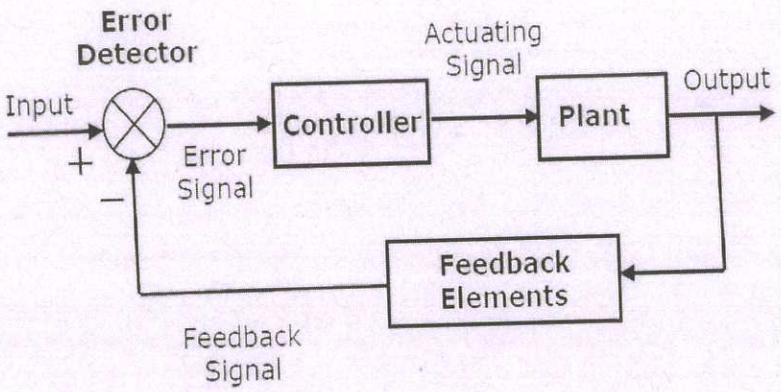
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

4

6

15

X (b) Block Diagram



4

9

Control system is a system or mechanism which directs the input to other systems and regulates their output
Control system alters the response of a plant or system as desired.

Reference input is given to the system.

Feedback senses the plant output and gives a signal which can be compared to the reference. feedback helps to track the present output so that suitable control action can be produced.

Comparator or error detector compares reference and feedback signal and computes the error.

The error is manipulated by the **controller** and give the control input to the plant. The controller directs the plant to produce desired performance specifications like speed of response, limiting steady state error and reject disturbances.

Actuating signal from the controller is fed to the **plant** or the system where the process occurs and desired response is obtained from the plant by control action.

5

------- End ------