B.Tech.

Second Semester Examination, May-2011

Electrical Technology (EE-101-F)

Note : Attempt any *one* question from each Section. ***Section—A** is **compulsory.***

Section—A

Q. 1. (a) State Kirchhoff's voltage law.

Ans. Kirchhoff's Voltage Law : K.V.L. state that algebraic sum of voltage drop and emf in close loop is equal to zero.

Q. 1. (b) State superposition theorem.

Ans. Superposition Theorem : In a linear bilateral network current flowing through any branch will be the sum of currents flowing through that branch if each generators are considered separately and others are replaced by their equivalent resistance.

Q. 1. (c) Define RMS and average values.

Ans. R.M.S. Value : The R.M.S. or effective value of a.c. current is equivalent steady current which when allowed to flow through a given circuit for a given time produces the same amount of heat as produced by the alternating current when allowed to flow through the same circuit for same time.

Average Value : Average value is the arithmetic sum of all the values divided by total number of value used to obtain the sum. The average value of any cycle of waveform is area under waveform divided by time period.

Q. 1. (d) State parallel resonance.

Ans. Parallel Resonance : In parallel resonance the total reactive component of the parallel R-L-C or LC circuit become zero.

Q. 1. (e) What are eddy currents ?

Ans. Eddy Currents : When a conductor, such as armature core in a generator is either moved in relative to magnetic field or present in a magnetic field of varying current then the induced emf are produced. These emf set up induced currents which circulate in large number of closed concentric paths usually short are throughout the solid mass of conductor. These currents are called eddy currents.

Q. 1. (f) What is synchronous speed ?

Ans. Synchronous Speed : Speed of the rotating magnetic field in an induction motor or synchronous motor is given by the synchronous speed.

$$N_s = \frac{120f}{p}$$

N_s = synchronous speed

f = frequency

p = no. of polls.

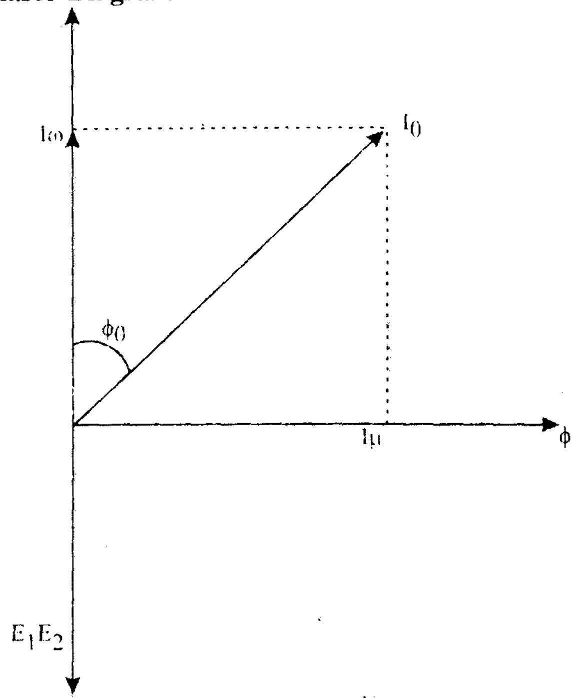
Q. 1. (g) Give difference between wattmeter and energy meter.

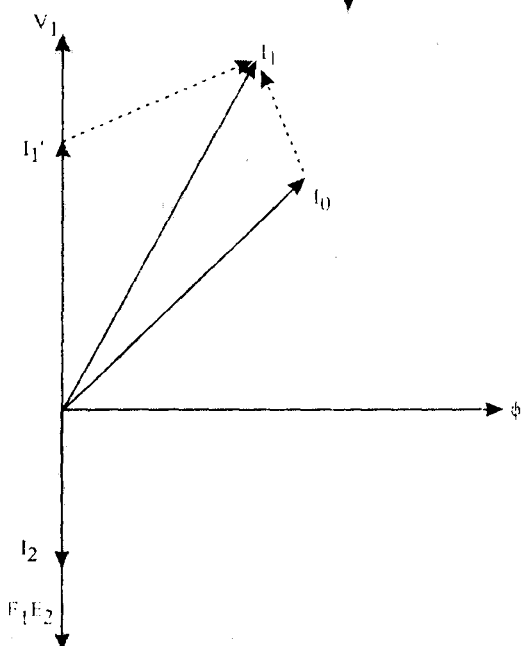
Ans. Wattmeter is an indicating (Instantaneous) instrument while the energy meter is an integrating type instrument. Wattmeter measure power while energy meter energy.

Section—B

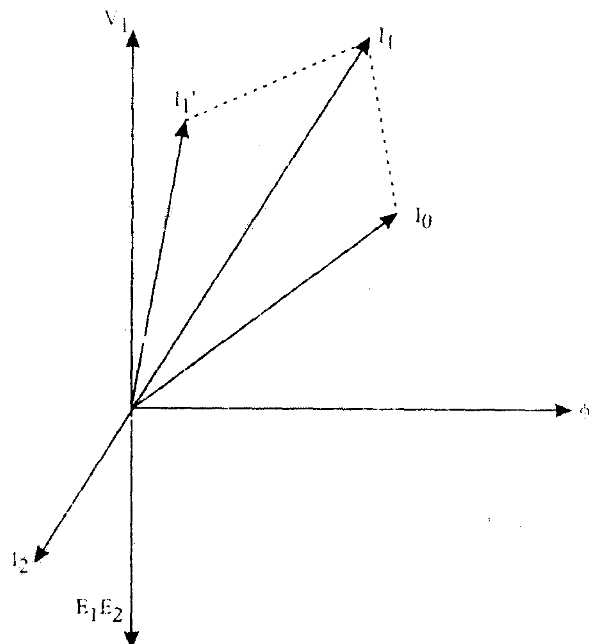
Q. 2. Draw phasor diagram of transformer on no load and full load (resistive, capacitive and inductive).

Ans. No LOAD Phasor Diagram :

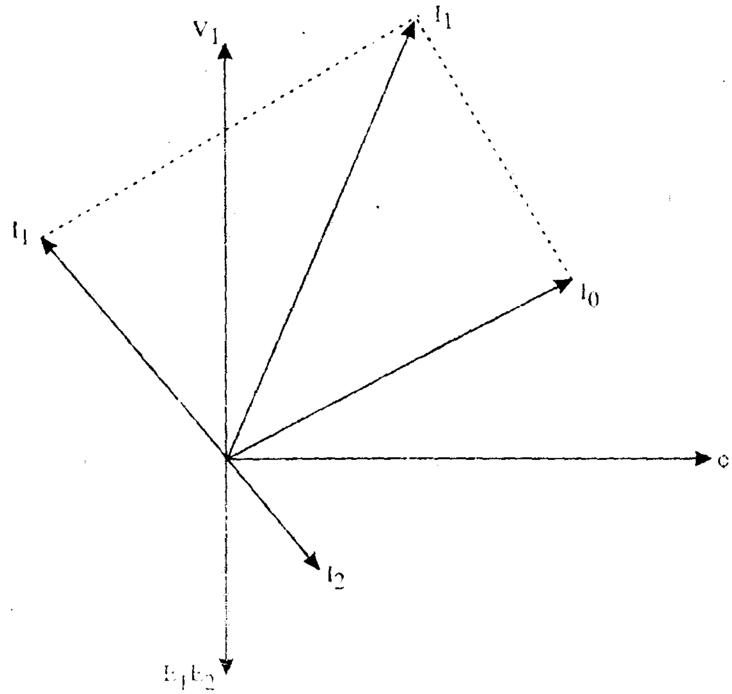




Resistive Load



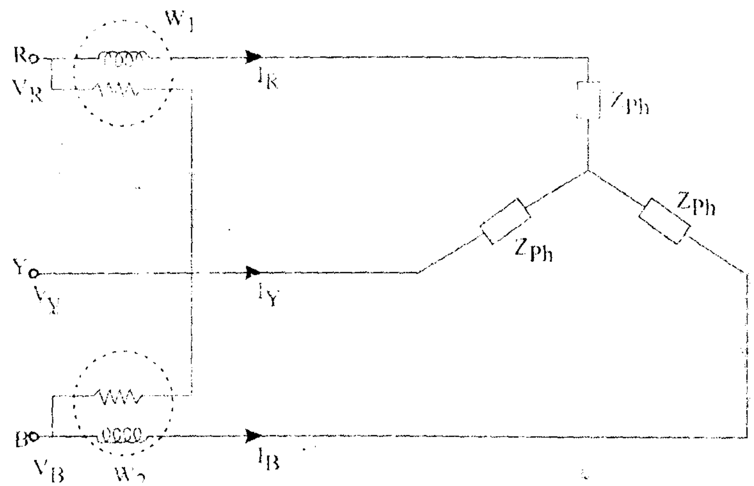
Inductive Load



Capacitive Load

Q. 3. (a) Explain how 3-ϕ power can be measured by two-wattmeter method for a balance load.

Ans. 3-ϕ Power Measurement by Two Wattmeter :



Instantaneous current through $W_1 = i_R$

Instantaneous voltage across $W_1 = V_R - V_Y$

Instantaneous power of $W_1 = I_R(V_R - V_Y)$

$$\text{Instantaneous current through } W_2 = I_B$$

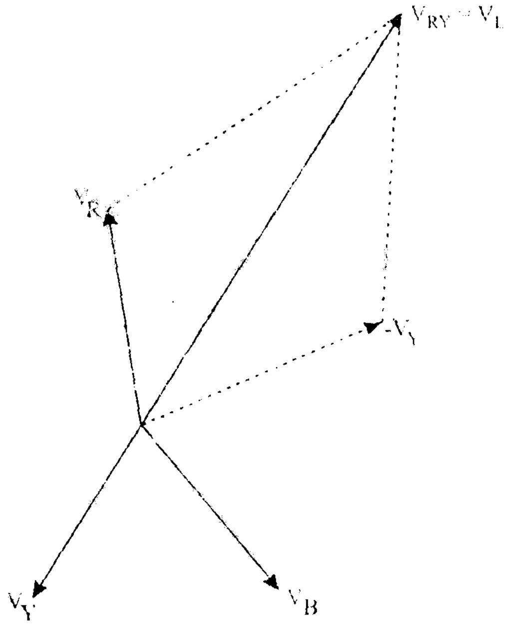
$$\text{Instantaneous power voltage across } W_2 = V_B - V_Y$$

$$\text{Instantaneous power of } W_2 = I_B (V_B - V_Y)$$

$$W_1 + W_2 = I_R (V_R - V_Y) + I_B (V_B - V_Y)$$
$$= I_R V_R - I_R V_Y + I_B V_B - I_B V_Y$$
$$= I_R V_R + I_B V_B - V_Y (I_R + I_Y)$$
$$= I_R V_R + I_B V_B + I_Y V_Y$$
$$W_1 + W_2 = \text{Total power}$$

Q. 3. (b) Derive relation between I_L & I_{ph}, V_L and V_{ph} in case of star connected three phase circuit.

Ans. Relation between line voltage and phase voltage in star connection :



$$V_{RY} = V_R - V_Y$$
$$= (V_R + V_Y) \cos 30^\circ$$
$$= 2V_{ph} \cos 30^\circ$$
$$= 2V_{ph} (\sqrt{3}/2) = \sqrt{3}\, V_{ph}$$

$$\boxed{V_L = \sqrt{3}\, V_{ph}}$$

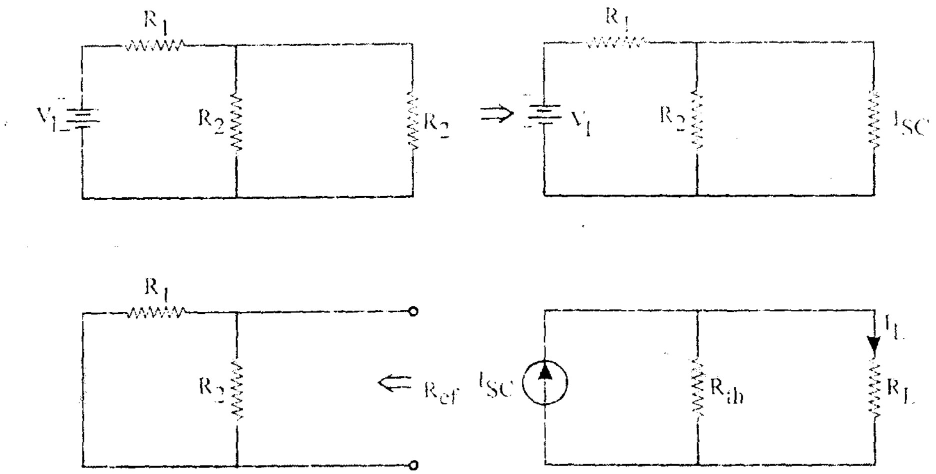
Line current = Phase current

$$\boxed{I_L = I_{ph}}$$

Section—C

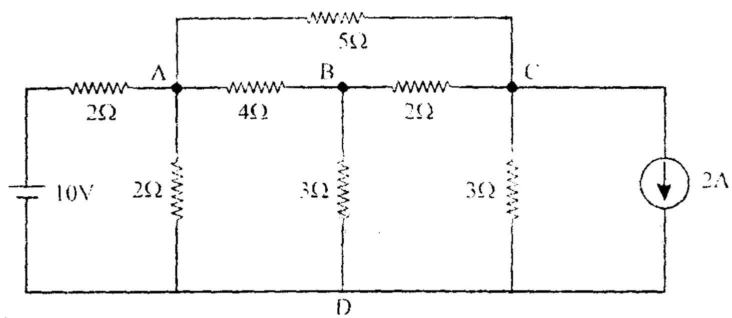
Q. 4. (a) State and explain Norton's theorem.

Ans. Norton's Theorem : Any two terminal linear network containing resistances independent voltage source and current sources may be replaced by an equivalent current I_{sc} in parallel with resistance R_L so that voltage between the two points in the network = I_{sc} R_t where I_{sc} = short circuit current of network between the two points and R_t = resistance of network viewed from these point when all sources emf have been replaced by their respective resistances only.



$$I_L = \frac{I_{sc} \times R_{th}}{R_{th} + R_L}$$

Q. 4. (b) Calculate the current flowing in the 5 Ω, branch AC of the circuit, using Nodal analysis.



Ans. Applying the K.C.L. at node A,

$$\frac{29}{20} V_A - \frac{V_B}{4} - \frac{V_C}{4} = 5$$

At node B

$$\frac{V_A}{4} - \frac{13}{12} V_B + \frac{V_C}{2} = 0$$

At node C

$$\frac{V_A}{5} - \frac{8V_C}{15} = 2$$

$\therefore$

$$V_A = \mathbf{2.9} \text{ volts}$$

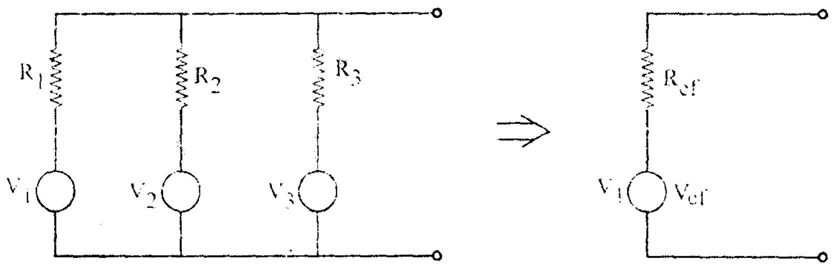
$$V_B = \mathbf{-0.56} \text{ volts}$$

$$V_C = \mathbf{-2.66} \text{ volts}$$

$$I = \frac{V_A - V_C}{5} = \frac{2.9 + 0.56}{5} = 0.692 \text{ amp.}$$

Q. 5. (a) State and explain Millman's theroem.

Ans. Millman Theorem : Millman theorem state that a network which contain number of parallel branches. Each branch contain a resistance in series with a voltage source can be replaced by a network containing a series resistance R_{ef} and a voltage source V_{ef} any.

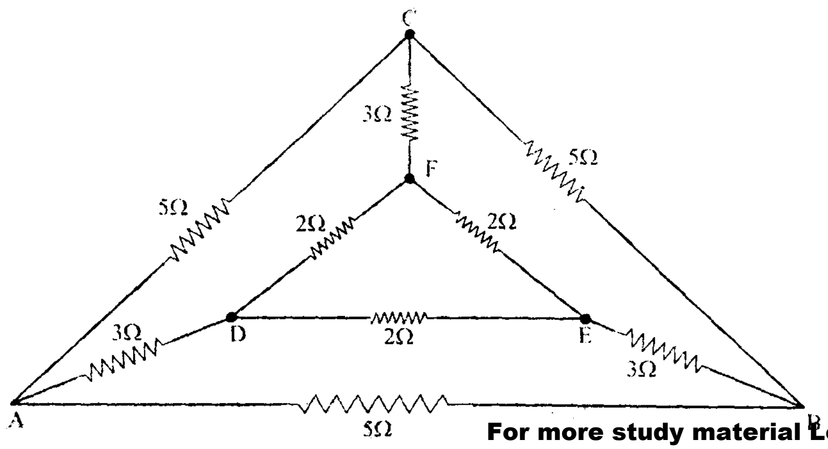


$$V_{ef} = \frac{V_1Y_1 + V_2Y_2 + V_3Y_3}{Y_1 + Y_2 + Y_3}$$

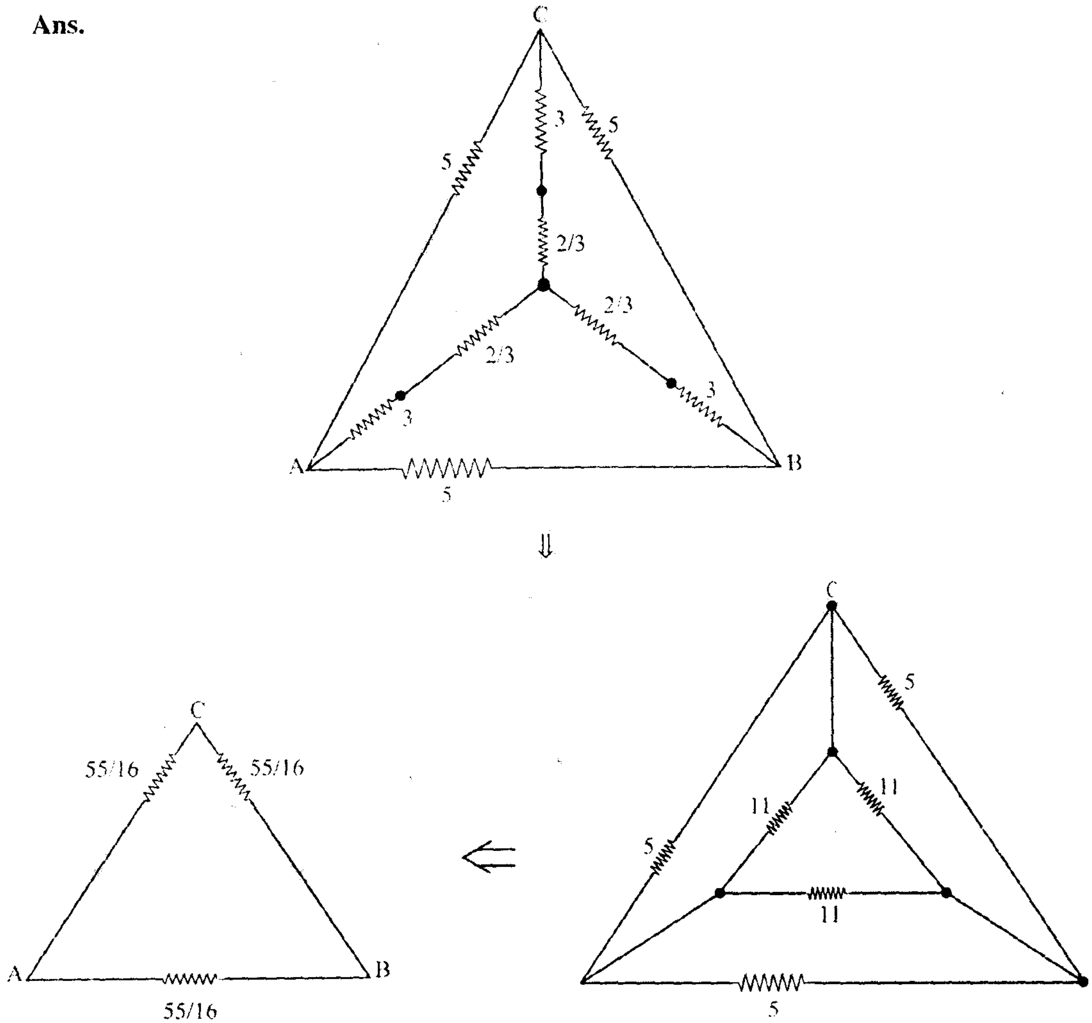
$$R_{ef} = \frac{1}{Y_1 + Y_2 + Y_3}$$

Where, $Y = \frac{1}{R}$

Q. 5. (b) In the network shown in fig. find the resistance between the point A and B.



Ans.



$$R_{AB} = \frac{55}{16} + \frac{55}{16} \bigg\| \frac{55}{16}$$

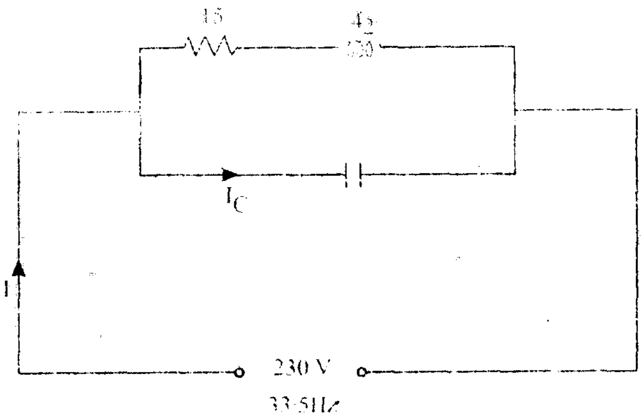
$$= \frac{\frac{55}{8} \times \frac{55}{16}}{\frac{55}{8} + \frac{55}{16}} = \frac{\frac{55}{8} \times \frac{55}{16}}{\frac{165}{16}} = \frac{55 \times 55}{8 \times 165}$$

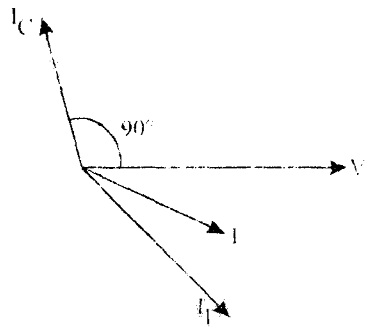
$$= \mathbf{2.3\ \Omega}$$

Section—D

Q. 6. An inductive coil of resistance 15 Ω and inductive reactance 42 Ω is connected in parallel with a capacitor of capacitive reactance 47.6 Ω. The combination is energized from a 200V, 33.5 Hz a.c. supply. Find the total current drawn by the circuit and its power factor. Draw to scale the phasor diagram of the circuit.

Ans.





$$Z_1 = 15 + j42$$
$$\phi_1 = 70.40 \text{ Lagg.}$$
$$I_c = 200/74.6 = 4.2 \text{ Amp.}$$
$$I = 4.484\,(0.335 - j0.942) + j4.2 = 1.5 - j0.025$$
$$V_{IA} = (120 + j160)\,(10 - j0) = 1200 + j1600$$
$$K_W = 1200/1000 = 1.2$$
$$K_{VAR} = 1600/1000 = 1.6$$
$$K_{VA} = \sqrt{1.2^2 + 1.6^2} = 2$$
$$V_{I_B} = (120 + j60)\,(-4 - j8) = 800 - j1600$$
$$K_W = 800/1000 = 0.8 \qquad \therefore \qquad K_{VAR} = -\frac{1600}{1000} = -\mathbf{1.6}$$
$$K_{VA} = \sqrt{0.8^2 + (1.6)^2} = 1.788$$
$$Y = Y_A + Y_B = 0.05 + j0$$
$$I_{V_Y} = (120 + j160)\,(0.05 + j0) = 6 + j8$$
$$= 10\angle 53°8'$$
$$I = I_A + I_B = (10 + j0) + (-4 + j8) = 6 + j8$$
$$= \cos 0° = 1$$

Q. 7. Explain basic principle, working, construction of 3-ϕ induction motor and find the induced EMF in stator and rotor windings.

Ans. Principle : Induction motor works on the principle of Faraday's law of electromagnetic induction. i.e., whenever there is rate of change of flux across on conductor an emf will induce in conductor.

Working : When 3-ϕ winding of stator is connected to 3-ϕ supply then the 3-ϕ current in stator winding produces a rotating magnetic field which rotates round the stator at synchronous speed. This rotating flux passes through the air gap and cuts the rotor conductor. Due to the relative velocity between them (starter flx and rotor) emf induce in the rotor conductor since the rotor conductor circuit is close so induce emf produces the rotor current which start flowing in the rotor conductor, consequently a torque producing condition is established as per Lenz's law the rotor start rotating in same direction with stator magnetic field.

Construction : An induction motor has two main parts stator and rotor.

Stator is an outer stationery hollow cylindrical structure made of laminated sheet steel. The lamination are slotted on their inner periphery. In these slots normal a three phase winding is placed which constitute a stator winding.

Rotor is an inner cylindrical core, built of laminated sheet steel strips with partially enclosed slots the rotor is of two type squirrel cage and slip ring.

Frequency of rotor current (or emf)

$$\text{Rotor emf frequency } f' = S \times \frac{120f}{p} \times \frac{p}{120}$$

$$f' = S_f$$

Rotor emf is given by

$$E_2' = E_1 \frac{N_2}{N_1}$$

E_2 = Rotor emf

E_1 = Stator emf

N_2 = Rotor No. of turns

N_1 = stator No. of turns.

Section—E

Q. 8. (a) Explain working principle of DC machine and derive emf equation for it.

Ans. Principle of D.C. Machine :

Case I : In case of generator when a conducting coil is rotated in a magnetic field the flux linked with the coil changes due to motion of coil due to this an emf is induced;

Case II : In case of motor when a current carrying conductor is placed in magnetic field a force is excited on conductor.

EMF Equation : EMF generated in parallel path and also in the whole winding.

Ex : $$E_g = \frac{\phi NP}{60} \times \frac{Z}{A} \text{ volts}$$

$$\text{EMF / conductor} = \phi NP/60 \text{ volts}$$

$$\text{Time for revolution} = N/60$$

For lap wound

$$E_g = \frac{PN\phi}{60}$$

Wave wound

$$E_g = \frac{P_\phi ZN}{60A}$$

Q. 8. (b) Explain construction, working and EMF equation of transformer.

Ans. Construction : Construction wise transformer consist of following main parts :

(i) Core

(ii) Winding

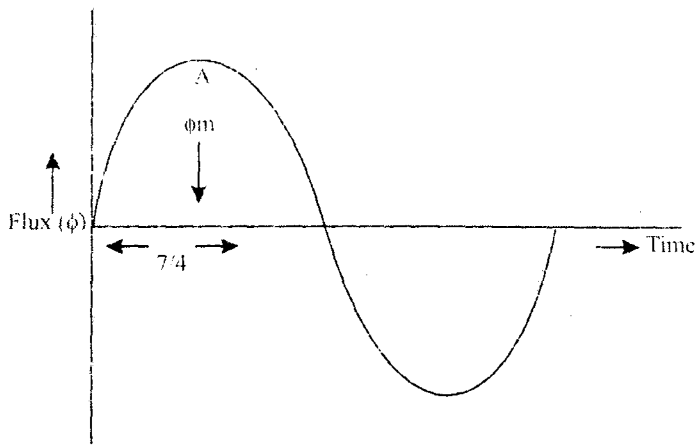
(iii) Insulator

(iv) Cooling arrangement

(v) Conservator and breather

Working : When ever an alternating voltage is applied to the primary winding an alternating flux is set up in primary winding. This flux through core came in contact with primary as well as in secondary winding. Hence produces an EMF E_1 in primary and E_2 in secondary the secondary emf E_2 produces a terminal voltage V_2 at secondary winding.

EMF Equation :



Average rate of change of flux $= \phi m / 1 / 4_f$

$$= 4\phi_m f \text{ Wb}$$

RMS value of the emf induced per turn

$$= 4f\,\phi_m \times 1.11 = 4.44 f\,\phi_m$$

RMS value of the emf induced in entire winding

$$= 4f\,\phi_m \times 1.11 \times N_1$$

$$= 4.44f\,\phi_m N \text{ (volts)}$$

$$E_1 = 4.44f\,\phi_m\,N_1 \text{ (volts)}$$

$$E_1 = 4.44f\,\phi_m\,M_2 \text{ (volts)}$$

Q. 9. Write short notes on :

(a) Energy Meter

(b) Moving iron type instruments

Ans. (a) Energy Meter : Induction type energy meter is used for single phase a.c. measurement and based on the fact that torque is produced when reaction between flux of an AC magnet and the eddy current induced by the flux.

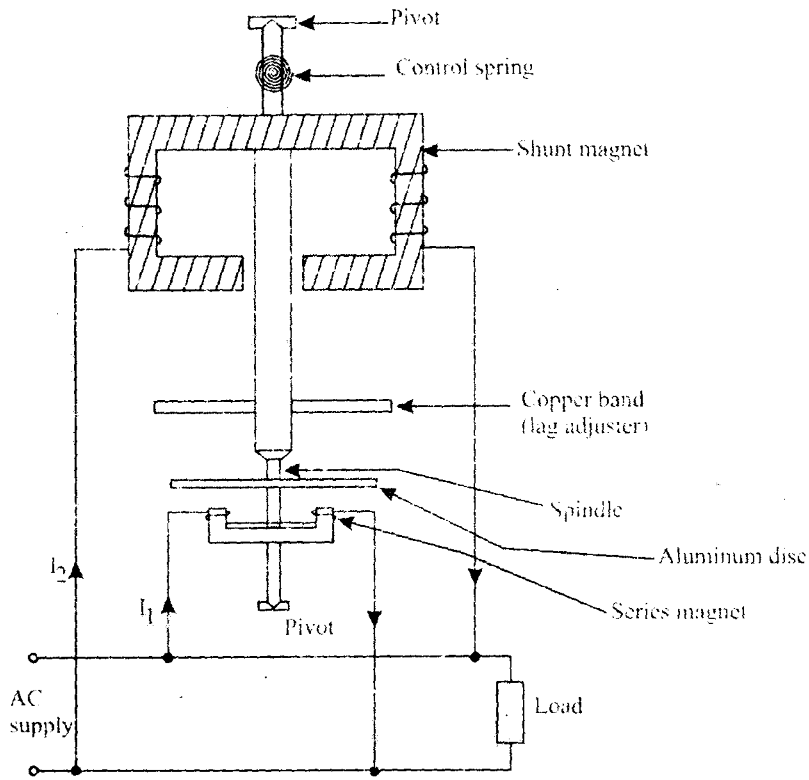


Fig. Induction type single-phase energy meter

Construction : It consist of :

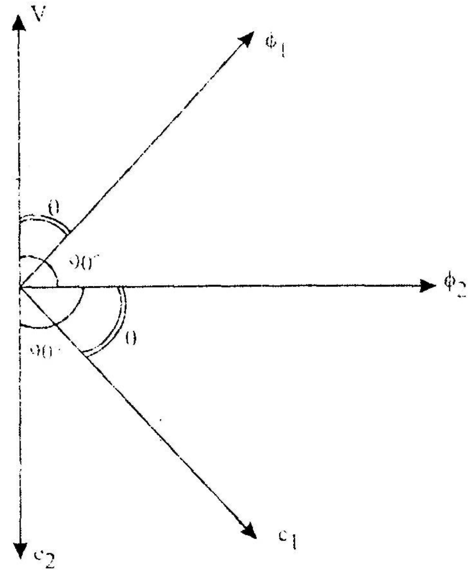
(i) Two laminated electromagnets are is excited by load current and other by the current proportional to voltage.

(ii) A thin aluminium disc is mounted between two magnets so that it cuts the leakage fluxes of both magnets.

(iii) **Log Adjuster :** In this instruments it is absolutely essential that the shunt coil flux log behind the voltage by 90°. This is accomplish by log adjuster.

(iv) **Control :** Instrument is spring control. The springs are fixed to the spindle of rotating aluminium disc having a pointer.

Operation : The shunt magnet produces a flux which after correct adjustment by copper bands logs behind the applied voltage exactly by 90°. The series magnet produces a flux ϕ_1 which is in phase with current I. The flux ϕ_2 and ϕ_1 induces current e_2 and e_1 respectively in the disc which logs behind the respective fluxes by 90°. The eddy currents are set up by these emfs.



(b) Moving Iron Type Instruments : Moving Iron Instruments can be two basic form :

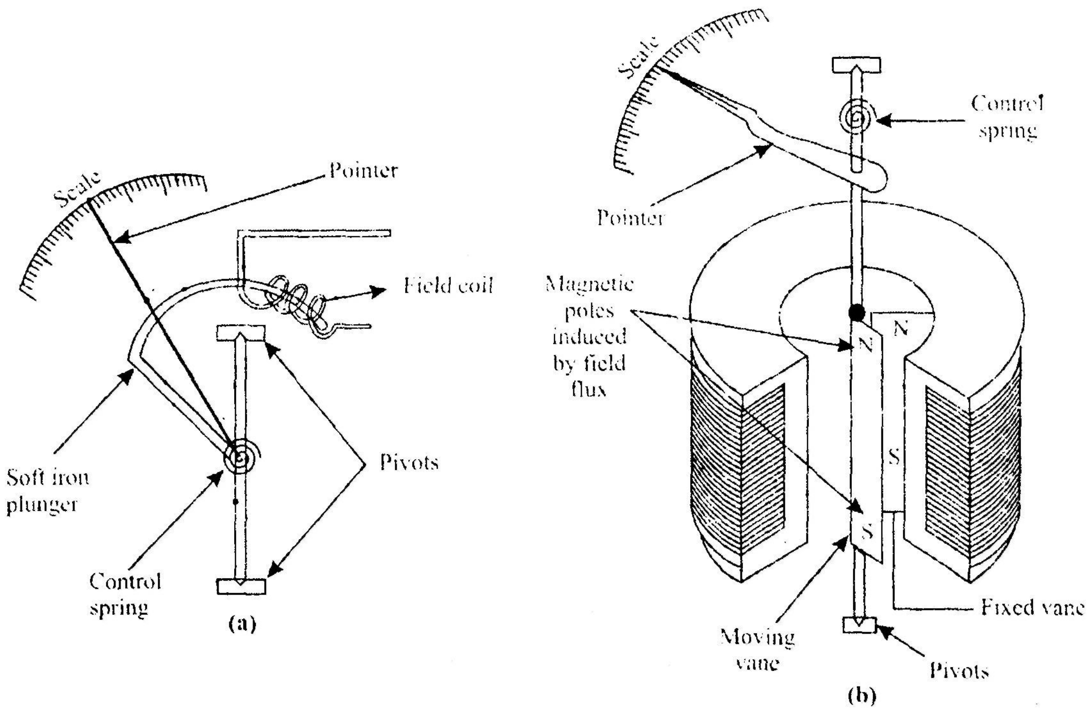


Fig. Moving iron instrument :
(a) attraction types; (b) repulsion type.

Attraction Type : Its operation depend upon the attraction of single piece of soft Iron into a magnetic field produced by stationery coil which is excited by current, voltage under measurement when the current flows in stationery coil the iron vane is attracted into field of stationary coils irrespective of the direction of current flowing in the stationery coil. This attractive force so produced rotates the moving system.

Repulsive Type : This type of instrument has stationery coil and two soft iron vares one of which is stationery while the other is movable. The fixed vane is attached to the stationery coil frame while the movable vane is attached to the shaft of the instrument when the current flows through movable coil the two vanes get similarly magnetized thereby resulting a force of repulsion between them. This force rotate the moving system.