2018 (New)

Basic Electrical Engg.

1.(a) Introduce Resistance, Inductance and Capacitance.

Ans. **Resistance :** Resistance may be defined as that property of a substance which opposes (or restricts) the flow of an electric current (or electrons) through it.

A physical device which has the principal characteristics symbol for a resistance. A resistor is an electric circuit element.

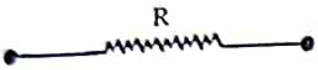


Fig. (a) : Symbol for a Resistance 'R'

The S.I. unit of resistance is ohm and is given by

$$R = \frac{\rho l}{A}$$

Where, ρ = resistivity of the material of the wire

l = Length of wire

A = Area of x-section

Inductance : Inductance is a property of an electrical conductor which opposes the rate of change of current, when current passes through the conductor (coil).

The circuit symbol for a inductance is shown in Fig. (b).

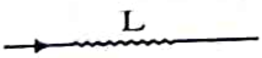


Fig. (b) : Symbol for a Inductance 'L'

The S.I. unit of Inductance is Henry and is given by :

$$\phi \propto I$$

$$\phi = LI$$

$$L = \frac{\phi}{I}$$

Capacitance : Capacitance is a property of a capacity to store electric charge require to raise its potential through unity.

When a charge of Q coulombs is given to a conductor and if its potential rises from 0 to v volts then the capacitance of the conductor will be given by :

$$C = \frac{Q}{v}$$

The symbol is shown in fig. (c)

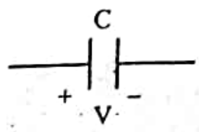


Fig.

The S.I. unit of capacitance is farad.

(b) State Superposition theorem.

Ans. In a linear dc network containing more than one independent energy source, the overall response (that is, the current through or voltage across) in any branch is equal to the algebraic sum of the responses due to each independent source acting one at a time with all other ideal independent sources set equal to zero.

(c) A sinusoidal voltage of 60 Hz has a maximum value of $100\sqrt{2}$ voltage. At what time measured from a positive maximum value will the instantaneous voltage be 100 volts ?

Ans. Given, $f = 60$ Hz

$$v_m = 100\sqrt{2} \text{ volt}$$

$$t_2 = ?, \quad for\ v = 100 \text{ volts}$$

$$v = v_m \sin \omega t$$

$$v = v_m \sin 2\pi f t$$

The instantaneous value is

$$v = 100 \text{ volt at } t = t_1$$

$$100 = 100\sqrt{2}\ \sin 2\pi \times 60 \times t_1$$

$$\sin 2\pi \times 60 \times t_1 = \frac{100}{100\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\sin 2\pi \times 60t_1 = \sin 45°$$

$$\text{or, } \sin\frac{\pi}{4} \quad \text{or, } \sin\frac{3\pi}{4}$$

$$2\pi \times 60t_1 = 45°$$

$$\text{or, } \frac{\pi}{4} \quad \text{or, } \frac{3\pi}{4}$$

$$2\pi \times 60t_1 = \frac{3\pi}{4}$$

$$t_1 = \frac{3}{120\times 4} = \frac{1}{160} \text{ sec.}$$

$$t_1 = 0.00625 \text{ sec.}$$

Time to reach the positive maximum value is :

$$= \frac{1}{4}T = \frac{1}{4f} = \frac{1}{4\times 60}$$

$$= 0.004167 \text{ sec.}$$

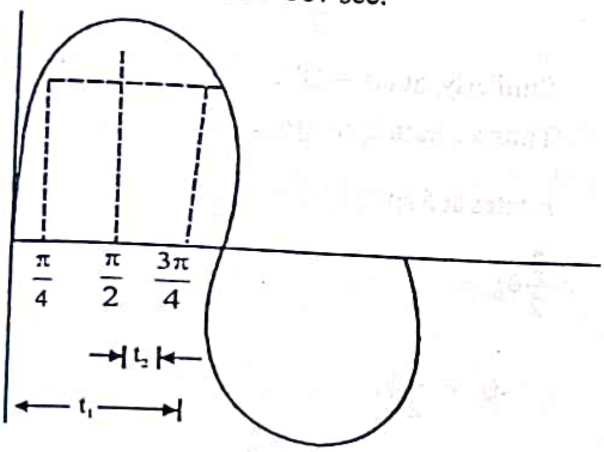


Fig.

Hence, the time t_2 measured from the positive max^{m} value when the instantaneous voltage is 100 volt is given by :

$$t_2 = t_1 - 0.004167$$

$$= 0.00625 - 0.004167$$

$$t_2 = 0.002083$$

or, 2.083 m sec.

(d) What are the two main advantages of DC excitation system ?

Ans. The two main advantages of DC excitation system are :

(i) It is more reliable.

(ii) It is compact in size, it can brought any where due to its low weight.

(e) In two wattmeter method, what will be the power factor when both wattmeter show 50 watts readings.

Ans. When $W_1 = W_2 = 50$ watts.

i.e., both the wattmeter reads equal value, then the power factor is unity.

i.e., $\boxed{\cos\phi = 1}$.

(f) Explain power triangle ?

Ans.

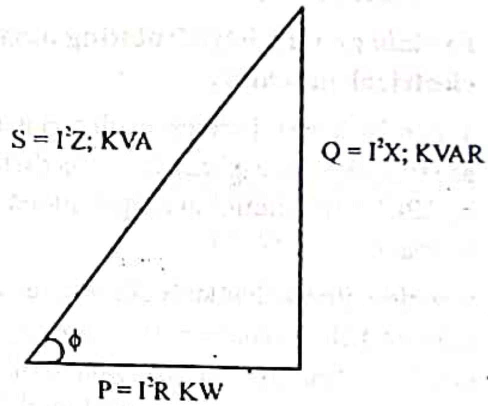


Fig. : Power triangle

Where, P = Active power, unit is kw

Q = Reactive power, unit is KVAR

S = Apparent power, unit is KVA

and $P = VI\cos\phi$

$Q = VI\sin\phi$

and $P^2 + Q^2 = S^2$

i.e., $S = VI$

(g) How do hysteresis and eddy current loss depend on frequency ?

Ans. The hysteresis and eddy current losses are given by :

$$P_h = k_h f B_m^{1.6} \text{ watts}$$

and $$P_e = k_e f^2 B_m^2 \text{ watts}$$

i.e., $$P_h \propto f \text{ and } P_e \propto f^2$$

Hence, from above it is clear that hysteresis loss depends on frequency and eddy current loss depend on square of frequency.

(h) Define average value and RHS value.

Ans. **Average value :** The average (or mean) value of an alternating current is equal to the value of direct current with transfers across any circuit the same charge as is transferred by that alternating current during a given time.

RMS value : The rms or effective value of an alternating current or voltage is given by that steady current or voltage which when flows or applied to a given resistance for a given time produces the same amount of heat as when the alternating current or voltage is flowing or applied to the same resistance for the same time.

(i) Explain generation of rotating magnetic field in electrical machine.

Ans. When 3-phase windings displaced in space by 120° are supplied by 3-phase currents displaced in time by 120°, a magnetic flux is produced which rotates in space.

Consider three identical coils located on axes physically at 120° in space as shown in fig. (a). Let each coil be supplied from one phase of a balanced 3-phase supply. Each coil produced an alternating flux along its own axis. Let, the instantaneous fluxes be given by :

$$\phi_1 = \phi_m \sin \omega t$$
$$\phi_2 = \phi_m \sin (\omega t - 120°)$$
$$\phi_3 = \phi_m \sin (\omega t + 120°)$$

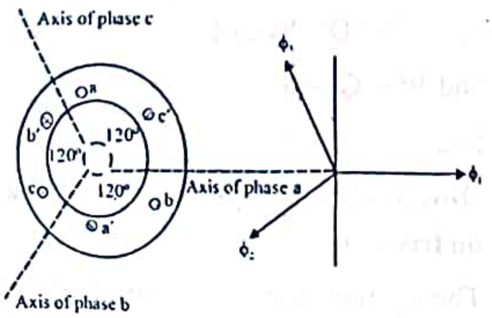


Fig. (a)

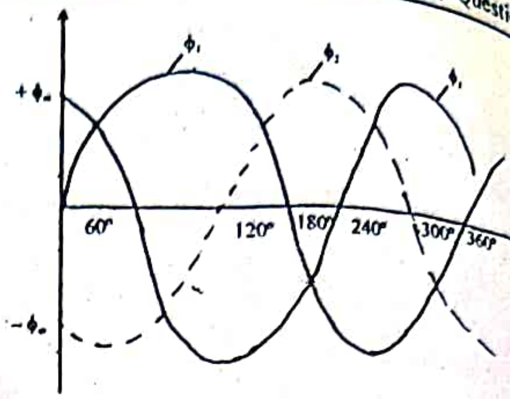


Fig. (b) : Wave form of fluxes produced by three phase currents.

(i) When $\omega t = 0$

$$\phi_1 = \phi_m \sin \omega t = \phi_m \sin 0° = 0$$

$$\phi_2 = \phi_m \sin (\omega t - 120°) = \phi_m \sin (-120°)$$
$$= -\frac{\sqrt{3}}{2}$$

$$\phi_3 = \phi_m \sin (\omega t + 120°) = \phi_m \sin 120°$$
$$= \frac{\sqrt{3}}{2}\phi_m$$

$\therefore$ Resultant flux, ϕ_r

$$= \frac{3}{2}\phi_m$$

Similarly, at $\omega t = 60°, 120°, 180°$ .... and so on.

Thus a rotating magnetic field is produced which rotates at a speed, $N_s = \frac{120f}{p}$ with magnitude $\phi_r = \frac{3}{2}\phi_m$.

$$\phi_r = \frac{3}{2}\phi_m$$

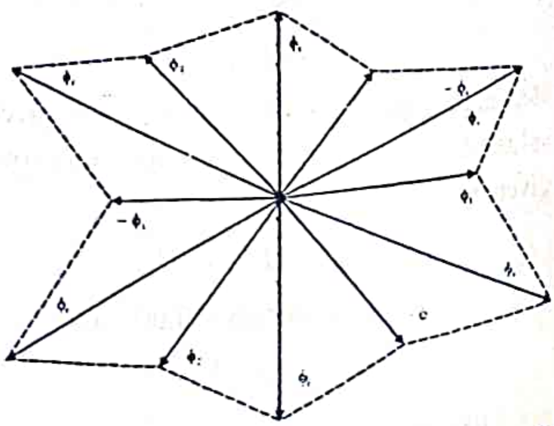


Fig. : Rotating magnetic field at suitable angle.

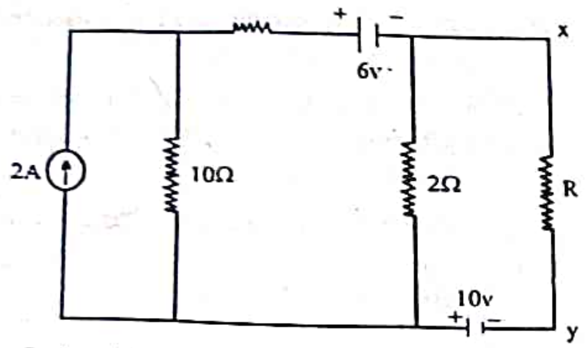
(i) **Differentiate among Neutral, Grounding and Earthing.**

Ans. Earthing : Earthing means connecting the dead part (it means the port which does not carries current under normal condition) to the earth. For example electrical equipment's frames, enclosures, support etc.

Grounding : Grounding means connecting the live part (it means the part which carries current under normal condition) to the earth. For example neutral of power transformer.

Neutral : Neutral is the point of connection of all the phases. It is a common point in a system.

2.(a) Find R to have maximum power transfer in the circuit shown in fig. 1. Also obtain the amount of maximum power.



Ans. Let us first convert the current source to voltage source to voltage source. R is also replaced by open circuit. Hence V_{0c} is the open circuit voltage at the output terminal *x-y*.

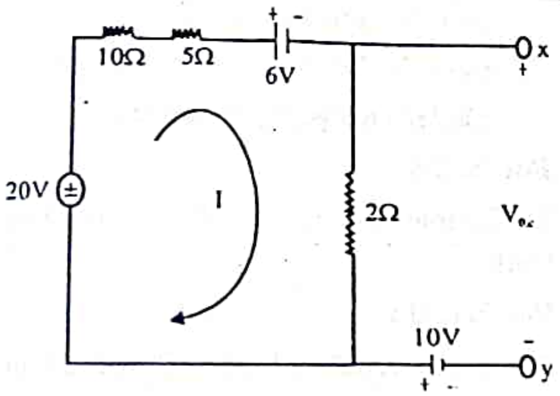


Fig.

The application of mesh equation at the left loop yields

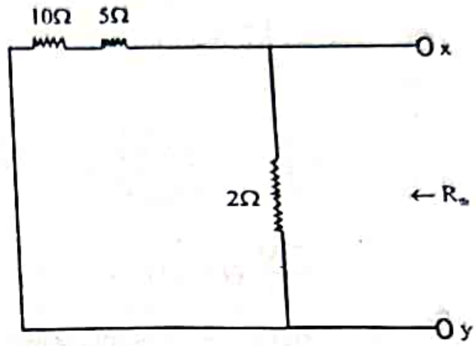
$$-20 + 6 + I(10 + 5 + 2) = 0$$

or, $$I = \frac{14}{17}\ A$$

This gives, $$V_{0c} = 10 + \frac{14}{17} \times 2$$

$$= 11.65 \text{ volt}$$

The internal resistance of the circuit looking from *x-y* terminals is obtained by decaying, all sources as shown in fig.



Here, $$R_{th} = \frac{15 \times 5}{15 + 2} = \frac{30}{17}$$

$$= 1.765W$$

As per the theorem of maximum power transfer.

$$R = 1.765\Omega\ (= R_{th})$$

and P_{max} (amount of maximum power transfer)

$$= \frac{V_{th}^2}{4R} = \frac{(11.65)^2}{4 \times 1.765}$$

$$= 19.22 \text{ watt.}$$

2.(b) A coil having resistance of 10Ω and inductance of 1H is switched

on to a direct voltage of 100*v*. Calculate the rate of change of

the current (i) at the instant of closing the switch and (ii) when

$t = \frac{L}{R}$. **Also find the steady state value of the**

current.

Ans. Given, R = 10Ω, L = 1H, *v* = 100*v*

(i) The rate of change of the current of the instant of closing the switch in $\frac{d_I}{d_t}\Big/_{t=0} = \frac{v}{L}e^{-\frac{R}{L}\times 0}$

$$= \frac{100}{1} = 100 \text{ A/sec.}$$

(ii) Current at $t = \frac{L}{R}$

$$i = I\left(1-e^{-\frac{R}{L}t}\right)$$

$$= \frac{v}{R}\left(1-e^{\frac{-R}{L}\cdot\frac{L}{R}}\right)$$

$$= \frac{100}{10}(1-e^{-1})$$

$$= 10(1-e^{-1}) = 6.321 \text{ Amp.}$$

(iii) Steady state value of current,

$$i/_{t\to\infty} = \left[\frac{v}{R} - \frac{v}{R}e^{-\frac{R}{L}t}\right]$$

$$= \frac{v}{R} - \frac{v}{R}e^{-\infty} = \frac{v}{R} - 0 = \frac{v}{R}$$

$\therefore$ i_s = 100/10 = 10Amp

3.(a) What is the phase relationship between R, L and C components is a series AC circuit ? What are active, reactive power and apparent power ?

Ans.

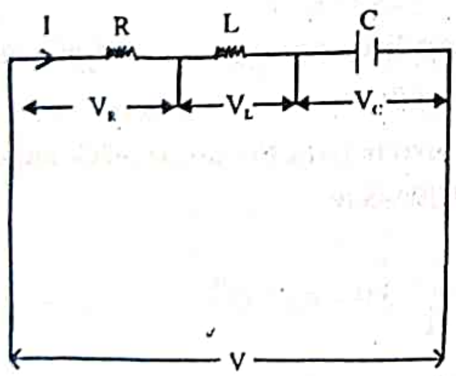


Fig. Series R-L-C circuit

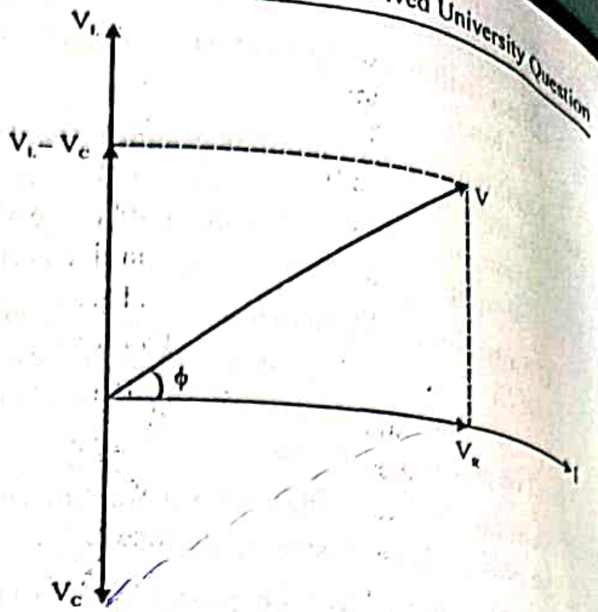


Fig. Phasor diagram to series R-L-C circuit when $X_L > X_C$

Active power : The power which is utilised by the load is called Active power.

Reactive power : The power which is continually exchanged between the source and the reactive load is called the reactive power.

Apparent power : The product of rms. values of voltage and current in a circuit is called the circuit voltameter. Sometimes it is known as apparent power.

3.(b) On a power distribution system, three loads run in parallel :

Load A : 100 VA, 0.5 pf (lag)

Load B : 150 w, 0.8 pf (lead)

Load C : 200 VA, 100 VAR (lag)

Find the net power position.

Ans. For load A

Power consumed by load A, $P_A = 100 \times 0.5 = 5$ watt

For load B :

Power consumed by load B, $P_B = 150$ watt

For load C : P.f of the load is calculated as :

$$\sin\phi = \frac{VAR}{VA}$$

$$= \frac{100}{200} = \frac{1}{2}$$

$$\phi = \sin^{-1}\left(\frac{1}{2}\right)$$

$$\phi = 30^\circ$$

$\therefore$ P.f., $\cos\phi = \cos 30^\circ$

$$= \frac{\sqrt{3}}{2}$$

$\therefore$ Power consumed by load C,

$$P_c = 200 \times \frac{\sqrt{3}}{2}$$

$$= 173.2 \text{ watt}$$

$\therefore$ Net power position,

$$P = P_A + P_B + P_C$$

$$= 50 + 150 + 173.2$$

$$= 373.2 \text{ watt}$$

4. **(a) What is eddy-current loss ? What are the undesirable effects of eddy currents ? How can they be minimized ? Mention some applications of eddy currents.**

Ans. Eddy-current loss : When an alternating magnetic field is applied to a magnetic material an emf is induced in the material itself according to Faraday's law of electromagnetic induction. Since the magnetic material is a conducting material, these EMFS circulates currents within the body of the material. These circulating currents are called Eddy currents. They occur when the conductor experiences a changing magnetic field.

As these currents are not responsible for doing any useful works, and it produces a loss (I^2R loss) in the magnetic material known as an Eddy current loss.

Undesirable effects of eddy currents :

1. There is a major heat loss cycling. Eddy currents cause loss of energy due to friction in the magnetic circuit, especially where the core is saturated. Thus there is the loss of useful electrical energy in the form of heat.
2. There is a magnetic then leakage.
3. Eddy current lead to unnecessary heating and this may lead to wastage of power. Un necessary heating due to eddy currents may also lead to the damage of the insulation of the coils.

Minimizing of eddy current :

To reduce the eddy current loss mainly there are two methods :

(a) The eddy current loss is reduced by using a magnetic material having higher value of resistivity like silicon-steel content.

(b) By reducing the magnetic of the eddy current. The magnitude can be reduced by splitting the solid core into thin sheets called laminations, in the plane parallel to the magnetic field. Each lamination is insulated from each other by a thin layer of coating of varnish or oxide film.

By laminating the core, area of each section in reduced and hence the induced emf. also reduces. As the area through which the current is passed is smaller, resistance of eddy current path increases.

Application of eddy current : Some of the application of eddy current are :

(i) Electric meters (Electromechanical Induction Metres)

(ii) Moving coil instruments

(ii) Induction heating

(iv) Proximity sensor

(v) Metal detectors

(vi) Eddy current testing and many more.

4. **(b) An iron ring of cross-sectional area 5 cm^2 is wound with a wireof 120 turns and has a cut of 3 mm. Calculate the magneting current required to produce a flux of 0.3 mwb, it mean length of magnetic path is 25 cm and relative permeability of iron is 650.**

Ans. $l = 25 \text{ cm} = 25 \times 10^{-2} \text{ m}$

$$= 0.25 \text{ m}$$

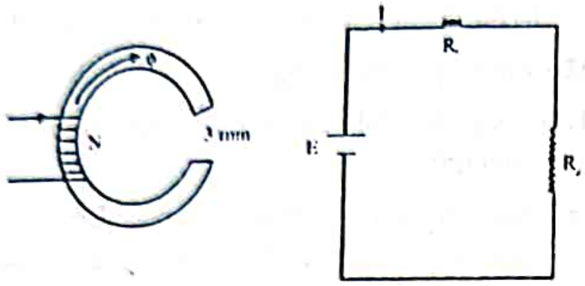
$a = 5\ cm^2 = 5 \times 10^{-4}\ m^2$

$\mu_r = 650$

$N = 120$

$\phi = 0.3$ mwb

$= 0.3 \times 10^{-3}$ wb



Calculation of mmf for the iron path :

l_i = original circumference – air gap length

$l_i = 0.25 - 0.003 = 0.247$ m

Flux density,

$$B_i = \frac{\phi}{a_i} = \frac{0.3\times10^{-3}}{5\times10^{-4}}$$

$$= 0.6T$$

$$\therefore \quad H_i = \frac{B_i}{\mu_0\mu_{ri}} = \frac{0.6}{4\pi\times10^{-7}\times650}$$

$$= 734.9338 \textbf{ Ans.}$$

$\therefore$ mmf for the iron path

$$F_i = H_i l_i$$

$$= 734.9338 \times 0.247$$

$$= 181.528 \text{ A}$$

Calculation of mmf for the air gap

$$H_a = \frac{\beta_a}{\mu_0} = \frac{0.4}{4\pi\times10^{-7}}$$

$$= 0.04777 \times 10^7$$

$$l_a = 3 \text{ mm} = 3 \times 10^{-3} \text{ m}$$

mmf for the airgap,

$$F_a = H_a l_a$$

$$= 0.04777 \times 10^7 \times 3 \times 10^{-3}$$

$$= 0.1433121 \times 10^4$$

$$= 1433.121 \text{ A}$$

Total mmf for the whole magnetic circuit

$$F = F_i \times F_a$$

$$= 181.528 + 1433.121$$

$$= 1614.649 \text{ A}$$

and existing current,

$$I = \frac{F}{N}$$

$$= \frac{1614.649}{120} = 13.455 \text{ A}$$

5.(a) Define voltage regulation of a transformer and derive condition for (i) zero regulation and (ii) maximum regulation. Also draw the curve of variation of voltage regulation with power factor.

Ans. Voltage regulation : The voltage regulation of a transformer is defined as the arithmetical difference in the secondary terminal voltage between no load ($I_2 = 0$) and full rated load ($I_2 = I_{fl}$) at a given power factor with the same value of primary voltage for both rated load and no load.

It is expressed as either a per unit or a percentage of the rated load voltage.

P.U voltage regulation at full load

$$= \left|\frac{|V_{2nl}| - |V_{2fl}|}{|V_{nl}|}\right|_{|V_1| = \text{constant}}$$

Percentage voltage regulation at full load

$$= \left|\frac{|V_{2nl}| - |V_{2fl}|}{|V_{nl}|}\right|_{|V_1| = \text{constant}}$$

Where, V_{2fl} = rated secondary terminal voltage rated load.

V_{2nl} = no. load secondary terminal voltage.

Condition for zero voltage regulation :

We know, the voltage regulation in given by :

$$\% \text{ Reg} = \frac{I_2 Re_2 \cos\phi_2 + I_2 x_{e2} \sin\phi_2}{V_{2nl}}$$

For zero voltage regulation,

$$I_2 R_{e2} \cos\phi_2 + I_2 x_{e2} \sin\phi_2 = 0$$

$$I_2 X_{e2} \sin\phi_2 = -I_2 R_{e2} \cos\phi_2$$

$$\tan\phi_2 = -\frac{R_{e2}}{X_{e2}}$$

$$\boxed{\phi_2 = -\tan^{-1}\left(\frac{R_{e2}}{X_{e2}}\right)}$$

The negative sign indicates that zero voltage regulation occurs when the load is capacitive (that is, the power factor is leading).

) Condition for maximum voltage regulation :

For maximum voltage regulation,

$$\frac{d}{d\phi_2}(\text{regulation}) = 0$$

$$\frac{d}{d\phi_2}\left(\frac{I_2 R_{e2} \cos\phi_2 + I_2 x_{e2} \sin\phi_2}{V_{2nl}}\right) = 0$$

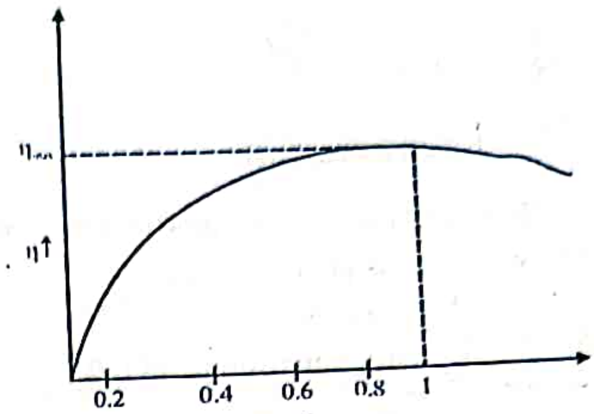
$$-I_2 R_{e2} \sin\phi_2 + I_2 x_{e2} \cos\phi_2 = 0$$

$$\tan\phi_2 = \frac{x_{e2}}{R_{e2}}$$

$$\boxed{\phi_2 = \tan^{-1}\left(\frac{x_{e2}}{R_{e2}}\right)}$$

Thus, maximum voltage regulation occurs at lagging power factor of the load.

Curve :



5. **(b) Let the flux at any instant be given by $\phi = \phi_m \sin \omega t$**

Ans. The instantaneous emf induced in the winding is given by Faraday's law as :

$$e = -N\frac{d\phi}{dt}$$

$$e = -N\frac{d}{dt}(\phi_m \sin\omega t)$$

$$e = -N\phi_m \cos\omega t . \omega$$

$$e = -N\phi_m \omega \cos\omega t$$

$$e = +N\phi_m \omega \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{.... (1)}$$

Eqⁿ (1) can be written as

$$e = E_{max} \sin\left(\omega t - \frac{\pi}{2}\right) \quad \text{... (2)}$$

Where, $E_{max} = N\phi_m \omega$

For a sine wave, the rms value of emf is given by—

$$E_{rms} = \frac{E_{max}}{2}$$

$$E_{rms} = E = \frac{N\phi_m.\omega}{2}$$

$$E = \frac{N\phi_m.2\pi f}{2}$$

$$\boxed{E = 4.44\phi_m f N} \quad ...(3)$$

Eqⁿ (3) is called the emf equation of transformer.

Where, f = supply frequency

N = number of turns

ϕ_m = maximum values of flux

Again, $B_{max} = \frac{\phi_{max}}{A}$

$\phi_{max} = B_{max}.A.$

∴ eqⁿ (3) can be written as—

$$\boxed{E = 4.44 fNB_{max}A}$$

When B_{max} = maximum flux density

A = Area of cross-section of the core.

Given, $\frac{E_1}{E_2} = \frac{3000}{200}$ volt

$f = 50$ Hz

$A = 150 \text{ cm}^2$

$N_2 = 80$ turns

(i) from the emf. equation of transformer

$E_2 = 4.44 fN_2$ transformer $B_{max}.A$

$$B_{max} = \frac{E_2}{4.44 fN_2A}$$

$$= \frac{200}{4.44\times50\times80\times150\times10^{-4}}$$

$= 0.750$ tesla or, Wb/m²

(ii) Again, $\frac{E_1}{E_2} = \frac{N_1}{N_2}$

$$N_1 = \left(\frac{E_1}{E_2}\right)\times N_2 = \left(\frac{3000}{200}\right)\times 80$$

∴ $N_1 = 1200$ turns

Q.6. The circuit shown in fig. 2 (i) in the thevenin equivalent ckt of the ckt shown in fig. 2 (ii). Find the value of the open circuit voltage V_{oc} and thevenin resistance R_{th}.

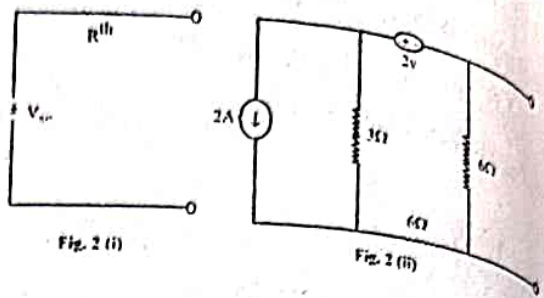


Fig.

To find R_{th} : All the voltage sources are short circuited and current sources are open circuited then the ckt is:

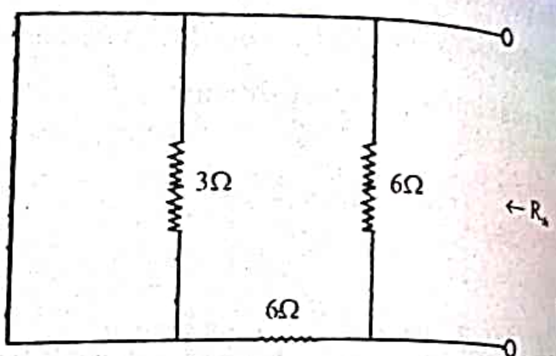


Fig. 2 (ii)

∴ $R_{th} = (3+6) \parallel 6$

$= 9 \parallel 6$

$$= \frac{9\times6}{9+6} = \frac{54}{15} = 3.6\Omega$$

To find $V_{0.C}$

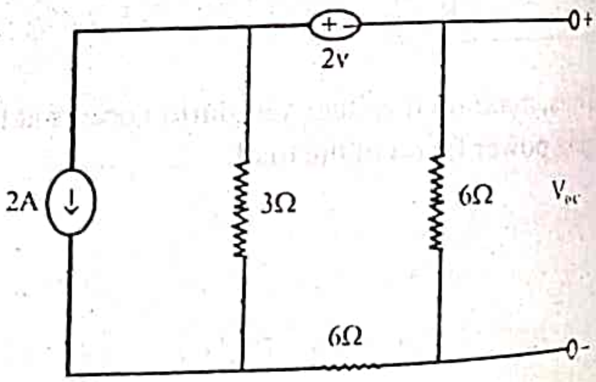


Fig.

Changing the current source into voltage source the ckt becomes—

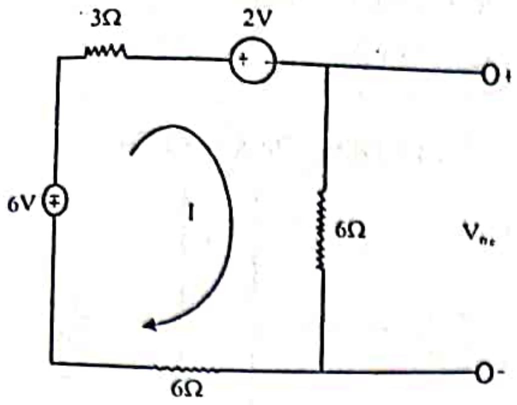


Fig.

Apply KVL in the loop we get,

$$3I + 2 + 6I + 6I + 6 = 0$$

$$15I + 8 = 0$$

$$I = \frac{-8}{15} = -0.533$$

i.e., $\quad I = 0.533$

(–ve sign indicates that the direction of current is opposite)

$$\therefore \quad V_{O.C} = 6I$$

$$= 6 \times 0.533$$

$$= 3.199 \text{ volt.}$$

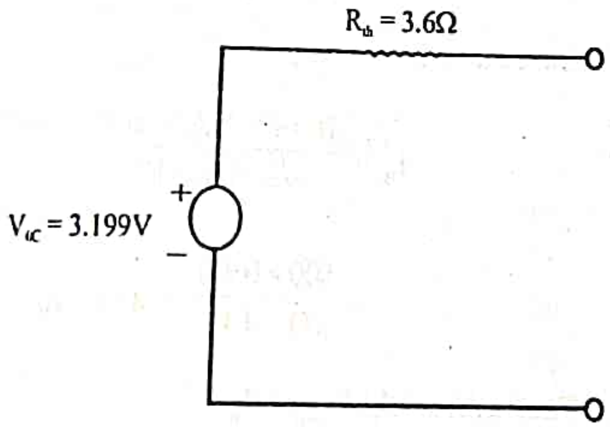


Fig. : Thevenin's equivalent circuit

7. **Determine current in 12Ω resistance using Norton's theorem in the network shown in fig. 3.**

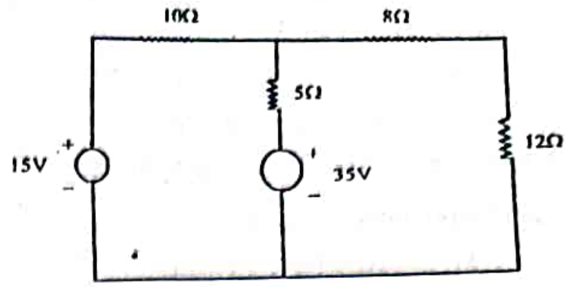


Fig.

Ans. To find R_N or R_{eq}

All the sources are deactivated i.e. voltage source are short circuited and current source are open circuited. The ckt becomes:

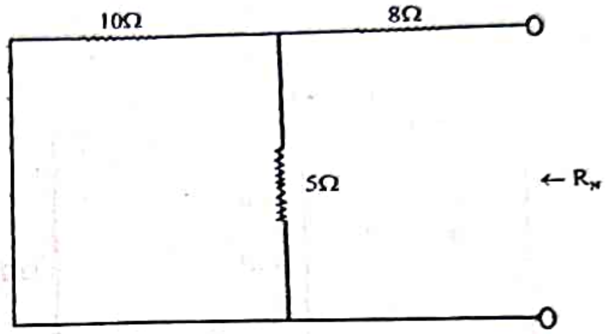


Fig.

$$\therefore \quad R_N = (10 \parallel 5) + 8$$

$$R_N = \left(\frac{10 \times 5}{10 + 5}\right) + 8$$

$$= \frac{50}{15} + 8 = 11.33\Omega$$

To find I_{sc} (Short ckt current)

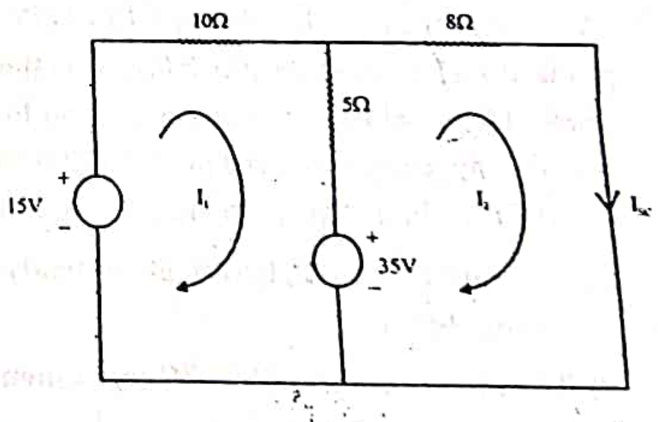


Fig.

Apply KVL in loop 1.

$$10I_1 + 5(I_1 - I_2) + 35 - 15 = 0$$

$$15I_1 - 5I_2 + 20 = 0$$

$$15I_1 - 5I_2 = -20 \quad \text{.... (1)}$$

and apply KVL in loop 2

$$8I_2 + 5(I_2 - I_1) - 35 = 0$$

$$13I_2 - 5I_1 = 35$$

$$-5I_1 + 13I_2 = 35 \quad \text{.... (2)}$$

From eq^n (1) and (2) we get,

$$I_1 = -0.5$$

$$I_2 = 2.5$$

$$\therefore \quad I_2 = I_{SC} = 2.5$$

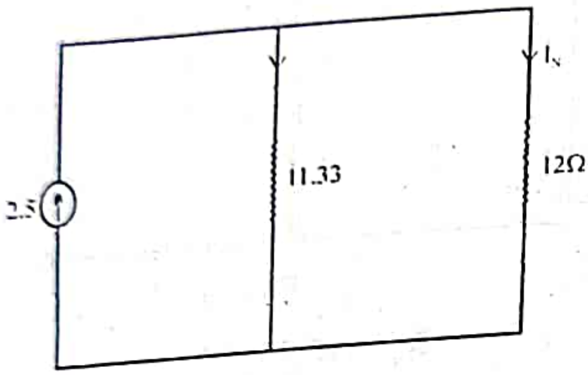


Fig. : Norton's equivalent ckt

$$\therefore \quad I_N = \left(\frac{11.33}{11.33+12}\right)\times 2.5$$

$$I_N = 1.214 \text{ Amp.}$$

8. **A 100 MVA Y-connected 13.2 kv synchronous generator is connected to a 13.2/132 KV, 100 MVA delta star transformer. The generators are $X''_d = 0.1$ Pu, $x'_d = 1.2$ Pu on a 100 MVA base, while transformer reactance is 0.1 Pu on the same base. The machine in operating on no load, at rated voltage when a three phase fault occurs at the HT terminal of transformer. Determine—**

(a) **The sub-transient, transient an steady-state symmetrical.**

(b) **The maximum possible DC component.**

(c) **The maximum value of instantaneous current.**

Ans. $X''_d = 0.1$ Pu, $X'_d = 0.254$

$X_d = 1.2$ Pu, 100 MVA

13.2 KV

100 MVA

13.2/132 KV, X = 0.1 Pu

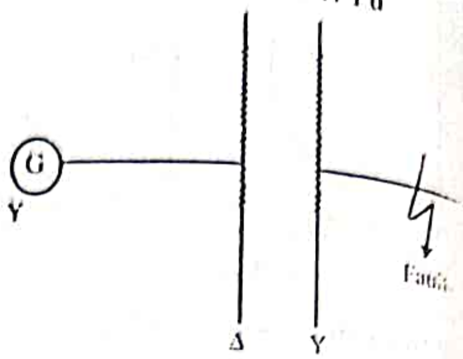
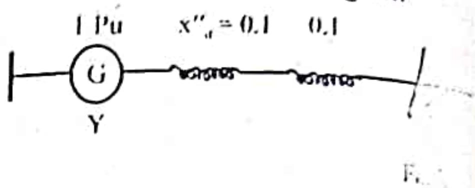


Fig. Single line diagram



Per unit fault current

$$I_{SCPU} = \frac{\text{per unit voltage}}{\text{per unit impedance}}$$

Per unit impedance upto fault is

$$= 0.1 + 0.1 = 0.2$$

$$\therefore \quad I_{SCPU} = \frac{1}{0.2} = \frac{10}{2} = 5 \text{ Pu}$$

Base current,

$$I_B = \frac{\text{Base MVA} \times 1000}{\sqrt{3} \times \text{base KV}}$$

$$= \frac{100 \times 1000}{\sqrt{3} \times 132} = 437.386$$

Fault current, $I_f = I_{SCPU} \times I_B$

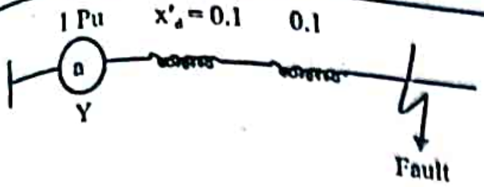
$$= 5 \times 437.386$$

$$= 2186.9 \text{ Amp.}$$

$\therefore$ Subtransient current in generator

$$= 2186.9 \times \text{transformative ratio}$$

$$= 2186.9 \times 132/13.2 = 21869 \text{ Amp}$$

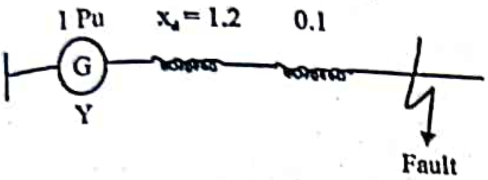


$$\therefore \quad I_{SCPU} = \frac{1}{0.35} = 2.857 \text{ Pu}$$

$$\therefore \quad I_f = 2.857 \times 437.386$$
$$= 1249.61$$

$\therefore$ Transient current in generation

$$= 1249.61 \times 10$$
$$= 12496.10 \text{ Amp.}$$



$$I_{SCPU} = \frac{1}{1.3} = 0.769 \text{ Pu}$$

$$I_f = 0.769 \times 437.386$$
$$= 336.34$$

$\therefore$ Steady state current

$$= 336.34 \times 10$$
$$= 3363.4 \text{ Amp.}$$

9.(a) **Derive the expression of equivalent star network resistances from the delta network comprising of R_{12}, R_{23}, R_{31}, where nodes are termed as 1, 2 and 3 respectively.**

Ans.

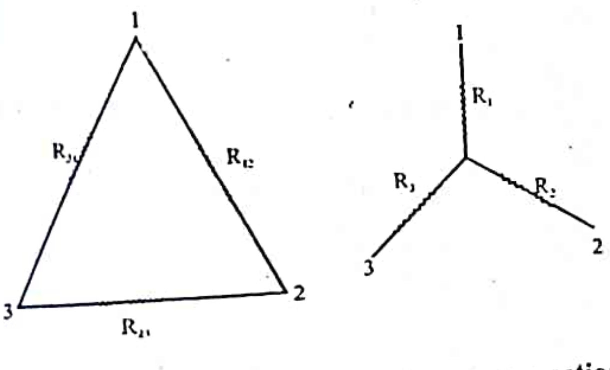


Fig. In delta connection, Fig. A star connection

Resistance between terminals 1 and 2 is $[R_{12} \parallel$

$$(R_{23} + R_{31})] = \frac{R_{12}(R_{23}+R_{31})}{R_{12}+R_{23}+R_{31}}$$

Resistance between terminals to 2 and 3 is $[R_{23} \parallel$

$$(R_{31} + R_{12})] = \frac{R_{23}(R_{31}+R_{12})}{R_{12}+R_{23}+R_{31}}$$

Resistance between terminals 3 and 1 is $[R_{31} \parallel$

$$(R_{12} + R_{23})] = \frac{R_{31}(R_{12}+R_{23})}{R_{12}+R_{23}+R_{31}}$$

In star connection,

Resistance between terminals 1 and 2 is $(R_1 + R_2)$

Resistance between terminals 2 and 3 is $(R_2 + R_3)$

Resistance between terminals 3 and 1 is $(R_3 + R_1)$

Now we equate the resistance in star and delta across appropriate terminals.

$$\text{i.e. } R_1 + R_2 = \frac{R_{12}(R_{23}+R_{31})}{R_{12}+R_{23}+R_{31}} \quad \text{.... (1)}$$

$$R_2 + R_3 = \frac{R_{23}(R_{31}+R_{12})}{R_{12}+R_{23}+R_{31}} \quad \text{.... (2)}$$

$$R_3 + R_1 = \frac{R_{31}(R_{12}+R_{23})}{R_{12}+R_{23}+R_{21}} \quad \text{.... (3)}$$

Subtracting equation (2) from equation (1) we get,

$$R = \frac{\rho l}{A}$$

$$R_1 - R_3 = \frac{R_{12}R_{31} - R_{23}R_{31}}{R_{12}+R_{23}+R_{31}} \quad \text{... (4)}$$

Adding equation (3) and (4)

$$2R_1 = \frac{2R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$$

$$\text{or,} \quad \boxed{R_1 = \frac{R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}}$$

In a similar way,

$$\boxed{R_2 = \frac{R_{12}R_{23}}{R_{12}+R_{23}+R_{31}}}$$

and $$\boxed{R_3 = \frac{R_{31}R_{23}}{R_{12}+R_{23}+R_{31}}}$$

9.(b) What is the main purpose of providing taps in transformer?

Suggest the addition in a simplified transformer model when it is used for tap changing transformer.

Ans. The purpose of a tap changer is to regulate the output voltage of a transformer. It does this by altering the number of turns in one winding and thereby changing the turns ratio of the transformer.

The change of voltage is affected by changing the numbers of terms of the transformer provided with taps. For sufficiently close control of voltage, taps are usually provided on the high voltage winding of the transformer. There are two different situation where tap changing transformer are used :

(i) Off-load tap changing.

(ii) On-load tap changing.

In the off load changing, the transformer is disconnected from the main supply when the tap setting is to be changed. The tap setting is usually done manually.

In the on-load tap changing, is used in order that the supply may not be interrupted. Such a transformer is known as a tap-changing under load transformer.

□□□