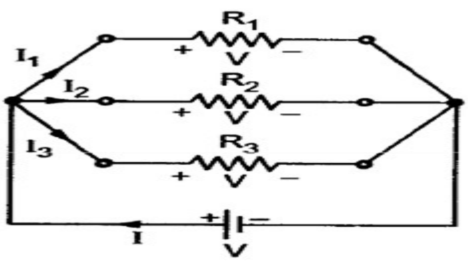
Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A)	**Attempt any SIX of the following :** **12 Marks**
a)	**Define the following for an electrical network : (i) Node (ii) Loop**
Ans:	**i) Node:** **(1 Mark)** A point or junction where two or more than two elements of network are connected together is called node. **ii) Loop:** **(1 Mark)** A closed path for flow of current in an electrical circuit is called loop.
b)	**State Kirchhoff's voltage law.**
Ans:	**Kirchhoff's voltage law:** **(2 Mark)** It states that, in any closed circuit, the algebraic sum of the emfs and products of the currents and resistances is zero. i.e. $\Sigma E - \Sigma IR = 0$
c)	**Draw a parallel electric circuit. Write the expression for equivalent resistance.**
Ans:	**(Diagram 1 Mark & Expression 1 Mark)**  **Or equivalent** $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

d) **Define crest factor and form factor.**

Ans:

1. Crest (Peak) factor for a sinusoidal quantity: **(1 Mark)**

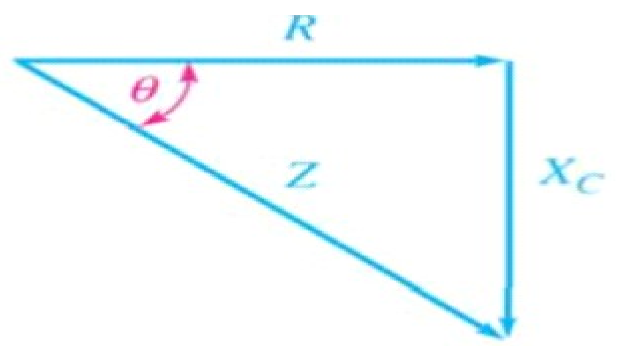
It is defined as the ratio of Maximum value to the RMS value of AC quantity.

2. Form factor : **(1 Mark)**

It is defined as the ratio of RMS value to the Average value of an alternating quantity

e) **Draw the impedance triangle of series RC circuit. Write the expression for magnitude of impedance.**

Ans: **Impedance triangle of series RC circuit:-** **(1 Mark)**

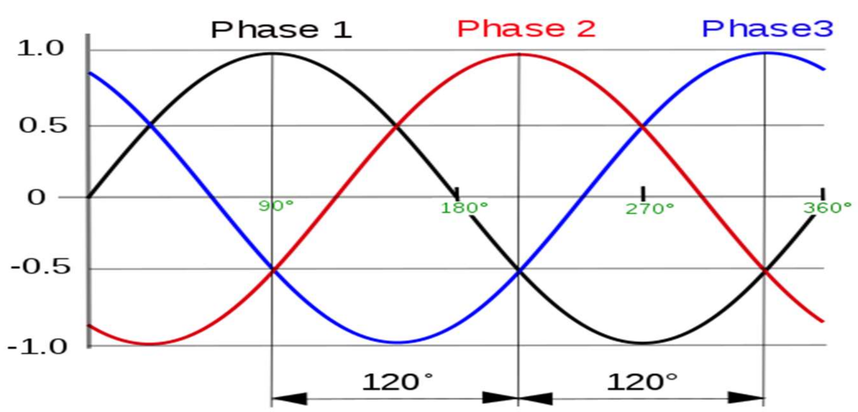


Expression for magnitude of impedance:- **(1 Mark)**

Impedance magnitude: $|Z| = \sqrt{R^2 + X_c{}^2}$

f) **Draw the voltage waveform of a 3-ph supply with respect to time.**

Ans: **(Waveform: - 2 Mark)**



or equivalent figure

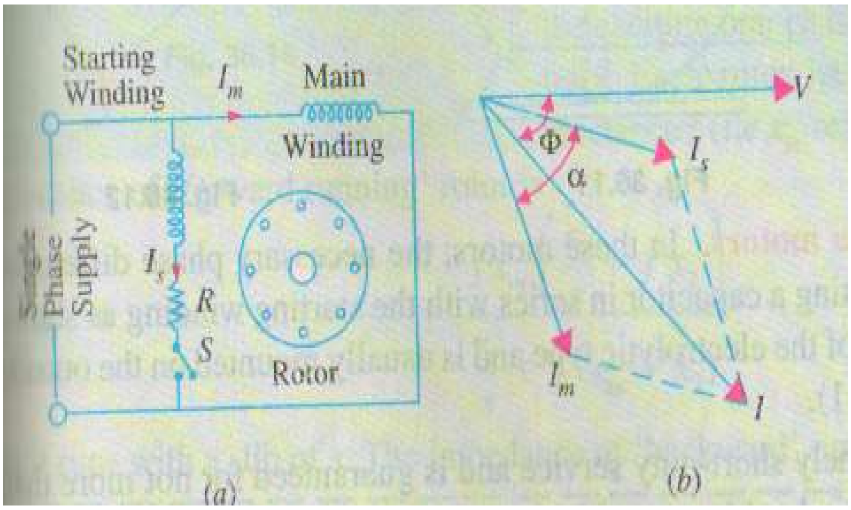
g)	**What is earthing? State its importance.**
Ans:	**Meaning of earthing:** (1 Mark) Connecting the metallic frame of the electrical machines /any electrical equipment body etc. to ground by using wire/conductor is known as earthing. **Importance of Earthing: (Any Two point are expected)** (1 Mark) 1. To provide an alternative path for the leakage current to flow towards earth. 2. To save human life from danger of electrical shock due to leakage current. 3. To protect high rise buildings structure against lightening stroke. 4. To provide safe path to dissipate lightning and short circuit currents. 5. To provide stable platform for operation of sensitive electronic equipment's.
h)	**State the necessity of fuse.**
Ans:	**Necessity of fuse in the circuit:** (2 Marks) The fuse is provided in an electric circuit to protect the apparatus connected to it from being damaged due to excessive current. If **no** fuse is provided in the circuit then in case of fault a heavy current flows through the apparatus which may damage due to excessive current.
Q.1 B)	**Attempt any TWO of the following :** 08 Marks
a)	**Compare auto transformer & two winding transformer on the basis of (i) construction (ii) cost (iii) efficiency (iv) application**
Ans:	(Each Point : 1 Marks, Total marks 4)

S.No.	Points	Autotransformer	Two winding transformer
1.	**Construction**	Autotransformer is a transformer having only one winding.	Two winding transformer is a transformer having two windings
2.	**Cost**	Cost is less	Cost is high
3.	**Efficiency**	Autotransformer is more efficient.	Two winding Transformer are less efficient than auto transformer.
4.	**Application**	Variac, starting of ac motors, dimmerstat.	Mains transformer, power supply, welding, isolation transformer

b)	**Explain the working of resistance split phase induction motor with a neat diagram.**

Ans: **Circuit diagram of resistance split single phase induction motor:**

(Figure : 2 Marks & Working : 2 Marks)



or equivalent figure

- **Working of resistors split single phase induction motor:**

  To make a single phase induction motor self-starting, we should somehow produce a **rotating magnetic field**. This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding. In a split phase induction motor, the additional winding is known as auxiliary winding or starting winding.

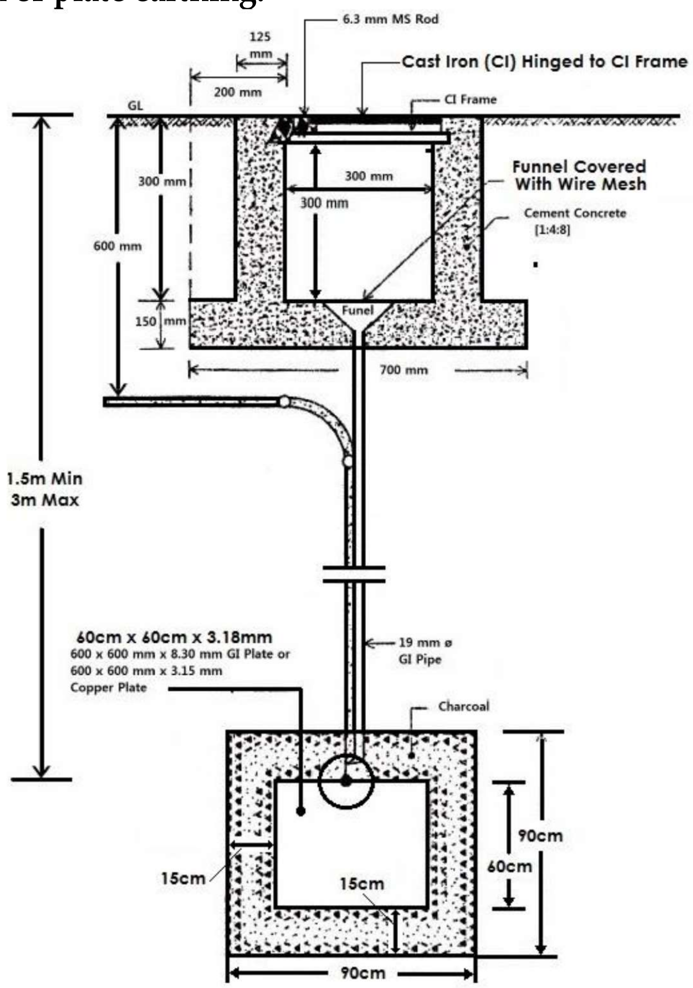
- Because of the high value of resistance in the starting winding, a phase shift of 30 to 40^0 is introduced in the current carried by starting and running windings. This creates rotating magnetic field and the motor starts running.
- A centrifugal switch S is connected in series with the starting winding

  It function is to automatically disconnected the starting winding from the supply

  Once motor is started.

l) **Draw a neat diagram of plate earthing.**

Ans: **Diagram of plate earthing:** **(4 Marks)**



Or Equivalent Figure

Q.2 **Attempt any FOUR of the following :** **16 Marks**

a) **Determine the current through 20 Ω resistance using Nodal voltage method in the fig. 1.**

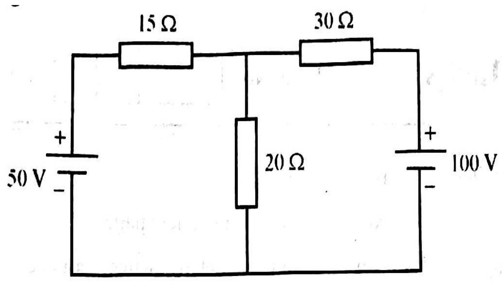
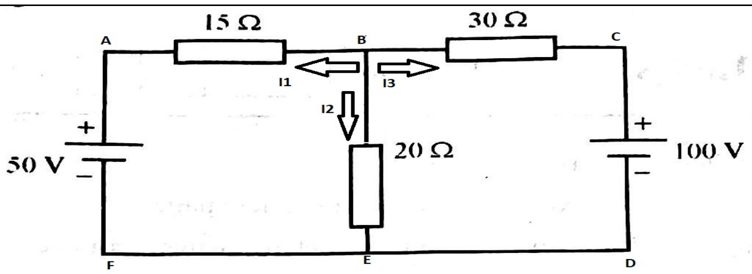


Fig. 1

Ans:



-----------------------(1 Marks)

Applying KCL at node B

$$\frac{V_B - 50}{15} + \frac{V_B}{20} + \frac{V_B - 100}{30} = 0 \quad ---------------------(1\ mark)$$

$$\frac{V_B}{15} - \frac{50}{15} + \frac{V_B}{20} + \frac{V_B}{30} - \frac{100}{30} = 0$$

$$\frac{V_B}{15} + \frac{V_B}{20} + \frac{V_B}{30} = \frac{100}{30} + \frac{50}{15}$$

$$V_B * (\frac{1}{15} + \frac{1}{20} + \frac{1}{30}) = \frac{100}{30} + \frac{50}{15}$$

$$V_B * \frac{3}{20} = \frac{20}{3}$$

$$V_B = \frac{20 * 20}{3 * 3}$$

$$V_B = 44.4444 \quad -------------------------(1\ Marks)$$

$$current\ through\ 20\ \Omega = \frac{V_B}{20} = \frac{44.4444}{20}$$

$$current\ through\ 20\ \Omega = 2.2222\ amp \quad -------------- (1\ Marks)$$

b) **For the circuit given in fig. 2 find the current I through 10 Ω by mesh analysis method.**

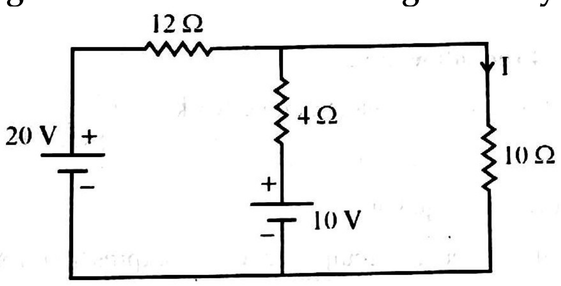
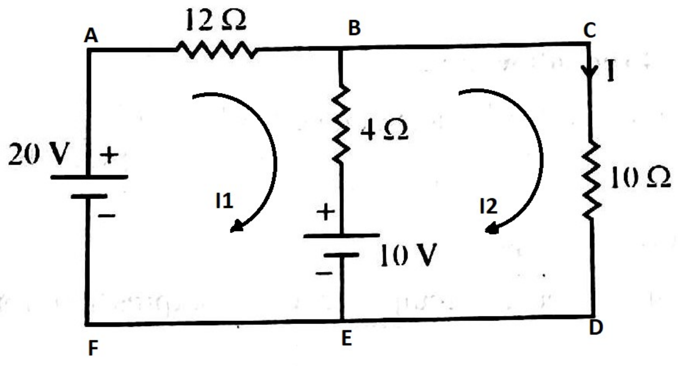


Fig. 2

Ans:



Applying KVL for loop ABEFA

$$20 - 12 * I_1 - 4(I_1 - I_2) - 10 = 0$$

$$20 - 12 * I_1 - 4 * I_1 + 4 * I_2 - 10 = 0$$

$$-16 * I_1 + 4 * I_2 = -10$$

$16 * I_1 - 4 * I_2 = 10 \quad - - - - - - eq.(1)$------ **(1 Marks)**

Applying KVL for loop BCDEB

$$-10 * I_2 + 10 - 4(I_2 - I_1) = 0$$

$$-10 * I_2 - 4 * I_2 + 4 * I_1 = -10$$

$4 * I_1 - 14 * I_2 = -10 - - - - - eq.(2)$ ------------**(1 Marks)**

Multiplying eq.(1)by 4

$$16 * I_1 - 4 * I_2 = 10 \quad - - - - - * 4$$

$64 * I_1 - 16 * I_2 = 40 \quad - - - - - - eq.(3)$ -------------------**(1/2 Marks)**

Multiplying eq.(2)by 16

$$4 * I_1 - 14 * I_2 = -10 - - - - - * 16$$

$64 * I_1 - 224 * I_2 = -160 - - - - - eq.(4)$-----------------**(1/2 Marks)**

Subtracting eq. (4) from eq. (3)

$$64 * I_1 - 16 * I_2 = 40$$

$$+ \; -64 * I_1 - 224 * I_2 = -160$$

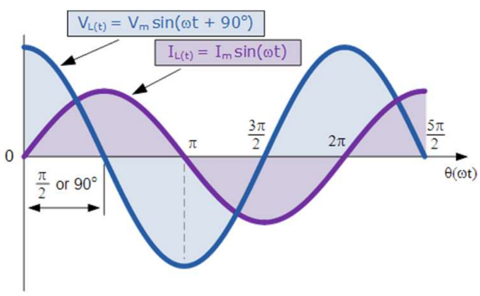
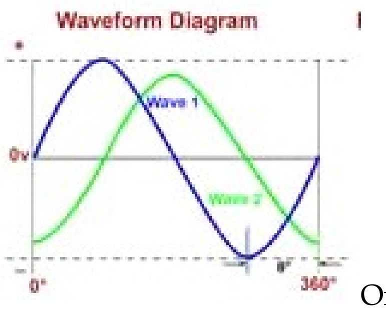
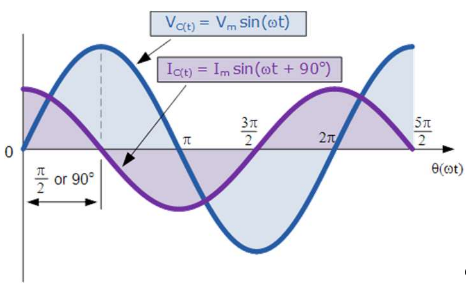
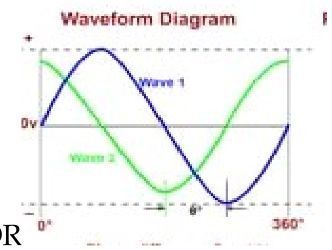
$$\quad + \qquad\qquad + $$

$$\overline{\qquad 208 * I_2 = 200}$$

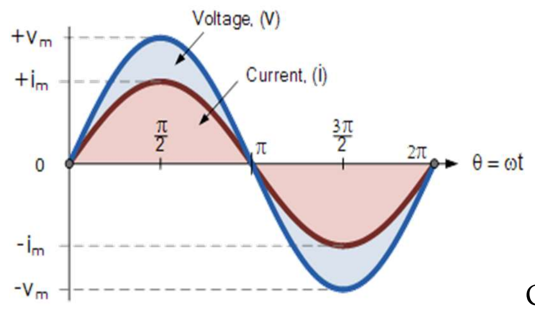
$$208 * I_2 = 200$$

$I_2 = 0.9615 amp$--------------------------------------**(1 Marks)**

Hence current flowing through 10Ω resistance is 0.9615 amp.

c)	**Define the following terms with respect to A.C : i) amplitude (ii) frequency (iii) RMS value (iv) angular velocity**
Ans:	**i) Amplitude:** **(1 Marks)** It is defined as the maximum or peak value attained by an alternating quantity during its positive or negative half cycle. **ii) Frequency:** **(1 Marks)** It is the number of cycles completed by an alternating quantity in one second. **iii) RMS value:** **(1 Marks)** For an alternating current, the RMS value is defined as that value of steady current (DC) which produces the same heat or power as is produced by the alternating current during the same time under the same conditions. **iv) Angular velocity:** **(1 Marks)** The angular velocity is defined as the rate of change of the angular displacement of a phasor or vector during its rotation about a point. Angular velocity $\omega = \theta/t$ rad/sec OR $\omega = 2\pi f\ rad/sec$
d)	**Draw A.C. waveforms showing (i) lagging quantities (ii) leading quantities (iii) in phase quantities (iv) out of phase quantities**
Ans:	**(i) lagging quantities** **(1 Marks)**  **OR**  Or Equivalent Figure **(ii) leading quantities** **(1 Marks)**  OR  Or Equivalent Figure

(iii) in phase quantities **(1 Marks)**



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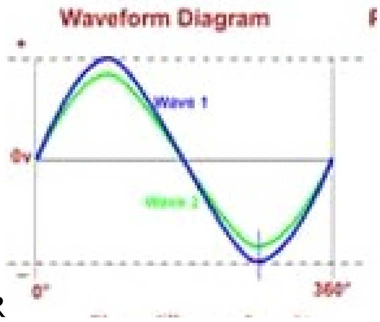
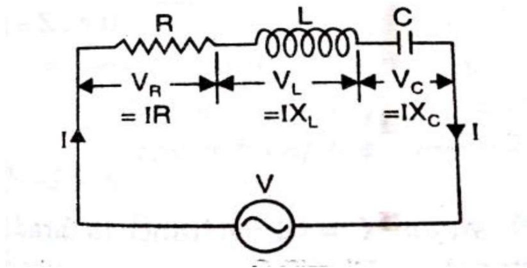


Or Equivalent Figure

(iv) Out of phase quantities **(1 Marks)**

Or Equivalent Figure

e)	**Draw series R-L-C circuit and describe resonance.**
Ans:	**Series R-L-C circuit:** **(Figure: 2 Mark & Description : 2 Mark)**



Explanation of Series R-L-C Resonance circuit:

A series circuit containing resistance, inductance and capacitance, is said to be resonant when the circuit power factor is unity,(XL = XC) i.e. applied voltage and current are in phase. This condition is termed as series resonance.

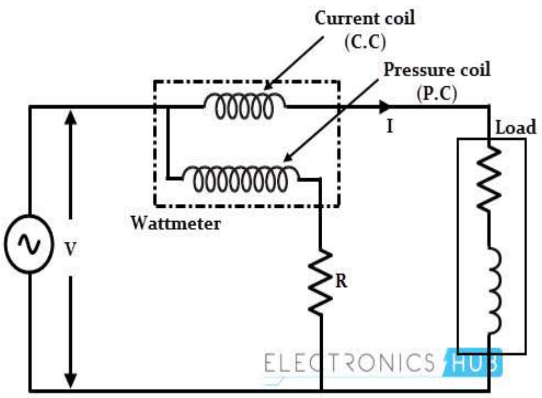
OR

In a series RLC circuit there becomes a frequency point were the inductive reactance of the inductor becomes equal in value to the capacitive reactance of the capacitor. In other words, $X_L = X_C$. The point at which this occurs is called the **Resonant Frequency** point, (f_r) of the circuit, and as we are analyzing a series RLC circuit this resonance frequency produces a **Series Resonance**.

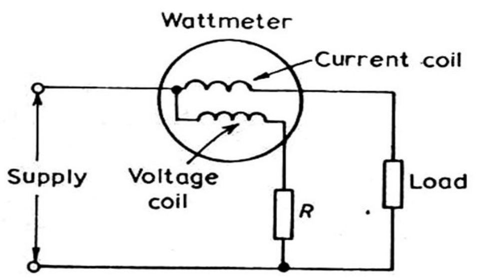
f)	**Draw and explain the circuit diagram for measurement of single phase power using dynamometer type wattmeter.**

Ans: **(Figure: 2 Mark & Explanation : 2 Mark)**

Circuit diagram for measurement of single phase power using dynamometer type wattmeter:



Dynamometer Type Wattmeter



OR

Or Equivalent Figure

Explanation:

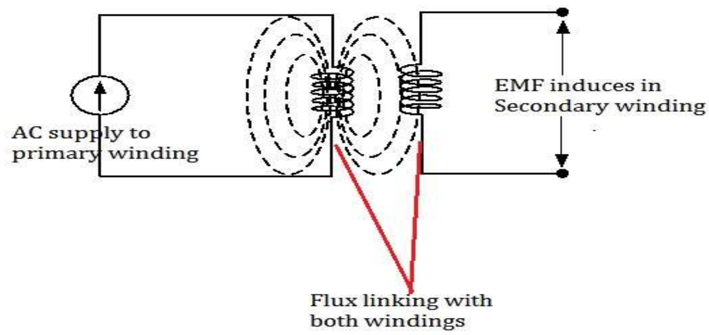
It consists of two stationary coils, called current coils and one moving coil, called voltage or potential coil. The moving coil is mounted on the spindle, in the gap between two stationary coils, as shown. The current coils are connected such that they carry the current proportional to (or equal to) the load current and the voltage coil is connected in such a way that it carries the current proportional to the load voltage.

The interaction between two magnetic fields causes the production of force on moving system, which is proportional to the product of voltage and current i.e. power. The meter can be calibrated directly to indicate the power in watts.

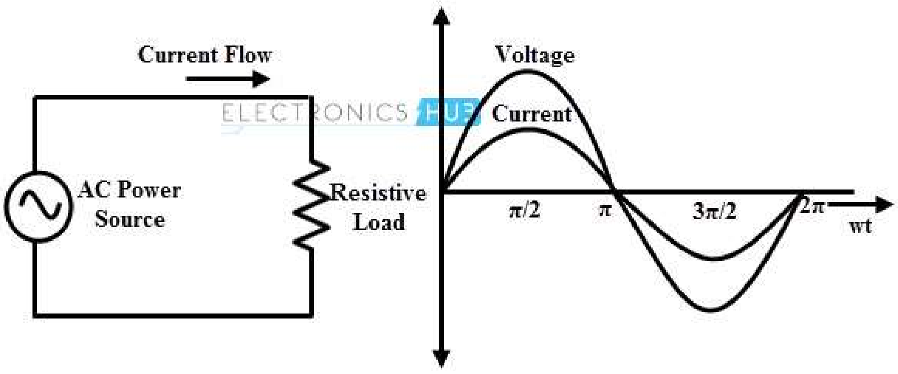
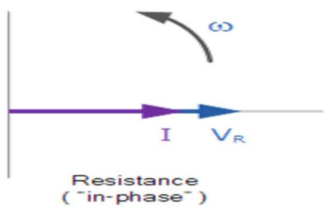
Q.3	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain two methods of statically induced emf.**

Ans: **(Each method 2 Marks, Total 4 Marks)**

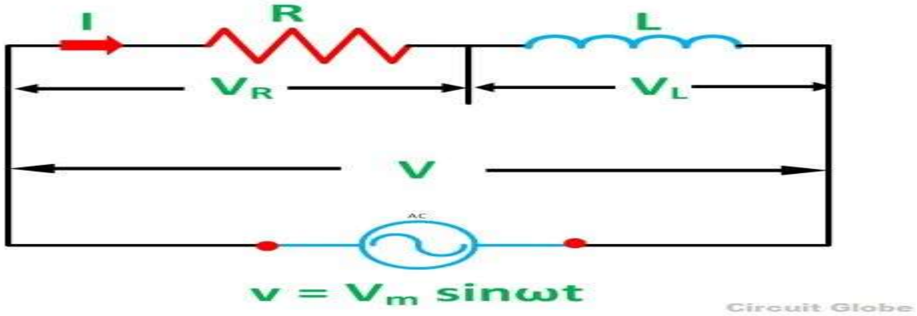
Figure:- Emf induced in Primary winding is self induced emf and Emf induced in Secondary winding is mutally induced emf



Example of Statically and Mutually induced EMF

	i) Self-induced emf : **Self-induced emf** is the e.m.f induced in the coil due to the change of flux produced by linking it with its own turns. This phenomenon of self-induced emf $e \, \alpha \frac{dI}{dt} or \;\; e = L \, \frac{dI}{dt}$ **OR** **ii) Mutually induced emf :** The emf induced in a coil due to the change of flux produced by another neighbouring coil linking to it, is called **Mutually Induced emf.** $e_m \; \alpha \frac{dI_1}{dt} or \;\; e = M \, \frac{dI_1}{dt}$
b)	**'Draw the circuit diagram, waveforms, phasor diagram of a simple resistive circuit, when ac is applied across it. Write voltage and current equations.**
Ans:	(Diagram:-1 Mark, Waveforms:-1 Mark, Phasor diagram 1Mark, Equation 1 Mark, Total 4 Marks)  **OR equivalent Figure**  Instantaneous value of voltage, V = Vm sin ωt Current can be written as , I= Im sin ωt

c)	**State Faraday's laws of electro-magnetic induction and explain.**
Ans:	**First Law: -** --(2 Mark) Whenever change in the magnetic flux linked with a coil or conductor, an EMF is induced in it. **OR** Whenever a conductor cuts magnetic flux, an EMF is induced in conductor. **Second Law:** -- (2 Mark) The Magnitude of induced EMF is directly proportional to (equal to) the rate of change of flux linkages. $e = \frac{-N}{dt} d\varphi$
d)	**An alternating voltage is represented by the following equation, v= 25 sin 200 nt. Find, (i) amplitude (ii) time period (iii) angular velocity (iv) frequency**
Ans:	Given v = 25 sin 200πt Compare with standard equation $V = V_m \sin \omega t$ • **Amplitude value:** $V_m = 25\ volt$ --(1 Marks) ➢ **frequency** $\omega = 2 * \pi * f$--(1/2 Marks) $200 * \pi = 2 * \pi * f$ $200 = 2 * f$ $f = 100\ hz$--(1/2 Marks) ➢ **Time period** $T = \frac{1}{f}$--(1/2 Marks) $T = \frac{1}{100}$ $T = 0.01\ sec$--(1/2 Marks) ➢ **Angular velocity:** $\omega = 2 * \pi * f$--(1/2 Marks) $\omega = 2 * \pi * 100$ $\omega = 200 * \pi$ $\boldsymbol{\omega} = \mathbf{628.39\ rad/sec}$ --(1/2 Marks)

e)	**For R-L series circuit, write voltage and current equations. Write the equation for power and state the nature of power factor.**
Ans:	 1.The equation Of voltage :- $$v = V_m \sin\omega t ....(1)$$ ---------------------------------(1 Marks) 2.The equation of current :- $$i = I_m \sin(\omega t - \varphi) \ldots\ldots\ldots (2)$$ ------------------------------(1 Marks) 3.The equation of power:- P= VICosØ---------------------------------(1 Marks) 4.Nature of Power Factor:- ➢ **Lagging in nature** ----------------- ----- (1 Marks)
f)	**State different types of power in ac circuits. Write the expression and units for the same. Draw the power triangle.**
Ans:	**i) Active Power (P):-** (1 Mark) The active power is defined as the average power P_{avg} taken by or consumed by the given circuit. $P = V.I.Cos\phi$ **Unit: -** Watt **OR** Kilowatt

ii) Reactive Power (Q):- **(1 Mark)**

The reactive power is defined as the product of voltage and current (V, I) and sine of angle between voltage (V) and current (I) i.e. ϕ

OR

The power which flows back and froth that mean it moves in both the direction in the circuit or react upon itself, is called Reactive Power.The reactive power is measured in volt ampere reactive (kVAR).

$Q = V.I. \sin \phi$

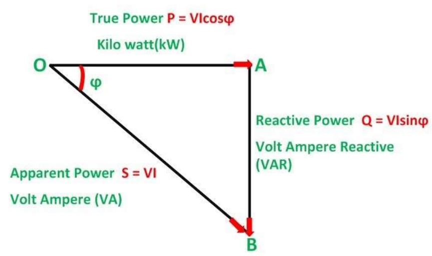
Units: - VAR **OR** KVAR

iii) Apparent Power (s):- **(1 Mark)**

Apparent power is defined as the product of rms values of voltage (v) and current (I) it is given by

S=V.I **Units: -** VA **OR** KVA

iv) Power Triangle: **(1 Mark)**



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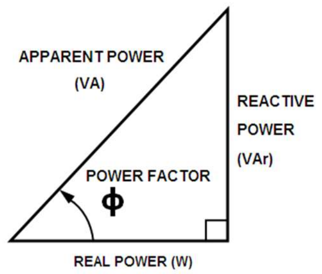
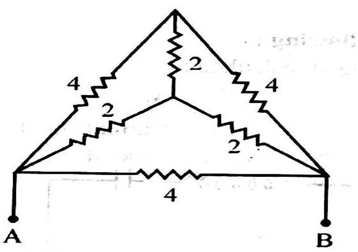


Equivalent Fig.

Q.4 Attempt any FOUR of the following : **16 Marks**

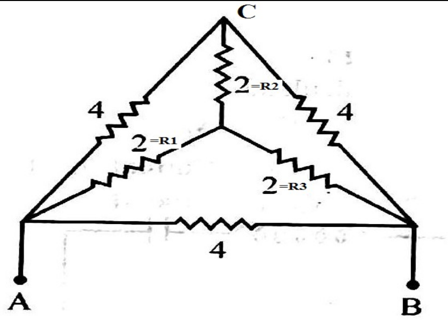
a) **Calculate the equivalent resistance between A & B using star-delta conversion for fig. 3.**



(All resistances are in Ω)

Fig. 3

Ans:



Converting Inner star in to delta- ---------------------------------- **(1 Mark)**

$$R_{12} = \frac{R_1 * R_2 + R_2 * R_3 + R_3 * R_1}{R_3} = \frac{2*2+2*2+2*2}{2} = 6\ \Omega$$

$$R_{23} = \frac{R_1 * R_2 + R_2 * R_3 + R_3 * R_1}{R_1} == \frac{2*2+2*2+2*2}{2} = 6\ \Omega$$

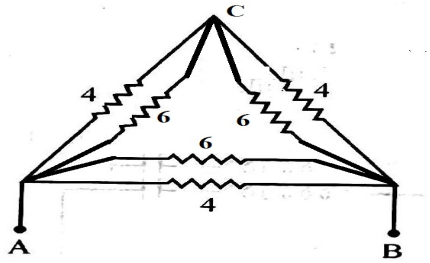
$$R_{13} = \frac{R_1 * R_2 + R_2 * R_3 + R_3 * R_1}{R_2} == \frac{2*2+2*2+2*2}{2} = 6\ \Omega$$

$$OR$$

$$R_{12} = R_1 + R_2 + \frac{R_1 * R_2}{R_3} = 2 + 2 + \frac{2*2}{2} = 6\ \Omega$$

$$R_{23} = R_2 + R_3 + \frac{R_2 * R_3}{R_1} = 2 + 2 + \frac{2*2}{2} = 6\ \Omega$$

$$R_{13} = R_1 + R_3 + \frac{R_1 * R_3}{R_2} = 2 + 2 + \frac{2*2}{2} = 6\ \Omega$$

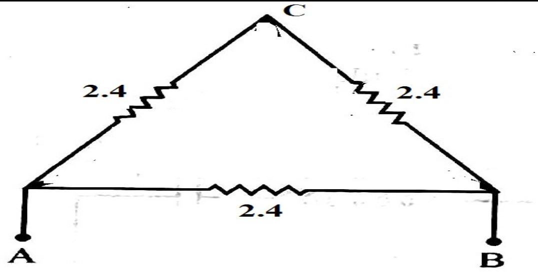


Resistances 4 and 6 are in parallel in all branch so ---------------------------------- **(1 Mark)**

$$R_{AC} = \frac{4*6}{4+6} = 2.4\ \Omega$$

$$R_{AB} = \frac{4*6}{4+6} = 2.4\ \Omega$$

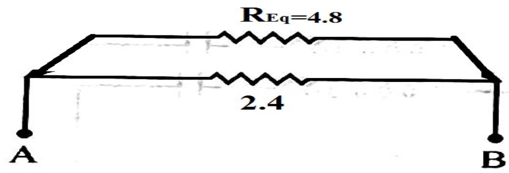
$$R_{BC} = \frac{4*6}{4+6} = 2.4\ \Omega$$



R_{AC} & R_{BC} *are in series*

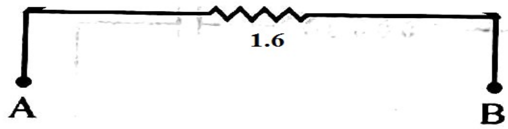
$$R_{Eq} = R_{AC} + R_{BC} = 2.4 + 2.4 = 4.8\ \Omega$$

$R_{Eq} = 4.8\ \Omega$--(1 Mark)



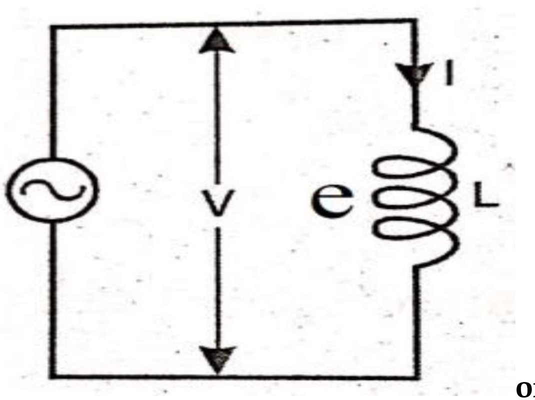
4.8 *and* 2.4 *are in parallel*

$R_{AB} = \frac{4.8*2.4}{4.8+2.4} = 1.6\ \Omega$------------------------------------ (1 Mark)



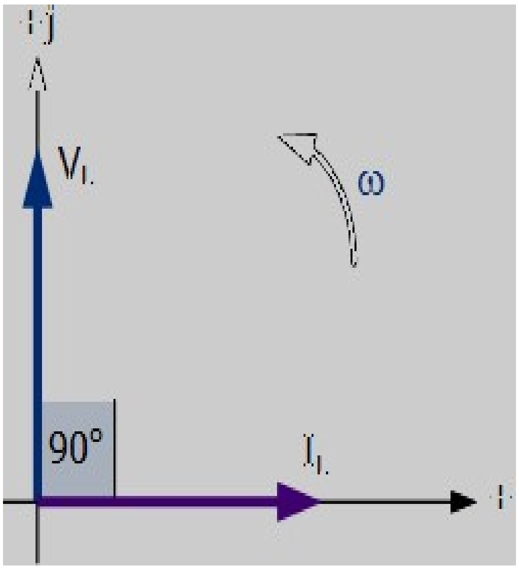
b) **Draw the schematic circuit diagram of ac flowing through pure inductance. Write the expression for voltage and current. Draw the phasor diagram.**

Ans: **Schematic diagram of AC flowing through pure inductance:** (1 Mark)



or equivalent Diagram

Pure inductance circuit Phasor Diagram : (Waveform not expected) (1 Mark)

	Phasor Diagram :  **or equivalent figure** **Expression for Voltage and Current:** 1. Equation for voltage V= V_m sin ωt **(1 Mark)** 2. Equation for current I = I_m sin $(\omega t-\frac{\pi}{2})$ or I_m sin $(\omega t-90^0)$ **(1 Mark)**
c)	**Define power factor. State its significance. What is the condition for unity power factor ?**
Ans:	**Definition of Power factor:** **(1.5 Mark)** Power factor is cosine of angle between voltage and current. **OR** $\cos\phi = R/Z$ **OR** Power factor is the ratio of active power to the apparent power $P.f = KW/KVA$ **Significance of Power factor: (Any two point expected)** **(1.5 Mark)** 1. P.F. increases current reduce so; cross section of conductor decreases hence its cost is educes. 2. P.F. increases current reduce so, cross section of conductor decreases hence weight decreases. So design of supporting structure becomes lighter. 3. Copper losses decreases, hence transmission efficiency increases.

4. Voltage drop reduces, hence voltage regulation becomes better
5. Handling capacity (KW) of each equipment increases as p.f. increases.
6. Less capacity (KVA) rating of equipments are required so capital cost decreases.

The condition for unity power factor: **(1 Mark)**

- When cosine of angle between voltage and current **is zero.**

OR

- When R = Z

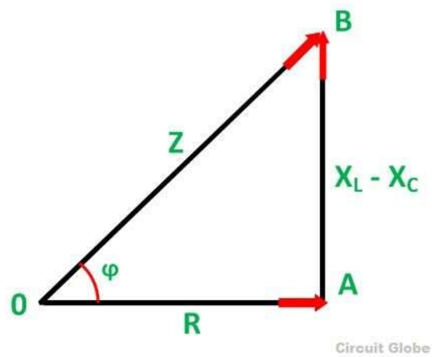
OR

- When KW = KVA

d) Draw the impedance triangle for series RLC circuit for (i) XL > Xc (ii) XC > XL

Ans: **i) Phasor Diagram for XL > Xc** **(2 Marks)**

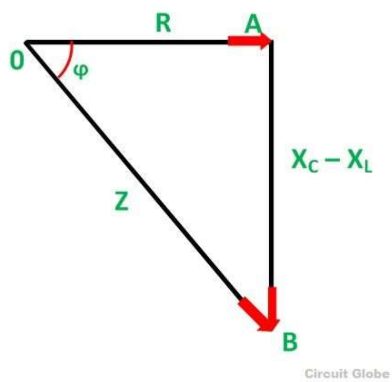
The impedance triangle of the RLC series circuit, when $X_L > X_C$ is shown below



or equivalent figure

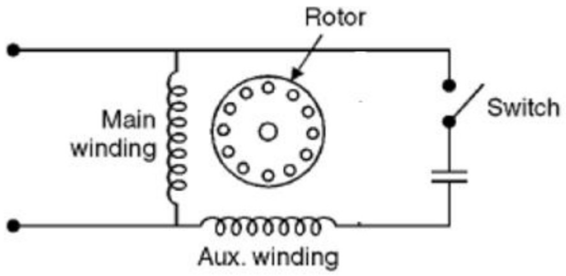
ii) Phasor Diagram for XC > XL **(2 Marks)**

The impedance triangle of the RLC series circuit, when $X_c > X_L$ is shown below



or equivalent figure

e)	**State and explain the working principle of capacitor start single phase induction motor.**
Ans:	**(Figure: 2 Mark & Explanation : 2 Mark)**



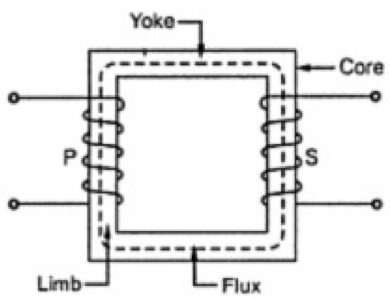
or Equivalent Figure

working principle of capacitor start single phase induction motor:

- In this motor, auxiliary winding is in series with a capacitor and remains in the circuit only during starting.
- Due to capacitor, the phase difference of approximately 90^0 is obtained between main and auxiliary winding currents which results in production of rotating magnetic field.
- This rotating magnetic field is cut by stationary rotor conductors; emf is induced in it, so according to faradays law of electromagnetic induction motor starts rotating.
- After attaining 75-80% of rated speed, centrifugal switch in series with auxiliary winding get opened and auxiliary winding gets disconnected.
- The motor then continues to run without capacitor & only with main winding in the circuit.

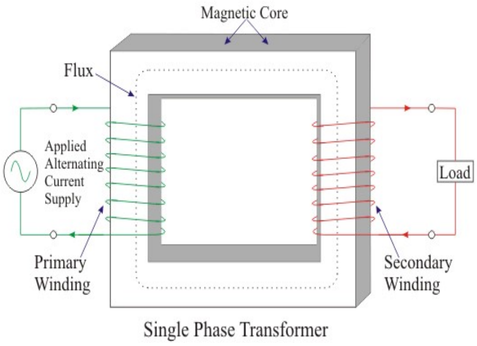
f)	**Draw a labelled diagram showing constructional details of core type single phase transformer. State its working principle.**
Ans:	**(Construction 2 Marks, Working 2 Marks)**

construction of single phase transformer : **(2 Marks)**



(a) Representation

OR



Single Phase Transformer

or equivalent figure

Working Principle: - -- (2 Marks)

- The primary winding is connected to single phase AC supply. an ac current starts flowing through primary winding.
- The AC primary current produces an alternating flux in the magnetic core.
- This Changes flux gets linked with the secondary winding through the magnetic core
- The varying flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction.

Q.5	**Attempt any FOUR of the following : 16 Marks**
a)	**A 318 μF capacitor is connected across 230 V, 50 Hz system. Determine capacitive reactance, RMS value of current and equations for voltage and current.**

Ans: Given :- C= 318μF

V=230v

F=50Hz

1) $X_C = \frac{1}{2\pi f C}$ -- **(1/2 Mark)**

$= \frac{1}{2 * \pi * 50 * 318 * 10^{-6}}$

$X_C = 10.0097\Omega$--- **(1/2 Mark)**

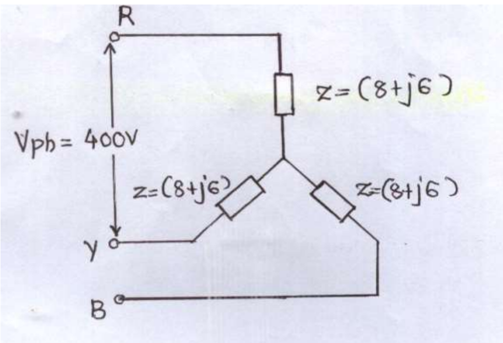
2) $I_{rms} = \frac{V}{X_c}$-- **(1/2 Mark)**

$= \frac{230}{10.0097}$

$I_{rms} = 22.9777$ amp-- **(1/2 Mark)**

	$I_m = \frac{I_{rms}}{0.707} = \frac{22.9777}{0.707}$ $I_m = 32.5002amp$ $V_m = \frac{V_{rms}}{0.707} = \frac{230}{0.707}$ $V_m = 325.3182v$ $\omega = 2\pi f\ rad/sec$ $= 2\pi * 50$ ω = 314.1592 radian/second or $\omega = 100\pi$ 3)Voltage equation (v) = 325.3182 sin(314.1592t) v--- **(1Mark)** 4) Current equation (i) = 32.5002 sin(314.1592t + $\frac{\pi}{2}$) amp------------------------------------- **(1 Mark)**
b)	**Write the relationship for phase and line voltages & currents for the following :** **(i) star connected system (ii) delta connected system**
Ans:	**(i) Star connected:** **(2 Mark)** **a)** The relation between line current and phase current in star connected load. $I_L = I_{ph}$ **b)**The relation between line voltage and phase voltage in star connected Load $V_L = \sqrt{3}\ V_{Ph}$ **(ii) Delta connected load:** **(2 Mark)** **a)** The relation between line current and phase current in delta connected circuit. $I_L = \sqrt{3}\ I_{ph}\ \ OR\ \ I_{ph} = I_L/\sqrt{3}\ \ \ where\ I_L\ is\ line\ Current\ and\ I_{ph}\ is\ phase\ Currnts$ **b)** The relation between line voltage and phase voltage in delta connected circuit $V_{ph} = V_L\ \ \ where\ V_L = line\ voltage\ \&\ Vph = Phase\ volatge$

c)	**Explain the following terms in 3-ph : (i) phase sequence (ii) balanced load**
Ans:	**1. Phase sequence:** **(2 Mark)** **Phase sequence**, is the order in which the voltage waveforms of a poly-phase AC source reach their respective peaks. **ii) Balanced load :** **(2 Mark)** A **balanced load** is a **load** that draws the same current from each **phase** of the **three-phase system.**
d)	**Three impedances of (8 + j6) ohm each are connected in star to a 3-ph, 440 V, 50 Hz balanced ac supply. Calculate line voltage, phase voltage, line current, phase current, power and power factor.**
Ans:	**Solution:-**



or equivalent fig

i) line voltage V_L = 440 Volt

In Star connection $V_{Ph} = \frac{V_L}{\sqrt{3}}$ ------------------------------------- **(1/2 Mark)**

ii) Phase voltage V_{ph} = 440 Volt

$$V_{Ph} = \frac{440}{\sqrt{3}} = 254.034 \ \ volt$$ --- **(1/2 Mark)**

iii) Phase current (I_{ph}) ;

$$Phase\ current\ \ (I_{Ph}) = \frac{V_{Ph}}{Z_{Ph}}$$

$$Phase\ current\ \ (I_{Ph}) = \frac{254.034}{(8+j6)} = \frac{254.034}{10\ \angle 36.86}$$

$$Phase\ current\ \ (I_{Ph}) = 25.403\ \angle -36.86$$ -------------------------- **(1/2 Mark)**

iv) Line current (I_{line}) ;

Phase current is equal to line current :-

$$\therefore Line\ \ current\ \ (I_L) = 25.403\ \angle -36.86$$ ----------------------------- **(1/2 Mark)**

v) Power factor.

$$\therefore\ \ Power\ \ \ factor\ = Cos\,\phi = Cos\ (36.86)$$

$$\therefore\ \ Power\ \ \ factor\ = Cos\,\phi = 0.80\ \ lagging$$ -------------------------------- **(1 Mark)**

vi) Power:

$$P\ = 3 * V_{ph} * I_{ph} * \cos\theta$$ ------------------------------------ **(1/2 Mark)**

$$P\ = 3 * 254.034 * 25.403 * 0.8$$

$$P\ = 15487.7416\ watt$$ ------------------------------------ **(1/2 Mark)**

e)	**List any four advantages of 3-ph systems over 1 -ph systems.**
Ans:	**Advantages of 3-phase supply over 1-phase supply:**

(Any Four advantages expected or equivalent : 1 Mark each, Total marks 4)

1. **More output:-**

For the same size output of poly-phase machines is always higher than single phase machines.

2. **Smaller size:-**

For producing same output the size of three phase machines is always smaller than that of single phase machines.

3. **More power is transmitted:-**

It is possible to transmit more power using a three phase system than single system.

4. **Smaller cross-sectional area of conductors:-**

For the same amount of power is transmitted then the cross-sectional area of the conductors used for three phase system is small as compared to that of single phase system.

5. **Better power factor:-**

Power factor of three phase machines is better than that of single phase machines.

6. Power delivered by a single phase system fluctuates whereas for three phase system power delivered to the load is the same at any instant.

f) Define voltage regulation and efficiency of single phase transformer.

Ans: **i) Voltage Regulation: --(2 Mark)**

The voltage regulation of the transformer is the percentage change in the output voltage from no-load to full-load.

Mathematically, the voltage regulation is represented as

$$\text{Voltage Regulation} = \frac{E_2 - V_2}{E_2}$$

$$\%\ \text{Voltage Regulation} = \frac{E_2 - V_2}{E_2} \times 100$$

where,
E_2 – secondary terminal voltage at no load
V_2 – secondary terminal voltage at full load

ii) Efficiency:- ---(2 Mark)

It is the ratio of output power to the input power of the transformer.

OR

$$\eta = \frac{\text{output power}}{\text{input power}} = \frac{\text{output power}}{\text{output power} + \text{losses}}$$

$$\eta = \frac{\text{output power}}{\text{output power} + \text{iron losses} + \text{copper losses}}$$

$$\eta = \frac{V_2 I_2 \cos\varphi_2}{V_2 I_2 \cos\varphi_2 + P_i + P_c}$$

Q.6	**Attempt any FOUR of the following : 16 Marks**
a)	**or the circuit given in fig. 4, calculate : (i) X_L=2πf L (ii) Xc (iii) Z (iv) Current (I_{rms})**

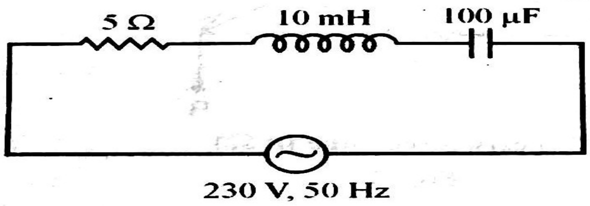


Fig. 4

Ans:

i) X_L

$X_L = 2\pi f L$-- **(1/2 Mark)**

$= 2\pi \times 50 \times 0.01$

$X_L = 3.1415\ \Omega$--- **(1/2 Mark)**

ii) X_C

$X_C = \frac{1}{2\pi f C}$ -- **(1/2 Mark)**

$= \frac{1}{2 * \pi * 50 * 100 * 10^{-6}}$

$X_C = 31.8309\Omega$-- **(1/2 Mark)**

iii) Impedance Z =

$\text{Im} pedance\ \ Z = \sqrt{(R)^2 + (X_l - Xc)^2}$ ------------------------------------- **(1/2 Mark)**

$\therefore Z = \sqrt{5^2 + (3.1415 - 31.8309)^2}$

$\therefore Z = \sqrt{25 + (-28.6894)^2}$

$\therefore Z = \sqrt{25 + 823.0816}$

$\therefore Z = \sqrt{848.0816}$

$\therefore Z = 29.1218\ \Omega$-- **(1/2 Mark)**

Or

$Z = R + j(X_L - X_C)$ -- **(1/2 Mark)**

$Z = 5 + j(3.1415 - 31.8309)$

$Z = 5 - j(28.6894)$

$Z = 29.1218\angle -80.1137$-- **(1/2 Mark)**

	iv) To Find Current= $I = \frac{V}{Z}$-- **(1/2 Mark)** $I = \frac{230}{29.1218} = 7.8978$ I=7.8978 Amp --- **(1/2 Mark)**
b)	**A coil of resistance 10 Ω and inductance 0.1 H is connected in series with a capacitor of 150 μF across 220 V, 50 Hz supply. Calculate : (i) impedance (ii) current (iii) active power (iv) power factor**
Ans:	**I= V/Z** **i) X_L =** $X_L=2\pi fL$ $= 2\pi\times50\times0.1$ $X_L= 31.4159\ \Omega$ **ii) X_C =** $X_C=\frac{1}{2\pi\, f\, C}$ $=\frac{1}{2\pi\times50\times150\times10^{-6}}$ $\boldsymbol{X_C = 21.2206\ \Omega}$ **iii) Impedance Z =** $\text{Im}\,pedance\ \ Z\ =\sqrt{(R)^2+(X_l-Xc)^2}$ --- **(1/2 Mark)** $\therefore Z = \sqrt{10^2 + (31.4159 - 21.2206)^2}$ $\therefore Z = 14.2809\ \Omega$--- **(1/2 Mark)** **Or** $Z = R + j(X_L - X_C)$ -------------------------------------- **(1/2 Mark)** $Z = 10 + j(31.4159 - 21.2206)$ $Z = 10 + j(10.1953)$ $Z = 14.2812\angle 45.5554$-------------------------------------- **(1/2 Mark)** **iv) To Find Current=** $\boldsymbol{I = \frac{V}{Z}}$--- **(1/2 Mark)** $I = \frac{230}{14.2812\angle 45.5554} = 16.1050\angle -45.5554$

	$I = 16.1050\angle -45.5554$ Amp --- (1/2 Mark)
	iii) power factor
	$\cos\emptyset = \frac{R}{Z}$-- (1/2 Mark)
	$\cos\emptyset = \frac{10}{14.2812} = 0.7002$--- (1/2 Mark)
	or
	$\cos\emptyset = \cos 45.5554 = 0.7002$-------------------------------(1 Mark)
	Power Consumed P :
	$\therefore P = V\ I\ Cos\ \phi$ -- (1/2 Mark)
	$P = 230 * 16.1050 * 0.7002$
	$P = 2593.6458\ Watt$-- (1/2 Mark)
c)	**Distinguish between star connected system and delta connected system.**
Ans:	**Compare Star and Delta connected system:**
	(Any Four Point expected : 1 Mark each, Total 4 marks)

S.No	Star connected system	Delta connected system
1	In STAR connection, the starting or finishing ends (Similar ends) of three coils are connected together to form the neutral point. A common wire is taken out from the neutral point which is called Neutral.	In DELTA connection, the opposite ends of three coils are connected together. In other words, the end of each coil is connected with the start of another coil, and three wires are taken out from the coil joints
2	There is a **Neutral** or **Star Point**	No Neutral Point in Delta Connection.
3	Three phase four wire system is derived from Star Connections (**3-Phase, 4 Wires System**) We may Also derived 3 Phase 3 Wire System from Star Connection.	Three phase three wire system is derived from Delta Connections **(3-Phase, 3 Wires System)**
4	Line Current is Equal to Phase Current. i.e. Line Current = Phase Current $\mathbf{I_L = I_{PH}}$	Line Voltage is Equal to Phase Voltage. i.e. Line Voltage = Phase Voltage $\mathbf{V_L = V_{PH}}$
5	Line Voltage is √3 times of Phase Voltage. i.e. $\mathbf{V_L = \sqrt{3}\ V_{PH}}$	Line Current is √3 times of Phase Current. i.e. $\mathbf{I_L = \sqrt{3}\ I_{PH}}$

d)	**State the emf equation of transformer and write meaning of each term. Also, define transformation ratio.**
Ans:	➤ **EMF equation of Transformer:- --(2 Marks)**

$$E_1 = 4.44\, f\, \phi m N_1$$

$$\mathbf{E_1 = 4.44\, f\, BmAN_1}$$

And

$$E_2 = 4.44\, f\, \phi m N_2$$

$$\mathbf{E_2 = 4.44\, f\, Bm\, A\, N_2}$$

Let, E_1 = Primary emf

E_2 = Secondary emf

N_1= Number of turns in the primary

N_2= Number of turns in the Secondary

Øm= Maximum flux in core (wb)

Bm= Flux density (wb/m^2 /Tesla)

A= Area of cross section of core m^2

F = Frequency

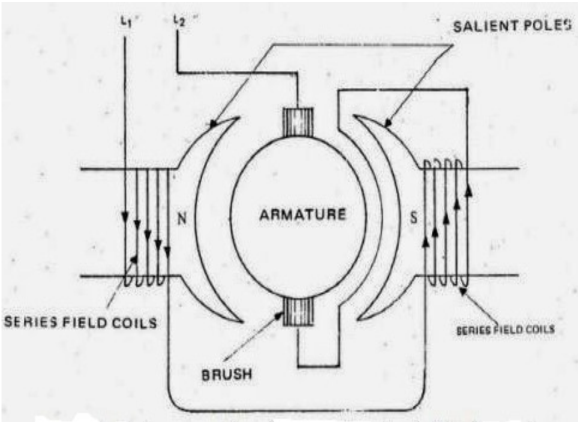
➤ **Transformation Ratio (k):- ---(2 Marks)**

It is the ratio of secondary number of turns to primary number of turns. OR It is the ratio of secondary voltage to primary voltage. **OR** It is the ratio of primary current to secondary current.

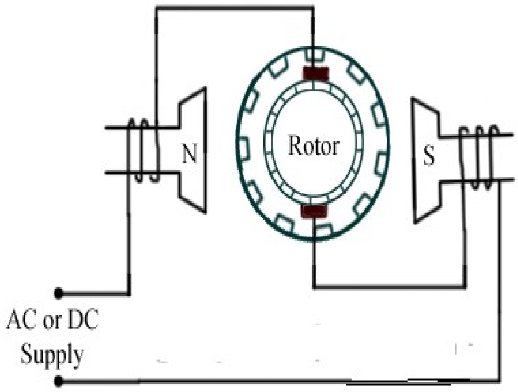
OR

$$Transformation\ \ ratio\,(k) = \frac{N_2}{N_1}\ or = \frac{E_2}{E_1}\ or = \frac{V_2}{V_1}\ or = \frac{I_1}{I_2}$$

e)	**State the principle of operation of universal motor with a neat diagram.**
Ans:	**Figure of Universal motor:** **(Figure : 2 Marks & Explanation : 2 Marks)**



OR



OR Equivalent figure

Working of universal motor: **(Following or equivalent working is to be accepted)**

- A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due to this mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule.

  When fed with AC supply, it still produces unidirectional torque. Because, armature winding and field winding are connected in series, they are in same phase. Hence, as polarity of AC changes periodically, the direction of current in armature and field winding reverses at the same time. Thus, direction of magnetic field and the direction of armature current reverses in such a way that the direction of force experienced by armature conductors remains same. Thus, regardless of AC or DC supply, universal motor works on the same principle that DC series motor works.

f)	**State any four safety precautions against electric shock.**
Ans:	**The Following are the precautions against electrical shocks:-** **(Following or equivalent safety precautions is to be accepted 1 Mark each, Total 4 Marks)** 1. Avoid working on live parts. 2. Switch off the supply before starting the work. 3. Never touch a wire till you are sure that no currents are flowing. 4. Do not guess, whether electric current is flowing through a circuit by touching. 5. Insulate yourself on the insulating material like wood, plastic etc. before starting the work on live main. 6. Your hand & feet must be dry (not wet) while working on live main. 7. Rubber mats must be placed in front of electrical switch board/ panel. 8. Use hand gloves, Safety devices & proper insulated tools. 9. Ground all machine tools, body, and structure of equipment's. 10. Earthing should be checked frequently. 11. Do not use aluminum ladders but use wooden ladders. 12. Use proper insulated tools & safety devices. 13. Do not work on defective equipment. 14. Use shoes with rubber soles to avoid shock. 15. Do not work if there is an unfavorable condition such as rain fall, fog or high wind. 16. Avoid using electrical equipment near wet, damp areas. 17. Use approved discharge earth rod for before working. 18. Do not Do the work if you are not sure or knowledge of the condition of equipment/ machine.

---END---