SUMMER– 2017 Examinations

Model Answer **Subject Code: 17331 (ETG)**

Important Instructions 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 principal components indicated in the 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 of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7. For programming language papers, credit may be given to any other program based on equivalent concept.

1 (A) Attempt any SIX of the following: **12**

1 A) a) Define current. State its unit.

Ans:

Electric current: — 1 Mark for definition

It is a measure of the amount of electrical charge transferred per unit time. It represents the flow of electrons through a conductive material, such as a metal wire.

Unit: 1 coulomb/second. OR — 1 Mark for unit

Its unit is ampere represented by A.

1 A) b) State the formula to find equivalent resistance when three resistances are connected in parallel.

Ans: — 2 Marks

$$\frac{1}{R}=\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R3}$$

1 A) c) Define peak factor for sine wave and state its value.

Ans:

The peak factor of an alternating quantity is defined as the ratio of its maximum value to the rms value. — 1 Mark for definition

Peak factor = (maximum value/rms value) — 1 Mark for value

Peak factor = Imax/(Imax/√2) = **1.414** for sine wave.

1 A) d) Write formula for inductive reactance and capacitive reactance.

Ans: — 1 Mark for formulae

Inductive reactance $X_L = 2\pi f L$

Capacitive reactance $Xc = \frac{1}{2\pi f C}$ — 1 Mark for meaning of terms

where, f is the frequency of current or voltage in hertz (Hz),

L is the inductance in henry (H),

C is the capacitance in farad (F).

1 A) e) List the types of induced emf.

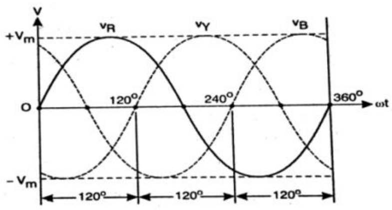
Ans:

There are mainly two types of induced emf: — 1 Mark each

1. Statically Induced EMF.
2. Dynamically Induced EMF.

1 A) f) Draw wave form of voltage of 3 phase AC supply.

Ans: — 2 Marks for labeled diagram; 1 Mark for unlabeled diagram



1 A) g) List out the losses occurring in transformer.

Ans:

(1) Iron losses: (a) Eddy current losses (b) Hysteresis losses — 1 Mark

(2) Copper losses — 1 Mark

1 A) h) State the need of earthing in electrical systems.

Ans:

Need of Earthing:

- Earthing is provided to protect human from shocks due to leakage current. **OR** — 2 Marks
- Earthing is to ensure safety or protection of electrical equipment and Human by discharging the electrical leakage current to the earth.

1 (B) Attempt any TWO of the following: 8

1 B) a) Write the equations of instantaneous values of voltage and current through a pure inductor. Draw the wave form and phasor diagram of voltage and current.

Ans:

Equations of instantaneous values of voltage and current through a pure inductor — 1 Mark for each equation

$v = Vm\ sin\omega t$

$i = Im \sin\left(\omega t - \frac{\pi}{2}\right)$

OR

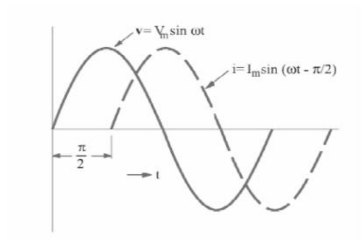
The equations can be expressed as:

$v = Vm \sin(\omega t + \frac{\pi}{2})$

$i = Im \sin(\omega t)$

1 Mark for phasor diagram

Voltage And Current Waveforms:

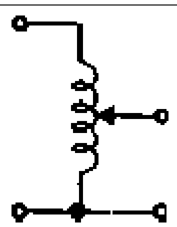
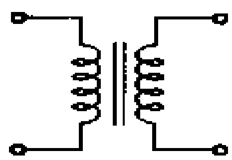


1 Mark for waveform

1 B) b) Compare Auto transformer with two winding transformer based on construction, working principle, application and cost.

Ans:

Comparison of Auto transformer with two winding transformer:

Sr. No.	Point	Auto transformer	Two winding transformer
1	Construction	 It has one winding.	 It has two windings.

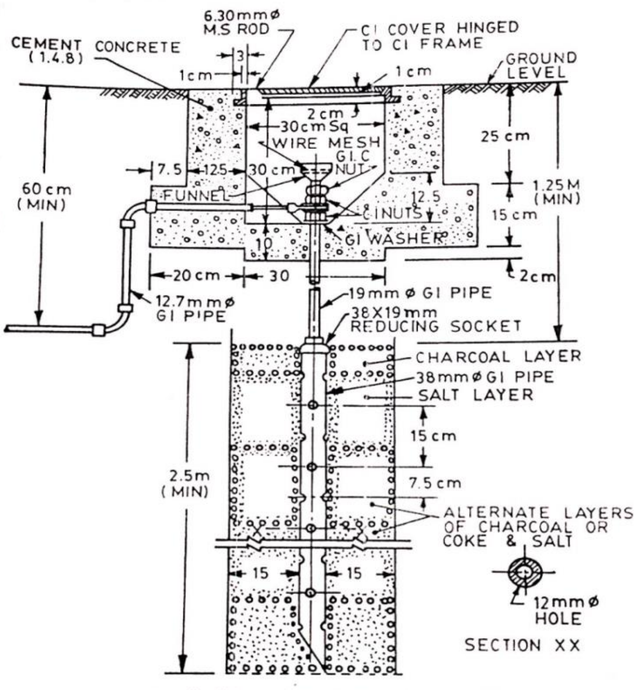
1 Mark for each point = 4 marks

2	Working principle	Self- induction	Mutual induction
3	Application	Variac, starting of ac motors, dimmerstat	Power / Distribution transformer, power supply, welding, isolation transformer
4	Cost	Cost is low (Economical)	Cost is high (Expensive)

1 B) c) Draw a neat labelled diagram of pipe earthing.

Ans:

Pipe earthing:



A typical illustration of pipe earthing.

4 Marks for labeled diagram

3 or 2 Marks for partially labeled diagram

1 Mark for unlabeled diagram

2 Attempt any FOUR of the following: 16

2 a) Find the value of current flowing through 10Ω resistor using Kirchhoff's voltage law as shown in fig. no.1.

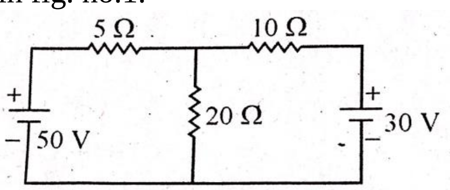
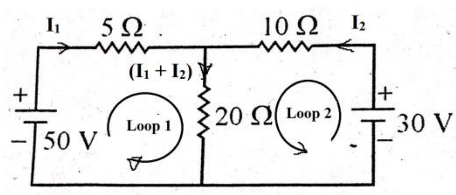


Fig. no. 1



Ans:

Consider Loop 1 and apply KVL to it

$-5I_1 - 20\,(I_1 + I_2) + 50 = 0$

$-25I_1 - 20I_2 = -50$

$5I_1 + 4I_2 = 10$ …………..(1)

Consider Loop 2 and apply KVL to it

$-10I_2 - 20(I_1 + I_2) + 30 = 0$

$-30I_2 + 30 - 20I_1 = 0$

$2I_1 + 3I_2 = 3$ ------------------- (2)

Multiply eq (1) by 2 and eq (2) by 5, we get

$10I_1 + 8I_2 = 10$ -------------------------(3)

$10I_1 + 15I_2 = 15$ ------------------------(4)

Subtracting eq (3) from eq (4), We get

$7I_2 = 5 \quad \therefore \quad I_2 = \frac{5}{7} = 0.714$ A

Hence current through 10Ω resistance is,

$I_2 =$ **0.714A**

1 Mark for identifying loops
1 Mark for eq. (1) & eq. (2)
1 Mark for solving equation
1 Mark for Final answer

2 b) Find value of equivalent resistance between points A and B for circuit shown in fig. no. 2.

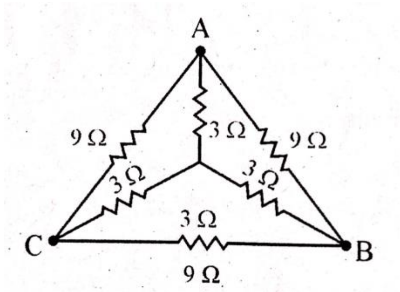


Fig. no. 2

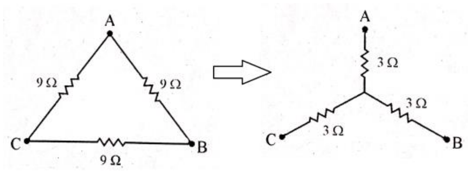
Ans:

1) Converting outer delta having each resistance of 9 Ω into equivalent star:

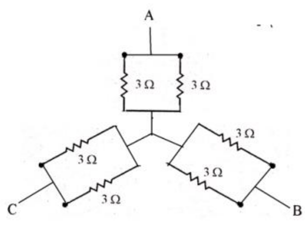
$$R_A = \frac{R_{AB}R_{CA}}{R_{AB}+R_{BC}+R_{CA}} = \frac{9\times9}{9+9+9} = 3\Omega$$

Similarly, R_B and R_C both will be equal to 3Ω as shown below

1 Mark for conversion of outer delta to star

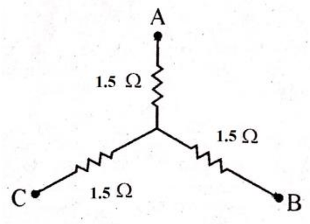


2) The equivalent star of outer delta and the inner star appear in parallel with each other as shown below.



1 Mark

3) The equivalent resistance of two parallel 3Ω resistances will be:
$R_A = \frac{3\times3}{3+3} = 1.5\Omega$
Similarly, $R_B = R_C = 1.5\ \Omega$ as shown below. 1 Mark



1 Mark

4) The equivalent resistance between terminals A and B is:
$R_{AB} = R_A + R_B = 1.5 + 1.5 =$ **3Ω**

2 c) State Kirchhoff's current law and explain with simple circuit.

Ans:

Kirchhoff's laws:

1) Kirchhoff's Current Law (KCL): 1 Mark for statement

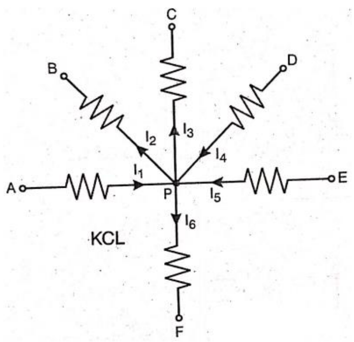
It states that in any electrical network, the algebraic sum of the currents meeting at a node (point or junction) is zero.

i.e $\Sigma I=0$ 1 Mark for circuit

At junction point P, $I_1-I_2-I_3+I_4+I_5-I_6 = 0$

Sign convention:

Incoming current at the node is considered to be positive and outgoing current to be negative.



Explanation:

In the circuit shown in Fig., the currents I_1, I_4, I_5 are incoming currents, hence considered positive whereas the currents I_2, I_3 , I_6 are outgoing currents, hence considered as negative. These currents are then added considering their sign: 2 Marks for explanation

At junction point P, $I_1-I_2-I_3+I_4+I_5-I_6 = 0$

$I_1 + I_4 + I_5 = I_6 + I_2 + I_3$

Therefore, KCL can be expressed as Incoming current = Outgoing currents

2 d) Define;

i) Frequecny
ii) Cycle
iii) Time period
iv) Amplitude

Ans:

1) Frequency: 1 Mark for each bit = 4 marks

It is the number of cycles completed by an alternating quantity in one second. It is measured in cycles per second or hertz (Hz).

2) Cycle:

It the complete set of variation in the magnitude of an alternating quantity which is continuouisly repeated at regular interval of time. It consists of positive and negative half cycles.

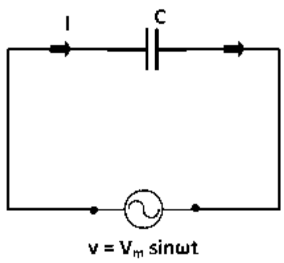
3) Time Period:
It is the time required for an alternating quantity to complete one cycle. It is measured in second.

4) Amplitude:
It is the maximum value attained by an alternating quantity during its positive or negative half cycles.

2 e) When sinusoidal voltage is applied to a circuit containing capacitance only,
(i) Draw circuit diagram
(ii) Write equation for voltage and current
(iii) Draw waveform of voltage and current
(iv) Draw phasor diagram

Ans:

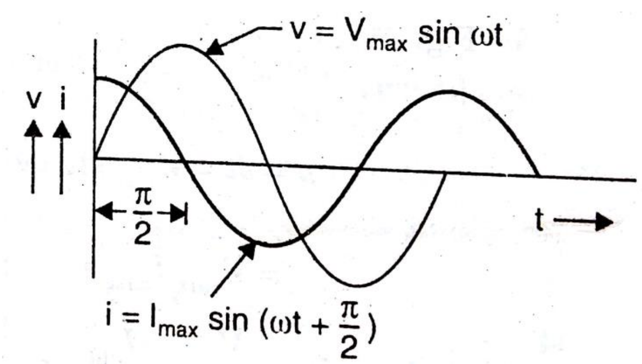
(i) Circuit diagram:



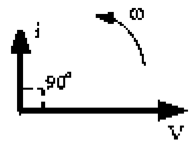
1 Mark for each bit = 4 marks

(ii) Equation for voltage and current:
$v = V_m \sin(\omega t)$
$i = I_m \sin(\omega t + 90°)$ or $I_m \sin(\omega t + \pi/2)$

(iii) Waveform of voltage and current:



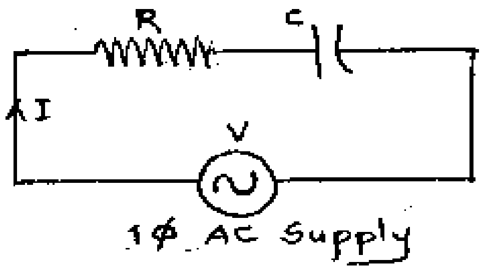
(iv) Phasor diagram:



2 f) Draw series RC circuit, write its expression for impedance and show it on impedance triangle.

Ans:

Series RC Circuit:



1 Mark for circuit

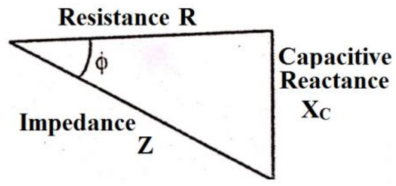
Impedance is given by,

$$Z = R - jX_C = |Z|\angle - \phi \quad \text{OR} \quad Z = \sqrt{R^2 + X_C^2}$$

1 Mark for impedance

where Capacitive reactance $X_C = 1/(2\pi fC)$

Impedance triangle:



Impedance triangle for R-C series circuit

2 Marks for impedance triangle

3 Attempt any FOUR of the following: 16

3 a) Find the value of equivalent resistance and current flowing through each resistance as shown in fig. No.3

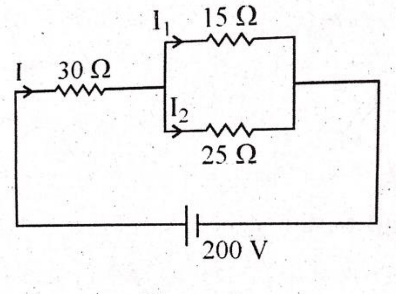


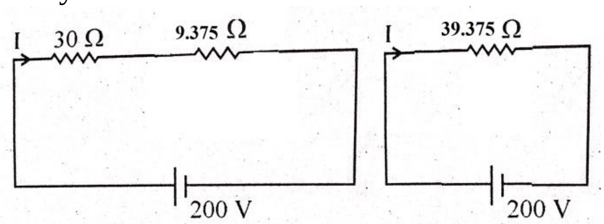
Fig. no. 3

Ans:

1) In given circuit, 15Ω and 25Ω resistances appear in parallel. The equivalent resistance of this parallel combination is

15 || 25 = 15×25/(15+25) = **9.375Ω** 1 Mark

2) This equivalent resistance appears in series with 30Ω resistance. The total circuit resistance is therefore given by,
R_T = 30 + 9.375 = **39.375Ω** 1 Mark
3) The current is given by I = 200/39.375 = 5.08 A 1 Mark



4) This current get divided in parallel combination of 15Ω and 25Ω. By current division formula, the current through 15Ω is given by,
I_1 = I. R_2/(R_1 + R_2) = 5.08{25/40} = **3.175 A**
5) The current through 25Ω is then,
I_2 = I – I_1 = 5.08 – 3.175 = **1.91 A** 1 Mark for branch currents

3 b) State Faraday's first and second law of electromagnetic induction.
Ans:
Faraday's Laws of Electromagnetic Induction:
First Law:
Whenever a changing magnetic flux links with a conductor, an emf is induced in that conductor. 2 Marks

OR

When a conductor cuts across magnetic field, an emf is induced in that conductor.

Second Law:
The magnitude of induced emf is directly proportional to the rate of change of flux linking with the conductor or the rate of flux cut by the conductor. 2 Marks

3 c) An alternating current is given by equation $i = 25\ sin628t$. Find
(i) Average value
(ii) RMS value
(iii) Frequency
(iv) Time period
Ans:
Standard equation of sinusoidal quantity is $i = I_m \sin(\omega t)\ A$. On comparing the given current with standard equation, we get
(i) Maximum Value $I_m = \mathbf{25\ A}$
(ii) RMS value $I = \frac{I_m}{\sqrt{2}} = \frac{25}{\sqrt{2}} = \mathbf{17.678\ A}$
(iii) Average value (over full cycle) = 0 A
Average value (over half cycle) $I_{av} = 0.637 I_m = 0.637 \times 25$
= **15.925 A**

1 Mark for each of 4 bits = 4 Marks

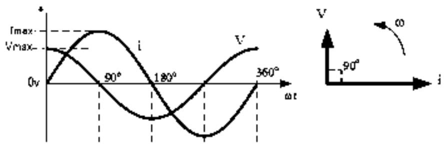
(iv) Angular frequency ω = 628 rad/sec = 2πf

∴ frequency $f = \frac{628}{2\pi} = 99.95 \cong$ **100Hz**

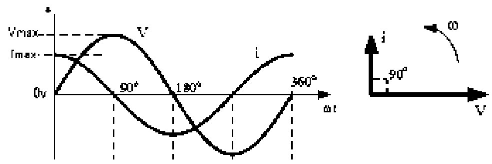
(v) Time period T = 1/f = 1/100 = **0.01 sec = 10 millisecond**

3 d) Draw waveform and phasor representation for lagging and leading AC quantities.

Ans:



1) Voltage is leading current by 90°. — 2 Marks



2) Voltage is lagging behind the current by 90°. — 2 Marks

3 e) A coil having 25Ω resistance and 0.1H inductance is connected across 100V, 50 Hz supply. Calculate:

(i) Impedance of coil
(ii) Current
(iii) Power factor
(iv) Active power

Ans:

Data Given: Resistance R = 25Ω, Inductance L = 0.1H — 1 Mark for each bit = 4 Marks

Supply Voltage V = 100∠0° V, Supply frequency f = 50Hz,

(i) Inductive reactance $X_L = 2\pi f L = 2\pi(50)(0.1)$ =**31.4Ω**

(ii) Impedance of series circuit

$Z = R + jX_L = 25 + j31.4$

$= \mathbf{40.14\angle 51.47°\Omega}$

(iii) Current $I = \frac{V}{Z} = \frac{100\angle 0°}{40.14\angle 51.47°} = \mathbf{2.49\angle -51.47°}$ **A**

(iv) Power factor cos∅ = cos(51.47°) = **0.623 lagging**

(v) Active power $P = VIcos\emptyset = (100)(2.49)(0.623) = \mathbf{155.127}\ \boldsymbol{watt}$

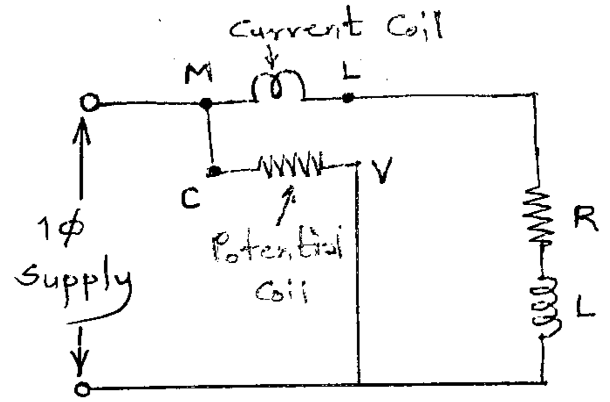
OR

Any other method of computation may please be considered and marks be alloted

3 f) Draw circuit diagram for measurement of single phase power, using dynamometer type wattmeter.

Ans:

Measurement of Single-phase power using of dynamometer type wattmeter: — 4 Marks for labeled diagram



2 to 3 Marks for partially labeled diagram

1 Mark for unlabeled diagram

4 Attempt any FOUR of the following: 16

4 a) Define and write expression for (a) RMS value (b) AVG value of an AC.

Ans:

RMS Value of Sinusoidal AC Waveform:

The RMS value is the Root Mean Square value. It is defined as the square root of the mean value of the squares of the alternating quantity over one cycle. — 2 Marks

For sinusoidal quantity, the rms value is given by,

RMS Value = Maximum Value / $\sqrt{2}$ = 0.707 × Maximum value

And/OR

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.

Average Value of Sinusoidal AC Waveform:

The average value is defined as the arithmetical average or mean value of all the values of an alternating quantity over one cycle. For sinusoidal quantity, the average value over a cycle is zero. So it is calculated over half-cycle and given by, — 2 Marks

Average Value = 0.637 × Maximum Value

And/OR

For an alternating current , the average value is defined as that value of steady current (DC) which transfers the same charge as is transferred by the alternating current during the same time under the same conditions.

4 b) Define:-

(i) Active power
(ii) Reactive power
(iii) Power factor
(iv) Apparent power

Ans:

(i) **Active Power:** — 1 mark for each bit = 4 marks

Active power (P) is the product of voltage, current and the cosine of the phase angle between voltage and current.

Unit: watt (W) or kilo-watt (kW) or Mega-watt (MW)

$$P = VI\cos\emptyset = I^2R \text{ watt}$$

(ii) **Reactive Power:**

Reactive power (Q) is the product of voltage, current and the sine of the phase angle between voltage and current.

Unit: volt-ampere-reactive (VAr), or kilo-volt-ampere-reactive (kVAr) or Mega-volt-ampere-reactive (MVAr)

$$Q = VI\sin\emptyset = I^2X \text{ volt-amp-reactive}$$

(iii) **Power Factor:**

It is the cosine of the angle between the applied voltage and the resulting current.

Power factor = $\cos\phi$

where, ϕ is the phase angle between applied voltage and current.

OR

It is the ratio of true or effective or real power to the apparent power.

$$\text{Power factor} = \frac{\text{True Or Effective Or Real Power}}{\text{Apparent Power}} = \frac{VI\cos\emptyset}{VI} = \cos\emptyset$$

OR

It is the ratio of circuit resistance to the circuit impedance.

$$\text{Power factor} = \frac{\text{Circuit Resistance}}{\text{Circuit Impedance}} = \frac{R}{Z} = \cos\emptyset$$

(iv) **Apparent Power (S):**

This is simply the product of RMS voltage and RMS current.

Unit: volt-ampere (VA) or kilo-volt-ampere (kVA) or Mega-vol-ampere (MVA)

$$S = VI = I^2Z \text{ volt-amp}$$

4 c) For the circuit shown in fig. no. 4, find the value of (i) XL, (ii) XC, (iii) Z, (iv) Current.

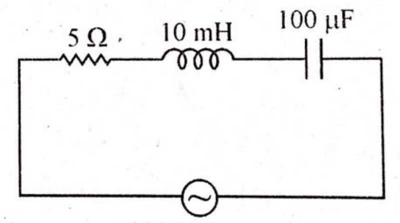


Fig. no. 4

Ans:

Data Given: Resistance R = 5Ω, Inductance L = 10 mH, Capacitance C = 100μF

Supply Voltage V = 230∠0°, Supply frequency f = 50Hz

(i) Inductive reactance $X_L = 2\pi fL = 2\pi(50)(10 \times 10^{-3}) = \mathbf{3.14\Omega}$

(ii) Capacitive reactance $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)(100\times10^{-6})} = \mathbf{31.83\Omega}$

1 Mark for each bit = 4 Marks

(iii) Impedance of series circuit
$Z = R + jX_L - jX_C = 5 + j3.14 - j31.83 = \mathbf{29.12\Omega}$

(iv) Current $I = \frac{V}{Z} = \frac{230}{29.12} = \mathbf{7.9\ A}$

4 d) State any four advantages of 3 phase over single phase circuits.

Ans:

Advantages of Three phase circuits over Single phase circuits:

i. Three phase transmission line requires less conductor material for same power transfer at same voltage.
ii. For same frame size, three phase machine gives more output.
iii. For same rating, three phase machines have small size.
iv. Three phase motors produce uniform torque.
v. Three phase induction motors are self-starting.
vi. For same rating, three phase motors have better power factor.
vii. Three phase transformers are more economical. Power capacity to weight ratio is more.
viii. Three phase machines have higher efficiencies.
ix. Three phase system is more economical with regards to generation, transmission and distribution of power.
x. Three phase system requires less maintenance and it increases the life of the system.
In three phase system rotating magnetic field is produced rather than the pulsating field produced by single phase system.

1 Mark for each of any four advantages

4 e) Calculate:
(i) Line current
(ii) Phase current
(iii) Power factor
(iv) Total power for circuit in fig. no. 5
Delta connected balanced system

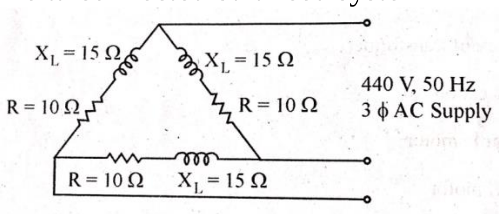


Fig. no. 5

Ans:

Data Given: Line voltage V_L = 440V, Frequency f = 50 Hz,
Delta connected load impedance per phase Z = (10 + j15) = 18.03∠56.31°Ω
For delta connection, Phase voltage = Line voltage = 440V

1 Mark for each bit = 4 Marks

i) Phase current $= \frac{Phase\ Voltage}{Impedance\ per\ phase} = \frac{440\angle 0°}{18.03\angle 56.31°} = \mathbf{24.4\angle -56.31°\ A}$

ii) Line current $= \sqrt{3}(Phase\ current) = \sqrt{3}(24.4) = \mathbf{42.26\ A}$

iii) Power factor cosϕ = cos(56.31°) = **0.555 lagging**

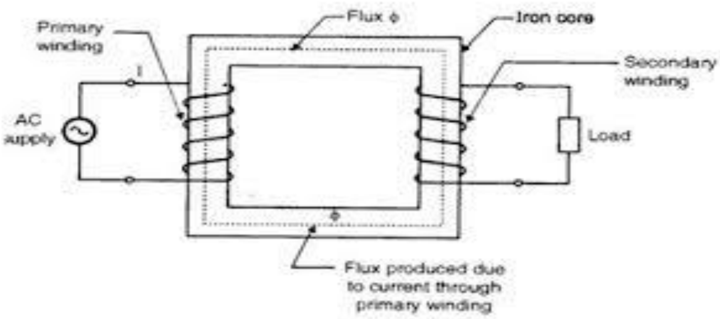
iv) Total power $P_{3\emptyset} = \sqrt{3}V_L I_L cos\phi$

$$= \sqrt{3}(440)(42.26)\cos(56.31°)$$

$$= \mathbf{17874.57}\ \boldsymbol{watt}$$

4 f) Exaplain construction and working principle of single phase transformer.

Ans:



Construction 2 Marks

Construction of single phase transformer:

Single-phase transformer essentially consists of following components:

i) Windings: Two windings generally of copper are placed round the core and are insulated from each other and also from the core.

ii) Core: Magnetic core is made up of thin silicon steel laminations which act as a magnetic circuit.

For big size transformers, tank is used to accommodate the core-winding assembly.

In fact, the core-winding assembly is kept immersed in oil in the tank. The oil acts as a cooling medium and also the insulating medium. The terminals are taken out of the tank using bushings. The supply is connected to primary winding and load is connected to secondary winding.

Working 2 Marks

Working of single phase transformer:

Transformer works on the principle of Mutual electromagnetic induction. When AC voltage is applied to the primary winding, it produces alternating flux in the core. This flux links with the secondary winding and according to Faraday's law of electromagnetic induction, an emf is induced in the secondary winding and the current flows in the secondary circuit if load is connected.

5 Attempt any FOUR from the following: 16

5 a) A 230 V, 50 Hz supply is applied to a pure capacitor of 26.5 μF . Calculate:
i) X_C
ii) Write equation for voltage and current
iii) Draw voltage and current waveforms

Ans:

Given:

C= 26.5 μF = 26.5× 10^{-6} F, V = 230V, f = 50Hz

The reactance of the capacitor.

$$Xc = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 26.5 \times 10^{-6}} = \mathbf{120.1169\ \Omega}$$ 1 Mark

Maximum value of voltage $V_{max} = V\times\sqrt{2} = 230 \times \sqrt{2} = 325.2691$ volt

Rms value of current

$$I_{rms} = \frac{V}{X_c} = \frac{230}{120.1169} = 1.9148 \text{ A}$$

The maximum current.

$I_{max} = \sqrt{2} \times I_{rms} = \sqrt{2} \times 1.9148 = 2.7079$ A

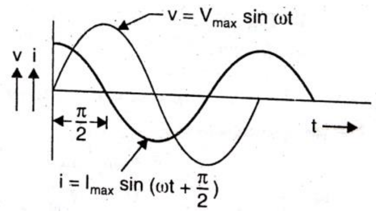
Equation for voltage and current

$\boldsymbol{v = 325.2691 \sin(\omega t)}$ **volts** 1 Mark

$\boldsymbol{i = 2.7079 \sin(\omega t + 90°)}$ **amp**

OR $\boldsymbol{i = 2.7079 \sin(\omega t + \frac{\pi}{2})}$ **amps** 1 Mark

Voltage and current waveforms



1 Mark

5 b) A circuit draws a current of 10 A at a voltage of 200 V with power factor of 0.8 (lag).
Calculate:
i) Active power
ii) Ractive power
iii) Apparent power
Draw power triangle.

Ans:

Given I = 10A, V = 200V, pf = $\cos\phi = 0.8$ lag

As $\cos\phi = 0.8$, $\phi = cos^{-1}(0.8) = 36.8698^0$

$\sin\phi = \sin(36.8698^0) = 0.6$

(i) Active power (P):

$$P = VI\cos\phi = 200 \times 10 \times 0.8 = 1600 \text{ watt.}$$ 1 Mark

(ii) Reactive power (Q):

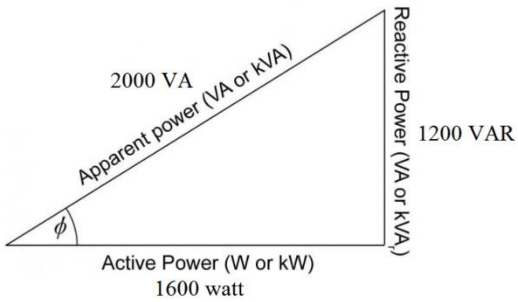
$$Q = VI\sin\phi = 200 \times 10 \times 0.6 = 1200\text{VAR.}$$ 1 Mark

(iii) Apparent power (S):

$$S = VI = 200 \times 10 = 2000VA$$ 1 Mark

Power Triangle:

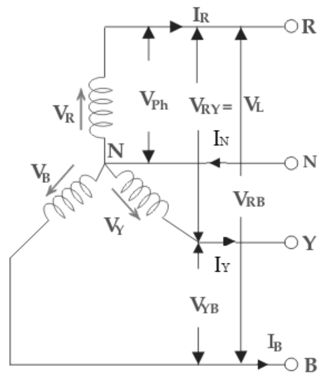
1 Mark



5 c) Draw balanced star system. Show all voltages and currents, write the relation for voltage and current.

Ans:

Balanced star system:



Labeled Diagram 2 Marks OR Unlabeled diagram 1 Mark

Relation for voltage and current:

Line voltage $V_L = V_{RY} = V_{YB} = V_{RB}$

Phase voltage $V_{ph} = \frac{V_L}{\sqrt{3}}$

Line current $I_L = I_R = I_Y = I_B$

Phase current $I_{ph} = I_L = I_R = I_Y = I_B$

Relation 2 Marks

5 d) Write emf equation of a transformer, state meaning of each term and write their units.

Ans:

E.M. F. equation of transformer:

$E_1 = 4.44\ f\ Ø_{max}\ N_1$ OR

$E_1 = 4.44\ B_{max}\ A\ N_1$ 1 Mark

$E_2 = 4.44\ f\ Ø_{max}\ N_2$ OR

$E_2 = 4.44\ B_{max}\ A\ N_2$

Where

N_1 = number of turns of primary winding

N_2 = number of turns of secondary winding

$Ø_{max}$ = maximum flux in core in weber

B_{max} = maximum flux density in core in wb/m^2

A = core area in (meter)^2

E_1 = R. M. S. value of induced emf in primary winding in volts

E_2 = R. M. S. value of induced emf in secondary winding in volts

Meaning of terms with units 3 Marks

Without units 2 marks

5 e) Define:-

(i) Voltage ratio
(ii) Current ratio
(iii) Transformation ratio
(iv) Efficiency of transformer

Ans:

i) Voltage Ratio:

The ratio of secondary load voltage V_2 to the primary supply voltage V_1. OR The ratio of Primary voltage V_1 to secondary voltage V_2. — 1 Mark

Voltage Ratio $= \frac{V_2}{V_1}$ OR Voltage Ratio $= \frac{V_1}{V_2}$

ii) Current Ratio:

The ratio of secondary current I_2 to the primary current I_1

OR

The ratio of primary current I_1 to the secondary current I_2. — 1 Mark

Current Ratio $= \frac{I_2}{I_1}$ OR Current Ratio $= \frac{I_1}{I_2}$

iii) Transformation Ratio:

The ratio of secondary emf E_2 to the primary emf E_1 — 1 Mark

OR

The ratio of secondary voltage V_2 to the primary voltage V_1

OR

The ratio of secondary turns N_2 to the primary turns N_1

OR

The ratio of primary current I_1 to the secondary current I_2.

Transformation Ratio (K) $= \frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{V_2}{V_1} = \frac{I_1}{I_2}$

iv) Efficiency of transformer:

The ratio of Output power (P_2) to Input power (P_1) is known as the Efficiency. — 1 Mark

Efficiency $\eta = \frac{P_2}{P_1} \times 100$

5 f) State two applications of
1) Shaded pole motor
2) Universal motor

Ans:

(i)Applications of Shaded pole motor:

1. Small fans
2. Toy motors
3. Hair dryers
4. Ventilators
5. Electric clocks
6. Record players
7. Motorized valves
8. Gramophones
9. Photocopying machines
10. Recording instruments
11. Advertising displays
12. Circulators
13. Churns
14. Phonograph turn tables
15. Desk fans etc.

1 Mark for each of any two applications = 2 Marks

(ii) Applications of Universal motor:

1. Vacuum cleaners
2. Food Mixers
3. Food Grinders
4. Sewing Machines
5. Portable Drilling Machines
6. Electric Shavers
7. Mechanical computing Machines
8. Machine Tools etc.

1 Mark for each of any two applications = 2 Marks

6 Attempt any FOUR of the following: 16

6 a) A RLC series circuit having R = 10Ω, L = 0.1H and C = 150μF is supplied by 1- phase, 200V, 50Hz supply, Find
(i) Impedance
(ii) Current
(iii) Power factor
(iv) Power absorbed

Ans:

Data Given:

Resistance R = 10Ω, Inductance L = 0.1H, Capacitance C = 150μF = 150×10^{-6} F
Supply Voltage V = 200V and f = 50Hz

Inductive reactance $X_L = 2\pi f L = 2\pi(50)(0.1) = 31.4159\Omega$

Capacitive reactance $X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)(150\times10^{-6})} = 21.22\Omega$

(i) Impedance of series circuit

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{10^2 + (31.4159 - 21.22)^2} = 14.2813\Omega$ 1 Mark

(ii) Current $I = \frac{V}{Z} = \frac{200}{14.2813} = 14.0043$ A 1 Mark

(iii) Power factor = cosϕ = $\frac{R}{Z} = \frac{10}{14.2813} = 0.7002\ lag$ 1 Mark

(iv) Power absorbed = P = VI cosϕ = $200\times 14.0043 \times 0.7002 = 1961.1621$watt 1 Mark

6 b) For balanced three phase star connected load for which line voltage is 230V and per phase resistance and reactance is 6 Ω and 8 Ω respectively. Calculate

(i) Phase voltage
(ii) Line current
(iii) Power factor
(iv) Total power absorbed

Ans:

Data Given:

Line Voltage V_L = 230V, Resistance per phase R_{ph} = 6 Ω,
Reactance per phase X_{ph} = 8 Ω

In star-connected system, phase voltage $V_{ph} = \frac{1}{\sqrt{3}}$ Line voltage = $\frac{230}{\sqrt{3}} = 132.79\ V$ 1Mark

Impedance per phase $Z_{ph} = \sqrt{R^2 + (X)^2} = \sqrt{6^2 + (8)^2} = 10\Omega$

∴ Phase current $I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{132.79}{10} = 13.279$ A

In star-connected system, Line current = Phase current = 13.279 A 1Mark

Power factor = $cos\emptyset = \frac{R_{ph}}{Z_{ph}} = \frac{6}{10} = 0.6$ 1Mark

Total Power absorbed by the circuit,

$$P_{3\emptyset} = \sqrt{3}V_L I_L cos\emptyset = 3V_{ph}I_{ph}cos\emptyset$$ 1Mark

$$= \sqrt{3} \times (230) \times (13.279) \times 0.6$$

= 3173.9865 **watt**

6 c) Define for polyphase circuit

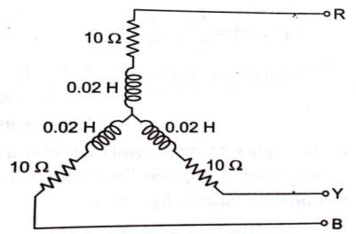
(i) Balanced load
(ii) Unbalanced load. Draw one example circuit for each type of load.

Ans:

i) Balanced Load:

Balanced three phase load is defined as star or delta connection of three equal impedances having equal real parts and equal imaginary parts. 1 Mark

Example circuit:

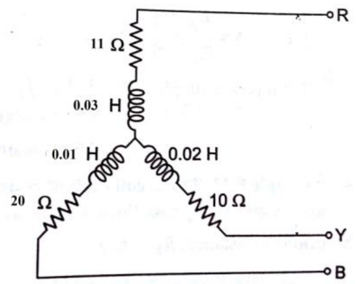


1 Mark

ii) **Unbalanced Load:**

When the magnitudes and phase angles of three impedances are differ from each other, then it is called as unbalanced load. OR If a load does not satisfy the condition of balance, then it is called as unbalanced load. 1 Mark

Example circuit:



1 Mark

6 d) Explain why 1∅ induction motor is not self starting.

Ans:

Reason of why single phase induction motors are not self-starting: When single phase AC supply is given to main winding it produces alternating flux. According to double field revolving theory, alternating flux can be represented by two opposite rotating flux of half magnitude.

These oppositely rotating flux induce current in rotor & there interaction produces two opposite torque hence the net torque is Zero and the rotor remains standstill. Hence Single-phase induction motor is not self-starting.

OR

Single phase induction motor has distributed stator winding and a squirrel-cage rotor. When fed from a single-phase supply, its stator winding produces a flux (or field) which is only alternating i.e. one which alternates along one space axis only. It is not a synchronously revolving (or rotating) flux as in the case of a two or a three phase stator winding fed from a 2 of 3 phase supply. Now, alternating or pulsating flux acting on a stationary squirrel-cage rotor cannot produce rotation (only a revolving flux can produce rotation). 4 Marks

That is why a single phase motor is not self-starting**.**

6 e) Explain construction and working of single phase Auto transformer.

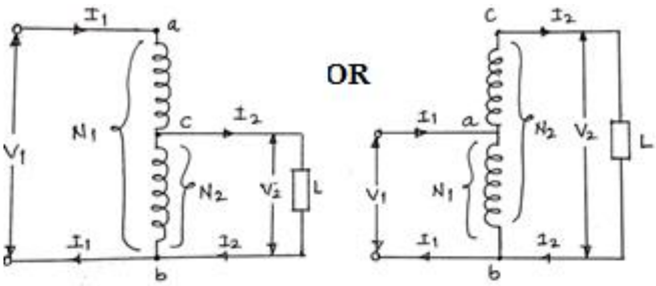
Ans:

Construction of single phase auto transformer:

(i) It has only one winding wound on a laminated circular magnetic core.
(ii) The core is made of silicon steel stampings.
(iii) The two terminals of the winging are connected to the supply.
(iv) A variable point on the winding is connected to a carbon brush and brush can be moved by a circular handle.

1 Mark for construction

Working of single phase auto transformer:



Step down autotransformer   Step-up auto transformer

1 Mark for diagram

1) The transformer which works on the principle of self-induction and gives variable output voltage is called an auto transformer.
2) The primary winding is connected to the supply and it has N_1 number of turns as shown in above diagrams.
3) By moving the handle we can select N_2 number of turns on the secondary. Thus the same winding can function as primary as well as secondary.
4) Hence, from the auto-transformer we can get a variable voltage by varying N_2 by moving the brush with the help of handle.
5) The same transformer can be used as step-up or step down auto-transformer.

2 Marks for working

6 f) Suggest various safety precautions which should be taken while working with Electricity.

Ans:

Safety precautions to be taken while working with Electricity :

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.
10. Earthing should be checked frequently.

1Mark for each of Any 4 precautions = 4 Marks

11. Do not use aluminum ladders but use wooden ladders.
12. Do not operate the switches without knowledge.
13. Use proper insulated tools & safety devices.
14. When working on live equipment obey proper instruction.
15. Do not work on defective equipment.
16. Use safe clothing.
17. Use shoes with rubber soles to avoid shock.
18. Do not wear suspected Necklace, arm bands, finger ring, key chain, and watch with metal parts while working.
19. Do not use defective material. Do not work if there is improper illumination such as in sufficient light or unsuitable location producing glare or shadows.
20. Do not work if there is an unfavorable condition such as rain fall, fog or high wind.
21. Do not sacrifice safety rules for speed.
22. Do not allotted work to untrained person (worker) to handle electrical equipment.
23. Make habit to look out for danger notice, caution board, flags, and tags.
24. Warn others when they seen to be in danger near live conductors or apparatus.
25. Inspect all electrical equipment & devices to ensure there is no damage or exposed wires that may causes a fire or shock.
26. Avoid using electrical equipment near wet, damp areas.
27. Use approved discharge earth rod for before working.
28. Never speak to any person working upon live mains.
29. Do not Do the work if you are not sure or knowledge of the condition of equipment/ machine.
30. Safety book/ Training should be given to all persons working in plants.