Assignment-1 with Answers. Total = 70 Marks.

Short answer questions :- 2 × 10 = 20 Marks.

1. State ohms law and write any four limitations.

A. Ohms law (statement) :-

Current flowing through a conductor is directly proportional to the potential difference between its two ends, provided temperature and other physical parameters of the conductor remain unchanged.

$$I \propto V$$

$$I = \frac{1}{R} \cdot V$$ where R = Resistance of the conductor.

Limitations :-

1. Not applicable to semi conductors.
2. Not applicable to gas discharge devices.
3. Not applicable to arcing devices
4. Not applicable to non linear devices.

2. State Super position Theorem.

A. Superposition theorem. (Statement)

In a linear, bi lateral network containing several sources, the response in any element is the algebraic sum of the responses, due to each source acting separately, with all other sources set equal to zero.

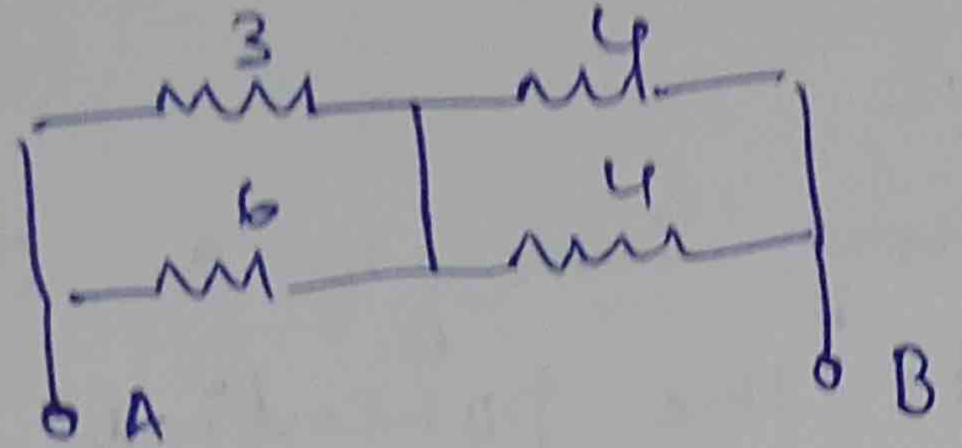
3. Write the Faraday's laws of Electromagnetic induction.

Faraday's 1st law :- Whenever a conductor cuts magnetic field (Flux lines), emf is induced in the conductor.

Faraday's 2nd Laws :- The induced emf is directly proportional to the rate of change of flux linkages

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

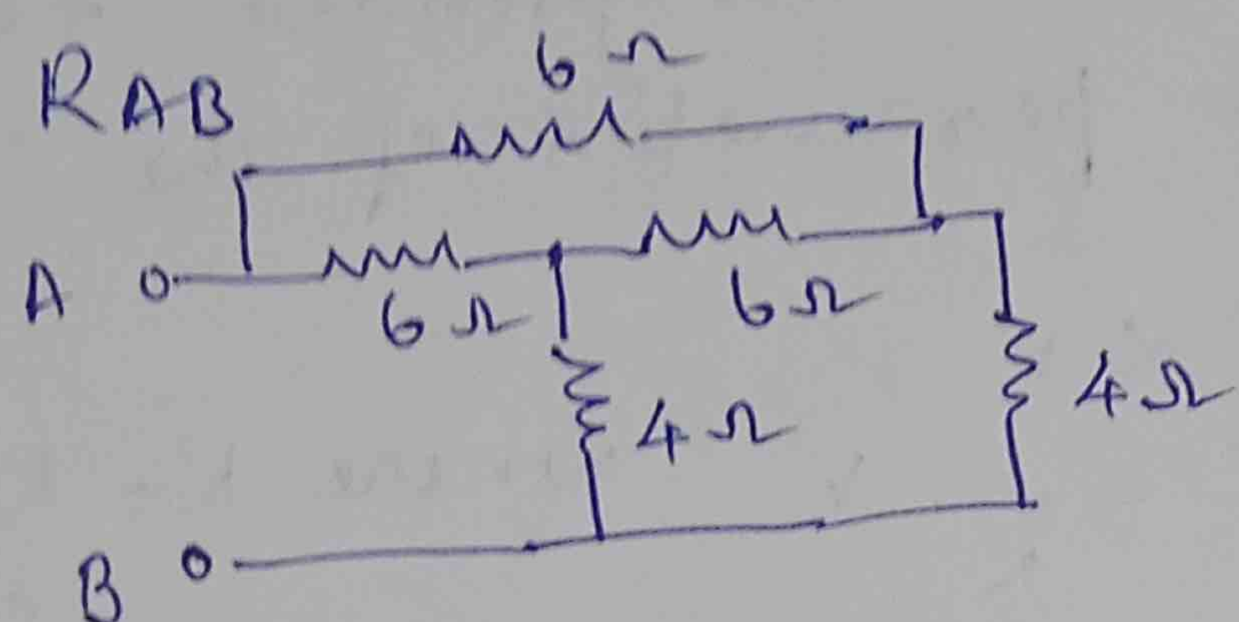
4A. Reduce the network.



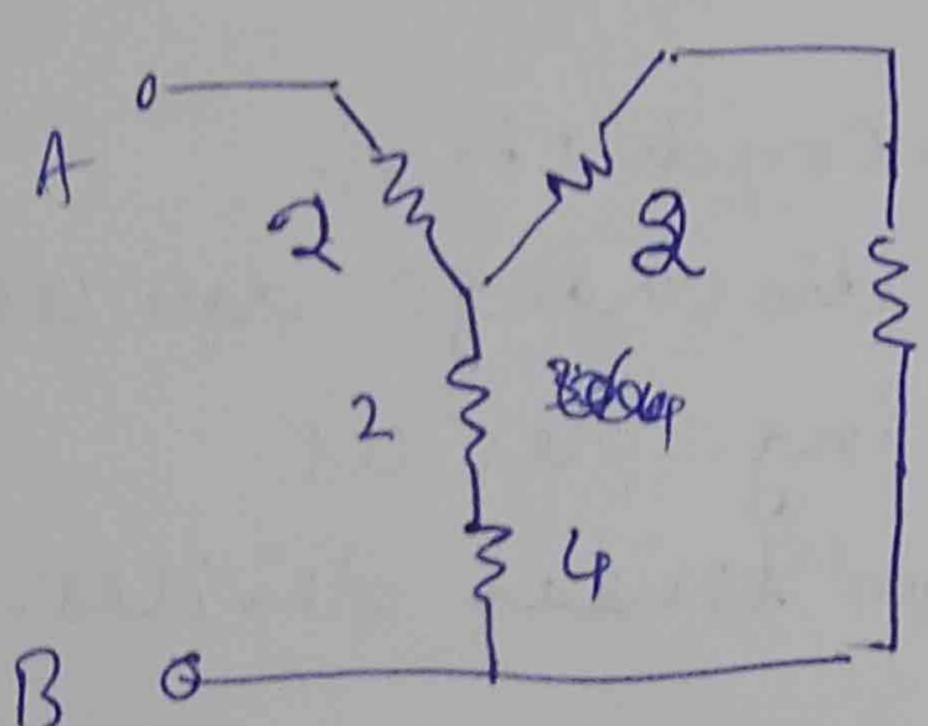
$$R_{AB} = \frac{6\times3}{6+3} + \frac{4\times4}{4+4}$$

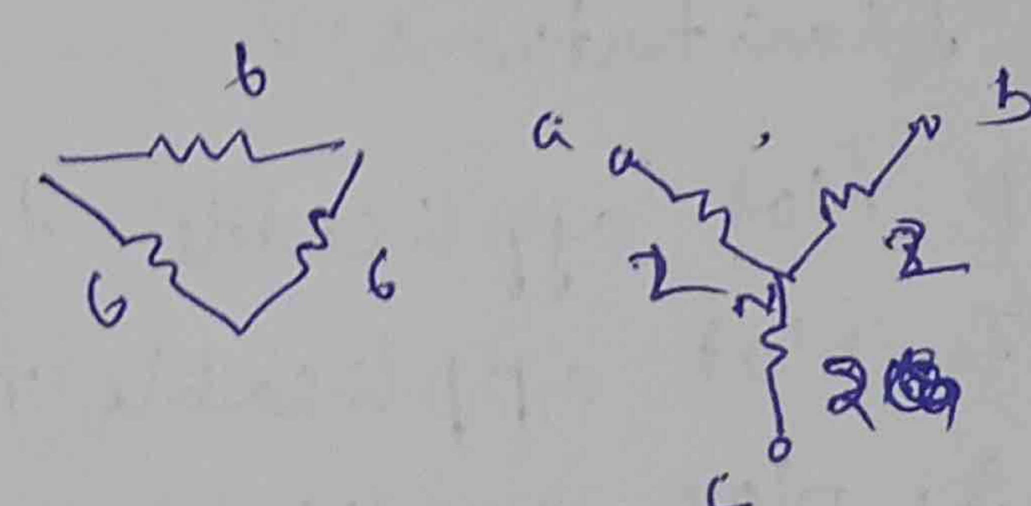
$$= \frac{18}{9} + \frac{16}{8} = 2+2 = 4\,\Omega$$

5A. Find R_{AB}



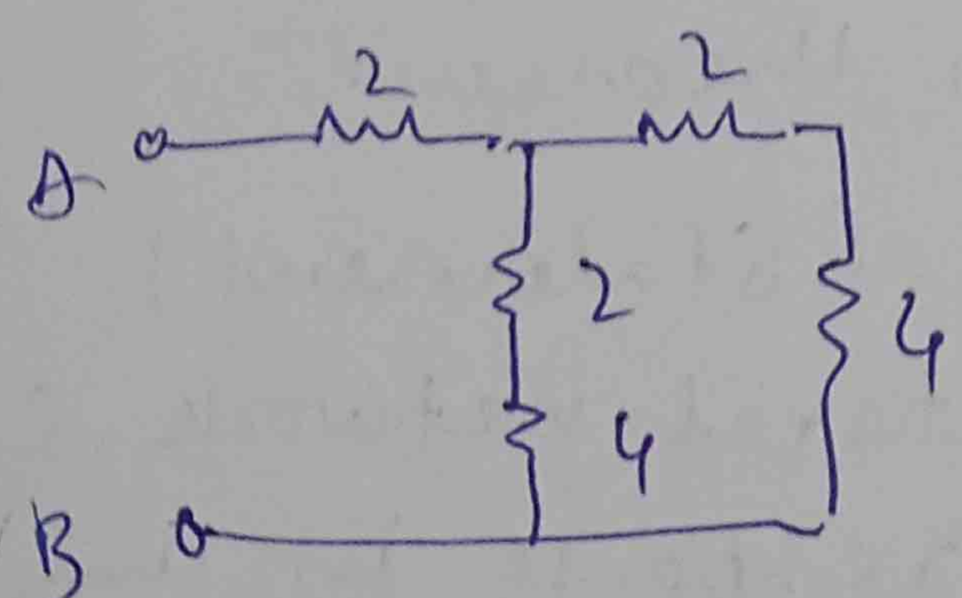
using Star-Delta conversion, we can reduce the given network.





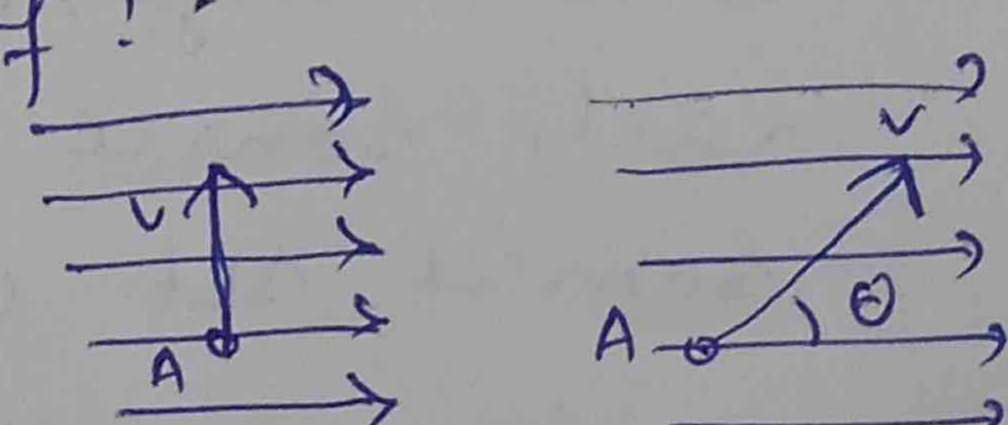
$$R_{AN} = \frac{6\times6}{6+6+6} = 2\,\Omega$$

$$R_{AB} = 2 + \frac{6\times6}{6+6} = 5\,\Omega$$



6A. Dynamically induced emf :-

$$e = Blv\sin\theta$$



e = induced emf.

B = Flux density in Wb/m^2

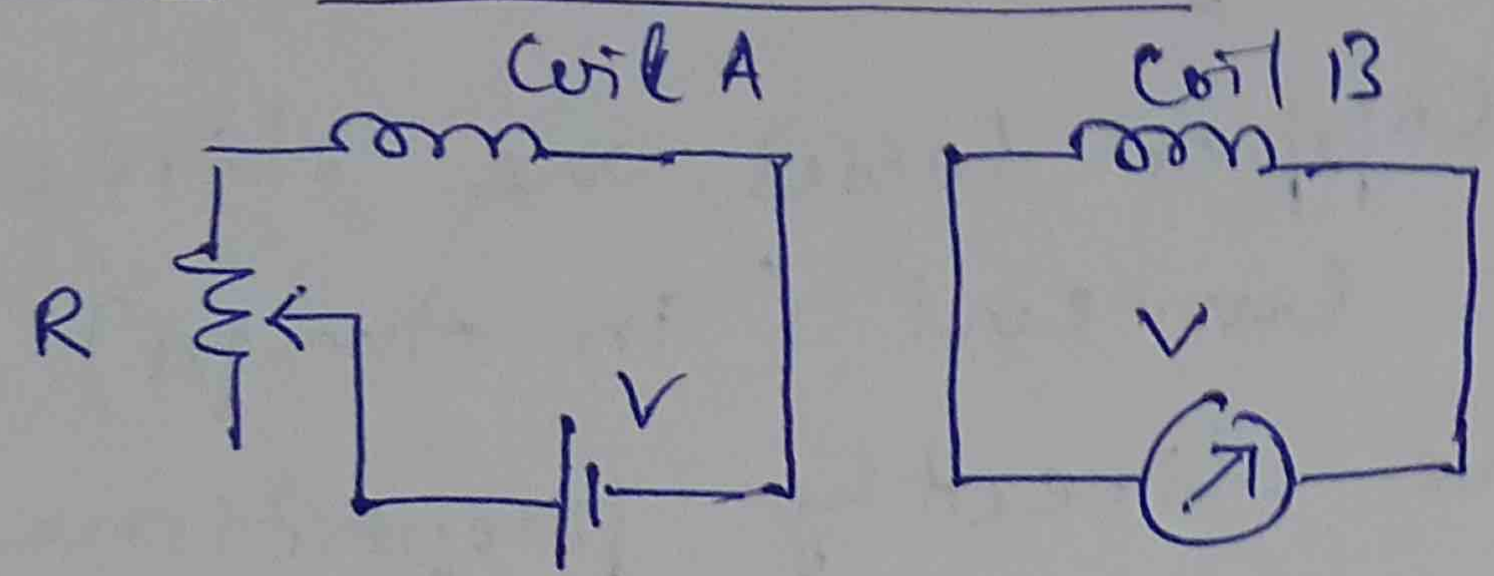
l = length of the conductor in meters

V = velocity of the conductor $= \frac{dx}{dt}$.

$v\sin\theta$ = Component of velocity ⊥ to field.

Example :- Dynamo (DC generator)

Statically induced emf :-



If flux in coil A is varied, by varying current, the flux linked with coil B also changes. As per Faradays 2nd law., emf is induced in coil B. This is statically induced emf.

Example :- Transformer.

7A. Measuring instruments classification :-

- Absolute instruments
- Secondary instruments.
  - ~~Deflecting instruments~~
  - ① Indicating Instruments
  - ② Integrating instruments.
  - ③ Recording Instruments

8A. **RMS Value** (Root mean square Value) :-

It is given by the steady current that produces the same heating effect in a resistance in a given time as the alternating current does in the same resistance in the same time.

Form factor :- It is the ratio of rms value to the average value.

Peak factor :- It is the ratio of maximum value to the r.m.s. value.

9. Why transformer rating will be in kVA or MVA.

Since transformer copper losses are directly proportional to the current (in Amps) and constant losses are directly proportional to the voltage (in volts). Transformer rating will be deviced as in Volt Amps (VA). So as the size of the transformer increases it will be in KVA or MVA.

10. Losses of a transformer:-

Variable losses — Copper losses. (I^2R)

Constant losses (iron losses). — Hysterisys losses ($\eta B_m^{1.6} f \cdot V$)

Eddy current losses.

($P_r \cdot B_m^2 f^2 t^2$) W.

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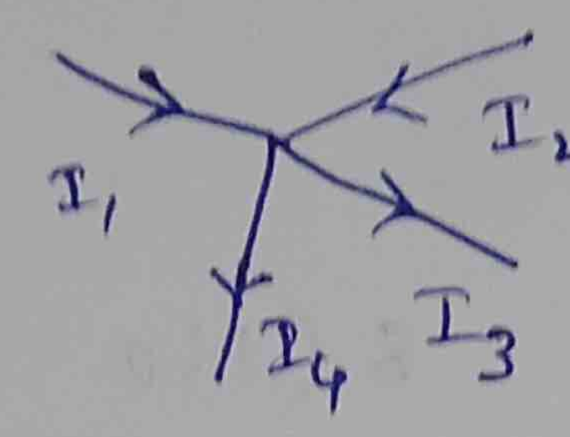
Long Answer Questions:-

1. (a) **Kirchoff's current Law:** The algebraic sum of currents meeting at a junction (or node) is zero.



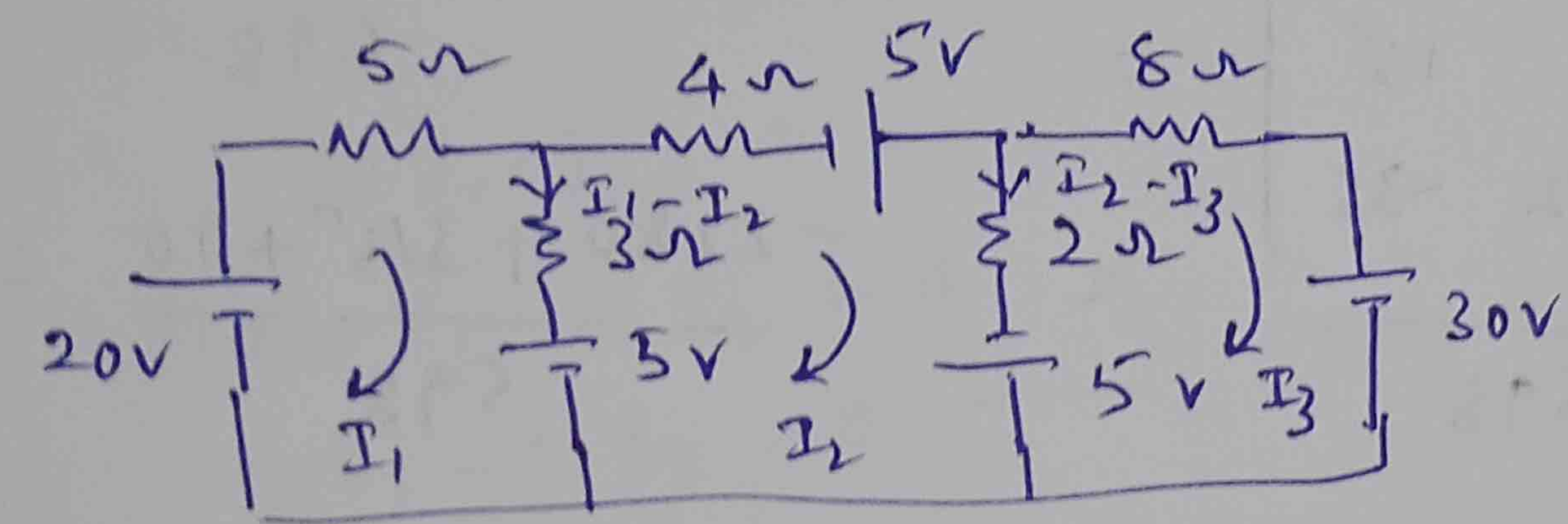
$I_1 + I_2 = I_3 + I_4$

$I_1 + I_2 - I_3 - I_4 = 0.$

Kirchoff's voltage Law:- The algebraic sum of emfs and products of resistance and current in any closed loop or mesh is zero.

$$\sum e.m.f + \sum IR = 0.$$

(b)



From loop 1 $\quad 5I_1 + 3(I_1 - I_2) + 5 - 20 = 0$

$5I_1 + 3I_1 - 3I_2 - 15 = 0$

$8I_1 - 3I_2 + 0\,I_3 = 15$ — (1)

From loop 2 $\quad 4I_2 - 5 + 2(I_2 - I_3) - 5 - 5 - 3(I_1 - I_2) = 0$

$4I_2 - 5 + 2I_2 - 2I_3 - 10 - 3I_1 + 3I_2 = 0$

$-3I_1 + 9I_2 - 2I_3 = 15$ — (2)

From loop 3. $\quad 8I_3 + 30 + 5 - 2(I_2 - I_3) = 0$

$8I_3 + 35 - 2I_2 + 2I_3 = 0$

$0\,I_1 - 2I_2 + 10I_3 = -35$ — (3)

Using Crammers rule.,

$[Z][I] = [V]$

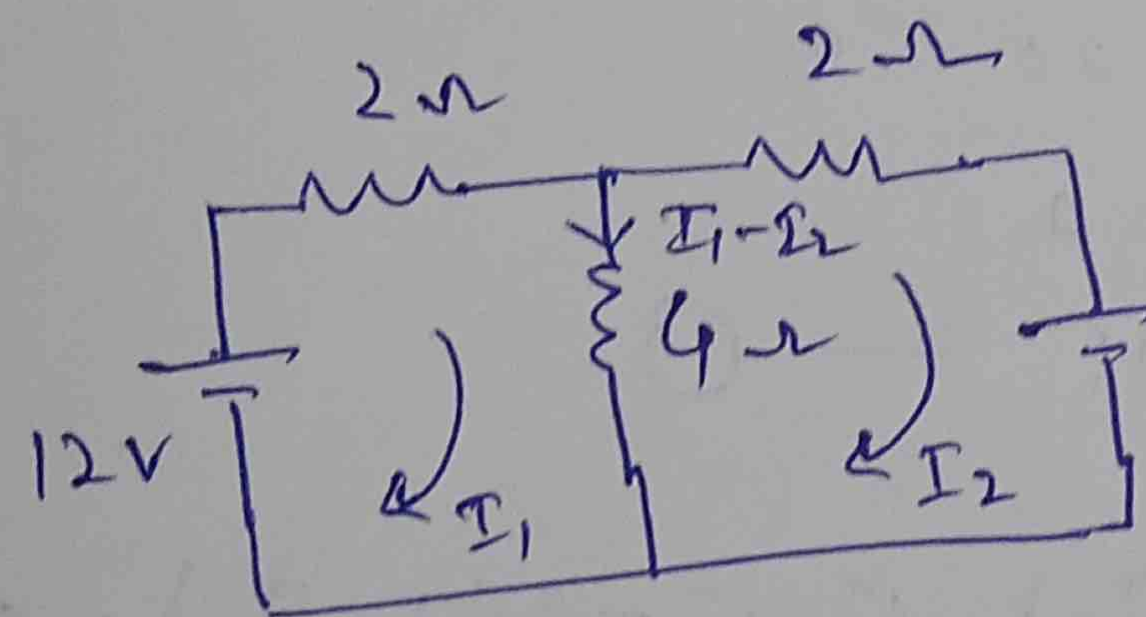
(P. T. O)

$$I_1 = \frac{\begin{bmatrix} 15 & -3 & 0 \\ 15 & 9 & -2 \\ -35 & -2 & 10 \end{bmatrix}}{\begin{bmatrix} 8 & -3 & 0 \\ -3 & 9 & -2 \\ 0 & -2 & 10 \end{bmatrix}} = \frac{15(90-4)+3(150-70)}{8(90-4)+3(-30)} = \frac{1290+240}{688-90} = \frac{1530}{598} = 2.55A$$

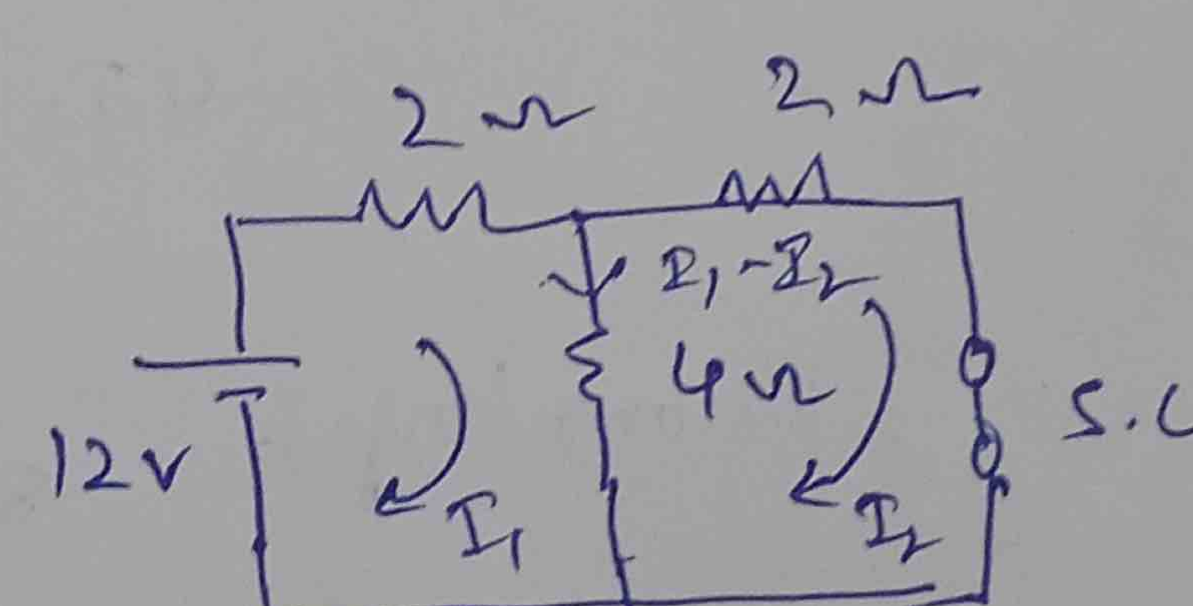
$$I_2 = \frac{\begin{bmatrix} 8 & 15 & 0 \\ -3 & 15 & -2 \\ 0 & -35 & 10 \end{bmatrix}}{598} = \frac{8(150-70)-15(-30)}{598} = \frac{640+450}{598} = \frac{1090}{598} = 1.822A$$

$$I_3 = \frac{\begin{bmatrix} 8 & -3 & 15 \\ -3 & 9 & 15 \\ 0 & -2 & -35 \end{bmatrix}}{598} = \frac{8(-315+30)+3(105)+15(6)}{598} = \frac{-2280+315+90}{598} = -3.135A$$

2,A



Determine current through 4Ω resistor using Superposition theorem.



For finding I' :-

From loop 1

$$2I_1 + 4(I_1 - I_2) - 12 = 0$$
$$2I_1 + 4I_1 - 4I_2 = 12$$
$$6I_1 - 4I_2 = 12 \quad \text{— (1).}$$

From loop 2

$$2I_2 + 10 - 4(I_1 - I_2) = 0.$$
$$2I_2 - 4I_1 + 4I_2 = 0$$
$$-4I_1 + 6I_2 = 0 \quad \text{— (2).}$$

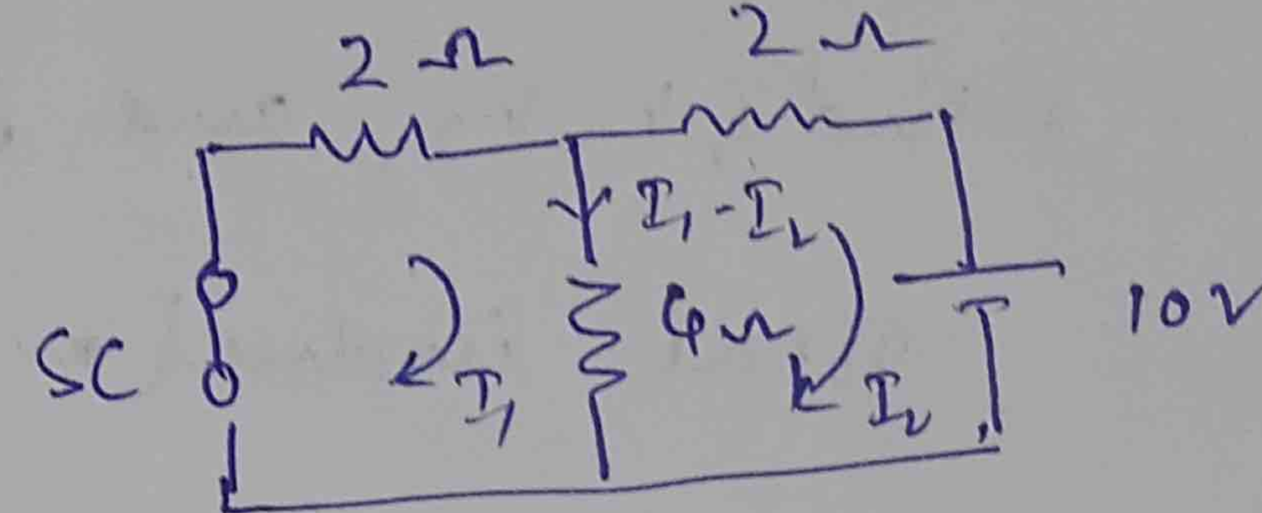
2024/8/17 21:37

$$I_1 = \frac{\begin{bmatrix} 12 & -4 \\ 0 & 6 \end{bmatrix}}{\begin{bmatrix} 6 & -4 \\ -4 & 6 \end{bmatrix}} = \frac{72}{36-16} = \frac{72}{20} = 3.6$$

$$I_2 = \frac{\begin{bmatrix} 6 & 12 \\ -4 & 0 \end{bmatrix}}{20} = \frac{48}{20} = 2.4$$

$$I' = I_1 - I_2 = 3.6 - 2.4 = 1.2\ A.$$

For finding I'' :-



From loop 1

$$2I_1 + 4(I_1 - I_2) = 0$$

$$2I_1 + 4I_1 - 4I_2 = 0$$

$$6I_1 - 4I_2 = 0 \quad \text{— (1).}$$

From loop 2

$$2I_2 + 10 - 4(I_1 - I_2) = 0$$

$$2I_2 + 10 - 4I_1 + 4I_2 = 0$$

$$-4I_1 + 6I_2 = -10 \quad \text{— (2).}$$

$$I_1 = \frac{\begin{bmatrix} 0 & -4 \\ -10 & 6 \end{bmatrix}}{\begin{bmatrix} 6 & -4 \\ -4 & 6 \end{bmatrix}} = \frac{-40}{36-16} = -\frac{40}{20} = -2$$

$$I_2 = \frac{\begin{bmatrix} 6 & 0 \\ -4 & -10 \end{bmatrix}}{20} = \frac{-60}{20} = -3$$

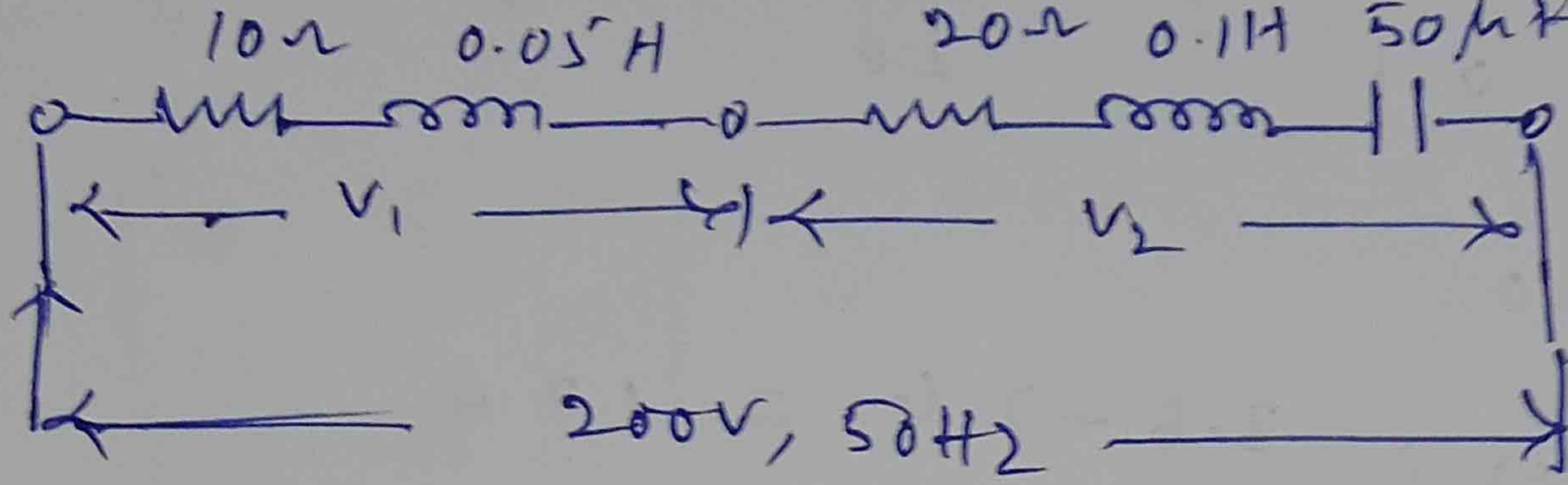
$$I'' = I_1 - I_2 = -2 + 3 = 1\ A$$

(P.T.O)

Current flowing in 4Ω resistor according to Superposition theorem $= I' + I'' = 1.2 + 1$

$= 2.2\ A$

3.(A)



Find I, V_1, V_2, and p.f.

Total inductance of the circuit $= L_1 + L_2$
$= 0.05 + 0.1 = 0.15\ H.$

$\omega = 2\pi f = 2\pi \times 50 = 314$ rad/sec.

$X_L = 2\pi f L = 314 \times 0.15 = 47.1\ \Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{314 \times 50 \times 10^{-6}} = 63.7\ \Omega$

$X = X_L - X_C = 47.1 - 63.7 = -16.6\ \Omega$

$R = R_1 + R_2 = 10 + 20 = 30\ \Omega$

Z = Impedance of the circuit $= \sqrt{R^2 + (X_L - X_C)^2}$
$= \sqrt{30^2 + (-16.6)^2} = 34.28\ \Omega$

$I = \frac{V}{Z} = \frac{200}{34.28} = 5.83\ A$

$Z_1 = \sqrt{R_1^2 + X_{L_1}^2} = \sqrt{10^2 + (314 \times 0.05)^2} = 18.61\ \Omega$

$Z_2 = \sqrt{R_2^2 + (X_{L_2} - X_{C_2})^2} = \sqrt{20^2 + \left[(314 \times 0.1) - \frac{10^{-6}}{314 \times 50}\right]^2}$

$= 38\ \Omega$

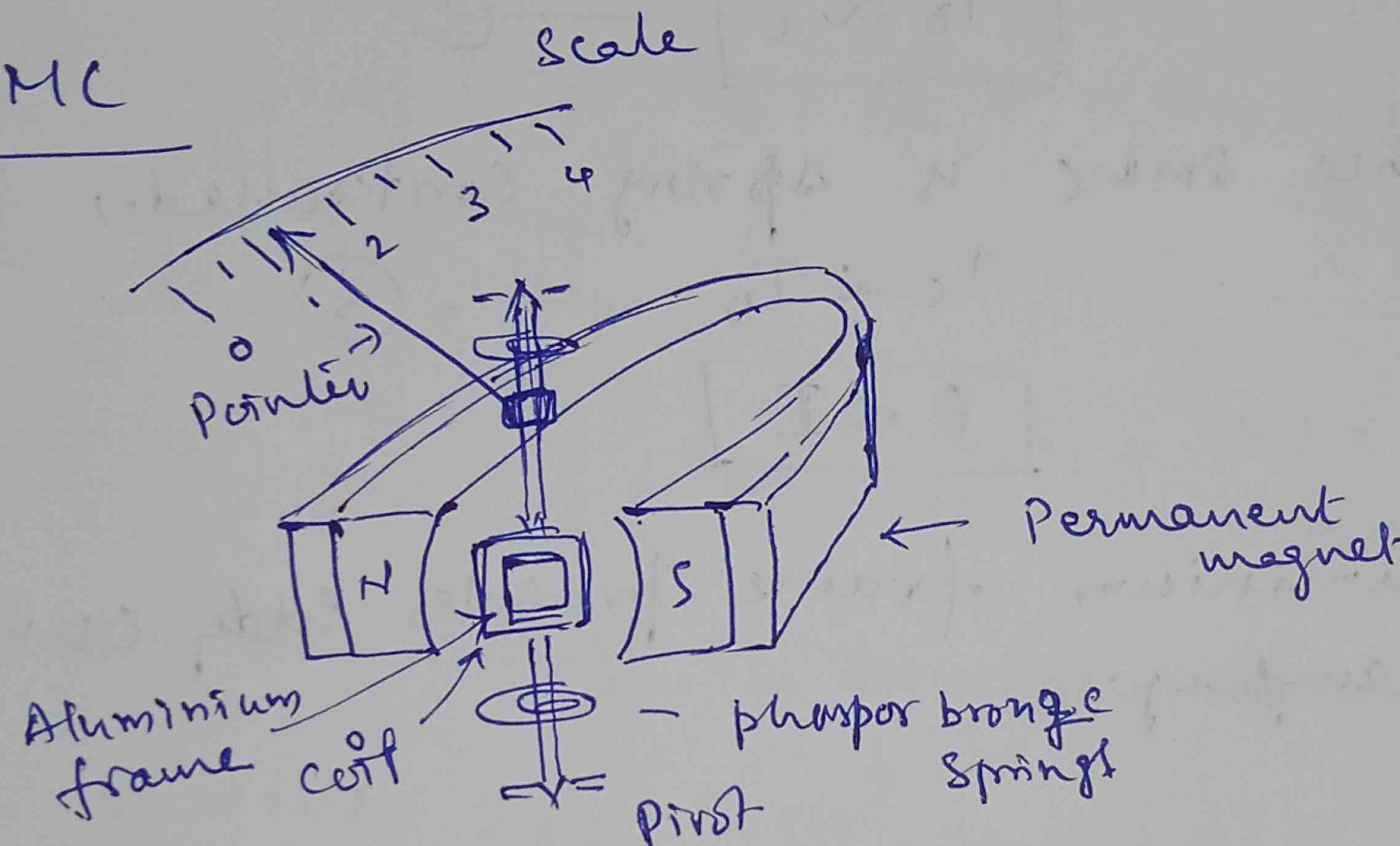
$V_1 = I Z_1 = 5.83 \times 18.61 = 108.$…V

$V_2 = I Z_2 = 5.83 \times 38 = 221.54\,V$

$\cos\phi = \frac{R}{Z} = \frac{30}{34.28} = 0.875$ leading

(4.A) Explain PMMC (Permanent Magnet Moving coil instrument)

A. PMMC



Principle :- Current carrying conductor (coil) placed in the magnetic field of permanent magnet, force acts on the coil., pointer attached to the coil along with the coil deflects on scale.

Construction :- It consists of permanent magnet. coil with the arrange_ment of spindle is provided in the flux of permanent magnet
Springs provided for obtaining controlling torque

working :- when current (or voltage proportional to current) to be measured is passed through coil spindle along with pointer moves.

Deflecting force = $F = NBil$.

where = B = Flux density
N = No. of turns of coil.
i = Current
l = length of the coil (active length).

Deflecting Torque = $T_D = F \times 2r = 2NBilr$ — (1')

$$\boxed{T_D \propto i} \quad \text{— (1)}$$

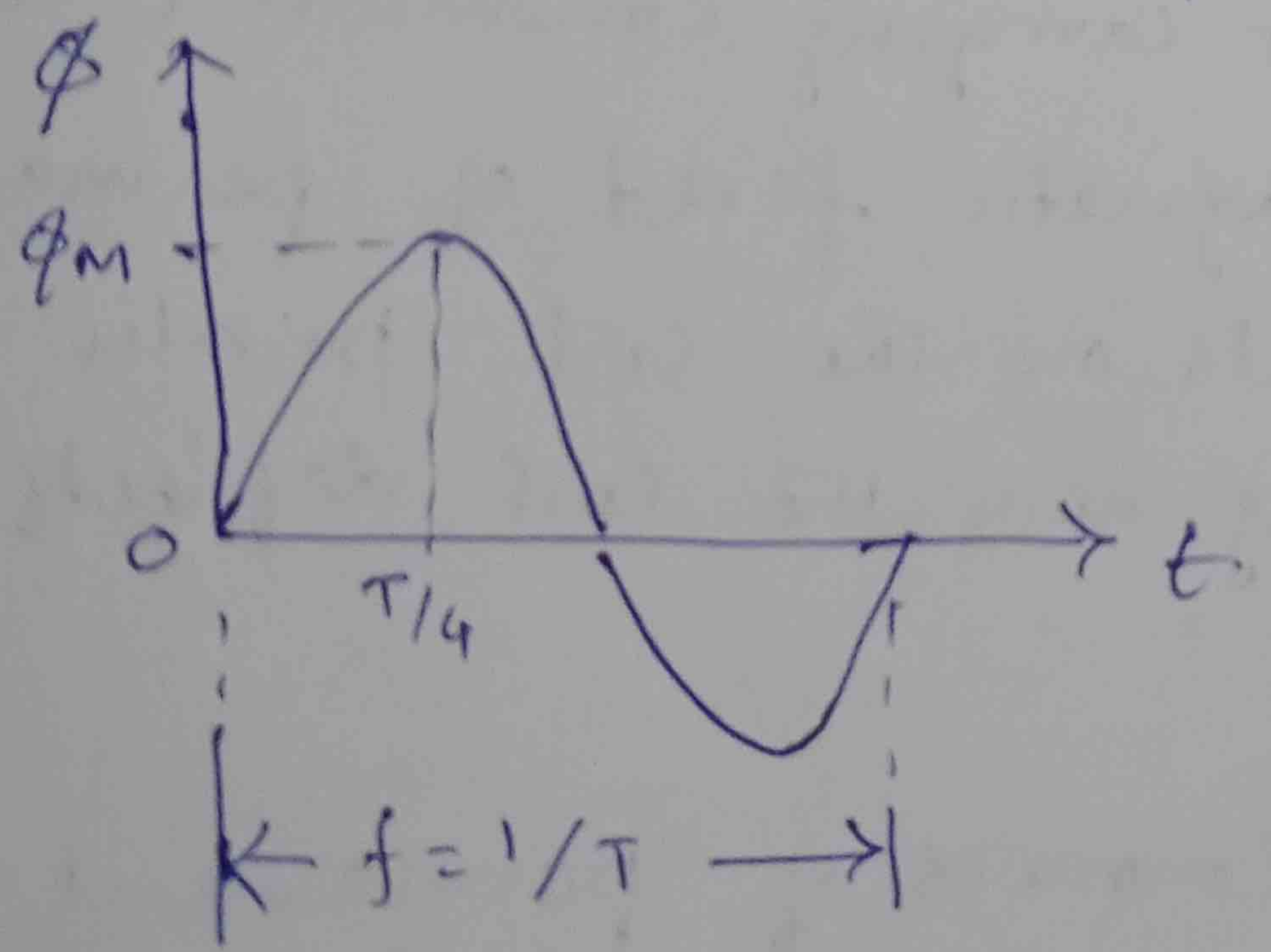
Since PMMC is spring controlled, $T_C \propto \theta$ — (2)

$T_C \propto T_D$ — (3)

$$\boxed{\theta \propto I}$$

Aluminium frame provides eddy current damping.

5(A), (a) Derivation for emf equation of a transformer.



instantaneous value of flux $\phi = \phi_m \sin \omega t$

$\phi_m = B_m A$ [where B_m = Max. flux density and A = Area of C.S]

Average rate of change of flux = $\frac{\phi_m}{1/4f}$ = 4fϕ_m

Average induced emf per turn = $4f\phi_m$ volts.

R.M.S value of induced emf per turn = $4.44\,\phi_m f$ volts

[Form factor = 1.11 = $\frac{\text{rms value}}{\text{Ave. value}}$]

RMS value of induced emf per N no of turns = $4.44\,\phi_m f N_1$ volts

(N_1 = No. of turns of primary)

(b). $P = 50\,kVA$, $N_1 = 500$ $N_2 = 100$ $E_1 = 2100V$, $f = 50Hz$

$$k = \frac{N_2}{N_1} = \frac{100}{500} = 0.2$$

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} \qquad E_2 = \frac{N_2}{N_1}E_1 = 0.2 \times 2100 = 420V.$$

Secondary voltage V_2 for open circuit = 420V.

F.L Current (Primary) = $I_1 = \frac{50\times10^3}{2100} = 23.81A.$

F.L Current (secondary) = $I_2 = \frac{50\times10^3}{420} = 119A.$

$$\phi_m = \frac{E_1}{4.44fN_1} = \frac{2100}{4.44\times50\times500} = 0.0189\ wb$$