Sanothimi, Bhaktapur

Regular/Back Exam-2074, Shrawan/Bhadra

Program:	**Diploma in Electrical Engineering**	**Full Mark: 80**
Year/Part:	**II/II (New Course)**	**Pass Mark:32**
Subject:	**Electrical Measurements and Measuring Instruments**	**Time: 3 hrs.**

Candidates are required to give their answers in their own words as far as practicable. The figures in the margin indicate full marks.

Attempt Any Five questions.

1. a) Explain the operating principle of electrodynamometer instrument. Explain how it can be used as wattmeter. [5+3]

   b) Following data refers to moving coil voltmeter: [8]
   Resistance (R)= 15000Ω. Dimension of coil=30mmx30mm, Number of turns on a coil=100. Flux density in air gap (B) =0.05wb/m^2, spring constant (k)=3x10^{-6} NM/degree. Find the deflection produced by voltmeter of 300V.

2. a) Write down classification of resistance with examples. Explain Kelvin double bridge method for measurement of Resistance. [2+6]

   b) What are errors in wheat stone bridge in measurement of resistance? Explain measurement of high resistance using Megger. [2+6]

3. a) Describe Maxwell inductance bridge with appropriate figure. [8]

   b) A moving coil instrument has a resistance of 12Ω and gives full scale deflection when carrying a current of 60mA. Show how it can be used to measure voltage upto 750V and current upto 10A. [8]

4. a) Explain measurement of energy with single phase energy meter along with its construction & operation. [8]

   b) Explain working principle of AC or inductive potentiometer. What are type of AC potentiometer. [8]

5. a) What do you mean by TOD? Explain working principle & Application of TOD meter. [1+7]

   b) The power flowing in a 3 phase, 3 wire balanced system load is measured by two wattmeter method, the reading of wattmeter A is 7500w and that of wattmeter B is 5000w. Supply frequency is 50Hz (i) What is power factor (ii) If circuit voltage (L-L) is 400v what value of capacitance must be introduced in each phase to cause the whole power measured appears in wattmeter A? [8]

6. a) Explain construction & operation of thermocouple. [8]

   b) What ~~ary~~ are current transformer & potential transformer. Explain construction & operating principle of CT. [8]

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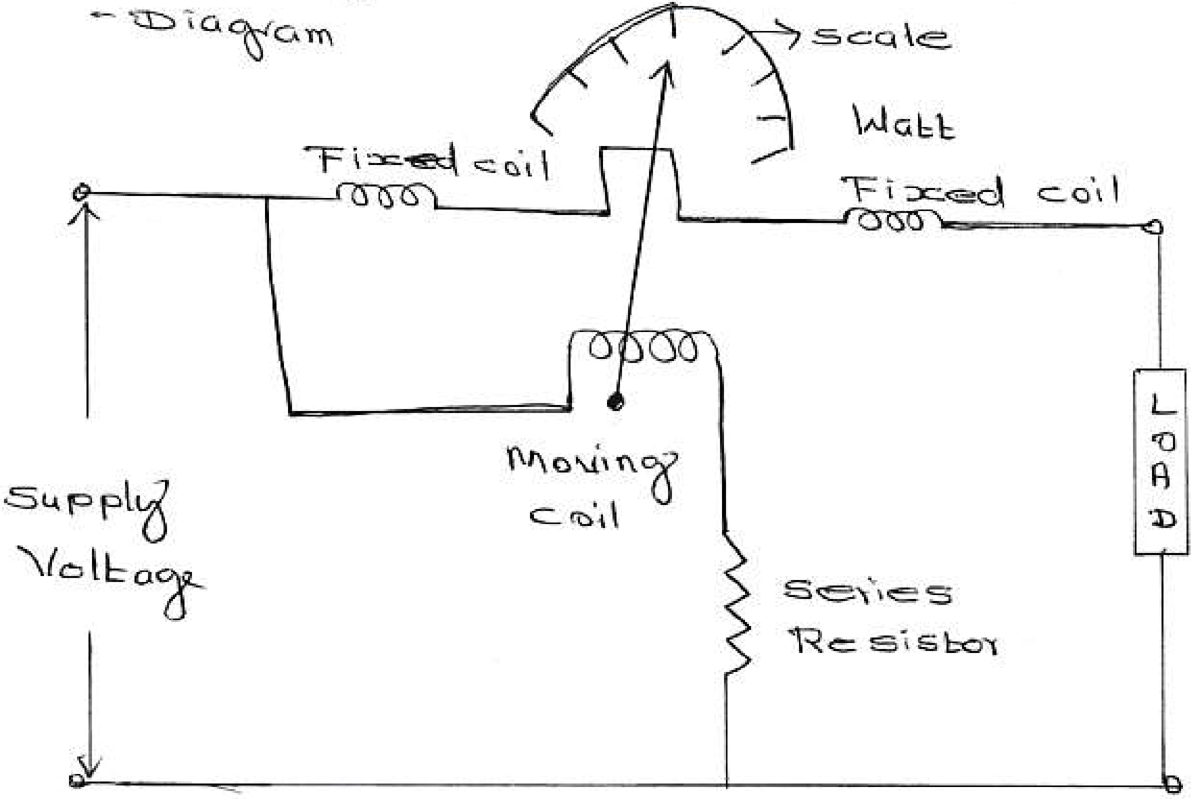
Emmi Question & Answer - 2074

①

① Explain the operating principle of electro-
ⓐ -dynamometer instrument. Explain how it can be used as wattmeter.

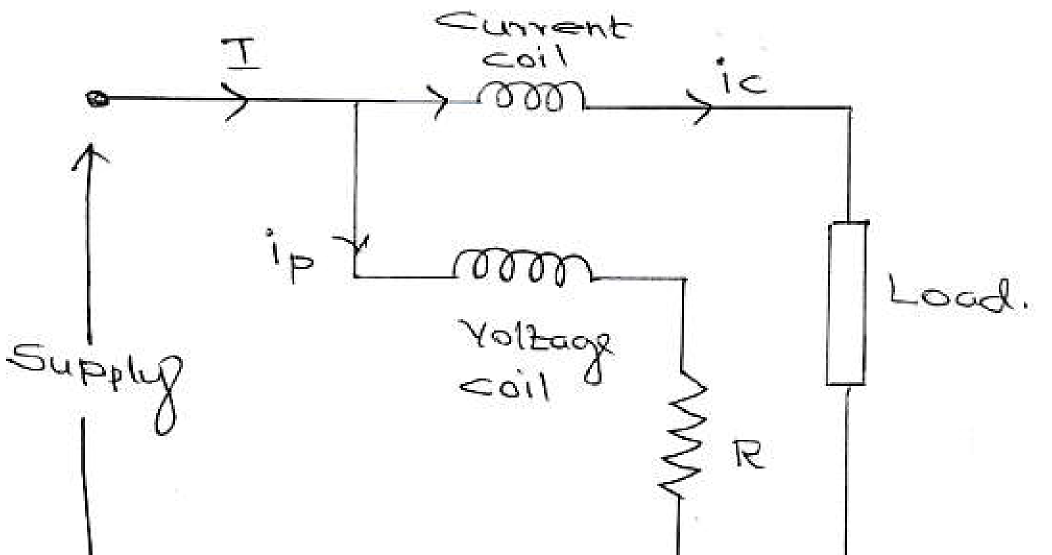
Answer: p. 24 Unit - I

1. Electrodynamic definition
2. Construction
   - Diagram
   - Fixed coil
   - moving coil
   - springs
   - shielding
3. Applications.
4. Electrodynamometer as Wattmeter.
   - Diagram



5. Explaination

- It works based on current - carrying conductor magnetic force when it is placed in a magnetic field.
- Deflection takes place due to mechanical force.
- It has two coils
  1. Fixed coil (current coil)
  2. moving coil (Voltage coil)
- Fixed coil carry the current.
- Moving coil carry the voltage proportional to current
- current across the moving coil is controlled by resistor.
- Resistor is connected seriesly with the moving coil.
- Two magnetic fields are generated due to the current & voltage in the fixed coil & moving coil.
- pointer deflects as the two magnetic fields interact.
- Deflection is directly proportional to the power flowing through it.



~~Lab Layout~~

Given

- R = 15000 Ω

Coil dimension = 30mm X 30mm. = lb

N. of coil turns = 100 = (N-m) = N

air gap (B) = 0.05 wb/m² = B

Spring Constant (k) = 3×10^{-6} Nm/degree.

Voltmeter (V) = 300V

deflection = ?

① Full Scale deflection current

$$\boxed{i = \frac{V}{R}} = \frac{3\cancel{0}\cancel{0}}{15\cancel{0}\cancel{0}} = 0.02A$$

B = air gab
i = current
l = length of coil
b = breath of coil
n = no of turns

② Deflecting Torque on the coil

$$\boxed{Td = Bilnb}$$

$$Td = \underbrace{0.05}_{B} \times \underbrace{0.02}_{\substack{\text{coil}\\\text{Current}}} \times \underbrace{30 \times 10^{-3} \times 20 \times 10^{-3}}_{\text{coil Dimension}} \quad \underbrace{\times 100}_{\text{no. of turn.}}$$

③ Control Torque of the spring $\boxed{Tc = ks \, \theta}$

$$\boxed{Tc = 3 \times 10^{-6} \times \theta}$$

ks = string constant

= deflecti

At Equilibrium $\boxed{Td = Tc}$

$\boxed{T_d = T_c}$

$$0.05 \times 0.02 \times 30 \times 10^{-3} \times 20 \times 10^{-3} \times 100 = 3 \times 10^{-6} \times \theta$$

$$\frac{0.05 \times 0.02 \times \overset{1}{\cancel{3}}0 \times 1\cancel{0}^{-\cancel{3}} \times 20 \times 1\cancel{0}^{-\cancel{3}} \times 100}{\cancel{3} \times 1\cancel{0}^{-\cancel{6}}} = \theta$$

$$0.001 \times 10 \times 20 \times 100 = \theta$$

$$0.001 \times 20000 = \theta$$

$\boxed{20^\circ = \theta}$ Ans

(b)

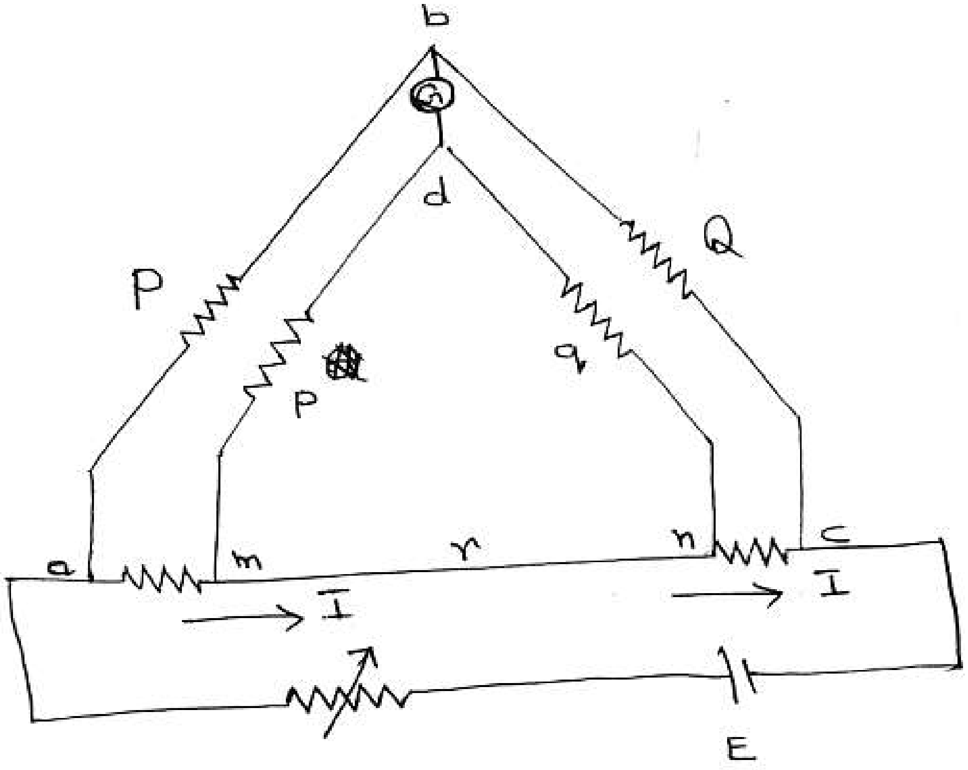
) a) Write down classification of resistance with examples. Explain kelvin double bridge method for measurement of Resistance.

Classification of Resistances:

1. Low Resistance = less than 1 ohm(Ω)
2. medium Resistance = From 1 Ω to 0.1 M-Ω
3. High Resistance = Above 0.1 MΩ.

Kelvin Double Bridge (page = 07 notes) (unit - II)

1. Definition
2. Principle of kelvin Bridge.
3. Derivation for finding unknown Resistance value.



The ratio $P/q = P/Q$

$$E_{ab} = E_{amd}$$

$$E_{ab} = \left[\frac{P}{P+Q}\right] \times E_{ac}$$

$$E_{ac} = I\left[R+S+\frac{[p+q]r}{p+q+r}\right]$$

$$E_{amd} = I\left[R+\left(\frac{p}{p+q}\right) * \left(\frac{(p+q)r}{p+q+r}\right)\right]$$

$$E_{ac} = I\left[\frac{p \times r}{p+q+r}\right]$$

When Galvanometer $= 0$

$$E_{ab} = E_{ac}$$

$$\left[\frac{P}{P+Q}\right] \times E_{ac} = I\left[\frac{p*r}{p*q+r}\right]$$

$$\left[\frac{p}{p+Q}\right] * I\left[\left[R+\left(\frac{p}{p+q}\right)\right] * \left[\frac{(p+q)r}{p+q+r}\right]\right] = I\left[\frac{p*r}{p+q+r}\right]$$

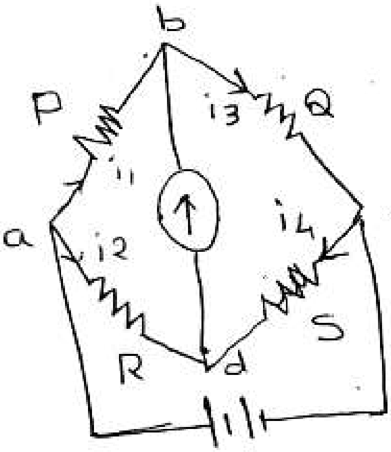
$$R = \left(\frac{P}{R}\right) * S + \left(\frac{p*r}{p+q+r}\right)\left[\left(\frac{P}{Q}\right) - (P/q)\right]$$

Unknown Resistance $\boxed{R = \left(\frac{P}{Q}\right) R}$

⑤

2 b) What are errors in Wheat stone Bridge in measurement resistance? Explain high resistance using megger?

Errors in Wheat stone Bridge:
[Unit-2 page-27]



1. The difference between true & the mark value of the three resistance can cause the error in measurement.
2. Inaccuracy in balance point due to the galvanometer's less sensitivity
3. Resistance of the bridge changes because of self - heating.
4. Thermal emf cause serious trouble.
5. Personal error occurs in the galvanometer by finding null point.

Megger

[Unit - 2 page - 28]

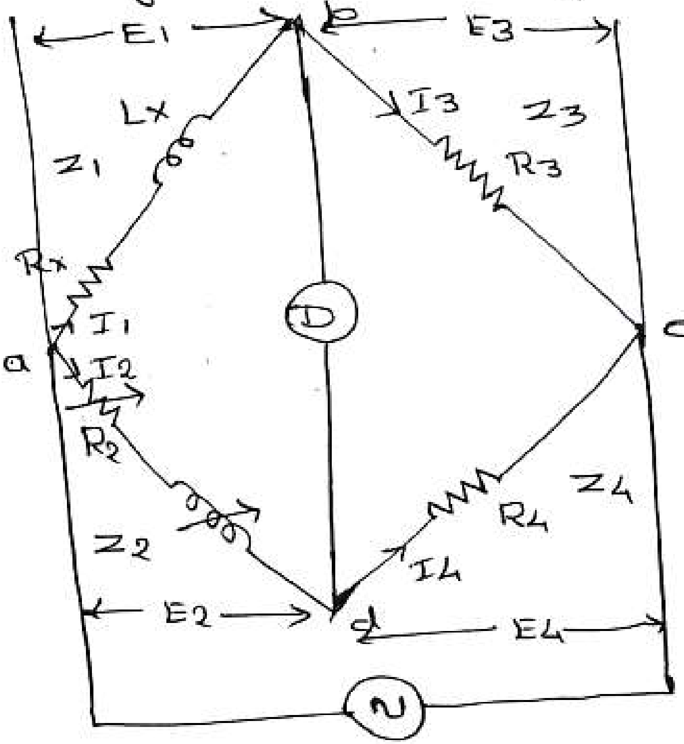
1. What is Megger?
2. Construction of megger?
   - Diagram
   - Circuit construction Features
   - Working principle of megger.
3. High Resistance:-
4. Small Resistance:-

3. ⓐ Describe Maxwell Inductance Bridge.

[Unit-3 page → 9-11]

1. What is Maxwell Bridge?

2. Bridge circuit Diagram



R3, R4 = Known Resistanc

R2, L2 = known Inductance & Resistance.

Rx, Lx = Unknown Inductanc & Resistance.

3. Derivation & Loops:

4. To Find Unknown :-

⇒ at Balance Condition.

$$\boxed{Z_1 Z_4 = Z_2 Z_3} \longrightarrow ①$$

Z_1 = ab impedence

Z_2 = ad impedence

Z_3 = bc impedence

Z_4 = dc impedence

$Z_1 = R_x + j\omega L_x$

$Z_2 = R_2 + r_2 + j\omega L_2$

$Z_3 = R_3$

$Z_4 = R_4$

Sub Z_1, Z_2, Z_3, Z_4 in Eqn ①

$$\boxed{Z_1 Z_4 = Z_2 Z_3}$$

$$(R_x + j\omega L_x) R_4 = (R_2 + r_2 + j\omega L_2) R_3$$

$$R_x R_4 + j\omega L_x R_4 = R_2 R_3 + r_2 R_3 + j\omega L_2 R_3$$

$$R_x R_4 + j\omega L_x R_4 = R_3(R_2 + r_2) + j\omega L_2 R_3$$

Equate Real & Imaginary terms.

$$R_x R_4 = R_3 (R_2 + r_2)$$

$$\boxed{R_x = (R_2 + r_2) \frac{R_3}{R_4}}$$

$$\cancel{j\omega} L_x R_4 = \cancel{j\omega} L_2 R_3$$

$$L_x R_4 = L_2 R_3$$

$$\boxed{L_x = L_2 \left(\frac{R_3}{R_4}\right)}$$

3) ⓑ A moving coil instrument has a resistance of 12 Ω and gives full scale deflection when carrying a current of 60mA. Show how it can be measured voltage upto 750V & current upto 10A.

Answer

Ideally no current flows in voltmeter.

If Resistance is connected in series.

ⓐ

$$\boxed{V = IR}$$

$\cancel{R} = 12\Omega$

$V = 750$

$I = 60\,mA$.

$$750 = 60\times10^{-3}(R+r)$$

$$750 = \frac{60}{10^3}(R+r)$$

$$750 = \frac{60}{1000}(R+r)$$

$$\frac{75000\cancel{0}}{6\cancel{0}} = R+r$$

$$12500 = R+r$$

$$\boxed{r = 12}$$

$$12500 = R + 12\Omega$$

$$12500 - 12 = R$$

$$\boxed{12.5\,k\Omega = R}$$

[12 Ω is small, it is neglected]

12.5 kΩ resistance is connected seriously

ⓑ Ammeter works on no voltage drop

$$60\times10^{-3}\times12 = 10A \times R$$

$$\boxed{I\,R = I \times R}$$

$$60\times10^{-3}\times12 = 10\times10^{3}\times R$$

$$\frac{72}{10^6} = R$$

$$\frac{72}{1000000} = R$$

$$0.00072 = R$$

④ ⓐ Explain measurement of energy with single phase energy meter along with its construction & operation.

Answer → (Unit - 6 page → 26 - 30)

1. Definition
2. construction
   - Diagram.
3. Driving System
4. Moving System
5. Braking System
6. Registration.
7. Phasor Diagram.

④ ⓑ Explain working of AC (or) inductive potentiometer. What are the types of AC potentiometer.

Answer → [Unit - 5, pages → 11 - 13]

1. Definition.
2. Measurement of EMF by potentiometer
3. Applications.
4. Measurement of current
5. Measurement of Voltage

Types

1. Polar type potentiometer

⑤ ⓐ What do you mean by TOD? Explain working principle & application of TOD.

<u>Answer</u> [Unit - 6 . page - 39]

⑤ ⓑ The power flowing in a 3 phase, 3 wire balanced sytem load is measured by two wattmeter method, the reading of wattmeter A is 7500 W, and that of wattmeter B is 5000 W. supply frequency is 50 Hz.

(i) What is power factor.

(ii) If circuit Voltage (L-L) is 400V what value of capacitance must be introduced in each phase to cause the whole power measured appears in Wattmeter A.

Given Data :-

$W_1 = A = 7500\,W$ $\quad F = 50\,Hz.$

$W_2 = B = 5000\,W$ $\quad V_L = 400\,V$

$P = W_1 + W_2.$

$P = 7500 + 5000$

$\boxed{P = 12500\,W}$

(i) $$\theta = \cos\left[\tan^{-1}\left[\frac{W_1 - W_2}{W_1 + W_2}\right]\right]$$

$$\theta = \cos\left[\tan^{-1}\left[\frac{7500 - 5000}{7500 + 5000}\right]\right]$$

$$= \cos\left[\quad \left[2500\right]\right.$$

$$\theta = \cos\left[\tan^{-1}(0.2)\right]$$

$$= \cos(11.30)$$

$$\boxed{PF = \theta = 0.98}$$

(ii)

$$P = W_1 + W_2 = 7500 + 5000 = 12500\,W$$

$V = 400V$ Frequency (F) $= 50Hz$

$$P = VI$$

$$\boxed{\frac{P}{V} = I}$$

$$\frac{12500}{400} = I$$

$$\boxed{31.25 = I}$$

$$R = \frac{V}{I}$$

$$R = \frac{400}{31.25}$$

$$R = 12.8$$

$$\boxed{X_c = \frac{1}{2\pi f c}}$$

$$\boxed{R = X_C = 12.8}$$

$$12.8 = \frac{1}{2\pi \times 50 \times C}$$

$$C = \frac{1}{2\pi \times 50 \times 12.8}$$

$$= \frac{1}{2\pi \times 768}$$

$$\boxed{C = 12 \times 10^{-4} \text{ Farad}}$$

Ⓑ ⓐ Explain construction & operation of thermo couple.

Answer → [unit-7, pages → 01 – 05]

1. Definition
2. Working principle of Thermocouple.
    - See Back Effect
    - Peltier Effect
    - Thompson Effect.
3. Construction
    - Ungrounded Junction
    - Grounded Junction
    - Exposed Junction.
4. Measurement of Thermocouple output.
    - multimeter
    - potentiometer
    - Amplifier with o/p Devices.
5. Advantages
6. Dis Advantages
7. Application.

ⓑ ⓑ What are Current Transformer & potential transformer. Explain construction & Operating principle of CT.

Anwer → [unit - 8 , pages → 01, 07 - 11]

1. CT Definition. (only)
2. PT Definition. (only

Curent Transformer:

1. Circuit Diagram.
2. Construction
   - Diagram with 3 phases
   - Symbol of CT.
3. Burden on a Load
4. Effect of open windings of a CT:
5. phasor Diagram.

✓ **Example 2.1**

The coil of a PMMC instrument has 60 turns, on a former that is 18 mm wide, the effective length of the conductor being 25 mm. It moves in a uniform field of flux density 0.5 Tesla. The control spring constant is 1.5 × 10^{-6} Nm/degree. Calculate the current required to produce a deflection of 100 degree.

Solution Total deflecting torque exerted on the coil,

$$T_d = Bilnb \text{ (N-m)}$$

$$= 0.5 \times i \, x \, 25 \times 10^{-3} \times 60 \times 18 \times 10^{-3}$$

The control torque of the springs is

$T_C = k_s \times \theta$

$= 1.5 \times 10^{-6} \times 100$

At equilibrium, $T_d = T_C$

$= 0.5 \times i \times 18 \times 10^{-3} \times 25 \times 10^{-3} \times 60 = 1.5 \times 10^{-6} \times 100 \; 1.5 \times 10^{-6} \times 100$

$$i = \frac{1.5 \times 10^{-6} \times 100}{0.5 \times 18 \times 10^{-3} \times 25 \times 10^{-3} \times 60} = 11.11 \text{ mA}$$

Example 2.2

A PMMC instrument has a coil of dimensions 15 mm × 12 mm. The flux density in the air gap is 1.8 × 10^{-3} wb/m^2 and the spring constant is 0.14 × 10^{-6} N-m/rad. Determine the number of turns required to produce an angular deflection of 90° when a current of 5 mA is flowing through the coil.

Solution Total deflecting torque exerted on the coil,

$$\boxed{T_d = Bilnb \text{ (N-m)}}$$

$= 1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3} \times n$

The control torque of the springs is

$$\boxed{T_C = k_s \times 6}$$

$= 0.14 \times 10^{-6} \times 90 \times \pi/180$

At equilibrium, $T_d = T_C$

$1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3} \times n = 0.14 \times 10^{-6} \times 90 \times \pi/180$

$$n = \frac{0.14 \times 10^{-6} \times 90 \times \pi/180}{1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3}} = 136$$

Example 2.3

A PMMC voltmeter with a resistance of 20 Ω gives a full-scale deflection of 120° when a potential difference of 100 mV is applied across it. The moving coil has dimensions of 30 mm × 25 mm and is wound with 100 turns. The control spring constant is 0.375 × 10^{-6} N-m/degree. Find the flux density in the air gap. Find also the dimension of copper wire of coil winding if 30% of the instrument resistance is due to coil winding. The specific resistance of copper is 1.7 × 10^{-8} Ωm.

Solution Full-scale deflecting current

$100 \times 10^{-3} = 5 \times 10^{-3}$ A

Total deflecting torque exerted on the coil,

$$T_d = Bilnb \text{ (N-m)}$$

$$= B \times 5 \times 10^{-3} \times 30 \times 10^{-3} \times 25 \times 10^{-3} \times 100$$

The control torque of the springs is

$$T_C = k_s \times \theta$$

$$= 0.375 \times 10^{-6} \times 120$$

At equilibrium, $T_d = T_C$

$$B \times 5 \times 10^{-3} \times 30 \times 10^{-3} \times 25 \times 10^{-3} \times 100 = 0.375 \times 10^{-6} \times 120$$

$$B = \frac{0.375 \times 10^{-6} \times 120}{5 \times 10^{-3} \times 30 \times 10^{-3} \times 25 \times 10^{-3} \times 100} = 0.12 \text{ wb/m}^2$$

Coil winding resistance = 20 × 0.3 = 6 Ω

If the copper wire has a cross-sectional area of *a* m then

$$n\rho\frac{l}{a} = R$$ [where n be the number of turns, ρ is the resistivity of the copper wire, l is the length of the wire and a is the cross-sectional area]

$$100 \times 1.7 \times 10^{-8} \times \frac{2 \times (30 + 25) \times 10^{-3}}{a} = 6$$

$$a = 100 \times 1.7 \times 10^{-8} \times \frac{2 \times (30 + 25) \times 10^{-3}}{6} = 31.16 \times 10^{-3} \text{ mm}^2$$

If d be the diameter of the copper wire then

$$d = \sqrt{\frac{4 \times 31.16 \times 10^{-3}}{\pi}} = 0.199 \text{ mm}$$

Example 2.4

The coil of a moving-coil voltmeter is 40 mm long and 30 mm wide and has 100 turns on it. The control spring exerts a torque of 240 × 10^{-6} N-m when the deflection is 100 divisions on full scale. If the flux density of the magnetic field in the air gap is 1 wb/m^2, estimate the resistance that must be put in series with the coil to give one volt per division. The resistance of the voltmeter coil may be neglected.

Solution Let the full scale deflecting current be I amp.

Total deflecting torque exerted on the coil,

$$T_d = Bilnb \text{ (N-m)}$$

$$= 1 \times I \times 40 \times 10^{-3} \times 30 \times 10^{-3} \times 100$$

The control torque of the springs is

$$T_C = k_s \times \theta$$

Problems

1. **The input power to a 3-phase a.c. motor is measured as 5kW. If the voltage and current to the motor are 400V and 8.6A respectively, determine the power factor of the system?**

Power $P=5000W$,

line voltage $VL = 400$ V,

line current, $IL = 8.6A$ and

power, $P=\sqrt{3}\ VLIL \cos \varphi$

Hence

power factor = $\cos \varphi = P\sqrt{3}\ VLIL$

$=5000\ \sqrt{3}\ (400)\ (8.6)$

$=0.839$

2. Two wattmeters are connected to measure the input power to a balanced 3-phase load by the two-wattmeter method. If the instrument readings are 8kW and 4kW, determine (a) the total power input and (b) the load power factor.

(a)Total input power,

$P=P1+P2=8+4=$**12kW**

(b) $\tan\varphi=\sqrt{3}(P1-P2)/(P1+P2)$

$=\sqrt{3}\,(8-4)/(8+4)$

$=\sqrt{3}\,(4/12)$

$=\sqrt{3}(1/3)$

$=1/\sqrt{3}$

Hence $\varphi=\tan{-1}\ 1\ \sqrt{3}\quad=30°$

Power factor= $\cos\varphi=\cos 30°=$**0.866**

3. Two wattmeters connected to a 3-phase motor indicate the total power input to be 12kW. The power factor is 0.6. Determine the readings of each wattmeter.

If the two wattmeters indicate $P1$ and $P2$ respectively

Then $P1+P2=12$kW ---(1)

$\tan\varphi=\sqrt{3}(P1-P2)/(P1+P2)$

And power factor=0.6= $\cos\varphi$.

Angle $\varphi=\cos{-1}0.6=53.13°$ and

$\tan 53.13°=1.3333$.

Hence

$1.3333=\sqrt{3}(P1-P2)/12$

From which,

$P1-P2\quad=12(1.3333)/\sqrt{3}$

i.e. $P1-P2=9.237$kW ----(2)

Adding Equations (1) and (2) gives:

$2P1=21.237$

i.e. $P1=21.237/2$

(12−10.62)=1.38kW

4. **Three loads, each of resistance 30, are connected in star to a 415 V, 3-phase supply. Determine (a) the system phase voltage, (b) the phase current and (c) the line current.**

A "415 V, 3-phase supply" means that 415 V is the line voltage, VL

(a) For a star connection, VL =√3Vp Hence phase voltage, Vp = VL/√3

=415 /√3

=239.6 V or 240 V

correct to 3 significant figures

(b) Phase current, Ip = Vp/Rp

=240/30

=8 A

(c) For a star connection, Ip = IL Hence the line current, IL = **8 A**

5. **Three identical coils, each of resistance 10*ohm* and inductance 42mH are connected (a) in star and (b) in delta to a 415V, 50 Hz, 3-phase supply. Determine the total power dissipated in each case.**

(a) **Star connection**

Inductive reactance,

$XL = 2\pi f L = 2\pi (50) (42\times 10-3) = 13.19$

Phase impedance,

$Zp = \sqrt{(R^2 + XL^2)}$

$= \sqrt{(10^2 + 13.19^2)} = 16.55$

Line voltage, $VL = 415\ V$

And phase voltage,

$VP = VL/\sqrt{3} = 415/\sqrt{3} = 240\ V$

Phase current,

$Ip = Vp/Zp = 240/16.55 = 14.50\ A$. Line current,

$IL = Ip = 14.50\ A$.

Power factor= $\cos \varphi = Rp/Zp = 10/16.55 = 0.6042$ lagging.

$P = \sqrt{3}\ V\text{L}\ I\text{L} \cos\varphi = \sqrt{3}\ (415)\ (14.50)(0.6042) =$ **6.3kW** (Alternatively,

$P = 3I^2R = 3(14.50)^2(10) =$ **6.3kW**)

(b) **Delta connection**

$V\text{L} = V\text{p} = 415$ V,

$Z\text{p} = 16.55$_, $\cos\varphi = 0.6042$ lagging (from above). Phase current,

$I\text{p} = V\text{p}/Z\text{p} = 415/16.55 = 25.08$A. Line current,

$I\text{L} = \sqrt{3}I\text{p} = \sqrt{3}(25.08) = 43.44$A.

Power dissipated,

$P = \sqrt{3}\ V\text{L}\ I\text{L} \cos\varphi$

$= \sqrt{3}\ (415)(43.44)(0.6042) =$ **18.87kW**

(Alternatively,

$P = 3I^2\text{R}$

$= 3(25.08)2(10) =$ **18.87 kW**)

6. **A 415V, 3-phase a.c. motor has a power output of 12.75kW and operates at a power factor of 0.77 lagging and with an efficiency of 85 per cent. If the motor is delta-connected, determine (a) the power input, (b) the line current and (c) the phase current.**

(a) Efficiency=power output/power input.

Hence

(85/100)=12.750 power input from which, **Power input** = 12. 750 × 10085

= **15 000W** or **15Kw**

(b) Power, $P = \sqrt{3}\ V\text{L}\ I\text{L} \cos\varphi$, hence

(c) **line current,**

$I\text{L} = P/\ \sqrt{3}\ (415)\ (0.77)$

$= 15\ 000/\ \sqrt{3}\ (415)\ (0.77)$

= **27.10A**

Phase current, I_p = IL/√3

=27.10 /√3

= **15.65A**

7. **A 400V, 3-phase star connected alternator supplies a delta-connected load, each phase of which has a resistance of 30_ and inductive reactance 40_. Calculate (a) the current supplied by the alternator and (b) the output power and the kVA of the alternator, neglecting losses in the line between the alternator and load.**

A circuit diagram of the alternator and load is shown in Fig.

(a) Considering the load:

Phase current, $I_p = V_p/Z_p$

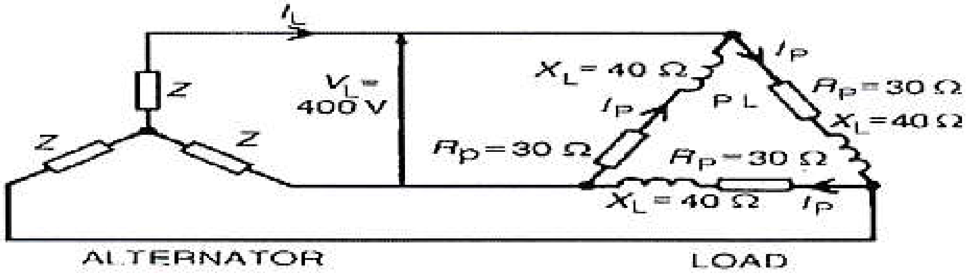
$V_p = V_L$ for a delta connection,

Hence V_p =400V.

Phase impedance,

$Z_p = \sqrt{(R^2+X_L^2)}$

$= \sqrt{(30^2+40^2)} = 50$



Figure

Hence $I_p = V_p/Z_p$ =400/50=8A.

For a delta-connection,

Line current, $I_L = \sqrt{3}\, I_p = \sqrt{3}\,(8)$ =13.86 A.

Hence **13.86A is the current supplied by the alternator**.

(b) Alternator output power is equal to the power Dissipated by the load

I.e. $P = \sqrt{3}\, V_L I_L \cos\varphi$, Where $\cos\varphi = R_p/Z_p$ = 30/50 = 0.6.

Hence $P = \sqrt{3}$ (400) (13.86) (0.6) = **5.76kW**.