Tutorial I <Hints>

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1) Here,

Area of coil (A) = $(15 \times 17)\ mm^2$

Flux density (B) = $1.8 \times 10^{-3}\ wb/m^2$

Spring constant (K) = 0.14×10^{-6} Nm/rad

Angular deflection (θ) = $90^\circ = \pi/2$ rad

No. of turns (N) = ?

At balance condition,

$$T_d = T_c$$

$$BINA = K\theta$$

$$\Rightarrow N = \frac{K\theta}{BIA} = \_\_\_\_$$

2) Here,

Resistance of meter (R) = 20Ω

Full scale deflection (θ) = 120°

Potential difference (V) = 100 mV

dimension of coil (A) = 30 mm × 25 mm

No. of turns (N) = 100

Spring constant (K) = 0.375×10^{-6} Nm/deg.

Flux density (B) = ?

diameter of copper wire (d) = ?

current in instrument for full scale deflection,

$$I = \frac{V}{R} = \frac{100 \times 10^{-3}}{20} = \_\_\_\_$$

for steady (balance) condition,

$$T_d = T_c$$

or, $BINA = K\theta$

$$\Rightarrow B = \frac{K\theta}{INA} = \frac{0.375 \times 10^{-6} \times 120}{5 \times 10^{-3} \times 100 \times 30 \times 25 \times 10^{-6}} = \_\_\_\_$$

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Resistance of coil,

$R_c = 0.3 \times 20 =$ ____

(Since resistance of coil is 30% of resistance of instrument)

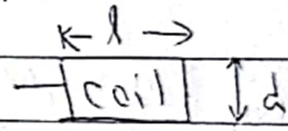
Length of meanturn, $L_{mt} = 2(l+d)$

$= 2(30+25)$

$= 110\,mm$

If 'A' be the cross-sectional area of wire, then,

Resistance of coil $(R) = \frac{\rho L_{mt}}{A} \times N$

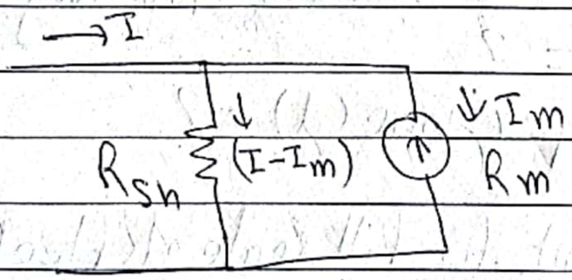


or, $R = \frac{\rho L_{mt} N}{\frac{\pi d^2}{4}} = \frac{4\rho L_{mt} N}{\pi d^2}$

diameter of coil$(d) = \sqrt{\frac{4\rho L_{mt} N}{R\pi}}$

$=$ ____

3)



$I_m R_m = (I - I_m) R_{sh}$

$\Rightarrow R_{sh} = \frac{I_m R_m}{I - I_m} =$ ____

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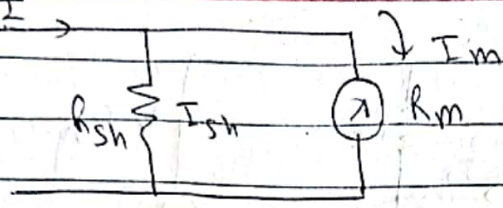
4)



i) $I_m = \frac{V}{R_m} = \underline{\qquad}$

$I_{sh}R_{sh} = I_m R_m$

$I_{sh} = \underline{\qquad}$

ii) Given, $I_{sh} = 10A$

$I_{sh}R_{sh} = I_m R_m$

$\Rightarrow R_m = \frac{I_m}{I_{sh}R_{sh}} = \underline{\qquad}$

iii) For 40% deflection,

$I_m' = 0.4 \times 0.5 \times 10^{-3} = \underline{\qquad}$

Now,

$I_{sh} = 100A$ (Given)

$I_{sh}R_{sh} = R_m' I_m'$

$R_m' = \frac{I_{sh}R_{sh}}{I_m'} = \underline{\qquad}$

5) i) 0 - 10mA $\Rightarrow I = 10mA$

$R_{sh1} = \frac{I_m R_m}{I - I_m}$

$= \frac{1 \times 50}{10 - 1} = \frac{50}{9} = \underline{\qquad}$

Similar for others

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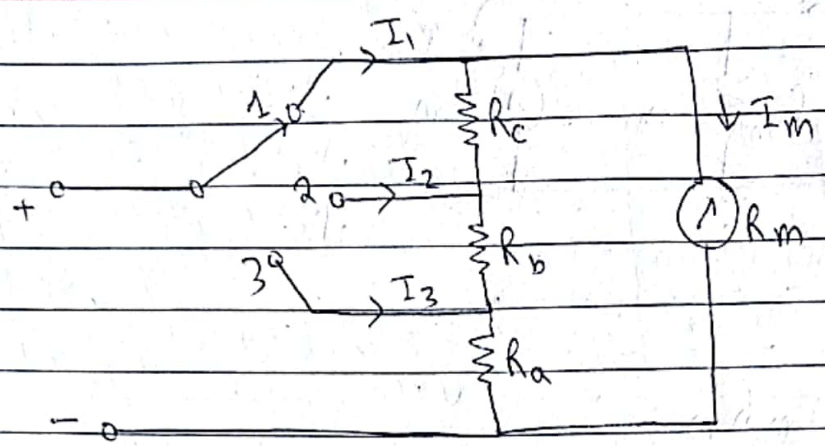
6)



Here,

$I_m = 1mA$, $R_m = 50\Omega$

$I_1 = 1A$, $I_2 = 5A$, $I_3 = 10A$

when switch is at position 1,

$$R_a + R_b + R_c = \frac{R_m}{m_1 - 1} \quad \text{— i)} ; \; m_1 = \frac{I_1}{I_m}$$

when switch is at position 2,

$$R_a + R_b = \frac{R_c + R_m}{m_2 - 1} \quad \text{— ii)} ; \; m_2 = \frac{I_2}{I_m}$$

when switch is at position 3,

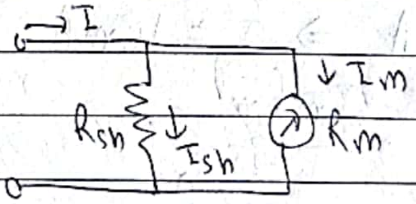
$$R_a = \frac{R_b + R_c + R_m}{m_3 - 1} \quad \text{— iii)} ; \; m_3 = \frac{I_3}{I_m}$$

Solve eq^n i), ii) & iii) & obtain values of R_a, R_b & R_c.

7) a) $I = 100A$

$I_m = 10mA$

$v = 100mV$



$I_{sh} R_{sh} = I_m R_m$

$$R_{sh} = \frac{I_m R_m}{(I - I_m)} = \frac{v}{I - I_m}$$

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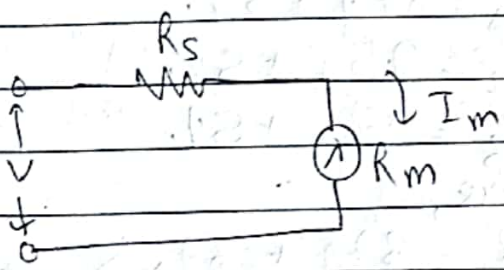
Power dissipation $= VI =$ ______

b) $V = 1000V$



$V - I_m(R_S + R_m) = 0$

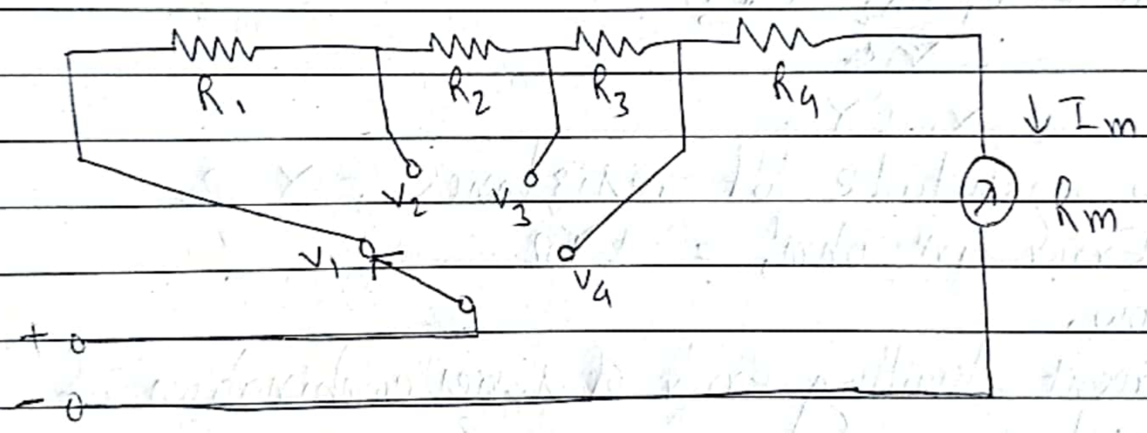
or, $R_S = \frac{V}{I_m} - R_m$

$= \frac{1000}{10 \times 10^{-3}} - \frac{V}{I_m}$ → $100 m\Omega$

$=$ ______

Power dissipation $= V I_m =$ ______

8)



$R_1 = R_m(m_1 - m_2)$	$m_1 = \frac{V_1}{V_m}$
$R_2 = R_m(m_2 - m_3)$	$m_2 = \frac{V_2}{V_m}$
$R_3 = R_m(m_3 - m_4)$	$m_3 = \frac{V_3}{V_m}$
$R_4 = R_m(m_4 - 1)$	$m_4 = \frac{V_4}{V_m}$

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9) Question correction

$R_1 = 37\Omega \pm 5\%$

$R_2 = 75\Omega \pm 5\%$

$R_3 = 50\Omega \pm 5\%$

Here,

$R_1 = 37\Omega \pm 37 \times \frac{5}{100} =$ ______

$R_2 = 75\Omega \pm 75 \times \frac{5}{100} =$ ______

$R_3 = 50 \pm 50 \times \frac{5}{100} =$ ______

∴ The limiting value of resultant resistance,

$R = R_1 + R_2 + R_3$

$= \cancel{x \pm}$

$= X \pm Y$

So, magnitude of resistance $= X\ \Omega$

Error in ohm, $= \pm Y\Omega$

Now,

Percent limiting error of series combination of resistance,

$= \pm \frac{Y}{X} \times 100\% =$ ______ //

10) Here,

$\text{Resistance}(R) = \frac{\text{Power}}{(\text{current})^2} = \frac{P}{I^2} = PI^{-2}$

∴ Relative limiting error in measurement of resistance is,

$\frac{\partial R}{R} = \pm \left(\frac{\partial P}{P} + 2\frac{\partial I}{I} \right)$

$= \pm (1.5 + 2 \times 1)\% = \pm 3.5\%$

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11) $R_x = \dfrac{R_2 R_3}{R_1} = \_\_\_\_\_\_$

Relative limiting error of unknown resistance,

$$\frac{\partial R_x}{R_x} = \pm \left(\frac{\partial R_2}{R_2} + \frac{\partial R_3}{R_3} + \frac{\partial R_1}{R_1} \right)$$

$$= \pm (1 + 0.5 + 1)$$

$$= \pm 2.5\%$$

Limiting error in ohm $= \pm \dfrac{2.5}{100} \times R_x \Rightarrow E$

Guaranteed value of resistance,

$R_x - E = \_\_\_\_\_\_$

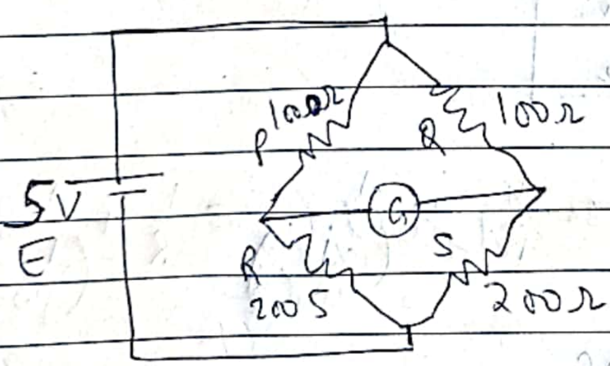
& $R_x + E = \_\_\_\_\_\_$

12) See class notes

13) } $\longrightarrow$ Same as 12
14)

15) See class notes

16)



$E_{TH} = E \left[\dfrac{P}{P+R} - \dfrac{Q}{Q+S} \right]$

$R_{th} = P \parallel R + Q \parallel S$

$$I_g = \frac{E_{th}}{R_{th} + R_g} = \_\_\_\_\_\_$$

Deflection in galvanometer $=$ Sensitivity $\times I_g$

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Notes :-

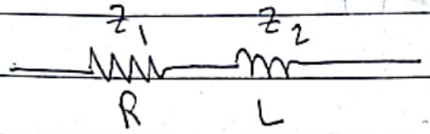
$Z_C = \frac{1}{j\omega C} = \frac{-j}{\omega C}$

$Z_L = j\omega L$

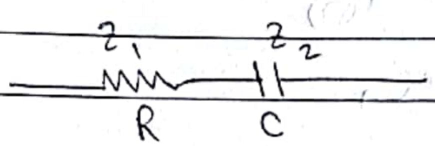
$Y = \frac{1}{Z}$

$Y \rightarrow$ Admittance

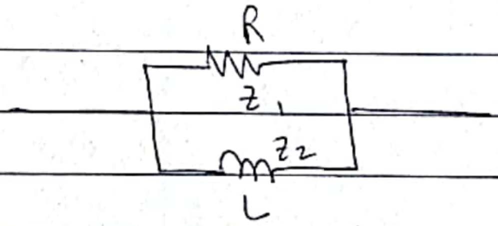
$Z \rightarrow$ Impedance

1)


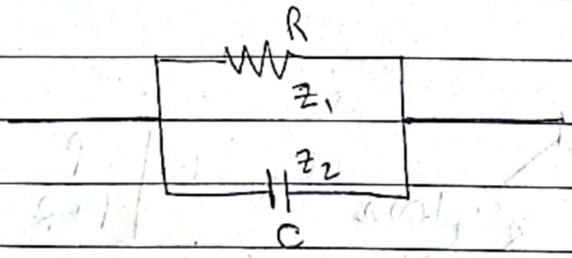
$Z = Z_1 + Z_2 = R + j\omega L$

2)


$Z = Z_1 + Z_2 = R - \frac{j}{\omega C}$

3)


$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} = \frac{1}{R} + \frac{1}{j\omega L}$

4)


$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} = \frac{1}{R} + \frac{1}{\left(\frac{1}{j\omega C}\right)}$

or, $\frac{1}{Z} = \frac{1}{R} + j\omega C$

or, $Y = \frac{1}{R} + j\omega C$