5/9/19

CMR INSTITUTE OF TECHNOLOGY

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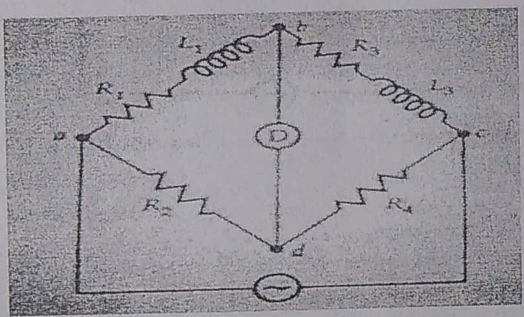
Internal Test –1 September 2019

Sub:	Electrical and Electronic Measurements							Code:	18EE36
Date:	07/09 /2019	Duration:	90 mins	Max Marks:	50	Sem:	III	Branch:	EEE

Note: Answer any **FIVE** full questions with neat diagram wherever necessary.

		Marks	OBE CO	OBE RBT
1	With neat sketch explain Kelvin's double bridge and obtain an expression for balancing condition. Write down the advantage and disadvantage.	[10]	CO1	L1
2	With necessary sketch,explain megger.	[10]	CO1	L1
3	What do you mean by sensitivity?Derive an expression for galavanometer current under unbalanced condition.	[10]	CO1	L2
4	With proper phasor diagram, derive the balancing equation for Anderson's bridge.	[10]	CO1	L2
5	With proper phasor diagram, explain the Maxwell's Inductance capacitance bridge. Write the advantage and disadvantage.	[10]	CO1	L2
6	Write a short note on (a) Shielding of bridges	[5]	CO1	L2
	(b)Hay's bridge	[5]	CO1	L2

7a	In wheat stone bridge, the values of resistors of various arms are P=1000Ω,Q=100Ω,R=2005Ω and S=200Ω.The battery has an emf of 5V .The galvanometer has a current sensitivity of 10mm/μA and an internal resistance of 100Ω.Calculate the deflection of the galvanometer and the sensitivity of the bridge in terms of deflections per unit change in resistance.	[5]	CO1	L3
7b	An inductance of 0.22 H and 20Ω resistance is measured by comparison with a fixed standard inductance of 0.1 H and 40Ω resistance.The unknown inductance is in arm ab and the standard inductance is arm bc,a resistance of 750Ω is connected in arm cd and a resistance whose amount is not known is in arm da. Find the resistance of arm da and show any necessary and practical additions required to achieve both resistive and inductive balance. Refer to the below diagram.	[5]	CO1	L3



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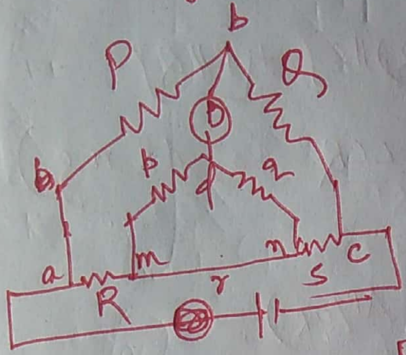
Solution

① Balancing Condⁿ :-



$$E_{ab} = \frac{P}{P+Q} E_{ac}$$

$$E_{ac} = IR + \frac{(p+q)r}{p+q+r} I + IS$$

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

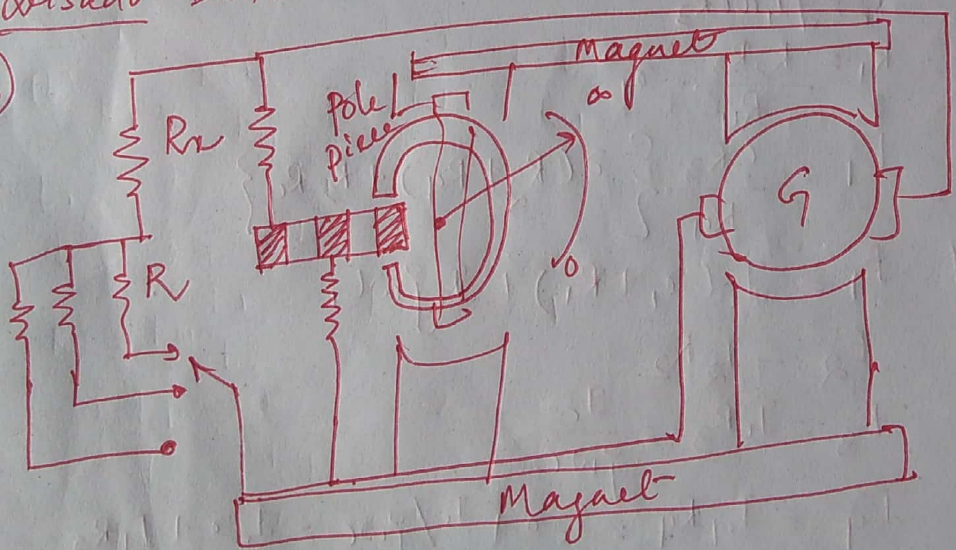
$$R = \frac{P}{Q}S + \frac{qr}{p+q+r}\left[\frac{P}{Q} - \frac{p}{q}\right]$$

$$\because \frac{P}{Q} = \frac{p}{q} \quad \therefore \boxed{R = \frac{P}{Q}S}$$

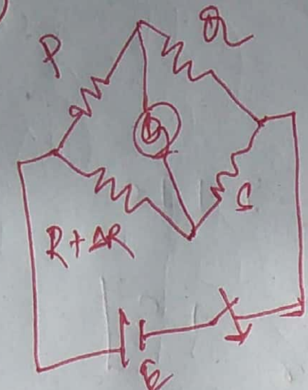
adv: Low value of R.

disadv: Extra ratio arms are there.

②



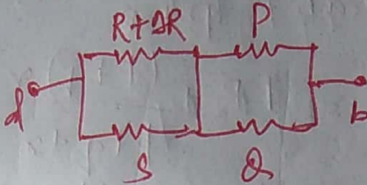
(3)



$E_0 = E_{ad} - E_{ab}$

$= E\left[\frac{R+\Delta R}{R+\Delta R+S} - \frac{P}{P+Q}\right]$ for $\because R = S = P = Q$.

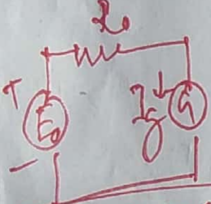
$\Rightarrow E_0 = E\left[\frac{\Delta R}{4R}\right]$ $\because \Delta R \ll R$



$R_0 = [(R+\Delta R) \| S] + [P \| Q]$

$R_0 = \left[\frac{RS}{R+S} + \frac{PQ}{P+Q}\right]$ [$\because \Delta R \ll R$ so; ΔR neg.]

for a bridge with equal arms;
$P = Q = R = S$ $\therefore$ $R_0 = R$



$\because I_g = \frac{E_0}{R_0+G}$; Equal arm; $I_g = \frac{E(\Delta R/4R)}{R_0+G}$

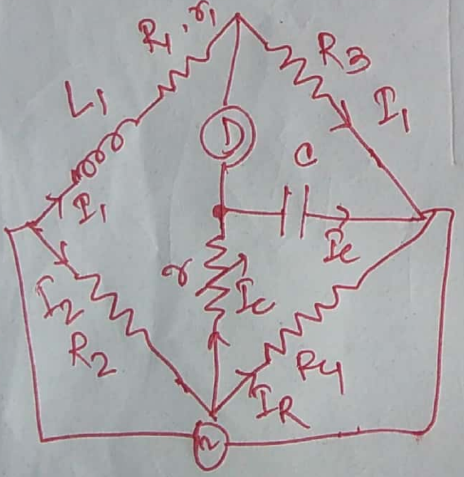
$\theta = S_v \frac{ES\Delta R}{(R+S)^2}$ $\because S_v = \frac{S_i}{R_0+G}$

$\theta = \frac{S_i ES\Delta R}{(R_0+G)^2(R+S)^2} = \frac{S_i E\Delta R}{4R(R+G)}$ (equal arm)

$S_B = \frac{S_i ES R}{(R_0+G)^2 (R+S)^2}$ $S_B = \frac{S_i E}{4(R+G)}$

$P = Q = R = S$.

(4) Anderson's Bridge



$I_c = jI_1\omega CR_3$

$R_1 = \frac{R_2R_3}{R_4} - r_1$

$L_1 = \frac{CR_3}{R_4}\{r(R_2+R_4) + R_2R_4\}$

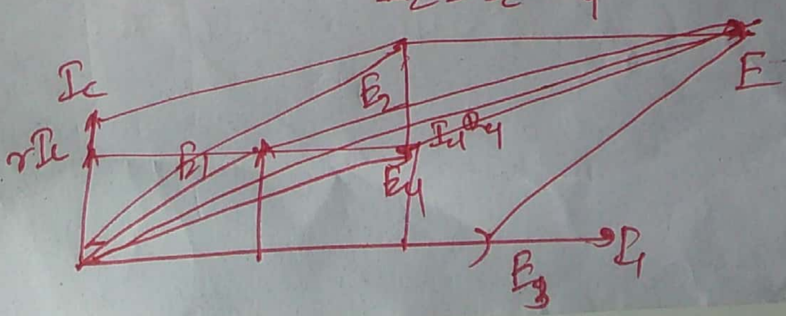
$E_1 = I_1(r_1+R_1) + I_1 j\omega L_1$

$E_2 = I_2R_2$

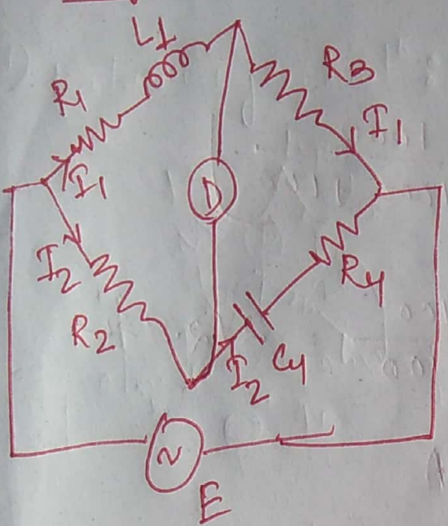
$E_3 = I_1R_3 = \frac{I_c}{j\omega C}$

$E_4 = I_4R_4 = I_c r + I_c/j\omega C = I_c r + I_1R_3$

$I_2 = I_c + I_4$



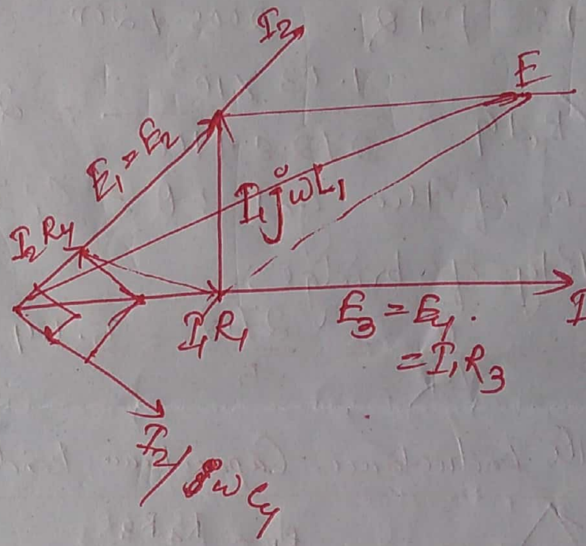
6(b) Hay's bridge



$$L_1 = \frac{R_1}{\omega^2 C_4 R_4}$$

$$R_1 = \frac{\omega^2 C_4^2 R_4 R_2 R_3}{1 + R_4^2 \omega^2 C_4^2}$$

$$L_1 = \frac{R_2 R_3 C_4}{1 + \omega^2 R_4^2 C_4^2}$$



7(b) $R_1 = \frac{R_2 R_3}{R_4}$ & $L_1 = \frac{R_2 L_3}{R_4}$

$$\frac{L_1}{L_3} = \frac{R_2}{R_4} = \frac{R_1}{R_3}$$

$$R_2 = R_4 \frac{L_1}{L_3} = 750 \times \frac{0.22}{0.1} = 1650\,\Omega$$

$$\& \ \frac{L_1}{L_3} = \frac{R_2}{R_4} = 2.2$$

$$\therefore \frac{R_1}{R_3} = \frac{20}{40} = 0.5$$

$$\therefore \frac{R_1 + r_1}{R_3} = 2.2 \ \text{or} \ r_1 = 2.2 \times 40 - 20 = 68\,\Omega$$

7(a) $R = \left(\frac{P}{Q}\right) S = \frac{1000}{100} \times 200 = 2000\,\Omega$

$\Delta R = 2005 - 2000 = 5\,\Omega$

$E_0 = E\left[\frac{R}{R+S} - \frac{P}{P+Q}\right] = 5\left[\frac{2005}{2005+200} - \frac{1000}{1000+100}\right]$

$= 1.03 \times 10^{-3}\,V$

$R_0 = \frac{RS}{R+S} + \frac{PQ}{P+Q} = \frac{2005 \times 200}{2005+200} + \frac{1000 \times 100}{1000+100} = 272.8\,\Omega$

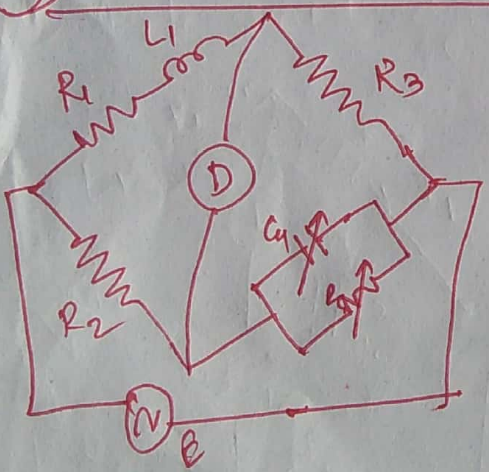
$I_g = E_0 / R_0 + G = \frac{1.03 \times 10^{-3}}{272.8 + 100} = 2.77\,\mu A$

Deflection of the gal; $\theta = S_i I_g = 10 \times 2.77 = 27.7\,mm/\Omega$

Sensitivity of bridge;

$S_B = \frac{\theta}{\Delta R} = \frac{27.7}{5} = 5.54\,mm/\Omega$

(5) Maxwell's Inductance-Capacitance Bridge



$R_1 = \frac{R_2 R_3}{R_4}$

$L_1 = C_4 R_2 R_3$

$E_1 = I_1 R_1 + I_1 j\omega L_1$

$E_2 = I_2 R_2$

$E_3 = I_1 R_3$

$E_4 = I_R R_4 = \frac{I_C}{j\omega C_4}$