

B.Sc. Part II

Paper IV

Current electricity

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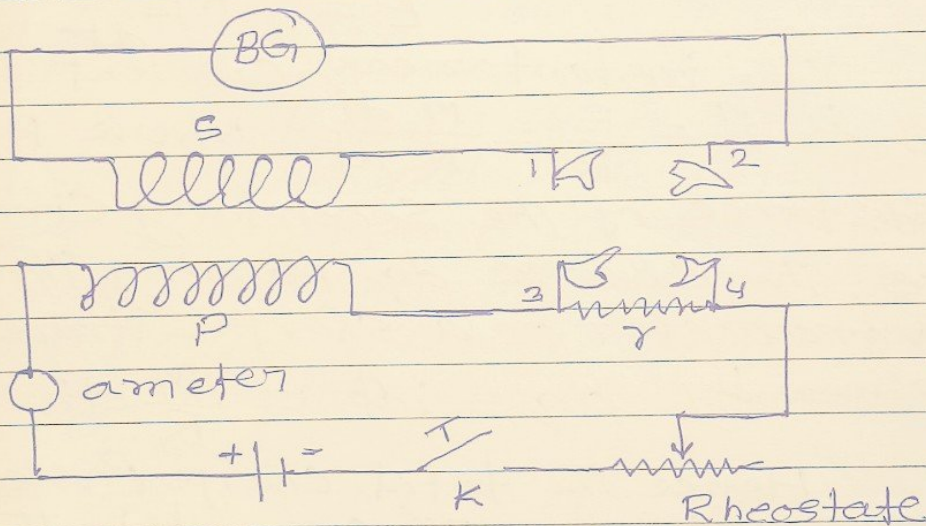
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Current electricity.

Measurement of Mutual Inductance :-

The circuit diagram for measurement of mutual inductance is as shown in figure. Primary P and Secondary S are two coils whose mutual inductance M is to be determined. Ballistic Galvanometer (B.G.) is C is a four segment commutator and r is a very small resistance of the order of $1/100$ ohm.



Working :-

First of all the segments 1 and 2 are connected together so that the ballistic galvanometer and the secondary coil S form a closed circuit. The resistance r is kept short circuited by connecting 3 and 4.

The rheostat is adjusted so that a suitable current passes through the primary on depressing the key K. As the key K is depressed, the current in the primary P takes some time to grow and the flux through the secondary S changes during this time.

Hence an induced e.m.f. is set up in the secondary and a momentary current flow and the galvanometer gives a throw.

Let i be the current at any instant in the primary, the e.m.f. induced in the secondary is given by

$$E = -M \frac{di}{dt}$$

The instantaneous current i' in the secondary is $i' = \frac{E}{R} = \frac{M}{R} \frac{di}{dt}$ where R is the total resistance of the secondary circuit.

Therefore, the charge dq passing through the galvanometer in a short-time interval dt is given by $dq = i' dt = \frac{M}{R} di$

Hence the total charge passed through the galvanometer, as the current in the primary grows from zero to a steady maximum value i_0 , is given by

$$q = \int_0^{i_0} \frac{M}{R} di = \frac{M}{R} i_0$$

Let Q_1 be the first observed throw of the ballistic galvanometer, then $q = \frac{T}{2\pi} \frac{C}{NBA} Q_1 \left(1 + \frac{\gamma}{2}\right)$

where the symbols have their usual meanings Hence,

$$\frac{M}{R} i_0 = \frac{T}{2\pi} \frac{C}{NBA} \theta_1 \left(1 + \frac{\gamma}{2}\right) \quad \text{--- (11)}$$

The eliminate i_0 and C/NBA . The contact between 1 and 2, and that between 3 and 4 are broken. The contact between 1 and 3, and that between 2 and 4 are made. The resistance r is now included in the primary circuit. The same steady current i_0 is now passed in the primary circuit. As the value of r is very small, the steady current i_0 in the primary circuit remains unchanged. The potential difference across r is $i_0 r$ and it sends a steady current $i_0 r/R$ through the galvanometer. Let ϕ be the steady deflection corresponding to this current then

$$\frac{i_0 r}{R} = \frac{C}{NBA} \phi \quad \text{--- (11)}$$

Dividing equⁿ (10) by equⁿ (11), we get,

$$M = \frac{\gamma T}{2\pi} \cdot \frac{\theta}{\phi} \left(1 + \frac{\gamma}{2}\right)$$