METER BRIDGE AND CAREY-FOSTER BRIDGE

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1. Aim

We calculate the resistance of an unknown Resistance (X) using a metre bridge and also with a Carey-Foster Bridge. In excess, we claculate the resistance of the wire used in the bridge and hence get the end-corrections using the Carey-Foster bridge to get a better value of resistance than with the Metre Bridge.

2. Theory

Both the metre bridge and the Carey-Foster Bridge are a simplified version of Wheatstone Bridge whose priciple lies in finding the null-point of the arrangement. Firstly, the Metre Bridge. The circuit can be seen below:

The Resistance (R) is the known resistance which is a decade box, so that we can change the resistance and various null-points to calculate the unknown resistance (X). The setup consists of a wooden board mounted with a metre long wire on which a jockey can slide which has tap key. The circuit has a Voltage supply of around $3V$. The Galvanometer(G) is connected as shown to check the null point. It is protected by a high resistance of around 15000Ω, from very high current flow. The arrangement is based on the Wheatstone bridge principle that is the ratio of resistance in the left arm to the corresponding resistance in the right arm, is equal to the corresponding two resistances. Here, we have the unknown resistance in one arm and the known resistance in another. Considering that the resistance of wire to be uniform we get that

$$\frac{R}{X} = \frac{l_1}{100 - l_1}$$

where l_i is the length of the wire where there is zero deflection in the Galvanometer.

Carey-Foster bridge is a modified version of metre Bridge. The circuit can be seen below:

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The only difference is that, we include two equal resistances in the two arms which in metre bridge are shorted. If the resistance per unit length of the wire used be ρ and let the contact resistances in both the arms be α and β,then we can get the following relation

$$\frac{P}{Q} = \frac{X + \alpha + l\rho}{R + \beta + (100 - l)\rho}$$

where l is the null-point of the bridge. If, X and R are interchanged then we get another null-point for the saeme vale of R, let's call this l', we have a similar relation. From these two relations, we can get that

$$\frac{P + Q}{Q} = \frac{X + R + \alpha + 100\rho}{X + \beta + (100 - l')\rho} = \frac{X + R + \alpha + \beta + 100\rho}{R + \beta + (100 - l)\rho}$$

From this, we get

$$X = R + (l' - l)\rho$$

. For, this we need to know ρ For this we replace the unknown resistance by a copper strip (we consider this to have zero resistance), and do the same null-point finding as before, from which we can get

$$\rho = \frac{R}{l - l'}$$

3. Procedure

- After the circuit has been completed, for various values of resistance (R) , the null point is measured. From this, the unkown resistance is calcualted using the afore mentioned formula. The unknown resistance can be taken as an average of the various values that we get. While getting the null point, we should use resistances such that we get a null point in the ranges of 40 to 60 for lesser errors in the values of resistance.
- In the Carey-Foster Bridge ase, first we try to measure the resistance per unit length of the wire used. For this we replace the unknown resistance by a thick copper strip which is considered to have zero reistance. And from thsi calculate, the null-point length and note as l
- Now, exchange the positions of the copper strip and the Resistance R, and again measure the null-point and note it as l' . From, this data, we can calulate the resistance of the wire.
- Now, replace back the unknown resistance. And follow the same procedure as mentioed in the earlier points and can use the formula mentioned in the procedure section to calculate the unknown resistance.

4. Observations and Results

- With Metre Bridge

S.No	Known Resistance(R)Ω	Null-point(l1) cm	Unknown Resistance(X) Ω
1	1.0	55.2	0.812
2	1.1	57.5	0.813
3	1.2	60.0	0.800
4	1.3	61.6	0.810
5	1.4	63.7	0.798
6	1.5	65.3	0.797

From this the average value of X can be calculated : **0.805Ω**

- With Carey-Foster Bridge
  Determining ρ of the wire used in the bridge

S.No	R Ω	l cm	l' cm	$l - l'$ cm	ρ Ω/cm
1	0.1	50.5	47.3	3.2	0.031
2	0.2	53.0	46.3	6.7	0.031
3	0.3	54.3	45.4	8.9	0.034
4	0.4	55.7	44.1	11.6	0.034

From this we can see that the resistance per cm is : **0.033** Ω/cm

- Finding the unknown resistance using Carey-Foster Bridge

S.No	R Ω	l cm	l' cm	$(l' - l)$	X Ω
1	0.5	47.8	52.1	4.3	0.642
2	0.6	48.5	50.7	2.2	0.673
3	0.7	49.5	49.7	0.2	0.707
4	0.8	50.7	48.4	-2.3	0.722
5	0.8	52.0	47.3	-4.7	0.740

The resistance of the unknown resistance wire is found to be : **0.697** Ω