Department of Electrical Engineering

Assignment

Date: 23/06/2020

Course Details

Course Title:	Instrumentation and Measurement	**Module:**	6^{th} (BE)
Instructor:	Sir Waleed Jan	**Total Marks:**	50

Student Details

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Note: Draw neat diagrams where necessary. Assume missing details if required.

Q1.		A student has connected two voltmeters in series and have applied 500V across them. Both voltmeters have the same range of 0-300V. What will be their readings if their internal resistances are 25kΩ and 15 kΩ respectively?	**Marks 10** **CLO 2**
Q2.		A dynamometer type wattmeter has two current coils each having a resistance of 0.5Ω. Both of the coils are connected in parallel. The wattmeter voltage coil is connected to the supply side. The wattmeter shows a reading of 200W while the reading on the ammeter is 4A which is connected in series with the current coil of the wattmeter. Calculate the following parameters: a) Power dissipated in the wattmeter b) True load power c) Percentage error due to the connection of wattmeter	**Marks 10** **CLO 2**
Q3.	(a)	What is the difference between Kelvin's bridge and Wheatstone Bridge? Explain briefly.	**Marks 05** **CLO 3**

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Q: 1

Ans:

Given data:

Two voltmeters range = 0-300V

Resistance $R_1 = 25K\Omega$
and $R_2 = 15K\Omega$

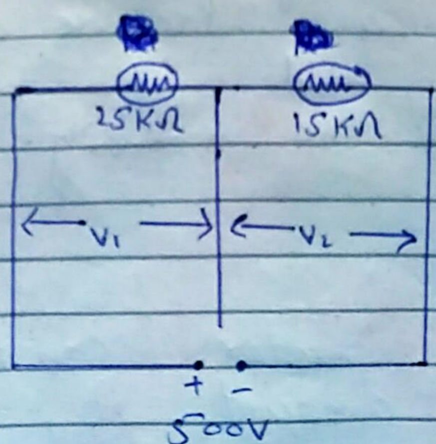
Total voltage $VI = 500V$

Required:

Voltage reading in ist voltmeter = V_1 = ?

Voltage reading in 2nd voltmeter V_2 = ?

Diagram:



Solution:

Here we use voltage divider rule the reading of the two voltmeter are.

$$V_1 = \frac{25K\Omega}{25K\Omega + 15K\Omega} \times 500V$$

$$V_1 = 312.5V$$

$$V_2 = \frac{15K\Omega}{15K\Omega + 25K\Omega} \times 500V$$

$$V_2 = 187.5V$$

Q:2
Ans:

Given data:

$R_1 = 0.5\Omega$
$R_2 = 0.5\Omega$

Power $P = 200W$

$I = 4A$

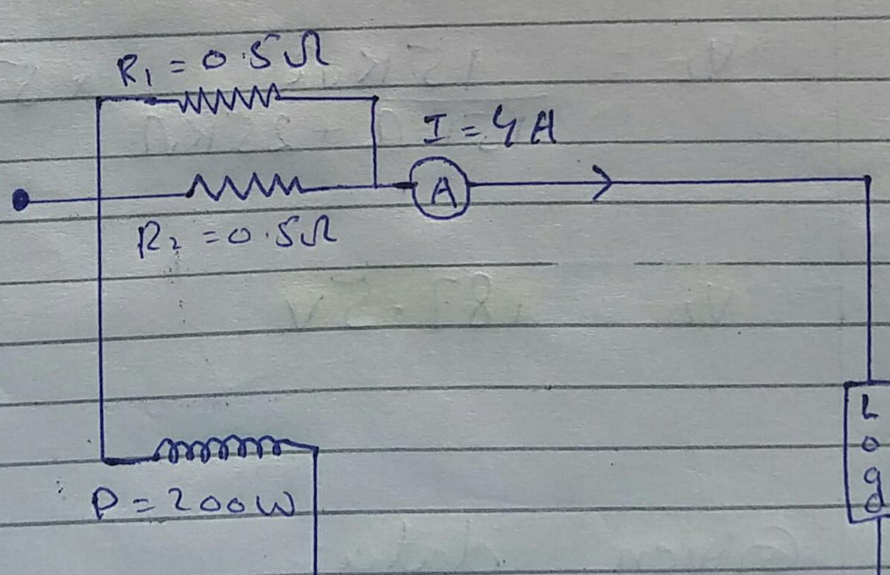
Required:-

(a) Power dissipated in the wattmeter = ?

(b) True load Power = ?

(c) Percentage error due to the connection of wattmeter = ?

Diagram:-



Solution:

Resistance of current coils

$$R_c = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_c = \frac{0.5 \times 0.5}{0.5 + 0.5}$$

$$R_c = \frac{0.25}{1} = 0.25\,\Omega$$

(a) Power dissipated in wattmeter $= I^2 R_c$

$$I^2 R_c = ((4)^2 \times 0.25)$$

$$= 16 \times 0.25$$

$$I^2 R_c = 4W$$

(b) True load Power $= 200 - 4$

$$= 196W$$

(c) % error $= \frac{P - \text{True load}}{\text{True load power}} \times 100$

$$= \frac{200 - 196}{196} \times 100$$

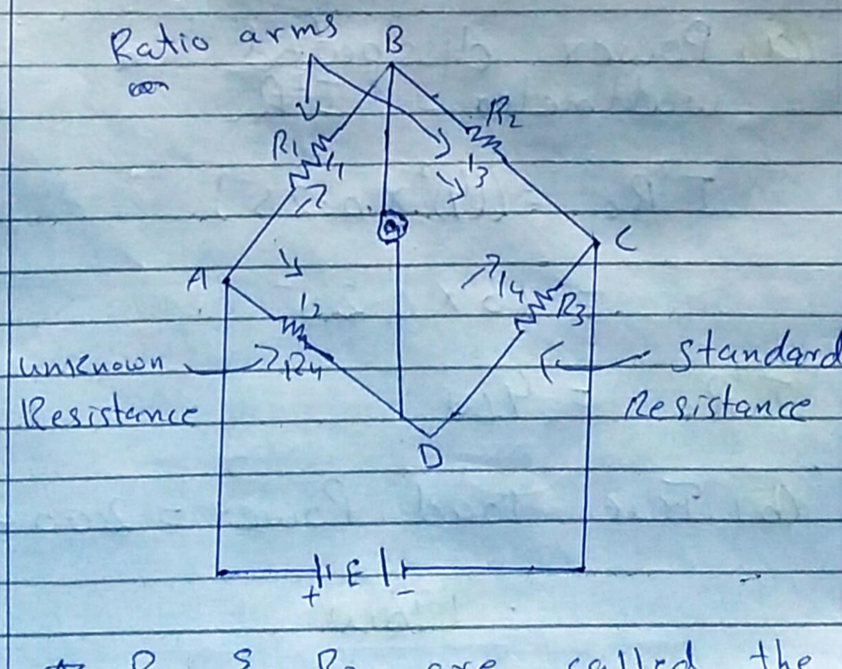
% error = 2.0408

Q:3 (a)
Ans:

Wheatstone Bridge:

A wheatstone bridge is an electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component.

Diagram:



- R_1 & R_2 are called the ratio arms.
- R_3 is called the standard arm containing the standard known resistance.
- R_4 is the unknown resistance to be measured.

* Battery connected b/w A & C
* Galvanometer attached b/w B & D

Mathematically:

$$I_1 R_1 = I_2 R_2 \quad -(i)$$

As Galvanometer current is zero.

$$I_1 = I_3 \quad \& \quad I_2 = I_4 \quad -(ii)$$

Considering the battery path under balanced condition.

$$I_1 = I_3 = \frac{E}{R_1 + R_2} \quad -(3)$$

$$I_2 = I_4 = \frac{E}{R_3 + R_4} \quad -(4)$$

using 3 & 4 in (1)

$$\frac{E}{R_1 + R_2} \times R_1 = \frac{E}{R_3 + R_4} \times R_4$$

$$R_1 (R_3 + R_4) = R_4 (R_1 + R_2)$$

$$R_1 R_3 + R_1 R_4 = R_1 R_4 + R_2 R_4$$

thus $R_4 = R_3 \quad R_1 / R_2$ and this is the required balanced condition of this bridge.

Application:

(1) Measurement of various DC resistances of wires for quality Control.

(2) Measurement of motor winding resistance, relay coils etc.

(3) used by telephone Companies to detect underground cable faults.

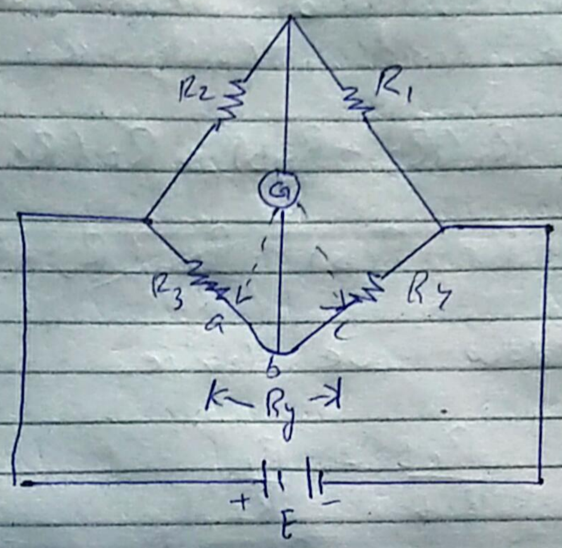
Advantages:

(1) Null Detection mechanism ensures accurate results.
(2) Source fluctuations do not hamper reading.
(3) Accuracy and sensetivity higher than direct reflection meters.

Kelvin bridge:

Low resistance can't be accurately measured by the wheatstone bridge due inaccuracies caused by the lead and contect resistances.
For low resistance measurement (below) 1Ω Kelvin bridge is used.

Diagram:



★ R_y represents the resistance of the connecting leads from R_3 to R_x.

★ R_x is the unknown resistance to be measured

★ Galvanometer could be connected either a, b, or c positions.

★

Mathematically:

$$\frac{R_{cb}}{R_{ab}} = \frac{R_1}{R_2} \quad -(1)$$

Now the bridge balance equation in its standard form is

$$R_1 R_3 = R_2 R_x \quad -(2)$$

But R_3 & R_x now are changed to $R_3 + R_{cb}$ respectively due to lead resistance.

$$R_1(R_3 + R_{ab}) = R_2(R_x + R_{cb}) \quad -(3)$$

$$(R_x + R_{cb}) = \frac{R_1}{R_2}(R_3 + R_{ab}) \quad -(4)$$

Now we have

$$\frac{R_{cb}}{R_{ab}} = \frac{R_1}{R_2}$$

$$\frac{R_{cb}}{R_{ab}} + 1 = \frac{R_1}{R_2} + 1$$

$$\frac{R_{cb} + R_{ab}}{R_{ab}} = \frac{R_1 + R_2}{R_2}$$

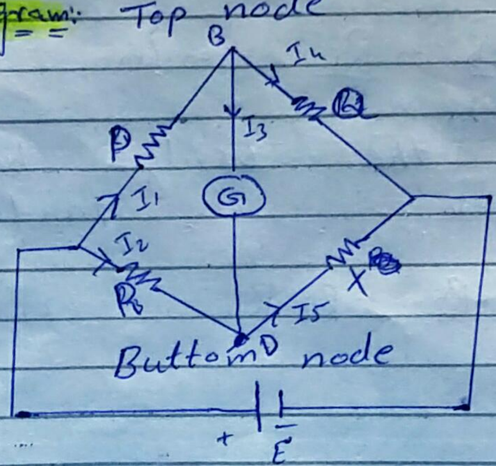
So

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

Q: 3 (b)

Ans:

Diagram: Top node



Where P & Q are known resistance
R is a variable resistor
X is unknown resistance
E is dc power supply

→ Now in order to find the value of unknown resistance X, we have to make the deflection of galvanometer equal to zero.

$I_3 = 0A$.

this condition is called balanced condition of bridge.

When $I_3 = 0A$

$I_5 = I_2$

&

$I_4 = I_1$

Also $V_{AB} = V_A - V_B = I_1 P$ —(i)

∵ $V = IR$

$V_{BC} = V_B - V_C = I_1 Q$ — (ii)

$V_{AD} = V_A - V_D = I_2 R$ — (iii)

$V_{DC} = V_D - V_C = I_2 X$ — (iv)

at balance condition, when $I_3 = 0A$ potential difference between point B and D is zero.

$V_B = V_D$ so it is proved.

Q:4 a

Ans:

No, it is because AC energy meter works due to the involvement of two alternating magnetic fields produced by AC quantities (voltage and current respectively) that interacts with an aluminium disk. Due to this eddy current to induced in the disk. Due to this eddy current and preexisting magnetic field, dist experiences a force which causes it to rotate & increament the reading in proportion to the amount of energy consumed by any DC circuit untill unless you convert the DC to AC then put it through the energy meter & again convert it to DC and the supply to the DC load.

Q:4 (b)

Ans:

It should be noted that when $\phi = 0°$ i.e two fluxes are in phase then deflecting torque is zero or no of torque can be produced.
Torque will be maximum when $\phi = 90°$. When the flun

has a phase difference of 90°. the defecting torque is the same at every instant since ϕ_m, ϕ_{2m} & α are fixed for a given condition.

the direction of deflecting torque depends upon which flux is leading the other.

Q:5 (a)
Ans:

it consist of two electromagnets, called "shunt" magnet and "series" magnet, of laminated construction. A coil having large number of turns of fine wire is wound on the middle limb of the shunt magnet. this coil is known as "Pressure or voltage" coil and is connected across the supply mains.

Q:5 (d)
Ans:-

Energy meter constant is the amount of the KWH used in its low voltage circuit. for each revolution of the induction disk. the unit of the energy meter constant is revolution per kilo watt hour (rev/KWH).

it is constant value. Energy meter constant value of 150 rev /KWh.

it will consume the energy of 1KWH (1unit) in every 150 revolution.

if it rotates 300 revolution it will consume 2KWh energy.