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**
	(b)	Explain how the potential on the upper (top) node in a DC bridge is equal to the potential on the lower (bottom) node?	**Marks 05** **CLO 3**

Q4.	**(a)**	Why the energy meters designed for DC circuits cannot be used for AC circuits?	**Marks 05** **CLO 03**
	(b)	What will happen if the phase difference between two alternating fluxes in an induction type energy meter is zero degrees?	**Marks 05** **CLO 03**
Q5.	**(c)**	Why the series magnet is wound with a wire of few turns as compared to shunt magnet in an induction type energy meter?	**Marks 05** **CLO 03**
	(d)	What is the significance of meter constant in an energy meter?	**Marks 05** **CLO 03**

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Final Term

Instrumentation & Measurement

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★ Instrumentation & Measurement ★

Q1:-

★ Given data:-

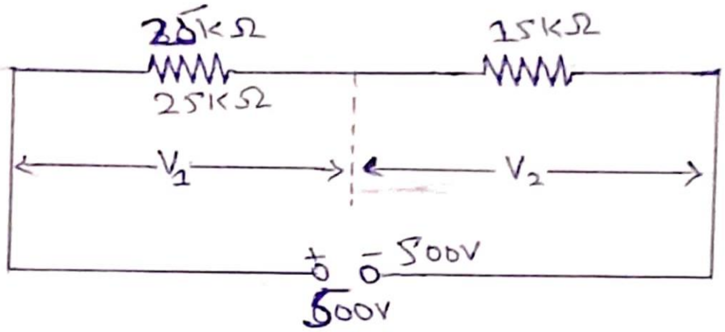
Applied voltage $= V = 500V$
Internal Resistance $= R_1 = 25K\Omega$
Internal Resistance $= R_2 = 15K\Omega$

★ Required data:-

What will be their reading?

★ Solution:-

According to the given data the figure will be;



So, by voltage divider rule, the readings of two voltmeter having same range are

$$V_1 = \frac{R_1}{R_1 + R_2} \times V$$

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

$$V_1 = (0.625)(500)$$

$$V_1 = 312.5V$$

$$V_2 = \frac{R_2}{R_1+R_2} \times V$$

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

$$= \frac{15}{40} \times 500 \Rightarrow (0.375)(500)$$

$$V_2 = 187.5V$$

Q2:-

★ **Given data:-**

Current coil resistance $R_1 \& R_2 = 0.5\Omega$

Wattmeter's reading = 200W

Ammeter's reading = I = 4A

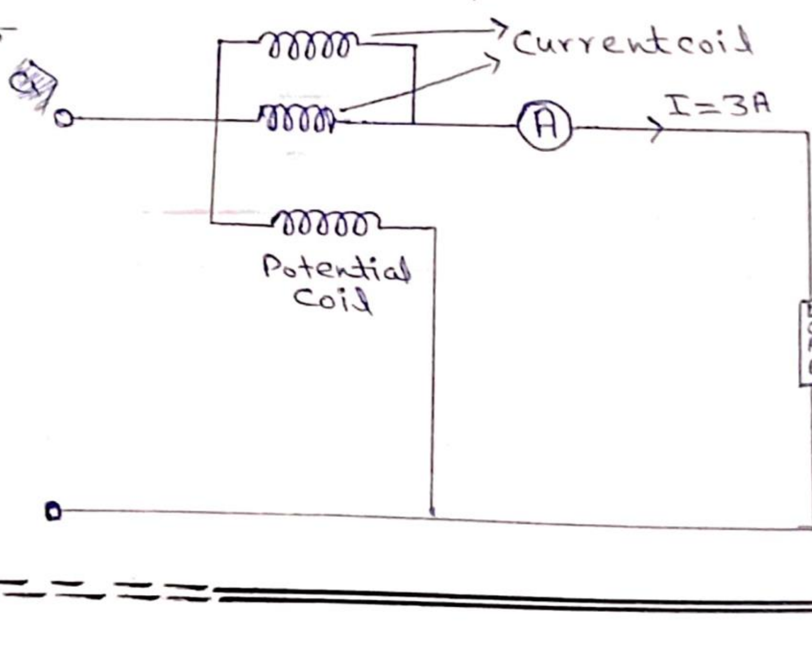
★ **Required data:-**

a) Power dissipated in wattmeter

b) True load Power

c) Percentage error due to connection of wattmeter.

★ **Solution:-**



So, Now the effective resistance of the current coil are;

$$R_c = \frac{R_1 R_2}{R_1 + R_2}$$ as the resistance are same

then, $$= \frac{(0.5)(0.5)}{0.5+0.5} = \frac{0.25}{1}$$

$$R_c = 0.25$$

a) Power dissipated in wattmeter

$= I^2 R_c$ put values

$= (4)^2 (0.25)$

$= (16)(0.25)$

$= 4w$

b) True load Power

= total Power − Power loss

$= 200 - 4$

$= 196w$

c) Percentage error

$$= \frac{\text{Power} - \text{true load Power}}{\text{true load Power}} \times 100$$

$$= \frac{200-196}{196} \times 100 = \frac{4}{196} \times 100$$

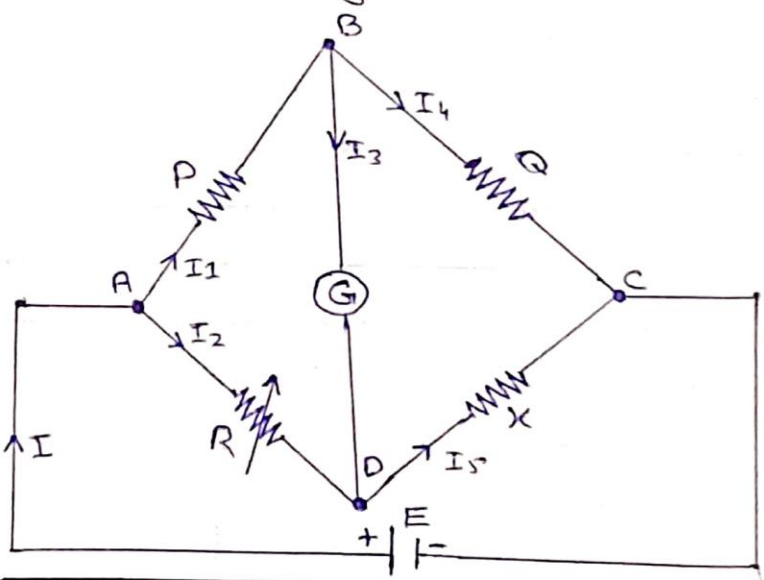
$= 2.04\%$

Q3:-

★ Difference between
Kelvin's bridge & wheatstone bridge ★

★ Wheat Stone Bridge :-

1) A wheatstone bridge measures electrical resistance by balancing a bridge circuit.
2) It measures an unknown electrical resistance.
3) The wheatstone bridge is the combination of 4 resistances forming a bridge.
4) The 4 resistances in the circuit are referred to as arms of bridge
5) The unknown resistance is connected with 2 known resistor & a galvanometer.
6) To find the value of unknown resistor, the deflection of galvanometer is made zero by adjusting the variable resistor.
7) The point is known as balance condition of wheatstone bridge.



where P & Q are Known resistance
R is variable resistance
x is unknown resistance
E is dc power supply.

★ In order to find the value of unknown resistor (x), we have to mke the deflection of galvanometer equal to zero i.e $I_3 = 0A$

★ This condition is called balanced condition of bridge.

★ Kelvin's Bridge:-

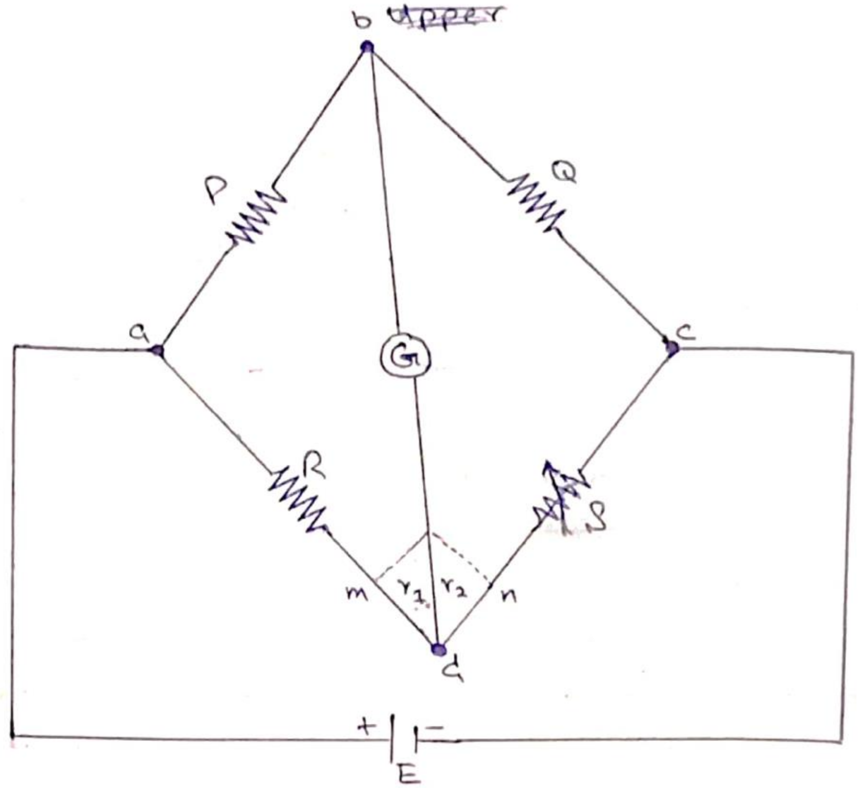
1) Kelvin's brige is the modification of wheat stone bridge & is used to measure low resistances very accurately.

2) When we are implementing wheatstone bridge in the laboratry, we connect all the resistances through connecting wires.

3) Hence, these connecting wires also have same resistance & in order to measure it, we will use Kelvin's bridge.

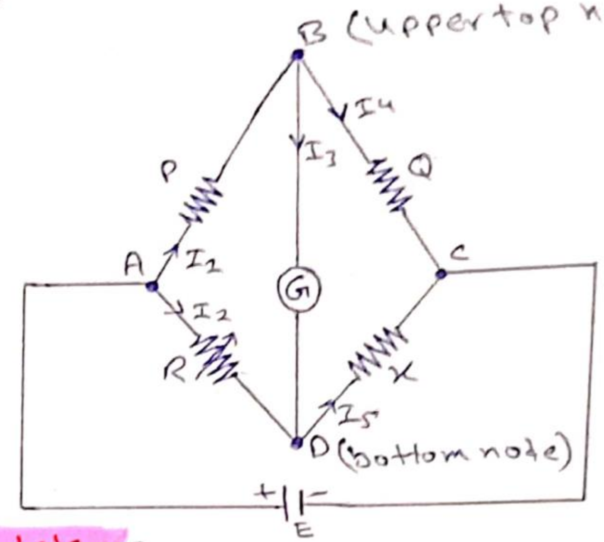
From wheatstone bridge,
we know that

$$R = P/Q \times S$$



* In kelvin bridge we have a connecting wire b/w point m & n having a resistance (r).
* The galvanometer can connect both to point m & n.

Q3:- (Part-b)



★ **Balance Condition:-**

In order to find the value of unknown resistor (x), we have to make the deflection of galvanometer equal to zero i.e $I_3 = 0A$. This condition is called balanced condition of bridge.

When $I_3 = 0A$

$$I_5 = I_2 \;\&\; I_4 = I_1$$

Also
$$V_{AB} = V_A - V_B = I_1 P \longrightarrow (1)$$
$$V_{BC} = V_B - V_C = I_1 Q \longrightarrow (2)$$
$$V_{AD} = V_A - V_D = I_2 R \longrightarrow (3)$$
$$V_{DC} = V_D - V_C = I_2 x \longrightarrow (4)$$

At balance condition when $I_3 = 0A$, Potential difference b/w point B & D is zero i.e $V_B = V_D$ & is proved as;

★ **Proof:-**

As we know that

$$V_{BD} = V_B - V_D = I_3 G$$

So, $V_{BD} = I_3 G_1$

$V_{BD} = (0)(G_1) \quad \because I_3 = 0A$

$V_{BD} = 0V$

or $V_B - V_D = 0$

or $V_B = V_D$ (Proved)

★ **Result:-**

So, the potential on the upper top node which is "V_B" in a DC bridge is equal to the potential on the lower (bottom) node which is "V_D" is same.

Q4:- (Part-a)

Ans:- It is because AC Energy meter works due to the involvement of two alternating magnetic fields produced by AC qualities that interacts with an aluminium disk causing eddy current to induced in the disk. Due to this eddy current & pre-existing magnetic field, disk experiences a force which causes it to rotate & increment the reading in proportion to the amount of energy consumed (in units or kWh both are same). In DC such iduction effect & eddy current are nor produced, so the same energy meter cannot measure the energy consumed by any DC circuit until unless you convert the DC into AC then put it through the energy meter & again convert it to DC & then supply to the DC load.

Q4:- (Part-b)

Ans:- As we know that when $\theta = 0^\circ$ then the fluxes are in phase.
So, in this case the deflecting torque will be zero.
And the deflecting torque will be maximum when $\theta = 90^\circ$ in which the fluxes has the difference of 90°. (alternating flux)
★ As the deflecting torque is the same at every instant.
Since, ϕ_m, ϕ, m & θ are fixed for a given condition.
★ And the direction of deflecting torque is depends upon which flux is leading the other.

Q5:- (Part-c)

Ans:- The shunt magnet is wound with a wire of many turns as is connected across the supply so that it carries current proportional to the supply voltage. Due to large no. of turns the coil of shunt meter is highly inductive. Hence the current (and the flux) passing through it lags the supplying voltage by 90°.

The series magnet is wound with a wire of few turns as is connected in series with the load, so that it carries the load current the coil of this magnet is highly inductive.

* * *

Qs:- (Part-d)

Ans:- Energy meter constant is the amount of KWH used in its low voltage circuit for each revolution of the induction disc.

* **Unit of Energy meter Constant:-** The unit of energy meter constant is rev/kwh.

It is constant value.

→ If an energy meter has energy meter constant value of 150 rev/kwh.

Then, it will consume the energy of 1kwh (1 unit) in every 150 revolution.

→ If it rotates 300 revolution then, it will consume 2kwh energy.