Department of Electrical Engineering

Assignment

Date: 23/06/2020

Course Details

Course Title: Instrumentation and Measurement **Module:** 6th (BE)

Instructor: **Total Marks:** 50

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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)		**Marks 05**

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

<u>Student Details</u>

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

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**

Question No 1

Given Data:

Applied voltage = 500V

R_1 = 25 kΩ

R_2 = 15 kΩ

Range = 0 - 300V

Required

Readings = ?

Solution

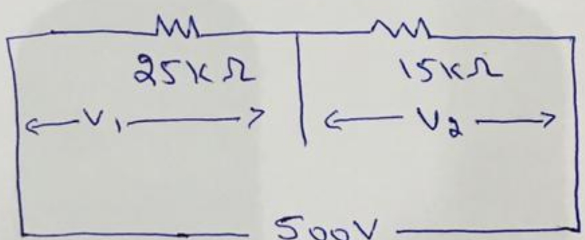


figure shows the condition of problem

Here, we will use the voltage divider rule to find the voltages.

$$V_1 = \frac{R_1}{R_1 + R_2} \times V_{applied}$$

$$= \frac{25 k\Omega}{25k + 15k} \times 500$$

$$= \frac{25 k\Omega}{40k} \times 500$$

$$\boxed{V_1 = 312.5V}$$

$$V_2 = \frac{R_2}{R_1 + R_2} \times V_{applied}$$

$$= \frac{15 k\Omega}{25k + 15k} \times 500$$

$$= \frac{15 k\Omega}{40 k\Omega} \times 500$$

$$\boxed{V_2 = 187.5 V}$$

Question No 2

1

Given Data:

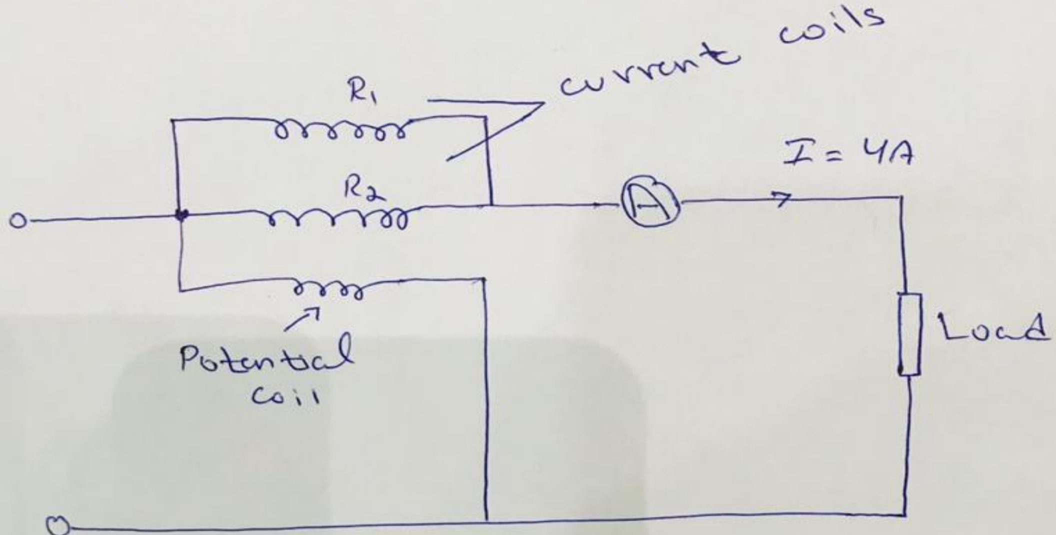
Resistance = 0.5 Ω

Both coils are in parallel, so resistance will be same

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

$P = 200W$

current = 4A



Solution:

Effective Resistan of current coil

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

$$= \frac{0.5 \times 0.5}{0.5 + 0.5} = 0.25\ \Omega$$

(a): Power dissipated

$$P = I^2 R_c$$

$$= 4^2(0.25)$$

$$P = 16(0.25)$$

$$\boxed{P = 4 \text{ Watt}}$$

(b): True load Power

True load Power = 200 − 4

True load power = 196 Watt

(c): Percentage error:

$$\%\text{age error} = \frac{200 - 196}{196} \times 100$$

$$\boxed{\%\text{age error} = 2.04\ \%}$$

Question No 3

Part (a)

A Wheatstone bridge measures electrical resistance by balancing a bridge circuit. The circuit has two legs, of which one contains the unknown resistance of value between 1 ohm to 10 ohms. Apart from resistance, this setup can also measure impedance, capacitance and inductance.

The Kelvin bridge is more advanced and helps in measuring resistances less than 1 ohm. However, it has two more resistors than the Wheatstone bridge.

Part (b)

The bridge is in balance condition when no current flows through the coil or the potential difference across the galvanometer is zero. This condition occurs when the potential difference across the a to b and a to d are equal, and the potential differences across the b to c and c to d remain same.

The current enters into the galvanometer divides into I_1 and I_2, and their magnitude remains same. The following condition exists when the current through the galvanometer is zero.

$$I_1 P = I_2 R \dots\dots\dots equ(1)$$

s

$$I_1 = I_3 = \frac{E}{P+Q}$$

$$I_2 = I_4 = \frac{E}{R+S}$$

The bridge in a balanced condition is expressed as:

Where E – emf of the battery.

By substituting the value of I_1 and 1_2 in equation (1) we get.

$$\frac{PE}{P+Q} = \frac{RE}{R+S} \quad \frac{P}{P+Q} = \frac{R}{R+S}$$

$$P(R+S) = R(P+Q)$$

$$PR + PS = RP + RQ$$

$$PS = RQ \dots\dots\dots equ(2)$$

$$R = \frac{P}{Q} \times S \dots\dots\dots equ(3)$$

The equation (2) shows the balance condition of the DC Bridge (Wheatstone bridge)

Question No 4
Part (a)

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 causing eddy current to induced in the disk. Due to this eddy current and pre-existing magnetic field, disk experiences a force which causes it to rotate and increment the reading in proportion to the amount of energy consumed (in Units or KWH both are same). In DC such induction effect and 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 to AC then put it through the energy meter and again convert it to DC and then supply to the DC load.

Part (b)

- It should be noted that when Ø= 0 degree (that is the two fluxes are in phase), then deflecting torque is zero.

- The deflecting torque will be maximum when Ø= 90 degree, that is when the alternating fluxes have a phase difference of 90 degree.

- The deflecting torque is the same at every instant since Ω1m, Ω2m and Ø are fixed for a given condition.

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

Question No 5
Part (a)

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 non-inductive. While,

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 the large number of turns, the coil of shunt magnet is highly inductive. Hence the current and the flux passing through it lags the supply voltage by 90 degree.

Part (b)

Meter Constant:

We know that

$N \propto \text{Energy}$

$N = K \times \text{Energy}$

Where K is a constant called Meter Constant

$$\text{Meter Constant } K = \frac{N}{\text{Energy}} = \frac{\text{No. of revolutions}}{\text{kwh}}$$

"Hence the number of revolutions made by the disc for 1 kwh of energy consumption is called Meter Constant."

For Example: If Meter Constant of an energy meter is 1500 rev/kwh, it means that for consumption of 1 kwh, the disc will make 1500 revolutions.