Department of Electrical Engineering

Assignment

Date: 23/06/2020

Course Details

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

Instructor:Sir Waleed **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**

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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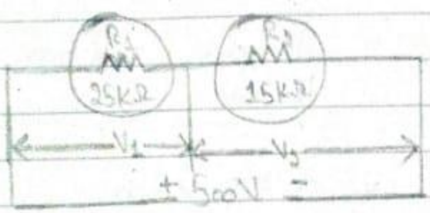
SUBJECT:- EMI SUBMITTED TO:- SIR WALEED

QUESTION 1:-

PART A:-

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 15kΩ respectively?

Solution:-



By applying voltage divider rule the readings of the two voltmeters are.

For V_1:-

$$V_1 = \frac{R_1}{R_1 + R_2} \times 500$$

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

$$V_1 = \frac{25,000}{25,000 + 15000} \times 500$$

$$V_1 = \frac{25{,}000}{40{,}000} \times 500$$

$$V_1 = 0.625 \times 500$$

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

For V_2 :-

$$V_2 = \frac{R_2}{R_1 + R_2} \times 500$$

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

$$V_2 = \frac{15{,}000}{40{,}000} \times 500$$

$$V_2 = 0.375 \times 500$$

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

Answer

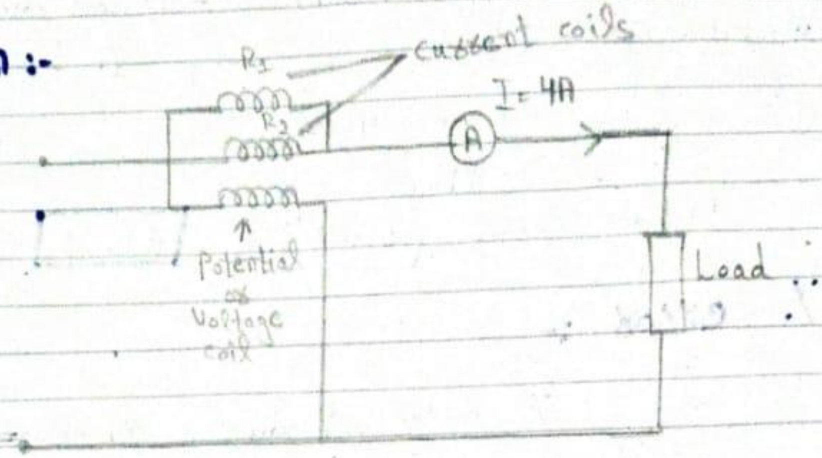
QUESTION 2:-

[redacted]:-

[redacted] A dynamometer type wattmeter has two current coils each having a resistance of 0.5 Ω. Both of the coils are connected in parallel. The wattmeter voltage coil is connected to the supply side. Wattmeter shows reading of 200 W while reading on ammeter is 4A, which is connected in series with the current coil of the wattmeter. Calculate the following parameters?

i) Power dissipated in the wattmeter.
ii) True load power.
iii) Percentage error due to the connection of wattmeter.

Solution :-



First we find effective resistance of the current coils.

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

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

$$= \frac{0.25}{1}$$

$$\boxed{R_c = 0.25\ \Omega}$$

i) Power dissipated in Wattmeter :-

$$P = I^2 R_c$$

$$= (4)^2 (0.25)$$

$$= 16 (0.25)$$

$P = 4W$

(ii) **True load power :-**

Reading on Wattmeter – Power dissipated in wattmeter.

$= 200W - 4W$

$= 196W$

True load power = $196W$

(iii) **% error :-**

$$\% \text{ error} = \frac{\text{Reading on wattmeter} - \text{True load}}{\text{True load}} \times 100$$

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

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

$$= 0.021 \times 100$$

$$= 2.1\ \%$$

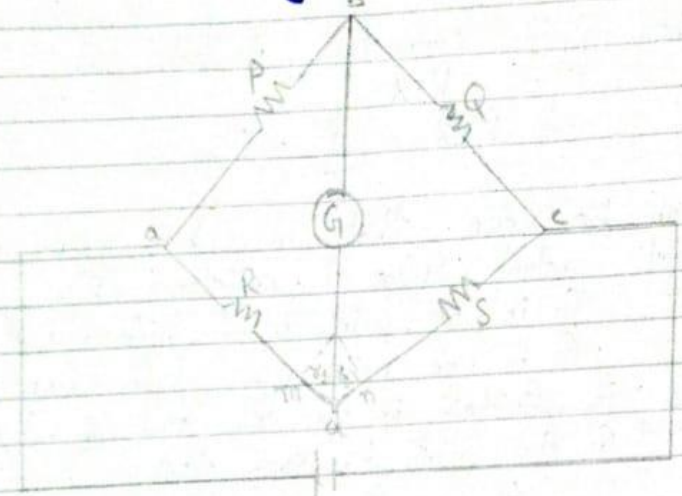
Answer

QUESTION 3 :-

PART A :-

Q What is the difference between Kelvin's bridge and Wheatstone bridge? Explain briefly?

Kelvin's Bridge :-



→ This bridge is modification of wheatstone bridge and is used to measure low resistance very accurately.

→ When we are implementing wheatstone bridge in the laboratory, we connect all the resistances through connecting wires.

→ These connecting wires have some resistance and in order to measure it we will use Kelvin's bridge.

From Wheatstone bridge we know that.

$$R = \frac{P}{Q} \times S \quad — ①$$

→ In Kelvin bridge we have a connecting wire b/w point m & n having a resistance r.

→ Galvanometer connect both to the point m and n.

When g is connected to point m.

$$S+r$$

$$\Rightarrow R = \frac{P}{Q}(S+r)$$

When g is connected to point n.

$$R+r$$

$$\Rightarrow R+r = \frac{P}{Q} \times S$$

It can be seen that in both cases we do not get actual value of resistance (R).

G is on point m → high value of R.
G is on point n → Low value of R.

Hence r is divided in to r_1 and r_2 by connecting G to point d, such that.

$$\frac{r_1}{r_2} = \frac{P}{Q}$$

From eq ①.

$$R+r_1 = \left(\frac{P}{Q}\right)(S+r_2) \quad \text{— (A)}$$

Adding 1 on both sides.

$$\frac{r_1}{r_2} + 1 = \frac{P}{Q} + 1$$

$$\frac{r_1+r_2}{r_2} = \frac{P+Q}{Q}$$

or

$$\frac{r_2}{r_1+r_2} = \frac{Q}{P+Q}$$

$$\frac{r_1}{r_1+r_2} = \frac{P}{P+Q}$$

$$\Rightarrow r_1 = \frac{P}{P+Q}(r_1 + r_2)$$

$$\Rightarrow r_1 = \frac{P}{P+Q}(r)$$

Similarly $r_2 = \frac{Q}{P+Q}(r)$.

From eq (A) :-

$$R + \frac{P}{P+Q}(r) = \frac{P}{Q}\left(S + \frac{Q}{P+Q}r\right)$$

$$R + \frac{P}{P+Q}(r) = \frac{P}{Q}S + \frac{P}{Q}\frac{Q}{P+Q}r$$

$$R + \frac{P}{P+Q}r = \frac{P}{Q}S + \frac{P}{P+Q}r$$

$$\boxed{R = \frac{P}{Q}S}$$

The above eq shows that the galvanometer is connected to point d, then the resistance of the load will not affect the result.

But practically finding point d is impossible. Such that ratio of r_1 and r_2 or $\frac{r_1}{r_2}$ is equal to $\frac{P}{Q}$.

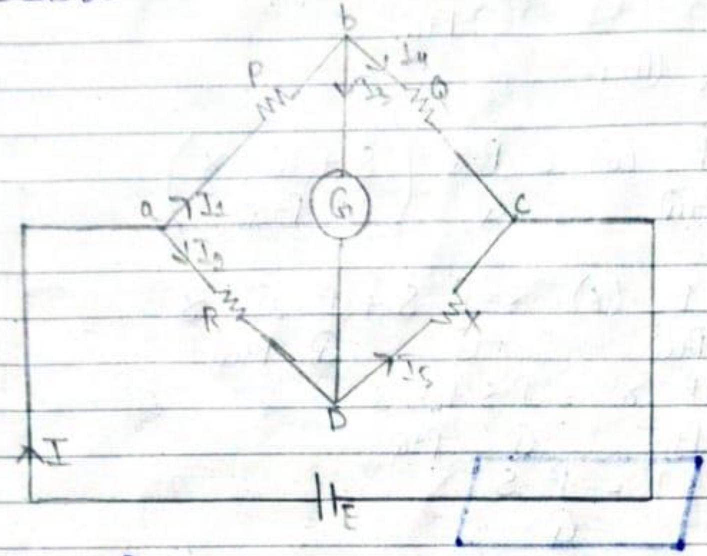
Wheatstone bridge :-

-> Wheatstone bridge is invented by Samuel Hunter Christie in 1833.

-> It is used to measure an unknown electrical resistance.

-> It is a combination of 4 resistance forming a bridge.

→ The unknown resistance is connected with known resistance and a galvanometer. To find the value of unknown resistance the deflection of galvanometer is zero. By adjusting the variable resistor.



P and Q are known resistance
R is variable
X is unknown
E is DC power supply

To find the unknown resistance we have to make deflection of galvanometer is equal to zero i-e :- $I_3 = 0A$

This is balanced condition of bridge.

$I_3 = 0A$

$I_5 = I_2$

$I_4 = I_1$

Also,

$$V_{AB} = V_A - V_B = I_1 P \quad \text{— ①}$$

$$V_{BC} = V_B - V_C = I_1 Q \quad \text{— ②}$$

$$V_{AD} = V_A - V_D = I_2 R \quad \text{— ③}$$

$$V_{DC} = V_D - V_C = I_2 X \quad \text{--- (4)}$$

When $I_3 = 0A$, P.D between point B and D is zero.

$$V_B = V_D$$

As we know $V_{BD} = V_B - V_D = I_3 G$

$$V_{BD} = I_3 G$$

$$V_{BD} = (0) G$$

$$V_{BD} = 0V$$

or $V_B - V_D = 0$

or $V_B = V_D$

Now putting $V_B = V_D$ in eq (1) and (2).

$\Rightarrow$ $V_{AB} = V_A - V_D = I_1 P \rightarrow$ new eq (1)

$V_{BC} = V_D - V_C = I_1 Q \rightarrow$ new eq (2)

Now Comparing both eq.

$$I_1 P = I_2 R$$

or $\dfrac{I_1}{I_2} = \dfrac{R}{P} \rightarrow (5)$

Comparing new eq (1) and (2).

$$I_2 X = I_1 Q$$

$$\frac{I_1}{I_2} = \frac{X}{Q} \rightarrow (6)$$

Now compare eq (5) and (6).

$$\frac{R}{P} = \frac{X}{Q}$$

or

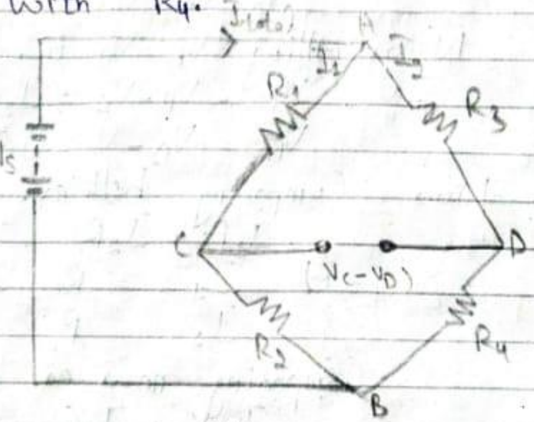
$$\boxed{X = \left(\frac{R}{P}\right) Q}$$

PART B :-

Q Explain how the potential on the upper (top) node in DC bridges is equal to the potential on the lower ~~(top)~~ (bottom) node?

Reason :-

In DC bridge circuits the upper and lower resistors are connected in series. R_1 is series with R_3 and R_2 is series with R_4.



So, As the two resistors are in series the same current flow through both of them. So the Same current flows in upper resistors and same in lower resistors. When this happens, both sides of the parallel bridge network are said to be balanced because the Voltage at point C is same as point D.

As we know that voltage is same in parallel So when the network is balanced voltage should be same in upper and lower nodes because they are in parallel.

So thats why the potential on the upper node of DC bridge is equal to the lower bottom node.

Q4 QUESTION 4:-

Q4a, Why the energy meter designed for DC circuit cannot be used for AC circuit?

Ans Its because AC energy meter works due to the involvement of two alternating magnetic field produced by AC quantities. (voltage and current) respectively), that intracts with an alminium disk causing eddy current induced in the disk. Due to this eddy current pre-existing magnetic field experience a force which cause it to rotate and increment the reading in proportion to the amount of energy consumed. In DC such indication effect and eddy current are not produced. So the same energy meter cannot measure the energy consumed by any DC circuit by, unless you convert the DC in to AC then put it through the energy meter and again convert it to DC and than Supply to DC load.

b, What will happen if the phase difference between two alternating fluxes in an indication type energy meter is zero degrees?

Ans In induction type energy meters, in order to maintain speed of rotation proportional to power. "The phase angle between Supply voltage and pressure coil flux should be equal to 90°. However in actual practice, the angle between Supply Voltage and pressure coil flux is exactly not 90° but few degree less.

If the phase difference between two alternating fluxes in an induction type energy meter is zero degrees than it results in improper rotation of disc. Improper phase angle is due to improper lag adjustment, variation of resistance with temperature or it may be due to abnormal frequency of supply voltage.

Question 5 :-

PART A.

Q Why the series magnet is wound with a wire of a few turns as composed to shunt magnet?

Ans The shunt magnet is voltage coil has many turns and is arranged to be highly inductive as possible. In other words the voltage coil produced a high ratio of inductance to resistance. This cause the current, and therefore the flux to lag the supply voltage by nearly 80 to 90. And Series magnet which is connected in series with load. So that it carry the load current. The flux produced by this magnet is proportional to, and in phase with the load current.

b, What is the significance of meter constant in an energy meter?

Ans In an energy meter the constant is shown on the meter nameplate. A "Kh = 7.2" Constant means that for each revolution of the disk, 7.2 watt-hours has been used (constant will vary with different meters). Energy meter Constant is the amount of KWH used in its low voltage circuit circuit for each revolution of the induction disc.

THE END