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**
Q5.	(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**
	(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**

Adnan Shah (13692)

Ans (1) Given data:

Two voltmeters connected in Series.

$V = 500V$

Range = 0-300V

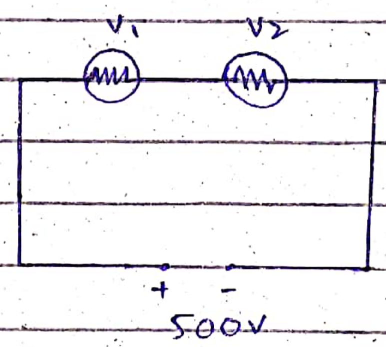
$R_1 = 25k\Omega$

$R_2 = 15k\Omega$

Required:

their readings

Solution:



By VDR (voltage divider rule)

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

$V_1 = 0.625 \times 500$

$\{V_1 = 312.5V\}$

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

$V_2 = 0.375 \times 500$

$\{V_2 = 187.5V\}$ So both voltmeters reading will be 312.5V and 187.5

Ans (2)

Given data:

No. of coils = 2

$R_1 = 0.5\Omega$

$R_2 = 0.5\Omega$

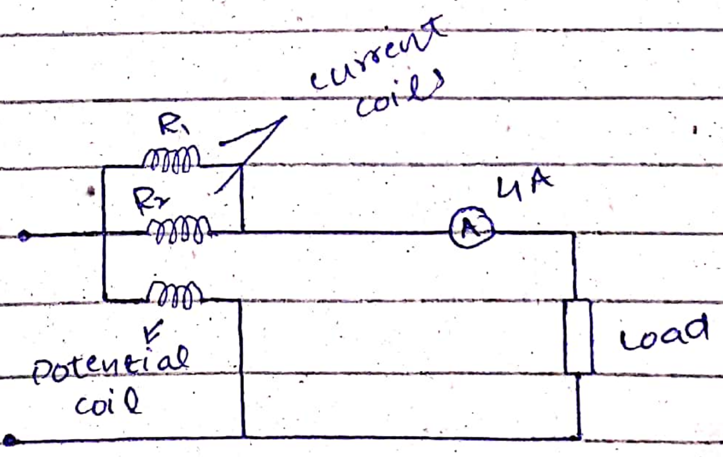
wattmeter reading = 200W

Ammeter reading = 4A

Required:

(a) Power dissipated in the wattmeter
(b) True load power
(c) Percentage error due to connection of wattmeter.

Solution:



(a) Power loss:

$= I^2 R_c$

The formula to find R_c is;

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

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

∵ R_c = Effective resistance of current coil

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

$$R_c = 0.25\,\Omega$$

So the power loss in wattmeter will be;

$= I^2 R_c$
$= (4)^2 \times (0.25)$
$= 16 \times 0.25$
{P. loss = 4W}

(b) True load Power:

= wattmeter reading − Power loss in wattmeter

= 200 − 4
{P = 196W}

(c) % error:

$$= \frac{\text{Total Power} - \text{True load Power}}{\text{True load power}} \times 100$$

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

{% error = 2%}

Ans ③ ⓐ

Kelvin's Bridge:

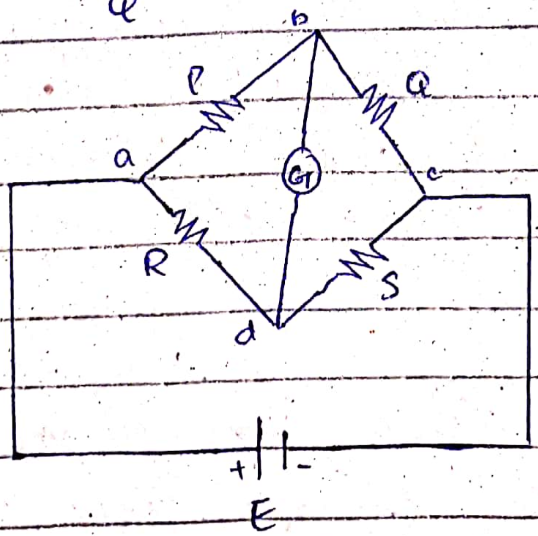
→ The bridge is modified wheatstone bridge and is used to measure low resistance very accurately. (upto 1 ohm or less)

→ When we implement wheatstone bridge in the laboratory, we connect all the resistances through wires.

→ So those connecting wires also have some resistance and in order to measure it we use kelvin's bridge.

From wheatstone bridge we know that;

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



Kelvin's bridge

wheatstone bridge:

→ wheatstone bridge was invented by Samuel Hunter Christie in 1833 and further improved by Sir charles wheatstone in 1843.

→ It is used to measure unknown electrical resistance. (upto some value)

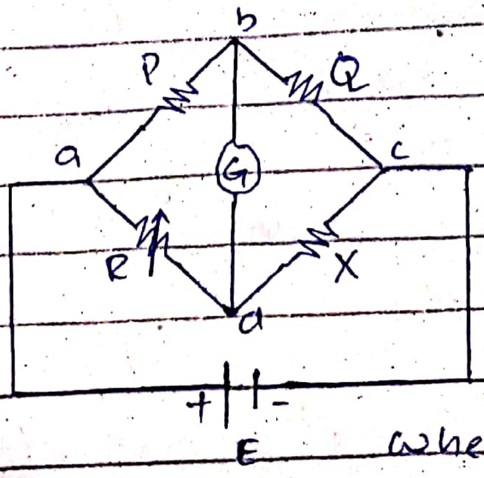
→ wheatstone bridge is the combination of 4 resistors forming a bridge.

→ The four resistors are as the arms of bridge.

→ The unknown resistor is connected to the two known resistor and a galvanometer.

→ To find the value of unknown resistor the deflection of galvanometer is made zero by adjusting the variable resistor.

→ This point is known as "Balance condition of wheat stone bridge".



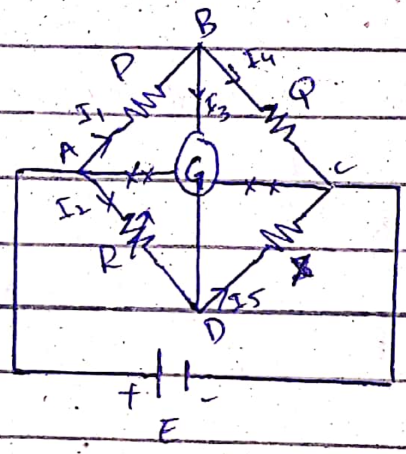
wheatstone bridge

Q③ ⑤

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;



$I_3 = 0A$

$I_5 = I_2$

and $I_4 = I_1$

Also; $V_{AB} = V_A - V_B = I_1 P$ — ①

$V_{BC} = V_B - V_C = I_1 Q$ — ②

$V_{AD} = V_A - V_D = I_2 R$ — ③

$V_{DC} = V_D - V_C = I_2 X$ — ④

⇒ At balance condition when $I_3 = 0$, potential difference b/w B point and D point is zero. i.e

$V_B = V_D$

A) we know that $V_{BD} = V_B - V_D = I_3 G$

$V_{BD} = I_3 G$

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

$V_{BD} = 0V$ OR

$V_B - V_D = 0$

$V_B = V_D$

Hence it is proved that potential on upper node is equal to lower node in DC bridges.

Ans (4)(a)

Because AC energy meters work due to the involvement of two alternating magnetic fields produced by AC quantities such as voltage and current that interact with the 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 increament the reading in proportion to the amount of energy consumed in units.

But in DC such induction effect and eddy current are nor produced, so the same energy meter cannot measure the energy consumed in DC circuit unit we convert it to AC.

Ans (4) (5)

Two alternating flux ϕ_1 and ϕ_2 whose magnitude depends upon the current having a phase difference (θ) passes through a metallic disc usually copper or Aluminium.

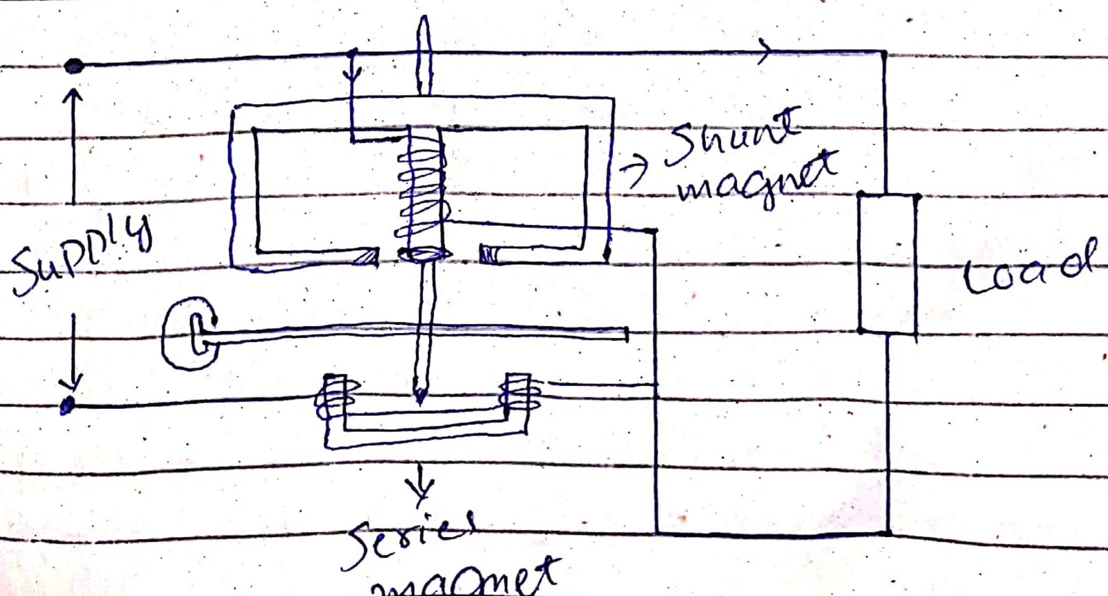
So when the $\theta = 0°$, the flux are in phase, the deflecting Torque is Zero.

And the deflecting torque will be maximum when $\theta = 90°$.

Ans (5) (a)

The shunt magnet is wound with a wire of many turns as it carries current proportional to the supply voltage (As it is connected to supply).
Due to the large number of turns, the coils of shunt magnet is highly inductive. Hence the current passing through it lags the supply voltage by 90°.

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



Ans. (5) (b)

The Energy meter constant is the amount of KWh used in its low voltage circuit for each revolution of the induction disc.

The unit of energy meter constant is rev. per kilo-watt hour (rev/kWh.)

we know that

$N \propto$ energy

$N = K \times$ energy

K is constant called meter constant

meter constant $K = \frac{N}{\text{energy}} = \frac{\text{no. of revolutions}}{\text{KWh}}$

Hence "the number of revolution made by the disc for 1kWh of energy consumption is called meter constant".

For example if a meter constant of an energy meter is 1500 rev/kWh, it means that for consumption of 1kWh, the disc will make 1500 revolutions