G.PULLA REDDY ENGINEERING COLLEGE (AUTONOMOUS): KURNOOL

ELECTRICAL & ELECTRONICS ENGINEERING DEPARTMENT

III Semester B.Tech. - E.E.E. (Scheme-2020)

ELECTRICAL MEASUREMENTS LAB (EM (P))

List of Experiments

1. Measurement of resistance using Wheat stone bridge and Kelvin's Double Bridge.
2. Measurement of inductance using Maxwell's Bridge, Anderson Bridge.
3. Measurement of capacitance using De-Sauty's bridge, Schering Bridge.
4. Calibration of single phase energy meter using direct loading method.
5. Calibration of energy meter using Phantom load kit.
6. Measurement of Power using three-Voltmeter and three-Ammeter methods in a single phase circuit.
7. Measurement of real and reactive power in a three phase circuit.
8. Extend the range of given Ammeter and Voltmeter.
9. Measurement of displacement using LVDT.
10. Study of CRO: Measurement of voltage, current, frequency using lissajous patterns.
11. Measurement of voltage of a given battery and current through divide circuit using Arduino.
12. Measurement of temperature and humidity using Arduino.
13. Measurement of distance of the object using Arduino
14. Measurement of different ranges of temperatures using i) RTD ii) Thermocouple
15. Measurement of load with the help of strain gauges.

TITLE: WHEATSTONE BRIDGE	GPRECD/EEE/EXPT-EM-1-A Date: 20-09-2021

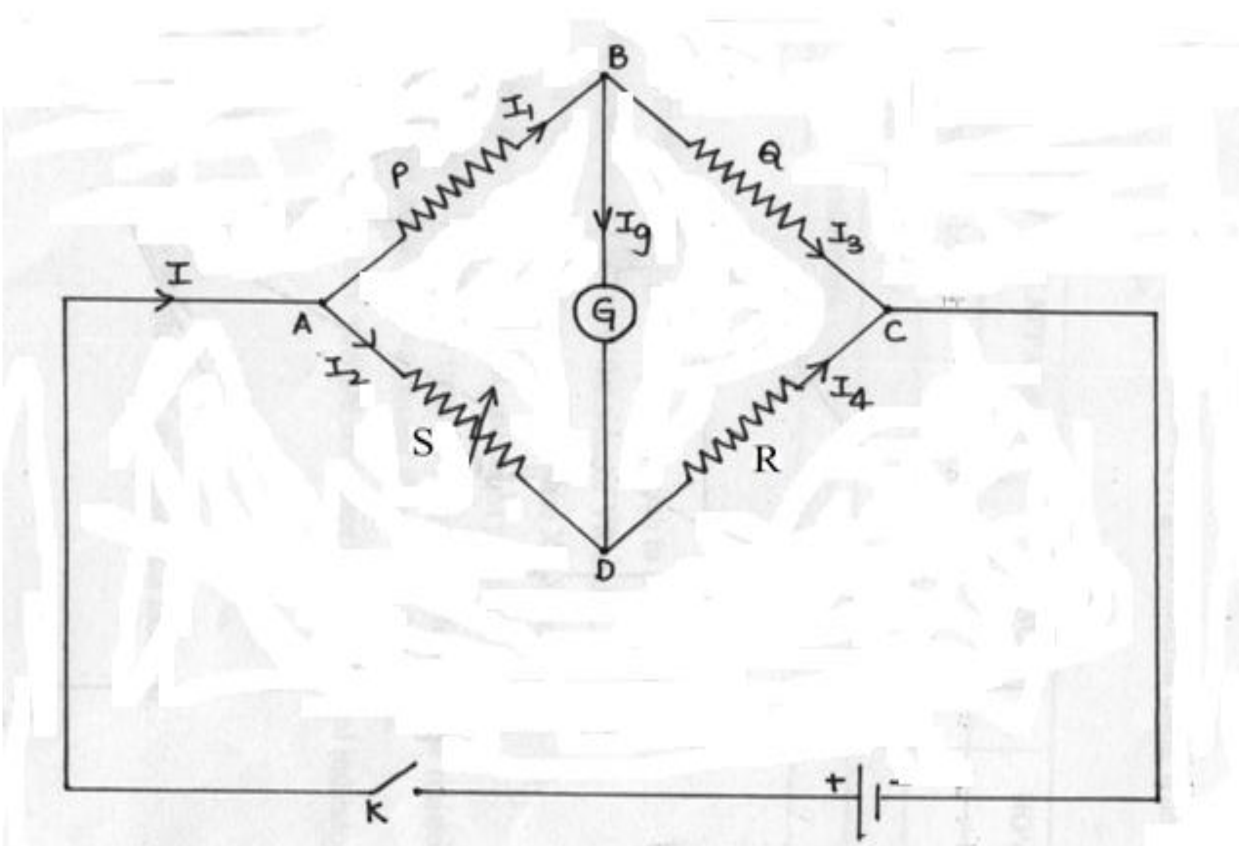
AIM:

To measure the values of unknown resistance of given material using Wheatstone bridge.

APPARATUS:

1. Wheatstone Bridge
2. Unknown Resistance
3. Digital Multimeter

CIRCUIT DIAGRAM:



TITLE: WHEATSTONE BRIDGE	GPRECD/EEE/EXPT-EM-1-A Date: 20-09-2021

THEORY:

It is used for the measurement of medium resistances. Very high degrees of accuracy can be achieved with the Wheatstone bridge. It has four resistive arms, consisting of resistances P, Q, R and S together with a battery source and a null detector usually a galvanometer or other sensitive current meter. The current through the galvanometer depends on the potential difference between points B and D. The bridge is said to be balanced when there is no current through the galvanometer or when the potential difference across the galvanometer is zero. For bridge balance we can write,

$$I_1 P = I_2 S \qquad \text{...... (1)}$$

For galvanometer current to be zero, the following conditions also exist

$$I_1 = I_3 = \frac{E}{P+Q} \qquad \text{........ (2)}$$

$$I_2 = I_4 = \frac{E}{R+S} \qquad \text{........ (3)}$$

From the above three equations

$$PR = QS \qquad \text{........(4)}$$

From Equation (4) we will get unknown resistance $R = \frac{QS}{P}$

TITLE: WHEATSTONE BRIDGE	GPRECD/EEE/EXPT-EM-1-A Date: 20-09-2021

PROCEDURE:

1. Set the galvanometer switch to INT position.
2. Two push buttons K_b and K_g are provided. While getting null point K_b should be pressed first and then K_g.
3. Connect the unknown resistance across the R_x terminal.
4. There are 5 range multipliers in the kit. The choice of range used depends upon the value of unknown resistance, which is given by R = A x R, where A is range used and R is the value of variable series arm which is given by the sum of four decades.
5. Get the null point of the galvanometer by adjusting range used and series arm value by gradually increasing the galvanometer sensitivity and by pressing K_b and K_g.
6. Repeat same procedre for different values of unknown resistances.

TABULAR COLUMN:

Sl. No	Multiplying factor	X 1000	X 100	X 10	X 1	Unknown Resistance (Practical) (R_X)	Unknown Resistance (Theoretical)
R_1							
R_2							
R_3							

FORMULA USED:

Basic equation of Wheatstone bridge for unknown resistance $R = \frac{QS}{P}$

In our experiment P=Q, so the equation becomes unknown Resistance R = S

Unknown resistance= Decade resistance X Multiplier dial indicator.

Sample Calculations: (Set No…………)

Multlipling factor = ………….

Series arm / decade resistance value = …………..

Unknown Resistance =

RESULT:

Hence we find the unknown resistance using Wheatstone bridge.

Viva Questions:

1. The sensitivity of Wheatstone bridge is defined as ratio of

a. Deflection of the galvanometer to the unit fractional change in the value of unknown resistance
b. Square of the deflection of the galvanometer to the unit fractional change in the value of unknown resistance
c. Deflection of the galvanometer to the twice of the unit fractional change in the value of unknown resistance
d. Unit fractional change in the value of unknown resistance to the deflection of the galvanometer

ANSWER: Deflection of the galvanometer to the unit fractional change in the value of unknown resistance

2. In a Wheatstone bridge method, the bridge is said to be balanced, when the current through the galvanometer is

a. 1 A b. 0 A c. Maximum d. Half of the maximum value

ANSWER: 0 A

3. The accuracy in a bridge measurement depends on--------------------------

ANSWER: Sensitivity of detector and Applied voltage

4. Which of the following can be measured using a Wheatstone bridge?

a) Resistance only b) Capacitance Only c) Inductance Only

d) Resistance, Capacitance, Inductance and Impedance

Answer: D
Explanation: Wheatstone bridge cannot be limited to measurement of a single quantity only, it can be used to measure resistance, capacitance, impedance, inductance etc. with some modifications.

5. Megger is used for the measurement of high value of

a) Current b) Power c) Insulation Resistance d) Voltage

Answer: C

6. In a Wheatstone bridge, if P = 10 ± 1%, Q = 100 ± 1%, R = 20 ± 1% and S is unknown then the unknown resistance will be--------------

TITLE: KELVIN'S DOUBLE BRIDGE	GPRECD/EEED/EXPT-EM-1-B Date: 20-09-2021

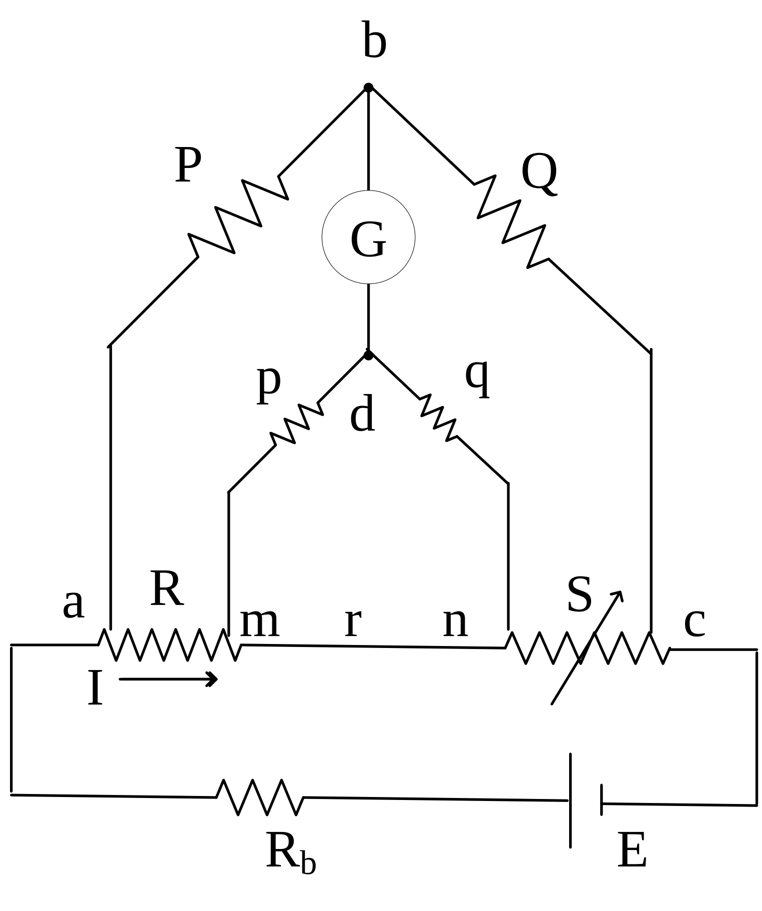
AIM:

To measure the values of unknown low resistance of given material using Kelvin double bridge.

APPARATUS:

1. Kelvin Bridge
2. Unknown Resistance
3. Digital Multimeter

CIRCUIT DIAGRAM :



TITLE: KELVIN'S DOUBLE BRIDGE	**GPRECD/EEED/EXPT-EM-1-B** **Date: 20-09-2021**

THEORY:

Kelvin Bridge is a modified Wheatstone bridge which provides high accuracy especially in the measurement of low resistance (<1Ω) and has wide range of applications in the industrial world. The above circuit diagram shows the schematic diagram of the Kelvin Bridge. The first set of ratio arms is P & Q, the second set of ratio arms p & q is used to connect the galvanometer to a point 'd' at the appropriate potential between points 'm' and 'n' to eliminate effect of connecting lead of resistance r between the unknown resistance 'R' and the standard resistance 'S'.

Under the bridge balance conditions there is no current through the galvanometer, which means that the voltage drop between a and b, E_{ab} is equal to the voltage drop E_{amd}.

Now $E_{ab} = \frac{P}{P+Q} E_{ac}$ and $E_{ac} = I[R+S+\frac{(p+q)r}{p+q+r}]$

$E_{amd} = I[R+\frac{p}{p+q}\{\frac{(p+q)r}{p+q+r}\}] = I[R+\frac{pr}{p+q+r}]$

For zero galvanometer deflection, $E_{ab} = E_{amd}$

$$\frac{P}{P+Q} I[R+S+\frac{(p+q)r}{p+q+r}] = I[R+\frac{pr}{p+q+r}]$$

$$R = \frac{P}{Q}S+\frac{qr}{p+q+r}[\frac{P}{Q}-\frac{p}{q}] \text{.......................................(1)}$$

If $\frac{P}{Q}=\frac{p}{q}$, the above equation becomes $R = \frac{P}{Q}S$ ....(2)

This eqn. (2) is the usual working equation for the Kelvin Double Bridge. It indicates that the resistance of connecting lead 'r' has no effect on the measurement; provided that the two sets of ratio arms have equal ratio. The former equation is useful however, as it shows the error that is introduced in case the ratios are not exactly equal. It indicates that it is desirable to keep r as small as possible in order to minimize the errors in case there is a difference between ratios P/Q and p/q.

PROCEDURE:

1. Set the galvanometer switch to INT position.
2. There are two current terminals marked as +C and –C and two potential terminals marked as +P and –P on the kit.
3. If the resistance to be measured is in the form of two terminals resistance, the leads from +C and +P are connected to one terminal and those from –C and –P are connected to the other terminal of the unknown resistance.
4. When the unknown resistance has been suitably connected, choose the suitable range multiplier depending upon the magnitude of the unknown resistance.
5. Get the null point of the galvanometer by adjusting the key momentarily and by adjusting the main dial and slide wire.
6. Note down the resistance values of main dail and slide wire in the observation table.
7. Repeat the similar procedure to know the unknown resistance of another resistance.

TABULAR COLUMN:

Sl No	Multiplier	Main Dial	Slide Wire	Unknown resistance (Practical) (Ω)	Unknown resistance (Theoretical) (Ω)
		R_1 (Ω)	R_2 (Ω)		

TITLE: KELVIN'S DOUBLE BRIDGE	GPRECD/EEED/EXPT-EM-1-B Date: 20-09-2021

Formulae:

Using kelvin double bridge the unknown resistance R = $\frac{P}{Q}S+\frac{qr}{p+q+r}[\frac{P}{Q}-\frac{p}{q}]$

In our experiment (i) $\frac{P}{Q}=\frac{p}{q}$, the unknown resistance R = $\frac{P}{Q}S$

(ii) P = Q, the unknown resistance R = S, Where S is standard variable resistance and it can be adjusted with the help of main dial and slide wire.

Unknown resistance R = S = Multiplier * (Main dail (R_1) + Slide wire (R_2)).

Sample Calculations: Set No(…..)

Multiplier = ………..

Main Dail (R_1) = ……

Slide Wire (R_2) = ……

Unknown Resistnace =

RESULT:

Hence we find the unknown resistance using Kelvin Double Bridge.

Viva Questions

1. Why Kelvin Bridge is used for measurement of low resistance?

a) due to e.m.f source used b) due to a large current flow c) due to contact and lead resistance d) due to power dissipation across the circuit

Answer: C
Explanation: While measuring very low resistances the contact and lead resistances cause significant errors in the value of the measured resistance. As a result Kelvin bridge is used for measurement of low resistances.

2. Low resistance refers to __________

a) resistances of the order of 1Ω b) resistances of the order of 1kΩ c) resistances of the order of 1mΩ d) resistances of the order of 1MΩ

Answer: A
Explanation: Low resistance refers to resistances of the order of 1Ω or less than that. Medium resistances range from above 1Ω to a few kΩ. High resistance value is greater than a few kΩ.

3. Why this method is called as double bridge method?

Answer: Unknown value of resistor is given as R = $\frac{P}{Q}S + \frac{qr}{p+q+r}[\frac{P}{Q} - \frac{p}{q}]$. It compares two ratio arms P,Q and p,q and hence is called 'double bridge'.

4. Why normal methods of resistance measurements cannot be used for measurement of resistance of electrolytes?

5. What are the limitations of this Bridge?

Answer: a) sensitive null detector or galvanometer is required to detect balance condition

b) measurement of current needs to be reasonably high to achieve sufficient sensitivity.

6. Name the factors that govern the choice of a suitable method of measuring resistance?

Answer: a) Range of resistance to be measred (b) Required accuracy.

TITLE:ANDERSON BRIDGE FOR SELF-INDUCTANCE **GPRECD/EEE/EXPT-EM-2-B**

Date: 20-09-2021

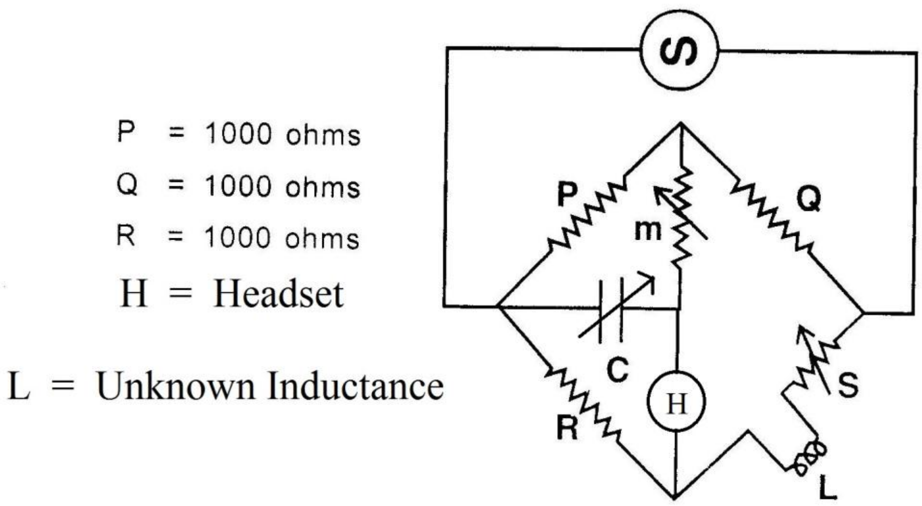
AIM:

To measure unknown inductance using Anderson bridge.

APPARATUS:

1. Anderson Bridge
2. Bridge oscillator
3. Oscilloscope / Headphone
4. Unknown Inductor

CIRCUIT DIAGRAM :



THEORY:

This method is used for precise measurement of inductance over a wide range. In this method the unknown self inductance is measured interms of standard variable capacitance.

TITLE:ANDERSON BRIDGE FOR SELF-INDUCTANCE	GPRECD/EEE/EXPT-EM-2-B Date: 20-09-2021

In the given circuit

L – Unknown self-inductance

S and m – Standard Variable Resistance

C – Standard variable Capacitor

P, Q and R – Standard fixed resistances

For balanced condition of bridge, $Z_1Z_4 = Z_2Z_3$, where Z_1, Z_2, Z_3 and Z_4 are foursides of bridge impedances.

By using above condition we will get unknown inductance $L_1 = C\frac{R}{P}[m(P+Q)+PQ]$

PROCEDURE:

1. Connect an external oscillator input to the oscillator terminals of the kit.
2. Connect a headphone or CRO probes to the headphone terminals of the kit.
3. Connect an unknown inductance to L terminals of the kit.
4. Assume the values of P, Q, R as 1KΩ where P, Q, R denotes non – inductive resistance.
5. Vary S, M and capacitance (C) values in such a way that the sound in the headphones is minimim and the waveform in the CRO gets nullified. This indiactes the bridge is balanced.
6. The unknown inductance is calculated by using the formula

$$L = C\frac{R}{P}[m(P+Q)+PQ]$$

TITLE:ANDERSON BRIDGE FOR SELF-INDUCTANCE **GPRECD/EEE/EXPT-EM-2-B**

Date: 20-09-2021

TABULAR COLUMN:

Sl No	P (1000Ω)	Q (1000Ω)	R (1000Ω)	S	C	m	L = C [RQ + (R + S) m]	Unknown Inductace L	Avg. Value of Inductor L
1									
2									

Sample Calculations: (Set No………)

Unknown Inductance L = $C\frac{R}{P}[m(P+Q)+PQ]$

C = ………………. P = ……………….

R = ………………. Q = ……………….

S = ………………. m = ……………….

Unknown Inductance L =

RESULT:

The value of the unknown inductance is calculated.

TITLE:ANDERSON BRIDGE FOR SELF-INDUCTANCE	GPRECD/EEE/EXPT-EM-2-B Date: 20-09-2021

Viva Questions:

1. The most common and best bridge method for precise measurement of inductance over a wide range is………..

Answer: Anderson bridge.

2. The bridge circuit employed for measuremet of measurement of mutual inductance is

a) Wein's b) Maxwell c) Anderson d) Heavide Campbell

Answer: Heavide Campbell

3. Match the following

List 1	**List 2**
A. Anderson's Bridge	1. Resistance
B. Wheatstone Bridge	2. Frequency
C. Wein bridge	3. Capacitance
D. Schering bridge	4. inductance

Answer: A-4, B-1, C- 2, D-3

4. Match List 1 (Frequency) and List 2 (Detector) and select the correct answer.

List 1	**List 2**
E. Zero Frequency	1. Head Phone
F. 50 Hz	2. D' Arsonval Galvanometer
G. 1200 Hz	3. CRO
H. 10 KHz	4. Vibration Galvanometer

Answer: A-2, B-4, C- 1, D-3

5. Name the commonly used detectors for AC bridges?

Answer: A) Head Phones or Telephone receivers (B) Vibration galvanometer (C) Tunable amplifier detectors.

TITLE:MAXWELL'S INDUCTANCE CAPACITANCE BRIDGE	**GPRECD/EEE/EXPT-EM-2-A** **DATE: 20-09-2021**

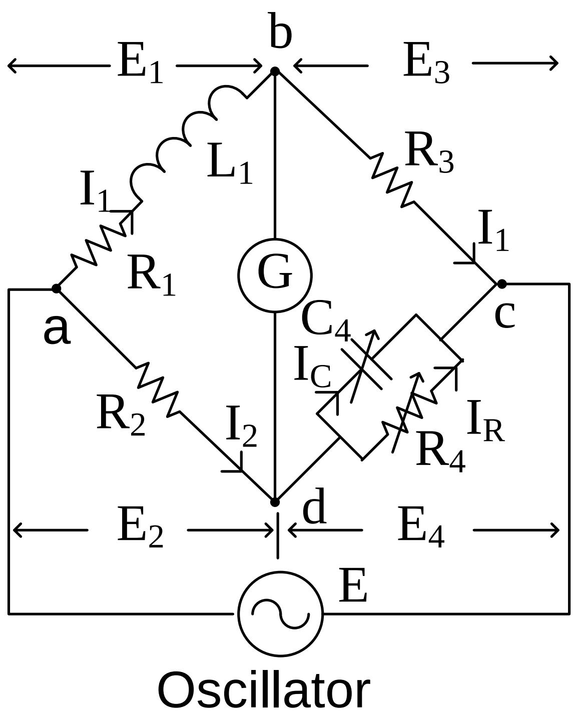
AIM:

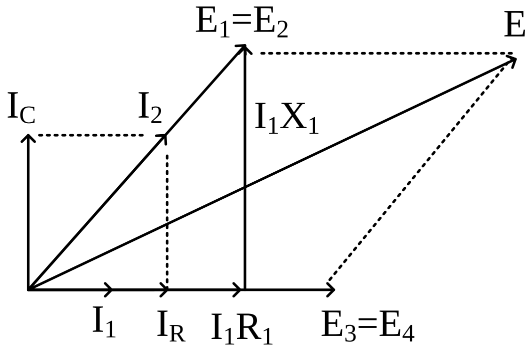
To measure the unknown inductance using Maxwell's Inductance Capacitance bridge.

APPARATUS:

1. Maxwell's bridge model
2. Bridge oscillator
3. Oscilloscope / Headphone
4. Unknown Inductor

CIRCUIT DIAGRAM:





TITLE:MAXWELL'S INDUCTANCE CAPACITANCE BRIDGE	GPRECD/EEE/EXPT-EM-2-A DATE: 20-09-2021

THEORY:

In this method of measurement of self – inductance, the unknown value is compared with a standard variable capacitance. In the circuit L_1 is unknown self inductance and R_1 is unknown resistance of the inductor, R_2, R_3 are known non inductive resistances, R_4 is variable non inductive resistances and C_4 is standard variable capacitor.

Impedance $Z_1 = R_1 + j\omega L_1$

$Z_2 = R_2$

$Z_3 = R_3$

$$Z_4 = \frac{1}{\frac{1}{R_4} + j\omega C_4} = \frac{R_4}{1 + j\omega R_4 C_4}$$

For balanced condition of bridge, $Z_1 Z_4 = Z_2 Z_3$

By solving above equation we will get unknown resistance of the inductor $R_1 = \frac{R_2 R_3}{R_4}$ and

unknown self inductance $L_1 = R_2 R_3 C_4$

This is very convenient and useful bridge for the determination of inductance having medim Q-factor (1<Q<10).

PROCEDURE:

1. Connect the oscillator to the input of the circuit.
2. Connect the unknown inductance in the appropriate arm (L_1 terminals in the kit).
3. Connect the headphone or CRO to check the bridge balance condition.

4. Adjust R_4 and C_4 to get minimum sound in the headphones and the waveform in the CRO gets nullified. This indiactes the bridge is balanced.

5. At balanced condition note values of R_4 and C_4.

6. Calculate the unknown inductance by using the formula.

$$L_1 = R_2R_3C_4$$

TABULAR COLUMN:

Sl No	R_4	C_4	R_2 (1000Ω)	R_3 (1000Ω)	$L_1 = R_2R_3C_4$

Sample Calculations: (Set No………)

R_2 = …………………

R_3 = …………………

C_4 = …………………

Unknown inductance L_1 =

RESULT:

The value of the unknown inductance is calculated by Maxwell's Inductance Capacitance Bridge.

TITLE:MAXWELL'S INDUCTANCE CAPACITANCE BRIDGE	GPRECD/EEE/EXPT-EM-2-A DATE: 20-09-2021

Viva Questions:

1. Maxwell's bridge is used for measurement of

a) Low Q Coils (b) Medium Q Coils (c) High Q Coils (d) Low and Medium Q Coils

Answer: B

2. Match the following

List 1	**List 2**
A. Hay's Bridge	1. Medium Resistance
B. Wheatstone Bridge	2. Frequency
C. Wein bridge	3. Capacitance
D. Schering bridge	4. High Q inductance

Answer: A-4, B-1, C- 2, D-3

3. Maxwell's inductance bridge is used for coils of Q value

a) Q<1 b) Q>10 c) 1<Q<10 d) Q>100

Answe : C

4. Quality Factor of a inductor is ………(Interms of L and r, where r is internal resistance of inductor)

Answer: ωL/r

5. Which onw of the following bridges can be used for inductance measurement?

i) Maxwell's ii)Hay's iii)Wein iv)Wheatstone

Select the correct answer using the code given below.

a) i and ii b) ii and iii c) iii and iv d) iv and i

answer: A

TITLE: DE SAUTY'S BRIDGE **GPRECD/EEE/EXPT-EM-3-A**
Date: 20-09-2021

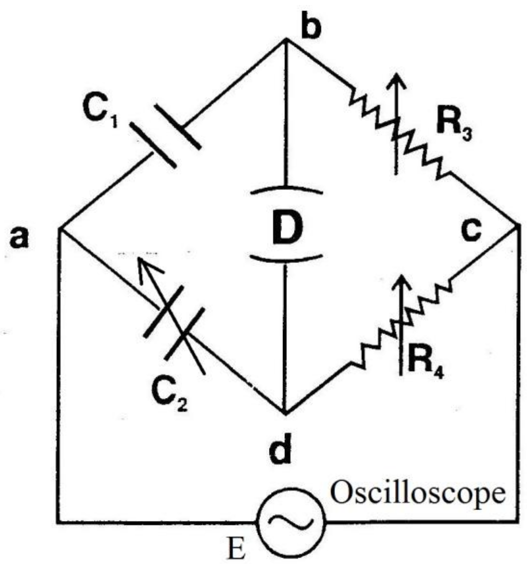
AIM:

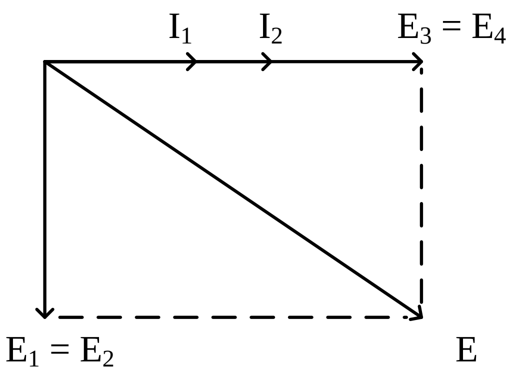
To measure unknown value of capacitance using De Sauty's Bridge.

APPARATUS:

1. De Sauty's bridge model
2. Bridge Oscillator
3. Oscilloscope / Headphone
4. Unknown Capacitor
5. Connecting Probes

CIRCUIT DIAGRAM:





THEORY:

The bridge is the simplest method of comparing two capacitances. The connections and phasor diagram of the bridge are shown in circuit diagam.

I_1 is current through C_1 and R_3

I_2 is current through C_2 and R_4

E_1 is voltage across C_1

E_2 is voltage across C_2

E_3 is voltage across R_3

E_4 is voltage across R_4

For balanced condition of bridge, $Z_1Z_4 = Z_2Z_3$ or $E_1 = E_2$ & $E_3 = E_4$

$$\left(\frac{1}{j\omega C_1}\right)R_4 = \left(\frac{1}{j\omega C_2}\right)R_3$$

The unknown Capacitance $C_1 = \dfrac{C_2R_4}{R_3}$

The advantage of this bridge is simplicity but the drawbak is with this method loss-less capacitor (perfect capacitors) like air capacitors can be compared. Measrement of capcitance of imperfect capacitors is not possible.

PROCEDURE:

1. Connect the oscillator to the input of the circuit.
2. Connect the unknown capacitor in the appropriate arm (C_1 terminals in the kit).
3. Connect the headphone or CRO to check the bridge balance condition.
4. Adjust C_2, R_3 and R_4 to get minimum sound in the headphones and the waveform in the CRO gets nullified. This indiactes the bridge is balanced.
5. At balanced condition note values of C_2, R_3 and R_4.
6. Calculate the unknown capacitance by using the formula $C_1 = \dfrac{C_2R_4}{R_3}$

TITLE: DE SAUTY'S BRIDGE **GPRECD/EEE/EXPT-EM-3-A**
Date: 20-09-2021

TABULAR COLUMN:

Sl No	C_2	R_3	R_4	$C_1 = \frac{C_2 R_4}{R_3}$

Sample Calculations: (Set No………)

C_2 = …………………

R_3 = …………………

R_4 = …………………

Unknown capacitance C_1 =

RESULT:

The unknown capacitance is calculated.

Viva Questions:

1. In a desaty bridge (unmodified) it is possible to obtain balanace

(a) Even if both the capacitors are imperfect (b) If one of the capacitors is perfect (c) only if both the capacitors are perfect (d) All of the above.

Answer: C

2. Wagner's earthing devices is used in AC bridges for------------

Answer: Eliminating the effect of earth capacitances.

3. What are the factors which lead to inaccuracy in measurement by AC bridges?

Answer: Stray conductance effect due to imperfet insulation

Mutual inductance effect due to magnetic coupling

Stary capacitance effect due to electrostatic fields

Residual in components

4. Which one of the following bridges is generally used for measurement of frequency and also capacitance?

(a) Hay's (b) Owen's (c) Schering (d) Wein

Answer: D

5. The four arms of bridge network has $Z_{AB} = 100\angle 30°\Omega$, $Z_{BC} = 100\angle -30°\Omega$, $Z_{CD} = 50\angle -60°\Omega$ and an unknown impedance is connected between D and A. Then unknown impedance Z_{DA} is ---------(Supply is connected between B and D).

Answer: $50\angle 0°\ \Omega$

TITLE: SCHEARING BRIDGE	**GPRECD/EEE/EXPT-EM-3-B** **Date: 20-09-2021**

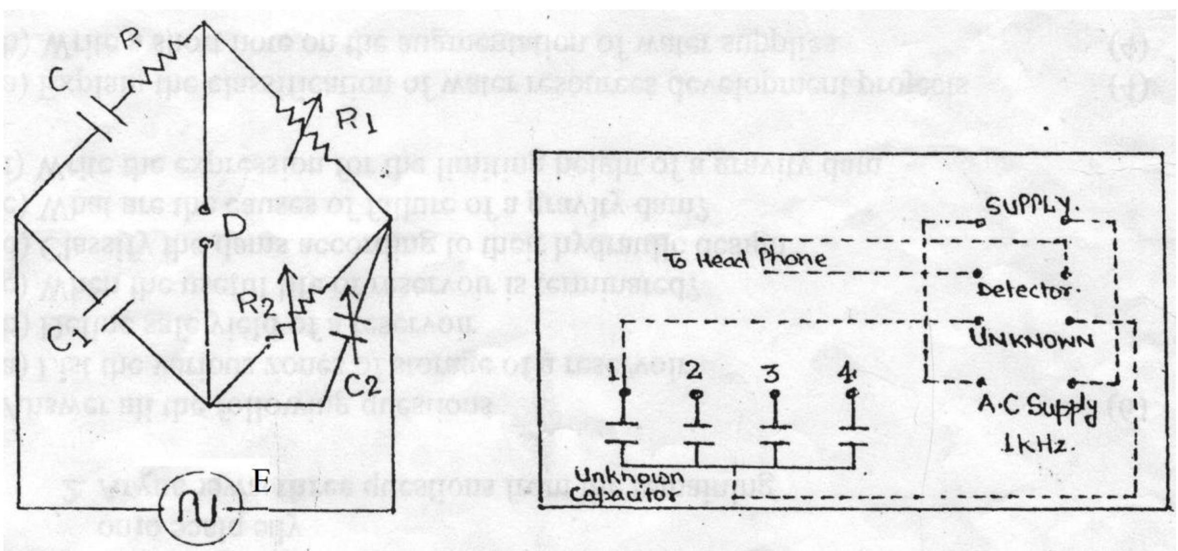
AIM:

To measure the value of unknown capacitance using Schering Bridge.

APPARATUS:

1. Schering bridge model
2. Bridge Oscillator
3. Oscilloscope / Headphone
4. Unknown Capacitor
5. Connecting Probes

CIRCUIT DIAGRAM:



TITLE: SCHEARING BRIDGE	GPRECD/EEE/EXPT-EM-3-B Date: 20-09-2021

THEORY:

In the above circuit which is shown in circuit diagram

C = Capacitor whose capacitance is to be determined

R = A series resistance representing the loss in the capacitor C

C_1 = A standard capacitor. This capacitor is either an air or gas capacitor and hence is loss free

R_1 and R_2 = A non-inductive variable resistances

C_2 = A variable capacitor.

For balanced condition of bridge, $Z_1Z_4 = Z_2Z_3$

$$\left(R + \frac{1}{j\omega C}\right)\left(\frac{R_2}{1 + j\omega R_2 C_2}\right) = \frac{1}{j\omega C_1} * R_1$$

Equating real and imaginary terms, we obtain R = $\frac{R_1 C_2}{C_1}$ and C = $\frac{C_1 R_2}{R_1}$

The advantage of this bridge is it can measure the capacitance of imperfect capacitors (capacitors having dielectric loss).

PROCEDURE:

1. Connect the oscillator to the input of the circuit.
2. Connect the unknown capacitor in the appropriate arm (C_1 terminals in the kit).
3. Connect the headphone or CRO to check the bridge balance condition.

4. Adjust C_2, R_1 and R_2 to get minimum sound in the headphones and the waveform in the CRO gets nullified. This indiactes the bridge is balanced.
5. At balanced condition note values of C_2, R_1 and R_2.
6. Calculate the unknown capacitance by using the formula $C = \frac{C_1 R_2}{R_1}$

TABULAR COLUMN:

S. No	R_1	R_2	C_1	C_2	$C = \frac{C_1 R_2}{R_1}$

Sample Calculations: (Set No………)

C_1 = …………………

C_2 = …………………

R_1 = …………………

R_2 = …………………

Unknown capacitance C =

RESULT:

The value of unknown capacitance can be calculated.

Viva Questions:

1. The capacitance and loss angle of a capacitor can be accurately measured by ……………

Answer: Schering Bridge

2. What is meant by term dielectric loss in a dielectric?

Answer: There is a definite amount of dissipation of energy when a dielectric is subected to alternating voltage. It is this dissipation of energy that is called the dieectric loss.

3. What is meant by dissipation factor of a leakage capacitor?

Answer: In a leakage capacitor, the leakage current does not lead applied voltage by exactly 90°. The complementary angle δ (δ = 90 – φ) is called the dielectric loss angle. Tangent of dielectric loss angle i.e., tan δ is called the dissipation factor.

4. An imperfect capacitor is represented by a capacitance C in parallel with a resistance R. The value of its dissipation factor tan δ is

(a) ωCR (b) $\omega^2 CR$ (c) $1/\omega^2 CR$ (d) $1/\omega CR$

Answer: D

5. Schering bridge can be used to measure which one of the following?

(a) Q of a coil (b) Inductance and its Q value (c) Very small resistance (d) Capacitance and its power factor

Answer: D

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER BY DIRECT LOADING | **GPRECD/EEE/EXPT-EM-4** | **Date: 20-09-2021**

AIM:

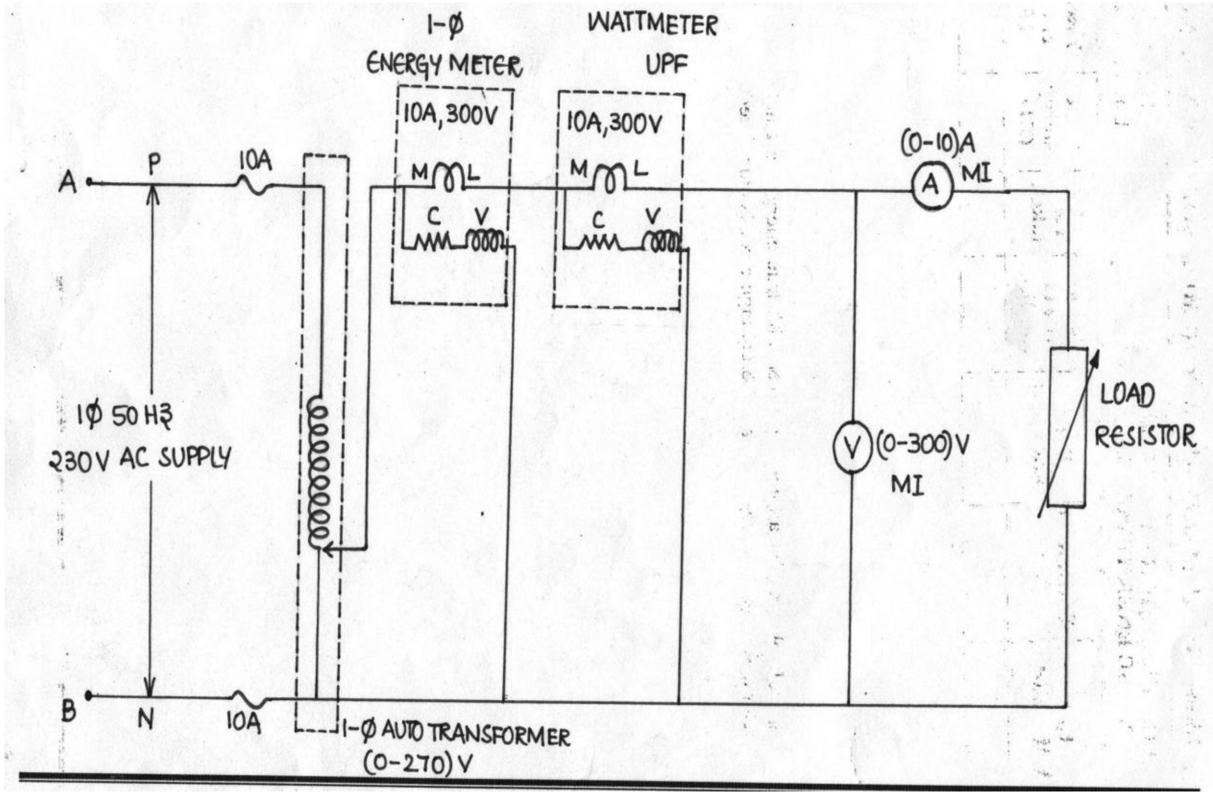
To compare the energy measured by energy meter with the true energy calculated from wattmeter and stopwatch readings and hence calculate percentage error.

APPARATUS:

S.NO	NAME OF THE APPARATUS	RANGE	TYPE	NO'S REQUIRED
1	Voltmeter			
2	Ammeter			
3	Wattmeter			
4	Energy meter			
5	Connecting wires			
6	Load Resistor			

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER BY DIRECT LOADING	**GPRECD/EEE/EXPT-EM-4** **Date: 20-09-2021**

CIRCUIT DIAGRAM:



THEORY:

Induction type of energy meters are universally used for measurement of energy in domestic and industrial AC. circuits. Induction type of meters possesses lower friction and higher torque/weight ratio. Also they are inexpensive and accurate, and retain their accuracy over a wide range of loads and temperature conditions. The calibration of energy meter may become inaccurate during its vigorous use due to various reasons. It is necessary to calibrate the meter to determine the amount of error i.e. its reading so that same meter can be used for correct measurement of energy. In this method precision grade indicating instruments are used as reference standard. These indicating instruments are connected in the circuit of meter under test. The numbers of revolutions made by the meter under test are recorded for different loadings. The time taken is also measured.

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER BY DIRECT LOADING	GPRECD/EEE/EXPT-EM-4 Date: 20-09-2021

Meter constant = N rev/kWh

Energy recorded by meter under test = n/N kWh= E_r

Where 'n' is number of revolutions

Energy computed from the readings of the indicating instrument = kW × t = E_C

Where kW = power in kilowatt as indicated in wattmeter

t = time in hours.

$$\text{Percentage Error} = \frac{E_r - E_c}{E_c} x100\%$$

PROCEDURE:

1. The connections are made as per the circuit diagram.
2. By varying the load, wattmeter readings and the revolution of the disc for a fixed time say 20 minutes .Take atleast 5 readings in to full load rating for energy meter .
3. Calculate percentage error and a graph showing percentage error against load in KW.
4. Calculate the average percentage error from the graph drawn.

FORMULA USED:

True energy = E1= wattmeter reading x time taken
= P x t Kwh
Observed energy = E2 = (no of revolutions/ (Energy meter constant (600)) kWh
% error = (E2-E1)/(E2) x 100
Multiplying factor of Wattmeter = (VI COSΦ)/(Full Scale Reading)

TABULAR COLUMN:

Voltage(V)	Load Current(A)	Wattmeter(W)	Total power(Pt)	No. of rev of the disc	Time taken	True energy(E1)	Observed energy(E2)	% error= (E2-E1)/ E2

SAMPLE CALCULATIONS: (Set No ……….)

Energy meter constant (K) = ...

Number of Revolutions (N) = ...

Time taken for N Revolutions (T) = ... sec

Voltmeter reading (V) = ... volts

Ammeter reading (I) = ... amps

Wattmeter reading (W) = ... watts

Power = ...watts

True energy (E_1) = ...wattsecs

Observed Energy (E_2) = ...wattsecs

% Error = ...

RESULT:

The energy measured by an energy meter with true energy calculated is compared from watt meter and stopwatch readings and percentage error is calculated.

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER BY DIRECT LOADING	**GPRECD/EEE/EXPT-EM-4** **Date: 20-09-2021**

Viva Questions:

1. State the reason why holes are provided in Al disc.

Answer: To avoid creeping holes are provided on both sides of Al disc.

2. Name the constructional parts of induction type energy meter

Answer: Current coil with series magnet, Voltage coil with shunt magnet, Aluminum disc

Braking magnet, Registering mechanism

3. How is the flux of shunt coil related to voltage?

a) flux is proportional to square of voltage
b) directly proportional
c) inversely proportional
d) independent of each other
Answer: a

4. Supply voltage in an energy meter is __________

a) Constant always
b) Zero always
c) Depends on the load
d) Can fluctuate
Answer: a

5. Measurement of energy involves _________

a) Inductance and capacitance measurement
b) Power consumption and time duration
c) Resistance measurement and voltage drop
d) Current consumption and voltage drop
Answer: b

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER USING PHANTOM LOAD	GPRECD/EEE/EXPT-EM-5 Date: 20-09-2021

AIM:

To test single phase energy meter by using phantom load testing kit.

APPARATUS:

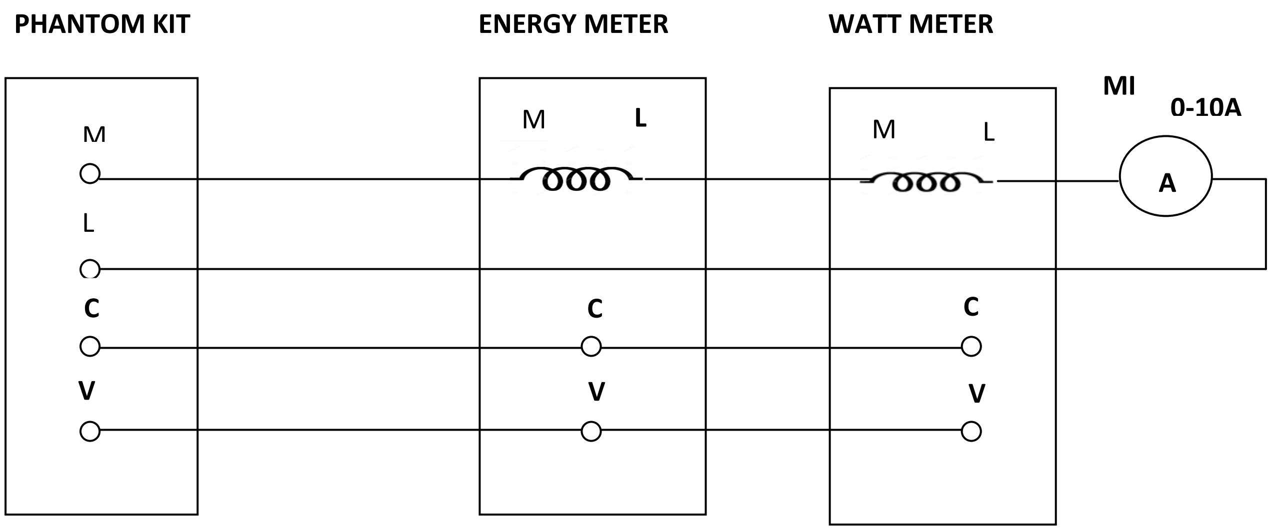
(1) Phantom Load Test Kit

(2) 1-Ø Energy Meter

(3) Ammeter MI, (0-10) A

(4) UPF Wattmeter (300V, 10A, UPF)

CIRCUIT DIAGRAM:

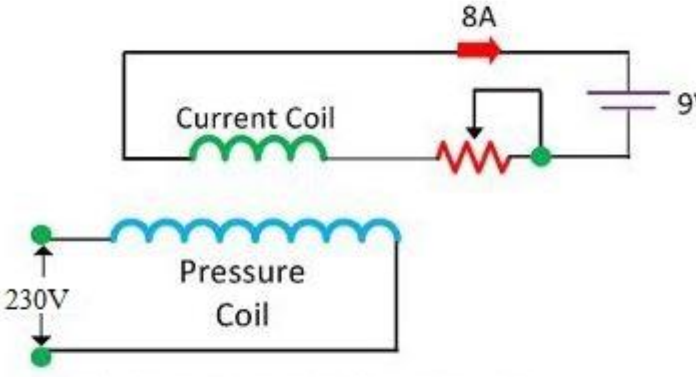


PHANTOM LAOD TEST

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER USING PHANTOM LOAD	**GPRECD/EEE/EXPT-EM-5** **Date: 20-09-2021**

THEORY:

When a load test with actual loading is to be done, it involves a considerable waste of power. In order to avoid this "phantom" or "Fictitious" loading is done. In phantom loading, pressure coil is excited from normal supply voltage and current coil is excited from a separate low voltage supply. The low impedance of current coil circuit makes it possible to circulate the required current even with low supply voltage.



Phantom Loading Arrangement

With this arrangement the total power supplied for the test is that due to the pressure coil current (small) at normal voltage, plus that due to the current circuit supplied at low voltage. The total power, therefore, required for testing the meter with phantom loading is comparatively very small.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Select the current range to (0-10A) in the Phantom load kit.
3. Before switching on, set the dimmer in fully anti-clockwise position (minimum current).
4. By rotating the dimmer in clockwise (to increase the current), for fixed no of revolutions (N) note down the following values in the tabular column.
   a. Voltage
   b. Load current
   c. Wattmeter

   d. No of revolutions of the disc (N)
   e. Time taken to complete the N number of revolutions (T).
5. Repeat step 4 for different load currents. (Make sure that last reading is near to rated current i.e, 10A).
6. After taking values for different load currents, bring the load to original position.
7. Before switch off the supply make sure that the dimmer has to be brought to original position.
8. Calculate percentage error for different load currents.

FORMULA USED:

Multiplication Constant of Wattmeter = VI cosφ / Full scale Reading

Power (P) = Wattmeter Reading (W) * Multiplication Constant of Wattmeter

True energy = E_1= Power (Watts) * time taken (sec)

=P * T (Watt-sec)

Observed energy = $E_2 = \frac{N*1000*3600}{1200}$ (Watt-sec)

% error = $\frac{E_2 - E_1}{E_1} * 100$

TABULAR COLUMN:

Voltage (V)	Load Current (A)	Wattmeter Reading (W)	Power (P)	No. of rev (N)	Time taken in Sec (T)	True Energy(E_1)	Observed Energy(E_2)	% Error= $\frac{E_2 - E_1}{E_1}$ *100

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER USING PHANTOM LOAD	GPRECD/EEE/EXPT-EM-5 Date: 20-09-2021

SAMPLE CALCULATIONS: (Set No ……….)

Energy meter constant (K) = ...

Number of Revolutions (N) = ...

Time taken for N Revolutions (T) = ... sec

Voltmeter reading (V) = ... volts

Ammeter reading (I) = ... amps

Wattmeter reading (W) = ... watts

Power = ...watts

True energy (E_1) = ...watt-secs

Observed Energy(E_2) = ...watt-secs

% Error = ...

RESULT:

The percentage error of the energy meter is calculated and energy meter is calibrated by comparing theoretical and practical values using phantom loading kit.

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER USING PHANTOM LOAD	GPRECD/EEE/EXPT-EM-5 Date: 20-09-2021

Viva Questions:

1. How voltage coil and current coil is connected in induction type energy meter?

Answer: Voltage coil is connected in parallel to supply and load and current coil is connected in series to the load.

2. Define phantom loading and it's advantage over direct loading?

Answer: Method by which energizing the pressure coil circuit and current coil circuits separately is called phantom loading. Advantage is Power loss is minimm.

3. Energy meter is an _____________ (i) integrating instrument (ii) indicating instrument

Answer: Integrating instrument

4. Which type of energy meters are used in dc circuits?

5. Can the measured percentage error be negative?

TITLE: MEASUREMENT OF SINGLE PHASE(1 – φ) POWER BY 3-VOLTMETER AND 3-AMMETER METHOD **GPRECD/EEE/EXPT-EM-6** **DATE: 20-09-2021**

AIM:

To measure the power and power factor of a choke coil in a single phase circuit by

(a) 3 Voltmeter Method (b) 3 Ammeter Method

APPARATUS:

S.No.	NAME	RANGE	TYPE	NO's REQUIRED
1	Voltmeter	0-300 V	MI	2
2	Voltmeter	0-150 V	MI	1
3	Ammeter	0-2 A	MI	3
4	Load Choke	350 ohms/ 1.1 A	-	1
5	1-Phase Auto Transformer	230/0-270V	-	1

CIRCUIT DIAGRAM:

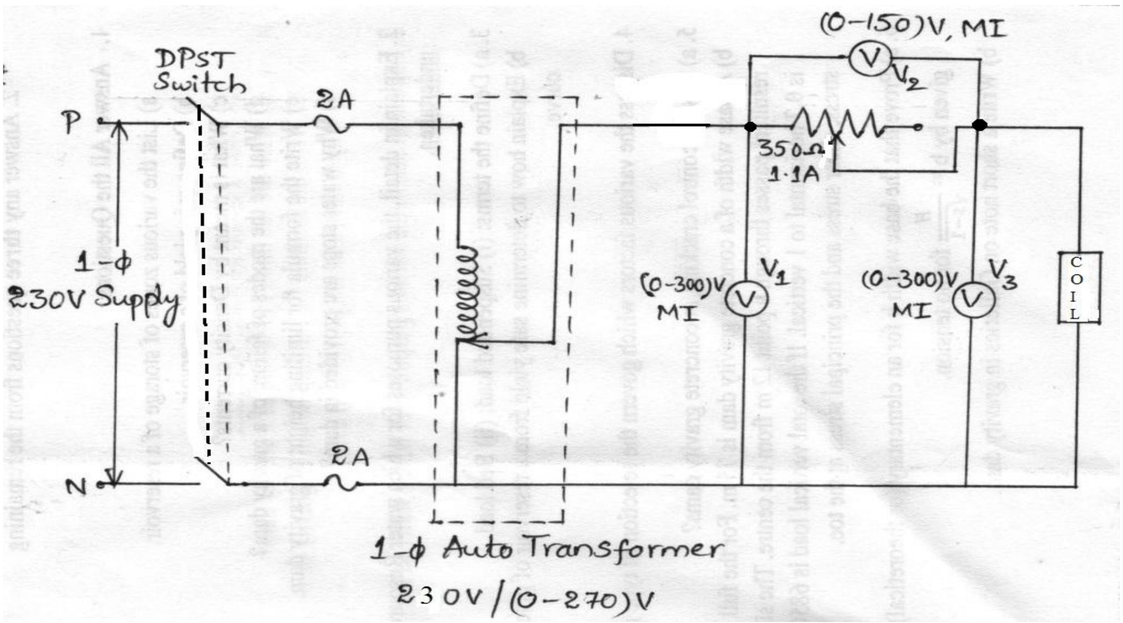


Fig.1 Circuit Diagram of 3 Voltmeter Method

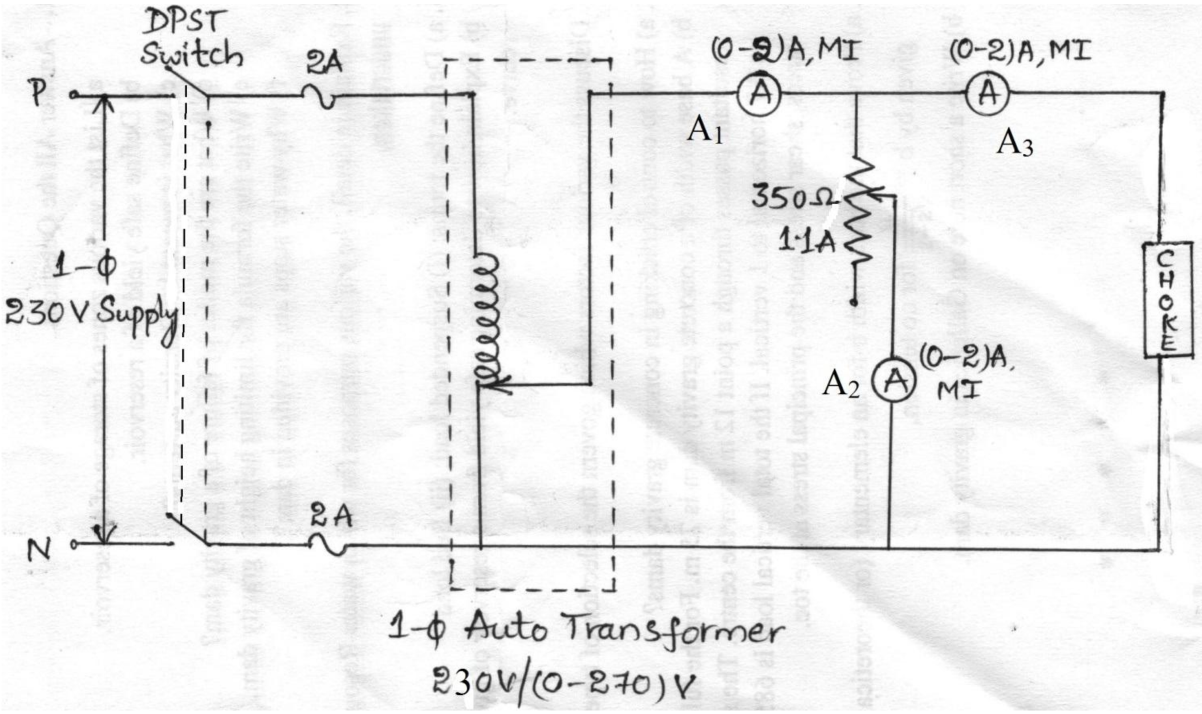


Fig.2 Circuit Diagram of 3 Ammeter Method

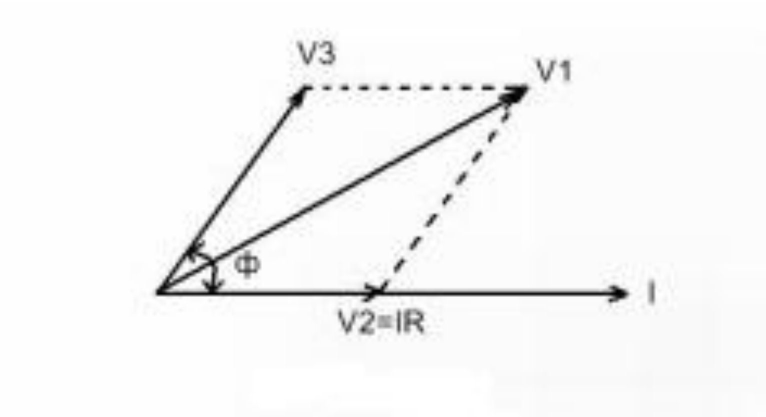
THEORY:

The power and power factor of impedance load can be measured using either 3 voltmeter method or 3 ammeter method.

(A) 3 VOLTMETER METHOD

V_1, V_2, V_3 are the voltmeter readings and R is a non-inductive resistance connected in series with the load as shown in Fig.1.

The phasor diagram of 3 voltmeter method is shown below, which shows the relation between voltages and load current (I) by taking load current as reference.



Phasor Diagram of 3 Voltmeter Method

From the phasor diagram, $V_1^2 = V_2^2 + V_3^2 + 2V_2V_3 \cos\phi$ ………. (1)

The power in the inductive load is => $P = V_3 I \cos\phi$ ……………….. (2)

The voltage across non-inductive resistor is $(V_2) = IR$ …………... (3)

Substituting (2) & (3) in eqn. (1),

$$V_1^2 = V_2^2 + V_3^2 + 2PR$$

$$P = \frac{V_1^2 - V_2^2 - V_3^2}{2R}$$

Power factor of the impedance coil is given by

$$\cos\phi = \frac{V_1^2 - V_2^2 - V_3^2}{2V_2V_3}$$

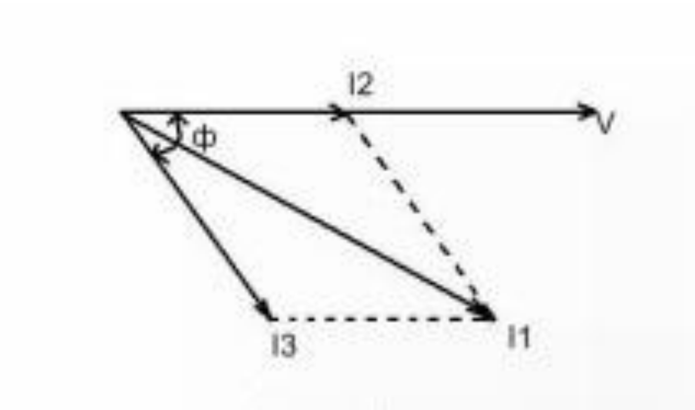
Disadvantages:

- Supply voltage higher than normal voltage is required because an additional resistance R is connected in series with the load Z (choke coil).
- Even small errors in measurement of voltages may cause serious errors in the value of power determined by this method, as square of the voltage are involved.

(B) 3 AMMETER METHOD

The circuit diagram for measurement of power and power factor in 3 ammeter method is given in Fig.2. The current measured by the ammeter A_1 is the vector sum of the load current and that taken by the non-inductive resistor R, this latter being in phase with V.

The phasor diagram of circuit is shown in fig.4 taking input voltage as reference.



Phasor Diagram -3 Ammeter Method

From the phasor diagram, $I_1^2 = I_2^2 + I_3^2 + 2I_2I_3 \cos\phi$ ………….. (4)

The power in the inductive load is $P = VI_3 \cos\phi$ ……………... (5)

The current in non-inductive resistor is $I_2 = V/R$ …………….……. (6)

Substituting (5) & (6) in eqn. (4),

$$I_1^2 = I_2^2 + I_3^2 + 2(P/R)$$

$$P = \frac{R}{2}(I_1^2 - I_2^2 - I_3^2)$$

Power factor of the choke coil is given by

$$cos\phi = \frac{I_1^2 - I_2^2 - I_3^2}{2I_2 I_3}$$

Advantages:

- The advantage of this method is that the power and power factor determined are independent of supply frequency and waveforms.
- The disadvantages in measurement of power by three voltmeter method are overcome in this method.

PROCEDURE:

3-VOLTMETER METHOD

1. Make the connections as per the circuit diagram shown in the Fig.1.
2. Initially, set the rheostat to a particular value (R_1) with the help of multimeter.
3. Apply three different voltages using auto transformer and note down all the meter readings (Ensure that the current through rheostat does not exceed its rated value.)
4. Repeat the step 3 for three different rheostat (R_1, R_2 and R_3) values.
5. Calculate the power (& Mean Power) and power factor (& Mean Power Factor) using the formula provided.

3-AMMETER METHOD:

1. Make the connections as per the circuit diagram shown in the Fig.2.
2. Initially, set the rheostat to a particular value (R_1) with the help of multimeter.
3. Apply three different voltages using auto transformer and note down all the meter readings (Ensure that the current through rheostat does not exceed its rated value.)
4. Repeat the step 3 for three different rheostat (R_1, R_2 and R_3) values.
5. Calculate the power (& Mean Power) and power factor (& Mean Power Factor) using the formula provided.

TITLE: MEASUREMENT OF SINGLE PHASE(1 – φ) POWER BY 3-VOLTMETER AND 3-AMMETER METHOD **GPRECD/EEE/EXPT-EM-6** **DATE: 20-09-2021**

TABULAR COLUMN:

3-VOLTMETER METHOD

R (Ω)	V_1 (V)	V_2 (V)	V_3 (V)	Power (W)	Power factor	Mean	
						Power (W)	Power factor
R_1							
R_2							

3-AMMETER METHOD

R (Ω)	I_1 (A)	I_2 (A)	I_3 (A)	Power (W)	Power factor	Mean	
						Power (W)	Power factor
R_1							
R_2							

FORMULAE USED:

TITLE: MEASUREMENT OF SINGLE PHASE(1 – φ) POWER BY 3-VOLTMETER AND 3-AMMETER METHOD	GPRECD/EEE/EXPT-EM-6 DATE: 20-09-2021

a) 3-VOLTMETER METHOD

$$P = \frac{V_1^2 - V_2^2 - V_3^2}{2R} \qquad cos\phi = \frac{V_1^2 - V_2^2 - V_3^2}{2V_2V_3}$$

b) 3-VOLTMETER METHOD

$$P = \frac{R}{2}(I_1^2 - I_2^2 - I_3^2) \qquad cos\phi = \frac{I_1^2 - I_2^2 - I_3^2}{2I_2I_3}$$

Sample Calculations:

a) 3-VOLTMETER METHOD

R = …………………..

V_1 = …………………

V_2 = …………………

V_3 = …………………

Power =

Powerfactor =

b) 3-AMMETER METHOD

R = …………………..

I_1 = …………………

I_2 = …………………

I_3 = …………………

Power =

Powerfactor =

RESULT:

Power and power factor are calculated by 3 Voltmeter and 3 Ammeter methods.

Viva Questions:

1. A coil having resistance of 50Ω and inductance of 0.1H, at what frequency the load angle of the coil will be 45°--------
2. Unit of power factor is -------
3. The current passing through the coil will lag the voltage across the coil. (True/False) Explain it?
4. Power factor of coil (R, L are parameters of given coil) depends on

   a) R only b) L only c) R and L d) R, L and Supply Frequency
5. Power dissipated in a coil (R, L are parameters of given coil) depends on

   a) R b) L C) Both R and L d) None

G. PULLA REDDY ENGINEERING COLLEGE (Autonomous) : KURNOOL
ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT
ELECTRICAL MEASUREMENTS (EM) LABORATORY MANUAL
(SCHEME-2020)

TITLE: MEASUREMENT OF POWER (REAL AND REACTIVE) AND POWER FACTOR IN 3 PHASE CIRCUIT	**GPRECD/EEE/EXPT-EM-7** **Date: 20-09-2021**

AIM:

1. To measure power and power factor in 3 phase circuit.
2. To measure reactive power in 3 phase circuit by single wattmeter.

APPARATUS:

S.No.	NAME	TYPE	RANGE	NO'S REQUIRED
1	Ammeter	MI	0-10 A	1
2	Voltmeter	MI	0-500 V	1
3	Wattmeter	UPF	10A, 500V	2
4	Wattmeter	LPF	10 A, 500V	1
5	Rheostat	WW	26 ohms/4A	3
6	3 phase inductive load		10 A	1
7	Connecting wires			

CIRCUIT DIAGRAM:

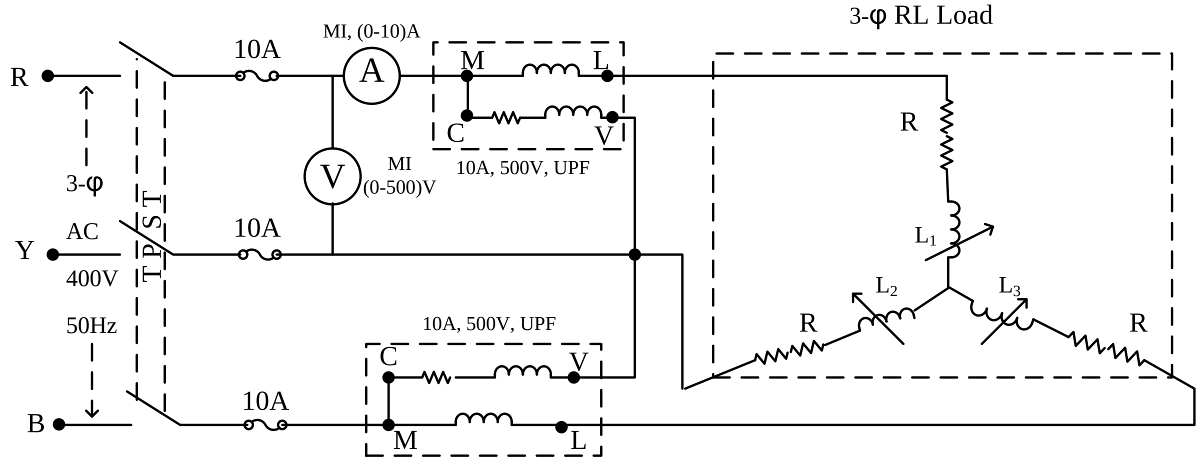


Fig. 1 Measurement of real power and power factor

TITLE: MEASUREMENT OF POWER (REAL AND REACTIVE) AND POWER FACTOR IN 3 PHASE CIRCUIT	GPRECD/EEE/EXPT-EM-7 Date: 20-09-2021

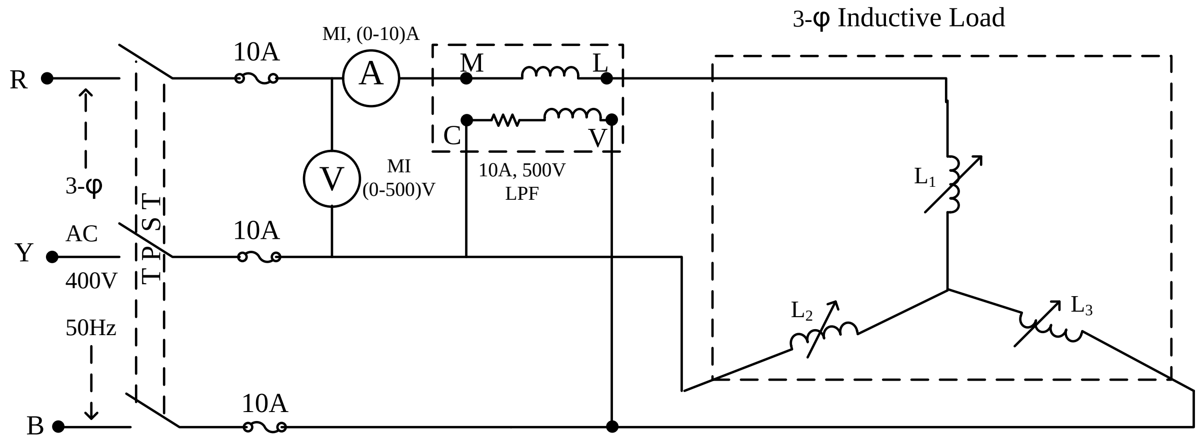


Fig.2 Measurement of Reactive Power

THEORY:

A. MEASUREMENT OF REAL POWER

Real power in balanced (or unbalanced), 3-phase circuits can be measured by employing two wattmeters in the three lines supplying the load system, irrespective of whether the load is star or delta connected (or a combination of them). The schematic circuit arrangement used for such a measurement is shown in Fig. 1. The current coil (cc) of the wattmeters carry line current and the pressure coil (pc) of wattmeter have line voltage impressed across it. In order to verify the possibility of 3-phase power measurement with the help of two wattmeters, let us consider that the load is Y-connected and let the instantaneous voltages and currents in the R, Y and B phases of the load be (v_R, i_R), (v_Y, i_Y)and (v_B, i_B) respectively.

The total instantaneous power flow in the 3-phase load will be given by

$$P_i = v_R\, i_R + v_Y\, i_Y + v_B\, i_B$$

For any Y-connected load with ungrounded neutral, the sum of three phase currents must be zero, i.e., $i_R+i_Y+i_B=0$, irrespective of whether the load is balanced or not. Therefore we have

$$i_Y=-(i_R + i_B)$$

and hence

$$P_i= (v_R - v_Y)i_R+(v_B - v_Y)i_B$$

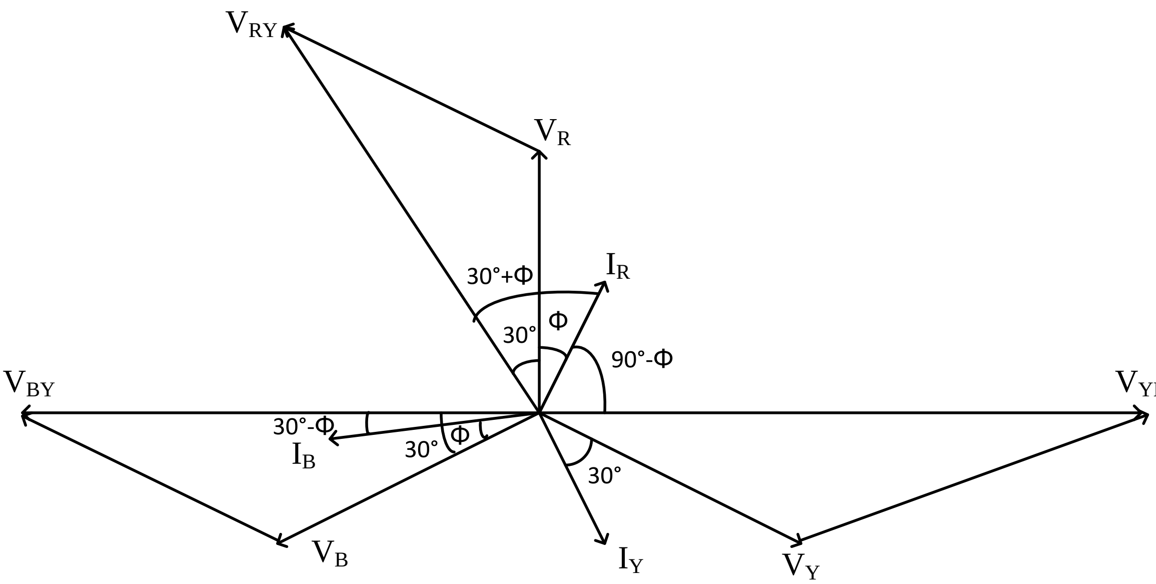
Examination of the circuit in Fig.1 will show that the current through the current coil (cc) of W_1 is i_R and the voltage across the pressure coil (pc) of W_1 is $v_R - v_Y$. Similarly, the current through the cc of W_2 is i_B and the voltage across the pressre coil of W_2 is $v_B - v_Y$. Hence, at any instant,

$$P_{total} = W_1 + W_2$$

where W_1 and W_2 are the instantaneous power readings. The wattmeters, however, measure the average power only, which is by definition, the real power of the circuit. Thus, we conclude that the real power of a 3-phase circuit – balanced or unbalanced can be measured using two wattmeters (provided $I_R + I_B + I_Y = 0$) and is simply given by

$$P_{Total} = W_1 + W_2$$

It is interesting to note that W_1 and W_2 may be used in estimating the power factor of the load provided that the voltage and current waveforms are sinusoidal.



Phasor Diagram

From phasor diagram,

$$W_1 = \sqrt{3}VI\cos(30^\circ + \phi) \text{ and } W_2 = \sqrt{3}VI\cos(30^\circ - \phi)$$

and

$$W_2 - W_1 = \sqrt{3}VI\sin(\phi) \text{ and} W_2 + W_1 = 3VI\cos\theta$$

Hence,

B. MEASUREMENT OF REACTIVE POWER

One wattmeter method for measurement of reactive power is for 3 phase balanced load only. The current coil of the wattmeter is connected in one of the lines. The pressure coil is connected across the two remaining lines similar to the circuit connection which is shown in Fig.2.

Wattmeter reading = voltage across pressure coil * Current through currnet coil * Cosθ

Where θ = Phase angle between pressure and current coils

So, the wattmeter (W) reading = I_R * V_{YB} * Cos (90°-φ) = $\sqrt{3}VI\sin(\phi)$ and this can be verified by phasor diagram. The reactive power in any balanced circuit is $3VI\sin(\phi)$.

Therefore reactive power= Q= $\sqrt{3}$ W = $3VI\sin(\phi)$ VAR.

PROCEDURE:

MEASUREMENT OF TOTAL POWER AND POWER FACTOR:

1. Make connections as per the circuit diagram as shown in the Fig.1.
2. Switch on the supply with the help of TPST switch.
3. By varying the load take 4 to 5 sets of readings and note down in the observation table.
4. Minimise the load to bring it to original position.
5. Switch off the supply with the help of TPST switch.
6. Calculate the power and power factor for each set of observations.

MEASUREMENT OF REACTIVE POWER:

1. Make the connections as per the circuit diagram as shown in Fig. 2.
2. Switch on the supply with the help of TPST switch.
3. By varying the load take 4 to 5 sets of readings and note down the values in the observation table.
4. Minimise the load to bring it to original position.
5. Switch off the supply with the help of TPST switch
6. Calculate the reactive power for each set of observations.

TITLE: MEASUREMENT OF POWER (REAL AND REACTIVE) AND POWER FACTOR IN 3 PHASE CIRCUIT	GPRECD/EEE/EXPT-EM-7 Date: 20-09-2021

FORMULAE USED:

Total Power = P = $((W_1 * K_1) + (W_2 * K_2))$

Power Factor Power factor angle $\phi = \tan^{-1}\left(\sqrt{3}\frac{W2 - W1}{W2 + W1}\right)$

Power Factor = $\cos\varphi$

Reactive power = Q = $\sqrt{3}$ (W*K).

Multiplying factor (K)= $\frac{\text{VI Cos}\varphi}{\text{F.S.R}}$

TABULAR COLUMN:

REAL POWER

Voltage (V)	Current (A)	W_1 Wattmeter reading(W)	W_2 Wattmeter reading(W)	Real Power Consumed by 3-Phase Load $W_1 + W_2$	Power factor

REACTIVE POWER

Voltage	Current	Wattmeter(W)	Reactive Power $\sqrt{3}$ (W*K).

TITLE: MEASUREMENT OF POWER (REAL AND REACTIVE) AND POWER FACTOR IN 3 PHASE CIRCUIT	**GPRECD/EEE/EXPT-EM-7** **Date: 20-09-2021**

RESULT:

Real power, power factor and reactive power for a three phase circuit are measured.

Viva Questions:

1. Unit or Real(active), complex(reactive) and total power?
2. A dynamometer type wattmeter responds to the

(a) Average value of active power (b) average value of reactive power (c)peak value of active power (d) peak value of reactive power.

3. The current through the current coil of a wattmeter is given by I = (1 + 2 sinωt) A and the voltage across the pressure coil is v = (2 + 3sin2ωt) V. The wattmeter will read…..

Answer: 2W

4. The power delivered to a 3 – phase load can be measured by the use of 2 wattmeters only when the 3- phase load is

(a) Balanced (b) unbalnaced (c) Both a and b.

Answer: C

5. In a two wattmeter method of power measurement one of the wattmeters will show negative reading when the load power factor angle is

(a) <30° (b) <60° (c) >30° (d) >60°

6. In a two wattmeter method of power measurement one of the wattmeters is reading zero watts. The load power factor is ----
7. W1 and W2 are the readings of two wattmeters used to measure power of a 3- phase balanced load. The reactive power drawn by the load is……..

TITLE: EXTENSION OF RANGE OF AMMETER AND VOLTMETER	GPRECD/EEE/EXPT-EM-8 Date: 20-09-2021

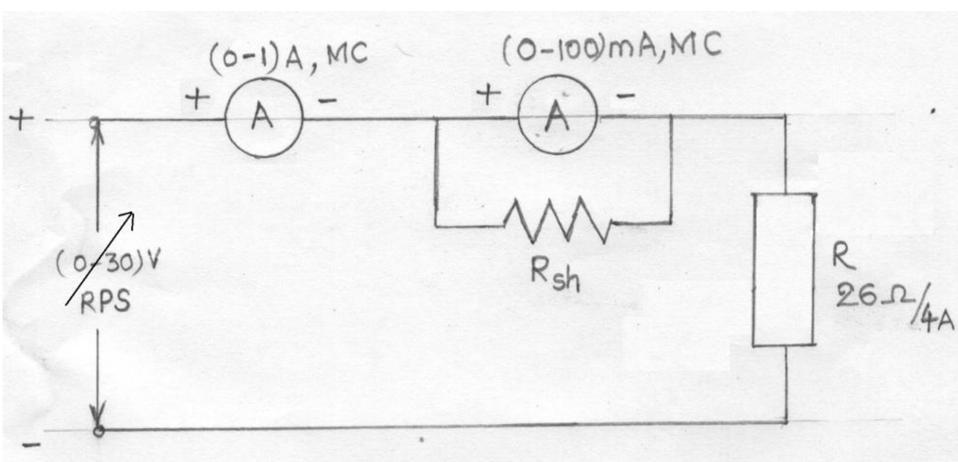
AIM: To show that the range of the ammeter and a voltmeter can be extended using shunt and multiplier respectively.

APPARATUS:

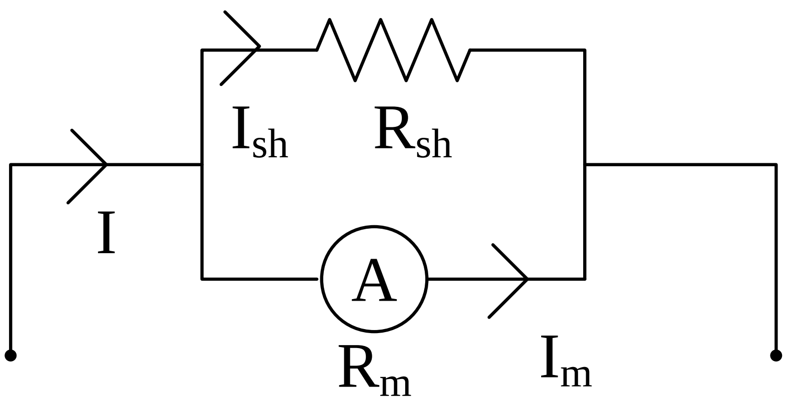
S.No.	NAME	RANGE	NO'S REQUIRED
1	Ammeter	(0-1) A	1
2	Milliammeter	(0-100) mA	1
3	Variable Resistance	0-26 Ω/4A	2
4	Resistance Box or POT	0-40 kΩ	1
5	Voltmeter	(0-30) V	1
6	Millivoltmeter	(0-500) mV	1
7	RPS	0-30V, 0-2A	1

A) Extension of Ammeter using Shunt Resistance.

CIRCUIT DIAGRAM:



THEORY: The moving – coil ammeter has a coil wound with very fine wire. It can carry only few milli- amperes safely to give full- scale deflection. For measuring high currents, a low resistance is connected in parallel with the instrument. The low resistance connected in parallel with the instrument is called a shunt.



Calculation of Shunt Resistance, R_{sh}:

Let I = current to be measured

I_m = meter current (current through R_m), I_{sh} = shunt current (current through R_{sh})

R_m = meter resistance, R_{sh} = Shunt resistance

Current to be measured = meter current + shunt current

$I = I_m + I_{sh}$

$I_{sh} = I - I_m$

Voltage across the meter = Voltage across the shunt

$I_m R_m = I_{sh} R_{sh}$

$$R_{sh} = \frac{I_m R_m}{I_{sh}} = \frac{R_m}{\left(\frac{I - I_m}{I_m}\right)} = \frac{R_m}{\left(\frac{I}{I_m} - 1\right)} = \frac{R_m}{(M.F - 1)} \quad \text{..........(1)}$$

Where M.F = Mutiplication Factor = I/I_m

PROCEDURE:

i) Calcuation of shunt resistance:

1. Note down the value of full scale deflection of milli ammeter (I_m) whose range is to be extended.
2. Measure the resistance of milli ammeter using multimeter, say R_m.
3. Assume range of ammeter to be extended is from I_m to I, and calculate multliplication factor (M.F) with the help of I_m and I.
4. Calculate the reuired value of shunt resistnace (R_{sh}) to extend the milli ammeter.

$$R_{sh} = \frac{I_m R_m}{I_{sh}} = \frac{R_m}{\left(\frac{I - I_m}{I_m}\right)} = \frac{R_m}{\left(\frac{I}{I_m} - 1\right)} = \frac{R_m}{(M.F - 1)}$$

ii) Experimental procedure:

5. Set the value of shunt resistance with the help of multimeter.
6. Make the connections as shown in the circuit diagram.
7. By adjusting the supply voltage take few readings of ammeter (I) and milliammeter (I_m) whose range is to be extended.
8. Calculate the extended current range (E.R).
9. Calculate the % error.

Formulae:

1. M.F = $\frac{Extended\ Full\ Scale\ Reading}{Actual\ Full\ Scale\ Reading}$
2. R_{sh} = $\frac{R_m}{M.F - 1}$
3. Extended Current=Actual Current * Multiplication Factor (M.F)

TABULAR COLUMN:

S.No	Standard Ammeter Reading, S.R (A)	Actual Ammeter Reading, A.R (mA)	Extended Current Range, E.R=A.R*MF (A)	% Error = $\frac{E.R - S.R}{S.R}*100$
1.				
2.				
3.				
4.				
5.				

Sample calculations:

S. R = …………….

A.R = …………….

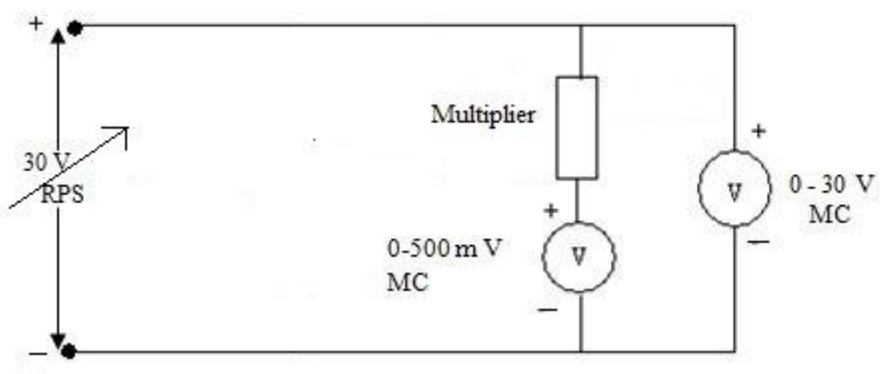
E. R =

% Error =

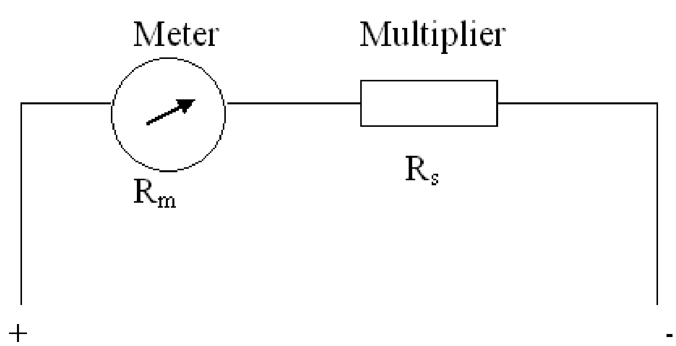
RESULT: Extension range of ammeter with shunt resistance is verified by theoretical values.

B) Extension of Voltmeter using Multiplier.

CIRCUIT DIAGRAM:



<u>THEORY</u>: For measuring high voltage, a high resistance is connected in series with the instrument to limit the current in the coil to a safe value. This value of current should never exceed the current required to produce the full- scale deflection. The high resistance connected in series with the instrument is called a multiplier. A multiplier is made of manganin or other suitable alloy having a negligible temperature coefficient of resistance. It therefore also serves as swamping resistor for the instrument coil.



Calculation of Series or Multiplier Resistance, R_s:

Let, V = Voltage to be measured
I_m = meter current
R_m = meter resistance
R_s= resistance of multiplier
$V = I_m (R_m + R_s)$ ---------------------- (2)

Voltage across meter, $V_m = I_m R_m$ ---------------------- (3)

From, (2) & (3), $R_s = \frac{V}{I_m} - R_m = R_m\left(\frac{V}{V_m} - 1\right) = R_m(M.F - 1)$

Where, M.F = Extended Full Scale Reading / Actual Full Scale Reading.

PROCEDURE:

a) Calcuation of shunt resistance

1. Note down the value of full scale deflection of milli voltmeter (V_m) whose range is to be extended.
2. Measure the resistance of milli voltmeter using multimeter, say R_m.
3. Assume range of milli voltmeter to be extended is from V_m to V, and calculate multliplication factor (M.F) with the help of V_m and V.
4. Calculate the reuired value of multliplier or series resistnace (R_s) to extend the milli voltmeter.

$$R_s = \frac{V}{I_m} - R_m = R_m\left(\frac{V}{V_m} - 1\right) = R_m(M.F - 1)$$

b) Experimental procedure:

5. Set the value of multliplier or series resistance with the help of multimeter.
6. Make the connections as shown in the circuit diagram.

7. By adjusting the supply voltage take few readings of voltmeter (V) and millivoltmeter (V_m) whose range is to be extended.
8. Calculate the extended current range (E.R).
9. Calculate the % error.

TABULAR COLUMN:

S.No	Standard Voltmeter Reading, S.R (V)	Actual Voltmeter Reading, A.R (mV)	Extended Voltage Range, E.R (V)	% Error = $\frac{E.R-S.R}{S.R}*100$
1.				
2.				
3.				
4.				
5.				

Formulae:

1. M.F = $\frac{Extended\ Full\ Scale\ Reading}{Actual\ Full\ Scale\ Reading}$
2. $R_s = \frac{R_m}{M.F-1}$
3. Extended Current=Actual Current * Multiplication Factor (M.F)

Sample calculations:

S. R = …………….

A.R = …………….

E. R =

% Error =

RESULT: Verified extend the range of voltmeter with series resistance.

Viva Questions:

1. The shunt resistance of an ammeter is usally

(a) Less than meter resistnace (b) equal to meter resistance (c) more than meter resistance (d) of any value

Answer: A

2. A 100mA ammeter has an internal resistance of 100Ω. For extending its range to measure 500mA, the shunt required is of resistance (in Ω)

3. The series resistance required to extend the 0 – 100V of a 20,000Ω/V meter to 0 – 1000V is---------

4. A current of -4+4.242 sin(ωt+30°) A is passed through a centre zero PMMC meter and moving iron meter. The two meters wil read respectively

(a) -4A and -5A (b) 4A and -5A (c) -4A and 5A (d) 4A and 5A

Answer: C

5. Which one of the following is used in the fabrication of swamping resisance of PMMC instrments?

(a) Copper (b) Aluminium (c) Manganin (d) Tungsten

Answer: C

TITLE: MEASUREMENT OF DISPLACEMENT USING LVDT	GPRECD/EEE/EXPT-EM-9 Date: 20-09-2021`

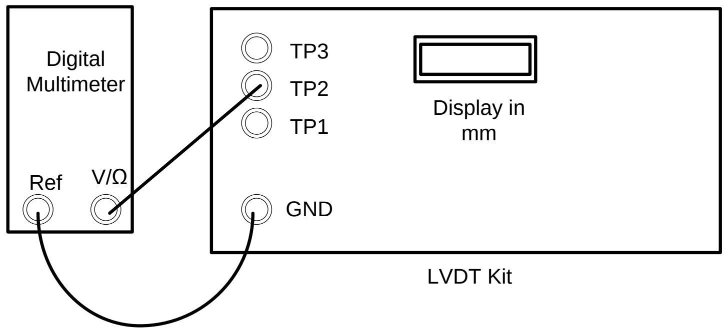
AIM:

Measurement of displacement using linear variable differential transformer (LVDT).

APPARATUS:

(1) LVDT kit
(2) Multi Meter

CIRCUIT DIAGRAM:



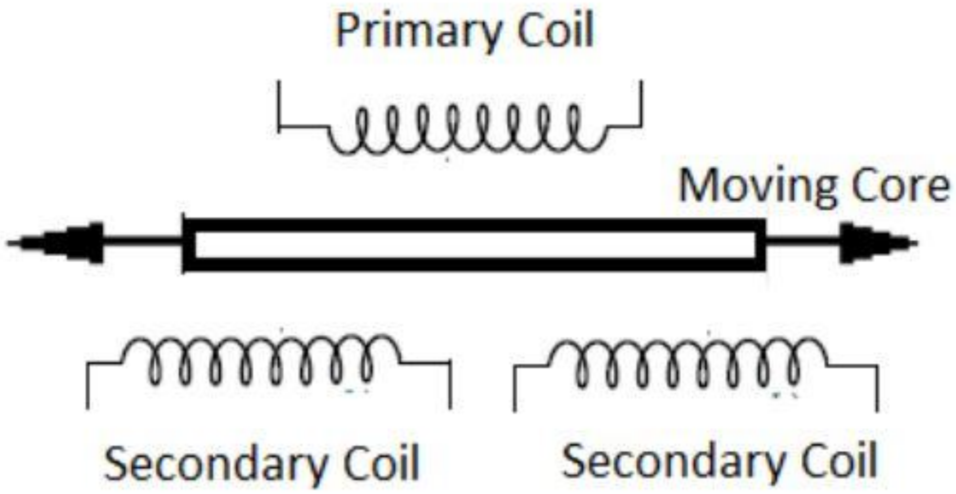
THEORY:

The linear variable differential transformer is a position sensing device that provides an AC output voltage proportional to the displacement of its core passing through its windings. LVDTs provide linear outputs for small displacements where the core remains within the primary coils. The exact distance is a function of the geometry of the LVDT.

An LVDT is much like any other transformer in that it consists of a primary coil, secondary coils and a magnetic core. An AC current, known as the carrier signal, is produced in the primary coil. The changing current in the primary coil produces a varying magnetic field around the core. This magnetic field induces an AC voltage in the secondary coils that are in proximity to the core. As with any transformer, the voltage of the induced signal in the secondary coil is linearly related to the number of coils.

The basic transformer relation is $\frac{V_{out}}{V_{in}} = \frac{N_{out}}{N_{in}}$

TITLE: MEASUREMENT OF DISPLACEMENT USING LVDT	GPRECD/EEE/EXPT-EM-9 Date: 20-09-2021`



As the core is displaced the number of coils in the secondary coil exposed to the coil changes linearly. Therefore the amplitude of the induced signal varies linearly with displacement. The LVDT indicates direction of displacement by having the two secondary coils whose outputs are balanced against one another. The secondary coils in an LVDT are connected in the opposite sense (one clockwise, the other counter clockwise). Thus when the same varying magnitude field is applied to both secondary coils, their output voltages have the same amplitude but differ in sign. The outputs from the two secondary coils are summed together, usually by simply connecting the secondary coils together at a common center point. At an equilibrium position (generally zero displacement) a zero output signal is produced. The induced AC signal is then demodulated so that a DC voltage that is sensitive to the amplitude and phase of the AC signal is produced.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Switch on the supply, keep the instrument in ON position for 15 minutes for initial warm up.

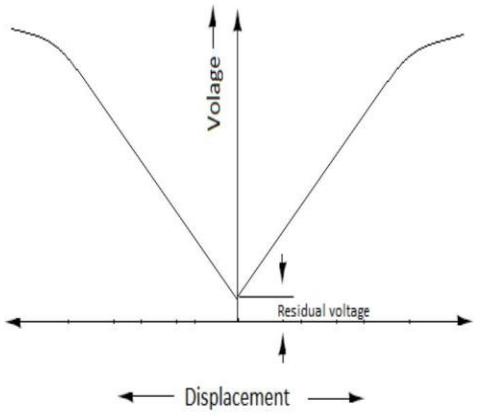
3. Move the LVDT transformer core to 0.00 mm (zero) position and adjust the MIN potentiometer to display zero on the LVDT trainer kit.
4. Move the LVDT transformer core to 20.00 mm (right side) position and adjust the MAX potentiometer to display 20 on the LVDT trainer kit.
5. Move back the LVDT transformer core to 0.00 mm (zero) position and adjust once again the MIN potentiometer to display zero on the LVDT trainer kit. Now the instrument is calibrated for 20mm range.
6. Move the LVDT transformer core in steps of 2mm on both sides and tabulate the readings of LVDT core distance from center position, LVDT trainer kit display value and multimeter readings.
7. Plot the graph voltage vs displacement.

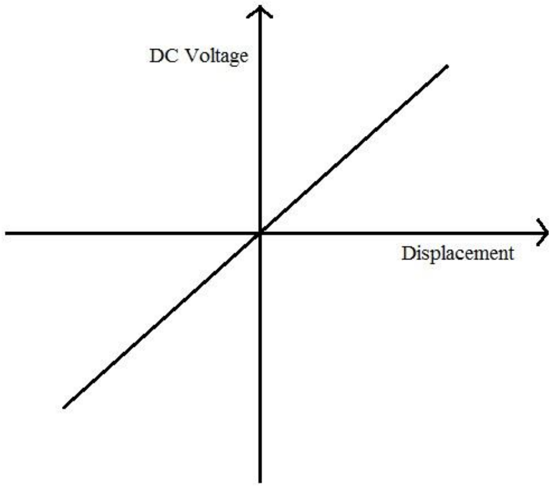
TABULAR COLUMN:

Sl. No	LVDT core distance from center position (mm)	LVDT trainer kit display (mm)	multimeter readings(V)	
			AC Vol	DC Vol

TITLE: MEASUREMENT OF DISPLACEMENT USING LVDT	GPRECD/EEE/EXPT-EM-9 Date: 20-09-2021`

SAMPLE GRAPH:





RESULT:

Measured the displacement using linear variable differential transformer.

TITLE: MEASUREMENT OF DISPLACEMENT USING LVDT	**GPRECD/EEE/EXPT-EM-9** **Date: 20-09-2021`**

Viva Questions:

1. Define Transducer and Give an example?
   Ans: Transducer is a device which converts one form of energy into electrical energy. A thermocouple converts heat energy into electrical voltage.
2. List the factors responsible in selection of a transducer?
   Ans: 1.Operating principle 2.Sensitivity
   3.Operating range. 4. Accuracy.
3. What is LVDT?
   Ans: The Linear Variable Differential Transformer (LVDT) is the most common mutual inductance element. This can be considered to be a versatile transducer element for most of the electromechanical measuring systems with regards to resolution, hysteresis, dynamic response, temperature characteristics, linearity and life.
4. Which of the following is not a characteristic of ideal transducer?
   a) High dynamic range b) Non Linear c) High repeatability d) Low noise

   Ans: b
   Explanation: An ideal transducer should show high linearity. A linear system should produce exact output according to input.

5. Which of following represent active transducer?
   a) Strain gauge b) Thermistor c) LVDT d) Thermocouple

   Ans: d
   Explanation: Active transducers are self-generating type; they don't require external power to work while passive transducers require external power to work.

6. What is the principle of operation of LVDT?
   a) Mutual inductance b) Self-inductance c) Permanence d) Reluctance
   Ans: a
   Explanation: Linear variable differential transformer (LVDT) is type of transformer used for measuring displacement, and it has same principle of operation of transformer.

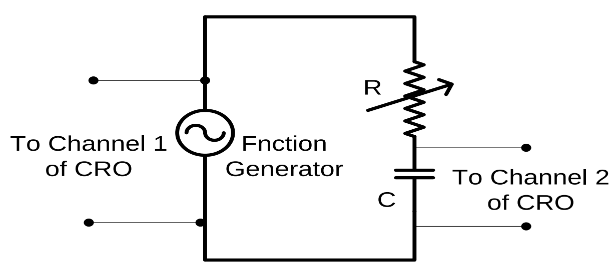
TITLE: STUDY OF CRO **GPRECD/EEE/EXPT-EM-10**
Date: 20-09-2021

AIM: To measure amplitude and frequency of a given waveform using a calibrated cathode ray oscilloscope and to make use of Lissajous Figures for phase and frequency measurements.

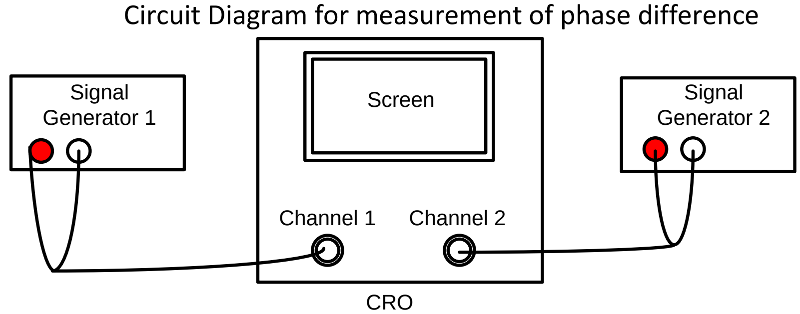
APPARATUS:

S.No.	NAME	RANGE	NO'S REQUIRED
1	CRO		1
2	Function Generator		2
3	Variable Resistance	0-150Ω	1
4	Capacitor	50μF	1
5	Inductor	150mH	1

CIRCUIT DIAGRAM:



Circuit Diagram for measurement of phase difference



Circuit diagram for measurement of Unknown frequency

TITLE: STUDY OF CRO	GPRECD/EEE/EXPT-EM-10 Date: 20-09-2021

THEORY:

Measurement of Voltage Using CRO:

A voltage can be measured by noting the Y deflection produced by the voltage; using this deflection in conjunction with the Y-gain setting, the voltage can be calculated as follows

V = (no. of Divisions) x (selected Volts/Division scale)

Measurement of Current Using a CRO:

Using the general method, a correctly calibrated CRO can be used in conjunction with a known value of resistance R to determine the current I flowing through the resistor.

$$I = V/R$$

Measurement of Frequency Using a CRO:

A simple method of determining the frequency of a signal is to estimate its periodic time from the trace on the screen of a CRT. To calculate the frequency of the observed signal, one has to measure the period, i.e. the time taken for 1 complete cycle, using the calibrated sweep scale. The period could be calculated by

T = (number of Divisions on X - Axis) x (selected Time/Division scale)

Once the period T is known, the frequency is given by

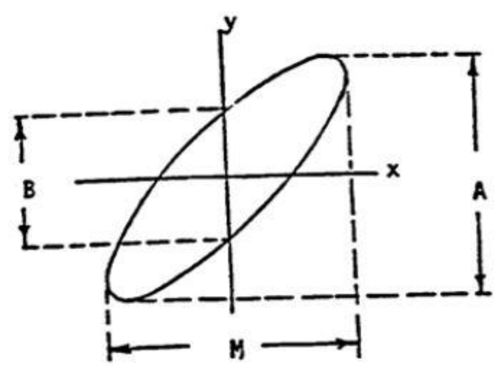
f (Hz)= 1/T(sec)

Use of Lissajous Patterns to Calculate Phase Shift:

Lissajous patterns are obtained on the scope simultaneously by applying the two sinusoidal inputs to be compared at the vertical and horizontal channels. The phase shift is then determined using measured values taken from resulting Lissajous pattern. When both applied waveforms are sinusoidal, the resulting Lissajous pattern may take many forms depending upon the frequency ratio and phase difference between the waveforms. Lissajous patterns for sinusoids of the same frequency, but varying phase relationships are shown below.

Figure.1 Lissajous patterns for phase difference 0°, 45° and 90° respectively

Let consider signals which are applied on CRO channels are $v_x = V_x \sin(\omega t)$ and $v_y = V_y \sin(\omega t + \theta)$ and the resultant lissaous figure is shown in below figure (Remember, this is valid only for signals for which $f_y = f_x$). The phase difference is $\theta = \sin^{-1}[B/A]$.



Use of Lissajous Patterns for Frequency Measurements:

Signal generator is connected to the vertical channel (or horizontal) and the calibrated signal source is fed to the horizontal channel (or vertical). The frequency of the signal generator is adjusted so that a steady Lissajous pattern is obtained. To determine the frequency ratio, draw horizontal and vertical lines through the lissaous figure. The ratio of the number of horizontal axis crossings to the number of vertical axis crossings determines the frequency ratio. This ratio is given as

$$\frac{f_y}{f_x} = \frac{Number\ of\ Horizantal\ crossings}{Number\ of\ \text{Vertical}\ crossings}$$

PROCEDURE:

i) Measurement of voltage and frequency:

1. Apply a random AC voltage to the CRO with the help of function generator.
2. Calculate the voltage magnitude of the applied waveform using number of divisions on Y – Axis of CRO.
3. Measure frequency of the applied wave form using number of divisions on X – Axis of CRO.
4. Repeat step 1 and 3 for three different input voltags.

Measurement of phase displacement using lissajous figure:

5. Make the connections as shown in the circuit diagram.
6. Keep the rheostat in minimum position.
7. By varying the rheostat note down the no of divisions of (X_1, Y_1) and (X_2, Y_2) using lissaous figure on CRO.
8. Calculate the value of phase displacement.

Measurement of unknown frequency using lisajous figure:

9. Connect the two function generator outputs to CRO channel 1 (Y- axis) and 2 (X - axis) respectively.
10. Apply a random (unknown) frequency with the help of function generator 2 on CRO channel 2 (X - axis).
11. Vary the frequency of function generator 1 till a steady lissaous pattern is obtained on CRO screen.
12. Note down the maximum number of interactions along X axis (N_x) and Y axis (N_y).

13. Repeat steps 10 to 12 for different unknown frequncies.
14. With the help N_x, N_y anf f_y calculate the unknown frequency of function generator 2 (f_x).

TABULAR COLUMN:

S.No	No of Divisions on Y axis	Y – Axis Scale Setting (Vol/div)	Voltage Magnitude (V)	No of Divisions on X - axis	X – Axis Scale Setting (time/div)	Time Period (sec)	Frequency (Hz)
1.							
2.							
3.							

Table for measurement of Voltage and Frequency

S.No	No of Divisions on X - axis		No of Divisions on Y axis		Phase Displacement
	X_1	X_2	Y_1	Y_2	
1.					
2.					
3.					

Table for measurement of Phase Displacement

S.No	No of Interactions on		Frequency of waveform on Channel 1 (f_y)	Unknown Frequency on Channel 2 (f_x)
	X axis N_x	Y – Axis N_y		
1.				
2.				
3.				

Table for measurement of Unknown Frequency

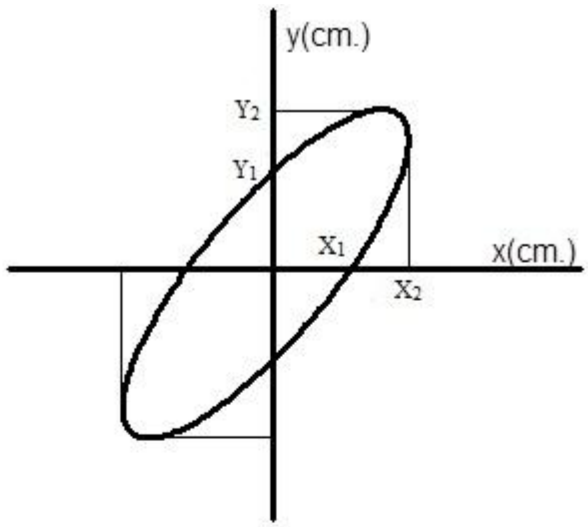
TITLE: STUDY OF CRO	GPRECD/EEE/EXPT-EM-10 Date: 20-09-2021

Formulae:

1. The phase difference is $\theta = \sin^{-1}[X_1/X_2]$ or sin-1 $[Y_1/Y_2]$.

2. $\frac{f_y}{f_x} = \frac{Number\ of\ Horizantal\ crossings(N_x)}{Number\ of\ \text{Vertical}\ crossings(N_y)}$

Sample Graph:



Measurement of Phase Shift

Sample calculations:

RESULT: Measured the Voltage, Frequency, Phase Displacement and Unknown frequency with the help of CRO.

TITLE: STUDY OF CRO	**GPRECD/EEE/EXPT-EM-10** **Date: 20-09-2021**

Viva Questions:

1. In CRO, Electron beam is deflected in

a) 1 direction b) 4 directions c) 3 directions d) 2 directions

Answer: D

Explanation: The electron beam in an oscilloscope can be deflected in two directions, namely the horizontal (x-direction) and the vertical (y-direction). Two dimensional displays are produced as a result.

2. CRO displays:

a) AC signals b) DC Signals c) Both AC and DC Signals d) None

Answer: C

3. CRO uses:

a) Electrostatic deflection b) Magnetic deflection c) Electro- magnetic deflection d) None of the above

Answer: Electrostatic deflection

4. The difference between the spectrum analyser (SA) and CRO is………

Answer: CRO measures time domain signal and SA measures frequency domain

5. Deflection sensitivity of CRO depends on……

Answer: Deflection voltage, separation between the plates and plate length

6. CRO stands for ___________

Answer: Cathode Ray Oscilloscope

7. CRO is voltage measuring device. (True/False)

TITLE: Measurement of Voltage & Curent of a Battery using Arduino	GPRECD/EEE/EXPT-EM-11 Date: 20-09-2021

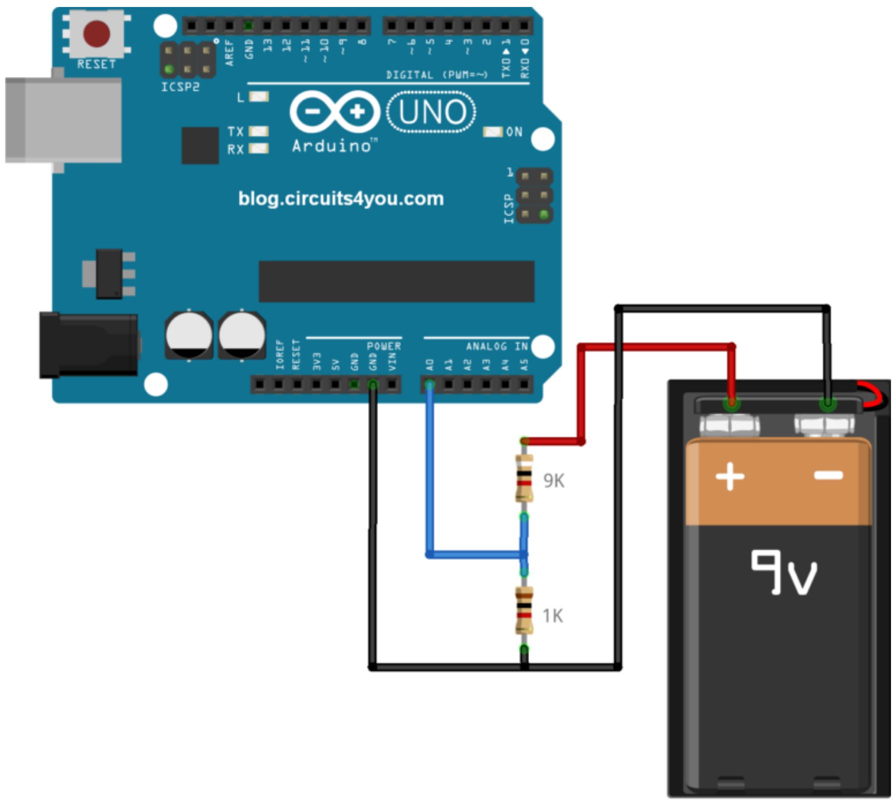
AIM:

To measure the voltage and current of a battery with the help of arduino.

APPARATUS:

(1) Arduino UNO board
2) Two resistors (1KΩ and 9KΩ)
3) Small Bread Board
4) Connecting wires
5) Arduino software
6) Battery/ DC Voltage Source

CIRCUIT DIAGRAM:



TITLE: Measurement of Voltage & Curent of a Battery using Arduino	**GPRECD/EEE/EXPT-EM-11 Date: 20-09-2021**

THEORY:

Voltage measurement is the simplest task that we can perform using Arduino internal ADC.

Arduino internal ADC reference voltage is 5V (V_{ref} = 5V) so maximum voltage that we can measure without using external circuit is 5V. It is having 10-bit resolution, 2^{10}=1024 values for 0 to 5V scale. 0V corresponds to 0 ADC reading and 5V corresponds to 1023. Single ADC value represents 4.88mV i.e 1=4.88mV.

To measure higher voltages than 5V we need external voltage divider to match the ADC requirements. It converters required measurement voltage in to 0 to 5V scale. It can be created using two resistors as shown in below figure. Here we are measuring 0 to 50V DC. In this example battery is used as voltage source to be measured you can measure maximum 50V DC.

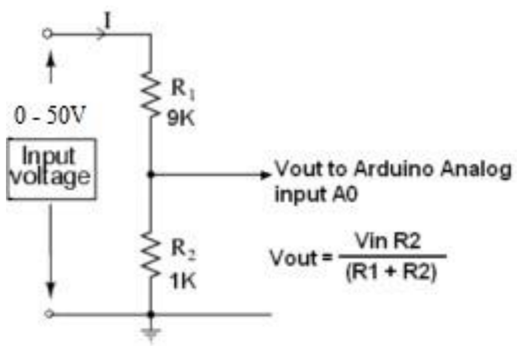
Voltage = ADC_value x (V_{ref}/1024) x Division Factor

Where:

Vref=5V

ADC_Value is AnalogRead integer

Division Factor is voltage divider ratio = Vin/Vout



Using smaller resistor values in voltage divider circuit affects the voltage measurement. Use higher values of resistors for better accuracy and avoid ***Loading Effect***.

Current through divide circuit:

TITLE: Measurement of Voltage & Curent of a Battery using Arduino	GPRECD/EEE/EXPT-EM-11 Date: 20-09-2021

The current through an element can be found by using ohm's law.

I = V/R

Where, V is voltage across a resistive element

R is Resistance value

We ust got voltage across the 1KΩ, using above formula we can find current through the circuit.

PROCEDURE:

1. Select the appropriate values of voltage divider resistive elements based on voltage of a battery
2. Connect the circuit as shown in the circuit diagram.
3. Write the program to measure the voltage of a battery and current through the divider circuit in Arduino sketch.
4. Compile the program.
5. Upload the program in to arduino kit.
6. To monitor the voltage and current values open serial monitor in arduino software.

Program:

TITLE: Measurement of Voltage & Curent of a Battery using Arduino	**GPRECD/EEE/EXPT-EM-11 Date: 20-09-2021**

Observations/ Serail Monitor:

RESULT:

Voltage of a given battery is measured with the help pf Arduino board.

TITLE: Measurement of humidity using Arduino	GPRECD/EEE/EXPT-EM-12-B Date: 20-09-2021

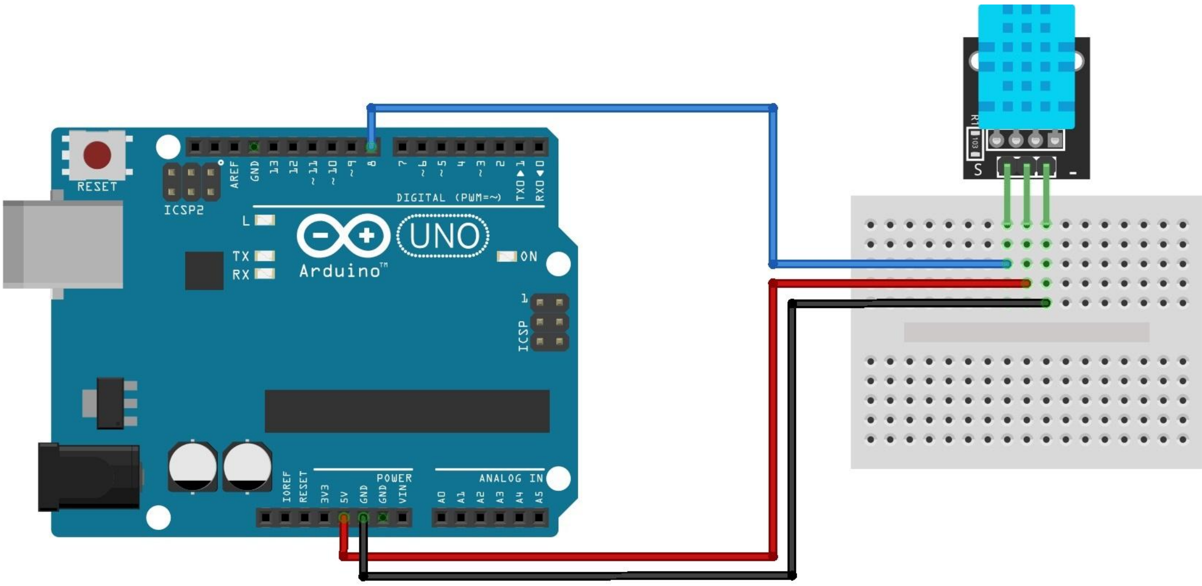
AIM:

To measure humidity of surounding atmosphere with the help of arduino.

APPARATUS:

(1) Arduino UNO board
2) DHT11 humidity Sensor
3) Small Bread Board
4) Connecting wires
5) Arduino software

CIRCUIT DIAGRAM:



THEORY:

HUMIDITY SENSING – CLASSIFICATION & PRINCIPLES

According to the measurement units, humidity sensors are divided into two types: Relative humidity (RH) sensors and absolute humidity (moisture) sensors. Most humidity sensors are relative humiditysensors and use different sensing principles.

Sensors based on capacitive effect

Humidity sensors relying on this principle consists of a hygroscopic dielectric material sandwiched between a pair of electrodes forming a small capacitor. Most capacitive sensors use a plastic or polymer as the dielectric material, with a typical dielectric constant ranging from 2 to 15. In absence of moisture, the dielectric constant of the hygroscopic dielectric material and the sensor geometry determine the value of capacitance. At normal room temperature, the dielectric constant of water vapor has a value of about 80, a value much larger than the constant of the sensor dielectric material.

Sensors based on Resistive effect

Resistive type humidity sensors pick up changes in the resistance value of the sensor element in response to the change in the humidity.

DHT11 Sensor:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It’s fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old. Compared to the DHT22, this sensor is less precise, less accurate and works in a smaller range of temperature/humidity, but its smaller and less expensive Comes with a 4.7K or 10K resistor, which you will want to use as a pullup from the data pin to VCC.

Technical Specifications:

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy

- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm

DHT11 humidity Sensor

PROCEDURE:

1. Connect the circuit as per the circuit diagram.

   A) GND pin of DHT11 sensor has to be connected GND pin of Arduino board.

   B) VCC pin of DHT11 sensor has to be connected 5V pin of Arduino board.

   C) DATA pin of DHT11 sensor has to be connected to any analog/ digital pin of Arduino board depending upon our program.

2. Write the program to measure the humidity of atmosphere in Arduino sketch.

3. Compile the program.

4. Upload the program in to arduino kit.
5. To monitor the humidity values open serial monitor in arduino software.

Program:

Observations/ Serail Monitor:

RESULT:

Atmospheric humidity measurement is done with the help pf Arduino and DHT11 sensor.

TITLE: Measurement of Temperature using Arduino	**GPRECD/EEE/EXPT-EM-12-A Date: 20-09-2021**

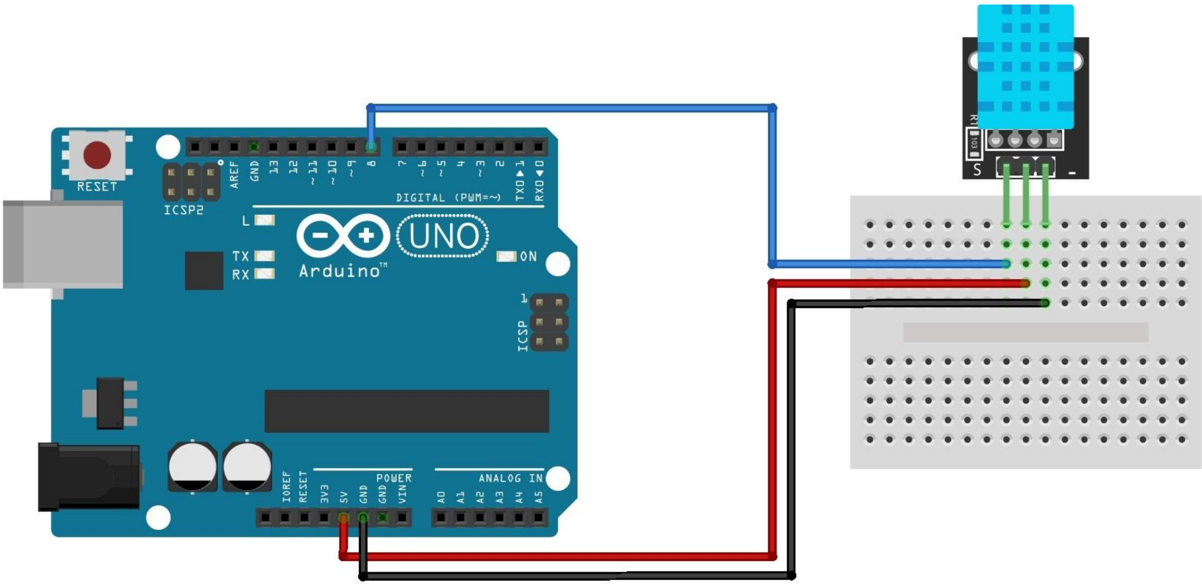
AIM:

To measure the atmospheric temperature with the help of arduino.

APPARATUS:

(1) Arduino UNO board
2) DHT11 Temperature Sensor
3) Small Bread Board
4) Connecting wires
5) Arduino software

CIRCUIT DIAGRAM:



THEORY:

Measurement of temperature:
The most commonly used type of sensors are those which detect **Temperature** or heat. These types of temperature sensors vary from simple ON/OFF thermostatic devices which control a

domestic hot water system to highly sensitive semiconductor types that can control complex process control plants. There are different types of **Temperature Sensors** available and all have different characteristics depending upon their actual application.

Types of temperature sensors:

Thermistor

The Thermistor is another type of temperature sensor, whose name is a combination of the words THERM-ally sensitive res-ISTOR. A thermistor is a type of resistor which changes its physical resistance with changes in temperature.

Thermocouple

The Thermocouple is by far the most commonly used type of all the temperature sensing devices due to its simplicity, ease of use and their speed of response to changes in temperature.Thermocouples also have the widest temperature range of all the temperature sensors from below -200^oC to well over 2000^oC. Thermocouples are thermoelectric sensors that basically consist of two junctions of dissimilar metals, such as copper and constantan that are welded or crimped together. One junction is kept at a constant temperature called the reference (Cold) junction, while the other the measuring (Hot) junction. When the two junctions are at different temperatures, a voltage is developed across the junction which is used to measure the temperature.

DHT11 Sensor:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old. Compared to the DHT22, this sensor is less precise, less accurate and works in a smaller range of temperature/humidity, but its smaller and less expensive comes with a 4.7K or 10K resistor, which you will want to use as a pullup from the data pin to VCC.

Technical Specifications:

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy

- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm

DHT11 humidity Sensor

PROCEDURE:

1. Connect the circuit as per the circuit diagram.

   A) GND pin of DHT11 sensor has to be connected GND pin of Arduino board.

   B) VCC pin of DHT11 sensor has to be connected 5V pin of Arduino board.

   C) DATA pin of DHT11 sensor has to be connected to any Analog/ Digital pin of Arduino board depending of our program.

2. Write the program to measure the Temperature of atmosphere in Arduino sketch.

3. Compile the program.

4. Upload the program in to arduino kit.
5. To monitor the Temperature values open serial monitor in arduino software.

Program:

Observations/ Serail Monitor:

RESULT:

Atmospheric Temperature measurement is done with the help pf Arduino and DHT11 sensor.

TITLE: Measurement of distance of the Object using Arduino	**GPRECD/EEE/EXPT-EM-13 Date: 20-09-2021**

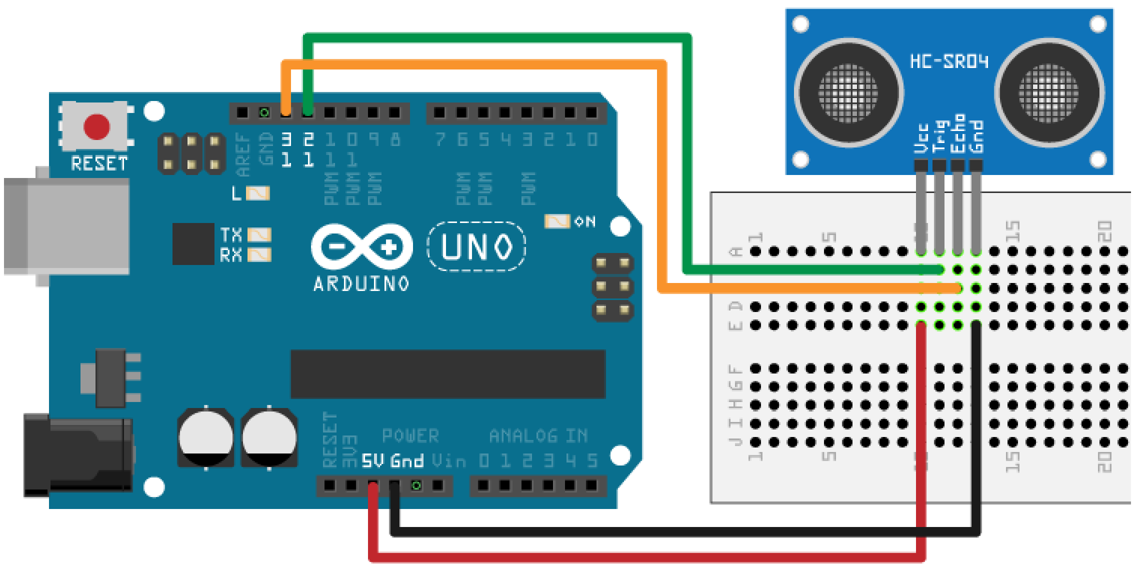
AIM:

To measure the distance of the object from the sensor with the help of arduino.

APPARATUS:

(1) Arduino UNO board
2) Ultrasonic Sensor HC-SR04
3) Small Bread Board
4) Connecting wires
5) Arduino software
6) LCD
7) Two LEDs
8) Two resistors 10KΩ each

CIRCUIT DIAGRAM:

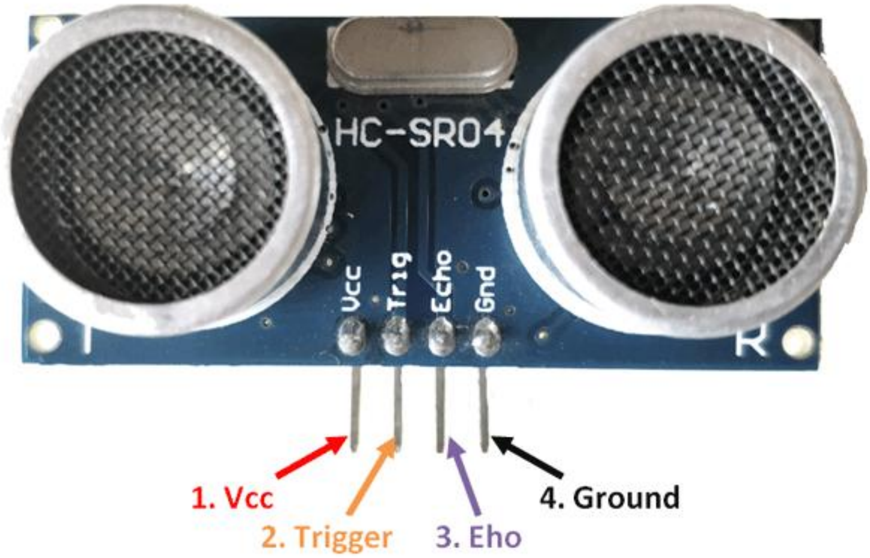


TITLE: Measurement of distance of the Object using Arduino	**GPRECD/EEE/EXPT-EM-13** **Date: 20-09-2021**

THEORY:

The **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively.

Pin Number	**Pin Name**	**Description**
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending Ultrasonic wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the Ultrasonic wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.



TITLE: Measurement of distance of the Object using Arduino	GPRECD/EEE/EXPT-EM-13 Date: 20-09-2021

This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple formula that

Distance = Speed * Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the picture below.

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave, we know the universal speed of Ultrasonic wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the Ultrasonic wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller or microprocessor.

HC-SR04 Sensor Features:

Operating voltage: +5V

Theoretical Measuring Distance: 2cm to 450cm

Practical Measuring Distance: 2cm to 80cm

TITLE: Measurement of distance of the Object using Arduino	**GPRECD/EEE/EXPT-EM-13** **Date: 20-09-2021**

Accuracy: 3mm

Measuring angle covered: <15°

Operating Current: <15mA

Operating Frequency: 40Hz

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
   A) GND pin of HC-SR04 sensor has to be connected GND pin of Arduino board.
   B) VCC pin of HC-SR04 sensor has to be connected 5V pin of Arduino board.
   C) Trig and Echo pins of HC-SR04 sensor can be connected to two digital pins (0-13) of Arduino board depending of our program.
2. Write the program to measure the distance of the object in Arduino sketch.
3. Compile the program.
4. Upload the program in to arduino kit.
5. To monitor/obseve the distance values, open serial monitor in arduino software.

Program:

TITLE: Measurement of distance of the Object using Arduino	**GPRECD/EEE/EXPT-EM-13 Date: 20-09-2021**

Observations/ Serail Monitor:

RESULT:

Distance between the sensor and object is measured with the help pf Arduino and HC-SR04 sensor.