Manipal Institute of Technology, Manipal
A Constituent Institution of Manipal Academy of Higher Education
MANIPAL-576104

Department of Instrumentation and Control Engineering

MEASUREMENTS AND TRANSDUCERS
LABORATORY MANUAL-ICE-2162

III SEM. B.Tech.

Name of the Student: …………………………………

Registration Number: ………………………………..

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MANIPAL INSTITUTE OF TECHNOLOGY
(A constituent Institute of Manipal Academy of Higher Education, Manipal)

CERTIFICATE

This is to certify that the Laboratory Manual for the lab titled MEASUREMENTS AND TRANSDUCERS LABORATORY(ICE-2162) submitted by Mr./Ms.________________________________

(Reg. No:________________) of third semester, Electronics and Instrumentation Engineering for the academic year 2021 , as per laboratory course requirements, which has been evaluated and duly certified.

Place: Manipal
Date: **Lab In-Charge**

CONTENTS

Evaluation Plan:

Continuous Evaluation : **60%** (Preparation, Lab performance, Observation book and Regularity)

End Semester Lab Test : **40**

EXPERIMENT NO.1	Date:

VERIFICATION OF SERIES AND PARALLEL RESONANCE

Objective: To observe series and parallel resonance for the given RLC circuit and obtain the frequency response.

Apparatus:

Decade Resistance box, Inductance box, Capacitance box, Digital Multimeter (DMM), NI Elvis board.

Circuit diagram:

(i) **Series Resonance:**

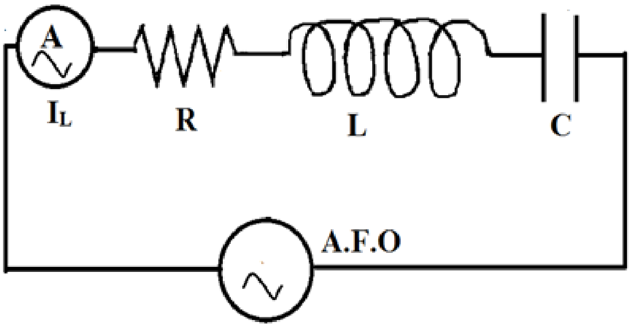


Fig. 1

(ii) **Parallel Resonance:**

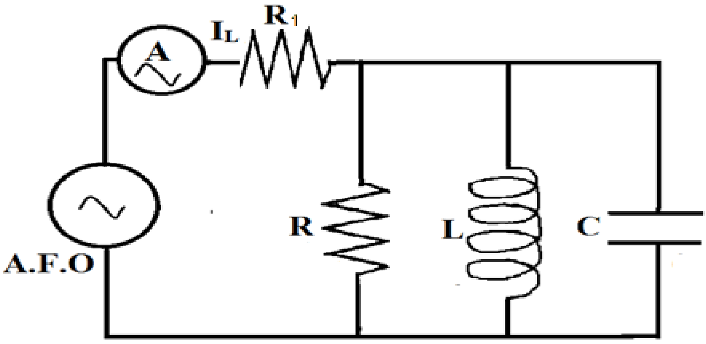


Fig. 2

Formula to be used:

Resonant frequency (theoretically) $F_r = \frac{1}{2\pi\sqrt{LC}}$ K Hz

Procedure:

1) Circuit connection is shown in Fig. 1.
2) Set the input voltage to 3V and maintain it constant throughout.
3) Vary the input frequency and note down the current at every frequency.
4) Calculate values for inductive reactance X_L, Capacitive reactance X_C and net Impedance Z.
5) Plot frequency vs current and frequency vs Impedance graph (refer sample graph).
6) Note down the resonant frequency from the graph and verify it with theoretical resonant frequency.
7) Repeat steps 1 to 7 for parallel resonance using Fig. 2.

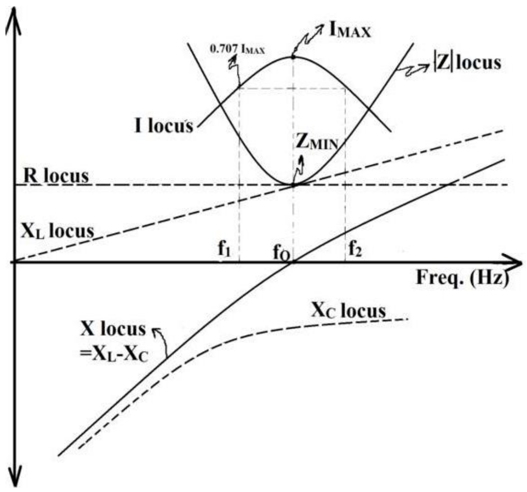


Fig. 3: Series resonance characteristics

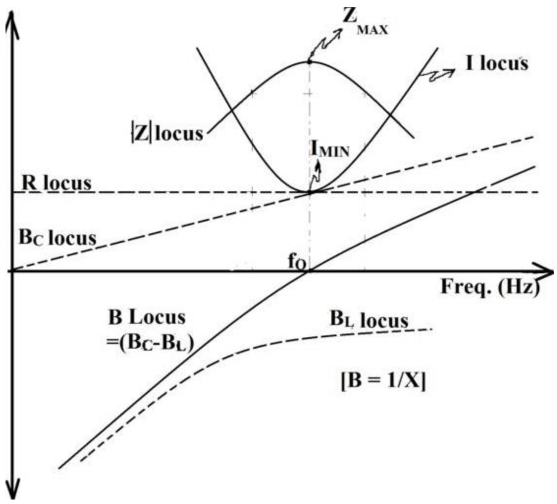


Fig. 4: Parallel resonance characteristics

Tabular column:

Series resonance

Frequency (Hz)	**Current (mA)**	**X_L=2πfL (Ω)**	**X_C=1/2πfC (Ω)**	**Z=|R+j(X_L-X_C)| (Ω)**

Parallel resonance*

Frequency (Hz)	**Current (mA)**	**X_L=2πfL (Ω)**	$X_C = \frac{1}{2\pi f C}$ **(Ω)**	$P = \frac{1}{R} + j\left(\frac{1}{X_L} - \frac{1}{X_c}\right)$ **(℧)**	$Z = \frac{1}{\|P\|}$

Compute resonant frequency, maximum current, minimum current* and bandwidth for given RLC circuits.**Conclusion:**

EXPERIMENT NO. 2	Date:

MEASUREMENT OF INDUCTANCE BY MAXWELL'S BRIDGE

Objective: To measure the a) inductance of the given inductor using Maxwell's bridge,

Apparatus:

Decade Resistance box, Decade Inductance box, unknown inductance, Decade Capacitance box, unknown capacitance, Digital Multimeter, NI Elvis board.

Circuit diagram of Maxwell's bridge:

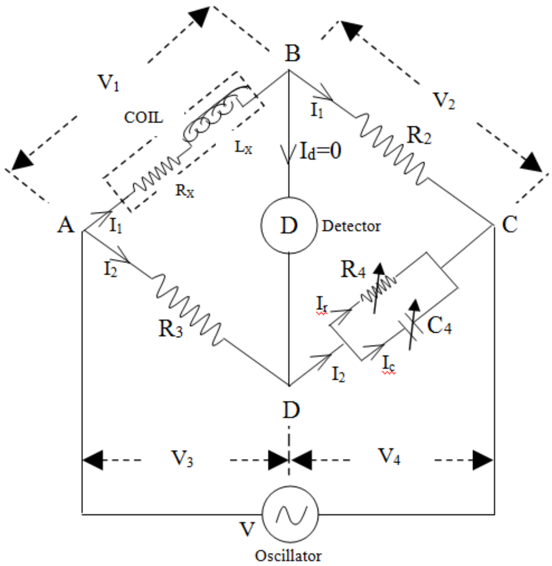


Fig. 1

Procedure:

1. Make the connections as shown in circuit diagram. The given coil of unknown inductance L_X (with internal resistance R_X) is connected in the arm A & B of the bridge. Connect a DC ammeter between the points B & D and apply a DC voltage of 2V across the points A&C from a source.
2. Keeping R_2 & R_3 at some value, vary R_4 to get DC balance condition (ammeter reading zero). [Since L_X is short and C_4 is open in DC, it becomes essentially a Wheatstone bridge]. Find the value of R_X.
3. Replace DC supply by the oscillator and DC ammeter by AC ammeter. Do not disturb R_4 from the DC balance condition.
4. Switch on the oscillator and set the frequency around 1.5 kHz and 3V AC voltage. Vary C_4 to obtain AC balance i.e. minimum amplitude in the AC ammeter.

5. Repeat the experiment for different values set for R_2 & R_3 for the same value of unknown inductance.

Tabular column:

Frequency of supply from Oscillator, 'f' = ____________________ Hz.

Trial No.	R_2 (Ω)	R_3 (Ω)	R_4 (Ω)	C_4 (F)	$R_x = \frac{R_2 \times R_3}{R_4}$ (Ω)	$L_x = R_2 R_3 C_4$ (H)	$Q = \frac{wL_x}{R_x} = wC_4R_4$	Time constant $\tau = \frac{L_x}{R_x}$ (s)	Power factor of coil $\cos\emptyset = \frac{R_x}{\sqrt{R_x^2 + (wL_x)^2}}$

Results:

1) DC resistance of the given coil = ________________ Ω
2) Average self-inductance of the given coil = ________________ H
3) Average Quality factor of the coil = ________________
4) Time constant of the given coil = ________________ sec.
5) Power factor of the given coil = ________________

Conclusion:

EXPERIMENT NO.3	Date:

TORQUE AND FORCE TRANSDUCERS

A. TORQUE TRANSDUCERS

Objective: To study the characteristics of the developed torque due to load applied to the beam and the bridge output in millivolts.

Apparatus:
Torque sensor setup, Weights (100 gram * 10 Nos), Power cord, DMM.

Formula to be used: (for radial distance = 1 meter)

Theoretical torque = mass (m) * acceleration due to gravity (g) * radial distance (x)
= 1 kg * 9.81 m/s^2 * 1m
= 9.81 Nm

Procedure:

1. Install the torque sensor set-up and interface with DMM in millivolts mode.
2. Switch "ON" the module.
3. Connect the analog input node across T2 and T3 for bridge output voltage measurement.
4. First, unload the beam and nullify the bridge output voltage by using zero adjustment POT.
5. By applying load to the beam, torque will be developed on the shaft and measure the bridge output voltage across T2 and T3.
6. Gradually increase the force by applying load and note down the bridge output voltage.
7. Tabulate the readings and plot a graph between torque and bridge output voltage.

Tabular column:

Trial No.	Theoretical Torque (Nm)	Bridge Output Voltage (mV)	
		Loading	Unloading

Compute: Hysteresis, Sensitivity, Range, Linearity

Objective: To study the characteristics of the developing torque and the signal conditioned sensor output voltage (for radial distance = 1 meter).

Apparatus:
Torque sensor setup, Weights (100 gram * 10 Nos), Power cord, DMM.

Formula to be used:

$$\% \, e = \frac{(Actual\ torque - Theoretical\ torque)}{Actual\ torque} \times 100$$

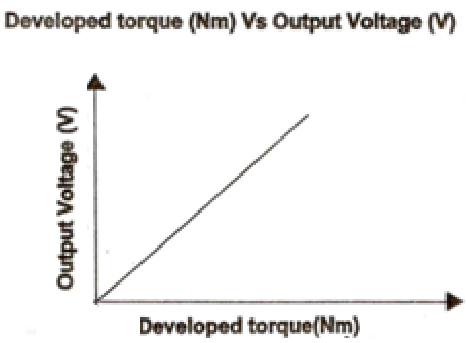
Procedure:

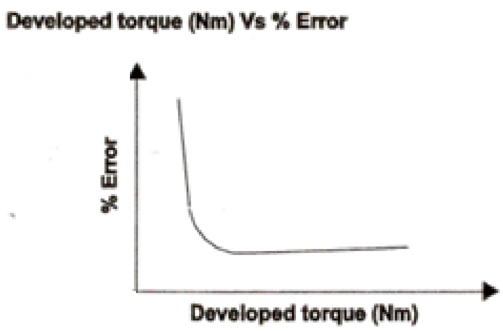
1. Install the torque sensor set-up and Switch “ON” the module.
2. Connect the Multimeter in Volts mode across T5 and GND for sensor voltage measurement.
3. First, unload the beam and nullify the display by using zero adjustment POT.
4. Apply the maximum load of 1kg to the beam and adjust the display to 9.81Nm by using gain adjustment POT.
5. By applying load to the beam, torque will develop on the shaft and measure the signal conditioned sensor output voltage (V) across T5 and GND.
6. Gradually increase the force by applying load and note down the signal conditioned sensor output voltage (V).
7. Tabulate the readings and plot a graph between developed torque versus signal conditioned sensor output voltage (V).

Tabular column:

Trial No.	Theoretical Torque (Nm)	Signal conditioning voltage (V)	Actual Torque (Nm)	% Error

Model graph:





EXPERIMENT NO.4	Date:

MEASUREMENT OF SELF AND MUTUAL INDUCTANCE

Objective: To measure the self and mutual inductances of the given inductive coils

Apparatus:

Voltmeter (DC 0-5V; AC 0-100V)

Ammeter (DC 0-500mA; AC 0-10A)

Terminal Power supply (TPS)

Inductive coils

1 φ Auto transformer

Circuit diagram:

(i) To find DC resistances of the coil:

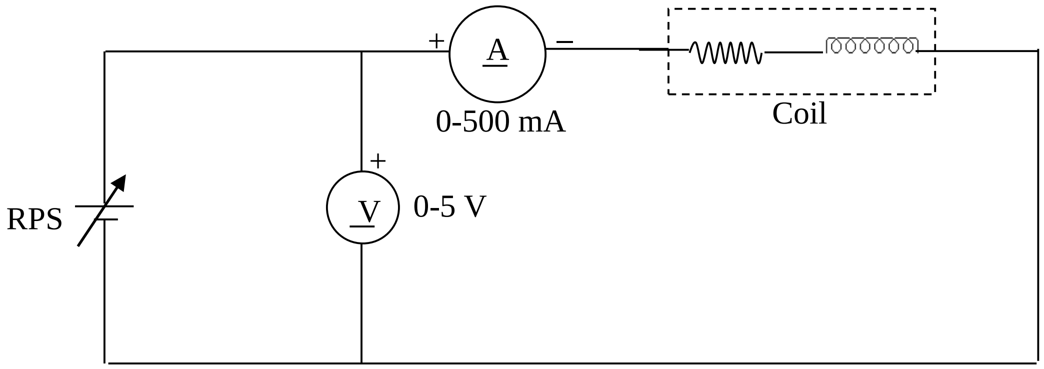


Fig. 1

(ii) To find self-inductances of the coil:

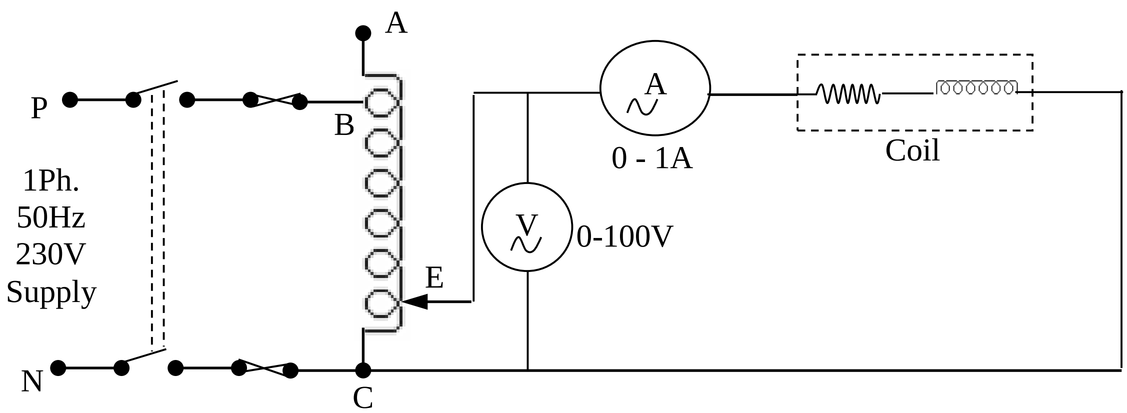


Fig. 2

(iii) To find mutual inductance between the two coils:

a) <u>Series Addition:</u>

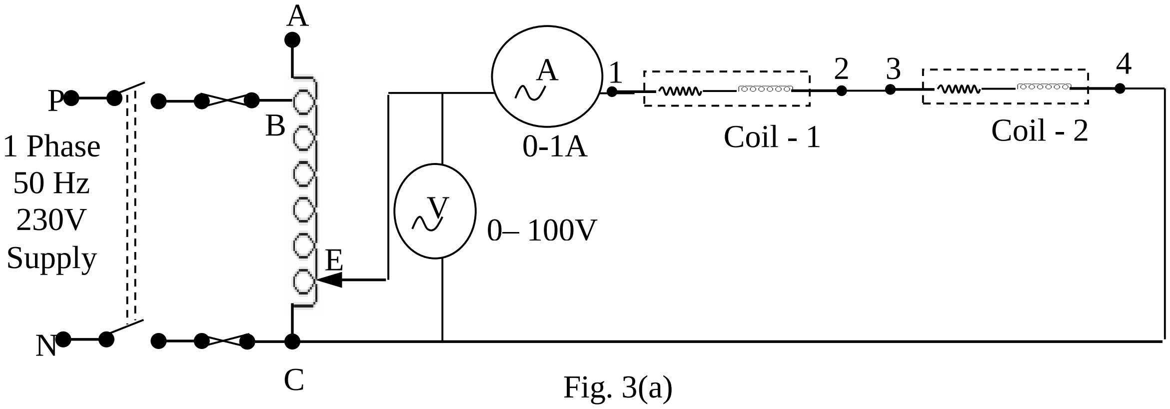


Fig. 3(a)

b) <u>Series Opposition:</u>

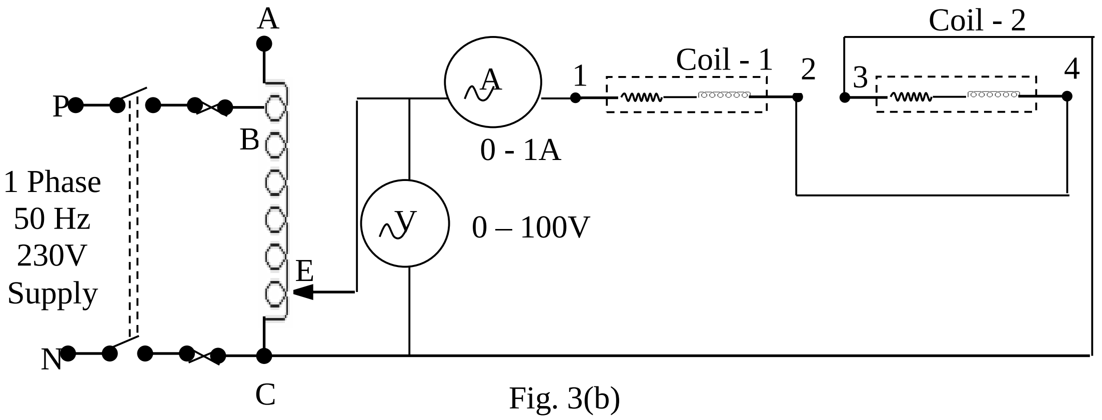


Fig. 3(b)

Procedure:

1. Connect the circuit as shown in Fig. 1.
2. Apply a low voltage DC and note down the DC meter readings to determine DC resistance R_1 of the first coil.
3. Repeat the steps (1) & (2) with the second coil to determine its DC resistance 'R_2'
4. Rig up the circuit as shown in Fig. 2 using coil-1.
5. Keeping the autotransformer in zero output position, switch on the AC supply.
6. Adjusting the autotransformer, apply a reduced voltage and note down the AC. meter readings to calculate the self-inductance L_1 of the first coil.
7. Repeat the steps (4) to (6) with coil-2, to determine its self-inductance 'L_2'.
8. Connect both the coils in series addition, as shown in Fig. 3 (a). Repeat the steps (5) & (6) to determine the reactance 'm_1'. Care must be taken to see that the two coils are co-axial by keeping them exactly one above the other.
9. Connect both the coils in series opposition, as shown in Fig. 3(b) and repeat the steps (5) & (6) to determine the reactance 'm_2'.

Tabulation & calculations:

(i) To find DC resistances of the two coils

COIL - 1			COIL - 2		
V_1 Volts	I_1 Amp	$r_1 = \frac{V_1}{I_1}\ \Omega$	V_2 Volts	I_2 Amp	$r_2 = \frac{V_2}{I_2}\ \Omega$

R_1 = Average of r_1 = ___ Ω ***R_2 = Average of r_2 ___ Ω***

(ii) To find Self inductances of the two coils

COIL - 1				
V_1 Volts	I_1 Amp	$Z_1 = \frac{V_1}{I_1}\ \Omega$	$X_{L1} = \sqrt{Z_1^2 - R_1^2}$ (Ω)	$L_1 = \frac{X_{L1}}{2\pi f}$ (H)

Average self-inductance of coil 1 = ______ H

COIL - 2				
V_2 Volts	I_2 Amp	$Z_2 = \frac{V_2}{I_2}$ (Ω)	$X_{L2} = \sqrt{Z_2^2 - R_2^2}$ (Ω)	$L_2 = \frac{X_{L2}}{2\pi f}$ (H)

Average self-inductance of coil 2 = ______ H

(iii) To find mutual inductance between the two coils

Series Addition			Series Opposition		
$V_1^{'}$ **Volts**	$I_1^{'}$ **Amps**	$Z_1^{'} = \frac{V_1^{'}}{I_1^{'}}\Omega$	$V_2^{'}$ **Volts**	$I_2^{'}$ **Amps**	$Z_2^{'} = \frac{V_2^{'}}{I_2^{'}}\Omega$

Here $Z_1^{'} = \sqrt{(R_1 + R_2)^2 + (X_{L1} + X_{L2} + 2\omega M)^2}$

$\therefore\ X_{L_1} + X_{L_2} + 2\omega M = \sqrt{(Z_1^{'})^2 - (R_1 + R_2)^2}$ = m_1 = __________ (1)

Similarly, $Z_2^1 = \sqrt{(R_1 + R_2)^2 + (X_{L_1} + X_{L_2} - 2\omega M)^2}$

$\therefore X_{L_1} + X_{L_2} - 2\omega M = \sqrt{(Z_2^{'})^2 - (R_1 + R_2)^2}$ = m_2 = __________ (2)

Equations (1) – (2) gives

$4\omega M = m_1 - m_2$

$\therefore$ Mutual inductance 'M' = $\frac{m_1 - m_2}{4\omega} = \frac{m_1 - m_2}{8\Pi f}$ = ___________ H.

Results:

Sl. No.	Parameter	Measured L in H
1	Self-inductance of coil-1	
2	Self-inductance of coil-2	
3	Mutual inductance between the two coils	

Conclusion:

EXPERIMENT NO.5	Date:

PHOTO DEVICES and ERROR ANALYSIS OF SINGLE PHASE ENERGY METER

Objective: To study the characteristics of LDR, photodiode and phototransistor.

Apparatus:

Variable source (0-12V), Photodiode (BPW34), Phototransistor (BPX38), Light Dependent Resistor (LDR), Regulated power supply(0-30V) and DMM.

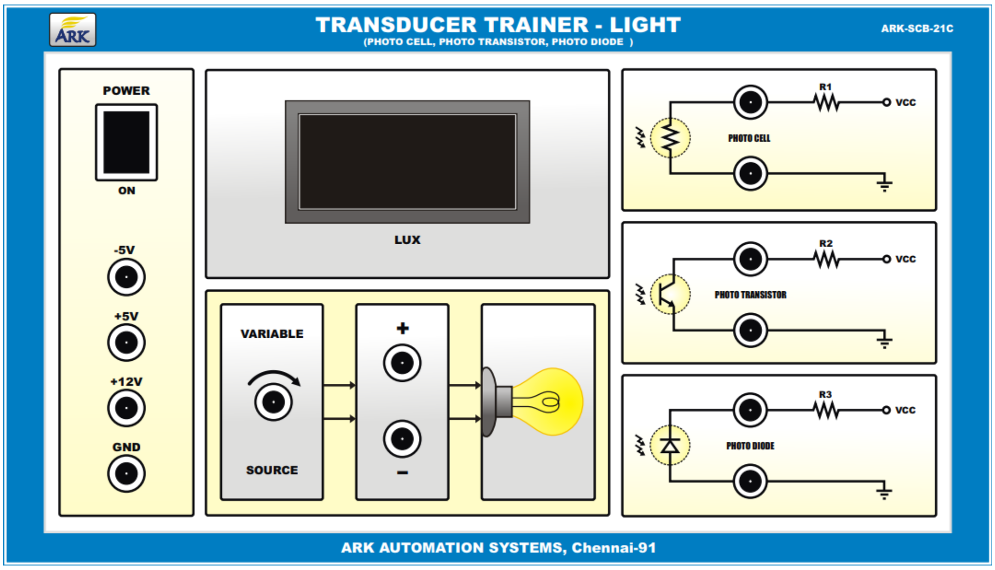


Fig. 1

Procedure:

1. Connect sensor module to board by using connector option provided in the panel as shown in Fig. 1.
2. Keep the switch in Left side to measure the Resistance for LDR.
3. Keep the Variable source knob in maximum position and switch ON the unit.
4. Tabulate the readings by gradually moving the light source knob to measure the corresponding output using Multimeter.
5. Sketch the graph between corresponding output (resistance for LDR and voltage for Photodiode & Phototransistor) Versus distance.
6. Similarly, tabulate the readings by changing Variable source knob with keeping distance as constant.
7. Repeat the steps 3 to 6 for Photodiode and Phototransistor.

Observation:

1. **Measurement of resistance of LDR for change in source displacement and intensity.**

Distance (cm)	Output Resistance (Ω)	
	Up readings	Down readings

Intensity (LUX)	Output Resistance (Ω)	
	Up readings	Down readings

2. **Measurement of voltage in Photodiode for change in source displacement and intensity.**

Distance (cm)	Output Voltage (V)	
	Up readings	Down readings

Intensity (LUX)	Output Voltage (V)	
	Up readings	Down readings

3. **Measurement of voltage in Phototransistor for change in source displacement and intensity.**

Distance (cm)	Output Voltage (V)	
	Up readings	Down readings

Intensity (LUX)	Output Voltage (V)	
	Up readings	Down readings

Compute: Hysteresis, Sensitivity, Range, Linearity for all photo sensors.

Conclusion:

ERROR ANALYSIS OF SINGLE PHASE ENERGY METER

Objective: To study the characteristics of single phase energy meter at unity power factor.

Apparatus:

1 φ Energy meter, AC voltmeter (0-300V), AC ammeter (0-10A), Load, Timer.

Circuit diagram:

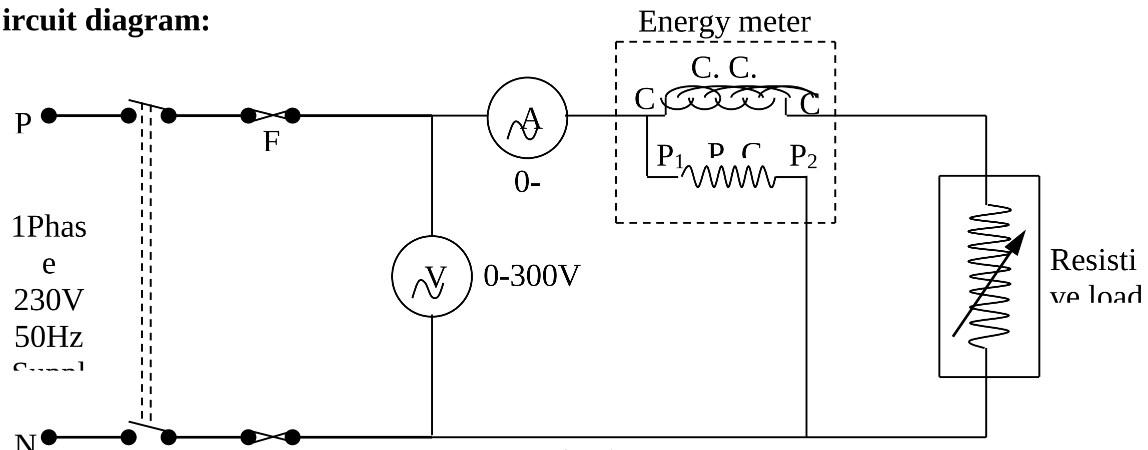


Fig. 1

Procedure:

1. Rig up the circuit as shown in Fig. 1 and note down energy meter constant ‘K’ in revolution/kWh.
2. Switch ON the power supply after circuit connection is verified by faculty in charge.
3. Note down the time for 10 revolutions of the aluminum disc using timer.
4. Determine the true energy & recorded energy for 10 revolutions and find the percentage error.
5. Repeat the experiment for different intermediate loads and plot the % error curve.

Tabular column:

1. Energy Meter constant, K = 600 rev/kWh.

2. Recorded Energy (RE) for 10 revolutions = $\frac{10 \times 3600 \times 1000}{K}$ = _______ watt-sec.

Trial No.	Load current I (A)	Supply Voltage V (V)	Time for 10 revolutions ‘t’ (secs.)	True Energy = (VI cos∅t) (watt secs.)	Percentage error $= \frac{R.E. - T.E.}{R.E.} \times 100$

Conclusion:

EXPERIMENT NO.6	Date:

VERIFICATION OF NETWORK THEOREMS

Objective: To verify (a) Thevenin's theorem and (b) Maximum power transfer theorem, (c) Superposition, and (d) Reciprocity as applied to electric circuits.

Apparatus: Resistances, Decade resistance box, NI Elvis board, DMM.

a) **Verification of Thevenin's theorem:**

   i. ***To find Load current in the circuit:***

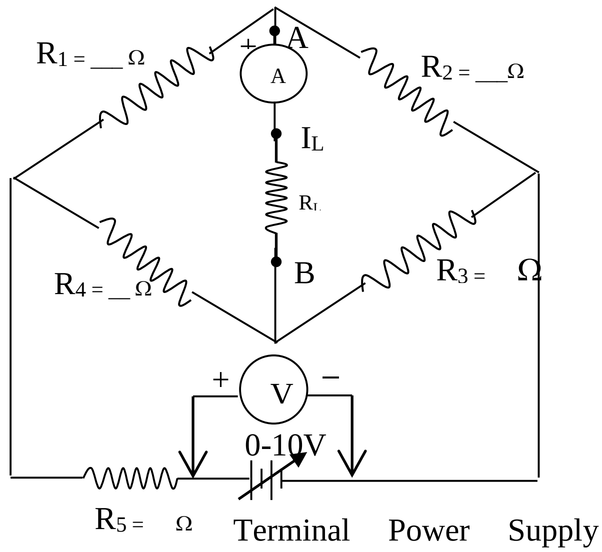


Fig.1(a)

ii. To find load current from Thevenin's equivalent circuit:

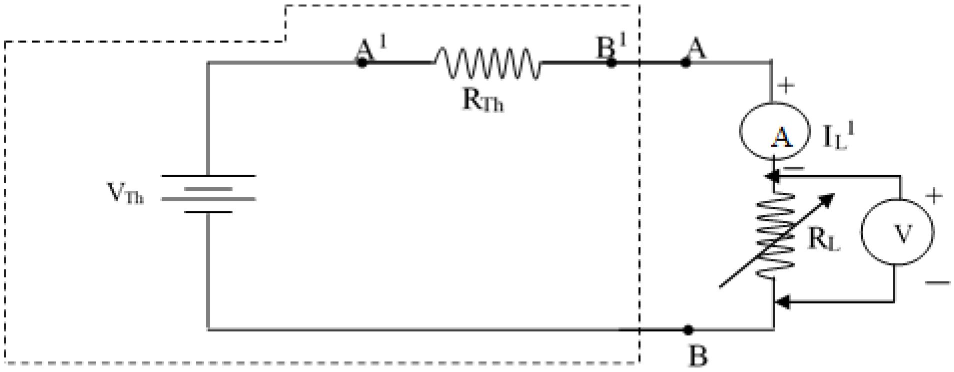


Fig.1(b): Thevenin's Equivalent Circuit

Procedure:

1. Rig up the circuit as shown in Fig. 1(a).
2. Apply a convenient voltage from TPS and note down the load current I_L.
3. Calculate the V_{TH} and R_{TH} for the circuit shown in Fig. 1(a).
4. Rewire the Thevenin's equivalent circuit, as shown in Fig. 1(b), using measured V_{TH} and R_{TH}. Note down the value of load current $I_{L'}$ for the value of V_{Th} obtained from circuit in Fig.1(b).
5. Compare I_L and $I_{L'}$ and comment on the result.

b) Maximum Power Transfer Theorem:

For the circuit shown in Fig. 1(b), replace R_L with decade resistance box and vary the value of resistance measuring corresponding voltage and current across it.

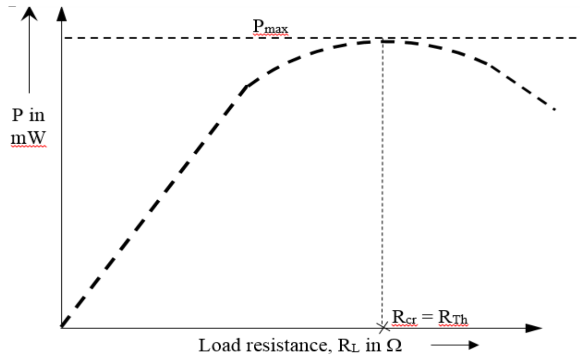
V_{th} = ________ V R_{th} = ________Ω

Trial No.	V (Volts)	$I_{L'}$ in (mA)	$R_L = \frac{v}{I_{L'}}$ (Ω)	$P = (I_{L'}{}^2 R_L)$ (mW)

Verification:

From the below shown graph, find out the value of load resistance R_L corresponding to maximum power as R_{cr}. At maximum power transfer, this particular value of R_L must be equal to equivalent internal resistance of the network as viewed from the output terminals A&B, which will be nothing but the Thevenin's equivalent resistance 'R_{TH}'.

$P_{max} = \frac{{V_{Th}}^2}{4R_{th}} =$ ________Watts.



Specimen curve for Maximum power transfer theorem

c) Superposition theorem:

(i) With both energy sources acting:

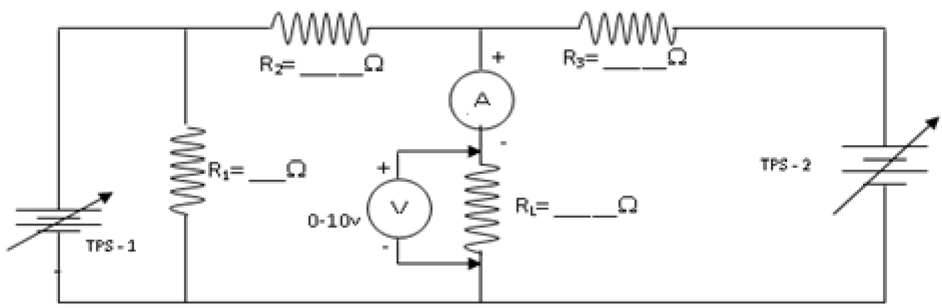


Fig. 2

ii) With only one source acting:

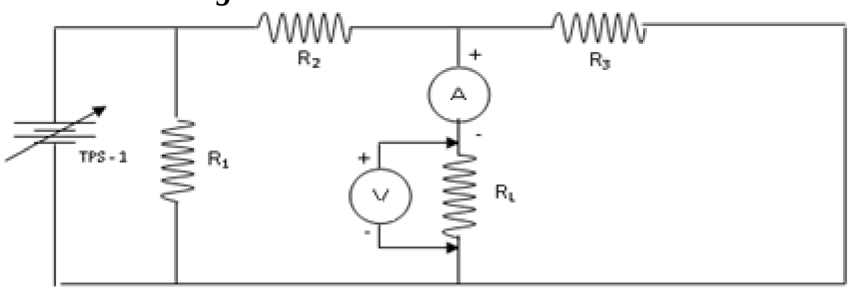


Fig.2(a)

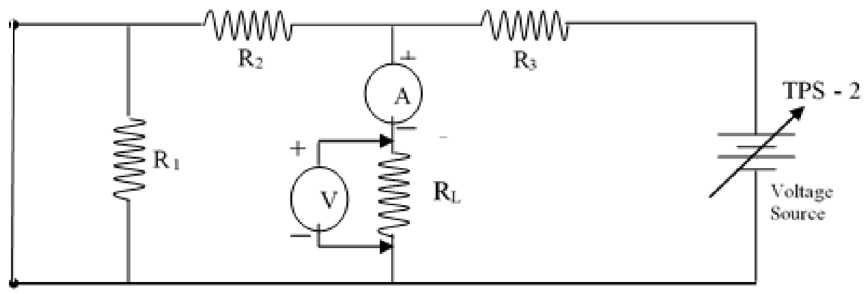


Fig.2(b)

Procedure:

1. Connect the circuit as shown in Fig. 2.
2. Switch on both the voltage sources (TPS-1&2) and set them to convenient values.
3. Note down the current through the load resistance R_L and voltage across it.
4. Repeat the experiment for different voltage settings.
5. Rewire the circuit as shown in Fig. 2(a).
6. Switch on the source 1, set it to previous fixed values and note down the current through & voltage across the load resistance R_L each time.
7. Rewire the circuit as shown in Fig. 2(b) with TPS 2 present.
8. Switch on the voltage source, set it to previous fixed values and each time, note down the current through and voltage across the load resistance R_L.

Tabular column:

Supply voltage		**Both sources acting**		**Source 1 acting**		**Source 2 acting**		**V_1+V_2 (Volts)**	**I_1+I_2 (Amps)**
TPS-1	**TPS-2**	**V (Volts)**	**I (mA)**	**V_1 (Volts)**	**I_1 (mA)**	**V_2 (Volts)**	**I_2 (mA)**		

Verification***:*** Superposition Theorem is verified when $V = V_1 + V_2$ & $I = I_1 + I_2$

d) Reciprocity theorem*:*

Voltage excitation & Current response:

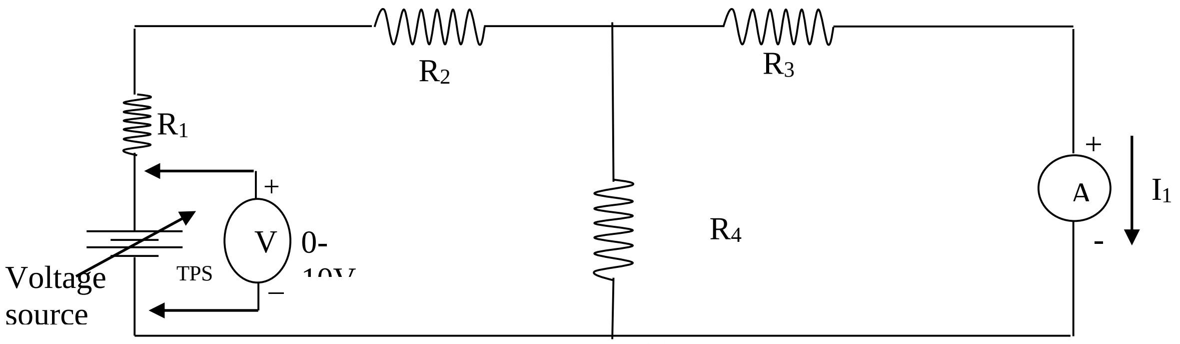


Fig. 3(a)

After exchanging the excitation and response

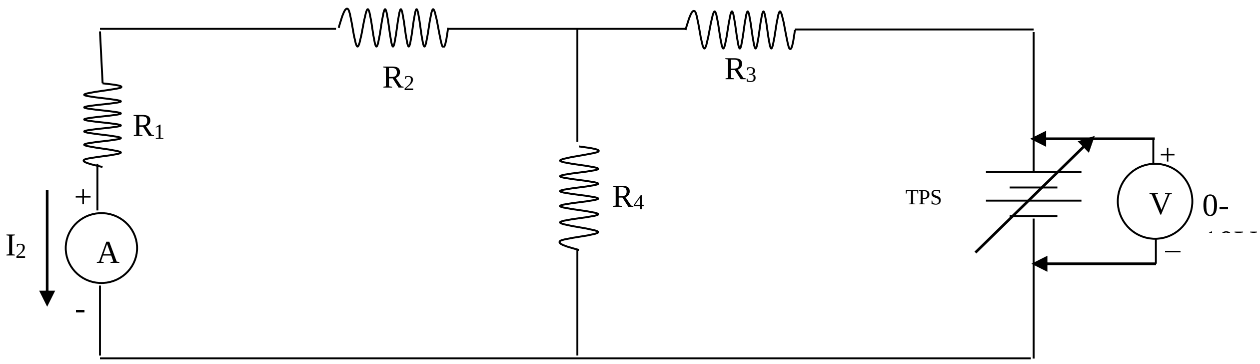


Fig. 3(b)

Procedure:

1. Connect the circuit as shown in Fig. 3(a).
2. Switch on the DC. Supply from Terminal Power Supply (TPS) and adjust it to some convenient value.
3. Note down the ammeter reading as I_1.
4. Repeat the experiment for different fixed values of voltage from TPS.
5. Interchange the positions of excitation and response i.e. the TPS and ammeter, as shown in Fig. 3(b).
6. Note down the ammeter readings (I_2) for different fixed values of voltage from TPS.

Tabular column:

Supply Voltage (TPS)	**Excitation V_1 (Volts)**	**Response I_1 (mA)**	**Excitation V_2 Volts**	**Response I_2 (mA)**	V_1/I_1 Ω	V_2/I_2 Ω

Reciprocity theorem is verified if $\frac{V_1}{I_1} = \frac{V_2}{I_2}$

Conclusion:

EXPERIMENT NO. 7	Date:

TEMPERATURE TRANSDUCERS

Objective: To study the characteristics of thermocouple and Resistance Temperature Detector (RTD) for variation in temperature.

Apparatus:

Thermocouple, RTD, thermometer, water bath with heater, and DMM.

Procedure:

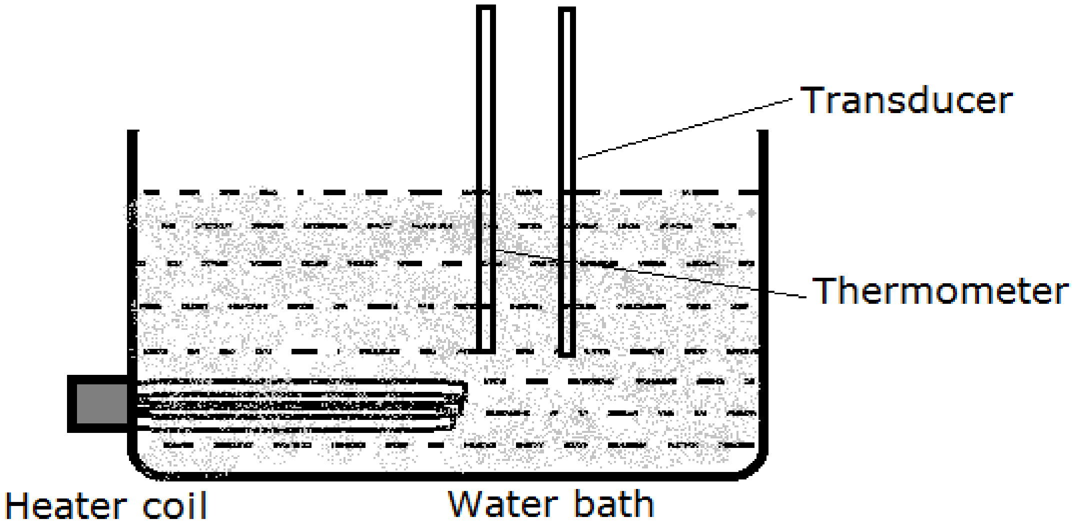


Fig.1

1. Connect the Temperature Transducer to the analog input channel of instrument.
2. Keep the sensor in water bath and start heating the water.
3. Note the temperature of water using glass thermometer.
4. Measure the change in output of transducer corresponding to thermometer reading.
5. Calculate the theoretical output.
6. Plot the graph between temperature and corresponding output.

Perform the same for both the transducers.

Observations:

1. **Measurement of voltage in thermocouple for change in temperature.**

The voltage and temperature relation for a particular thermocouple follow the equation given below:

$$Voltage\ (V) = Seeback\ coefficient\ \times \left[Temperature\ (T) - Ref.Temp.\left(T_{ref}\right)\right]$$

To calculate the theoretical voltage, note the following:

Type of the thermocouple: J -type

Seeback co-efficient for the respective type of thermocouple:54 µv/ºC

Reference temperature(T_{ref}): ___________

<table>
<tr><th rowspan="2">Trial No.</th><th rowspan="2">Temperature (T) ºC</th><th rowspan="2">Theoretical output voltage (mV)</th><th colspan="2">Output voltage (mV)</th></tr>
<tr><th>Up readings</th><th>Down readings</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

2. **Measurement of resistance in RTD for change in temperature.**

The input and output relation for a particular RTD follow the equation given below:

$$R_T = R_{ref}\left[1 + \alpha\left(T - T_{ref}\right)\right]\,\Omega$$

To calculate the theoretical output resistance, note the following:

Resistance of RTD at reference temperature(Rref): _____________

Reference temperature(Tref): _________________

Co-efficient of resistance(alpha): 0.00391

<table>
<tr><th rowspan="2">Trial No.</th><th rowspan="2">Temperature (T) ºC</th><th rowspan="2">Theoretical output resistance (Ω)</th><th colspan="2">Output Resistance (Ω)</th></tr>
<tr><th>Up readings</th><th>Down readings</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Conclusion:

EXPERIMENT NO.8	Date:

LINEAR AND ANGULAR DISPLACEMENT TRANSDUCER

Objective: To analyze the characteristics of Linear Variable Differential Transformer (LVDT), Capacitive transducer, Resistive transducer for variation in displacement.

Apparatus:
Displacement Sensor Panel (MIT2), DMM.

Procedure:

1. Select the required sensor using rotary position switch.
2. Connect the output of respective transducer to the DMM.
3. Move the micrometer towards left and note down the output.
4. Tabulate the output with respect to displacement for each of the transducers and draw the graph.

Tabular column:

Measurement of linear displacement using LVDT

Distance (mm)	Output Voltage (V)	
	Up readings	Down readings

Measurement of linear displacement using potentiometer

Distance (mm)	Output resistance (Ω)	
	Up readings	Down readings

Measurement of linear displacement using capacitive transducer

Distance (mm)	Output capacitance (nF)	
	Up readings	Down readings

Measurement of angular displacement using capacitive transducer

Angle	Output capacitance (nF)	
	Up readings	Down readings

Measurement of linear displacement using ultrasonic transducer

Distance (cm)	Output voltage (V)	
	Up readings	Down readings

Compute: Hysteresis, Sensitivity, Range, Linearity for all the transducers

Conclusion:

EXPERIMENT NO. 9	Date:

Viscosity measurement

Objective:
To measure the Kinematic viscosity of the oil sample.

Apparatus required:
Saybolt Viscosity Equipment, Thermometer, Timer.

Procedure:

1. First use the Saybolt Viscometer to investigate the possible dependence of the viscosity of a Society of Automotive Engineers (SAE) 10w-30-oi1 sample, at room temperature, on the rate of applied shear.
2. Next you are required to measure the viscosity of the oil at 5 different temperatures above "Room Temperature" each at a AT higher than the preceding one.
3. Temperatures should range from "Room Temperature" to a temperature like 90°C.
4. Choose a convenient AT in °C to accomplish this which will allow to calculate the required set-point temperatures need by the constant temperature bath controller.
5. Once the tests with the oil have been completed set the next desired temperature and turn on the controller.
6. The oil level will then begin to fall. Use the electric timer to measure the elapsed time it takes the oil level to fall.
7. Here it is the time required to fill a 60 ml flask located below the viscometer.
8. To start the flow, simply remove the cork at the bottom of the reservoir. At this point start the timer and stop it when the level of the oi1 at the flask reaches the indicator line.
9. Immediately replace the cork so as to stop the flow and prevent the remaining oil in the reservoir from running out.
10. Make sure you wipe off your hands before picking up the flask and pouring its contents back into the reservoir. If the oil level in the reservoir is low add a little new oil before taking the next data value.

Formula to be used:

Fort<100s v-0.00226f –“”5

Fort>100s v =0.00220t—1.35/t

Tabular column:

Trial No.	Temp(^{0}C)	Time’t’(sec)	Kinematic viscosity(Stokes)

B. Characteristics of the Humidity

EXPERIMENT NO. 10	Date:

MEASUREMENT OF CAPACITANCE BY DE-SAUTY BRIDGE

Objective: To measure the b) Capacitance of the given capacitor using De Sauty's bridge.

Apparatus:

Decade Resistance box, Decade Inductance box, unknown inductance, Decade Capacitance box, unknown capacitance, Digital Multimeter, NI Elvis board.

Circuit diagram of De sauty's bridge:

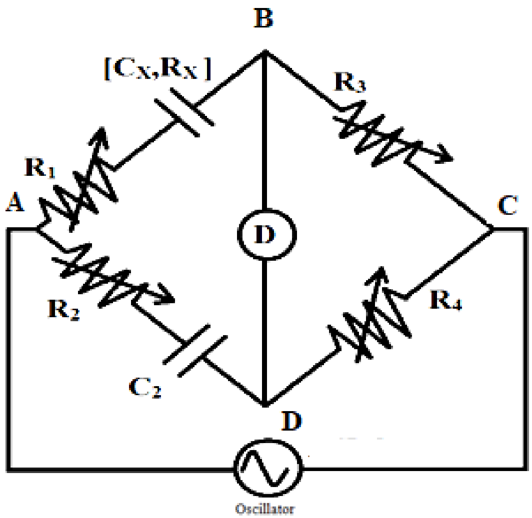


Fig. 2

Procedure:

1. Make the connections as shown in circuit diagram Fig. 2. The given unknown capacitor, C_x is connected in the arm A & B of the bridge.
2. Connect a AC ammeter between the points B & D. Switch on the oscillator and set the frequency around 1.5 kHz and 3V AC voltage.
3. Keep R_3 & R_4 at some ratio (eg. 1 or 0.5), vary R_1 and R_2 to obtain the same ratio as R_3/R_4.
4. Apply an AC voltage of 3V from an oscillator and frequency around 1.5 kHz.
5. Adjust C_2 to get minimum possible current across B and D.
6. Adjust R_2 and R_1 if necessary to get it fine-tuned.
7. Set different set of ratio for R_3 and R_4. Repeat step 3 to step 6 to obtain the value of Cx.

Tabular column:

Frequency of supply from Oscillator, 'f' = ____________________ Hz.

Trial No.	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_4 (Ω)	C_2 (μF)	$R_x = \left(\frac{R_2 \times R_1}{R_4}\right) - R_1$ (Ω)	$C_x = \left(\frac{R_4}{R_3}\right) \times C_2$ (μF)	Dissipation Factor D=ω C_x R_x

Results:

1. DC resistance of the unknown Capacitor = _______________ Ω
2. Capacitance of unknown capacitor = _______________ μF
3. Dissipation factor of the given coil = _______________

Conclusion:

Appendix

Hysteresis: Maximum deviation between upward and downward reading as shown in Fig.1 Hysteresis causes a difference in the output curve of a sensor when the direction of the input has been reversed. Common causes of hysteresis are mechanical strain and friction.

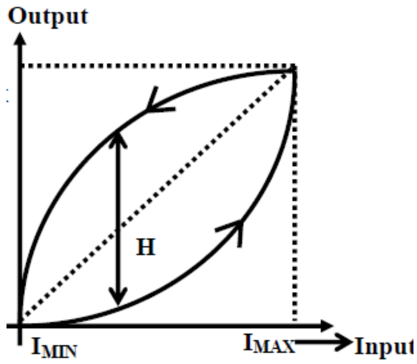


Fig. 1 Hysteresis

Sensitivity: The sensitivity of an instrument refers to its ability to detect changes in the measured quantity. The *sensitivity* is defined as the slope of the calibration curve if the input/output relationship is linear.

Range: Region of measurement. Mention about the input and output operating range

Linearity: max deviation from y =mx

Linearity is actually a measure of nonlinearity of the instrument. The *linearity* is defined as the maximum deviation from the linear characteristics as a percentage of the full scale output

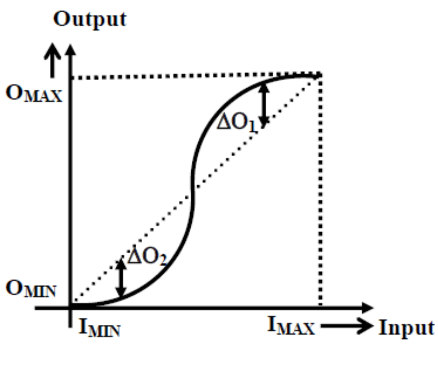


Fig. 2 Linearity

Threshold: Minimum input which produces change in output

Accuracy: Max difference between standard and actual measurement

Resolution: Minimum deviation measured

Precision: Max deviation on repetition