SESHADRIRAO GUDLAVALLERU ENGINEERING

COLLEGESESHADRIRAOKNOWLEDGEVILLAGE::GUDLAVALLER

UDEPARTMENTOFELECTRICALANDELECTRONICSENGINEERING

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LAB

SESHADRIRAO GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTU, Kakinada)
Seshadri Rao Knowledge Village, Gudlavalleru

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision:

To be a pioneer in electrical and electronics engineering education and research, preparing students for higher levels of intellectual attainment, and making significant contributions to profession and society.

Mission:

- To impart quality education in electrical and electronics engineering in dynamic learning environment and strive continuously for the interest of stake holders, industry and society.

- To create an environment conducive to student-centered learning and collaborative research.

- To provide students with knowledge, technical skills, and values to excel as engineers and leaders in their profession.

Program Educational Objectives (PEOs):

PEO1: Graduates will have technical knowledge, skills and competence to identify, comprehend and solve problems of industry and society.

PEO2: Graduates learn and adapt themselves to the constantly evolving technology to pursue higher studies and undertake research.

PEO3: Graduates will engage in lifelong learning and work successfully in teams with professional, ethical and administrative acumen to handle critical situations.

Program Outcomes (POs):

Graduates of the Electrical and Electronics Engineering Program will

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and Modern engineering and IT tools, including prediction and modeling to complex engineering activities, with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognizes the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

1. Apply the knowledge of circuit design, analog & digital electronics to the field of electrical and electronics systems.
2. Analyze, design and develop control systems, industrial drives and power systems using modern tools.

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LIST OF EXPERIMENTS AS PER AUTONOMOUS SYLLABUS

Any 10 of the following experiments are to be conducted:

1. Calibration and testing of single phase energy meter.
2. Kelvin's double bridge – measurement of low resistance.
3. Crompton D.C. potentiometer – calibration of PMMC ammeter.
4. Capacitance measurement using Schering Bridge.
5. Inductance measurement using Anderson Bridge.
6. Measurement of parameters of a choke coil using 3 ammeter method.
7. Measurement of 3 phases reactive power with single-phase wattmeter for balanced loading.
8. Calibration LPF wattmeter – by phantom testing.
9. Dielectric oil testing using H.T. testing kit.
10. LVDT– characteristics and calibration.
11. Resistance strain gauge – strain measurement and calibration.
12. Hall effect sensor.

Any 2 of the following experiments are to be conducted using virtual mode environment:

1. Measurement of self inductance by Owen bridge.
2. Measurement capacitance by Wien series bridge.
3. Q meter experiment-To determine the quality factor of an unknown coil.
4. Measurement of high resistance by Megohm bridge.

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CO – PO & PSO Mapping (R20)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1: develop the fundamental knowledge and demonstrate various electrical measuring instruments.	3	3	2	3	1				2	1		2	2	
CO2: co-relate the theoretical knowledge with the practical electrical measuring system.	3	3	2	2	1				2	1		2	2	
CO3: standardize various measuring instruments with the help of standard meters.	3	3	2	2	2				2	1		2	2	
CO4: measure unknown values of resistance, inductance and capacitance by balancing the bridges.	3	3	3	2	3				2	1		2	2	3
CO5: measure various physical quantities using appropriate transducers.	3	3	3	3	3				2	1		2	3	3

Experiments –CO mapping

Experiment Name	C0 1	C0 2	C0 3	CO 4	C0 5
1.CalibrationandTestingofsinglephaseenergyMeter.	3	3	3		
2.Kelvin'sdoubleBridge–Measurementoflowresistance.	3	3			
3.Crompton D.C. Potentiometer – Calibration of PMMC ammeter	3	3	3		
4. CapacitanceMeasurementusingScheringBridge.	3	3		3	
5. InductanceMeasurementusingAndersonBridge.	3	3		3	
6. Measurementofparametersofachokecoilusing3ammeter method.	3	3		3	
7. Measurement of 3 phases reactive power with single-phase wattmeter for balancedloading.	3	3			
8. CalibrationLPFwattmeter–byPhantomtesting.	3	3	3		
9. Dielectric oil testing using H.T. testingKit.	3	3			
10. LVDT– characteristics andCalibration.	3	3	3		3
11. Resistancestraingauge–strainmeasurementandCalibration.	3	3	3		3
12. Hall EffectSensor.	3	3			3
virtual mode:					
13. Measurement of self inductance by Owen bridge.	3	3		3	
14. Measurement capacitance by Wien series bridge.	3	3		3	
15. Q meter experiment-To determine the quality factor of an unknown coil.	3	3			3
16. Measurement of high resistance by Megohm bridge.	3	3		3	

INDEX

Calibration and Testing of Single Phase Energy Meter

Calibration And Testing of Single Phase Energy Meter

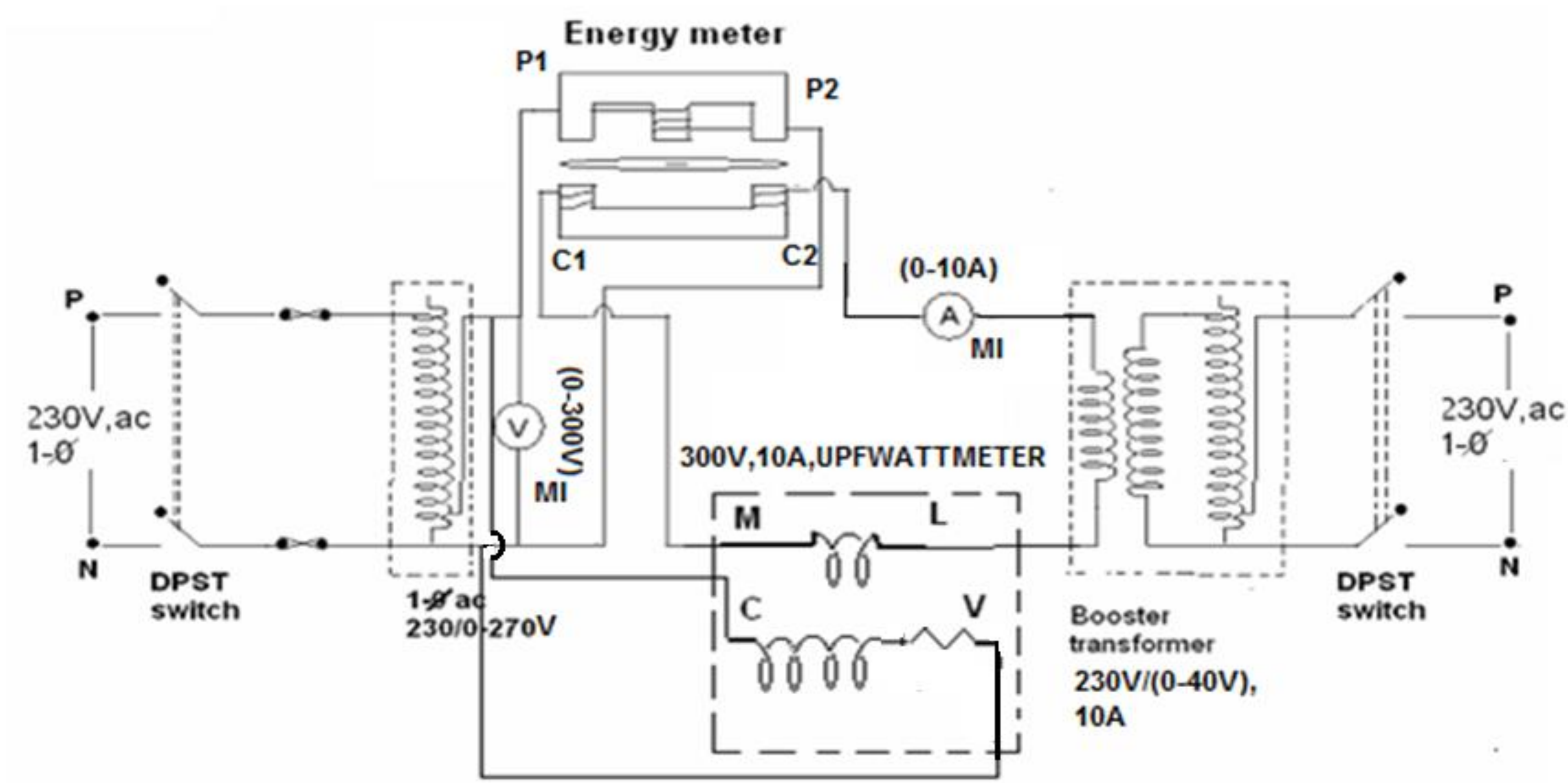
AIM:

To calibrate a given single phase energy meter by phantom loading

APPARATUS:

SL.No	APPRATUS	Type	Range	Quantity
1	Energy meter	Induction	10A,240V	1
2	Ammeter	MI	(0-10)A	1
3	Voltmeter	MI	(0-300)V	1
4	Wattmeter	Dynamometer	300V,10A,UPF	1
5	Stop watch	Digital	-	1
6	Booster transformer	-	(230V/0-40V), 10A	1
7	Auto Transformer	1-Φ	(230/(0-270V), 10A	1

CIRCUIT DIAGRAM



THEORY:

Generally the measurement of energy is essentially the same process as the measurement of power, except that the instrument used must not merely indicate the power, or rate of supply of energy, but must take in to account also the length of time for which this rate of supply is continued.

The constructional details of single phase induction energy meter. It mainly consists of two electromagnets.

One electro magnet carries current coil in which load current flows and other carries current proportional to supply voltage. Since it applied across which is know as pressure coil consequently the two electromagnets are known as series and shunt magnets

$$T_d = K_1 Ø_1 Ø_2$$

PROCEDURE

1. Connections are made as per CIRCUIT DIAGRAM.
2. Set the variac at zero output voltage position & switch on the supply.
3. Then the output of variac at rated voltage of the precision coil is adjusted by using voltmeter.
4. Switch on the booster transformer on the load and allow certain amount of current then the al, disc of energy meter starts rotating. Note down the time taken for 20 revolutions by a standard stop watch.
5. Determine the indicated energy (f) by using meter constant.
6. Find the actual energy by using (s) **W*T / 3600Whrs**.
7. The error was determined by using formula **(S-F)/F.**
8. Repeat the experiment by increasing the load current.
9. The graphs were plotted b/w %error & I (load).

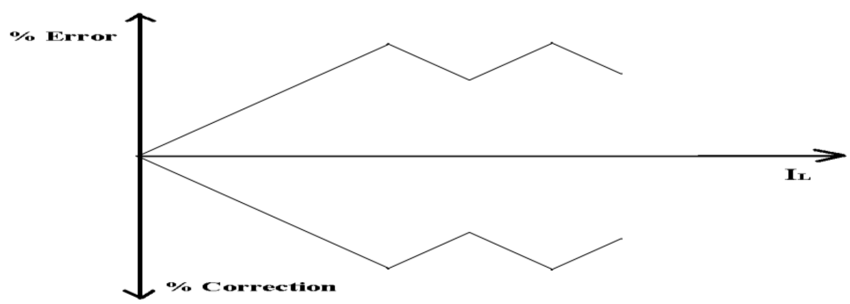
PRECAUTIONS

1. Connections should be tight enough.
2. Reading should be without any parallax error.
3. Both the input sources should be of same phase.

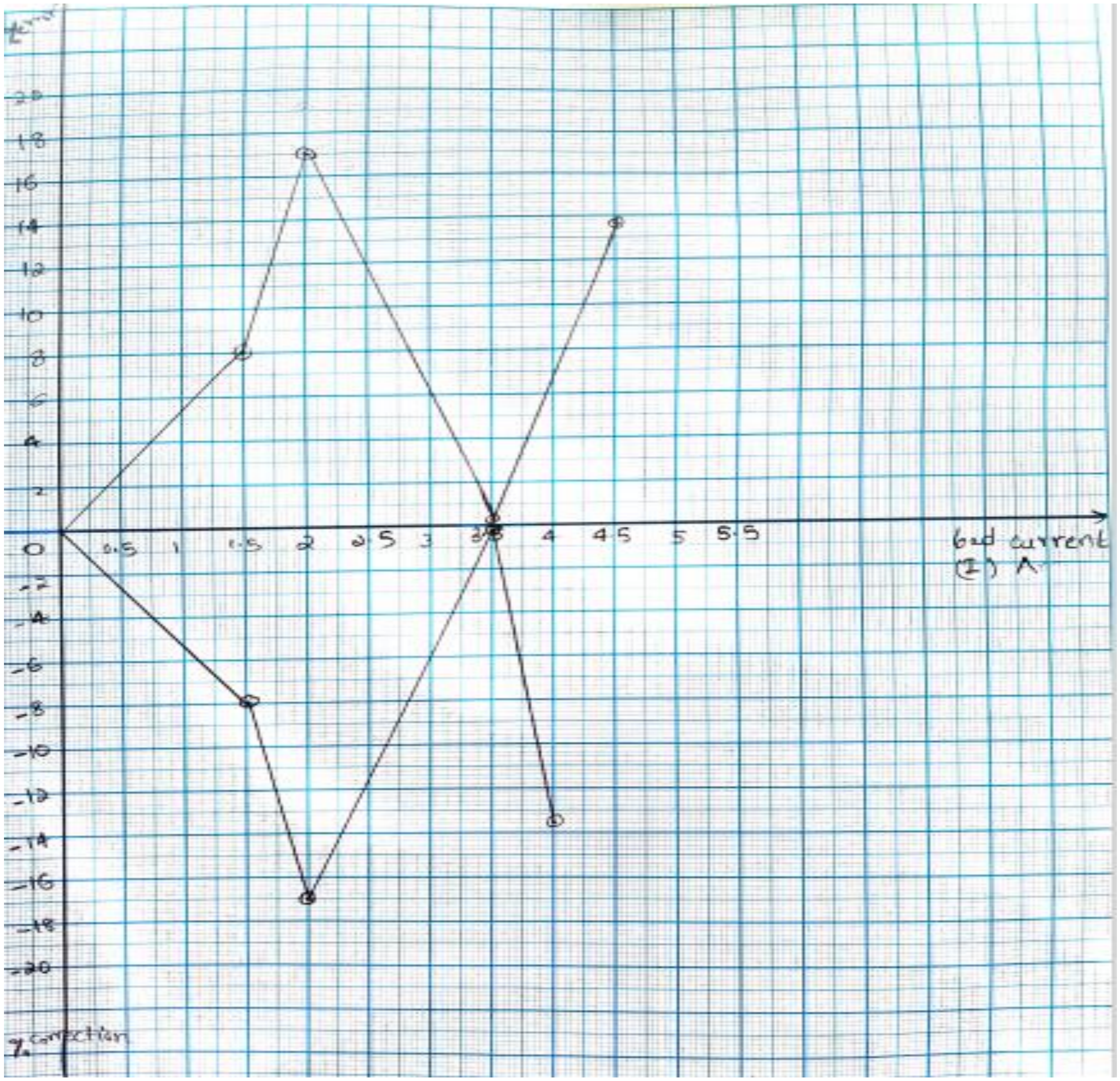
Observations and calculations

S. No	Voltage (v)	Wattmeter 'W'	Load Current (I_L)	T (sec)	Indicated energy (F) = N/K	Actual energy (S) = W*T/3600	% error (F-S)/S X100	% Correction (S-F)/F X100
1	230	400	1.5	163	0.01666	0.01811	-8.0	8.0
2	230	430	2	129	0.01666	0.0154	8.182	-8.182
3	230	600	2.5	121	0.01666	0.02016	-17.36	17.36
4	230	700	3	90	0.01666	0.0175	-4.8	4.8
5	230	800	3.5	75	0.01666	0.0166	0.36	-0.36
6	230	960	4	60	0.01666	0.0160	3.75	-3.75
7	230	1000	4.5	52	0.01666	0.0144	15.694	-15.694

MODEL GRAPH



GRAPH:



RESULT:

The single phase energy meter is hence calibrated and graphs are drawn for phantom loading

KELVINS DOUBLEBRIDGE – MEASUREMENT OF LOW RESISTANCE

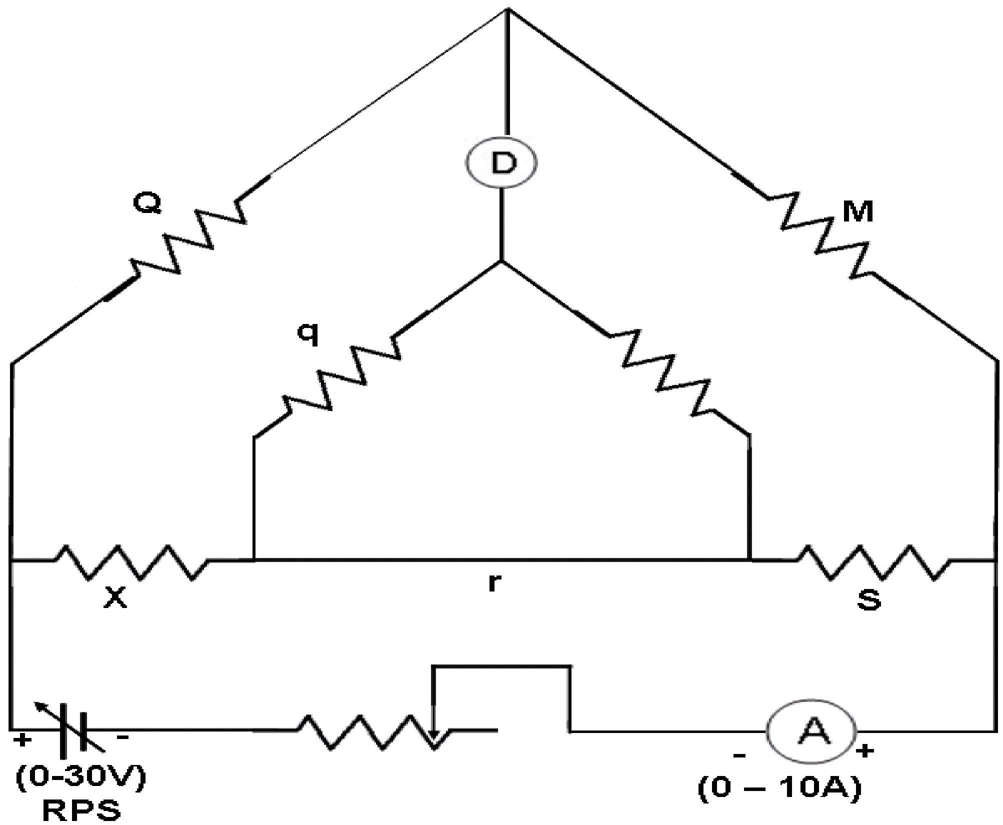
KELVINS DOUBLE BRIDGE– MEASUREMENT OF LOW RESISTANCE

AIM : To determine the low range resistance of a given resistor using Kelvin's Double Bridge.

APPARATUS:

S.No.	APPARATUS	Type	Range	Quantity
1	Kelvin's Double Bridge	-	-	1No.
2	Given resistor of low range resistance	-	-	1No.
3	Spot reflection galvanometer	-	-	1No.

CIRCUIT DIAGRAM:



Details of panel:-

+C and –C - Current terminals – to connect a h- terminal unknown

+P and –P - Potential terminals – resistance 'X'

Selector or current switch – To set the battery circuit in OFF Position, Forward Position or reverse position.

Range multiplier - To select proper range depending on the value of Unknown resistance.

Main dial - For course adjustment.

Slide Wire - For fine adjustment.

THEORY:

Kelvin Bridge is a modification of the Wheatstone bridge and provides high accuracy in measurement of law value resistances.

The Kelvin's Double Bridge incorporates the idea of a second set of ratio arms and hence the name double bridge and the use of four terminal resistors for the low resistance arms.

When the bridge is adjusted for balance.

Let i_1 = Current in arm P = Current in arm Q

i_2 = Current in arm P = Current in arm q

I = Current in arm R = Current in arm S.

Current i_2 = I r/ P+q+r ....(1)

Now P.d across "P" = P.d across "R" + P.d across "P"

i_1P = IR + I pr/ P+q+r

= I (R+Pr/P+q+r) ....(2)

Similarly, P.d across "Q" = P.d across "S" + P.d across"q"

i_1Q = IS + I qr/P+q+r

= I (S + qr/P+q+r) ....(3)

By division,

(2)/(3) = i_1P/ I_1Q = I (R+Pr/P+q+r)/ I (S + qr/P+q+r)

PS + Pqr/P+q+r = QR+Qpr/P+q+r

QR = PS + r/P+q+r(Pq-Qp)

R = PS/Q + r/Q(p+q+r) (Pq-Qp)

R = PS/Q + rq/p+q+r (P/Q – P/q)

If P/Q = p/q R = PS/Q

This indicates that the resistance of connecting lead r, has no effect on the measurement, provided that the two sets of ratio arms have equal ratios.

From this the unknown resistance can be found.

PROCEDURE:

Measurement of unknown resistance of low range :

1. Disconnect the copper strip connected between +C, +P and –P, -C. keeping the other connections as it is.
2. Connect the given unknown resistor "R" (Its current terminals to +C and –C and potential terminals to +P and –P of the bridge).
3. Set the range multiplier switch at a suitable range (10 or 1) and selector switch in the forward position.
4. Switch on the spot reflection galvanometer and regulated power supply.
5. Press the current key first and then the galvanometer key.
6. Now adjust the main dial and slide wire dial to get null deflection in the galvanometer.
7. Note down the main dial reading and slide wire dial reading and calculate the resistance of the given resistor (R) using the formula
   R = (Main dial reading + slide wire dial reading) * range multiplier used.
8. Next set the selector switch in the reverse position. Repeat the experiment and find the value of "R" in the zero manner. Find the mean of these values of get the correct value of "R". This is to be done be eliminate thermal effect.

PRECAUTIONS :

1. All connections should be done tightly.
2. It should be ensured that the knobs of the regulated power supply are at zero output voltage position, before it is switched on.
3. Minimum possible current, should be passed through the bridge.
4. Continuous flow of current should be avoided and current key should be pressed only for a short – while.
5. The spot reflection galvanometer should be locked after use.
6. During null point determination, positions of low sensitivity (1/1000 or 0.0001) should be used initially. As null point approaches, position "1" should be used for maximum sensitivity.

Observations and calculations:

SL. NO.	Standard resistance (mΩ)	Position of selector	Range multiplier	Main dial reading (mΩ)	Slide wire readin (mΩ)	Unknown resistance "R" (mΩ)
1	20	Normal	1	20	0.2	20.02
2	20	Reverse	1	20	0.2	20.02
3	500	Normal	10	50	0.2	502
4	500	Reverse	10	50	0.2	502

RESULT:

The low range resistance of a given resistor is measured using Kelvin's double bridge.

CROMPTON'S DC POTENTIOMETER – CALIBRATION OF PMMC AMMETERR

CROMPTON'S DC POTENTIOMETER –

CALIBRATION OF PMMC AMMETER

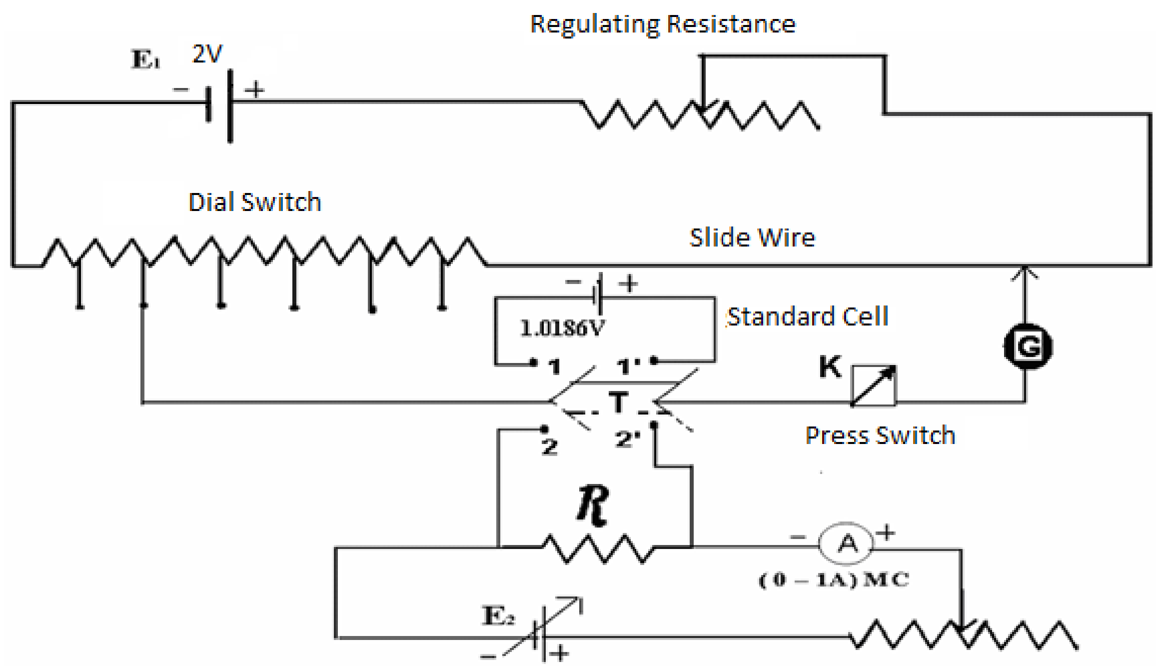
AIM: To calibrate the given ammeter using potentiometer.

APPARATUS:

S. No.	APPARATUS	Range	Type	Quantity
1.	Potentiometer	-	Dial Pattern	1
2.	Regulated Power Supply	(0 – 30V), 5A	Digital	2
3.	Regulated Power Supply	2V,250mA	-	1
4.	Weston Standard Cell	1.0186V	Centre Zero	1
5.	Galvanometer	(30 – 0 – 30)mA	Centre Zero	1

CIRCUIT DIAGRAM:

1.Calibration of Ammeter



Where E1 and E2 are RPS units (0-5/101V); where RPS - Regulated Power Supply

G- Galvanometer; R Unknown Resistance; K-Switch;

THEORY:

A potentiometer is an instrument designed to measure an unknown voltage by comparing it with a known voltage. The known voltage may be supplied by a standard cell or any other known voltage reference source. The advantage of these potentiometers is that since a potentiometer makes uses of a balance or null condition, no current flows through and hence no power is consumed in the circuit containing the unknown emf or component. True E.M.F's of batteries can be obtained..

The potentiometers are extensively used for the calibration of voltmeters and ammeters and have infact become the standard for the calibration of these instruments. One such an instrument is the "CROMPTON'S POTENTIOMETER", which is also known as "LABORATORY POTENTIOMETER".

"The process of adjusting the working current so as to match the voltage drop across a portion of sliding wire against a standard reference source is known as STANDARDISATION"

PROCEDURE:

1. Connect the galvanometer at the terminals "GALVO", Standard cell to the terminals marked E_1& either unknown resistor or standard resistor across terminals E_2.
2. Connect RPS to the terminals marked "BATT".

STANDARDIZATION:

1. The EMF of a standard cell is 1.0186V. So, set the dial switch & slide wire contacts at 1V & 18.6mV which is equal to 1.0186V.
2. Adjust the output voltage of RPS to get 2V.
3. Adjust the regulating rheostat to get the null deflection in the galvanometer.

Calibration of Unknown Ammeter:

1. Replace the unknown resistance with the standard resistance of 1Ω and standard ammeter with ammeter which is to be calibrated.
2. Adjust the ammeter reading to 0.1A and dial switch & jockey positions till null deflection is obtained in the galvanometer.
3. Read the value of potential difference across the standard resistor directly from dial switch and jockey positions.
4. Find the current (I) passing through standard resistor.
5. Compare the value with the ammeter reading and find the % correction & % error.
6. Repeat the experiment by increasing the ammeter reading.

PRECAUTIONS:

1. Make the connections tightly
2. Ensure that the output voltage of the power supplies is zero before the supply is switched on.
3. Ensure that the rheostats are at maximum resistance position at the time of switching on the supply.
4. Insert high resistance in galvanometer circuit initially and cut out completely when null deflection is observed in the galvanometer.
5. Keep the voltage across the terminals "BATT" to be more than across the terminals "E1" , "E2".

Observations and calculations:

S. No	Ammeter reading in amps(I) (F)	P.D. across standard resistance measured by pot in (mV) at R = 0.1 Ω	Standard value of current I (Amps) = V/R (S)	%Error S-F*100/S
1	0.24	25	0.25	4.00
2	0.53	54	0.54	1.851
3	0.79	80	0.80	1.250

RESULT:

The given Ammeter is also calibrated using potentiometer.

CAPACITANCE MEASUREMENTS USING SCHERING BRIDGE

CAPACITANCE MEASUREMENT USING SCHERING BRIDGE

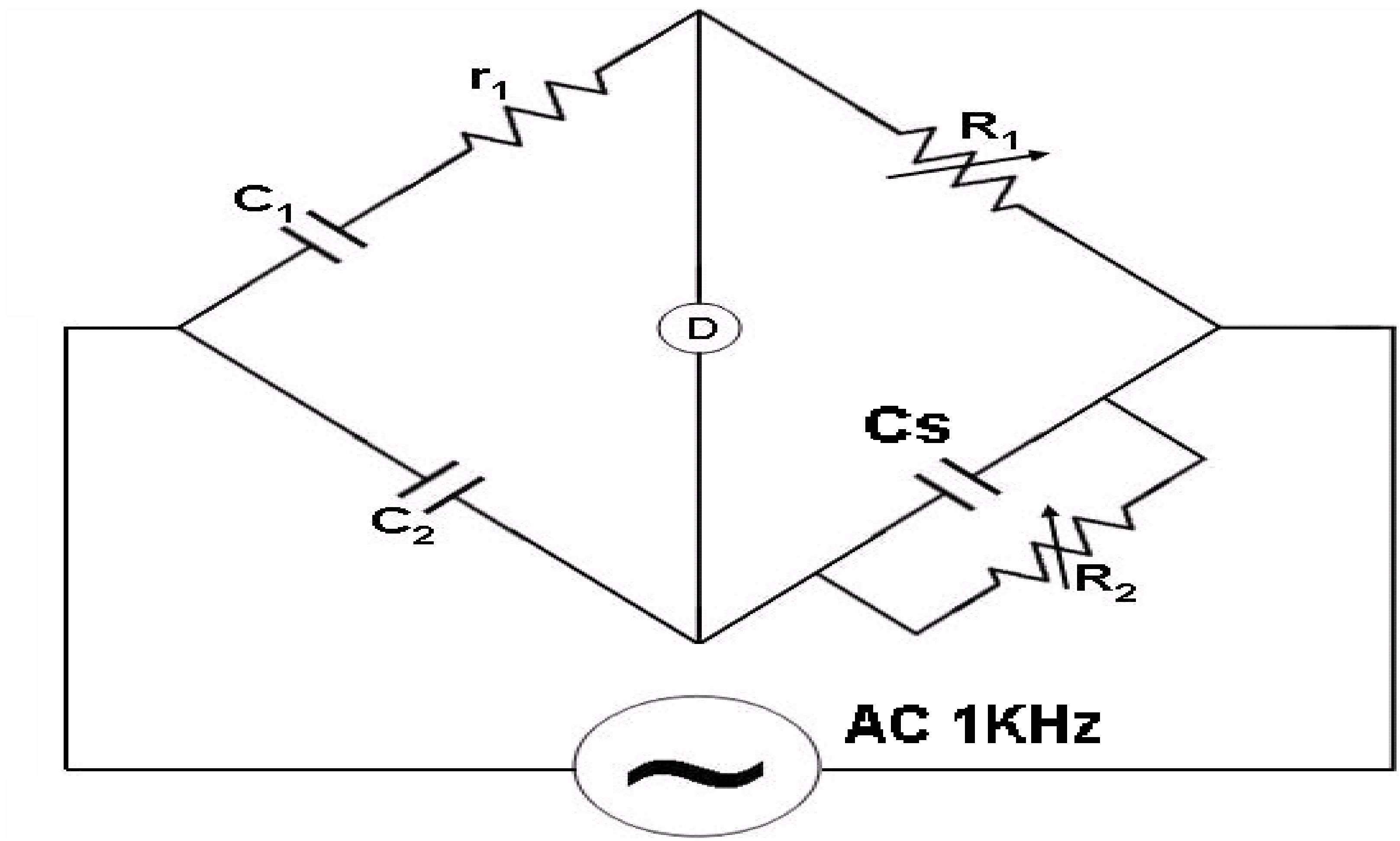
AIM :

To find the value of unknown given capacitance using "**SCHERING BRIDGE**"

APPARATUS:

S.No	APPARATUS	Type	Range	Quantity
1	SCHERING BRIDGE	-	-	1No
2	HEAD-PHONES	-	-	1No

CIRCUIT DIAGRAM:



THEORY:

Schering bridge is widely used for capacitance and dissipation factor measurements. Infect Schering Bridge is one of the most important of the AC bridges. It is extensively used in the measurement of capacitance, in general and in particular in the measurement of properties of insulators, capacitors bushings, insulating oils and other insulating materials. This bridge is particularly suitable for small capacitors and is then usually supplied from high frequency or a high voltage source.

LAY OUT OF THE DIADRAM :

R_1 = A plug type resistance bar of 10, 100, 200, 500, 1000 , 2000 & 5000 ohms . Constitute one arm of bridge.

R_2= Four decade dials of 1, 1, 10, 100 & 1000 ohms Constitute the second arm

C_2 = A calibrated variable capacitor (of air type) of 0 to 1000 Pf connected to R_2 in parallel

C_1 **=** Standard variable capacitances arranged ion four decade over the range of mfd constitute the third arm of the bridge.

C **=** Experimental capacitance placed in fourth arm of the bridge.

R = Imaginary resistance representing dielectric less in C_1.

For the Schering bridge network shown

Impedance of arm ab = $r_1 + \frac{1}{JWC} = Z_1$

Impedance of arm bc = r_1 = Z_2

1

Impedance of arm ca = $r_2 // \frac{1}{JWC_2}$

$$= \frac{R_2 * \frac{1}{JWC_2}}{R_2 + \frac{1}{JWC_2}}$$

$$= \frac{R_2}{1 + JWC_2 R_2} = Z_3$$

Impedance of arm da $= \frac{1}{JWC_1} = Z_4$

When the bridge is adjusted for balance $Z_1 Z_3 = Z_2 Z_4$

$$\left(r_1 + \frac{1}{JWC} = Z_1\right)\left(\frac{R_2}{1 + JWC_2 R_2}\right) = (r_1)\left(\frac{1}{JWC_1}\right)$$

$$r_1 R_2 + \frac{1}{JWC \ * R_2} = \frac{R_1}{JWC_1}(1 + JWC_2 R_2)$$

$$r_1 R_2 + \frac{1}{JWC \ R_2} = \left(\frac{R_1}{JWC_2} + \frac{R_1 C_2 R_2}{C_1}\right)$$

Equating the real terms

$$r_1 R_2 = \frac{R_1 C_2 R_2}{C_1}$$

$$r_1 = \frac{R_1 C_2}{C_1}$$

Now equating the imaginary parts

$$\left(\frac{1}{JWC}\right)R_2 = \left(\frac{1}{JWC_1}\right)R_1$$

$$\frac{R_2}{C} = \frac{R_1}{C_1}$$

$$C = C_1 * \frac{R_2}{R_1}$$

Dissipation factor, = wc_1r_1

PROCEDURE:

1. Connect the AC supply 1KHz with the terminals marked supply, unknown capacitor with the terminals marked unknown and head phone with the terminals marked detector.
2. Set the resistance dial R to zero position and also set capacitance dial C_2 to zero position, and also set resistance dial R_1 at 1000Ω.
3. Now adjust the decade resistance dial R_2 to minimize the sound in the head Phone.
4. Note the value R_1, R_2 and C_1 and calculate the value of unknown capacitor using above formula.
5. Repeat the same experiment on another value.
6. Check the values by LCR Q-meter.

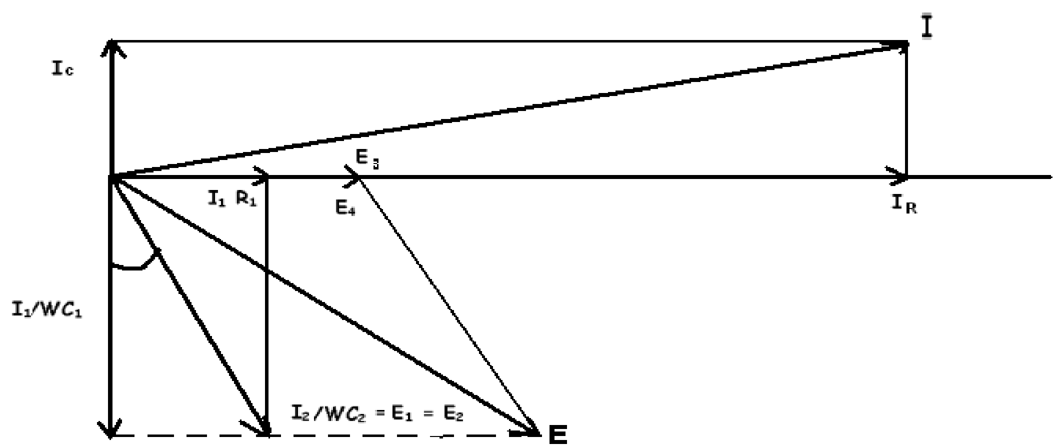
PRECAUTIONS :

- Make the connections tightly.
- Note the readings at minimum sound.
- Take care while handling with the switches.

Observations and calculations:

S.No	R_1 (Ω)	R_2 (Ω)	C_1 (μF)	$C = C_1 . \frac{R_2}{R_1}$ (nf)	LCR (nf)
1	1000	1000	0.01	10	10
2	1000	2000	0.01	20	19
3	1000	3000	0.01	30	29
4	1000	4000	0.01	40	39

PHASOR DIAGRAM:



RESULT :

The value of given unknown capacitance is found out by using Schering Bridge.

INDUCTANCE MEASUREMENT USING ANDERSON BRIDGE

INDUCTANCE MEASUREMENT USING ANDERSON BRIDGE

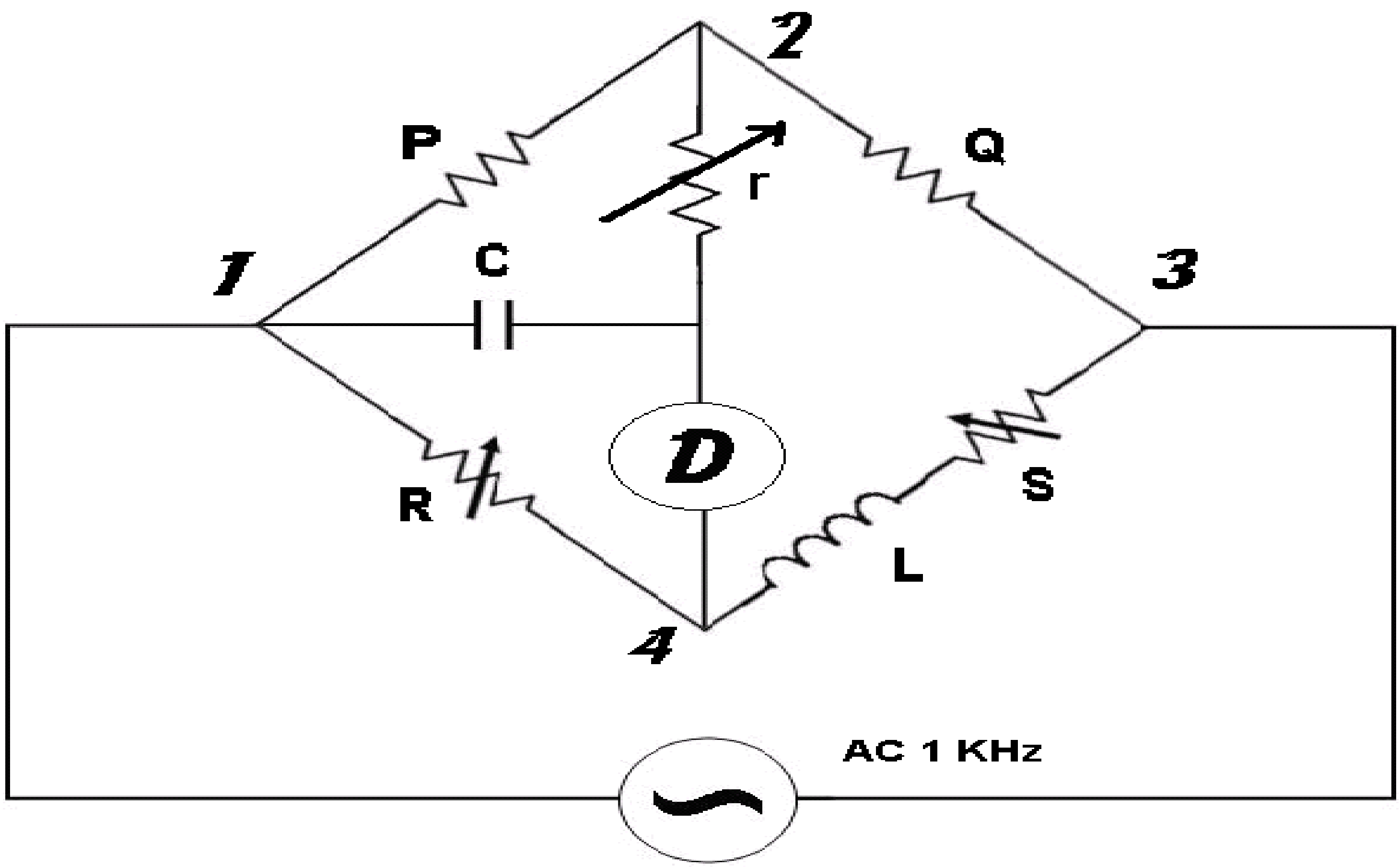
AIM:

To determine resistance and self-inductance of an inductor using Anderson bridge.

APPARATUS:

S.No.	APPARATUS	Type	Range	Quantity
1	Andersons Bridge	------	------	1 No.
2	Inductance	------	------	1 No.
3	CRO	------	--------	1 No.
4	Galvanometer	Current Zero	(30 – 0 – 30)	1 No.
5	High resistances Box		------	1 No.
6	Patch chords	------	------	------

CIRCUIT DIAGRAM:



THEORY:

The Anderson bridge is the modification of the Maxwell's inductance Capacitance Bridge. In this method, the self-inductance is measured in terms of a standard capacitor. This method is applicable for precise measurement of self-inductance over a very wide range of values.

PROCEDURE:

DC BALANCE:

1. Connect the DC supply 6 Volts with the terminals marked supply, unknown inductance with the terminals marked unknown and galvanometer with the terminals marked detector.
2. Now adjust the decade resistance dial R to find out balance point in galvanometer and also use resistance dial S for fine adjustment.
3. Note the value R

AC BALANCE:

1. After DC balance without disturbing the position of the bridge, connect the AC supply 1KHz instead of DC supply and head phone instead of galvanometer.
2. Now adjust the resistance dial r to minimize the sound in the head phone.
3. Note the value of r and calculate the value of unknown inductance by using above given formula.
4. Repeat the experiment with another values of "C".

PRECAUTIONS:

1. The value of "C" must be small to allow sufficient variation of "r", for good Result 0.01,0.02,…………0.007μ F capacitor are generally used.
2. In all calculations, the value of "S" the resistance of the given inductor.
3. Due to the presence of harmonics in the source, perfect balance cannot be achieved hence minimum sound heard is be taken as balance point.
4. Balance should be obtained by varying "s" and "r" alternatively.
5. Should be performed at a silence place.

Observations and calculations:

FORMULA : L=CR (Q+2r)

S. No.	P=Q (Ω)	R (Ω)	S (Ω)	R (Ω)	C (μF)	"L" (mH)	LCR
1	1000	30	0.2	7170	0.1	46.02	49.4
2	1000	60	0.2	6810	0.1	95.03	99.3
3	1000	102	0.2	6690	0.1	146.67	148.2

ADVANTAGES:

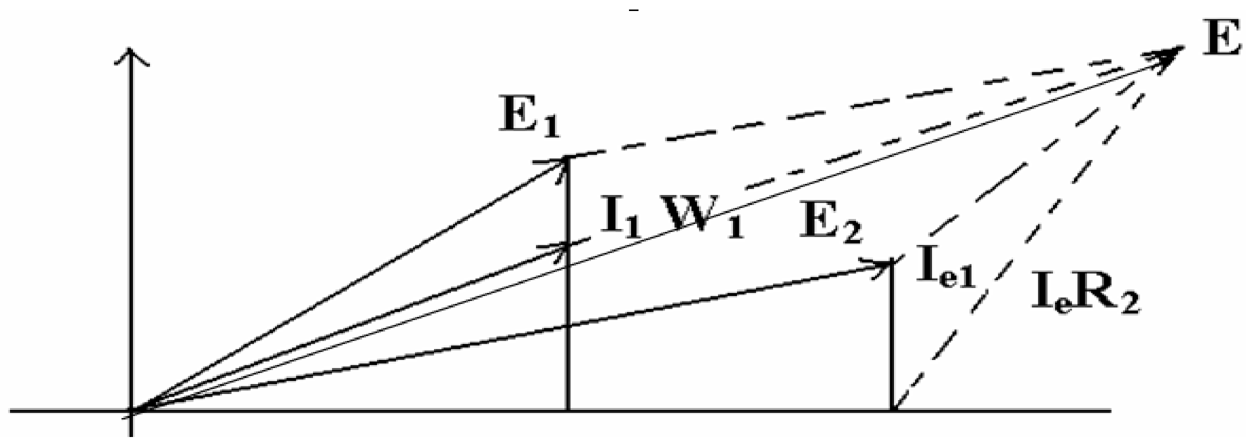
1. In case are carried out by manipulating control over r1 & r2 they become independent of each other. This is a marked superiority over sliding balance conditions met with low Q coils when measuring with Maxwell's bridge.
2. A fixed capacitor can be used instead of a variable capacitor as in the case of Maxwell's bridge.
3. This bridge may be used for accurate determination of capacitance in terms of inductance.

DISADVANTAGES:

1. The Anderson's bridge is more complex than it's prototype Maxwell's bridge. The balance equations are not simple & in fact are much more tedious.
2. An additional junction point increases the difficulty of shielding the bridge.

Considering the above complications of the Anderson's bridge, in all the cases where a variable capacitor is permissible the simpler Maxwell's bridge is used instead of Anderson's bridge.

PHASOR DIAGRAM:



RESULT:

The value of given unknown inductance is found out by using Anderson Bridge.

MEASUREMENT OF PARAMETERS OF A CHOKE-COIL USING 3 AMMETER METHOD

MEASUREMENT OF PARAMETERS OF A CHOKE-COIL USING 3-AMMETER METHOD

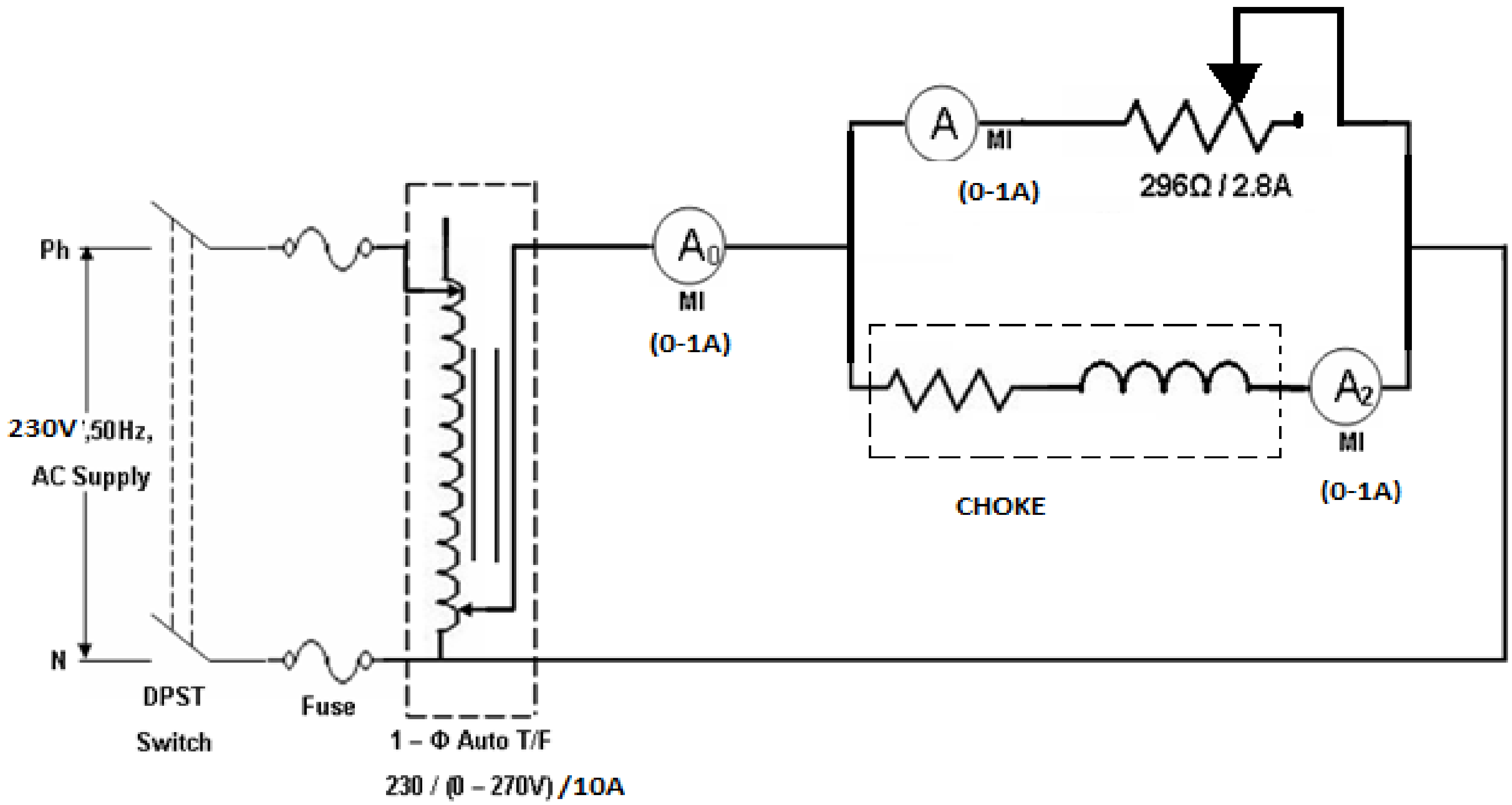
AIM:

To measure the choke coil parameters in 1-Φ circuit by using 3-ammeter method.

APPARATUS:

S.NO	APPARATUS	Range	Type	Quantity
1	Ammeter	(0-3) A	MI	1
2	Ammeter	(0-1) A	MI	2
3	Rheostat	296Ω/ 1.8A	TWW	1
4	Inductive Load(choke)	****	****	1
5	Auto Transformer	230V/(0-270) V	****	1

CIRCUIT DIAGRAM



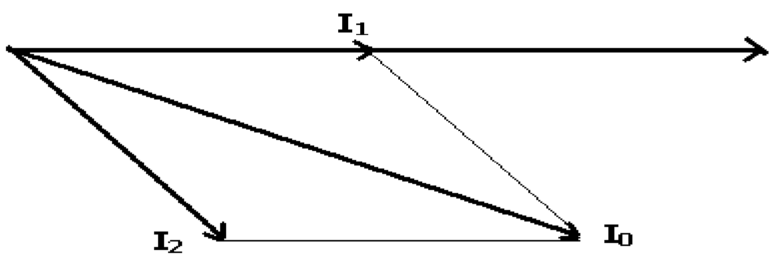
THEORY:

Parameters of Choke coil are found in different ways which include

- Ammeter Voltmeter method (involving both AC & DC)
- By using bridge circuits.
- Ammeter Voltmeter method (involving both AC & DC)
- By using bridge circuits.

Apart from above mentioned methods parameters may be found out by some other alternative methods also, and one such method is the experiment which is being dealt in this experiment.

From the PHASOR DIAGRAM



$$I_0^2 = I_1^2 + I_2^2 + 2\, I_1 I_2 \cos\Phi$$

$$I_0^2 = I_1^2 + I_2^2 + 2\, (V/R) I_2 \cos\Phi$$

(since $I_1 = V/R$)

But, $P = VI_2\cos\Phi$

P ⇨ $VI_2\cos\Phi = (I_0^2 - I_1^2 + I_2^2)\, R/2$

$$\cos\Phi = [\, (I_0^2 - I_1^2 + I_2^2)\, R/2\, VI_2\,]$$

$$\cos\Phi = [\, (I_0^2 - I_1^2 + I_2^2)\, /2\, I_1 I_2\,]$$

So $R = Z\cos\Phi$; $X_L = Z\sin\Phi$

PROCEDURE:

1. Make the connections as per the CIRCUIT DIAGRAM.
2. Vary the voltage applied to the circuit with the help of 1-Φ Variac.
3. Note the corresponding ammeter reading for each step of voltage.
4. Calculate the choke coil parameters using known formulae.
5. Verify the parametric values by connecting to L-C-R Q-Meter.

PRECAUTIONS:

1. Current flowing through the circuit should not exceed the rated value of experiment.
2. Connections should be tight enough.

Observations and calculations:

R=177Ω, $\cos\Phi = [(I_0^2 - I_1^2 + I_2^2) / 2 I_1 I_2]$, $R = Z\cos\Phi$; $X_L = Z \sin\Phi$

S. No	I_0 (AMPS)	I_1 (AMPS)	I_2 (AMPS)	$V = I_1 R$	Z ohms (V/I_2)	cosΦ	R_{ohms}	$L_{Henries}$
1	0.4	0.3	0.3	53.10	177.00	0.888	157.176	138.237
2	0.5	0.34	0.34	60.18	177.00	1.081	191.33	
3	0.6	0.44	0.46	77.88	169.80	0.933	157.677	132.91
4	0.7	0.48	0.5	84.96	169.92	1.061	180.285	
5	0.8	0.53	0.56	93.81	167.52	1.133	189.800	

RESULT:

Parameters of choke coil are found to be 1.   2.

MEASUREMENT OF 3 Ø REACTIVE POWER WITH SINGLE PHASE WATTMETER FOR BALANCED LOADING

MEASUREMENT OF 3 Ø REACTIVE POWER WITH SINGLE - PHASE WATTMETER FOR BALANCED LOADING

AIM: -

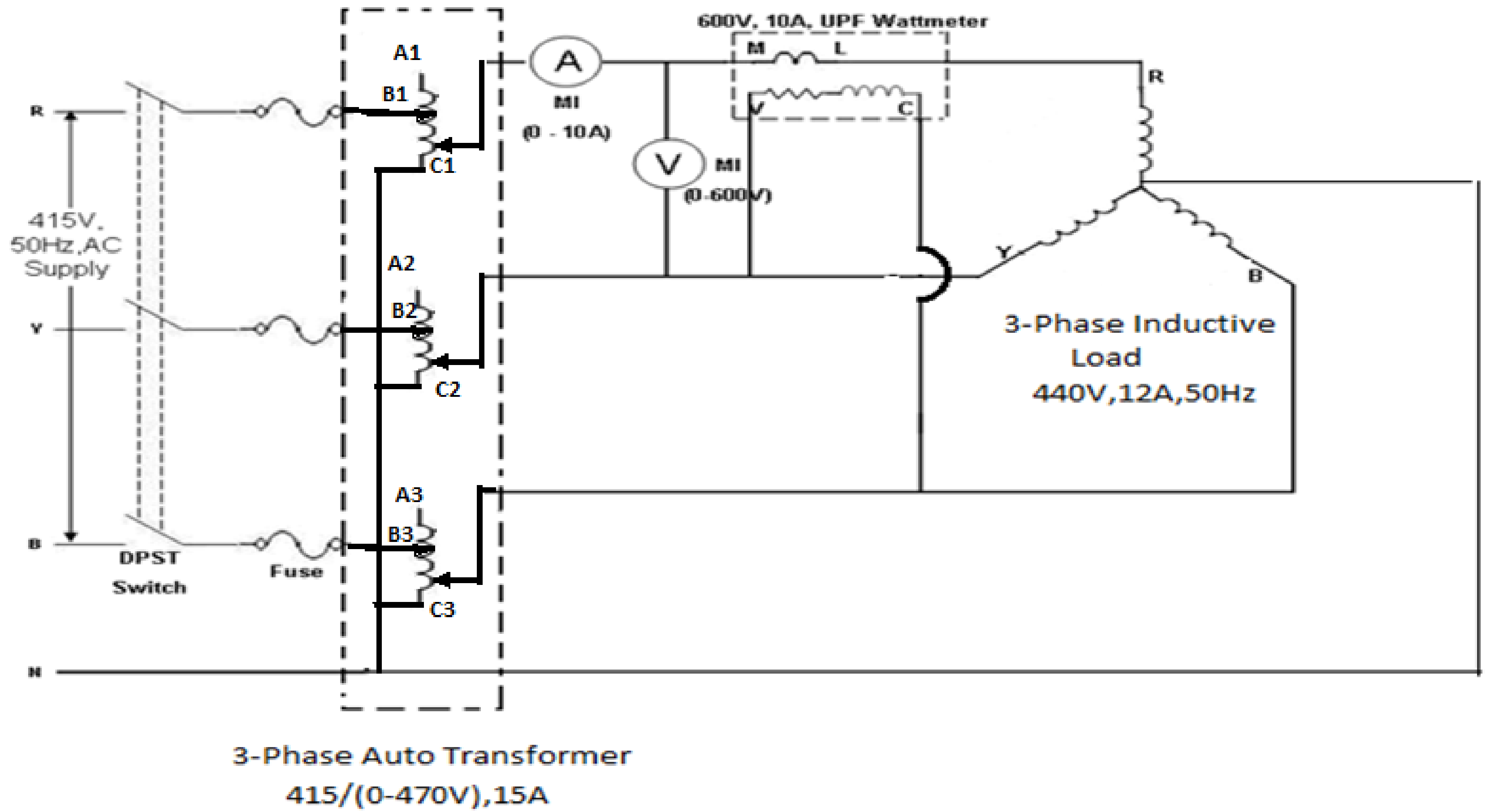
To measure 3 Ø reactive power by using one wattmeter method.

APPARATUS:-

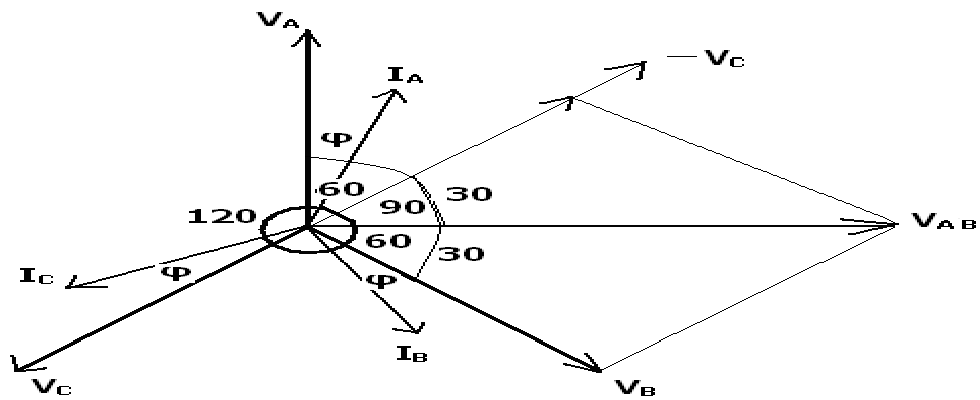
S.No.	Apparatus	Range	Type	Quantity
1	Voltmeter	(0-600)V	MI	1
2	Ammeter	(0-10)A	MI	1
3	Wattmeter UPF	(600V/ 10A)	Dynamometer	1
4	3 phase Auto transformer	(415V/0-470V) 15A	---	1

CIRCUIT DIAGRAMS:-

Circuit to measure 3 Ø reactive power using single wattmeter



PHASOR DIAGRAM of single wattmeter method:



THEORY:-

Reactive power is caused entirely by energy storage components inductors & capacitors. Although it does not contribute to transfer of energy it also the equipment as if it did consume active power Capacitors are positive storage of energy. Inductors are negative storage of energy For sinusoidal circuit relative power =VIsinΦ.For non sinusoidal circuit reactive **power q = En**

In a phase a.c circuit, reactive power is given as √3 $E_L I_L$ sin Φ where is the phase angle (angle between phase voltage and phase current). With a single wattmeter, it is possible to measure three phase reactive, provided the connections to its current coil and potential. Coil is made as shown in figure. The current coil is connected in series with one of the lines and the voltage coil is thrown across the other two lines the phasor diagram is as shown.

E_{RN}=phase voltage E_{RY} ,E_{YB} and E_{BR} are lines voltage RYB phase sequence is assumed.

E_{RN} lags behind E_{RY} by 30, and current lr lags behind E_{RN} by angle

It is evident the at the power measured by the wattmeter

=E_{YB} .I_R. cos (90- Φ) = E_{YB}. I_R. sinΦ if the lode is star-connected, we have:

E_{YB}=E_L, line voltage and I_r=line (or phase) current

Wattmeter reading =$E_L I_L$ sin c where IL=line current

We have 3-phase reactive power = √3 $E_L I_L$ sin Φ

PROCEDURE

1. Connections are made as per the CIRCUIT DIAGRAM
2. 3-Φ supply is given and variac is adjusted till the voltmeter show rated voltage
3. Gradually load is applied and corresponding voltmeter, ammeter and wattmeter reading are noted down
4. The wattmeter reading multiplied by √3 gives reactive power in one wattmeter method

PRECAUTIONS:-

1. Loose connections are to be avoided.
2. Reading is to be noted without parallax error

Observations and calculations:

Single Wattmeter method

S. No.	VOLTAGE (V)	CURRENT (I)	Power (W)	$\theta = \sqrt{3}P (or) \sqrt{3}W$
1	415	2	800	1385.64
2	415	3	1200	2078.46
3	415	4	1600	2771.28
4	415	5	2000	3464.10
5	415	6	2400	4156.92
6	415	7	2800	4849.74

RESULT:-

The 3 –Ø reactive power of 1-Ø wattmeter is measured √3, three phase reactive power is obtained.

CALIBRATION OF LOW POWER FACTOR WATTMETER BY PHANTOM TESTING

CALIBRATION OF LOW POWER FACTOR WATTMETER BY PHANTOM TESTING

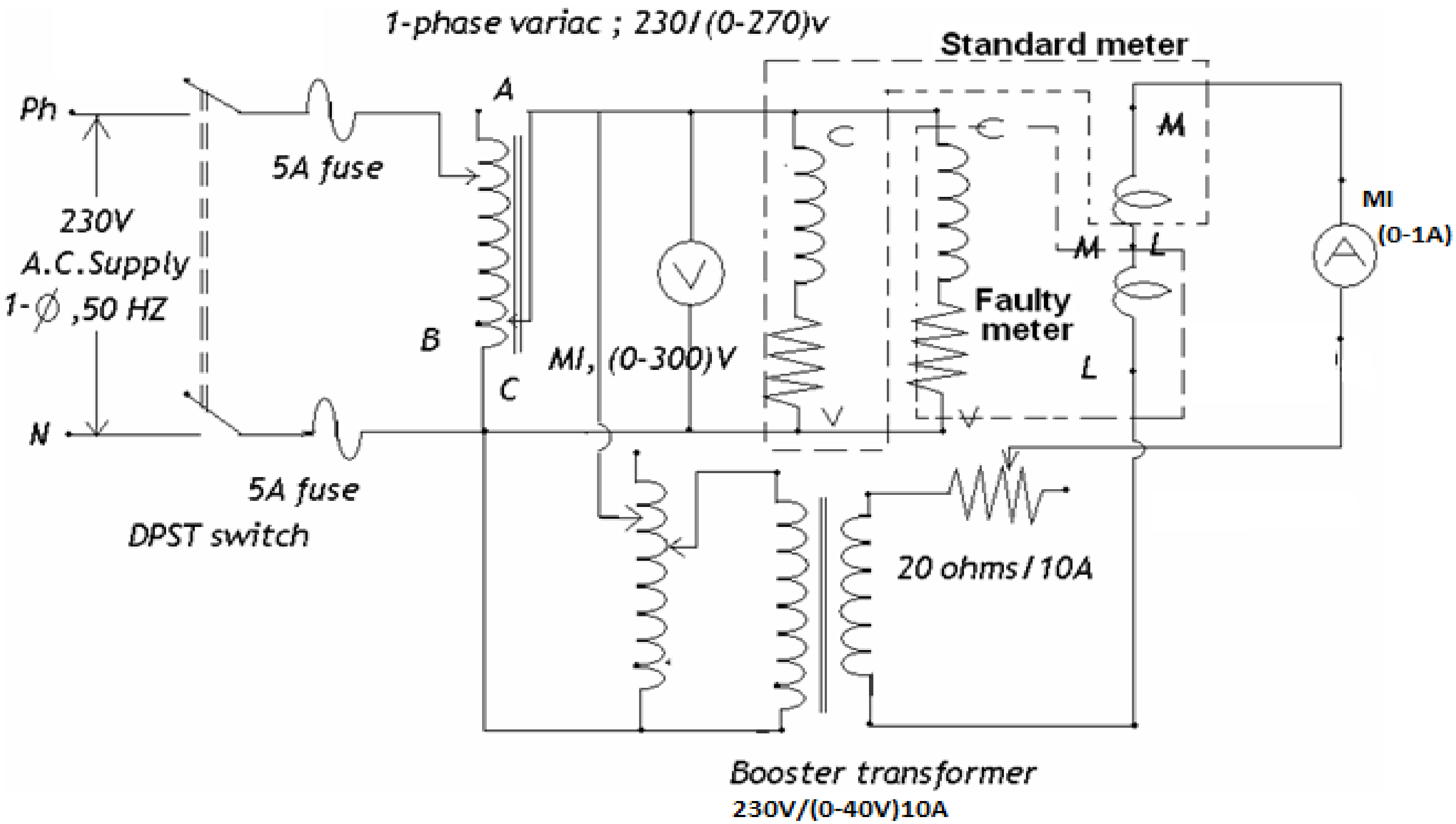
AIM:

To calibrate the given single phase Dynamometer type LPF wattmeter by Phantom loading method.

APPARATUS:

S.No.	APPARATUS	Range	Type	Quantity
1	Voltmeter	(0-300)V	MI	1
2	Ammeter	(0-1)A	MI	1
3	Rheostat	20 ohms/ 10A	TWW	1
4	Wattmeter LPF	(300V/5A)	Dynamometer	1
5	Faulty wattmeter LPF	300V/5A)	Dynamometer	1

CIRCUIT DIAGRAM:



THEORY:

Wattmeter reads the power in the circuit. LPF refers to unity power factor. And basically, a wattmeter consists of two coils i.e., a voltage coil or pressure coil and a current coil.

The applied voltage is impressed across the pressure coil and the current coil carries the load current.

The voltage coil consists of more number of turns, in comparison with current coil, so that the resistance is increased to limit the current to lower values. And the current coil has relatively less number of turns. The fluxes set up by the voltage and current coils interact with each other to get a Resultant torque on the needle which is calibrated over a scale. Because of large time constant of the system, it cannot follow the rapid variation of the torque having the double of that of voltage and the instrument takes up a position at which the average deflecting torque is balanced by the controlling torque.

PROCEDURE:

1. Connections are made as per the CIRCUIT DIAGRAM.
2. By varying the Variac, the voltage across the pressure coil is maintained 230V.
3. The current through the current coil is varied by charging the rheostat position.
4. By changing the current, the values of voltmeter, ammeter, and standard and faulty wattmeter readings are taken.
5. The above values are tabulated.
6. The percentage error and the percentage corrections are calculated.
7. A graph is plotted between the current and percentage error and the current and percentage correction.

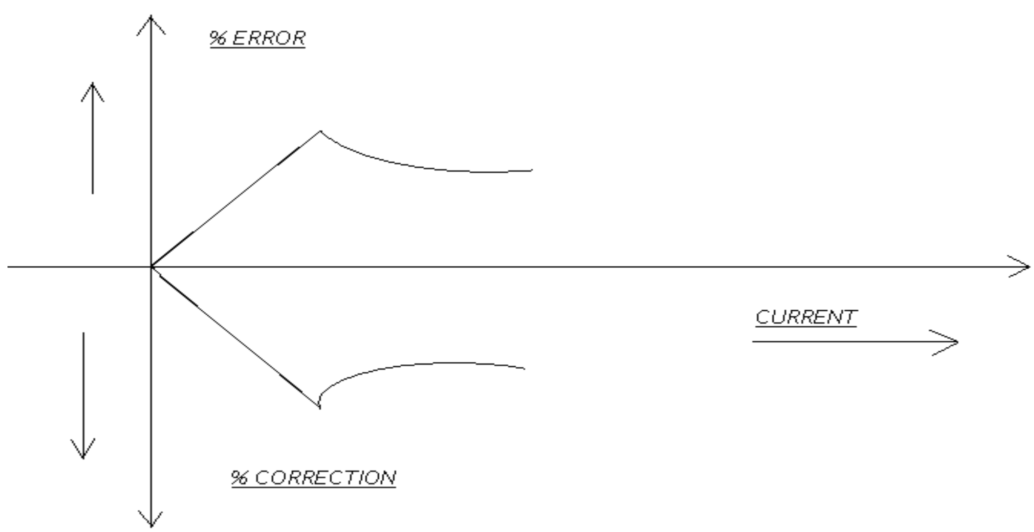
PRECAUTIONS:

1. Connections are made tight enough, so that loose connections are avoided.
2. The readings are taken without parallax errors.

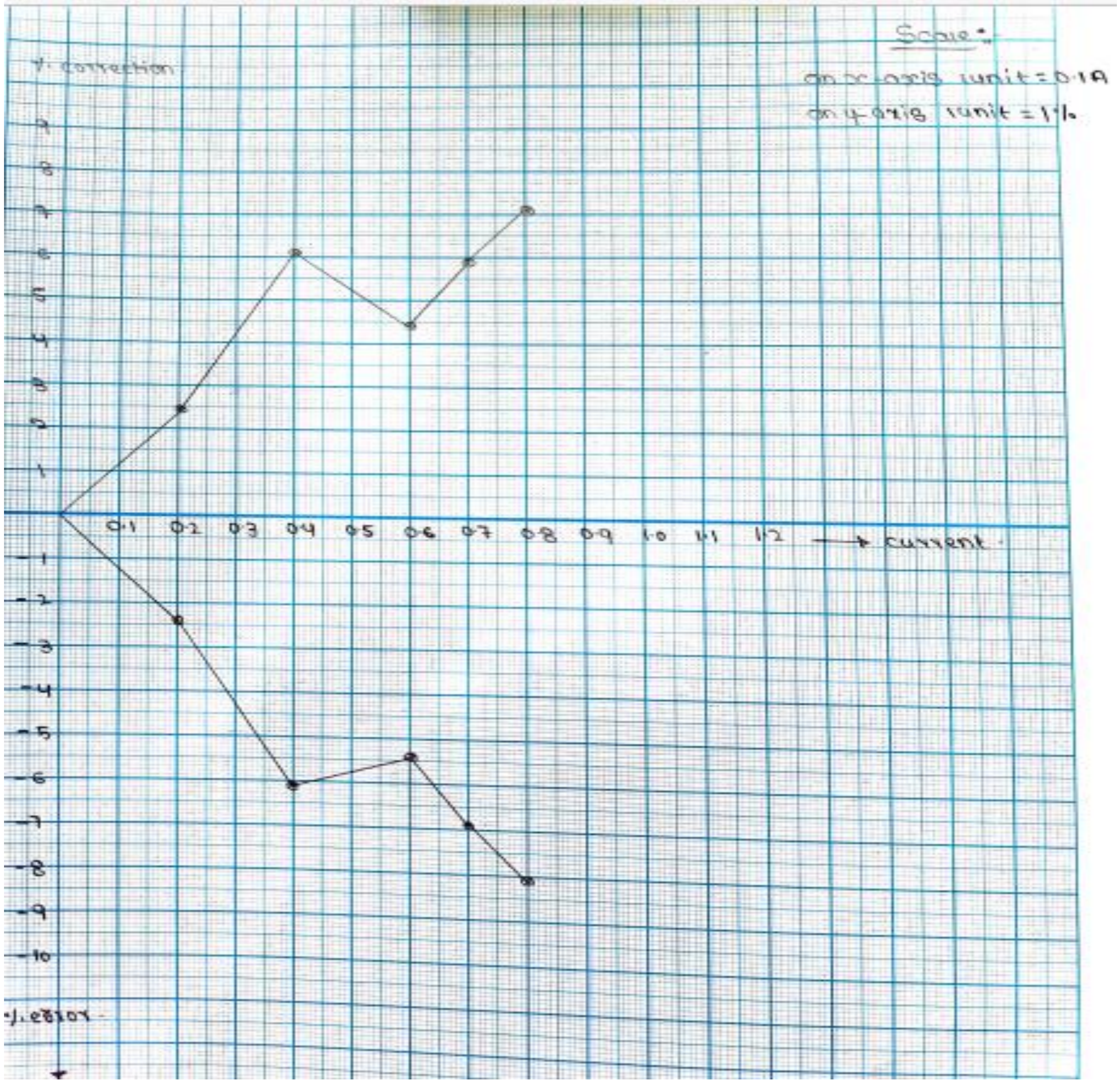
Observations and calculations:

S. No	VOLTEGE	CURRENT (A)	STANDARD WATTMETER (S)	FAULTY WATTMETER (F)	%ERROR: (F-S)/S*100	%CORRECTION
1	220	0.2	41	40	-2.43	2.43
2	220	0.3	70	68	-2.857	2.857
3	220	0.4	98	92	-6.122	6.122
4	220	0.5	122	116	-4.918	4.918
5	220	0.6	148	140	-5.405	5.405
6	220	0.7	172	160	-6.976	6.976
7	220	0.8	198	180	-8.163	8.163

MODEL GRAPH:



GRAPH:



RESULT:

The percentage error and the percentage correction plots against the current have followed the corresponding graphs. Thus, the wattmeter can be calibrated by using phantom loading.

DIELECTRIC OIL TESTING USING H.T. OIL TESTING KIT

DIELECTRIC OIL TESTING USING H.T. OIL TESTING KIT

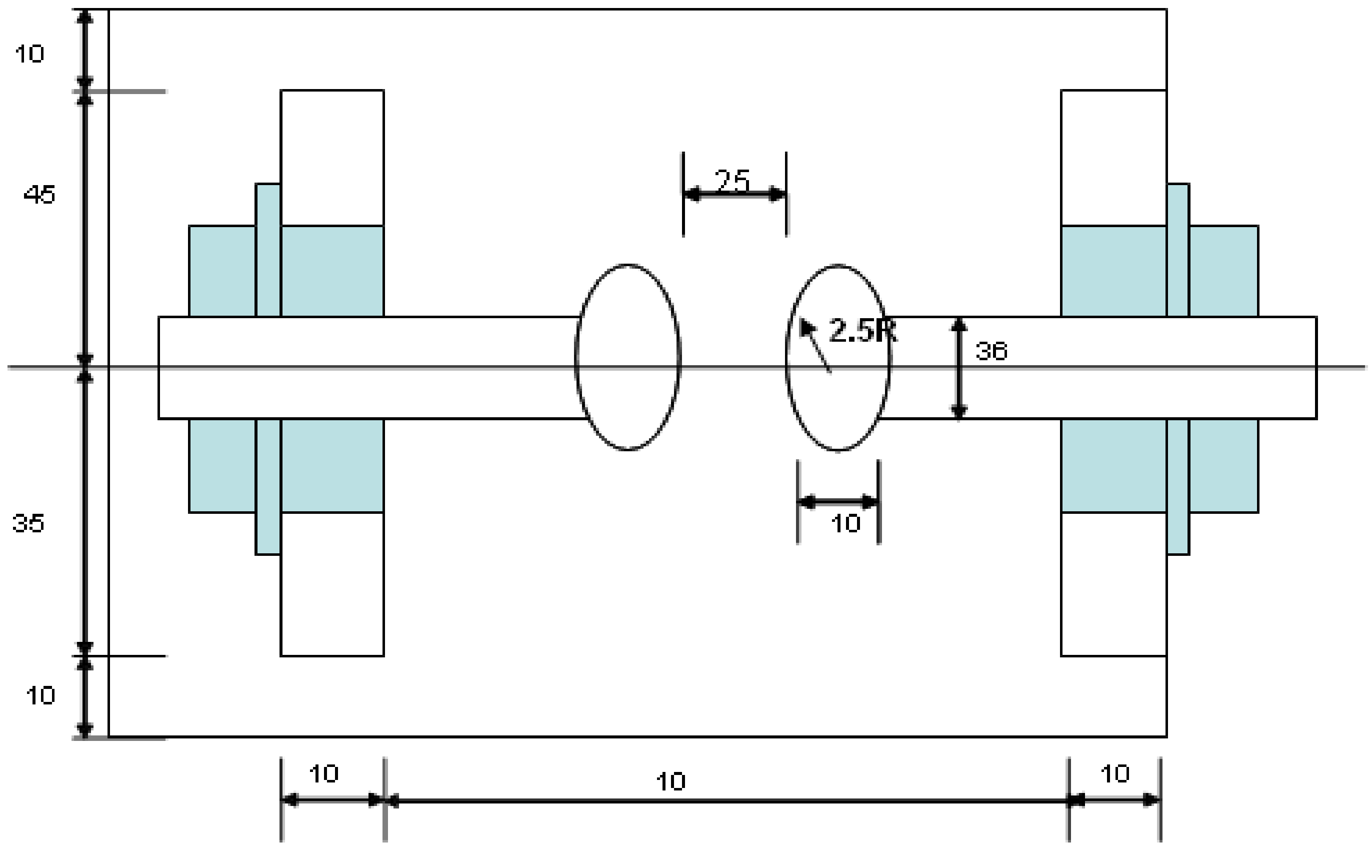
AIM:

To find the Dielectric strength of given sample of Oil by using HT oil testing kit.

APPARATUS:

S.No	Name of equipment
1	Portable oil testing kit
2	Oil sample
3	Standard Gaps adjusting bars (in mm's)

BLOCK DIAGRAM



All measurements are in "mm"

THEORY:-

High voltage distribution and power transformers are mostly filled with oil. The functions of the oil are to provide additional cooling to the core and the earth. Similarly insulating oil is used in low and medium voltage switch gears. Since it is mostly used in transformer it is commonly known as transformer oil. The transformer oil is obtained by refining suitably selected natural petroleum crude. The synthetic transformer oil is also available in the market but the use of mineral oil is preferred due to its property of self-restore after dielectric discharge or puncture. The transformer oil must comply with the bureau of Indian standard specification ISS 555 -1988 in respect of its tendency towards slugging acidity flash point dielectric strength Description of all the tests performed to ascertain suitability if the oil is beyond the scope of this experiment and only dielectric strength verification will be dealt with. The electric strength of transformer oil as per IS 335 1988 should be given below:

a) New unfiltered oil 30 kV (rms)

b) After filtration 60 kV (rms)

The electric strength of the oil is tested by finding the breakdown voltage at which there is visible arching through the oil across two electrodes. in order to standardize the Results, the test has to be carried out in a standard vessel as described in IS 6792.since high voltage ac is to be applied across two electrodes dipped in the test oil safety PRECAUTIONS are to be taken for safety of the operation personnel. Different manufactures are producing portable oil testing set for this purpose. these oil testing sets consisting of three main parts i.e. oil testing cell H.T transformer and control circuit .The necessary operation instructions as laid down by the manufactures of the set in their manual must be understood before starting the test and followed during the test. General constructional features of such set are described below.

The input voltage of such oil testing set is 230 volts, 50hz ac supply which is stepped up through a HT transformer while carrying out the test voltage is increased in steps by a variable auto transformer which controls the primary voltage.
of the HT transformer .secondary side of the HT transformer is connected to the electrodes arranged in the oil test cell. The voltage is increased till the spark between the electrodes occurs.

The display of flash voltage is held up in the volt meter and is brought to zero after reading it . the voltmeter is calibrated to read kV of the break down voltage.

The voltage can be increased either manually by turning a knob or automatically by built in motor which starts rotating the knob gradually as the test switch is turned on. Salient controls of a typical portable oil test get shown in fig 1.

The test cell dimensions are also standardized in IS 6792and are given in fig2. The cell is made of glass or rigid oil resistance plastic and should be transplanted . it should he transparent. It should have an effective volume between 300ml and 500ml.it should be covered.

IS 679. The copper brass or stainless steel polished electrodes are in common use. There surface is made up of spherical shape and dimensions are given in fig2. the electrodes are mounted on a horizontal as is 2.5mm apart .the gap between the electrodes is set to an accuracy of 0.01mm by means of thick ness gauge the electrodes is immersed to the depth of approximately 10mm .electrodes should be replaced as soon as pitting caused by the discharge is observed.

The Indian standards specifications that the sample vessel containing the test oil shall be gently agitated and turned over several times in such a way as to ensure as thin as possibly a homogeneous distribution of the impurities contained in the oil with out causing the formation of air bubbles. Immediately after this the sample should be poured down into the test cell slowly in order to avoid formation of air bubbles.

PROCEDURE:-

1) Read the instructions manual supplied by the manufacture of the set keep the set ready as pre instructions given in the manual.
2) Clean the test cell by rinsing with the test oil least twice before the final filling.
3) Fill the cell by sample oil up to the mark and place the cell in the proper place in the test set .close the lid and switch on the ac supply.
4) Check whether the voltmeter is reading zero at this stage.
5) Press the HT on push button and turn the knob for increasing the HT voltage across the electrodes keep the rate of increase of the voltage uniform and equal to approximately 2kv per second starting from zero up to the value producing breaking down step moving the knob any more as soon as break down. stop the moving the knob any more as soon as breakdown occurs.
6) Record the voltmeter reading and reset the konb and the voltmeter for the next observation.
7) Repeat the same test six times on the same cell filling. After each breakdown the oil is gently stirred so as to keep away the carbon practically formed between the electrodes .avoiding the production of air bubbles. Approximately a gap of 5min as recommended before two consecutive break downs .
8) Calculate arithmetic mean of the six RESULTs which is the reflective strength of the given sample.

Observations and calculations:

S. No	Brake down voltage (KV)	Dielectric strength in (KV/mm)
1	24	9.6
2	26	10.4
3	25	10
4	20	8
5	27	10.8
Avg	**24.40**	**9.76**

RESULT:-

By using HT oil testing for a given sample of oil the dielectric strength was determined.

L.V.D.T. – CHARACTERISTICS AND CALIBRATION

Linear Variable Differential Transformer (L.V.D.T.) – CHARACTERISTICS AND CALIBRATION

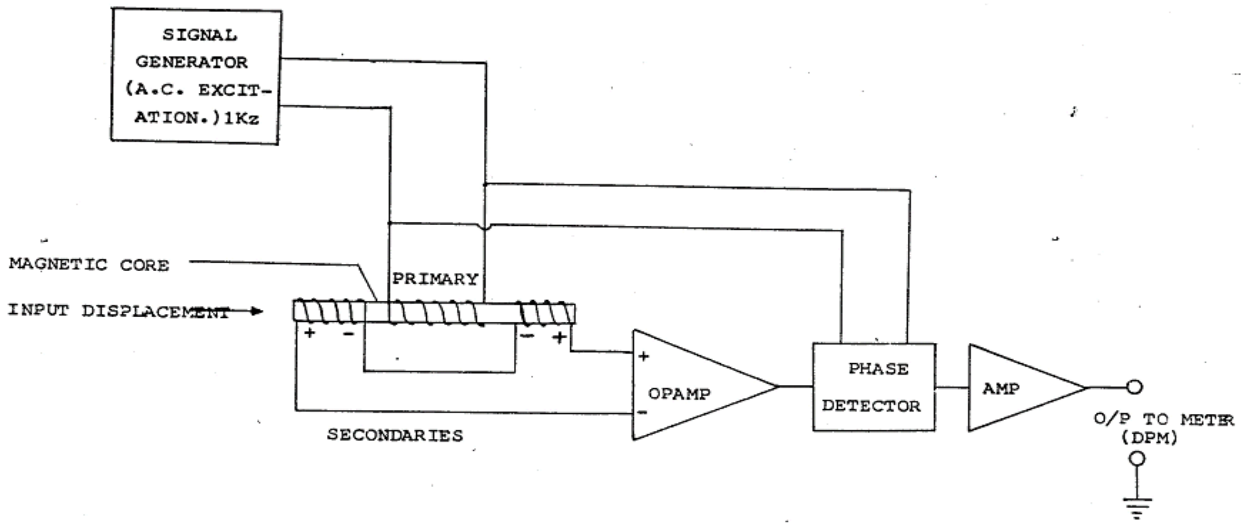
AIM :

To measure the electric voltage corresponding tothe Mechanical displacement of core.

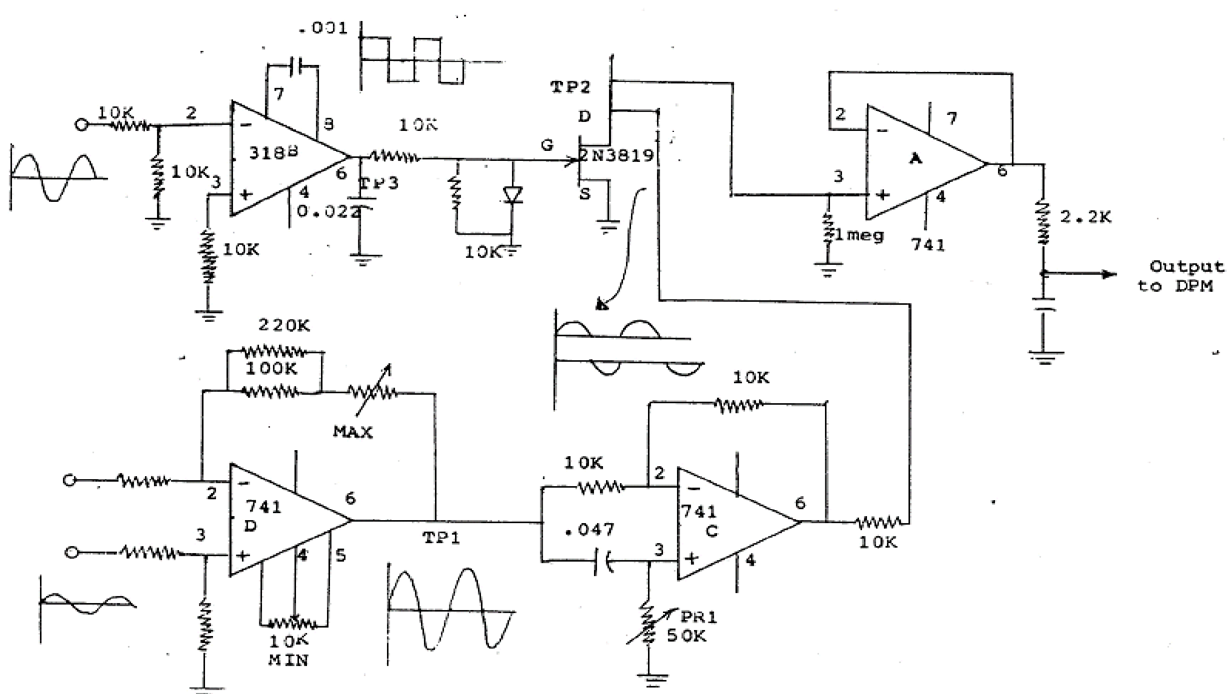
APPARATUS:

1. **Digital IT LVDT model.**
2. **LVDT with calibrated scale arrangement.**

CIRCUIT DIAGRAM:



Internal CIRCUIT DIAGRAM:



THEORY:-

One of the most useful variable inductance transducer is the differential transformer, which provides an a.c. voltage output proportional to the displacement of core passing through the windings. It is a mutual inductance device making use of three coils arranged generally on a single cylindrical concentric nonmagnetic form. The centre coil is energized from an external power source and the two end coils connected in series opposition to each other, are used as pick up coils, output amplitude and phase depend on the relative coupling between the two pick up coils and the primary coil. Relative coupling in them is dependent on the position of the core. Theoretically there should be core position for which, the voltage induced in each of the pick up coil or secondary will be of the same magnitude and Resulting output should be zero, because of series opposition connection.

PROCEDURE:

1. Connect the terminals marked "PRIMARY" on the front panel of the instrument to the terminals marked "PRIMARY" on the transducer itself, with the help of the flexible wires provided along with. Observe the Color code for the wires provided and the Color of the binding posts.
2. Identically establish connections from terminals marked "SECONDARY". Observe the Color code for the wires provided and the Color of the binding posts.
3. Keep pot marked "MAX" in most anticlockwise position.
4. The magnetic core may be displaced and the pointer may be brought to zero position. If the DPM is not indicating zero, use potentiometer marked "MIN" to get a zero on DPM at zero mechanical position. If the core is displaced in both directions, the meter must show indications with appropriate polarity. Now displace the core to 19 mm positions in one of the directions. Adjust the "MAX" pot to get an indication of 19.00 on the DPM under these conditions. Now the set up is ready for experimentation. You may again check for zero position also.
5. Now the core can be displaced by a known amount in the range of +19 and -19 mm and the meter readings can be entered in the table given below. It may noted that by inter changing the secondary terminals or the primary, the polarity of the meter indication can be reversed for a given direction of input displacement.
6. For LVDT provided with dial gage (range 0 to 10 mm or 0 to 15 mm), adjust the magnetic core carefully by rotating the control knob in the clockwise direction. Note that for these types (Dial gage type) arrangement, displacement in only one direction i.e. positive direction is possible. OPERATAE THE CONTROL KNOB VERY CAREFULLY.

1. Plot the graph of input displacement and the output indication on the X and Y axis respectively.

Maximum displacement 10 mm/15 mm/20 mm as per the model.

Important points to be noted:

a) Study the linearity of input and output displacements.

b) Note the effects of interchanging the secondary connections on the meter output polarity.

c) Note that when the core is mechanically at zero position, a small electrical output is obtained due to imperfections of the transducer.

PRECAUTIONS:

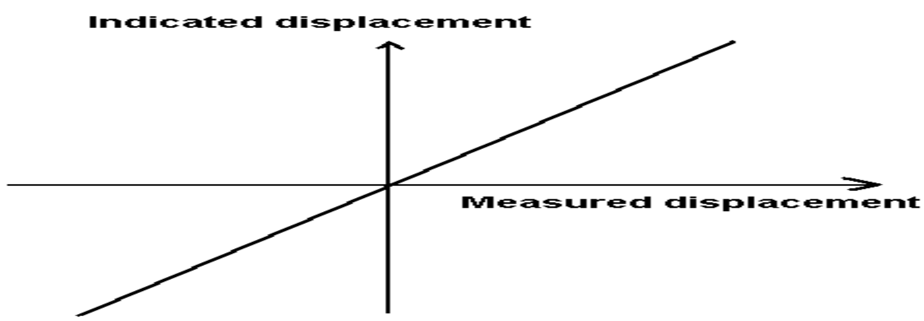
1. While connecting lead wire from panel to transducer, make proper connections following color code. Avoid shorting of the excitation source terminals.

2. Move the core with a gentle fashion by operating the knob for core movement very carefully. Do not try to effect the core movement beyond 10 mm/ 15 mm / 20 mm as per the given range.

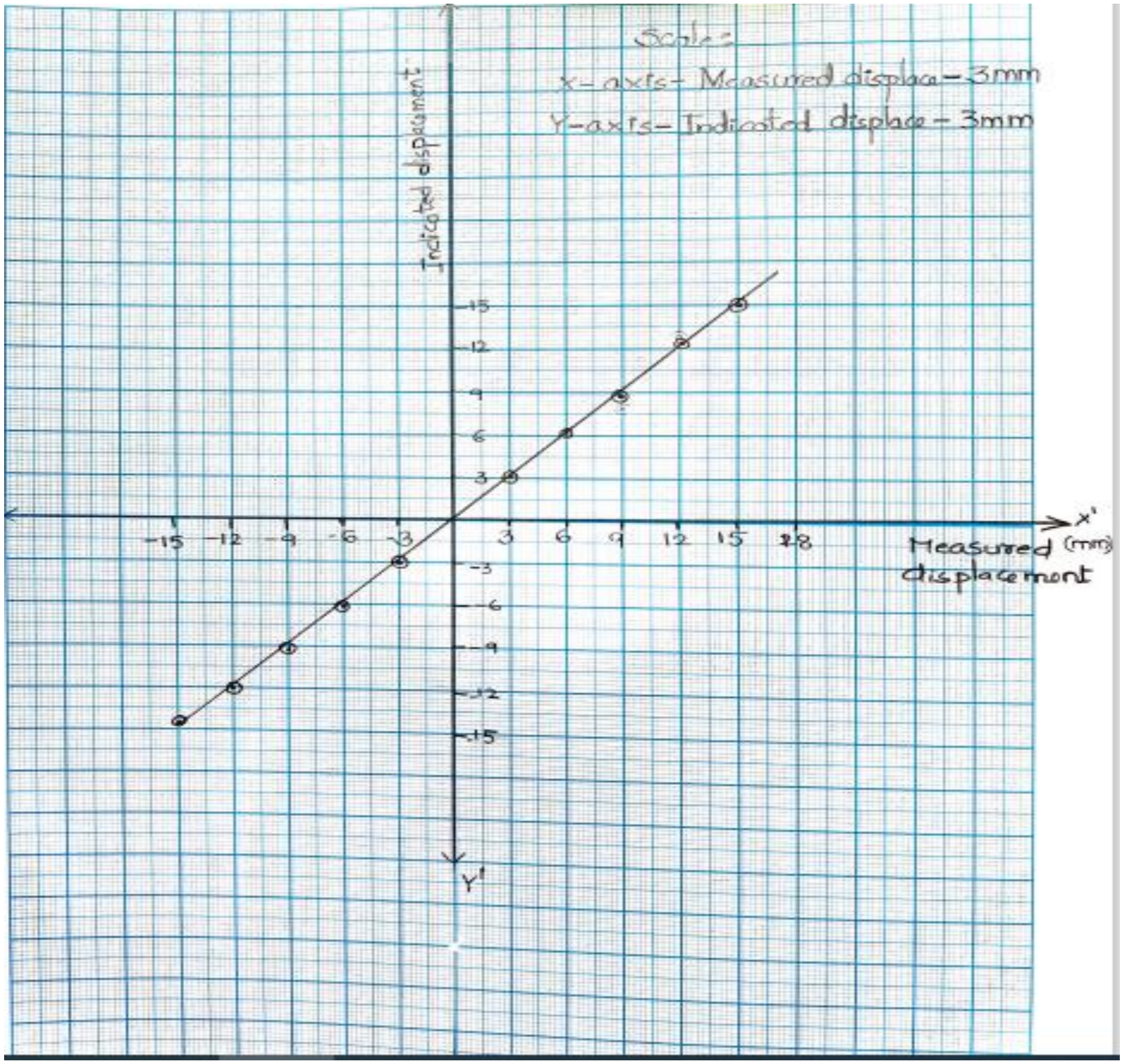
Observations:

S. No.	Input displacement	Output indication	% Error
1	15	15	0
2	12	12.3	-2.5
3	9	8.9	1.1
4	6	6.02	-0.33
5	3	3.14	-4.66
6	0	0	0
7	-3	-3.02	-0.66
8	-6	-6.02	-0.33
9	-9	-9.03	-0.33
10	-12	-12.06	-0.50
11	-15	-14.85	1.00

MODEL GRAPH:



GRAPH:



RESULT:

The electric voltage corresponding to mechanical displacement of the core is measured.

RESISTANCE STRAIN GAUGE – STRAIN MEASUREMENT AND CALIBRATION

RESISTANCE STRAIN GAUGE – STRAIN MEASUREMENT AND CALIBRATION

AIM :

To study the performance characteristics of a Strain Gauges.

EQUIPMENT DESCRIPTION

Strain Gauge Transducer Trainer Kit is designed for the students of Instrumentation Course. It allows the students to understand the concept Strain Gauge, its application and its associated electronic circuits.

This trainer kit consists of:

(i) Strain Gauge Transducer Four banded metal foil strain gauges are mounted on a cantilever with arrangement to fix some load on it to generate the deformation.
(ii) Electronic circuitry along with a 31/2 digit DVM

Specification:

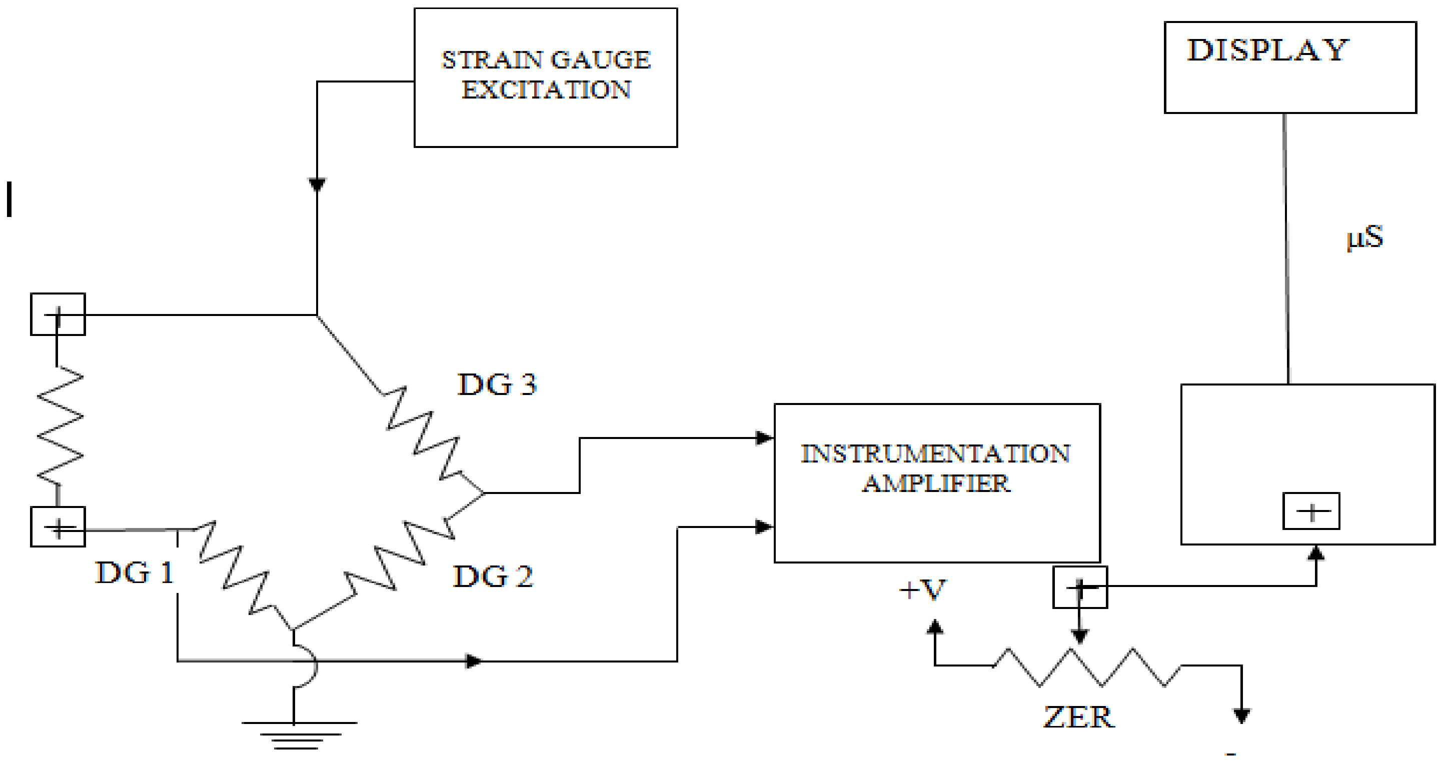
(i) Strain Gauge Transducer : Strain Gauge based
Measuring Range : 1000µS.
Non-linearity errors : ± 1 %
Resolution : 1 µS.

(ii) Electronic Circuit
Excitation Source : DC Excitation (5 Volt)
Amplifiers : Instrumentation and Inverting Summing Amplifier with Zero & Gain adjustment
Termination : For 4 arm strain gauge bridge.
Dummy Gauges : 3 nos. provided

(iii) DPM
Display : 31/2 Digit LED
Range : 0 - 2000 mV F.S.

(iv) Power Supply The kit has number of IC regulated power supplies which are permanently connected to all the circuits.
No external D.C. supply should be connected to the unit.
Only 230V ±10%, 50Hz mains supply is required to operate the kit.

STRAIN GAUGE TRAINER



THEORY:

Strain Gauge

If a metal conductor is stretched or compressed, its resistance changes on account of the fact that both length and diameter of conductor change. Also there is a change in the value of resistivity of the conductor when it is strained and this property is called piezo resistive effect.If a conductor of elastic material is subjected to tension or in other words positively strained, its longitudinal dimensions will increase while there will be a reduction in the lateral dimensions. So when a gauge is subjected to a positive strain, its length increases while its area of cross-section decrease. Since the resistance of a conductor is proportional to its length and inversely proportional to its area of a cross-section, the resistance of the gauge increases with positive strain.

The resistance of unstrained gauge is

$$R = \frac{\rho L}{A}$$

Where L is length, A is cross section area and ρ is the resistivity of wire.

The gauge factor is defined as the ratio of per unit change in resistance to per unit change in length.

$$G_f = \frac{\Delta R/R}{\Delta L/L}$$

The gauge factor can be written as

$$G_f = 1 + 2\,v\frac{\Delta\rho/\rho}{\epsilon}$$

The strain is usually expressed in terms of micro strains

1 micro strain = μm/m

Types of strain Gauges:

The following are the major types of strain Gauges

- Un-bounded metal strain gauges
- Bonded metal wire strain gauges
- Bonded metal foil strain gauges
- Vacuum deposited thin metal film gauges.
- Sputter deposited these metal strain gauges.
- Bonded semi conductor strain gauges
- Diffused metal strain gauges.

For the experimental cantilever beam,

The strain is given by

$$\epsilon = \frac{\sigma}{E}$$

Where

$$\sigma = \frac{6FL}{wt^2}$$

where L = length of cantilever beam (m)
t = thickness of cantilever beam (m)
w = width of cantilever beam (m)
E = modulus of Elasticity (N/m2)
F = the applied force (N)

For the experimental cantilever beam
L = 125 mm = 125 x 10^{-3} m
T = 2.0 mm = 2.0 x 10^{-3} m
w = 25.0 mm = 25.0 x 10^{-3} m
E = 210 x 10^{9} N/m^2

For 1 Kgf force applied on one end of cantilever

$$\sigma = \frac{(6x\ 1\ x\ 9.80665\ x\ 125\ x10^{-3})}{25.0\ x\ 10^{-3} x\ (2.0\ x\ 10^{-3})^2} \text{(1 Kgf = 9.80665N)}$$

= 73.549875 x10^{6} N/m^2

Hence $\in = \frac{\sigma}{E} = \frac{73.549875\ x10^{6}}{210x\ 10^{9}}$

E = 350.2375 x 10^{-6} 11S

So that for 1Kgf. force 350 µS will be developed in the present cantilever beam.

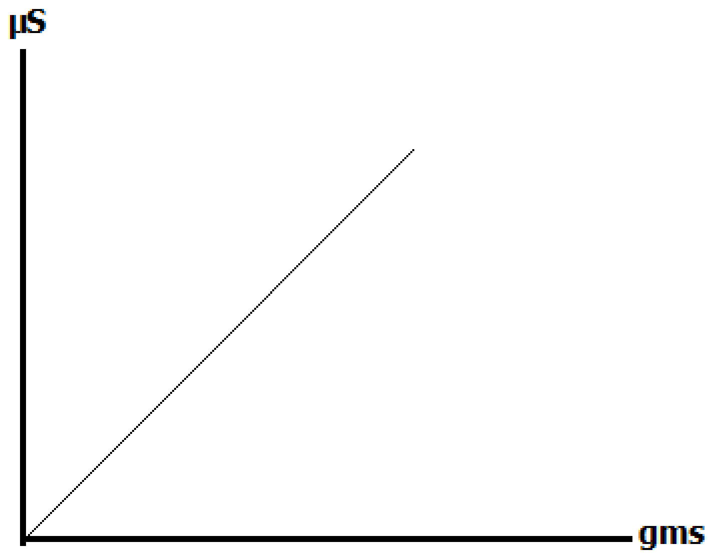
Procedure:

1. Connect the cantilever beam leads with the trainer kit terminals.
   Yellow lead with yellow terminal. Black lead with black terminal.
2. Connect the 3 pin mains plug of the kit to the mains socket (230V± 1 0%,501-1z power supply).
3. Switch on the trainer kit, the display will light up, and will show some reading.
4. Adjust zero pot to set 0.00 reading on display, without apply any load on the pan.
5. Put 1 Kgs. weight on the pan of the cantilever beam, and adjust span pot to show 350 reading on display.
6. Repeat steps 4 to 5.
7. Now apply loads in steps of 50/ 100 gms. and note down the reading in the following Table in increasing and decreasing mode.
8. Now plot the graph between applied load and DVM reading in p.S. with a resolution of 11 AS and measure non-linearity, hysteresis error etc.

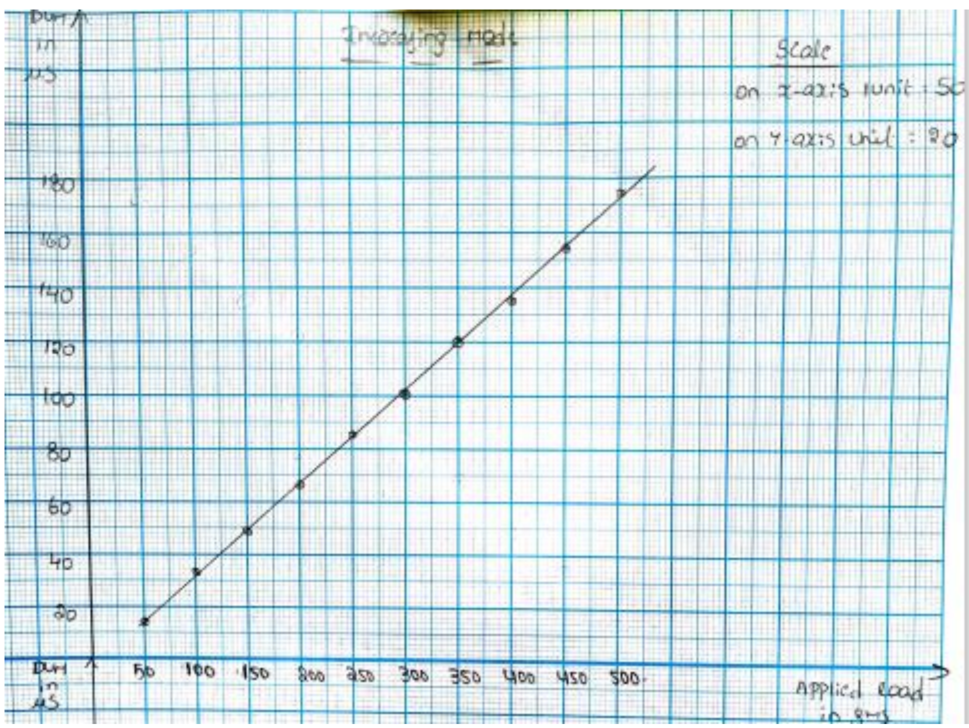
Observations:

S. No.	Reading in Increasing mode	
	Applied load in gms.	DVM in µS
1	50	17
2	100	33
3	150	49
4	200	67
5	250	85
6	300	103
7	350	122
8	400	137
9	450	156
10	500	175

MODEL GRAPH:



GRAPH:



RESULT:

The performance characteristics of Strain Guage are studied and the corresponding graphs were drawn.

HALL EFFECT SENSOR

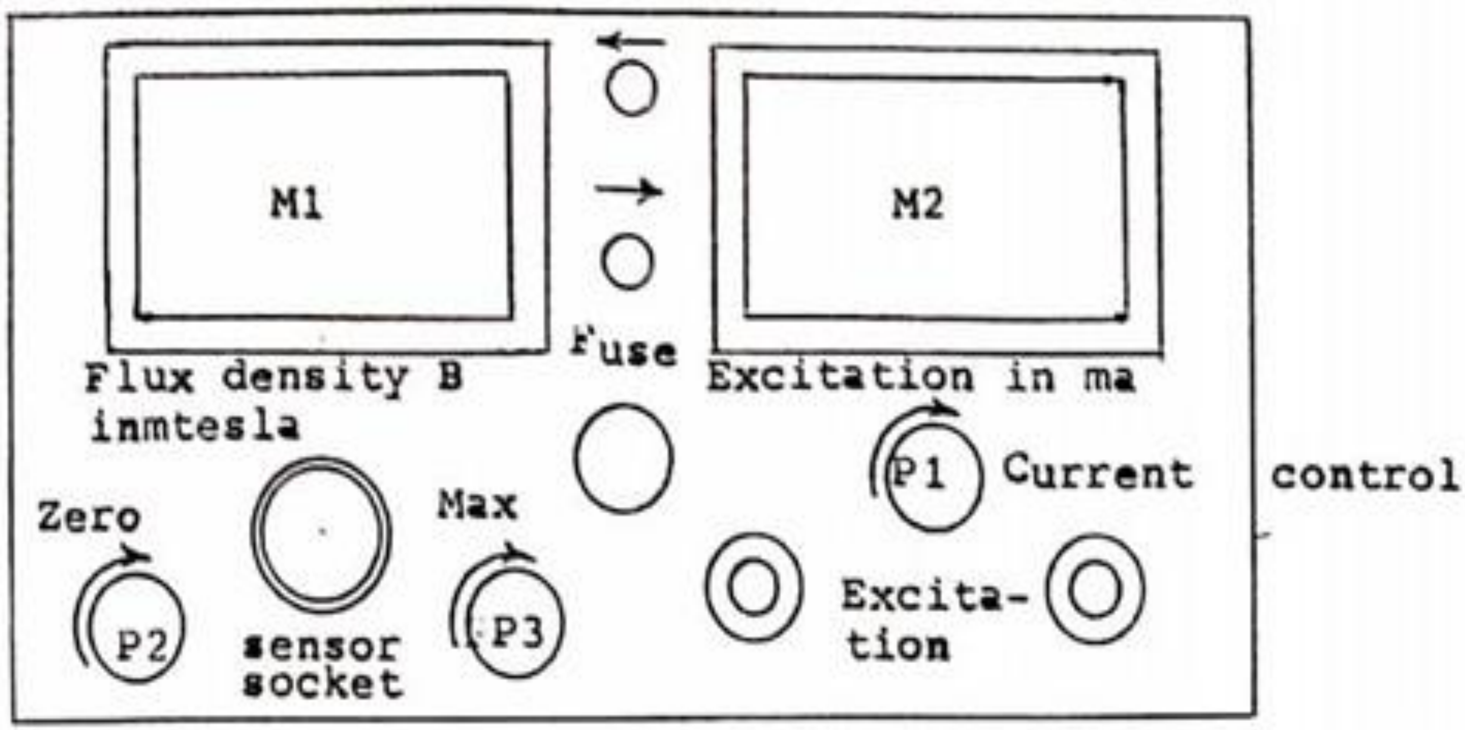
HALL EFFECT SENSOR

AIM : To measure the magnetic flux density produced by a current by using Hall effect sensor.

APPARATUS:

1. **Hall Effect Sensor modular set.**

CIRCUIT DIAGRAM:



FRONT VIEW OF HALL SENSOR TESTER.

THEORY:-

Magnetic field inside a coil is: $B = 2\pi KnI$ newtons/amp-metre.

Constant $K = 2.00 \times 10^{-7}$ newtons/amp^2

A long thin solenoid produces an axial magnetic field given by:

$B = \mu_o nI$ newtons/ amp-metre where μ_o is $2\pi K = 4\pi \times 10^{-7}$

n is number of turns **per metre length of solenoid. Number of turns / Length inmetres**

I is current through the coil **in amps.**

Connect the Hall probe to the socket on the front panel. Connect a calibration coil (an Air Cored Solenoid) to the terminals provided on the Constant Current Power Supply.

Importantnote: The magnetic field in the solenoid must be in the correct N-S direction or the Hall device cannot provide an output to the instrument. The magnetic field being measured must always pass through the Hall Effect device directly through its flatsurface.

To ensure this, be sure that the handle of the Hall probe is mounted so that it lies along the centre line and is parallel to the axis of the solenoid coil.

THEORITICAL CALCULATIONS:-

The coil has the following data

Turns : 1600. Length of the coil 19.2 cms

R = 27.3 ohms. We have,

$B = \mu_0 I_0 n$ (I_0 = Coil current in Amperes)

Where n = Turns/meter

μ_0 = permeability of free space.

$= 4*3.14*10^{-7}$ T*m/A

$B = \mu_0 I_0 n$

$= 4*3.14*10^{-7}*1600/0.192*0.4$A

$= 12.56*10^{-3}*0.8333*0.4$

= 4.14 millitesla.

This means that for a current of 400mA, the inside of the coil must have

B = 4.14millitesla.

PROCEDURE:

1. Connect the 5 Pin Amphenol cable to the socket marked "**Sensor**" on the main panel.

2. Keep pot P1 voltage output control for the current source to the most anticlockwise i.e. minimum position.

3. Switch on the mains power supply and adjust pot P2 to get 00.0 on the left hand side DPM used for magnetic field density B in millitesla. Wait for a warm up time of about 5 to 10 minutes, then connect the standard coil marked "**Standard**" for calibration of the set up, to the power supply on the front panel.

Adjust the current to 400mA and check for flux density indication. Adjust the pot P3 (MAX) so that indication is 4.1mT.

Do not keep the current passing through the coil continuously. If necessary check for 0.0 indication when patch cord from current source is removed. If necessary adjust P3 again for a current excitation of 400mA.

For 200mA current, the indication should be 2.0mT. you may note that B is directly proportional to current excitation. This completes the calibration process. Now do not disturb the MIN and MAX potentiometers.

4. Now you may take other coil with 33cm length. For this coil, calculate value of B for current excitation of 200 mA. The coil has number of turns equal to 2300. Calculate value of B for 100 mA also and check for the same on the instrument after the calibration check has been completed.

5. Inside the coil you may note that when the sensor is kept parallel to the axis, value of B is almost same, except at the coil ends. Inside the cross section also this holds true.

6. You may change the direction of current and check for the magnetic field intensity. We observe that a negative value of B is indicated. For negative indications, it is advised that 0.00 should be adjusted as -0.00. Do not keep the current passing through the coil continuously to avoid temperature effects.

7. You can also investigate magnetic flux density around a permanent magnet.

8. Adjust zero if the same changes because of temperature effects.

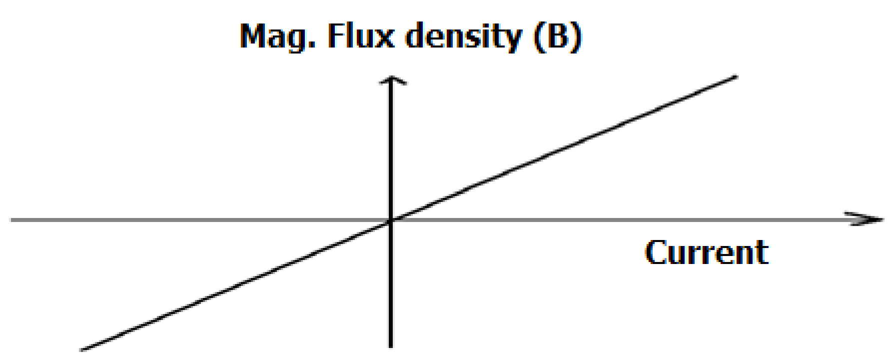
PRECAUTIONS:

1. Do not tamper with the probe as it is very delicate. Do not drop it.
2. Do not keep the probe inside a heated solenoid coil.
3. Avoid solenoid heating and allow the current to be passed on only for measurement duration.
4. Do not short the terminals of power supply.
5. Operate the potentiometers in a gentle fashion.
6. Store the solenoids and the instruments along with the probe carefully.

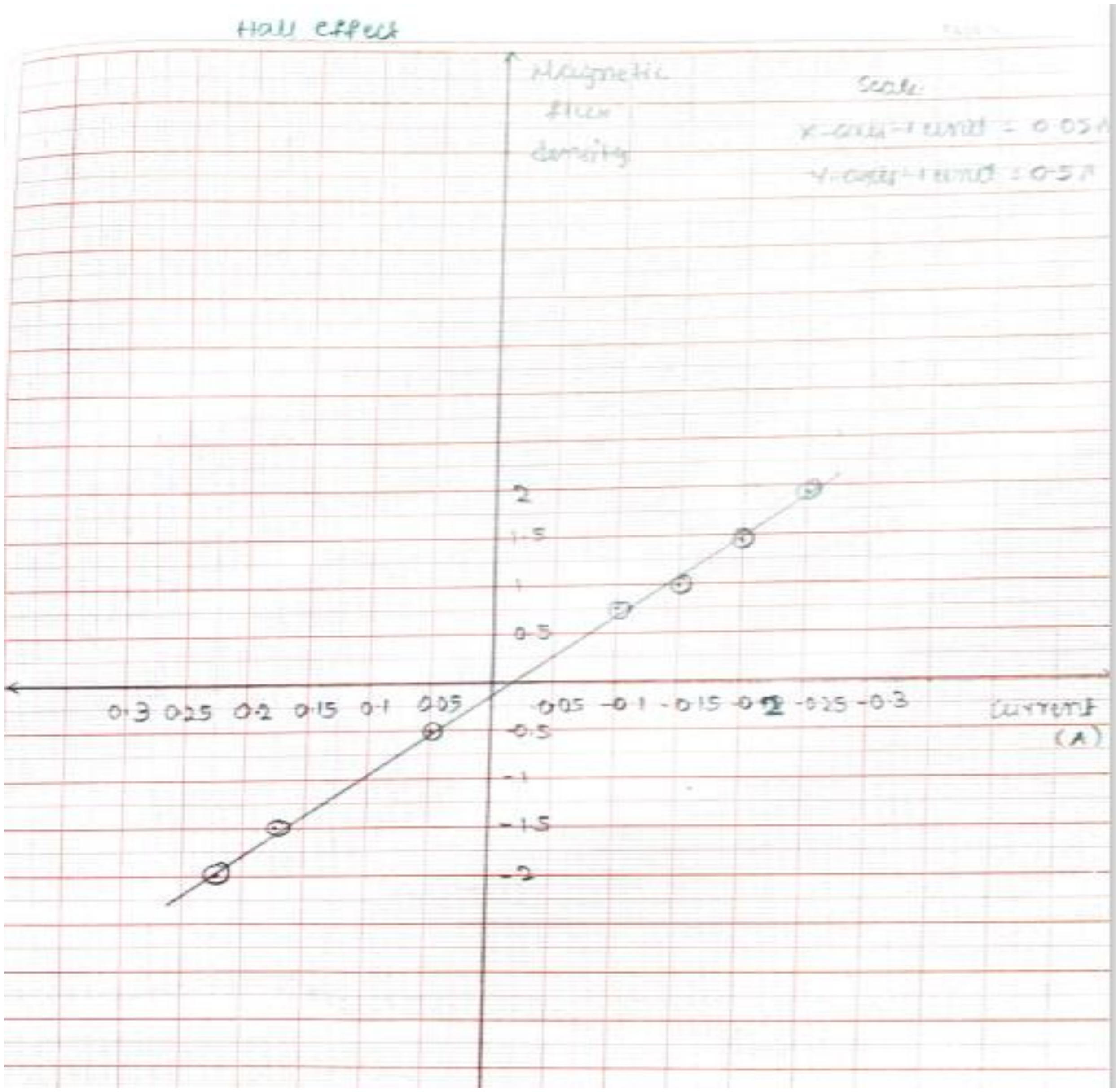
Observations:

S. No.	Current (mA)	Magnetic Flux Density (B)	
		Forward	Reverse
1	270	1.8	-1.6
2	250	1.6	-1.5
3	200	1.3	-1.2
4	150	1	-0.8
5	100	0.7	-0.5
6	50	0.4	-0.2
7	25	0.2	-0

MODEL GRAPH:



GRAPH:



RESULT:

The magnetic flux density of the coil is measured by using Hall effect sensor.

MEASUREMENT OF SELF INDUCTANCE BY OWEN BRIDGE

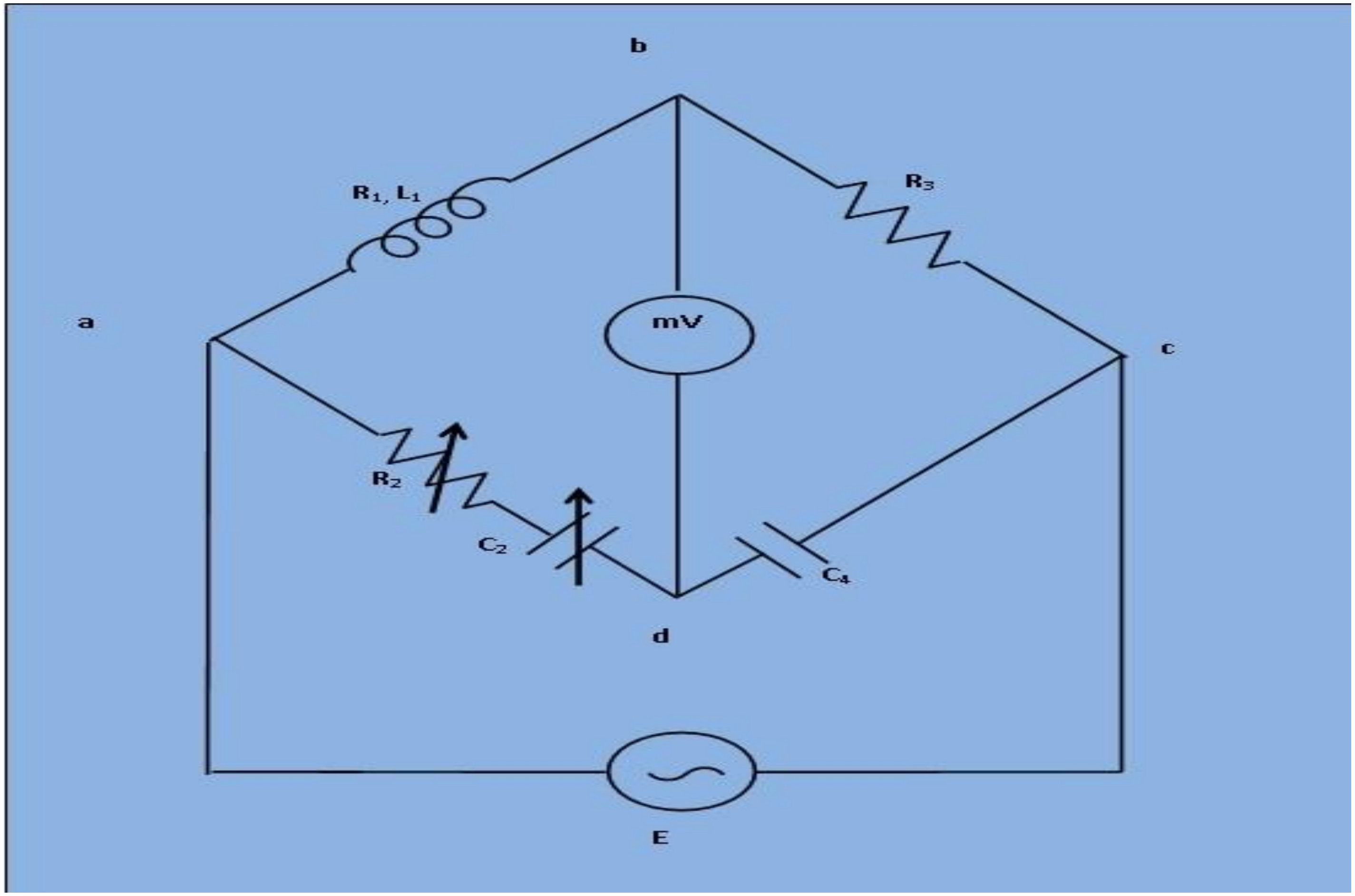
MEASUREMENT OF SELF INDUCTANCE BY OWEN BRIDGE

AIM: To determine the self-inductance of an unknown coil.

Minimum System Requirement:

- A standard PC running Microsoft Windows XP, Windows Vista.
- 512MB RAM and 500 MB of available hard-disk space is recommended
- 1024x768 or higher screen resolution;
- a mouse or other pointing device
- A CD-ROM drive

CIRCUIT DIAGRAM:



THEORY:

This bridge may be used for measurement of an inductance in terms of capacitance. Fig. shows the connections for this bridge, under balance conditions.

Let,
L_1= Unknown self Inductance of resistance R_1,
R_2= Variable non-inductive resistance,
R_3= Fixed non-inductive resistance,
C_2= Variable standard capacitor,
C_4= Fixed standard capacitor.
At balance condition,

$$(R_1+j\omega L_1)\cdot(1j\omega C_4)=(R_2+1j\omega C_2)\cdot R_3........(1)$$

Equating both the real and imaginary parts in eq.(1) and separating them,

$$L_1=R_2R_3C_4........(2)$$

$$R_1=R_3\cdot C_4C_2........(3)$$

The balance may be obtained by variation of resistance R_2 and capacitor C_2.

PROCEDURE:

1) Apply Supply voltage from the signal generator with arbitrary frequency. (V =3v). Also set the unknown Inductance value from 'Set Inductor value' tab.
2) Then switch on the supply to get milli voltmeter deflection.
3) Choose the values of R_2, R_3, C_2 and C_4 from the resistance and capacitance box. Very the values of R_2 and C_2 by fixing the values of R_3 and C_4 to some particular values to achieve Null.
4) Observe the milli voltmeter pointer to achieve "NULL".
5) If "NULL" is achieved, switch to 'Measure Inductor value' tab and click on 'Simulate'. Observe the calculated values of unknown inductance (L_1) and unknown internal resistance (R_1) of the inductor.

6) Also observe the Dissipation factor of the unknown inductor which is defined as ωLR. Where, $\omega=2\pi f$.

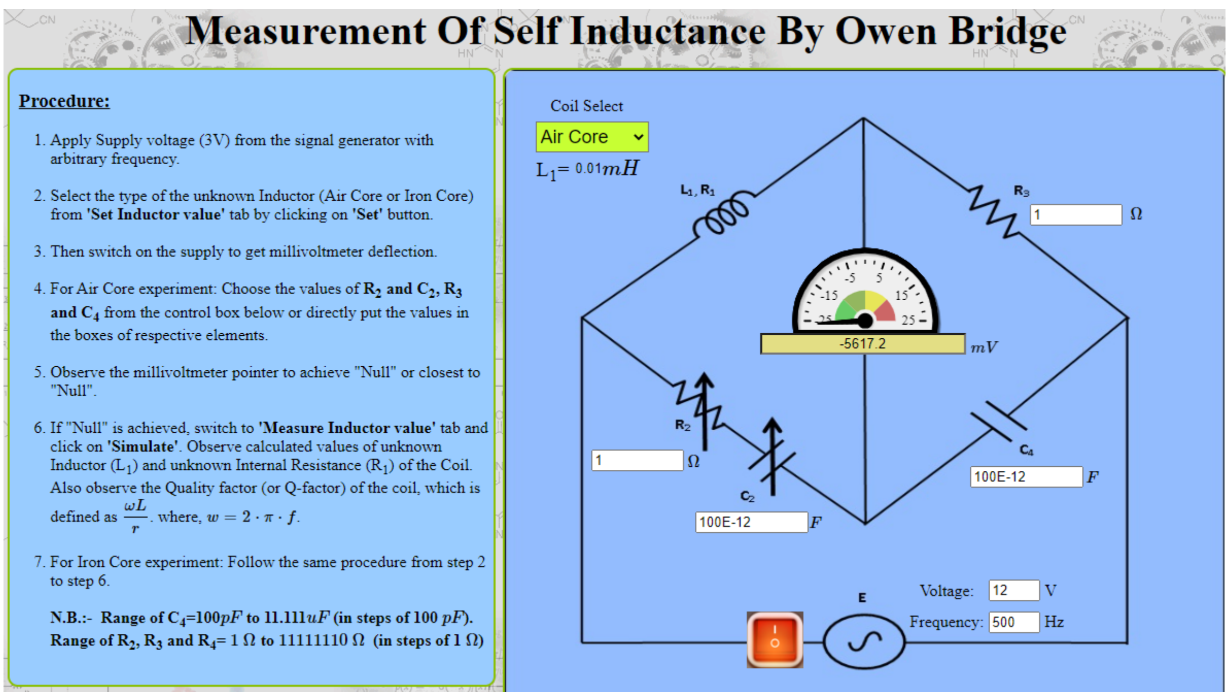
SIMULATOR:

Pre-Requisite to run the Simulator:

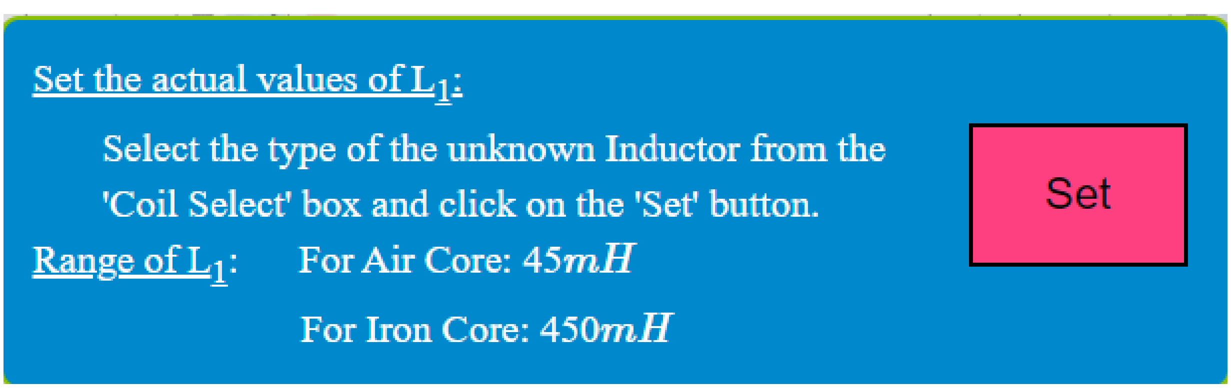
The simulator for this experiment is designed based on JavaScript platform combined with HTML5 Canvas for graphics. So the users are recommended to use browsers with HTML5 compatible.

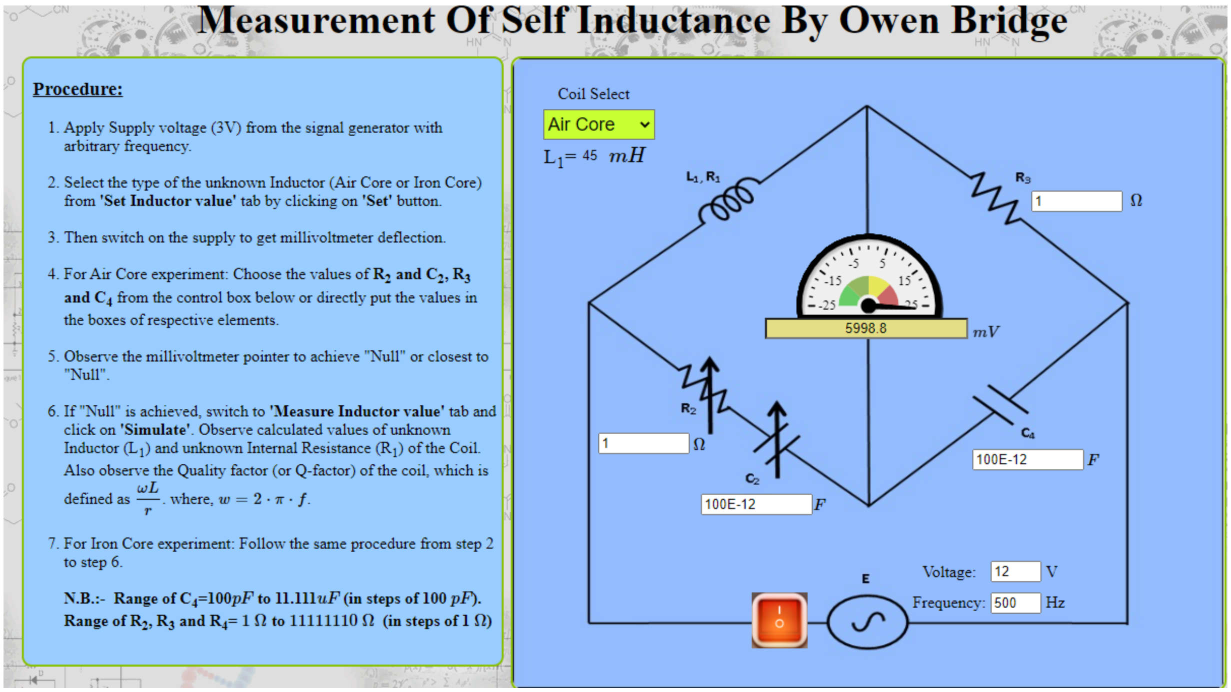
Link to the simulator:

http://vlabs.iitkgp.ac.in/asnm/exp20/js-simulator/owen.html

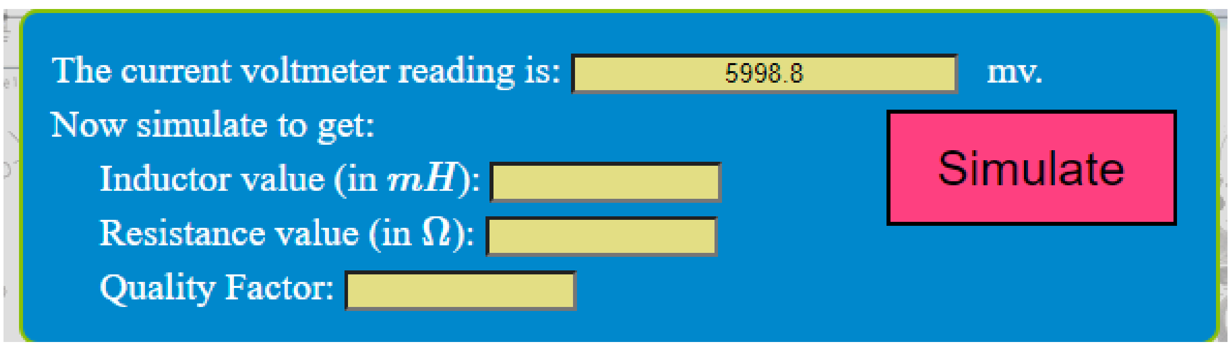


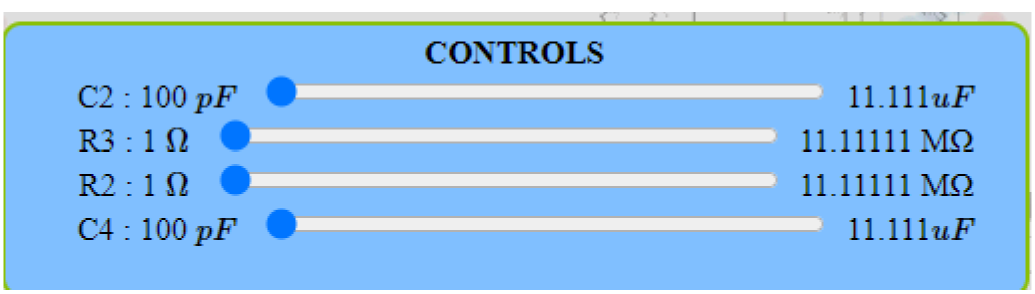
SET INDICATOR VALUES:





MEASURE INDUCTOR VALUE:





Observations:

S. No.	Voltage (V)	Frequency (f) (Hz)	L_{set}	R_2 (Ω)	R_3 (Ω)	C_2 (F)	C_4 (F)	$L_{measure}$ (mH)
1	3	500	Air core	57871	10^{-10}	9999	10^{-10}	57.8
2	3	500	Iron core	57871	10^{-10}	10098	10^{-10}	58.438

RESULT:

The self inductance of an unknown coil found on owen bridge.

MEASUREMENT CAPACITANCE BY WIEN SERIES BRIDGE

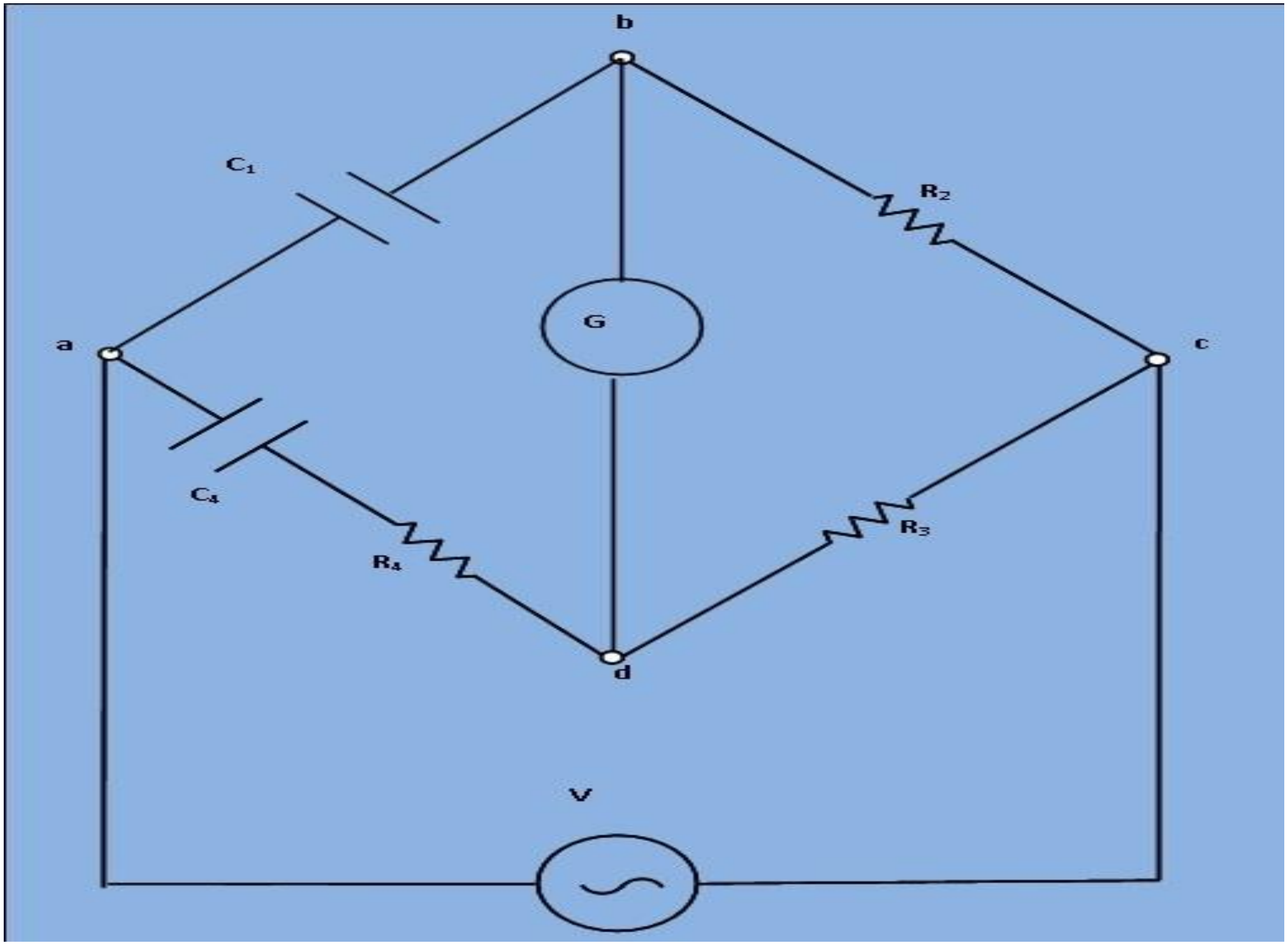
MEASUREMENT CAPACITANCE BY WIEN SERIES BRIDGE

AIM: To determine the capacitance of an unknown capacitor.

Minimum System Requirement:

- A standard PC running Microsoft Windows XP, Windows Vista.
- 512MB RAM and 500 MB of available hard-disk space is recommended
- 1024x768 or higher screen resolution;
- a mouse or other pointing device
- A CD-ROM drive

CIRCUIT DIAGRAM:



THEORY:

Let,

C_1= Capacitor whose capacitance is to be measured,

R_1= A series resistance representing the loss in the capacitor C1,

C_4 = A standard capacitance with series resistance of R_4,

R_2 and R_3 = Non-inductive resistances.

At balance,

$$(R_1+1j\omega C_1)\cdot R_3=(R_4+1j\omega C_4)\cdot R_2 \text{ ....(1)}$$

$$R_1R_3+R_3j\omega C_1=R_2R_4+R_2j\omega C_4 \text{ ....(2)}$$

Equating the real and imaginary terms,

$$R_1R_3=R_2R_4$$

$$R_1=R_2R_4R_3$$

and , $R_3j\omega C_1=R_2j\omega C_4$

$$C_1=C_4R_3R_2$$

If the bridge is used to measure capacitance , it may be written as

$$C_1=C_4R_3R_2\text{..........(3)}$$

$$R_1=R_2R_4R_3\text{..........(4)}$$

The dissipation factor of capacitance C_1 is defined as,

$$D_1=\omega C_1R_1\text{..........(5)}$$

While in measurement of capacitance C1 , R1 is not a separate unit but represents the equivalent series resistance of the capacitor and thus can be determined in terms of the elements of the bridge.

PROCEDURE:

1) Apply supply voltage from the signal generator V=3V at frequency 50Hz. Also set the unknown capacitance value from 'Set capacitor value' tab.

2) Then switch on the supply to get milli voltmeter deflection.

3) Choose the values of R_2, R_3, R_4 and C_4 from the resistance and capacitance box.

4) Observe the milli voltmeter pointer to achieve "Null".

5) If "NULL" is achieved, switch to 'Measure capacitance value' tab and click on 'Simulate'. Observe calculated values of unknown capacitance (C2) and unknown internal resistance (r_2) of the capacitor.

6) Also observe the Dissipation factor of the unknown capacitor which is defined as $\omega \cdot C \cdot r$. Where, $\omega = 2\pi f$.

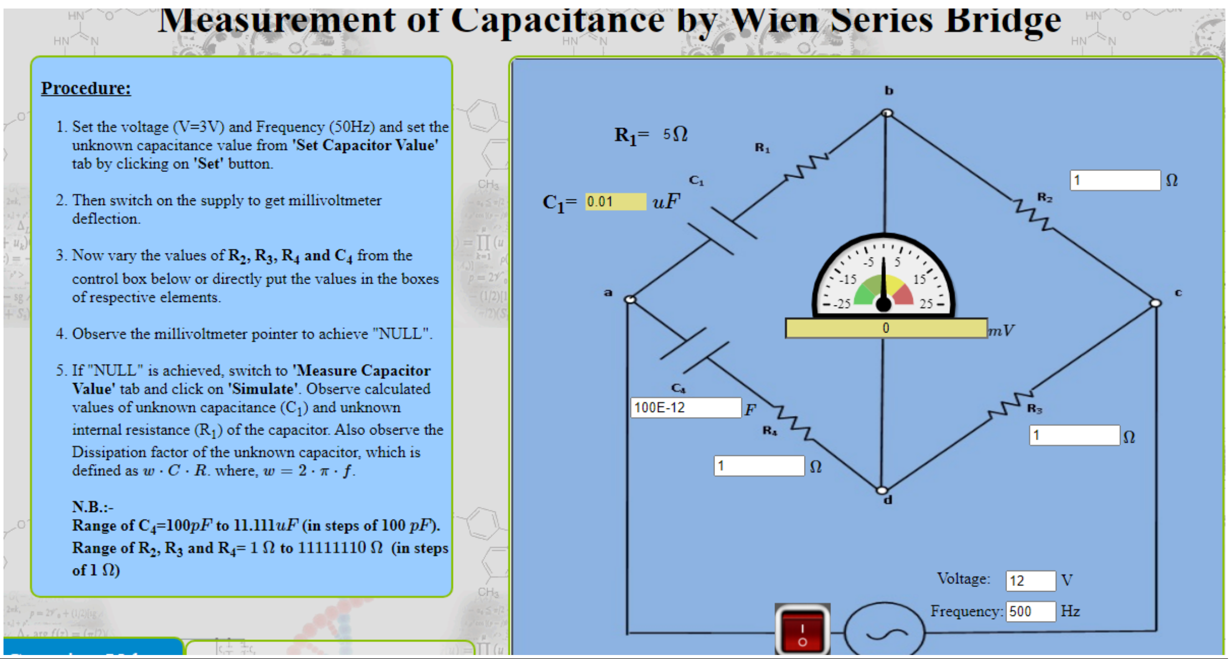
SIMULATOR:

Pre-Requisite to run the Simulator:

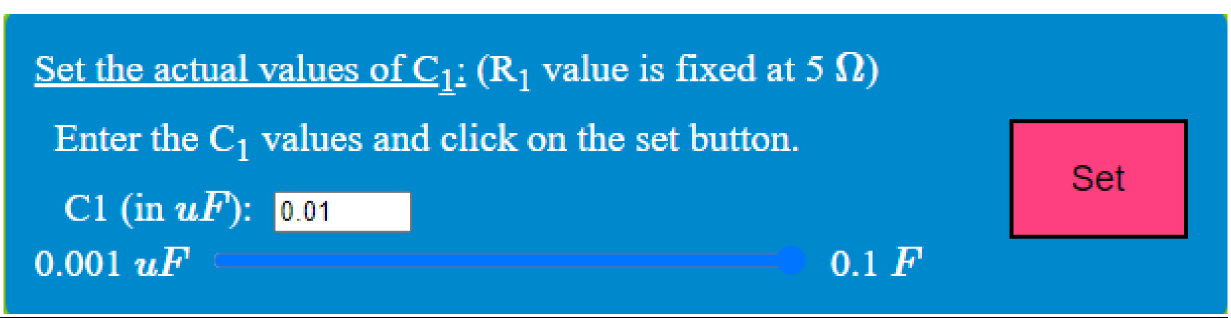
The simulator for this experiment is designed based on JavaScript platform combined with HTML5 Canvas for graphics. So the users are recommended to use browsers with HTML5 compatible.

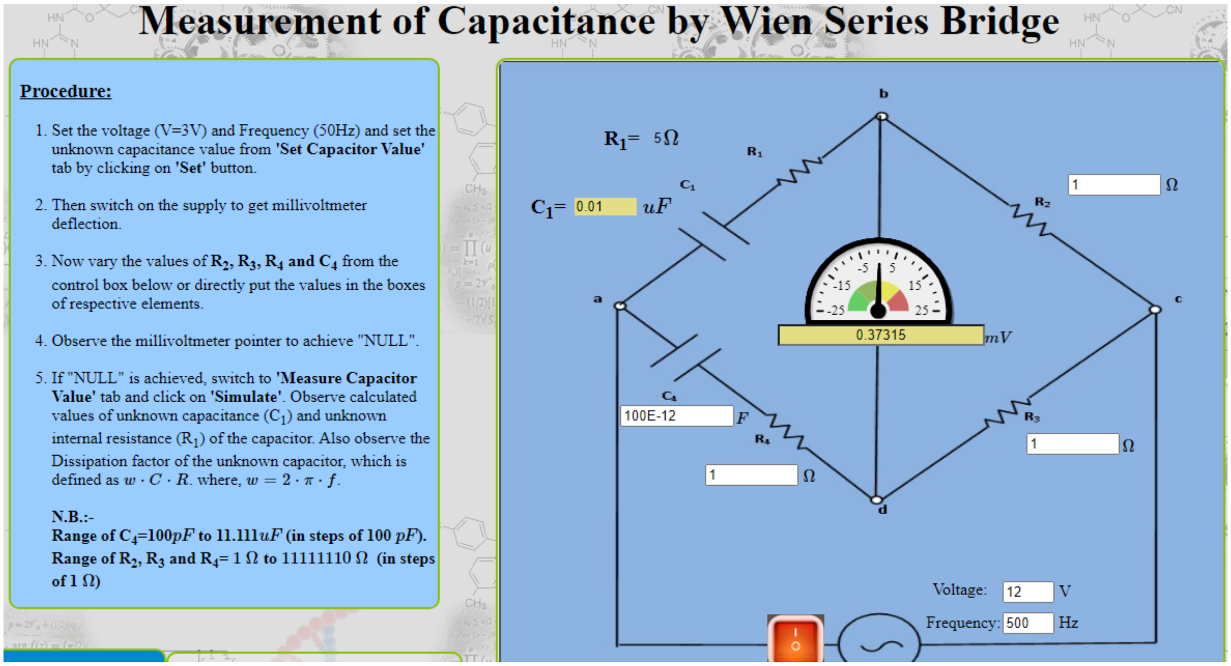
Link to the simulator:

http://vlabs.iitkgp.ac.in/asnm/exp16/js-simulator/wien_website.html

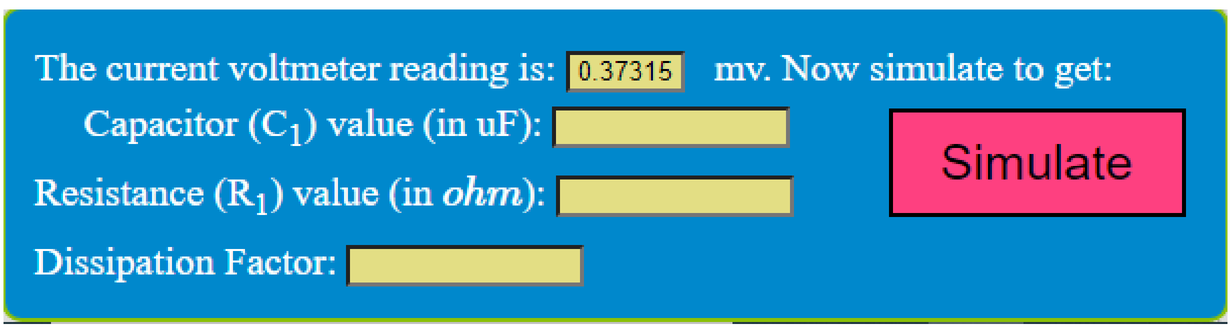


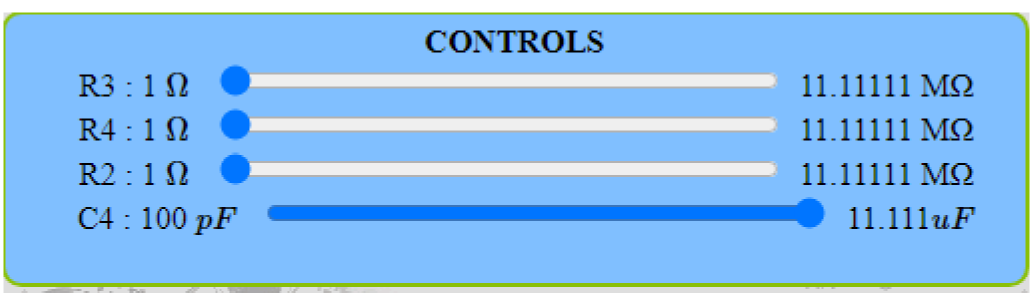
SET CAPACITOR VALUE:





MEASURE CAPACITOR VALUE:





Observations:

S. No.	Voltage (V)	Frequency (F)	R_2 (Ω)	R_3 (Ω)	R_4 (Ω)	C_4 (μf)	C_1 (μf)	C_{mea} (μf)
1	3	50	1Ω	1Ω	1Ω		0.01	0.001
2	3	50	1Ω	1Ω	1Ω		0.001	0.001

RESULT:

The capacitance of a capacitor found by using wien series bridge.

Q METER EXPERIMENT – TO DETERMINE THE QUALITY FACTOR OF AN UNKNOWN COIL

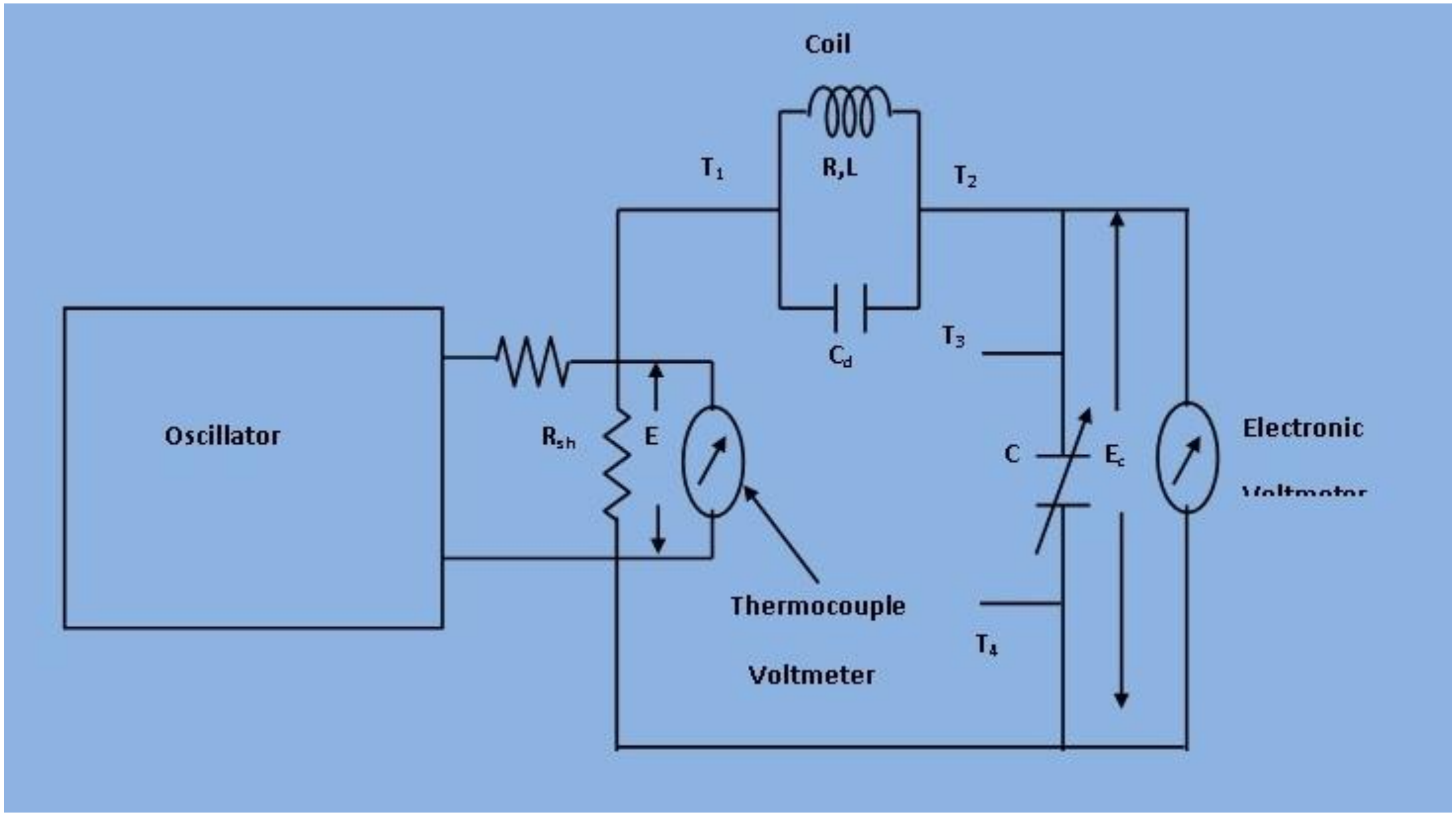
Q METER EXPERIMENT – TO DETERMINE THE QUALITY FACTOR OF AN UNKNOWN COIL

AIM: To determine accurate Quality Factor of an unknown coil.

Minimum System Requirement:

- A standard PC running Microsoft Windows XP, Windows Vista.
- 512MB RAM and 500 MB of available hard-disk space is recommended
- 1024x768 or higher screen resolution;
- a mouse or other pointing device
- A CD-ROM drive

IRCUIT DIAGRAM:



THEORY:

Measurement of Q:

The circuit for measurement of Q shown in Figure 1. The oscillator is set to the desired frequency and then the tuning capacitor is adjusted for maximum value E_0. The input voltage E is kept constant then the voltage across capacitor is calibrated to read the value of Q directly. The measured value of Q is defined whole circuit not of the coil. There are errors caused due to shunt resistance and distributed capacitance of the circuit.

Correction of Distributed Capacitance.

$$Q_{true} = Q_{meas}\left(1+\frac{C_d}{C}\right) \text{......2}$$

Where, C_d=distributed capacitance and C=tuning capacitance

Measurement of Self Capacitance:

The value of Inductance is given by $L = \frac{1}{4\Pi^2 \int_0^2 C}$ 1

The values of f_0 and C are known and therefore the value of inductance may be calculated.

Measurement of Effective Resistance:

The value of effective resistance may be computed from the relation

$$R = \frac{w_0 L}{Q_{true}} \text{....2}$$

Measurement of Self Capacitance:

The self capacitance is measured by making two measurements at different frequencies. The capacitor is set to a high value and the circuit is resonated by adjustment of the oscillator frequency. Resonance is indicated by the circuit Q meter. Let the values of tuning capacitor be C_1 and that of frequency be f_1 under these condition. Therefore,

$$f_1 = \frac{1}{2\pi\sqrt{L(C_1 + C_d)}} \text{.......3}$$

The frequency is now increased to twice its initial value and the circuit is resonated again this time with the help of the tuning capacitor. Let the values of tuning capacitor be C_2 and that of frequency be f_2 under these condition. Therefore,

$$f_2 = \frac{1}{2\pi\sqrt{L(C_2 + C_d)}} \text{.......4}$$

Now, $f_2 = 2 \cdot f_1$

The distributed capacitance,

$$C_d = \frac{C_1 - 4C_2}{3} \text{.........5}$$

PROCEDURE:

1. Set the Shunt Resistance (R_{sh}) value as small as possible (Say 0.02 Ohm). Set all the parameters (R, L, C) by yourself.
2. Set the voltage value of the oscillator (E=10 V).
3. At f=100 Hz. Check the value of voltage drop across capacitor. (E_C).
4. Change the frequency until E_C reach at the maximum value. Then calculate the value Q measured using this formula
$$Q_{meas} = \frac{\omega_0 L}{R + R_{sh}}.$$
5. Calculate the true value of unknown coil by using this formula
$$Q_{true} = \frac{\omega_0 L}{R}$$
6. First resonance occurs due to frequency (say f_1). Note down the value of tuning capacitor C. (say C_1). Double the input frequency (f_1) (say $f_2=2*f_1$). Change the tuning capacitor value until resonance occurs. Note down the value of tuning capacitor C. (say C_2). Discharge capacitance (C_d) would be $=(C_1-4*C_2)/3$.

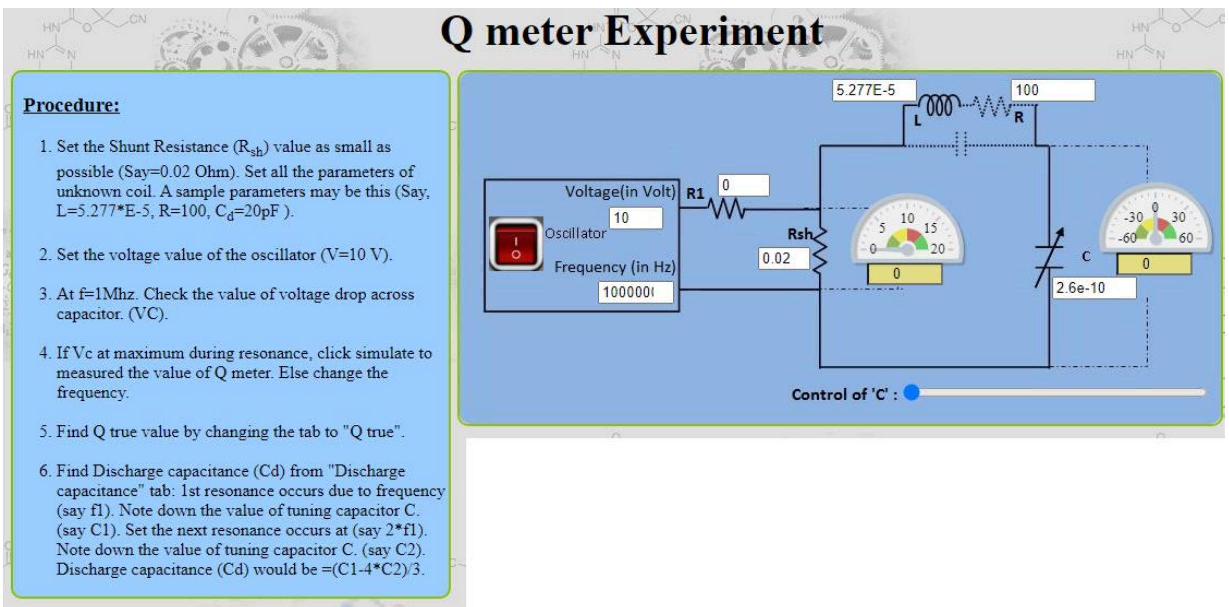
SIMULATOR:

Pre-Requisite to run the Simulator:

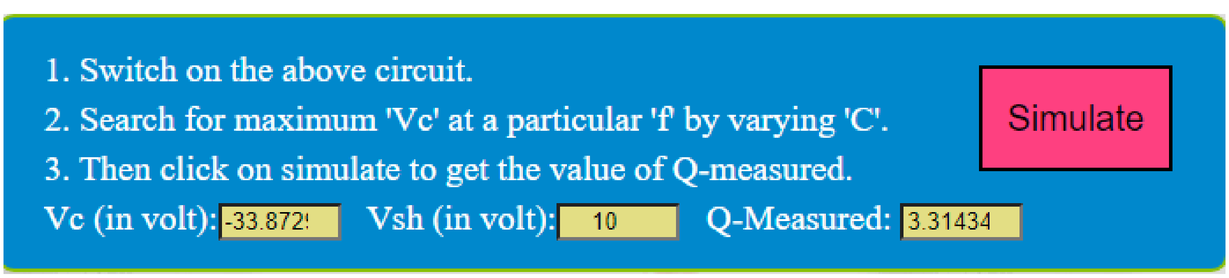
The simulator for this experiment is designed based on JavaScript platform combined with HTML5 Canvas for graphics. So the users are recommended to use browsers with HTML5 compatible.

Link to the simulator:

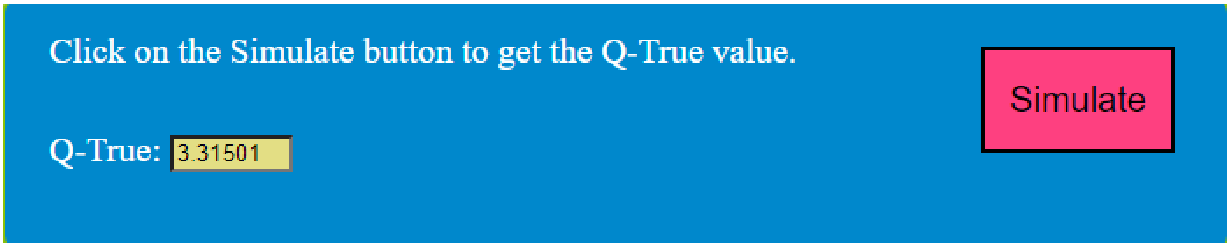
http://vlabs.iitkgp.ac.in/asnm/exp14/js-simulator/Q_meter.html



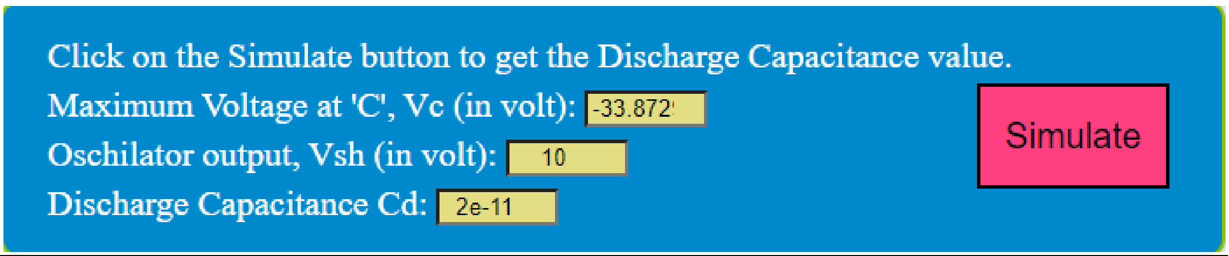
Q MEASURED:



Q TRUE:



Discharge Capacitance:



Observations:

S. No.	Voltage (V)	R_{sh} (Ω)	L (H)	R (Ω)	Cd (pf)	Frequency (f) (MHz)	Vc (V)	Vsh (V)	Q
1	10	0.02	$5.27X10^{-5}$	100	20	1	-10.57	10	3.31
2	10	0.02	$5.27X10^{-5}$	100	20	2	-12.37	10	6.62

RESULT:

The quality factor of an unknown coil is found by using Q meter.

MEASUREMENT OF HIGH RESISTANCE BY MEGOHM BRIDGE

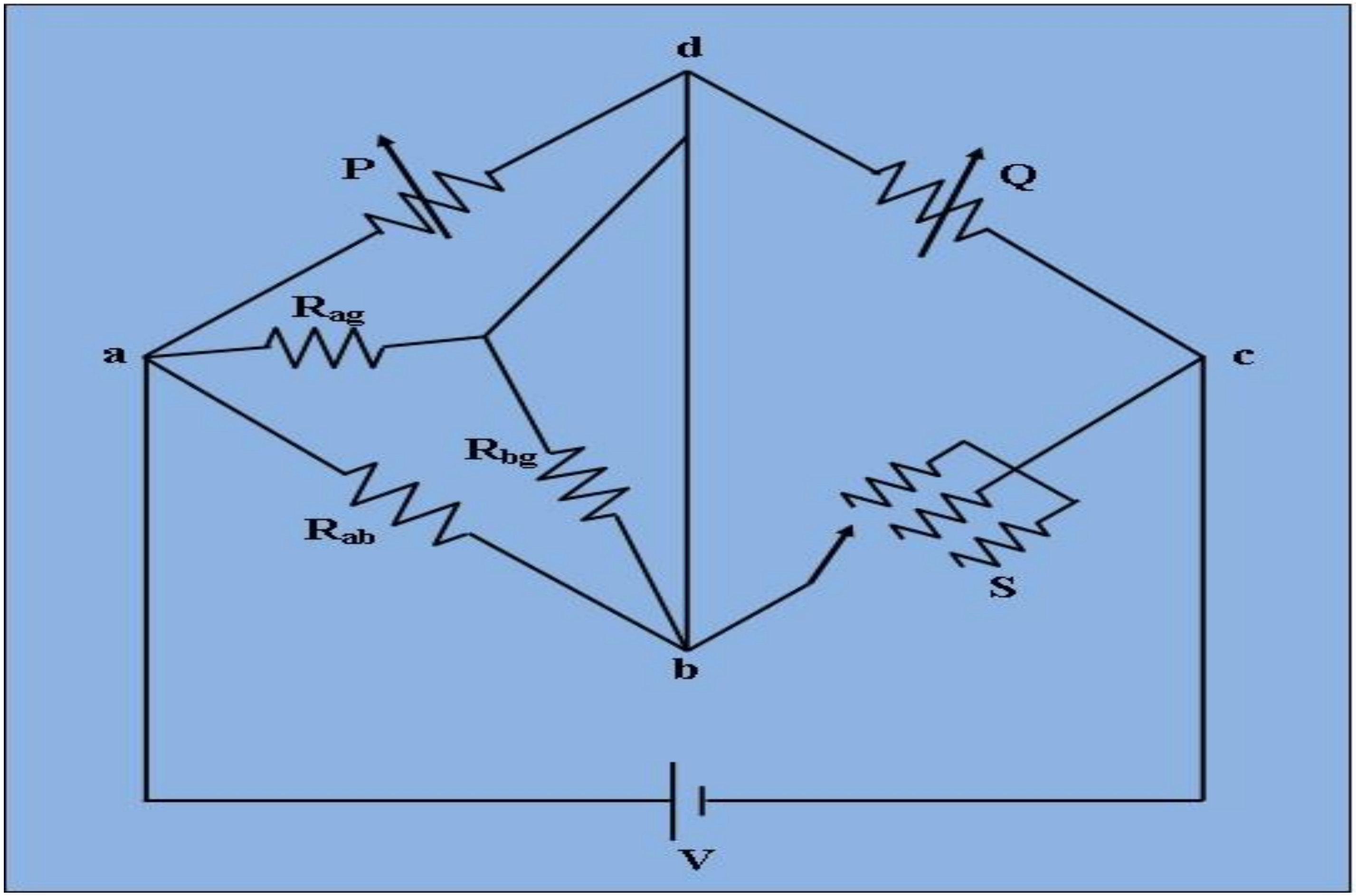
MEASUREMENT OF HIGH RESISTANCE BY MEGOHM BRIDGE

AIM: To determine the High Resistance by Megohm Bridge method.

Minimum System Requirement:

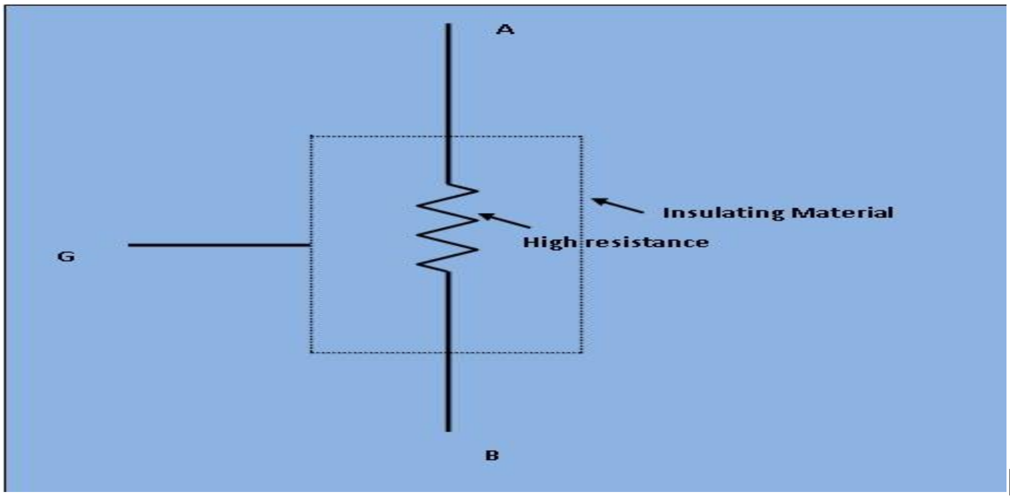
- A standard PC running Microsoft Windows XP, Windows Vista.
- 512MB RAM and 500 MB of available hard-disk space is recommended
- 1024x768 or higher screen resolution;
- a mouse or other pointing device
- A CD-ROM drive

CIRCUIT DIAGRAM:

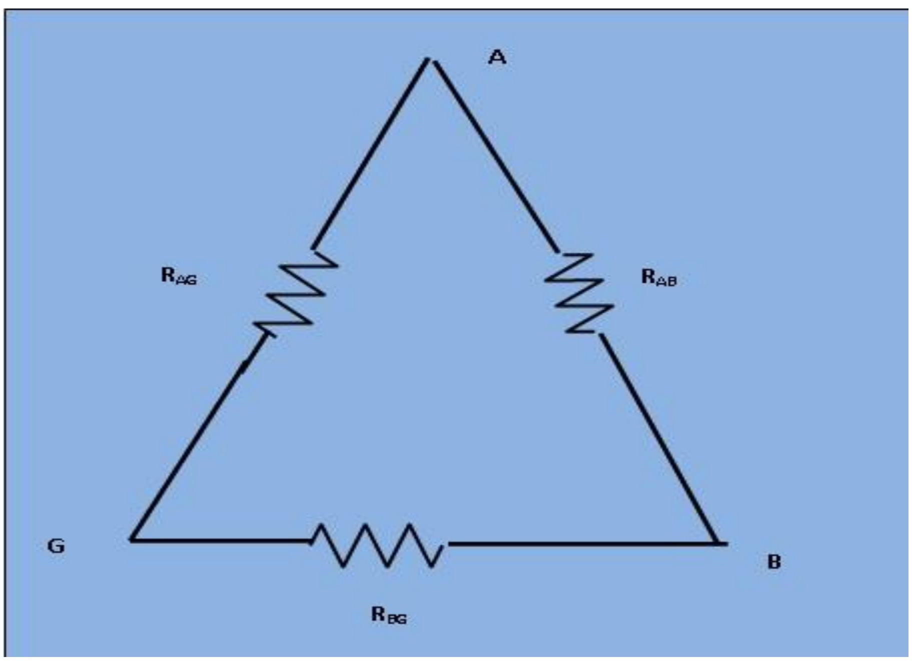


THEORY:

Figure 1 shows a very high resistance R with its two main terminals A and B and a guard terminal, which is put on the insulation. This high resistance may be diagrammatically represented as in Fig. 2

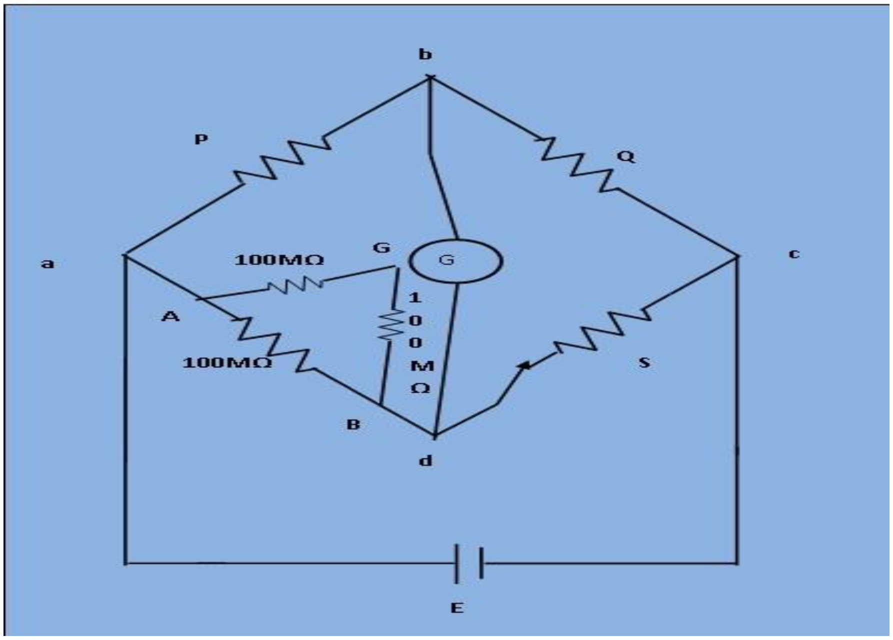


[Fig. 1]



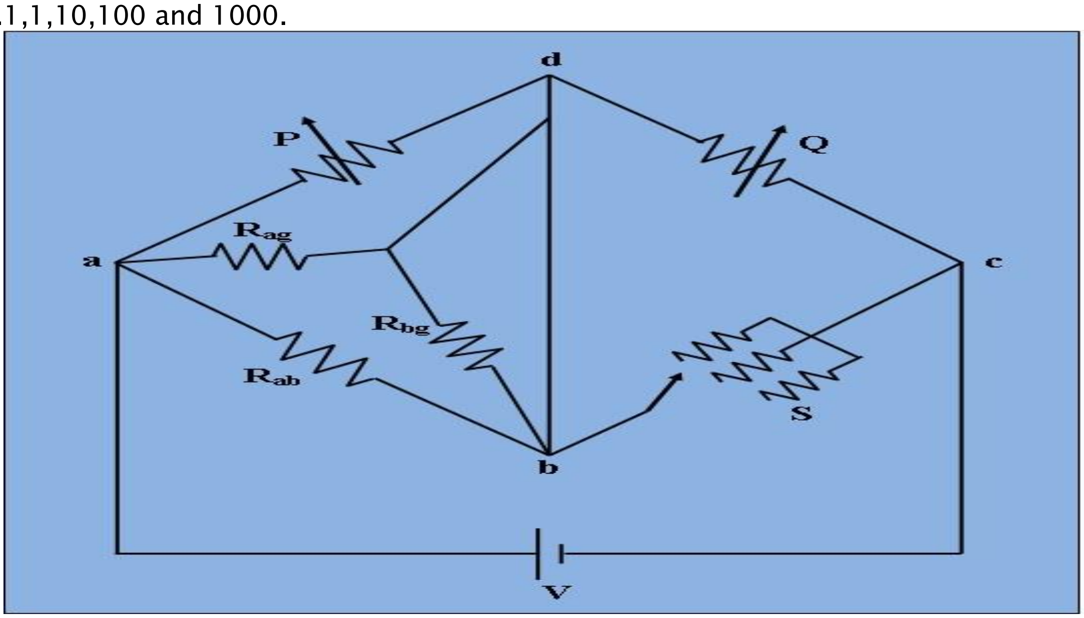
[Fig. 2]

The resistance R is between main terminals A and B and the leakage resistances Rag and Rbg between the main terminals A and B of form a "Three terminal resistance". Let us consider the hypothetically case of a `100 MΩ` resistance. We assume that each of the leakage resistances is also the same values. Measured by ordinary Wheatstone bridge method, we get the value of `67MΩ` and the giving error of `33%` of original value.



[Fig. 3]

However, if the same resistance is measured by a modified Wheatstone bridge as shown in Fig.3 the error in measurement is considerably reduced. For the arrangement shown in Fig.4 resistance Rbg is put in parallel with the galvanometer and thus it has no effect on the balance and only effects the sensitivity of the galvanometer slightly. Sensitivity for balancing against high resistance is obtained by use of adjustable high voltage supplies of 500V or 1000V and the use of a sensitive null indicating arrangement. The dial on Q is calibrated 1-10-100-1000M, with main decade 1-10 occupying greater part of the dial space. Since unknown resistance R=PS/Q ,the arm Q is made tapered, so that the dial calibration is approximately logarithmic in the main decade, 1-10. Arm S gives five multipliers, 0.1,1,10,100 and 1000.



[Fig. 4]

The arrangement of Fig.4 illustrates the operation of a Megohm bridge. Fig.4 shows the circuit completely self contained megohm bridge which includes power supplies, bridge members, amplifiers and indicating instrument. It has a range from `0.1MΩ` to `10^6MΩ`. The accuracy is within `3%` for the lower part of the range to possible `10%` above `10,000 MΩ`.

PROCEDURE:

1) Applying voltage E=500V.
2) Set the unknown resistance values Rab, Rag, Rbg from 'Set Unknown Resistor' tab.
3) Then switch on the supply to get millivoltmeter deflection.
4) Varry the values of bridge resistances P, Q, and S from the resistance box until the null deflection is occurred.
5) If "NULL" is achieved, switch to 'Measure Unknown Resistor' tab and click on 'Simulate'. Observe the unknown high resistance value R_{ab}.

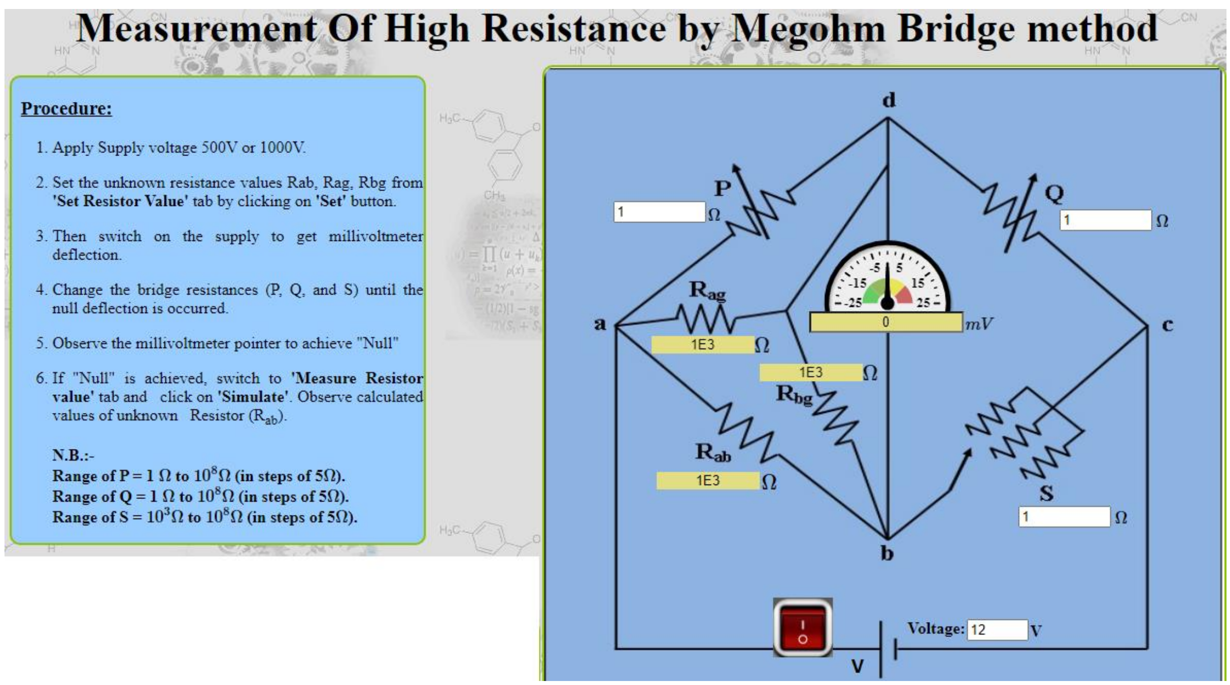
SIMULATOR:

Pre-Requisite to run the Simulator:

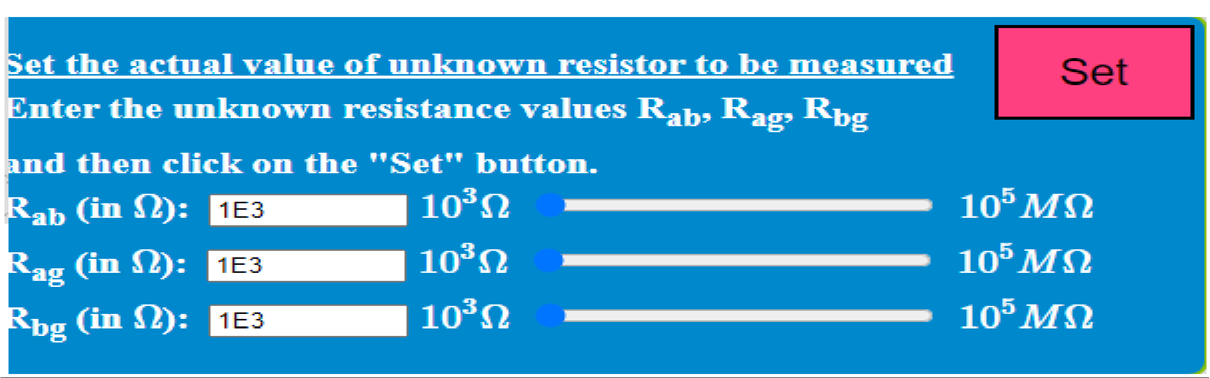
The simulator for this experiment is designed based on JavaScript platform combined with HTML5 Canvas for graphics. So the users are recommended to use browsers with HTML5 compatible.

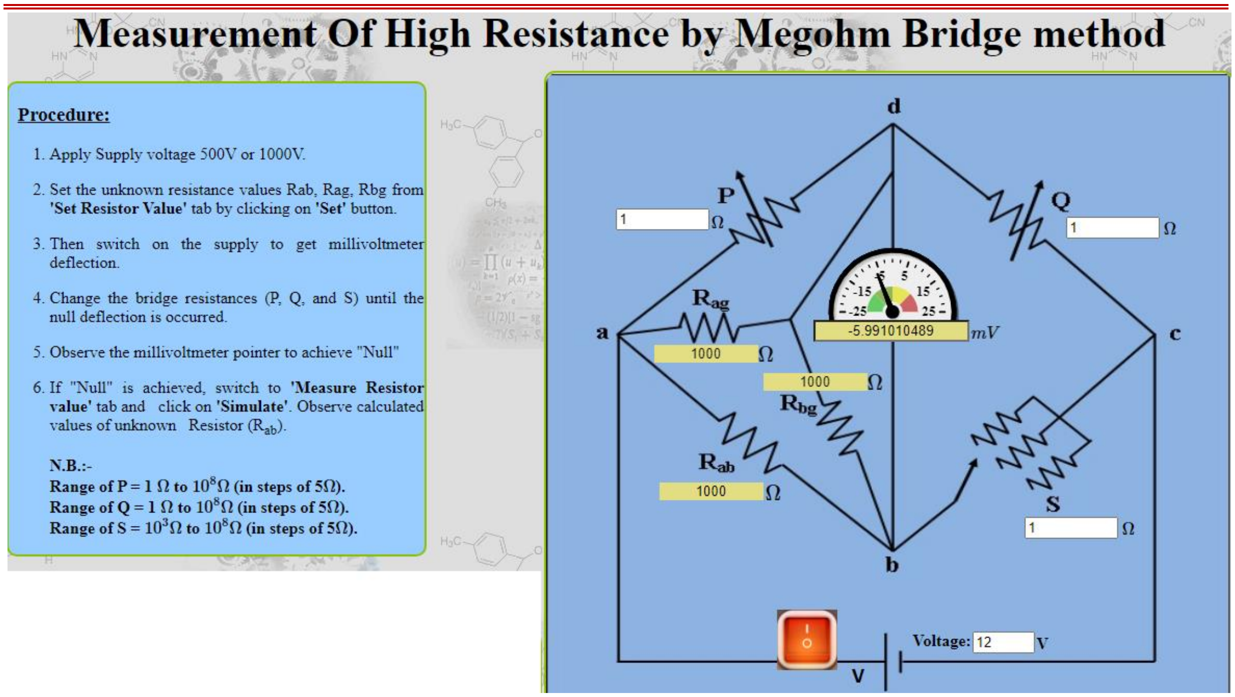
Link to the simulator:

http://vlabs.iitkgp.ac.in/asnm/exp24/js-simulator/megohmbridge.html

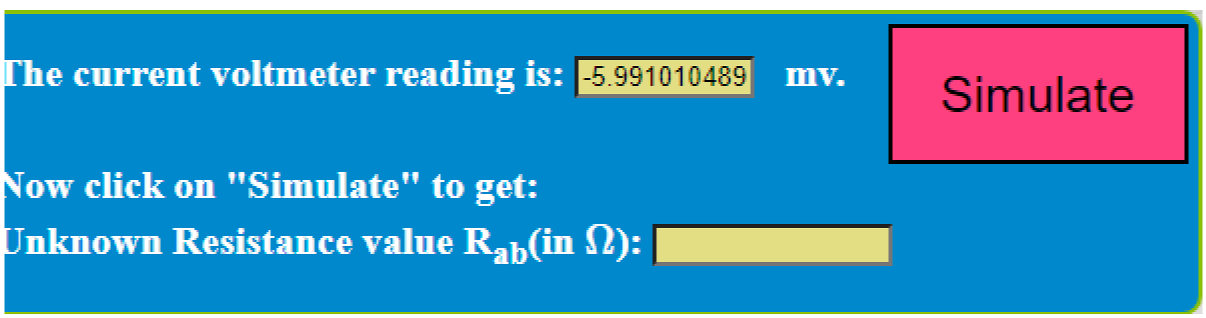


SET UNKNOWN RESISTER:





MEASURE UNKNOWN RESISTER:



Observations:

S. No.	Voltage (V)	R_{ab} (Ω)	R_{ag} (Ω)	R_{bg} (Ω)	P (Ω)	Q (Ω)	S (Ω)	R_{ab} (Measure) (Ω)
1	500	1000	1000	1000	94756156	57705966	75817685	1100
2	500	2000	2000	2000	37937976	106948391	11748	2100

RESULT:

The High Resistance is determined by Megohm Bridge method.