LAB MANUAL

MEASUREMENT LAB (EEC-453)

EEC-453 MEASUREMENT LAB

1. Study of semiconductor diode voltmeter and its use as DC average responding AC voltmeter.

2. Study of L.C.R bridge & determination of the value of the given components.

3. Study of distortion factor meter & determination of the % distortion of the given oscillator.

4. Study of the following transducer (i) K- type trans (ii) Pressure trans

5. Measurement of phase difference & frequency using CRO (lissajous figure)

6. Measurement of the resistance using Kelvin's double bridge.

1. <u>AIM:</u> Study of semiconductor diode voltmeter and its use as DC average responding AC voltmeter.

2<u>. APPARATUS REQUIRED</u>:

S.no	Component name	Specification	Qty
1.	Function Generator		
2.	DMM		
3.	Patch cords		

3. <u>THEORY</u>: The conventional voltmeter based upon a moving coil movement responds to a DC signal. To use dc voltmeter as an ac voltmeter diode rectifiers are employed. An AC signal can be converted into a unidirectional signal by passing it through a rectifier diode. Here the diode conducts during the positive half cycle of the signal, but presents a high impedance path to negative cycle. The output signal has series of positive half cycles, which can be used to deflect dc voltmeter. The meter movement is unable to respond to the rapidly changing signal, gives a reading which is proportional to the average value of the input signal over a period of time, The average value of half rectified sine wave pulses:

$$Vavg = (Vpk/\pi)$$

Which is 1/3 of the peak amplitude. The improved output of rectifier may obtained using diode rectifiers in bridge configuration. The bridge rectifier converts both half cycles to dc, gives an avg dc output to ac input is

$$Vavg = 2(Vpk/\pi)$$

Which is twice of half wave rectifier output. The input ac sinusoidal voltage is measured in rms & the output dc is averaged having a ratio equal to 1.11, called form factor. The series resistance of bridge rectifier can be adjusted to take rms readings

4. <u>PROCEDURE</u>:

1. The given switch at panel used to take reading in rms(in ON position) or avg in OFF position.

2. Connect the func gen with the ac input sockets, select sine wave at 100 Hz frequency.Kept the switch to ON position.

3. Connect DMM (ac 20V range) across the function generator & note the readings in rms.

4. Put the given to off position. Note the voltmeter reading as Vavg.

5. Select switch to ON position. Decrease the amplitude control to read 2V. Note the reading of DMM.

6. Select switch position to off stage. Note Vavg.

7. Take such readings for 1V & 0.5V (switch is in ON state), & note DMM readings. Compare the result, which clearly show the unaccuracy in dial readings in lower ac voltage measurements.

8. From the results plot a curve bw the input & o/p (voltmeter reading), which is a straight line. The average o/p may calculated:

$$Vavg = Vrms/1.11$$

Where Vrms is DMM reading & Vavg is voltmeter reading taken at switch off.

5. OBSERVATION:

S.No	Voltmeter Reading, Vrms (SW ON)	Voltmeter Reading, Vavg(SW OFF)	DMM reading, Vrms(i/p)
1,			
2.			
3.			
4.			

6. CALCULATION: Complete table with graph representation.

7. RESULTS AND DISCUSSION: Thus determine the i/p – o/p characteristics of rectifier voltmeter.

1. <u>AIM:</u> Study of L.C.R bridge & determination of the value of the given components.

2<u>. APPARATUS REQUIRED</u>:

S.no	Component name	Specification	Qty
1.	Capacitor	<1uF	
2.	Capacitor (Non Electrolytic)	>1uF	
3.	Capacitor (Electrolytic)	>1uF	
4.	Inductor	< 1H	
5.	Inductor	>1H	
6.	Resistor	< 10 K ohms	
7.	Resistor	>10 K ohms	

3. <u>THEORY:</u> The LCR Q Bridge 6018 measures inductance, capacitance, resistance & Q with a basic accuracy of ± 0.25% of reading for values upto 2000 H 2000 F & 99 respectively, either series equivalent or parallel equivalent component values are displayed. LCR-Q bridge is auto ranging it selects range automatically & also it discriminates automatically between inductors & capacitors. Frequencies of measurements is 100Hz or 1 KHz . An internal DC bias voltage of 2 v can be selected for use when testing electrolytic capacitors.

4. <u>PROCEDURE:</u>

1. <u>Frequency Test Prompts :</u> Capacitors in range 3nF to 2000uF, & inductor in range 2mH to 2000 H, can be measured, to the basic accuracy at a masurement frequency of 100 Hz. If an attempt is made to measure components in these range , at a frequency which prevent the basic accuracy from being attained, a frequency change will be indicated by flashing the frequency indicator LED. Thus LCR-Q bridge will provide a measurement at inappropriate frequency, but the basic accuracy may not be achieved.

2.<u>Measurement Conditions:</u>

LCR-Q is capable of providing both series & parallel equivalent values of components, at frequenceis of 100Hz & 1 Khz. This is to achieve measurements which have the most relevance either to the physical form of the component or to a manner in which is commonly used. This is for a number of reasons associated with the physical construction of this type of component. Their value at 100 Hz is the most useful, therefore. The loss term of such capacitors is is

expressed as Equivalent Series Resistance (ESR), series capacitance & resistance values should be measured.

5. CALCULATION:

1.Note the value of C,Vc,V2.
2. Q is calculated as $Q = VcVe3$.
3. L can be estimated using three relations:

$f = 1/2\pi\sqrt{LC}$

$f^2 = 1/4\Pi^2LC$

$L = 1/4\pi^2FC$

6.ASSUMPTIONS:-

1.Internal impedence of voltage source is neglected.
2.The capacitor is assumed to be non leaky.
3.Inverting capacitance is neglected.

7. RESULTS AND DISCUSSION: Measured Q is less than actual Q.

1. <u>AIM:</u> Study of distortion factor meter & determination of the % distortion of the given oscillator.

2<u>. APPARATUS REQUIRED</u>:

S.no	Component name	Specification	Qty
1.	Distortion factor meter		1
2.	Function generator		1
3.	Connecting wires.		

3. <u>THEORY:</u> When a sinusoidal signal is applied to an amplifier it produces sinusoidal output. However in most of cases the output is not exact replica of input because of the nonlinear of active device. The amount by which output waveform of an amplifier differs from that of input waveform to measure distortion. If B1 is fundamental, B2 is amplitude of Ist harmonic

Distortion of 2nd harmonic $D_2 = B2/ B1$

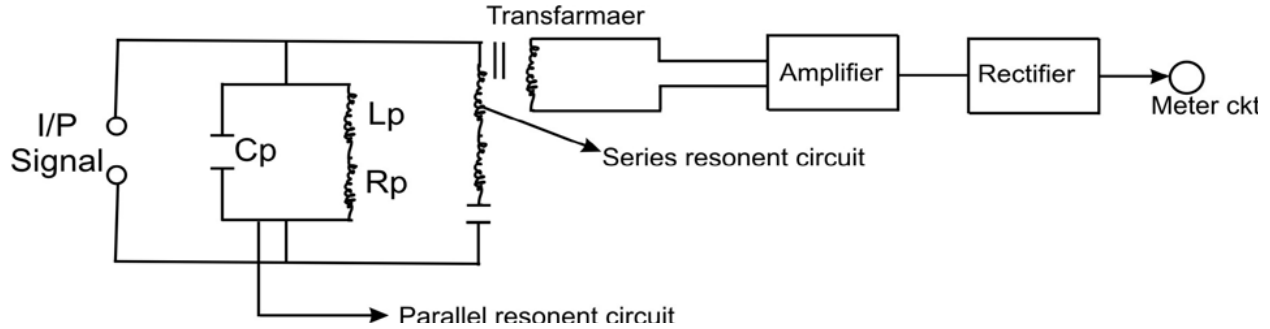Distortion of 3rd harmonic $D_3 = B3/B1$

Where D_n = distortion of nth harmonic

Total harmonic distortion $D = (D2^2 + D3^2 + D4^2 ....+Dn^2)^{½}$

The parallel resonant circuit consist of Lp, Rp and Cp is to provide compensation for the variation in the ac resistance of the series resonant circuit consisting of inductor L & capacitor C and also for the variation in the amplifier gain over the frequency range of the instrument.

The output of the series resonance circuit is transformer coupled to the input of an amplifier the output of the amplifier is rectified and applied to a meter circuit. Series resonant circuit is tuned to specific harmonic frequency.

4. CIRCUIT DIAGRAM:

5. PROCEDURE:

a) Connect the input signal from function generator to distortion meter.

b) Take the various signals, first sat calibration and see the distortion on 100% scale.

c) Note the distortion for different waves.

6. OBSERVATION:

Out put of the different input given.

S.No.	Frequency	Type of waveform	Distortion

7. RESULTS AND DISCUSSION:

Distortion for sine wave is minimum approximately 2-3% for triangular wave 11-12% and maximum for square wave 42-44%

8. PRECAUTIONS:

a) All connection should be according to the circuit diagram.

b) All connection should be right & tight.

c) Reading should be taken carefully.

d) Power supply switched off after completing the experiment.

EXPERIMENT 4

1. AIM: Study of the Pressure Cell transducer.

2. APPARATUS REQUIRED:

S.no	Component name	Specification	Qty
1.	Pressure cell		
2.	Digital Multimeter		
3.	Patch cords		

3. THEORY:

1. Pressure Cell: A pressure cell is an electromechanical device which converts applied pressure into an electrical signal & is used for measurement of static & dynamic forces. The pressure cell has a receiving element having highly tensile strength & strain gauges which convert this change in formation of pressure receiving element into proportional change in electrical signal. Pressure cell has three basic parts, the housing, the receiving element (diaphragm, disc) & strain gauges. In the pressure cell four strain gauges are mounted to form four arm active bridge. The bridge is excited with a dc potential obtained from a band gap reference.
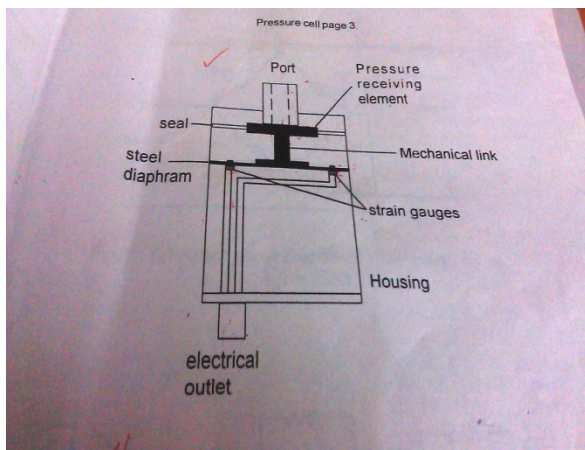
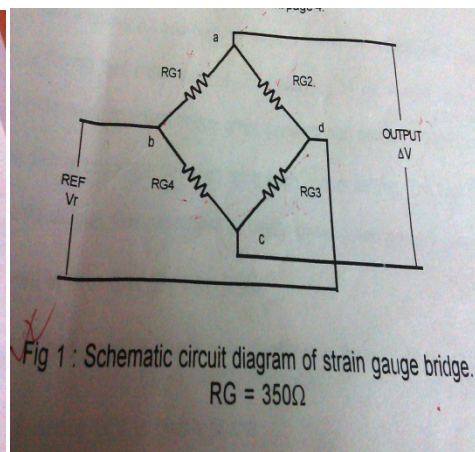## 4. CIRCUIT DIAGRAM:

Fig: Pressure Cell Transducer   Fig: Circuit Diagram of strain guage bridge

5. PROCEDURE:

1. Connect the given pressure cell with the set up by mean of 5 pin connector. Switch ON the power. The readout will glow.

2. Set zero control to made readout 00.0

3. Apply known pressure 50Psi, upon the cell by mean of pressure applying column handle clockwise rotation & read Bourden gauge.

4. Adjust the span control to read the o/p display as 50 Psi. Rotate the handle of pressure applying column reverse direction to read 0 at Bourden gauge, the readjust zero control for 00.0 readout. Put the same pressure again & adjust readout for 50Psi.

5. Bring back pressure to zero, if required adjust zero by zero adjust.

Measurement

1. Connect multimeter across the analog output. Apply same pressure (25 Psi) on the cell. Note the displayed psi from panel meter & analog voltage Van, from multimeter.

2. Connect multimeter at instrumentation ampliflier output(socket marked A) note voltage as Vin.

3. Apply pressure in same steps upto 100Psi & note the readings.

6. OBSERVATION:

P(psi)	Vin, mV	Van, volt	Psi/display
0			
25			
50			
75.			

7. CALCULATION:

$\varepsilon = V/GF.Vr$

$\Delta V = Van/Av$

$\varepsilon = 2[(Van/Av) / (Gf.Vr)]$

$Av' = \Delta Van / \Delta Vin$

Where Av is amplifiers voltage gains given as $Av = A1.A2.A3\ldots$

$\mathcal{E}$ = strain

Instrumentation Amplifier gain = 75

Av = 75. Av'

1. Plot a curve bw strain and pressure. The curve will be a straight line, which verify that strain is propotional to applied pressure.

2. Plot curve between P & displayed value. It should be linear.

8. RESULTS AND DISCUSSION:

Hence we have studied pressure cell transducer.

9. PRE- EXPERIMENT:

1. Define Transducer.

2. Give types of transducer.

3. Differentiate between transducer & sensor.

4. Explain Strain Gasuge in detail.

EXPERIMENT 5

1. <u>AIM:</u> Measurement of phase difference & frequency using CRO (lissajous figure).

2<u>. APPARATUS REQUIRED</u>:

S.no	Component name	Specification	Qty
1.	CRO		1
2.	Signal Generator		1
3.	Patch Cords		3

3. <u>THEORY</u>:

<u>1.1 Measurement of Voltage Using CRO :</u>

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

V = (no. of boxes in cm.) x (selected Volts/cm scale)

<u>1.2 Measurement of Current and Resistance Using a CRO :</u>

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

<u>1.3 Measurement of Frequency Using a CRO :</u>

A simple method of determining the frequency of a signal is to estimate its periodic time from the trace on the screen of a CRT. However this method has limited accuracy, and should only be used where other methods are not available. To calculate the frequency of the observed signal, one has to measure the period, i.e. the time taken for 1 complete cycle, using the calibrated sweep scale. The period could be calculated by

T = (no. of squares in cm) x (selected Time/cm scale)

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

f (Hz)= 1/T(sec)

<u>1.4. Measurement of Phase :</u>

The calibrated time scales can be used to calculate the phase shift between two sinusoidal signals of the same frequency. If a dual trace or beam CRO is available to display the two signals simultaneously (one of the signals is used for synchronization), both of the signals will appear in

proper time perspective and the amount of time difference between the waveforms can be measured.

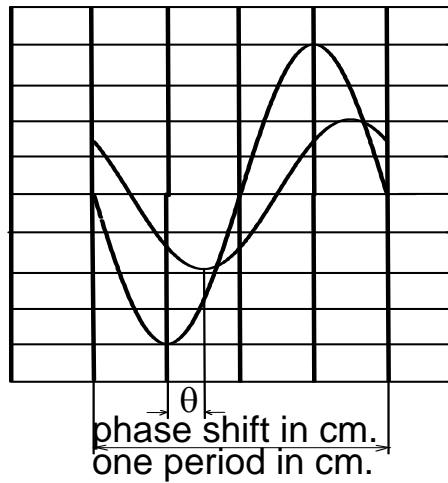This, in turn can be utilized to calculate the phase angle θ, between the two signals.

Figure.1 Phase shift between two signals

Referring to figure.1, the phase shift can be calculated by the formula ;

$$\theta = \frac{\text{Phase shift in cm.}}{\text{One period in cm.}} \text{ x } 360°$$

The frequency relationship between the horizontal and vertical inputs is given by;

$$\frac{f_h}{f_v} = \frac{\text{No. of tangencies (vertical)}}{\text{No. of tangencies (horizontal)}}$$

from which f_V , the unknown frequency can be calculated.

4. CIRCUIT DIAGRAM:

$V_v = ASin(wt + \theta)$

$V_h = BSin(wt)$

Fig: Lissajous Pattern

5. PROCEDURE:

2.1 The Lissajous pattern shown in figure1 is observed on the CRT screen. Find the phase shift between the signals applied to the X and Y inputs of the scope.
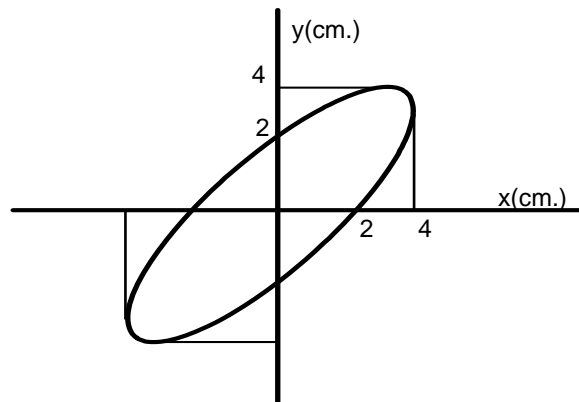
Fig.1

2.2. Figure 2 shows a Lissajous pattern observed on the CRT screen. Determine the frequency relationship between the signals applied to the X and Y inputs of the scope.
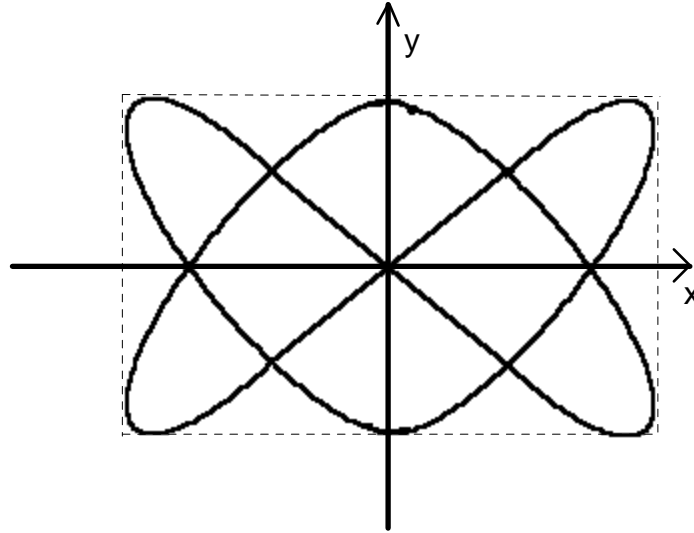

Fig.2

2.3 Two sinusoidal inputs having the same amplitudes but different period, are applied to the X and Y inputs of the CRO. Draw the Lissajous pattern which will be observed on the CRT, for $T_y = 4T_x$.

2.4 The signals given V1 and V2 are applied to the X and Y inputs of the scope. Sketch the Lissajous pattern and calculate the phase difference between the two signals.

$V_1 = 10Cos(wt)$
$V_2 = 15Sin(wt - 180)$

6. OBSERVATION: The output of CRO is traced with the help of tracing paper.

8. RESULTS AND DISCUSSION: Hence measurement of phase & frequency has been done & o/p is traced using CRO.

9. PRE EXPERIMENT Q.B:

1. How Phase can be measured using CRO.

2. How signal is displayed using CRO.

3. Define Lissajous Pattern.

EXPERIMENT 6

1. <u>AIM:</u> Measurement of the resistance using Kelvin's double bridge.

2<u>. APPARATUS REQUIRED</u>:

S.no	Component name	Specification	Qty
1.	Galvonometer		
2.	Multimeter		
3.	Resistance		
4.	Patch cords		

3. <u>THEORY:</u> The Kelvin Bridge is a modification of the Wheatstone bridge & provides greatly increased accuracy in the measurement of low- value resistances, generally below 1 ohm. The double bridge is used because the circuit contains a second set of ratio arms, which is connected to the galvanometer. The Kelvin bridge is used for measuring very low resistances (1 ohm to low as 0.00001 ohm). In this bridge, resistance is represented by the variable standard resistor. The ratio of arms(R1 & R2) can be usually be switched in a number of decade steps. Contact potential drops in the measuring circuit may cause large errors & to reduce this effect the standard resistor consists of nine steps of 0.001 ohm each plus a calibrated manganin bar of 0.0011 ohm with a sliding contact.

4<u>. CIRCUIT DIAGRAM:</u>
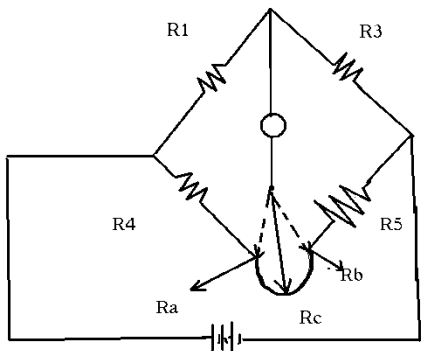

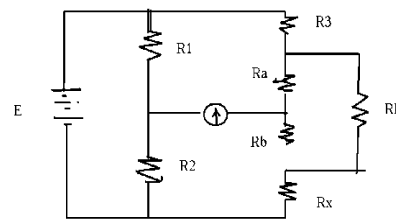Fig: Kelvin Bridge   Fig: Circuit Diagram of Kelvin Bridge
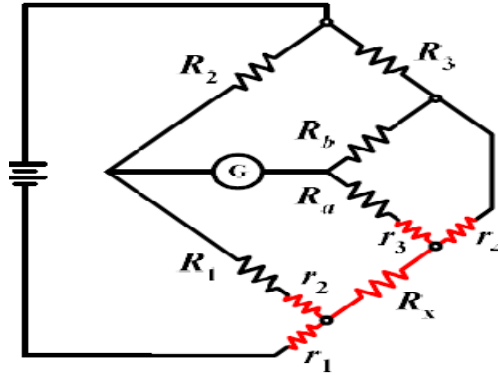
Fig: Kelvin Double bridge

5. PROCEDURE:

Application: Measurement of low resistance from 0.2 micro Ω to 11

Lay Out:

1. Main Dial: It consists of 10 coils of 0.01 Ω.

2. Slide Wire: It also of 0.01 ohm, divided into 500 equal parts.(least count of each small division =0.00002 ohm).

3. multiplying Ratio: A single dial having ratios of 0.01, 0.1, 1,10 & 100 ohms.

4. Current Reversing Switch: It is to reverse the direction of current & to switch off the battery circuit to the KELVIN'S BRIDGE>

5. Terminals: Eight terminals are fitted on the panel. Two terminals are marked D.C. meant for D.C source connected to the KELVIN BRIDGE. Two terminals are marked GALVO meant null detector to be connected. Four terminals on the left side of the panel are meant for unknown resistance.

Measurement of Two Terminal Resistance.

1. Connect the potential terminals of the Kelvin bridge to the resistance terminals.

2. Connect the current terminals of the Kelvin bridge to the resistance terminal.

6. CALCULATION:

$E_{kl} = \left(R_2/R_1 + R_2 \right) E = \left(R_2/R_1 + R_2 \right) I$

$R_x = R_3(R_1 / R_2)$

7. RESULTS AND DISCUSSION: Hence resistance has been measured using Kelvin double bridge.

8. PRE EXPERIMENT Q.B:

1. Define Kelvin Bridge.

2. Give the balanced condition.for AC bridges.

3. Why we use Kelvin Double bridge.

9. POST EXPERIMENT Q.B:

1. Define Wheatstone bridge.

2. Give example Ammeter & voltmeter methods