Experiment No. 1

Aim : Measurement of voltage, resistance, frequency using digital multimeter.

Objectives : To,

(*i*) state the function of different knobs on the panel of a multimeter;

(*ii*) measure ac and dc voltages with the help of a multimeter;

(*iii*) measure resistances, and compare the measured value with the value indicated on the resistance.

Apparatus Required :

(*i*) Multimeter

(*ii*) Signal generator

(*iii*) Dry cells

(*iv*) Power Supply

(*v*) Resistors of different values.

Brief Theory : A multimeter is an instrument that can measure ac and dc voltages and currents and resistances. It consists of separate voltage, current and resistance measuring circuits. The meter movement is common to all the three circuits. A selector switch is provided to set up the required circuit for a desired measurement.

While for measuring resistance, never connect the meter terminals to an energized circuit. Ensure that there is no parallel branch across the resistance you are measuring. When in doubt, disconnect one terminal of the component from the circuit. The measured value of a resistor can be compared with the value written on its body. Very often, the value is written in the form of a colour code.

Circuit Diagram :

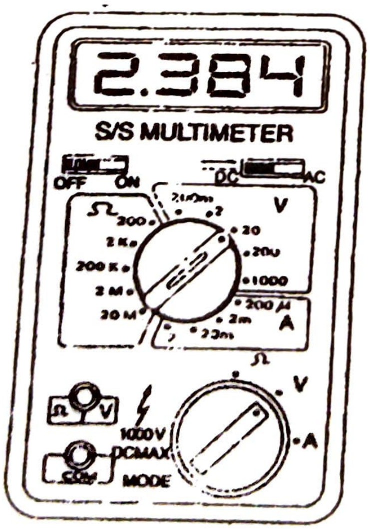


Fig. 1

Procedure : To study the use of a multimeter proceed as follows :

1. Make the connections as shown in Fig.
2. For dc voltage measurements bring the selector switch of multimeter towards d.c. side and measure the voltage.
3. By changing the position of knob of the POT measure dc voltage. Take two or three readings and record them on the observation chart.
4. For d.c. current measurement, bring the selector switch at the point where D.C. is marked and take reading on multimeter.
5. Change the position of knob of POT and take two or three readings for current.
6. For measurement of resistance, bring the selector switch at point where S2 is marked and note reading.
7. Replace the resistor with other one and take another reading.
8. For a.c. voltage measurement, bring the selector switch of multimeter towards a.c. side at 250 V mark and note a.c. reading.
9. Change the knob position of variac and take two or three readings for record.

Observation Table :

S. No.	D.C. Voltage in volts	D.C. Current in mA	A.C. Voltage in volts
1.			
2.			
3.			

Note : Whenever an electrical quantity (d.c. voltage or current, resistance or a.c. voltage) is required to be measured by multimeter, we must bring the selector switch at the suitable position. Otherwise the instrument may get damaged.

Resistance Measurement :

S. No.	Measured value	Value indicated in colour code	Tolerance indicated	Difference between measured and given value
1.				
2.				
3.				

Experiment No. 2

Aim: Measurement of voltage, frequency, time period and phase angle using CRO.

Apparatus required: CRO, Function generator and connecting leads.

Theory: CRO is the most important instrument used in Labs. It gives a visual display of signal waveforms. It is also used for trouble shooting in radio, television and laboratory measurements. The voltage amplitude, frequency, time period and phase shift of any signal can also be measured on CRO.

An audio signal generator is an electronic instrument which can generate signal of different frequencies and amplitude.

Operating Instructions: For voltage amplitude measurement:

(i) Connect the output of the function generator to the CRO.

(ii) Adjust the TIME/DIV switch for two or three cycles of waveform and set the volts/div switch for the largest possible on screen display.

(iii) Use the vertical position control and GND switch to centralize the wave.

(iv) Count the number of division from the graticule line (center line) touching the negative signal peaks to the positive signal peak with the central vertical graticule line. Multiply this number by the VOLTS/DIV switch setting to get the peak-to-peak voltage of the waveform.

For example: If the volts/div switch was set to 2V, the numbers of division are 3 then amplitude is 6V (3 DIV × 2V)

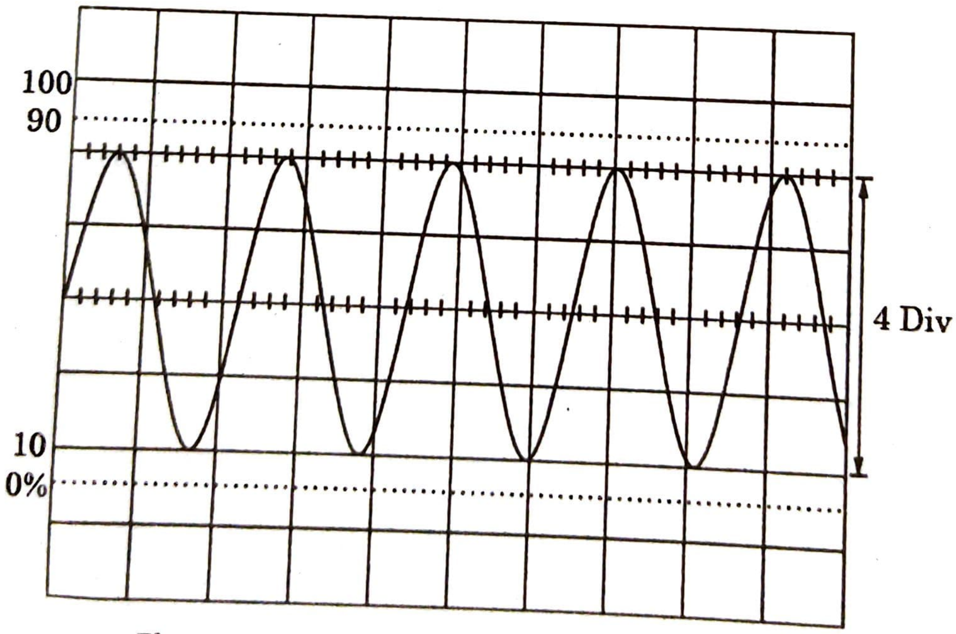


Fig. 2: (Peak to Peak voltage measurement)

Time period Measurement:

1. Set the CRO so that 2–3 cycles of signal are display on the screen of CRO.

2. Use the vertical position control to position the trace so the central horizontal graticule line passes through the points on the waveform between which you want to make the measurement.
3. Use the horizontal position control to set the left most measurement point on a nearly vertical graticule line.
4. Note the number of divisions to cover the one complete cycle. (For positive and negative cycle).
5. To determine the time interval, multiply the number of horizontal divisions by the setting of the TIME/DIV switch.

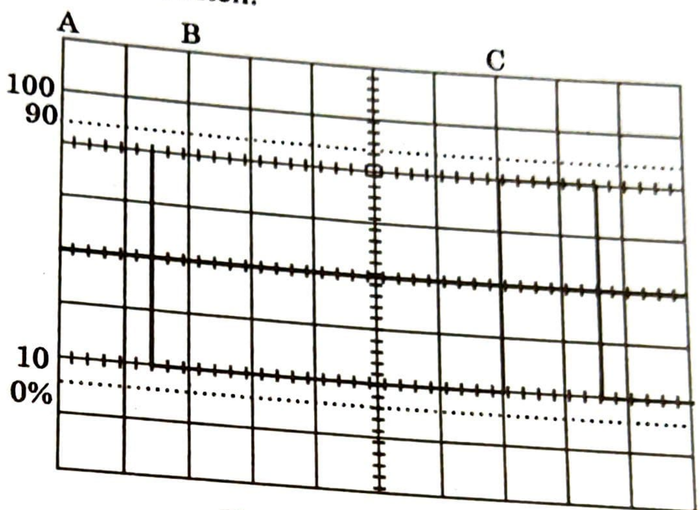


Fig. 3: ms Division

In case of pulses:

1. Pulse width is the distance between points A & B.
2. The period of a pulse is the time is takes for one full cycle of signal. In the figure, the distance between the points (A) and 'C'. The time interval of this distance is the period.

Duty cycle is the percentage of the period represented by the pulse width.

$$\text{Duty Cycle (\%)} = \frac{PW \times 100}{\text{Period}}$$

Frequency measurement: Frequency is the reciprocal of time interval or period. Period in seconds yields frequency in Hertz, period in millisecond yields frequency in Kilohertz (KHz), period in microseconds (μs) yields frequency in megahertz MHz.

Phase difference measurements: Phase difference or phase angle between two signals can be measured using the dual trace feature of CRO or by operating the CRO in the X–Y mode.

1. Connect the one signal to the CH_1 input connector & other to the CH_2 input connector.
2. Adjust the volt/div. switch of both the channels so that positive and negative peaks become display on the screen of CRO.
3. Precisely center the trace horizontally with the horizontal position controls.

4. Count the number of divisions between points a and a^{1}, Where two waveform cut the horizontal graticule (x-axis) line.
5. Multiply the number of division by setting of TIME/DIV switch.
6. The value obtained after multiplication is phase angle. (Convert this value into degree).

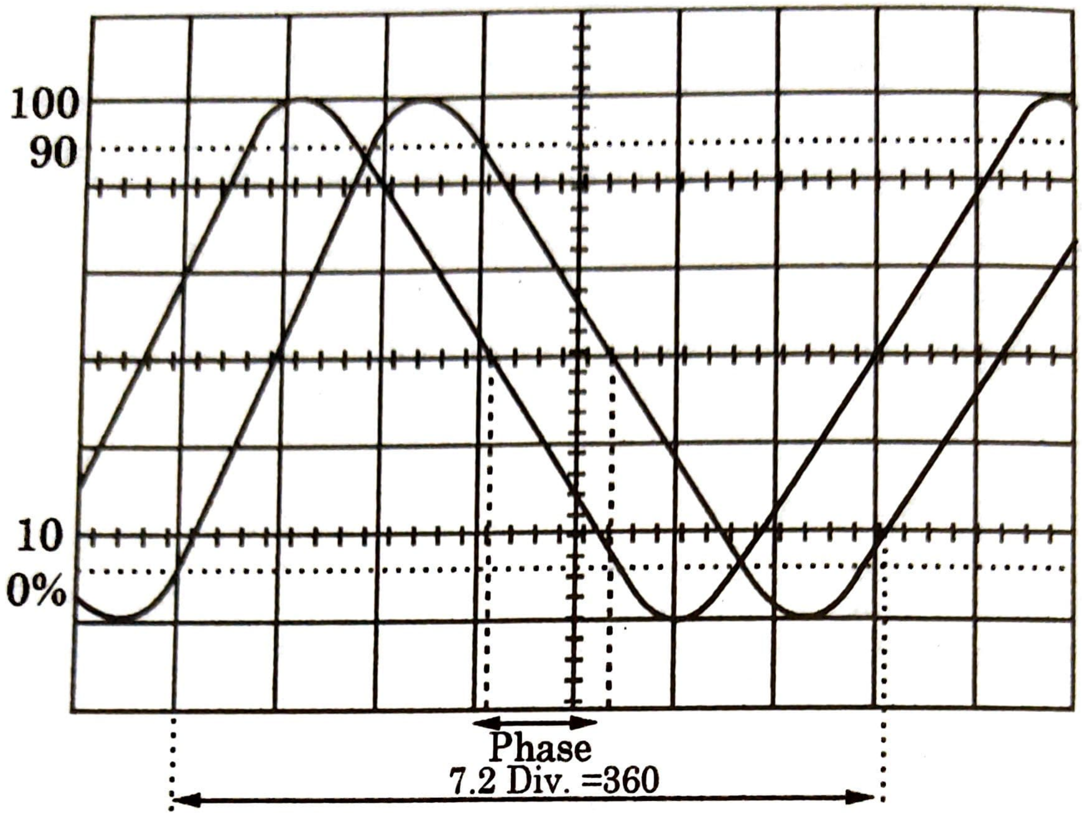


Fig. 4 : Dual Trace method of Phase measurement

Lissajous Pattern Method: This method is used primarily with sine waves. Measurement are possible at frequencies up to 500 KHz.

For this we have to operate the CRO in X–Y mode. In this internal time base of CRO are not utilized, deflection in both the vertical and horizontal directions is via external signal.

(*i*) A known frequency is applied to horizontal input (CH_1) and unknown frequency to the vertical input (CH_2).

(*ii*) Adjust the various control to stabilize the wave. The standard frequency is adjusted until a pattern appears as circle or an ellipse indicating that both signals are of same frequency. Some time pattern is formed when the standard frequency is multiple or sub multiple of unknown frequency.

(*iii*) Count the number of loops cut by horizontal line and number loops cut y vertical line.

$$\frac{f_y}{f_x} = \frac{\text{no. of looks cut by Horizontal Line (H)}}{\text{no. of looks cut by Vertical Line (V)}} \quad \frac{f_y}{f_x} = \frac{\text{number horizontal tangencies}}{\text{number of vertical tangencies}} = \frac{2+\frac{1}{2}}{1} = \frac{5}{2}$$

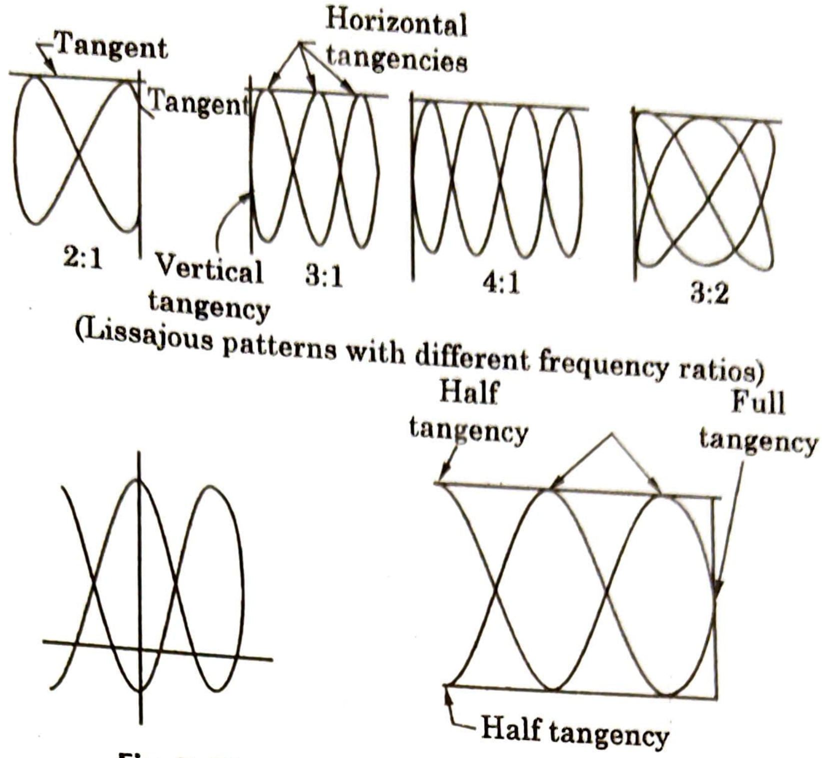
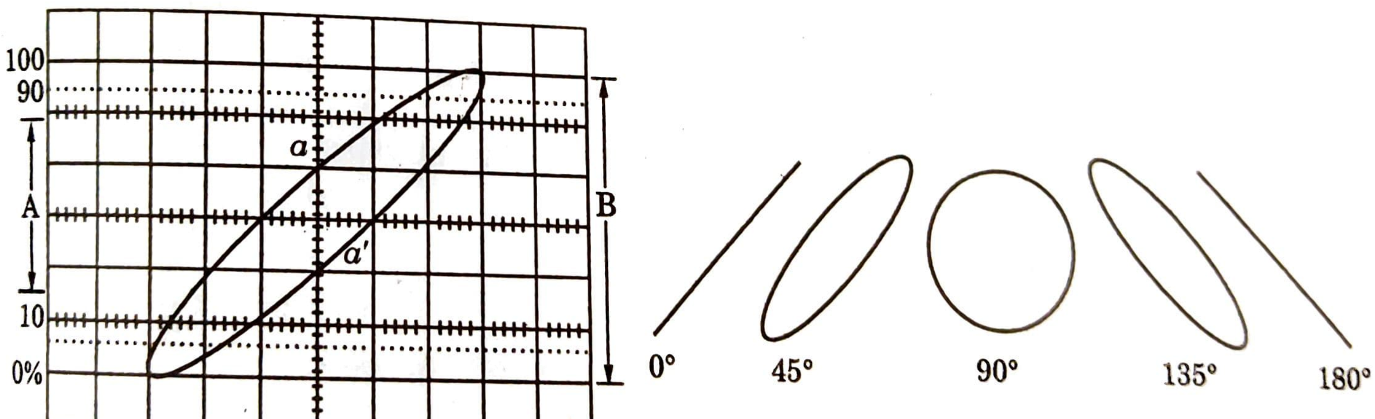


Fig. 5: Lissajous patterns with half tangencies

For phase difference: One of the two signals is connected to the vertical (CH2) input and other to the horizontal input (CH1). Precisely center the trace horizontally with horizontal position control and marks the point where Lissajous pattern cut the y – axis as an ellipse in fig. (*a*) cut y–axis



(*a*)

(*b*) **Lissajous patterns of various phase angles)**

Fig. 6

at points a and a' count the number of divisions between a and a' that is equal to "A". Count the number of divisions subtended by the trace along the central vertical graticule line (dimension B).

If the signals have no phase difference then the resulting pattern is a straight line (slanting from left to right). The slant angle is the function of amplitude of two signals. The phase angle 'θ' may be found from relation.

$$\theta = \sin^{-1}\frac{A}{B}$$ As shown in fig. (*a*).

OBSERVATION:

Measurement of voltage

S. No.	No. of div. covered by signal vertically (X)	volt/div. Position of Switch (Y)	Result $x \times y$ (Voltage)
1.			
2.			
3.			

Measurement of Time interval & Frequency:

S. No.	No. of div. Covered by one cycle (N)	Position of Tim/Div. Switch (P)	Time period (T) $N \times P$	Frequency $F = \frac{1}{T}$
1.				
2.				
3.				
4.				

Measure of Pulse width: Count the number of divisions between point A & B as shown in Figure ....

Position of switch TIME/DIV: ....

Pulse width = number of divisions × position of switch

= .... × ....

= ....

Frequency measurement using Lissajous Pattern:

S. No.	No. of loop cut/touch by horizontal line (H)	No. of loop cut/touch by vertical line (V)	Standard frequency (fx)	Frequency $f_y = \frac{H}{V} \times fx$
1.				
2.				
3.				
4.				

For Phase measurement:

No.	A	B	$\theta = \sin^{-1}\frac{A}{B}$
1.			
2.			
3.			
4.			

Experiment No. 3

Aim: Measurement of voltage, frequency, time and phase using DSO.

Apparatus Required: DSO function generator, connecting loads, power supply.

Operating instructions:

(*i*) Push the CH1 MENU button and set the probe option attenuation to 10X.

(*ii*) Set the switch to 10X on the probe.

(*iii*) Connect the channel 1 probe to the signal.

(*iv*) Push the auto set button.

(*v*) Push the 'mesure' button to see the Measure menu.

(*vi*) Push the top option button, the measure 1 Menu appears.

(*vii*) Push the type option button and select the frequency. The value readout displays the measurement.

(*viii*) Push the back option button.

(*ix*) Push the second option button from the top; Measure 2 Menu appears.

(*x*) Push the type option button and select period. The value readout displays the measurement (period).

The value readout the displays the measurement (period).

(*xi*) Push the back option button.

(*xii*) Push the middle option button; Measure 3 Menu appears.

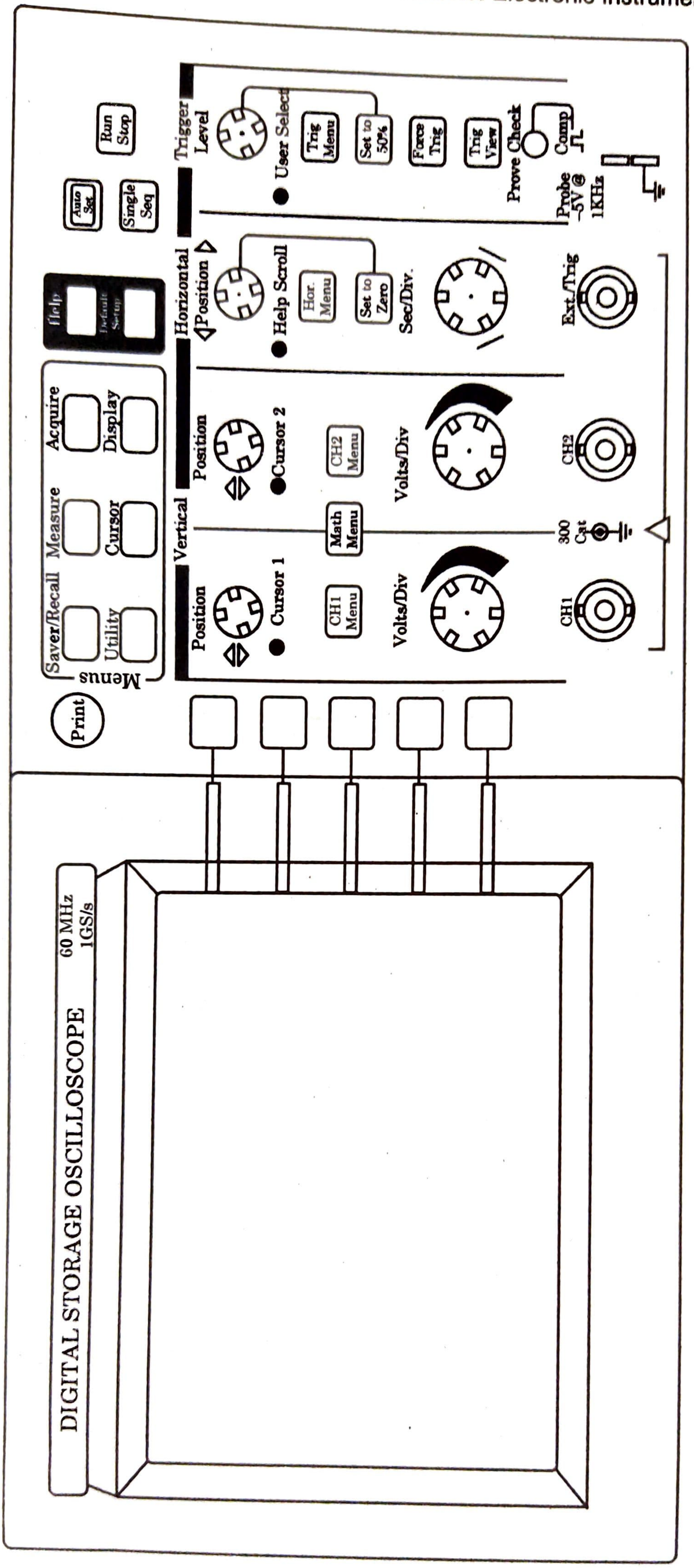


Fig. 7: Front Panel of Digital Storage Oscilloscope

(xiii) Push the type option button and select PK-PK.
The value readout displays the measurement (voltage pk-PK).

(xiv) Push the back option button.

(xv) To measure the phase difference you have to apply the one signal to the CH1 & other to CH2.

(xvi) Set the CRO to Autoset function.

(xvii) Two waveform of input signal (CH1 & CH2) displays on CRO : then proceed as in ordinary CRO.

Observation:

(i) Voltage (pk-PK) = ...

(ii) Period = ...

(iii) Frequency = ...

(iv) Phase = ...

If there is difficulty to read the no of div. then you can use the 'SAVE' feature of CRO, by using this you can save the display of CRO and then you can easily count the no. of divisions to calculate the phase difference.

Experiment No. 4

Aim : Measurement of Q of a Coil

Apparatus : Q Meter, Resistance, Inductance.

Theory : Q-factor (or quality factor) of a coil is defined as

$$Q = \frac{wL}{R}$$

Where L = Inductance

R = Resistance

$\omega = 2\pi f$ (f is supply frequency)

$$Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{X_C}{E}$$

If E is constant, a voltmeter connected across the capacitor can be calibrated directly in terms of Q.

Therefore if E is constant and known voltage, a voltmeter connected across the capacitor can be calibrated directly in terms of the circuit Q.

A practical Q-meter circuit is shown in Fig. 8A small shunt resistance As is connected across a wide range oscillator. The frequency may range from

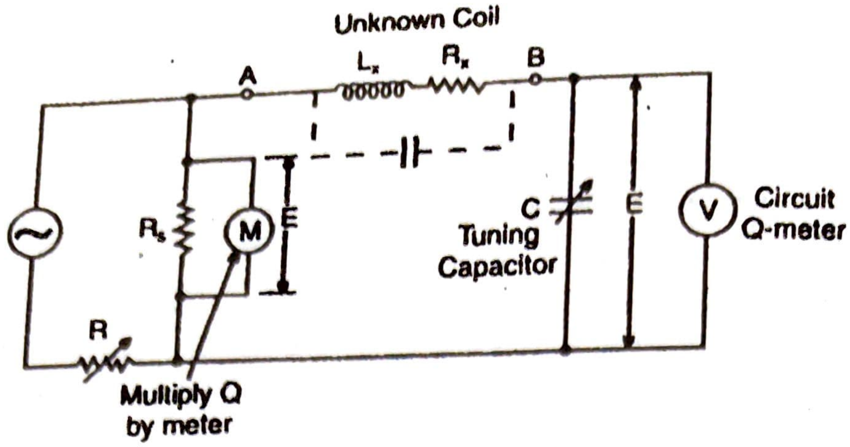


Fig. 8: Q- meter Circuit

50kHz to 50 MHz. The resistance of R_s is very low, of the order of 0.02 Ω, so that it introduces almost no resistance into the oscillator circuit. Therefore, the oscillator with the shunt represents a voltage source of nearly constant magnitude (say, E) and with a very small internal resistance. A thermocouple meter, marked "multiply 0 by" measures the voltage across the shunt. The voltage across the tuning capacitor E_c is measured with an electronic voltmeter, the scale of which is directly calibrated in Q values.

The unknown coil is connected across the test terminals AB and the tuning capacitor is tuned to resonance with the oscillator frequency. Alternatively, in some meters the oscillator frequency is adjusted to the resonant frequency of the circuit, keeping capacitor constant. The value of Q read by the output meter must be mulitplied by the index setting of tie "Multiply Q by" meter to obtain the actual value of Q.

Procedure :

1. The Q-tester is provided with three pin mains input socket. After plugging the mains cord, switch on the input On/Off switch.
2. The component, whose Q factor is to be determined is inserted in the jaws of test jig lay applying pressure on release bar. Care should be taken to avoid excess pressure on release bar.
3. The push button is provided for selection of frequency *i.e.* either 100Hz or 1kHz.
4. Now press the Q-button.
5. The Q value comes on the display.

Observation : Q value comes out to be

Experiment No. 5

Aim: Measurement of R, L and C using LCR bridge.

Apparatus Required: LCR bridge, different value of resistor, inductor and capacitor and connecting leads.

Operating instructions: For measurement of resistance:

(i) Select the push button switch (LC/R) for resistance measurement.

(ii) Connect the resistance directly to banana terminal or plugged into the crocodile cable connector jaws.

(iii) Switch ON the power supply.

(iv) LED under the R legend lit, it mean bridge measuring resistance and one of the LEDs on Ω, KΩ or MΩ on the range indicator panel will be lit.

(v) The digital display indicates the measured value on a four digits, seven segment, LED display.

For measurement of Inductor value:

(i) Select the push button switch (LC/R) for measurement of value of reactive component.

(ii) Connect the inductor directly to the test terminal of the LCR bridge.

(iii) Switch ON the power supply.

(iv) Then LED under the LC legend is lit, it means bridge measure inductance or capacitance.

- * Inductor (2mH – 200H) is measured to the basic accuracy at frequency 100 Hz.
- * Inductor (200 μH – 200H) is measured to the basic accuracy at frequency 1KHz.

(v) Select the frequency switch (100Hz/1KHz). For the selection, LCR bridge automatically suggest a change of frequency when necessary, by flashing the frequency LED.

(vi) When a mode change is required to improve accuracy this is indicated by the SER or PAR LED flashing. If this occurs, then equivalent circuit button may be operated to change mode and thus improves accuracy.

(vii) The unit in which the measured value is being displayed, is indicated on the range indication LED.

(viii) The digital display indicates the measured value on a four digit, seven segment, LED display.

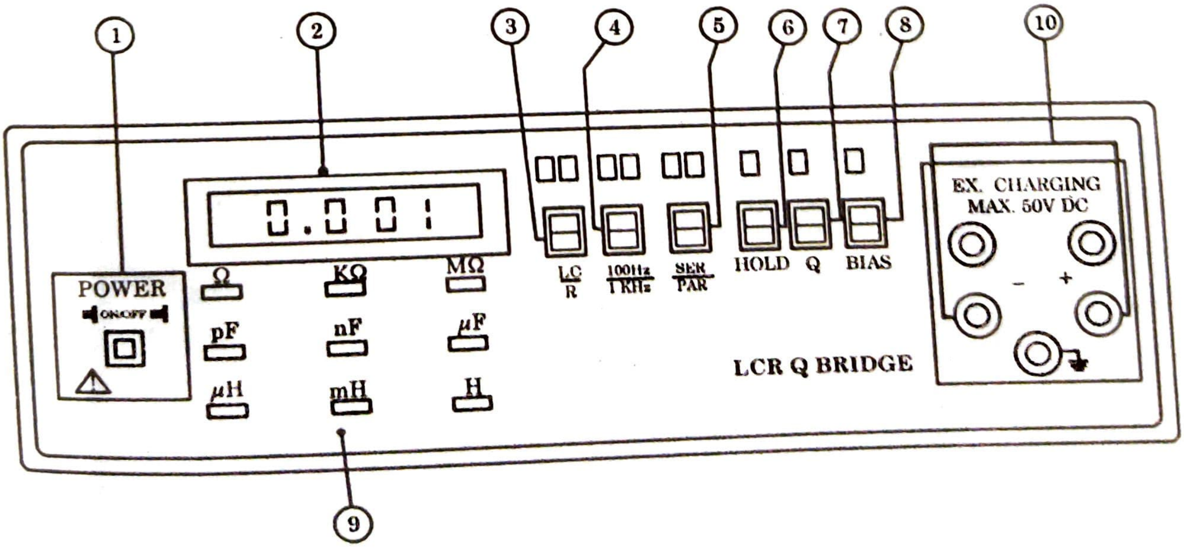


Fig. 9

For measurement of capacitor value:

1. Repeat the step (*i*) – (*iv*) as in inductance measurement.
   * Capacitor (2nF- 2000μF) is measured to the basic accuracy at frequency 100 Hz.
   * Capacitor (200PF-200μF) is measured to the basic accuracy at frequency 1 KHz.
   * Repeat the Step (V) – (VIII)

Observation:

A. Resistance (1) = ... Resistance (2) = ...

B. Inductance (1) = ... Inductance (2) = ...

C. Capacitance (1) = ... Capacitance (2) = ...

Experiment No. 6

Aim: Measurement of impedance using Maxwell Induction Bridge.

Apparatus:-

Digital multimeter, Patch cords. R_2 = 100 = 1M, R_3 = 9.97K, C_4=1 f LX_1 = 318 mH LX_2 =73 mH

Theory:- The Maxwell's bridge is used an inductance is measured by comparison with a standard variable capacitance. One of the ratio arms has a résistance and the capacitance in the parallel.

In this bridge at the balance in condition there is no current is flow in the galvanometer henced the balance equation for the bridge using the admittance of the arm 1 instead of the impedance.

$$Zx = (Z_2 * Z_3 * Y_1)$$

Where the Y_1 is the admittance of the arm-1. $Z_2 = R_2$

$$Z_3 = R_3$$

$$Y_1 = (1/R_1 + j)$$

By separating the real and imaginary term the unknown value of the resister (Rx) and the unknown value of the capacitor (Cx) has given below.

$$Rx = (R_2 * R_3 / R1).$$

$$Lx = (R_2 * R_3 * C_1)$$

Advantage-

1) This bridge is very useful for measurement of a wide range of a inductance at the power and audio frequencies.
2) The frequency does not appear in any of the two equations.

Disadvantage-

1) This bridge requires a variable standard capacitor, which may be Vary expensive if the calibration to a high degree of the accuracy.

2) The bridge is limited the measure the low Q value.

Procedure:-

1) Study circuit on kit from panel.
2) Connect unknown inductance L_{x1} in circuit. Make all possible connections to complete the network. Switch the supply on.
3) Set null point of galvanometer by adjusting variable resistance R_3
4) Note values of R_2, R_3, C_4 by removing their connections. Calculate theoretical values of L_x using $L_1 = R_2R_3C_4$.
5) Measure actual value of L_{x1} using LCR meter. Compare this value with calculated. Also calculate Q factor by using above equation.

Circuit Diagram :

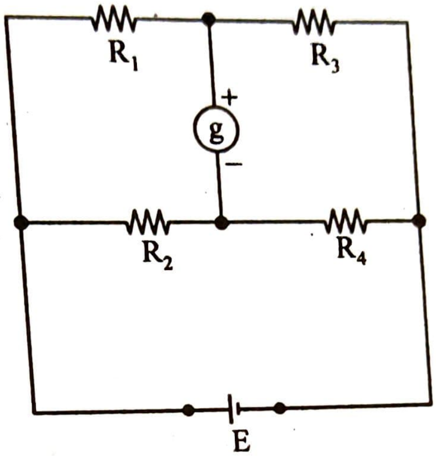


Fig. 10

Result:- Unknown inductance measured using Maxwell's bridge is found to be L_{x1}=_____

Precautions :

1. Connections should be tight.
2. Instrument should be handled carefully.

Experiment No. 7

Aim: To find the value of unknown resistance using Wheat Stone Bridge.

Apparatus: Power supply, Resistor: - 10K-1no, 5K-1no, 11K-1no, Unknown resistor=100, Pot – 1K-1no. Wheat stone bridge kit. Digital multimeter-1no, Patch codes.

Theory: A very important device used in the measurement of medium resistances is the Wheat stones bridge .it is an accurate and reliable instrument .The wheat stone bridge is an instrument based on the principle of null indication and comparison measurements. The basic circuit of a wheat stone bridge is shown in fig. 11 it has four resistive arms, consisting of resistances P,Q,R and S together with a source of emf and a null detector , usually a galvanometer

G or other sensitive current meter is used. The current through the galvanometer depends on the potential difference between point's b and d .The bridge is said to be balanced when there is on current through the galvanometer or when the potential difference across the galvanometer is zero. this occurs when the voltage from point 'b' to point 'a' equals the voltage from point 'd' to point 'i' or by referring to other battery terminal , when the voltage from point 'd' to point 'c' equals the voltage from point 'b' to point 'c'.

For bridge balance; $I_1P = I_2 R$ ...(1)

$I_1 = I_3 = E/P + Q$ ...(2)

$I_2 = I_4 = E/R+S$ ...(3)

E = emf of battery.

Combining equ (1) and (2) we get

$P/P + Q = R/R + S$ ...(4)

$QR = PS$ ... (5)

Equation (5) shows the balance condition of wheat stone bridge. If three of the resistances are known

then fourth may be determined by formula... R=S*P/Q

Where R is the unknown resistance, S is called the standard arm resistor and P and Q are called the ratio arms.

Procedure: -

1) Connect the patch cord as per the circuit diagram.
2) Note the resistance of P and Q using multimeter.
3) Adjust the resistance of P, Q, R, S
4) Switch on the power supply and adjust the resistance S such that galvanometer shows the zero deflection.
5) Now calculate R, R=P*S/Q

Circuit Diagram:-

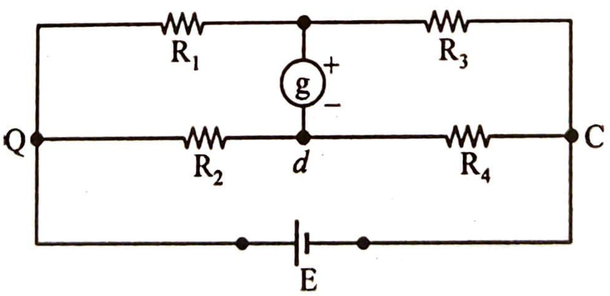


Fig. 11

Observation Table: -

P (ratio arm resistor)	Q (ratio arm resistor)	Standard resistor S	R measured value	R actual

Result:- Hence we have studied the low resistance by using whetstone bridge.

Precautions: 1. Connections should be tight. 2. Instrument should be handled carefully

Experiment No. 8

Aim: Measurement of distortion of RF signal generator using distortion factor meter.

1. Function generator
2. Distortion factor meter
3. Connecting leads

Theory: Distortion factor meter is available where by the distortion can be measured directly. This is operation on the principle of first measuring the r.m.s. value of total wave and then removing the component by means of highly selective filter circuit and measure r.m.s. of harmonics.

Operating instructions:

(*i*) Set the frequency range of signal generator.

(*ii*) Connect the signal generator and distortion factor meter as per circuit diagram.

(*iii*) First calibration of distortion factor meter is done and for this switch position at calibration and with rotate the potentiometer for full scale deflection. Then change the position of switch.

(*iv*) The reading given by the meter is the value of distortion.

(*v*) The above procedure is done for the different setting of signal generator.

Circuit Diagram:

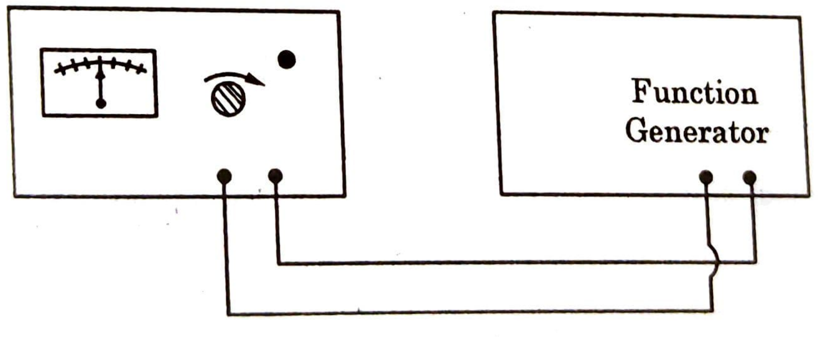


Fig. 12

Observation:

S. No	Frequency	Distortion (%)
1.		
2.		
3.		
4.		
5.		