LECTURE NOTES

ON

ELECTRONICS MEASUREMENT & INSTRUMENTATION

DIPLOMA

Subject code-TH4

3rd SEMESTER , E&TC ENGINEERING

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Static Characteristics:

The following are the static characteristics.

Static Error

Accuracy

Precision

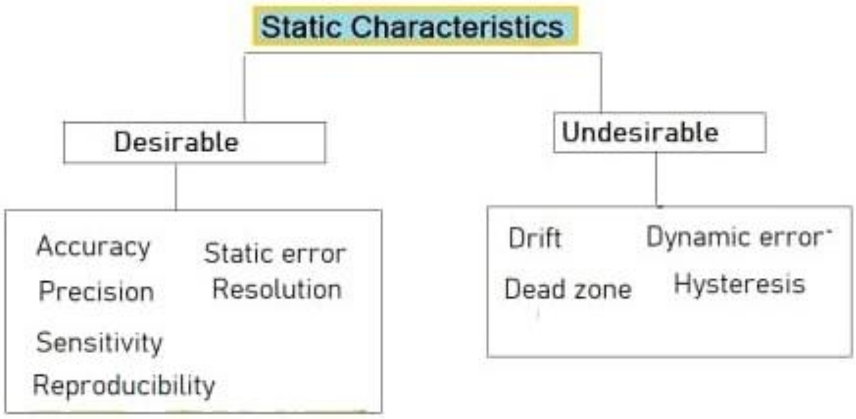
Sensitivity

Reproducibility

Hysteresis

Drift

Dead zone

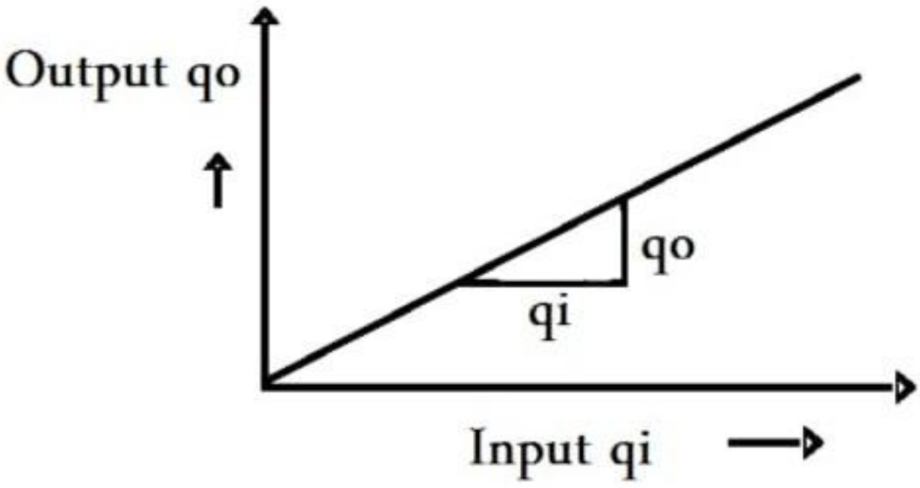


Static Error: The difference between the true value of the measuring quantity to the value shown by the measuring instrument under not varying process conditions.

Sensitivity: Sensitivity can also be derived as for the smallest changes in the measured variable for which the instrument responds.

Sensitivity can be defined as the ratio of a change in output to change in input which causes it, in steady-state conditions.

The usage of this term is generally limited to linear devices, where the plot of output to input magnitude is straight.



Sensitivity = Change in output / Change in input

Sensitivity can also be derived as for smallest changes in the measured variable instrument responds.

Drift is an undesired change in the output of a measured variable over a period of time that is unrelated to the changes in output, operating conditions, load.

Drift may be caused by environmental factors mechanical vibrations, changes in temperatures, stray electric fields, stray magnetic fields, thermal EMFs.

A drift in the calibration of the instrument occurs due to the aging of component parts. Drift occurs in flow measurement due to wear and tear of primary sensing elements such as orifice plates.

Drift occurs in temperature measurement due to scale formation on thermowell.

Drift occurs in Thermocouple or RTD elements due to the change of metallic properties.

Drift for a measuring device can be systematic or random or both some times. Due to wear and tear in the edge of an orifice plate the flow drift occurs systematic way.

The whole instrument calibration may gradually shift by the same amount as shown in the above figure.

The mechanical **bathroom weighing scale** is a common example. It is quite casual to find that there is a reading perhaps 1kg with no one stood on the scale. If someone of known weight weighs 70 kgs were to get on the scale, the reading would be 71 kgs. If someone with a known weight of 100 kg the reading would be 101 kgs.

The Zero shift is normally removable by calibration.

Span Drift:: If there is a proportionate change in its indication right along the upward scale the drift is termed span drift or sensitivity drift.

Zonal Drift: In case if the drift occurs only a certain portion of the span of an instrument. It is called zonal drift.

It indicates how active and fast the system is.

Fidelity: It is defined as the degree to which a measuring instrument is capable of faithfully reproducing the changes in input, without any dynamic error.

Lag: Every system takes at least some time to respond, whatever time it may be to the changes in the measured variable.

For Example Lag occurs in temperature measurement by temperature sensors such as Thermocouple or RTD or dial thermometer due to scale formation on thermowell due to process liquid.

Retardation lag: the response of the measurement begins immediately after the change in measured quantity has occurred.

Time delay lag: in this case after the application of input, the response of the measurement system begins with some dead times.

Differencial o/p voltage

$$E_0 = E_{s1} - E_{s2}$$

→ When the core is at Null position, the flux linking with both the secondary winding is equal & hence equal emfs are induced in them.

$\therefore E_{s1} = E_{s2}$

$E_0 = 0$

→ When the core is moved to the left, more flux links with winding S_1 than S_2.

So, $E_{s1} > E_{s2}$

o/p voltage $E_0 = E_{s1} - E_{s2}$

→ The o/p voltage is in phase with primary voltage.

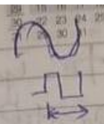
→ when the core is moved to the right, more flux link with winding S_2 than S_1,

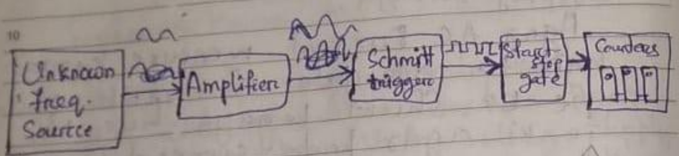
So $E_{s1} < E_{s2}$

o/p voltage $E_0 = E_{s2} - E_{s1}$

MEETINGS / APPOINTMENTS

Digital frequency meter





~~There is~~

Principle of Operation.

The signal waveform whose freq. is to be measured is converted into a train of pulses, one pulse for each cycle of the signal. The no. of pulses in definite interval of time is then counted by an electronic counter.

This shows the block diagram of a digital freq. meter.

→ ~~Firstly the unknown freq.~~ whose

→ The signal whose freq is to be measured or the unknown freq. is applied to the amplifier & this will amplify the signal before being measured.

→ Then ~~o/p of~~ the amplified o/p is given to the Schmitt trigger which convert the i/p signal ~~into~~ square wave with ~~first~~ fast rise & fall times, which is then cliped.

→ As a result, the o/p from a Schmitt trigger is a train of pulses, one pulse for each cycle of the signal.

Sunday 21

→ The o/p pulses from the Schmitt trigger is fed to start/stop gate.

→ When this gate is ~~enabled~~ enabled/open the i/p pulses pass through this gate &

the centre of the coil. The pointer also attracted to the spindle & thus deflect along with the moving iron over a graduated scale.

→ If the current in the coil is reversed, direction of the magnetic field produced by the coil will be reversed also & the magnetization produced in the soft iron will be reverse but the deflection torque remains unchanged.

→ These instrument can be used on AC system as well as DC system.

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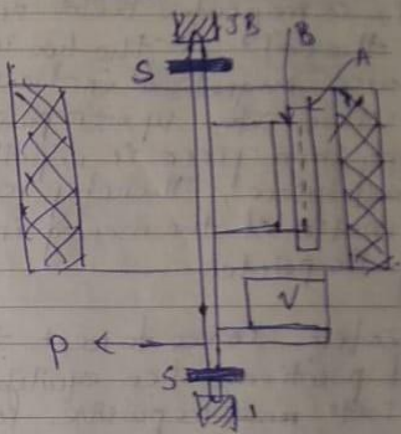
Repulsion Type



Here there are two irons, one fixed & other movable. The two irons lies in the magnetic field due to a coil.

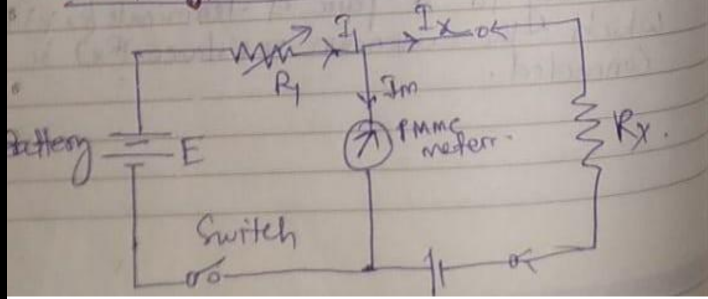
→ when there is no current in the coil the two iron pieces are almost touching each other & the pointer rests on zero position.

→ The current through the meter depends on the magnitude of unknown resistor.

→ When $R_x = 0$ (X & Y shorted), max^m current flows in the ckt. Under this cond^n. Shunt resistor R_2 is adjusted until the meter indicate the full scale current. This position of the pointer is marked "0 Ω" on this scale.

→ When $R_x = \infty$ (X & Y are open), the current in the ckt drops to zero. The meter indicates zero current. The pointer is marked '∞' on the scale.

Shunt-type Ohmmeter



It consists of a battery in series with an adjustable resistor R_1 & PMMC meter movement. The unknown resistor R_x is connected across terminals X & Y in parallel with the meter.

→ An on/off switch is provided to disconnect the battery from the ckt when the instrument is not used.

→ When $R_x = 0\,\Omega$, (X & Y terminals are shorted) the meter current is 0.

→ When $R_x = \infty$ (X & Y open), the current finds a path only through the meter & by appropriate selection of the value of R_1, the pointer can be made to read full scale.

→ This type suited to the measurement of low value of resistors.

→ Digital data ~~form~~ from the memory & from the control logic is then converted into analog form & passed through vertical deflection amplifier & Horizontal deflection amplifier respectively.

→ This horizontal & vertical signal is feed to the horizontal deflection plate & vertical deflection plate of CRT & signal will be displayed in to the CRT screen.

Mode of Operation

The DSO has ~~to~~ three modes of operation.

→ Roll mode

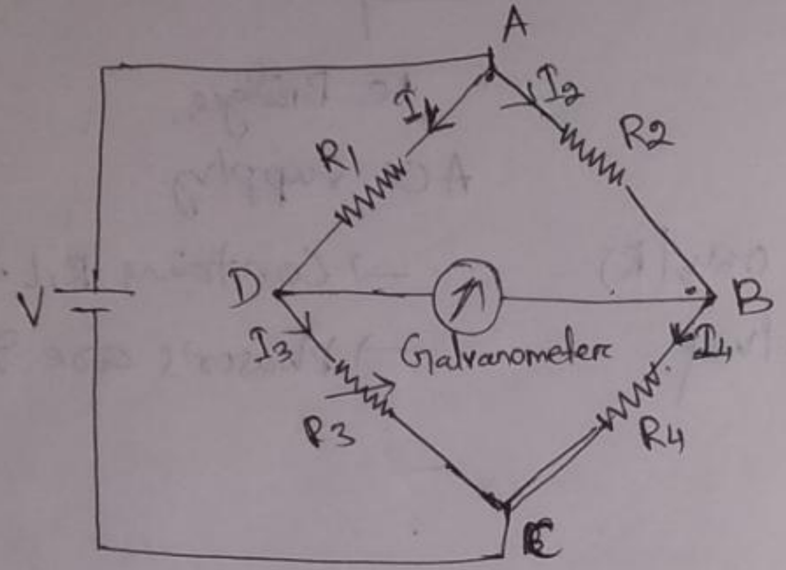
→ Store or refresh mode

→ Hold or Save mode

→ wheatstone's bridge is used to measure the value of medium resistance.

→

The ckt diagram of wheatstone bridge is shown in below figure



→ In the above ckt, the arms AB, BC, CD & DC together form a rhombus or square shape.

→ They consist of resistors R2, R4, R3, & R1 respectively.

→ Let the current flowing through the arms is I2, I4, I3 & I1 respectively.

→ The diagonal DB & AC consists of galvanometer & DC voltage sources respectively.

→ The resistor R3 is a standard variable resistor & R4 is an unknown resistor.

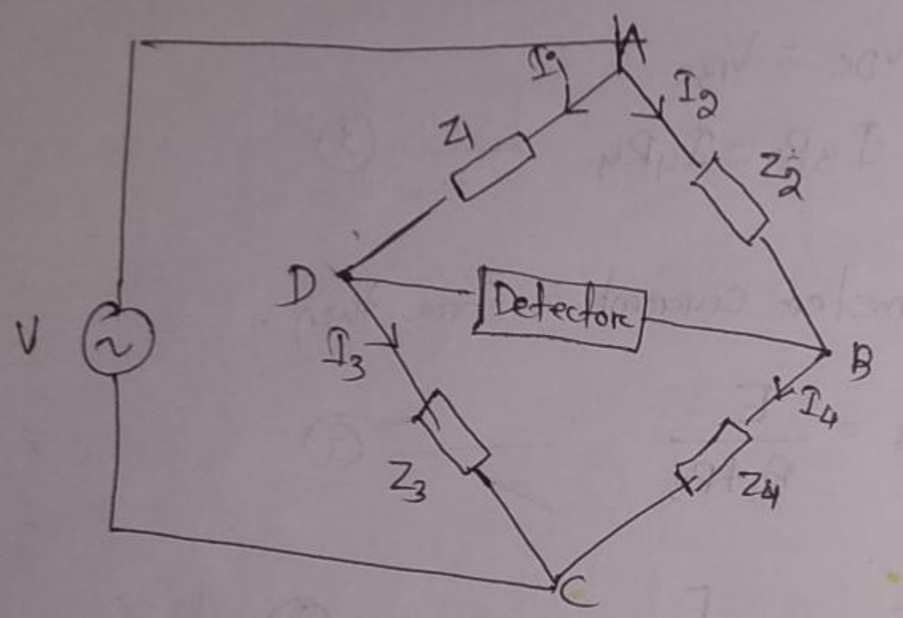
→ we can balance the bridge, by varying the resistance value of resistor, R3.

AC Bridge

AC bridge can be used to measure inductance

→ AC bridges operates with only AC voltage signal.

→ The ckt diagram of AC bridge is shown in below figure



AC bridge mainly consists of four arms, which are connected in rhombus or square shape.

→ All these arms consists of some impedance.

→ The AC bridges are formed by replacing the DC battery with an AC source & galvanometer by detector of wheatstone bridge.

→ They are highly useful to find inductance, capacitance storage factor, dissipation factor etc.

$$Z_2 = R_2$$

$$Z_3 = R_3$$

$$Z_4 = R_4 + j\omega L_4$$

Therefore bridge balanced cond^n,

$$Z_1 Z_4 = Z_2 Z_3$$

$$\Rightarrow Z_4 = \frac{Z_2 Z_3}{Z_1}$$

$$\Rightarrow Z_4 = Z_2 Z_3 Y_1$$

Putting the values of impedances, we get

$$\Rightarrow R_4 + j\omega L_4 = R_2 R_3 \left(\frac{1}{R_1} + j\omega C_1 \right)$$

$$\Rightarrow R_4 + j\omega L_4 = \frac{R_2 R_3}{R_1} + j\omega C_1 R_2 R_3$$

Equating real & imaginary parts, we get

$$\boxed{R_4 = \frac{R_2 R_3}{R_1}} \quad \text{--- (1)}$$

$$j\omega L_4 = j\omega C_1 R_2 R_3$$

$$\Rightarrow \boxed{L_4 = C_1 R_2 R_3} \quad \text{--- (2)}$$

Advantage

→ Both the values of resistor, R_4 & an inductor L_4 are independent of the value of frequency.

The bridge is balanced, when

$$\boxed{Z_1 Z_4 = Z_2 Z_3} \quad \text{--- (1)}$$

Putting the values of impedances in eqn (1)

$$\Rightarrow \left(R_1 - \frac{j}{\omega C_1}\right)\left(R_4 + j\omega L_4\right) = R_2 R_3$$

$$\Rightarrow R_1 R_4 + j\omega R_1 L_4 - \frac{jR_4}{\omega C_1} + \frac{L_4}{C_1} = R_2 R_3$$

Equating real & imaginary parts, we get

$$\Rightarrow R_1 R_4 + \frac{L_4}{C_1} = R_2 R_3 \quad \text{;} \quad \omega R_1 L_4 - \frac{R_4}{\omega C_1} = 0$$

$$\Rightarrow \frac{R_4}{\omega C_1} = \omega R_1 L_4$$

$$\Rightarrow R_4 = \omega^2 C_1 R_1 L_4$$

$$\Rightarrow \left(R_1 + j\omega L_1\right)\left(R_4 - \frac{j}{\omega C_4}\right) = R_2 R_3$$

$$\Rightarrow R_1 R_4 - \frac{jR_1}{\omega C_4} + j\omega L_1 R_4 + \frac{L_1}{C_4} = R_2 R_3$$

Equating the real & imaginary parts, we get

$$\Rightarrow R_1 R_4 + \frac{L_1}{C_4} = R_2 R_3 \quad \text{;} \quad -\frac{jR_1}{\omega C_4} + j\omega L_1 R_4 = 0$$

$$\Rightarrow -\frac{R_1}{\omega C_4} + \omega L_1 R_4 = 0$$

$$\Rightarrow \omega L_1 R_4 = \frac{R_1}{\omega C_4}$$

$$\Rightarrow L_1 = \frac{R_1}{\omega^2 R_4 C_4}$$

$$R_1 R_4 + \frac{L_1}{C_4} = R_2 R_3$$

$$\Rightarrow R_1 R_4 + \frac{R_1}{\omega^2 R_4 C_4^2} = R_2 R_3$$

$$\Rightarrow R_1\left(R_4 + \frac{1}{\omega^2 R_4 C_4^2}\right) = R_2 R_3$$

$$\Rightarrow R_1\left(\frac{\omega^2 R_4^2 C_4^2 + 1}{\omega^2 R_4 C_4^2}\right) = R_2 R_3$$

$$\Rightarrow \boxed{R_1 = \frac{\omega^2 C_4^2 R_2 R_3 R_4}{1 + \omega^2 R_4^2 C_4^2}} \quad \text{--- (1)}$$

$$L_1 = \frac{R_1}{\omega^2 R_4 C_4} = \left(\frac{\omega^2 C_4^2 R_2 R_3 R_4}{1 + \omega^2 R_4^2 C_4^2}\right) \times \frac{1}{\omega^2 R_4 C_4}$$

$$\Rightarrow \boxed{L_1 = \frac{R_2 R_3 C_4}{1 + \omega^2 R_4^2 C_4^2}} \quad \text{--- (2)}$$

The Q-factor of the coil

$$Q = \frac{\omega L_1}{R_1} = \frac{\omega}{R_1} \times \frac{R_1}{\omega^2 R_4 C_4}$$

$$= \frac{1}{\omega C_4 R_4}$$

where $Z_1 = \frac{R_1}{1+j\omega C_1 R_1}$

$Z_2 = R_2 + \frac{1}{j\omega C_2} = R_2 - \frac{j}{\omega C_2}$

$Z_3 = R_3$

$Z_4 = R_4$

$$\left(\frac{R_1}{1+j\omega C_1 R_1}\right) R_4 = \left(R_2 - \frac{j}{\omega C_2}\right) R_3$$

$$\Rightarrow \frac{R_4}{R_3} = \left(R_2 - \frac{j}{\omega C_2}\right)\left(\frac{1+j\omega C_1 R_1}{R_1}\right)$$

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

$$= \frac{R_2}{R_1} + j\omega C_1 R_2 - \frac{j}{\omega C_2 R_1} + \frac{C_1}{C_2}$$

$$\Rightarrow \frac{R_4}{R_3} = \frac{R_2}{R_1} + \frac{C_1}{C_2} + j\left(\omega C_1 R_2 - \frac{1}{\omega C_2 R_1}\right)$$

Equating real part & imaginary part,

We get

$$\frac{R_4}{R_3} = \frac{R_2}{R_1} + \frac{C_1}{C_2}$$

$$\omega C_1 R_2 - \frac{1}{\omega C_2 R_1} = 0$$

$$\Rightarrow \omega C_1 R_2 = \frac{1}{\omega C_2 R_1}$$

$$\Rightarrow \omega^2 = \frac{1}{R_1 R_2 C_1 C_2}$$

$$\Rightarrow \omega = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}$$

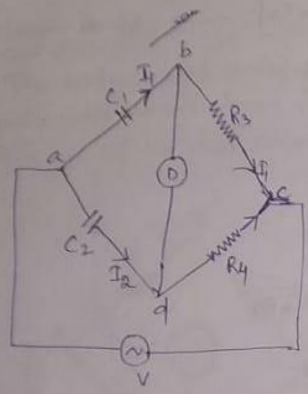
$$\boxed{\omega = 2\pi f} \qquad \omega = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}$$

$$\Rightarrow 2\pi f = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}$$

$$\Rightarrow \boxed{f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}}$$ Ans

Q-Meter

DeSauty Bridge



De Sauty's bridge is the simplest method of comparing two capacitances.

Let C_1 = Capacitor whose capacitance is to be measured.

C_2 = a standard capacitor

R_3, R_4 = non-inductive resistors

At balance Cond^n,

$$Z_1 Z_4 = Z_2 Z_3$$

$Z_1 = \frac{1}{j\omega C_1}$, $Z_2 = \frac{1}{j\omega C_2}$

$Z_3 = R_3$, $Z_4 = R_4$.

$$Z_1 Z_4 = Z_2 Z_3$$

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

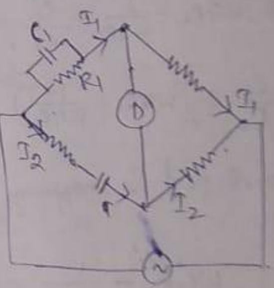
$$\Rightarrow \frac{1}{j\omega C_1} = \left(\frac{1}{j\omega C_2}\right) \frac{R_3}{R_4}$$

$$\Rightarrow C_1 = C_2 \left(\frac{R_4}{R_3}\right)$$

Wien's Bridge

This bridge is used to determine the value of unknown frequency.

→ The bridge measures the frequencies from 100Hz to 100kHz.



At balanced Cond^n,

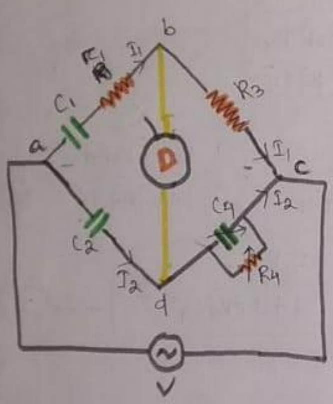
$$Z_1 Z_4 = Z_2 Z_3$$

Practice

Schering Bridge

This bridge is used to measure the capacitance of the capacitor, dissipation factor.

→ It is one of the most commonly used AC bridge.



where C_1 is the unknown capacitance whose value is to be determined with series resistance r_1.

C_2 = standard capacitor

C_4 = Variable capacitor

R_3 = pure resistor (i.e non inductive in nature)

R_4 = Variable non-inductive resistor connected in parallel with variable capacitor C_4.

The bridge will be balanced, when

$$\boxed{Z_1 Z_4 = Z_2 Z_3}$$

$$Z_1 = r_1 + \frac{1}{j\omega C_1}$$

$$Z_2 = \frac{1}{j\omega C_2}$$

$$Z_3 = R_3$$

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

$$\Rightarrow Z_1 Z_4 = Z_2 Z_3$$

$$\Rightarrow \left(r_1 + \frac{1}{j\omega C_1}\right)\left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = \left(\frac{1}{j\omega C_2}\right) R_3$$

$$\Rightarrow \left(r_1 + \frac{1}{j\omega C_1}\right) R_4 = \frac{R_3}{j\omega C_2}\left(1 + j\omega C_4 R_4\right)$$

$$\Rightarrow r_1 R_4 - \frac{jR_4}{\omega C_1} = \frac{-jR_3}{\omega C_2} + \frac{R_3 R_4 C_4}{C_2}$$

⇒ Equating the real & imaginary parts, we get

$$r_1 R_4 = \frac{R_3 R_4 C_4}{C_2}$$

$$\Rightarrow r_1 = \frac{R_3 C_4}{C_2}$$

$$\Rightarrow \boxed{r_1 = R_3\left(\frac{C_4}{C_2}\right)}$$

$$\frac{-jR_4}{\omega C_1} = \frac{-jR_3}{\omega C_2}$$

$$\Rightarrow \frac{R_4}{\omega C_1} = \frac{R_3}{\omega C_2}$$

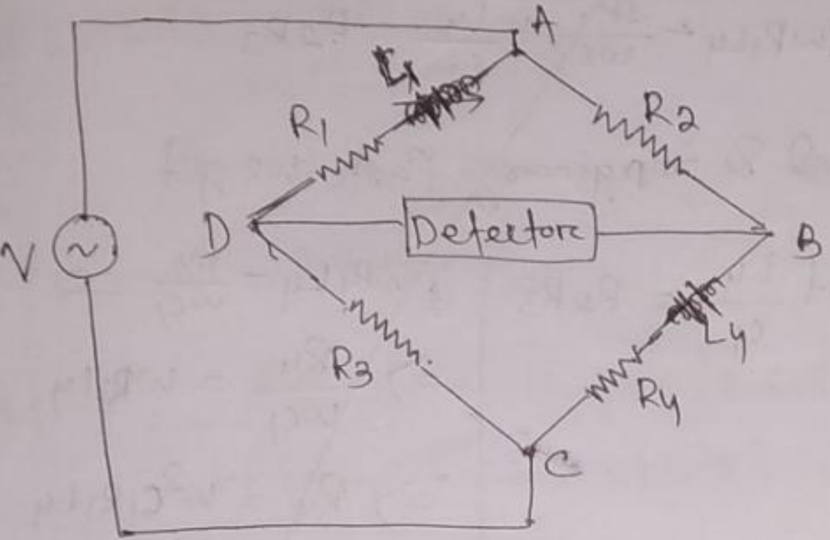
$$\Rightarrow \boxed{C_1 = C_2\left(\frac{R_4}{R_3}\right)}$$

Hay's bridge

→ Hay's bridge is a modified version of Maxwell's bridge.

→ It consists of a ~~parallel~~ series combination of resistor & capacitor

→ Hay's bridge is used to measure the value of high inductance.



→ The arm AB & CD consists of resistors R_2 & R_3 respectively.

→ The arms BC consists of a series combination of resistor R_4 & inductor L_4

→ The arm, DA consists of series combination of resistor R_1 & Capacitor C_1.

Let Z_1, Z_2, Z_3 & Z_4 are the impedances of the arms DA, AB, CD & BC respectively.

The values of the impedances will be

$$Z_1 = R_1 - \frac{j}{\omega C_1}$$

$$Z_1 = R_1 + j\omega L_1$$

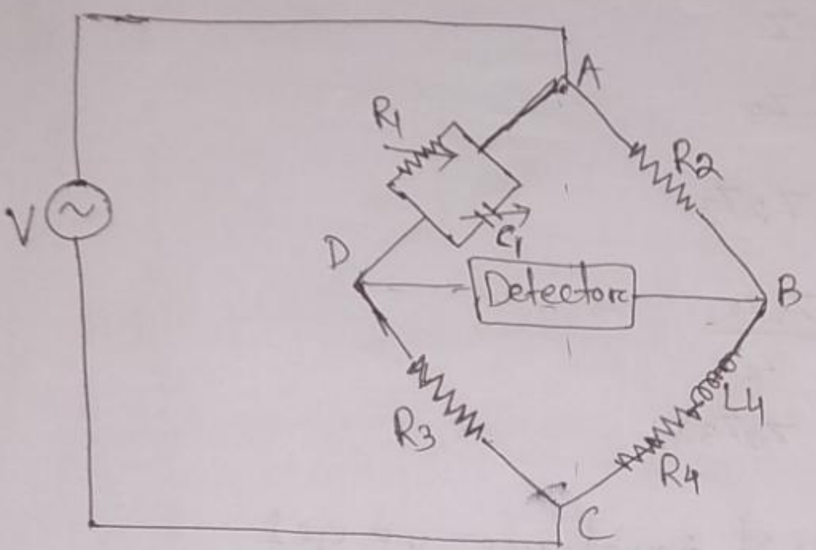
$$Z_2 = R_2$$

$$Z_3 = R_3$$

$$Z_4 = ~~R_4 + j\omega L_4~~ \; R_4 - \frac{j}{\omega C_4}$$

Maxwell's Bridge

Maxwell Bridge is used to measures an Unknown ~~induct~~ inductance in terms of unknown Capacitance.



→ In the above ckt, the arms AB & CD consists of resistors, R_2 & R_3 respectively.

→ The arm AD consists of a ~~series~~ parallel combination of a resistance & a capacitance.

→ The BC consists of a series combination of resistance & inductance.

→ The arms AB & CD consist of resistors, R_2 & R_3 respectively.

Let Z_1, Z_2, Z_3 & Z_4 are the impedance of arms DA, AB, CD & BC respectively. The value of these impedance will be

$$Z_1 = \frac{R_1\left(\frac{1}{j\omega C_1}\right)}{R_1 + \frac{1}{j\omega C_1}} = \frac{R_1}{1+j\omega R_1 C_1}$$

$$Y_1 = \frac{1+j\omega R_1 C_1}{R_1} = \frac{1}{R_1} + j\omega C_1$$

The balance condⁿ of wheatstone's bridge as :-

$$R_4 = \frac{R_2 R_3}{R_1}$$

→ we will get the balancing condition of AC bridge, just by replacing R with Z in the above eqn

$$Z_4 = \frac{Z_2 Z_3}{Z_1}$$

$$\Rightarrow \boxed{Z_1 Z_4 = Z_2 Z_3}$$

Where Z_1, Z_2 are fixed impedances.

Z_3 = a Standard variable impedance

Z_4 = Unknown impedance.

→ The bridge is balanced when the potential difference ~~betn~~ across the galvanometer is 0V, ~~so that~~ ~~then~~ That means no current flowing through the galvanometer & there is no deflection in the galvanometer.

i.e.,

$$V_{AD} = V_{AB}$$

$$\Rightarrow I_1 R_1 = I_2 R_2 \quad \text{——} (1)$$

$$V_{DC} = V_{BC}$$

$$\Rightarrow I_3 R_3 = I_4 R_4 \quad \text{——} (2)$$

If the galvanometer current is zero, then

$$I_1 = I_3 = \frac{E}{R_1 + R_3} \quad \text{——} (3)$$

&

$$I_2 = I_4 = \frac{E}{R_2 + R_4} \quad \text{——} (4)$$

Putting ~~the value~~ eqn (3) & (4) in (1)

$$I_1 R_1 = I_2 R_2$$

$$\Rightarrow \frac{E \cdot R_1}{R_1 + R_3} = \frac{E \cdot R_2}{R_2 + R_4}$$

$$\Rightarrow \frac{R_1}{R_1 + R_3} = \frac{R_2}{R_2 + R_4} \Rightarrow R_1R_2 + R_1R_4 = R_1R_2 + R_2R_3$$

$$\Rightarrow R_1 R_4 = R_2 R_3$$

$$\Rightarrow R_x = \frac{R_2 R_3}{R_1}$$

$$\Rightarrow \boxed{R_x = R_3 \frac{R_2}{R_1}}$$

Bridge

What is an Bridge Circuit.

Ans An Bridge is an special electrical ckt consisting of 4 arms & 4 nodes arranged in a predefined manner.

Bridges

DC Bridges	AC Bridges
→ DC supply	AC supply
→ Contains resistances only (R)	→ Contains R, L & C
→ Phasor Not Involved.	→ Phasor's are Involved

DC Bridge

→ DC bridges can be operated with only DC voltage signal.

→ DC bridges are useful for the measurement of the value of unknown resistance, which is present in the bridge.

Ex :- Wheatstone's Bridge

Wheatstone's Bridge

→ Wheatstone's bridge is a simple DC bridge.

→ Consists of 4 arms.

→ These four arms form a rhombus or square shape & each arm consists of one resistor.

→ To find the value of unknown resistance, we need the galvanometer & DC voltage source.

→ Hence one of these two are placed in one diagonal of wheatstone's bridge & the other one is placed in another diagonal of wheatstone's bridge.

Digital Storage Oscilloscope

→ Digital Storage Oscilloscope (DSO) is an electronic instrument that is capable of storing digital form of measured wave form (Signal).

→ DSO is the advance form of CRO which Overcome the drawback of CRO.

→ The i/p wave form is applied to the i/p attenuator & vertical amplifier to bring it into measurable form.

→ The amplified i/p from vertical amplifier is passes through the Sample & Hold ckt & analog to digital converter.

→ Sample & hold ckt samples the i/p signal & A to D Converter digitizes the i/p waveform to create data set which will be stored in memory.

→ Once the data is stored into memory, many manipulations are possible as memory can be read out without being erased.

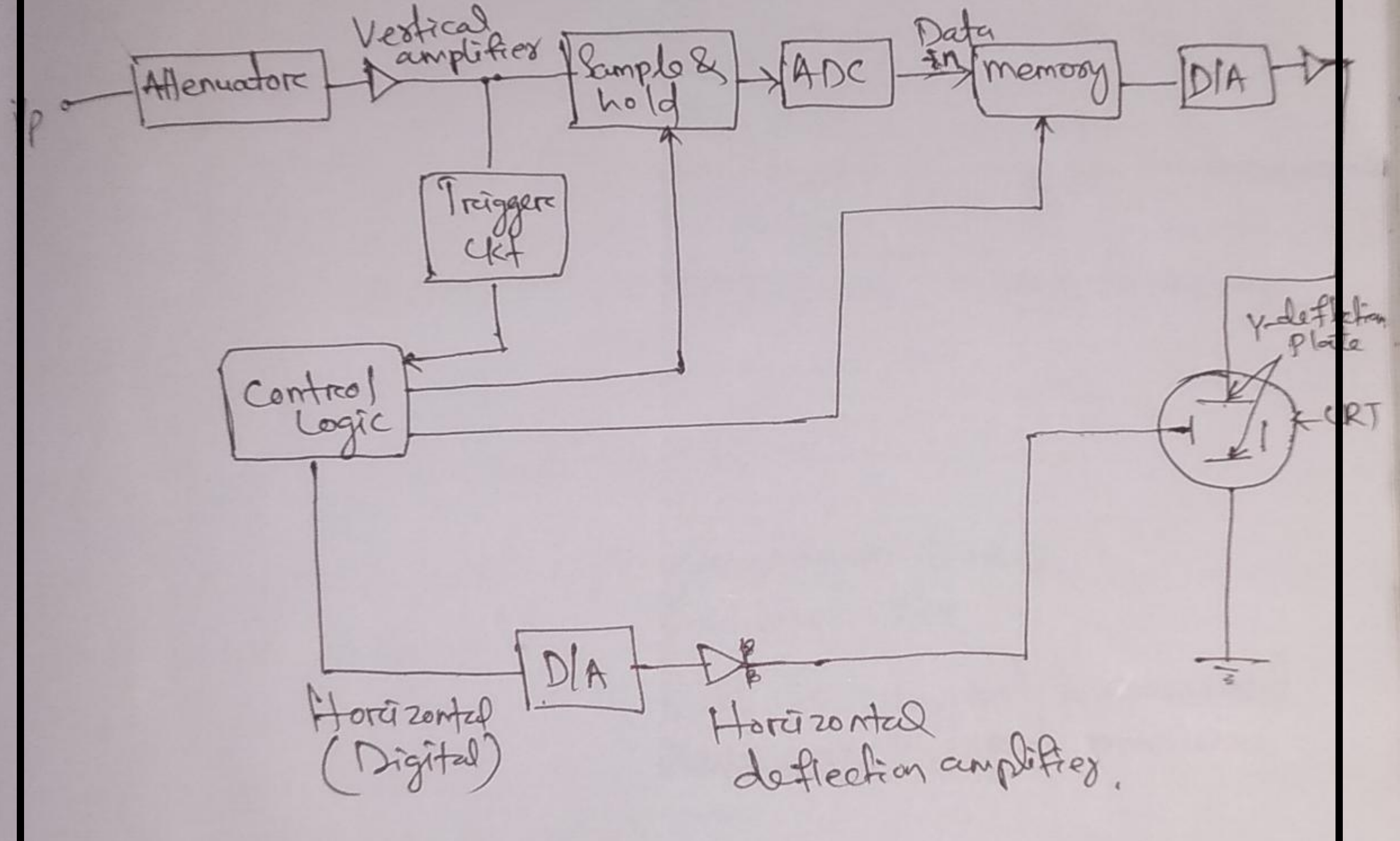
→ The data set is processed by the Control logic unit which is basically works as mini computer (Microprocessor).

→ The control logic units controls the functioning of sample & hold ckt, Analog to digital Converter, memory unit etc.

→ The read write operation in memory device is controlled by the memory unit only.

→ Timing & mode logic used to decide the timing & mode of operation of the DSO by enabling the control logic & trigger ckt.

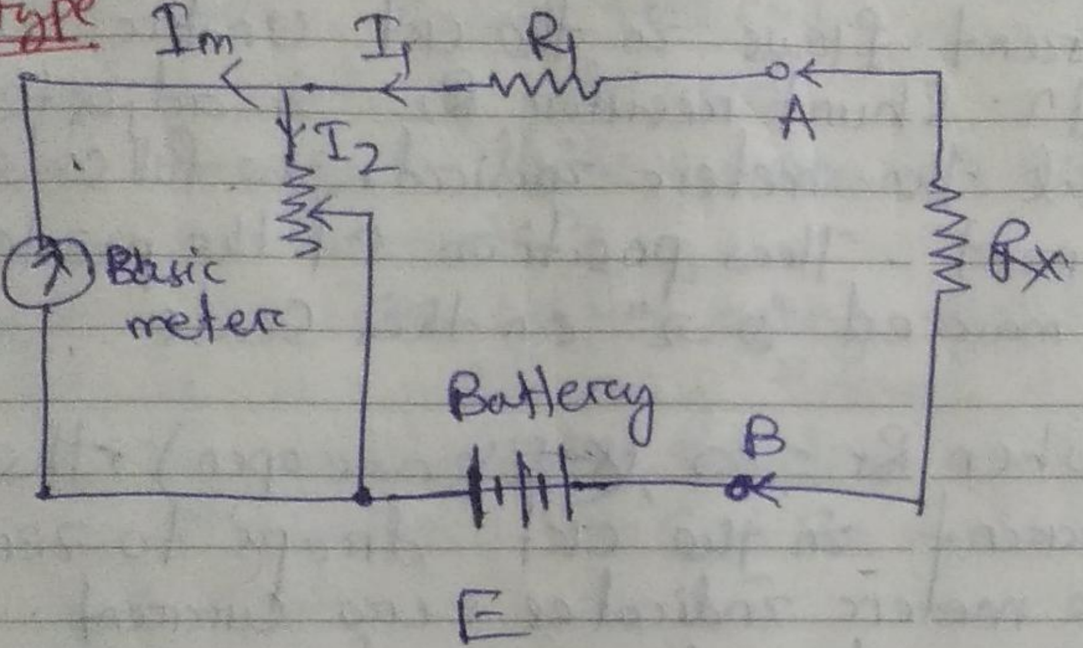
Digital Storrage Oscilloscope



Ohmmeters → it is a device for measurement of resistance
2 types

→ Series type Ohmmeter
→ Shunt " "

Series type



→ It consists of a D'Arsonval movement Connected in series with a resistance & a battery to a pair of terminals (X, X) to which the unknown resistance (R_x) is Connected.

→ When the current is passed through the coil, a magnetic field is set up inside the coil & the two iron pieces are magnetised in the same directn. This sets up a repulsive force so moving iron piece is repelled by fixed iron piece, Thereby resulting in the motion of the moving iron piece, carrying the pointer.

→ The pointer comes to rest in a deflected position when equilibrium is attained betn ~~reset~~ repulsive forces of the working elements & the controlling torque.

MEETINGS / APPOINTMENTS

Moving iron instruments

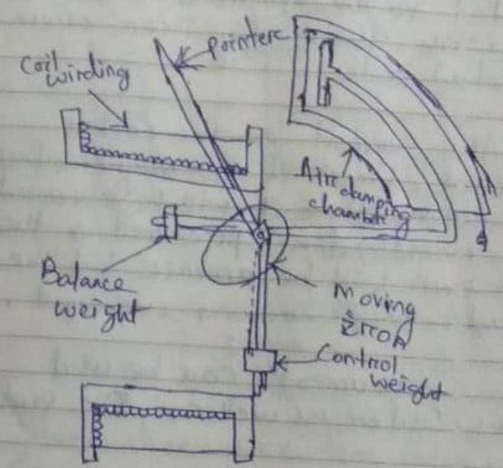
The basic principle of moving iron instrument can be explained below

- The moving element consists of a plate or vane of soft iron & this iron vane is placed such that it can move in a magnetic field produced by a stationary coil.

→ When the coil is excited by i/p current, it becomes electromagnet & iron vane moves in such a way so as to increase the flux of electromagnet. Becoz the iron vane tries to occupy a position of min^m reluctance. Thus a force exerted on the soft iron vane so as to increase the inductance of the coil.

MEETINGS / APPOINTMENTS

① Attraction type



It consists of a coil C & oval shaped soft iron. The coil is flat & has a narrow slot like opening. A pointer is attached when the current flows through the coil, a magnetic field is produced & the moving iron is magnetized that means it attracted towards

Resolution of Digital meter:-

It is defined as the digit positions or simply the no. of digits used in a meter.

If no. of full digit is n, then resolutio

$$R = \frac{1}{10^n}$$

Sensitivity

It is the smallest change in i/p which a digital meter is able to detect.

$$\text{Sensitivity} = (f_s)_{min} \times R$$

→ There is no physical contact betn the movable core & coil structure which means that LVDT is a frictionless device.

3. High i/p & high sensitivity

4. Low power consumption → most LVDTs consume power which is less than 1W.

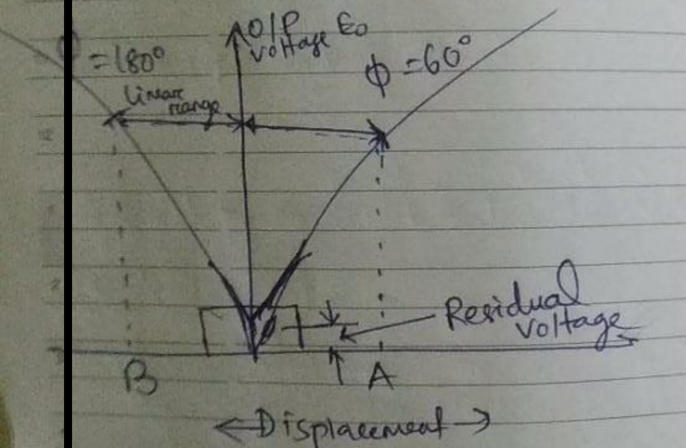
Disadvantages of

1. Large displacement are required for appreciable differential o/p.

2. Many times, the transducer's performance is affected by vibration.

3. Temp affects the performance of the transducers.

→ The o/p voltage is 180° out of phase with the primary voltage.



The o/p voltage of an LVDT is a linear functn of core displacement within a limited range of motion, about 5mm from the null position.

→ The curve is practically linear for small displacement (about 5mm upto). Beyond this range, the curve starts to deviate from a straight line.

→ fig shows, the variation of o/p voltage versus displacement for various position of core.

Advantage

① High range → This can be use for measurement of displacements ranging from 1.25 mm to 250mm

② Frictional & Electrical Isolation →

LVDT is an electrical transformer with a separable non-contacting core.