20EI403

Hall Ticket Number:

II/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

July/August,2023 **Electronics & Instrumentation Engineering**

Fourth Semester **Electrical and Electronic Measurements**

Time: Three Hours **Maximum:**70 Marks

Answer Question No.1 compulsorily. (14X1 = 14 Marks)

Answer ONE question from each unit. (4X14=56 Marks)

1.	a)	Define error.	L1	CO1	1M
	b)	What is the working principle of Potential transformer?	L1	CO1	1M
	c)	Define sensitivity of measuring instrument.	L2	CO1	1M
	d)	What is the working principle of power factor meter?	L2	CO1	1M
	e)	Draw the Maxwell’s bridge.	L1	CO2	1M
	f)	Draw Hay’s Bridge.	L1	CO2	1M
	g)	What are the various types of Digital volt meter?	L1	CO2	1M
	h)	What is working principle of RF millivolt meter?	L1	CO2	1M
	i)	What is Graticules,?	L1	CO3	1M
	j)	What is magnetic sensor?	L1	CO3	1M
	k)	What is aOscilloscope probe?	L2	CO3	1M
	l)	What is synthesized signal generator?	L1	CO4	1M
	m)	What is period measurement?	L1	CO4	1M
	n)	What is synthesis?	L2	CO4	1M
		Unit - I			
2.	a)	Differentiate Series type ohmmeter and Shunt type ohmmeter.	L1	CO1	7M
	b)	The shunt type voltmeter uses a 10mA D’Arsonval movement with an internal resistance of 5ohms.The battery voltage = 3V.It is desired to modify the circuit by adding an appropriate resistor R_{sh}across the movement, so that the instrument will indicate 0.5 ohms at the midpoint on its scale. Calculate the value of shunt resistor R_{sh}ii) the value of the current limiting resistor.	L3	CO1	7M
		(OR)			
3.	a)	Explain the following terms with examples i)Significant figures ii) Statistical analysis iii) Limiting errors	L1	CO1	7M
	b)	Explain the construction, principle and operation of PMMC instrument. Also derive the expression for deflecting torque.	L3	CO1	7M
		Unit - II			
4.	a)	Draw the bridge circuit used for measurement of low resistance and derive the expression for unknown resistance.	L2	CO2	7M
	b)	The four arms of a bridge are: arm *ab*: an imperfect capacitor C_1 with an equivalent series resistance of r_1 arm *bc*: a non-inductive resistance R_3, arm *cd*: a non-inductive resistance R_4, arm *da*: an imperfect capacitor C_2 with an equivalent series resistance of r_2 series with a resistance R_2.A supply of 450Hz is given between terminals *a* and *c* and the detector is connected between *b* and *d*. At balance: R_2=4.8Ω, R_3=2000Ω, R_4=2850Ω and C_2=0.5µF and r_2=0.4Ω. Calculate the value of C_1 and r_1 and also of the dissipating factor for this capacitor.	L3	CO2	7M
		(OR)			
5.	a)	Draw the block diagram of Stair case ramp type DVM and explain its working principle.	L1	CO2	7M
	b)	Draw the circuit diagram of true RMS voltmeter and explain its functioning?	L3	CO2	7M
		Unit - III			
6.	a)	What is meant by Lissajous figures? Explain how phase and frequency are measured using CRO	L2	CO3	7M
	b)	What is the minimum distance L that will allow full deflection of 4Cm at the CRO screen with a deflection factor of 1000V/Cm and with an acceleration potential of 4000V?	L3	CO3	7M

(OR)

7.	a)	Draw the circuit of Digital storage Oscilloscope and explain its operation.	L2	CO3	7M
	b)	Explain the current probe with magnetic sensor.	L2	CO3	7M

Unit - IV

8.	a)	Explain the Synthesized signal generator.	L1	CO4	7M
	b)	Explain the various measurement errors in frequency counter.	L2	CO4	7M

(OR)

9.	a)	With a neat block diagram, explain the operation of function generator	L1	CO4	7M
	b)	Draw the block diagram of laboratory square wave generator and explain its operation.	L2	CO4	7M

II/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

July/August,2023

Fourth Semester

Scheme of evaluation

Electrical and Electronic Measurements

(20EI403)

HOD,EIE

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1. a) **Define error.** L1 CO1 1M

Ans Any measurement made with a measuring device is approximate. If you measure the same object two different times, the two measurements may not be exactly the same. The difference between two measurements is called an error. The error in measurement is a mathematical way to show the uncertainty in the measurement.

b) **What is the working principle of Potential transformer?** L1 CO1 1M

Ans Instrument transformers are used in connection with measurement of voltage , current ,energy and power in ac circuits. There are principally two reasons for use of instrument transformers in measurement: first, to extend (multiply) the range of the measuring instrument and second , to isolate the measuring instrument from a high voltage line.

c) **Define sensitivity of measuring instrument.** L2 CO1 1M

Ans Sensitivity: It is defined as the ratio of the changes in the output of an instrument to a change in the value of the quantity being measured. It denotes the smallest change in the measured variable to which the instrument responds.

d) **What is the working principle of power factor meter?** L2 CO1 1M

Ans The power factor , by definition ,is the cosine of the phase angle between voltage and current, and power factor measurements usually involve the determination of this phase angle. This is demonstrated in the operation of the crossed coil power factor meter.

e) **Draw the Maxwell's bridge.** L2 CO2 1M

Ans

11.11 MAXWELL'S BRIDGE

Maxwell's bridge, shown in Fig. 11.15, measures an unknown inductance in terms of a known capacitor. The use of standard arm offers the advantage of compactness and easy shielding. The capacitor is almost a loss-less component. One arm has a resistance R_1 in parallel with C_1, and hence it is easier to write the balance equation using the admittance of arm 1 instead of the impedance.

The general equation for bridge balance is

$$Z_1 Z_x = Z_2 Z_3$$

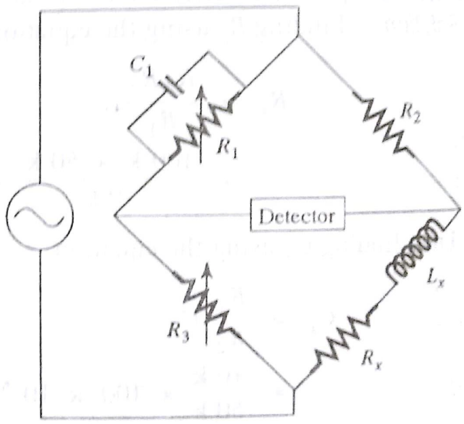


Fig. 11.15 Maxwell's Bridge

f) **Draw Hay's Bridge.** L1 CO2 1M

Ans

The equivalent series circuit is shown in Fig. Ex.11.7.

11.12 HAY'S BRIDGE

The Hay bridge, shown in Fig. 11.16, differs from Maxwell's bridge by having a resistance R_1 in series with a standard capacitor C_1 instead of a parallel. For large phase angles, R_1 needs to be low; therefore this bridge is more convenient for measuring high-Q coils. For $Q = 10$, the error is $\pm 1\%$, and for $Q = 30$, the error is $\pm 0.1\%$. Hence Hay's bridge is preferred for coils with a high Q, and Maxwell's bridge for coils with a low Q.

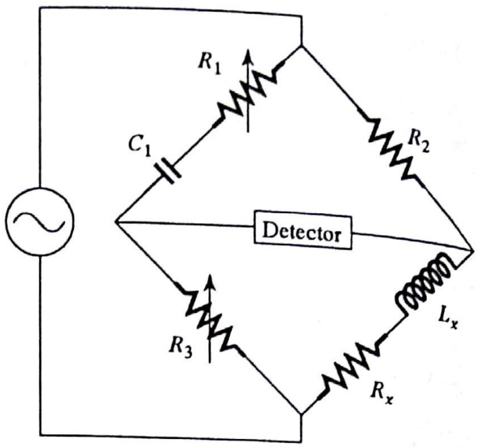


Fig. 11.16 Hay's Bridge

At balance $Z_1 Z_x = Z_2 Z_3$, where

g)	**What are the various types of Digital volt meter?**	**L1**	**CO2**	**1M**
Ans	Voltmeters are of five types based on construction - rectifier type voltmeter, MI voltmeter, electro dynamic voltmeter, PMMC, induction type voltmeter. Rectifier type voltmeter measures the voltage using a permanent magnet moving coil and rectifying elements.			
h)	**What is working principle of RF millivolt meter?**	**L1**	**CO2**	**1M**
Ans	RF milli voltmeter hs been designed to provide accurate RF level measurements from 20KHz to 1 GHz .It has useful response from 10 KHz to 1.5 GKHz and measures RF Voltages from 1mV to 3V in eight ranges .			
i)	**What is Graticules,?**	**L1**	**CO3**	**1M**
Ans	Graticule: graticule is the grid on the display screen of an oscilloscope that comprises the horizontal and vertical axes. The graticule is used to visually measure waveform parameters.			
j)	**What is magnetic sensor?**	**L1**	**CO3**	**1M**
Ans	A magnetic sensor usually refers to a sensor **that converts the magnitude and variations of a magnetic field into electric** signals.			
k)	**What is a Oscilloscope probe?**	**L2**	**CO3**	**1M**
Ans	An oscilloscope probe is a **device that makes a physical and electrical connection between a test point or** signal source and an oscilloscope.			
l)	**What is synthesized signal generator?**	**L1**	**CO4**	**1M**
Ans	The SSG, Synthesized Signal Generator, is designed to be a workhorse in the lab, providing a high quality synthesized output in a small package that is easy to move around, and a without the penalty of paying for features you don't need.			
m)	**What is period measurement?**	**L1**	**CO4**	**1M**
Ans	Period Measurement. In period measurements, the counter measures a period on its Gate input signal after the counter is armed. You can configure the counter to measure the period between two rising edges or two falling edges of the Gate input signal.			
n)	**What is synthesis?**	**L2**	**CO4**	**1M**
Ans	Synthesis is a work measurement technique for building up the time for a job at a defined level of performance by totaling element times obtained previously from time studies on other jobs containing the elements concerned, or from synthetic data.			

Unit - I

2. a) Differentiate Series type ohmmeter and Shunt type ohmmeter. **L1** **CO1** **7M**

Series type Ohmmeter 4M

Shunt type Ohmmeter --------3M

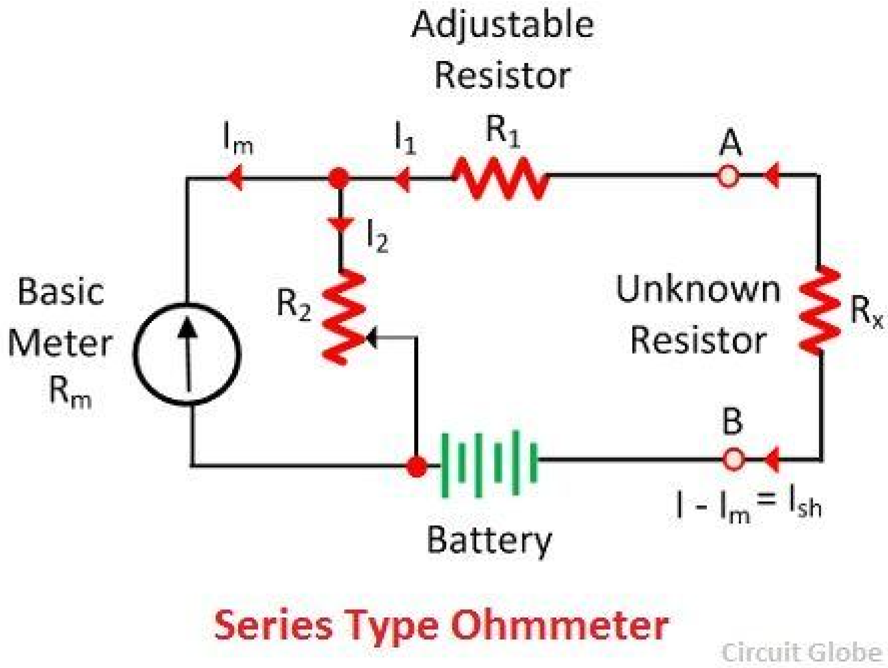
Ans **Definition:** The **meter** which **measures** the **resistance** and the **continuity** of the **electrical circuit** and their **components** such type of meter is known as the ohmmeter. It **measures** the resistance in **ohms.** The **micro-ohmmeter** is used for **measuring** the l**ow resistance** and the **mega ohmmeter** measures the **high resistance** of the circuit. The ohmmeter is very convenient to use but **less accurate**.

Types of Ohmmeter

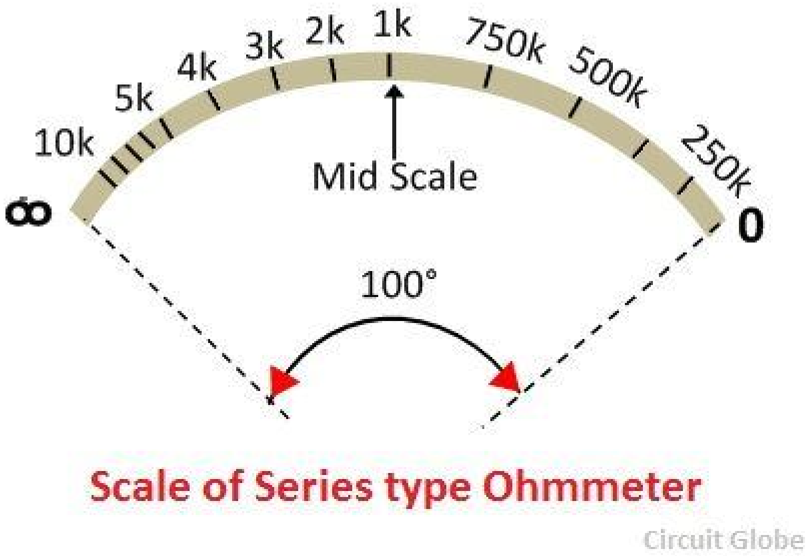
The ohmmeter gives the approximate value of resistance. It is very portable and hence used in the laboratory. It is of three types; they are the series ohmmeter, shunt ohmmeter and multi-range ohmmeter. The detail explanation of their types is given below.

Series Ohmmeter

In series ohmmeter, the measuring resistance component or circuit is connected in series with the meter. The value of resistance is measured through the d'Arsonval movement connected in parallel with the shunt resistor R_2. The parallel resistance R_2 is connected in series with the resistance R_1 and the battery. The component whose resistance is used to be measured is connected in series with the terminal A and B.The circuit diagram of the series ohmmeter is shown in the figure below.



When the value of unknown resistance is zero the large current flow through the meter. In this condition, the shunt resistance is adjusted until the meter indicates the full load current. For full load current, the pointer deflects towards zero 0 ohms.



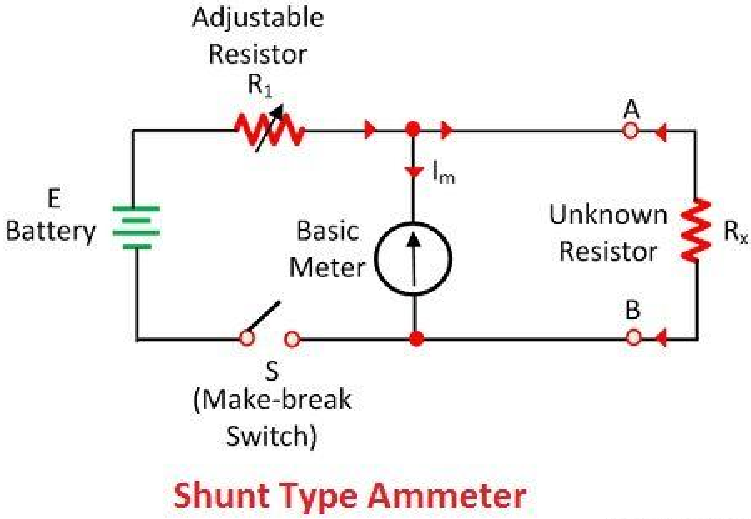
When the unknown resistance R_x is removed from the circuit the resistance of the circuit becomes infinite and no current flow through the circuit. The pointer of the meter deflects towards the ∞ (infinity). The meter shows the infinite resistance at zero current and the zero resistance when full range current flows through it.

When the unknown resistance is connected in series with the circuit and if their resistance is high, then the pointer of the meter deflects toward the left. And if the resistance is low, then pointer deflects toward the right.

Shunt Type Ohmmeter

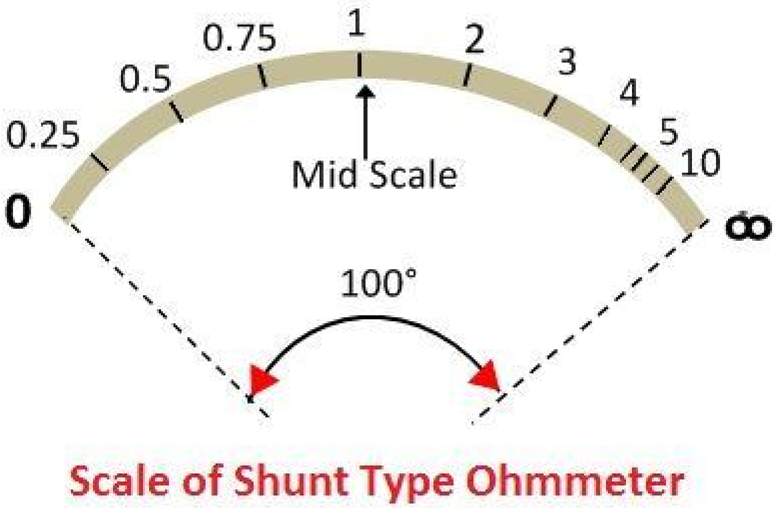
The meter in which the measuring resistance is connected in parallel with the battery is known as the shunt ohmmeter. It is mainly used for measuring the low-value resistance.

The circuit diagram of the shunt ohmmeter is shown in the figure below.



The battery (E), basic meter (R_m) and the adjustable resistance are the main components of the shunt ohmmeter. The unknown resistance is connected across terminal A and B.

When the value of unknown resistance is zero the meter current becomes zero. And if the resistance becomes infinite (i.e., the terminal A and B are open) then the current passes through the battery and the pointer shows the full-scale deflection toward left. The shunt type ohmmeter has the zero mark (no current) on the left of the scale and the infinity mark on their right side.



2.	**b)**	**The shunt type voltmeter uses a 10mA D'Arsonval movement with an internal resistance of 5ohms.The battery voltage = 3V.It is desired to modify the circuit by adding an appropriate resistor R_{sh}across the movement, so that the instrument will indicate 0.5 ohms at the midpoint on its scale. Calculate (i)the value of shunt resistor R_{sh}ii) the value of the current limiting resistor.**	**L3**	**CO1**	**7M**

(i) the value of shunt resistor R_{sh} **4M**

(ii) the value of the current limiting resistor. 3M

Ans Solution

For half-scale deflection

$$I_m = 0.5 I_{fsd} = 0.5mA$$

$$I_{sh} = I_m\left(\frac{R_m - R_h}{R_h}\right) = 0.5\times10^{-3} A\left(\frac{50-0.5}{0.5}\right) = 45mA$$

Therefore,

$$R_{sh} = \frac{I_m R_m}{I_{sh}} = \frac{0.5mA\times 50\Omega}{45mA} = 555.56m\Omega$$

$$I_t = 2I_m \frac{R_m}{R_h} = 2\times0.5mA\left(\frac{50\Omega}{0.5\Omega}\right) = 100mA$$

$$R_1 = \frac{E - I_m R_m}{I_t} = 3V - \frac{(0.5mA\times50\Omega)}{100mA}$$

$$\underline{= 29.75\Omega}$$

we can thus see that shunt-type ohmmeter can measure low values of resistance.

(OR)

3. a) Explain the following terms with examples **L1 CO1 7M**

i)Significant figures ii) Statistical analysis iii) Limiting errors

i)Significant figures 3M

ii) Statistical analysis 2M

iii) Limiting errors 2M

Ans i)Significant figures :

Precision is indicated from the number of significant figures in which it is expressed.

Significant figures actually convey the information regarding the magnitude and the measurement precision of a quantity. More significant figures imply greater precision of the measurement.

All non zero digits are **ALWAYS** significant

•How many significant digits are in the following numbers?

274 .... 3 Significant Figures

25.632 .... 5 Significant Digits

8.987 .... 4 Significant Figures

All zeros between significant digits are **ALWAYS**significant

•How many significant digits are in the following numbers?

504 .... 3 Significant Figures

60002 .... 5 Significant Digits

9.077 .... 4 Significant Figures

All **FINAL** zeros to the right of the decimal **ARE** significant

•How many significant digits are in the following numbers?

32.0 .... 3 Significant Figures

19.000 .... 5 Significant Digits

105.0020 .... 7 Significant Figures

Ruleforaddition/subtraction: Thelastdigitretainedinthesumordifferenceisdeterminedbythe*position*ofthefirstdoubtfuldigit

37.24+10.**3**=47.**5**

100**2**+0.23675=100**2**

225.618+0.2**3**=225.8**5**

Rule for multiplication/division: The product contains the same number of figures as the number containing the *least*sig figs used to obtain it.

12.34 x 1.23= **15.1**782

= 15.2 to 3 S.F.

0.123/12.34 = 0.00**996**75850891
= 0.00997 to 3 S.F.
ii) Statistical analysis

Population = all elements of measured quantity – finite (N) or infinite (∞).

Sample = n measurements of the population. Sample is representative of population if:

(a) sample can be characterized

(b) relationship between sample parameters and population parameters is *known*.

Central tendency (of population)

(a) median

(b) mean, μ

Dispersion parameters (of population)

(a) deviation: $d_i = e_i - \mu$, $\mu =$ population mean

(b) variance: $\sigma^2 = \frac{\Sigma d_i^2}{N}$

(c) standard deviation: σ

For the whole population of measurements we have the population parameters based on a total of N measurements. For a sample of n measurements (since the whole population may not be available) we have sample parameters. In general, one wants to obtain the population statistics from the sample statistics.

A summary of those is as follows:

Central tendency	Population	Sample	
Mean/average:	$\mu \equiv \frac{\Sigma e_i}{N}$	$\bar{e} \equiv \frac{\Sigma e_i}{n}$ $\Rightarrow \Sigma(e_i - \bar{e}) = 0$	Also called **Sample Mean**
Median:	middle pt., i.e. same # of pts. above and below median		

Dispersion tendency	Population	Sample	
Deviation:	$d_i = e_i - \mu$	$d_i = e_i - \bar{e}$	
However,	$\Sigma d_i = 0$	$\Sigma d_i = 0$	
so we can define			
Variance:	$\sigma^2 \equiv \frac{\Sigma d_i^2}{N} = \frac{\Sigma(e_i - \mu)^2}{N}$	$\hat{\sigma}^2 \equiv \frac{\Sigma(e_i - \bar{e})}{n}$	Also called **Sample Variance**
Std. Deviation:	$\sigma \equiv \sqrt{\frac{\Sigma(e_i - \mu)^2}{N}}$	$\hat{\sigma} \equiv \sqrt{\frac{\Sigma(e_i - \bar{e})^2}{n}}$	

To determine the sample standard deviation $\hat{\sigma}$ *during* a measurement, without having to store all observations, we can use the **recursive formulae**:

$$\hat{\sigma} = \left(\frac{\Sigma e_i^2}{w} - \bar{e}^2\right)^{1/2} = \left(\frac{\Sigma e_i^2 - \Sigma e_i}{n}\right)^{1/2}.$$

iii) Limiting errors

The maximum allowable error in the measurement is specified in terms of true value, is known as limiting error. It will give a range of errors. It is always with respect to the true value, so it is a variable error.

3. b) Explain the construction, principle and operation of PMMC instrument. Also derive the expression for deflecting torque. **L3** **CO1** **7M**

construction, principle and operation of PMMC instrument 4M

expression for deflecting torque. 3M

Ans D'ARSORVAL METER MOVEMENT

- Also called Permanent-Magnet Moving Coil (PMMC).
- Based on the moving-coil galvanometer constructed by Jacques d' Arsonval in 1881.
- Can be used to indicate the value of DC and AC quantity.
- Basic construction of modern PMMC can be seen in Figure 2.1.

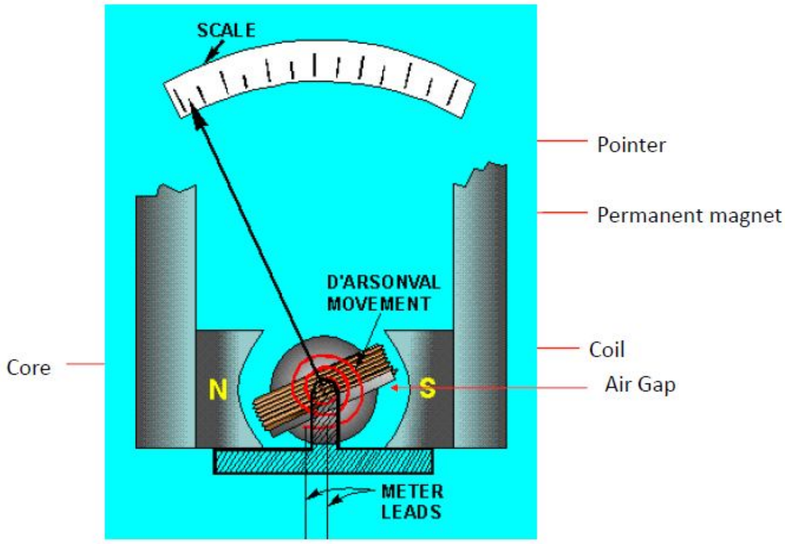


Figure 2.1: Modern D'Arsonval Movement

Principle of Operation

The principle on which a Permanent Magnet Moving Coil (PMMC) instrument operates is that a torque is exerted on a current carrying coil placed in the field of a permanent magnet . APMMC instrument is shown in Figure2.11. The coil C has a number of turns of thin insulated wire s wound on a rectangular aluminium former *F .The frame is carried on* a spindle S mounted in jewel bearings J_1,J_2. *A pointer P R is attached to the spindles o tha t* it moves over a calibrated scale. The whole of the moving system is made a s light in weight as possible to keep the friction at the bearing to a minimum.

Torque developed by PMMC

Let T_d =*deflecting torque*

T_C= *controlling torque*

q = angle of deflection

K=spring constant

b=width of the coil

l=height of the coil or length of coil

N=No. of turns

I=current

B=Flux density

A=area of the coil

The force produced in the coil is given by

$$F = BIL\sin\theta \tag{1.4}$$

When $\theta = 90^{\circ}$

For N turns, $F = NBIL$ (1.5)

Torque produced $T_d = F\times\perp_r$ distance (1.6)

$$T_d = NBIL\times b = BINA \tag{1.7}$$

$$T_d = BANI \tag{1.8}$$

$$T_d \propto I \tag{1.9}$$

Unit – II

4. a) Draw the bridge circuit used for measurement of low resistance and derive the expression for unknown resistance. **L2 CO2 7M**

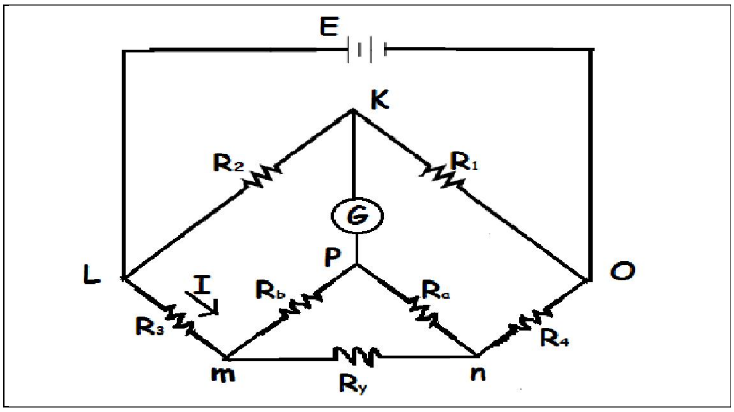
the bridge circuit used for measurement of low resistance 4M

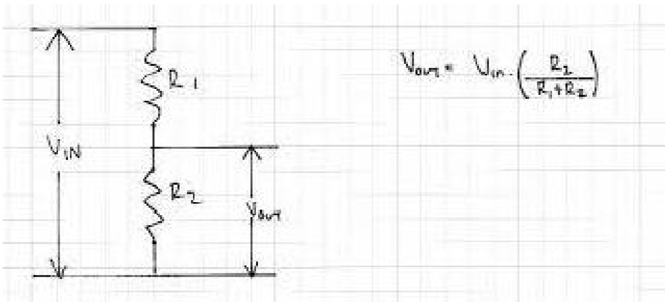
expression for unknown resistance. 3M

Ans Kelvin's Double-Bridge Method for Measuring Low Resistance

The term double bridge is used because the circuit contains a second set of ratio arms , as shown in the schematic diagram of fig 5.5.This second set of arms , labelled a and b in the diagram, connect the galvanometer to a pin tp at the appropriate potential between m and n. and it eliminates the effect of yoke resistance Ry. A n initially established condition is that theresistanceratioofaandbisthesameastheratioofR1andR2.

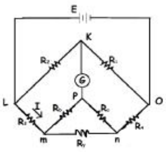
The galvano meter indication will be zero when the potential at k equals the potential at p, or when $E_{kl}=E_{lmp}$, where





$$E_{kl} = \frac{R_2}{R_1 + R_2} E = \frac{R_2}{R_1 + R_2} I \left[R_3 + R_x + \frac{(a+b)R_y}{a+b+R_y} \right]$$

$$E_{lmp} = I \left\{ R_3 + \frac{b}{a+b} \left[\frac{(a+b)R_y}{a+b+R_y} \right] \right\}$$



By solving above equations $\quad E_{kl} = E_{lmp}$

$$\frac{R_2}{R_1 + R_2} I \left[R_3 + R_x + \frac{(a+b)R_y}{a+b+R_y} \right] = I \left\{ R_3 + \frac{b}{a+b} \cdot \left[\frac{(a+b)R_y}{a+b+R_y} \right] \right\}$$

$$R_3 + R_x + \frac{(a+b)R_y}{a+b+R_y} = \frac{R_1 + R_2}{R_2} \left[R_3 + \frac{bR_y}{a+b+R_y} \right]$$

$$R_3 + R_x + \frac{(a+b)R_y}{a+b+R_y} = \frac{R_1 R_3}{R_2} + R_3 + \frac{R_1 + R_2}{R_2} \frac{bR_y}{a+b+R_y}$$

solving for R_x yields

$$R_x = \frac{R_1 R_3}{R_2} + \frac{R_1}{R_2} \cdot \frac{bR_y}{a+b+R_y} + \frac{bR_y}{a+b+R_y} - \frac{(a+b)R_y}{a+b+R_y}$$

so that

$$R_x = \frac{R_1 R_3}{R_2} + \frac{bR_y}{a+b+R_y} \left(\frac{R_1}{R_2} - \frac{a}{b} \right)$$

initially established condition

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

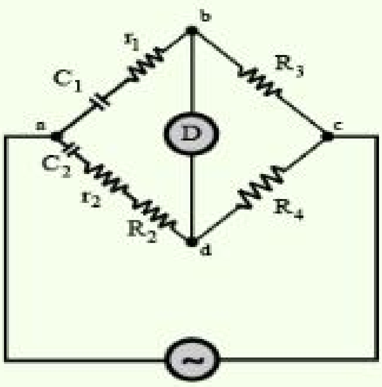
Equation 5.17 is the usual working equation for the Kelvin bridge .It indicates that the resistance of the yoke has no effect on the measurement , provided that the two sets of ratio arms have equal resistance ratios.

4.	**b)**	**The four arms of a bridge are: arm *ab*: an imperfect capacitor C_1 with an equivalent series resistance of r_1 arm *bc*: a non-inductive resistance R_3, arm *cd*: a non-inductive resistance R_4, arm *da*: an imperfect capacitor C_2 with an equivalent series resistance of r_2 series with a resistance R_2.A supply of 450Hz is given between terminals *a* and *c* and the detector is connected between *b* and *d*. At balance: R_2=4.8Ω, R_3=2000Ω, R_4=2850Ω and C_2=0.5μF and r_2=0.4Ω. Calculate the value of C_1 and r_1 and also of the dissipating factor for this capacitor.**	**L3**	**CO2**	**7M**

Ans

Calculate the value of C_1 and r_1 ....4M
dissipating factor for this capacitor............3M

The bridge is shown below,



At balance $\left(r_1 + \frac{1}{j\omega C_1}\right) R_4 = \left(r_2 + R_2 + \frac{1}{j\omega C_2}\right) R_3$

Separating the real and imaginary terms,

$r_1 = (r_2 + R_2)\frac{R_3}{R_4} = (0.4 \times 4.8) \times \frac{2000}{2850} = 3.65\,\Omega$

$C_1 = C_2 . \frac{R_4}{R_3} = (0.05 \times 10^{-6}) \times \frac{2850}{2000} = 0.712\,\mu F$

Dissipating factor, $D_1 = \tan \delta_1 = \omega C_1 r_1$

$= 2\pi \times 450 \times 0.712 \times 10^{-6} \times 3.65 = 0.00734 = 7.34 \times 10^{-3}$

(OR)

5.	**a)**	**Draw the block diagram of Stair case ramp type DVM and explain its working principle.**	**L1**	**CO2**	**7M**

Draw the block diagram of Stair case ramp type DVM …….4M
its working principle. …….3M

Ans Digital voltmeters can be classified according to the following broad categories :

(a)Ramp–type DVM

(b)Integrating DVM

(c)Continuous–balance DVM

(d)Successive-approximation DVM

Staircase–RampDVM

It is a variation of the ramp –type DVM but is simpler in overall design , resulting in a moderately priced general –purpose instrument that can be used in the laboratory, on production test-stands, in repair shops, and at inspection stations. Staircase ramp DVM makes voltage measurement s by comparing the input voltage to an internally generated staircase-ramp voltage.

It contains a10-M input attenuator , providing five input ranges from 100mV to 1,000V full scale. The dc amplifier with a fixed gain of 100 , delivers 10V to the comparator at any of the full scale voltage settings of the input divider .The comparator senses coincidence between the amplified in put voltage and the staircase-ramp voltage which is generated as the measurement proceeds through its cycle . A Clock (4.5kHzoscillator) provides pulses to three DCUs in cascade .The units counter provides a carry pulse to the *tens decade at every* tenth input pulse. The *tens decade counts the carry pulses from the units decade* and provides its own carry pulse after it has counted ten carry pulses. This carry pulse is fed to the *hundreds* *decade which provides a carry pulse to an over range* circuit .The over range circuit causes a front panel indicator to light up ,warning the operator that the input capacity of the instrument has been exceeded. The operator should then switch to the next higher setting on the input attenuator.

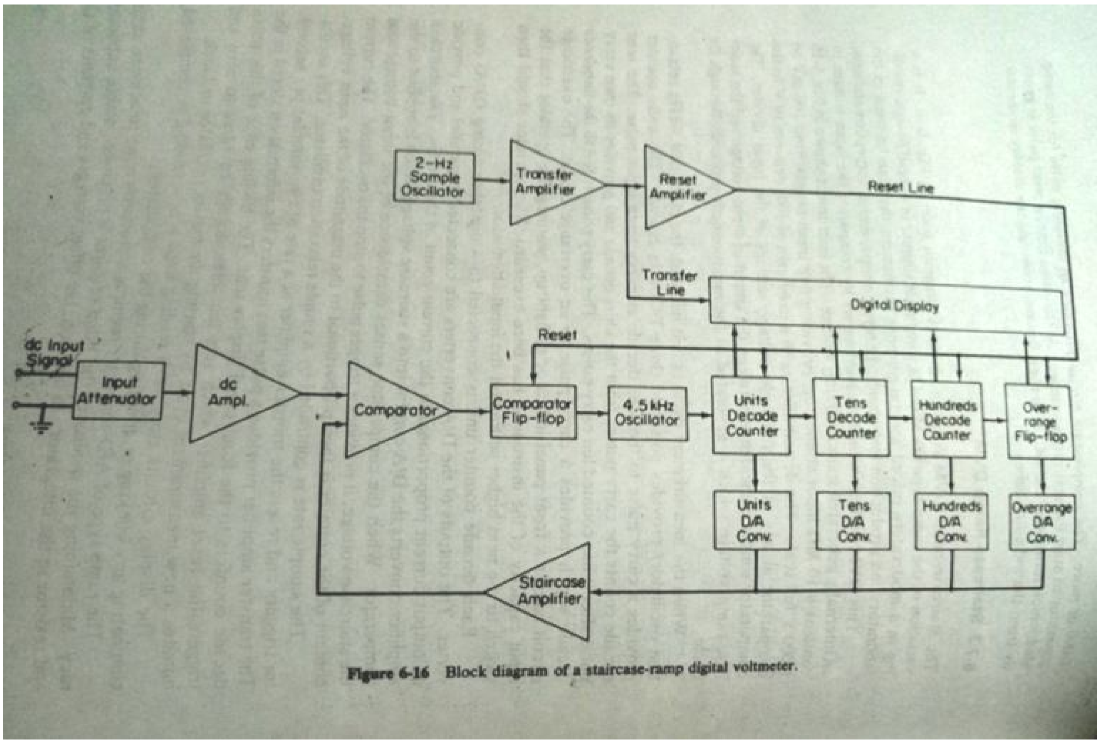


Figure 6-16 Block diagram of a staircase-ramp digital voltmeter.

Each decade counter unit is connected to a digital –to –an alog (D/A) converter. The outputs of the D/A converters are connected in parallel and provide an output current proportional to the current count of the DCUs. The staircase amplifier converts the D/A current in to a stair case voltage which is applied to the comparator. When the comparator senses coincidence of the input voltage and the staircase voltage ,it provides a trigger pulse to stop the oscillator. The current content of the counter is then proportional to the magnitude of the input voltage .The sample rate is controlled by a simple relaxation oscillator. This oscillator triggers and resets the transfer amplifier at a rate of two samples per second. The transfer amplifier provides a pulse that transfers the information stored in the decade counter s to the front panel display unit. The trailing edge of this pulse triggers the reset amplifier which sets the three decade counters to zero and initiates a new measurement cycle by starting the master oscillator or clock .The display circuits store each reading until a new reading is completed , eliminating any blinking or counting during the computation.

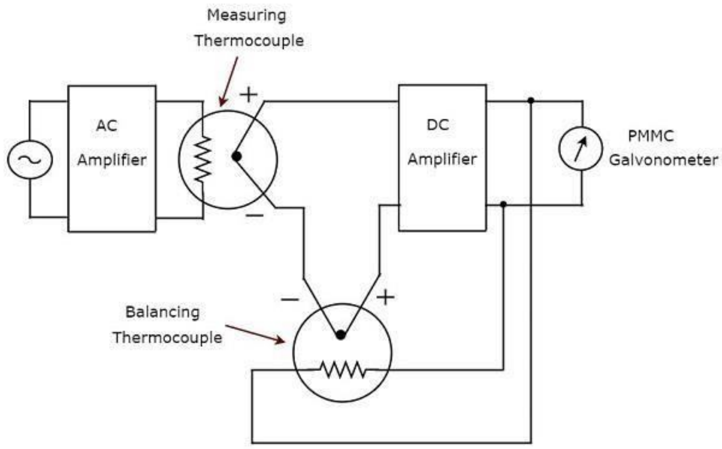
5. b) Draw the circuit diagram of true RMS voltmeter and explain its functioning? **L3 CO2 7M**

circuit diagram of true RMS voltmeter 4M

Explanation 3M

Ans True RMS Responding AC Voltmeter

As the name suggests , the true RM S responding AC voltmeter responds to the true RMS values of AC voltage signal. This voltmeter measures RMS values of AC voltages. The **circuit diagram** of true RMS responding AC voltmeter is shown in below figure.



The above circuit consists of an AC amplifier ,two thermocouples, DC amplifier and PMMC galvanometer. AC amplifier amplifies the AC voltage signal. Two thermo couples that are use d in above circuit are a measuring thermocouple and a balancing thermocouple. **Measuring thermocouple** produces an output voltage, which is proportional to RMS value of the AC voltage signal. Any thermocouple converts a square of input quantity in to a normal quantity. This means there exists an on-linear relationship between the output and input of a thermocouple. The effect of non-linear behaviour of a thermocouple can be neglected by using another thermocouple in the feedback circuit. The thermocouple that is used for this purpose in above circuit is known as **balancing thermocouple**.
The two thermocouples, namely measuring thermocouple and balancing thermocouple together form a bridge at the input of DC amplifier. As a result, the meter always responds to the **true RMS value** of Ac voltage signal.

Unit – III

6.	**a)**	**What is meant by Lissajous figures? Explain how phase and frequency are measured using CRO** **Lissajous figures .. ..4M** **phase and frequency are measured using CRO 3M**	**L2**	**CO3**	**7M**

Ans

Lissajous Figures Definition
The definition of a Lissajous figure can be defined as one of an infinite number of curves formed by combining two simple oscillations that are perpendicular to each other. This is usually viewed by an oscilloscope and is used to study the frequency, amplitude, and phase relationships of harmonic variables.
The Lissajous figures oscilloscope allows you to plot one sine wave along the x-axis against another sine wave along the y-axis. The result is the number of measurements. The Lissajous figure shows the phase difference between the two signals and the relationship between their frequencies.

Lissajous is the pattern that appears on the screen when a sinusoidal signal is applied to the horizontal and vertical caps of the CRO. These patterns depend on the amplitude, frequency, and phase difference of the sinusoidal signal applied to the horizontal and vertical baffles of the CRO.
Lissajous Figures Uses
The Lissajous figure's uses mainly consist of measurement of the frequency and measurement of the phase difference. The Lissajous figure is of high importance in physics in order to study the sinusoidal waves. The Lissajous figures are mainly used in analogue electronics to analyse the intersection of two or more sinusoidal wave constructing loops which are also known as Lissajous knots in general.
Some of the usage of Lissajous figure are as follows:
- The Lissajou figures are used to determine the unknown frequency by comparing it with the known frequency.
- Verifying audio oscillator with a known-frequency signal.

- Monitoring audio amplifiers and feedback networks for phase shift.

Measurements Using the Lissajous Figure

As previously mentioned in the Lissajous figure, using the Lissajous figure, we can measure the frequency of the sinusoidal waves and the phase difference between the two sinusoidal waves. Let us describe the measurement of frequency and phase difference with the help of the Lissajous figure definition or Lissajous pattern definition.

1. **Measurement of Frequency**

   When two sinusoidal frequencies are applied, a Lissajous figure or pattern will be formed. The Lissajous figure constructed will be illustrated on the CRO screen. To obtain the Lissajou figure, we must apply the sinusoidal signals to both horizontal and vertical deflection plates of CRO. Therefore, apply the sinusoidal signal, frequency of which is known to the horizontal deflection plates of CRO.

   Similarly, apply the sinusoidal signal, frequency of which is unknown to the vertical deflection plates of CRO.

   Suppose f_H and f_V are the frequencies of sinusoidal signals, which are implemented to the horizontal and vertical deflection plates of CRO, respectively. The relationship between known and unknown frequencies, i.e., f_H and f_V can be mathematically expressed as below:

   $$\Rightarrow fV/fH=nH/nV$$

   From the above equation, the frequency of sinusoidal signal applied to the vertical deflection plates of CRO can be drawn which is given below:

   $$\Rightarrow fV=(nH/nV)fH\Rightarrow \qquad ..(1)$$

   where, n_H is the number of horizontal squares and n_V is the number of vertical squares.

   The values of n_H and n_V also can be obtained from the Lissajous figure. Now, if we substitute the value of n_H and n_V in equation (1), we can determine the unknown frequency of sinusoidal signal applied to the vertical deflection plates of CRO.

2. **Measurement of the Phase Difference**

   We know that the Lissajous figure is constructed and displayed on the screen of a CRO when sinusoidal signals are employed to both horizontal and vertical deflection plates of the CRO. Therefore, apply the sinusoidal signals with the identical amplitude and frequency to both horizontal and vertical deflection plates of the CRO.

   Based on the shape of a few Lissajous figures, we can simply recognise the phase difference between the two sinusoidal signals used.

   - If the Lissajous figure resulted in a straight line that is inclined at an angle of 45° with the positive x-axis of the CRO display, then the phase difference between the two sinusoidal signals used will be 0°. This implies that no phase difference is present between those two sinusoidal signals used.
   - If the Lissajous figure resulted in a straight line that is inclined at an angle of 135° with the positive x-axis of the CRO display, then the phase difference between the two sinusoidal signals used will be around 180°. This implies that the sinusoidal signals used are out of phase.
   - If the Lissajous figure resulted in a circular shape, then the phase difference between the two sinusoidal signals used will be either 90° or 270°.

   We can estimate the phase difference between the two sinusoidal signals (Lissajous figures phase difference) by applying formulae when the constructed Lissajous figures are of elliptical shape, i.e., Lissajous ellipse.

   - If the major axis of an elliptical Lissajous figure is inclined at angles between 0° and 90° with the positive x-axis of the CRO display screen, then the phase difference between the two sinusoidal signals can be determined using the following equation:

     $$\Rightarrow \varphi=\sin^{-1}(x1/x2)=\sin^{-1}(y1/y2)$$

   - If the major axis of an elliptical Lissajous figure is inclined at angles between 90° and 180° with the positive x-axis of the CRO screen, then the phase difference between the two sinusoidal signals can be calculated using the following equation:

     $$\Rightarrow \varphi=180-\sin^{-1}(x1/x2)=180-\sin^{-1}(y1/y2)$$

   where,

   x_1 is the total distance measured from the origin to the point on the x-axis of the

display, where the intersection of elliptical Lissajous figures can be noticed.
x_2 is the total distance measured from the origin to the vertical tangent of the elliptical Lissajous pattern.
y_1 is the total distance measured from the origin to the point on the x-axis of the display, where the intersection of the elliptical Lissajous figure can be noticed.
y_2 is the total distance measured from the origin to the horizontal tangent of the elliptical Lissajous pattern (figure de Lissajous)

6.	**b)**	**What is the minimum distance L that will allow full deflection of 4Cm at the CRO screen with a deflection factor of 1000V/Cm and with an acceleration potential of 4000V?** **the minimum distance L formulas -------4M** **Solution -------3M**	L3	CO3	7M

Ans

Concept:

The deflection sensitivity of a cathode ray tube is defined as the deflection of the screen per unit deflection voltage.

$$s = \frac{D}{E_d} = \frac{Ll_d}{2d\ E_a} m/v$$

$$\Rightarrow E_d = \frac{2dE_a D}{Ll_d}$$

Where,

L = distance between screen and center of the deflecting plates

D = deflection of electron beam on the screen in Y direction

d = Distance between deflecting plates

L_d = Length of deflecting plates

E_a = Accelerating voltage

E_d = Potential between deflecting plates

What is the minimum distance L that will allow: L=?
full deflection of 4Cm ;
ld=4Cm
deflection factor of 1000V/Cm ;G=1/S

acceleration potential of 4000V

Ea=4000 V
S=1/1000=0.001Cm/V
0.001=L/(2*4*10^-2*4000)
L=30cm=0.3m

(OR)

7.	**a)**	**Draw the circuit of Digital storage Oscilloscope and explain its operation.** **circuit of Digital storage Oscilloscope -------4M** **Explain -------3M**	L2	CO3	7M

Ans **Digital Storage Oscilloscope**

There are a number of distinct disadvantages of the storage cathode ray tube . First ,there is a finite amount of time that the storage tube can preserve a stored wave form . Eventually ,the wave form will be lost . The power to the storage tube must be present a s long as the image as to be stored. Second ,the trace of a storage tube is ,generally ,not as fine as a normal cathode ray tube. Thus ,the stored trace tube is ,generally ,not as fine as normal cathode ray tube .Thus the stored trace is not as crisp as a conventional oscilloscope trace. Third , the writing rate of the storage tube is less than a conventional cathode ray tube, which limits the speed of the storage oscilloscope .Fourth ,the storage cathode ray tube is considerably more expensive than a conventional tube and requires additional power supplies. Finally ,only one image can be stored. If two traces are to be compared, the y must be superimposed on the same screen and displayed together.

Figure7-52 shows the block diagram of a storage oscilloscope .The input is amplified and attenuated with input amplifiers as in any oscilloscope . The digital storage oscilloscope uses the same types of input circuitry and oscilloscope probes as a conventional oscilloscope , and many digital storage oscilloscopes can operate in a conventional mode ,by passing the digitizing and storing features .The output of the input signal amplifiers feeds an analog - to digital (A/D)converter.

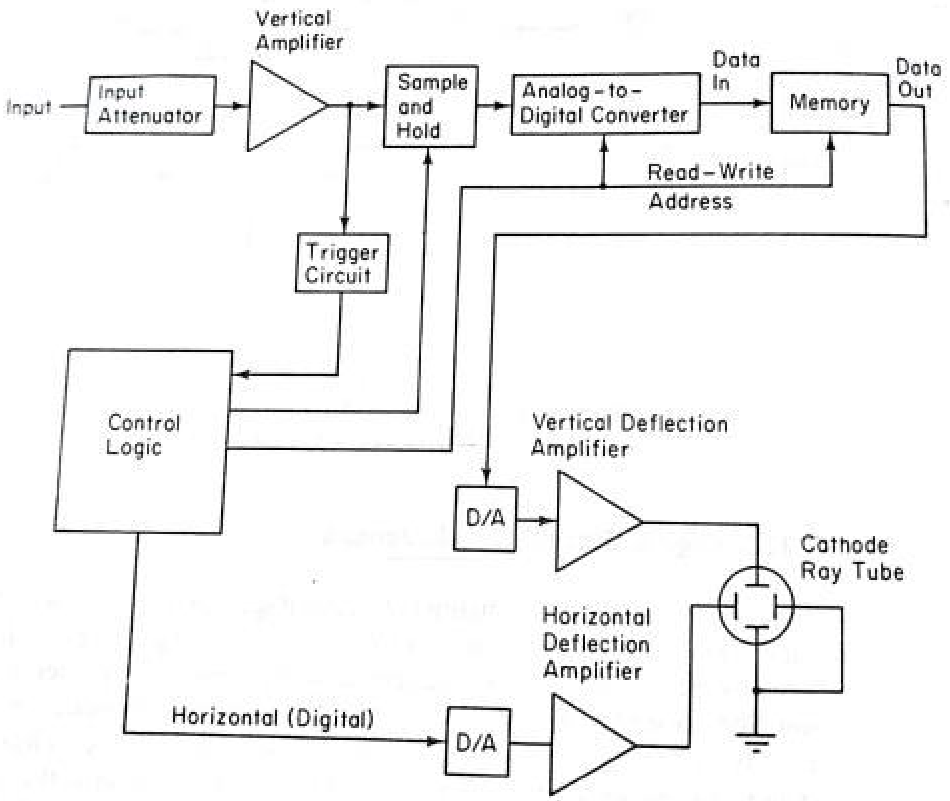


Figure 7-52 Block diagram of a digital storage oscilloscope.

The A/D converter can use any technique discussed in Chapter6 relative to digital voltmeters or in Chapter12 relative to data acquisition. However, in the storage oscilloscope application, the main requirement of the converter is speed. In a digital voltmeter application , accuracy and resolution were the main requirements of the converter, while speed was of secondary importance, as only slow moving data were being digitized. In addition , in the oscilloscope ,the digitized output need only be in binary form rather than BCD, which would be desirable for the display as digits on the digital voltmeter panel.

7. b) Explain the current probe with magnetic sensor. **L2 CO3 7M**

Diagram current probe with magnetic sensor. ------4M

Explanation ------3M

Ans The primary function of the oscilloscope is to display voltage as a function of time ,and the description of the attenuator probe was covered in Sec.7.5.There are other probes and transducers that can make the oscilloscope versatile . Other than the 10-to-1 probe ,there are also other attenuation ratios such as a 1 to 1 ,which is nothing more than a cable with a probe tip and no other components. One useful probe is active probe , which achieves a lower capacitance without the attenuation associated with the 10-to–1 probe .The final special transducer , since it is more than just a probe ,is the current probe ,which allows the

oscilloscope to measure current without breaking the circuit under test.
A schematic of the active probe is shown in Fig.7-34.In this example a field effect transistor is used as the active element to amplify the input signal . Although the voltage gain of the FET follower circuit shown in Fig.7.34 is unity , the follower circuit provides a power gain so that the input impedance can be increased . To be effective ,the FET must be mounted directly in the voltage probe tip so that the capacitance of an interconnecting cable can be eliminated . This requires that power for the FET be supplied from the oscilloscope to the FET in the probe tip .
The FET voltage follower drives a coaxial cable , but instead of the cable connecting directly to the high-input impedance of the oscilloscope ,the cable is terminated in its characteristic impedance . In this fashion , there is no high-frequency roll-off of the frequency due to the capacitance of the cable.

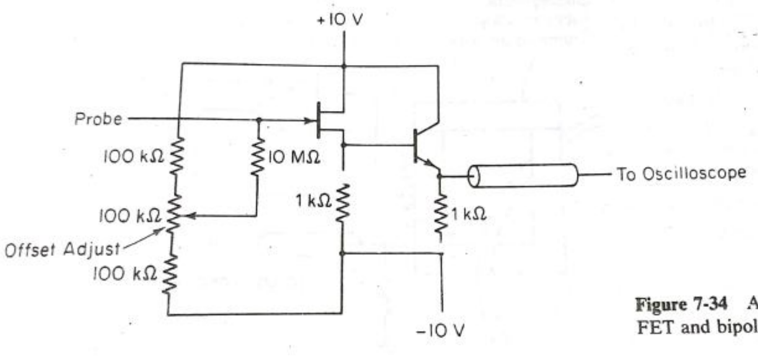


Figure 7-34 Activ
FET and bipolar tr

There is a significant disadvantage with the FET probe . Because there is no signal attenuation between the FET amplifier and the probe tip , the range of signal that can be handled by the FET probe is limited to the dynamic range of the FET amplifier , and this is typically less than a few volts . Therefore ,to handle a larger dynamic range ,external attenuators are added at the probe tip. Adding the attenuator to the FET probe thus there is no real need to use the active probe , and a conventional probe could serve the purpose unless the extremely low capacitance available from an active probe with an attenuator is required . It is for this reason that active voltage probes have limited use.
Oscilloscopes are typically used with a 10-to-1 attenuator probe , as many circuits are affected by the capacitance of the 1-to-1 probe . For this reason most oscilloscopes have input sensitivities of 2 or 5 mV per division so that the versatility of the oscilloscope is not destroyed by the attenuation of the signal.
One very valuable probe is the current probe . This device can be clamped around a wire carrying an electrical current without any physical contact to the probe ,allowing the oscilloscope to be used to measure the magnitude of the current with a frequency response from dc to 50 MHz . The current sensor consists of two parts , a conventional transformer for transforming alternating current to voltage ,and a Hall effect device for converting direct current to a voltage , As shown in figure .7.35.

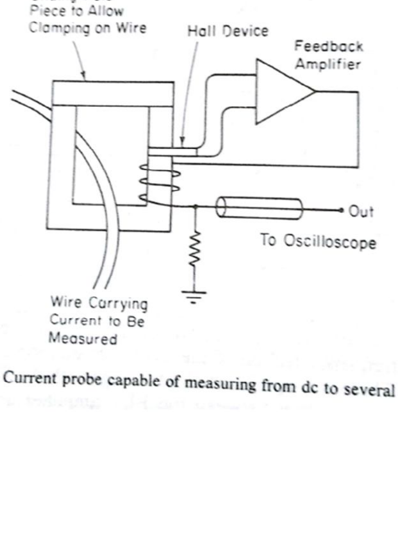


Figure 7-35 Current probe capable of measuring from dc to several megaherz.

Unit – IV

8. a) Explain the Synthesized signal generator. **L1 CO4 7M**

Diagram Synthesized signal generator. ……4M

Explanation ------3M

Ans Frequency–Synthesized Signal Generator To understand the basic function of the Frequency synthesizer , imagine that a technician, wishing to reduce the frequency drift of a signal generator , decides to set the frequency of the Generator every few seconds by reading the counter and adjusting the generator every few Seconds by reading the counter and adjusting the generator accordingly to the correct frequency. This is the human equivalent of a phase-locked loop frequency synthesizer . Although the imaginary technician accomplishes the task of adjusting the frequency every few seconds , the electronic equivalent can make these adjustments at a much greater rate. Actually , the stabilizing the generator manually would eventually be limited by the time required for the frequency counter to display the correct frequency ,which depends on the resolution of the counter. The phase- locked loop avoids this problem by not requiring a frequency determination ,but as its name implies , makes the frequency correction based on a phase measurement One every popular method of frequency synthesis is called the indirect method ,or the phase locked loop ,and is as shown in Fig.8-12. Five main components are required: the VCO or Voltage-Controlled Oscillator ,the programmable divider ,the phase detector ,the phase reference , and the loop filter.

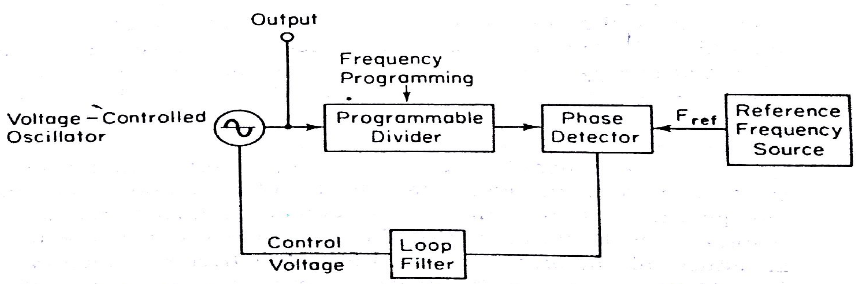


Figure 8-12 Block diagram of phase-locked loop.

The voltage-controlled oscillator is the source of the output frequency and has the ability to be tuned electronically , unusually by applying a variable voltage .Some oscillators are electronically tuned using a current, especially in the higher frequencies, but for the general discussion of a phase locked loop frequency synthesizer , the signal source will be considered a voltage controlled device.

The programmable divider is a logic element that divides the frequency of the VCO by an integer that can be entered via programming switches,a microprocessor ,or other method. The phase detector provides an analog output that is a function of the phase angle between the two inputs,whichinthecaseofafrequencysynthesizeristhereferencesourceandtheoutputoftheprogrammable divider. The reference source is a very accurate and stable frequency source, which is typically a quartz crystal oscillator . The accuracy of the entire synthesizer is dependent on the accuracy of the reference source.

The crystal oscillator operates in the region of 1 to 10MHz , and that frequency is divided down using digital counter to provide the necessary clock and reference frequencies for synthesizer.

The loop filter is an analog filter and is required to assure stable and noise free operation of the synthesizer .Assume that the VCO is to electronically tuned to a multiple of the reference frequency of the example of Fig.8-12.I fan integer is entered in to the programmable divider, we obtain

fv=Nfr

Where fv=desired frequency of the VCO

N=integer entered in to the programmable divider

fr=reference frequency applied to the phase detector.

Because the programmable divider divides the frequency of the VCO by N, the output frequency of the programmable divider is fv/Norfr.

8. b) Explain the various measurement errors in frequency counter. **L2 CO4 7M**

the various measurement errors in frequency counter. ------3M

Explanation ------4M

Ans

Measurement Errors

1.Gating Error

Frequency and time measurements made by an electronic counter are subject to several inaccuracies inherent in the instrument itself. One very common instrumental error is the gating error , which occurs whenever frequency and time period measurements are made . For frequency measurement the main gate is opened and closed by the oscillator output pulse . This allows the input signal to pass through the gate and be counted by the decade counters . The gating pulse is not synchronized with the input signal ;they are. the gating interval is indicated fact , two totally unrelated signals. In Figure.10-18 gating interval is indicated by waveform(c) .Waveforms(a) and (b) represent the input signal in different phase relationships with respect to the gating signal .Clearly ,in one case ,six pulses will be counted ;in the other case ,only five pulses are allowed to pass through the gate .We have there fore a case ,only pulses are allowed to pass through the gate . We have therefore a ±1 count ambiguity in the measurement.

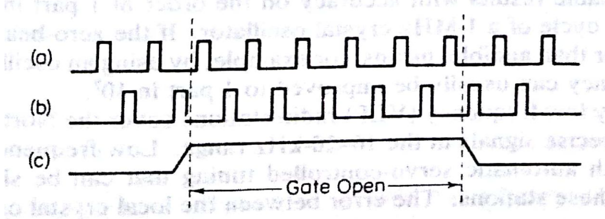


Figure 10-18 Gating error.

$$N_p = \frac{f_c}{f_x} \qquad (10-1)$$

In a frequency measurement with a 1-s gate time the number of pulses counted is

$$N_f = f_x \qquad (10-2)$$

The crossover frequency (f_o) at which $N_p=N_f$ is

$$\frac{f_c}{f_o} = f_o \quad or \quad f_0 = \sqrt{f_c} \qquad (10-3)$$

Signals with a frequency lower than f_O should therefore be measured in the “period” mode ; signals of frequencies above f_O should be measured in the “frequency” mode in order to minimize the effect of the ±1 count gating error is 100/√fc per cent.

2 Time Base Error

Inaccuracies in the time base also cause errors in the measurement .In frequency measurements the time base determines the opening and closing of the signal gate, and it provides the pulses to be counted . Time –base errors consist of oscillator calibration errors, short-term crystal stability errors ,and long term crystal stability errors. Several methods of crystal calibration are in common use . One of the simplest calibration techniques is to zero-beat the crystal oscillator against the standard frequency transmitted by a standard radio station , such as WWV. This method gives reliable results with accuracy on the order of 1 part 10^6,which corresponds to 1 cycle oscillator .If the zero-beating is done with visual (rather than audible) means , for example , by using an oscilloscopes, the calibration accuracy can usually be improved to 1 part in 10^7.

3 Trigger Level Error

In time –interval and period measurements the signal gate is opened and closed by the input signal . The accuracy with which the gate is opened and closed is a function of the trigger level error. In the usual application the input signal is amplified and shaped , and then it applied to a Schmitt trigger circuit that supplies the gate with its control pulses .Usually the input signal contains a certain amount of unwanted components or noise ,which is amplified along with the signal .The time at which triggering of the Schmitt circuit occurs is a function of the input signal amplification and of its signal to noise ratio . In general , we can say that trigger time errors are reduced with large signal amplitudes and fast rise times.

(OR)

9.	**a)**	**With a neat block diagram, explain the operation of function generator** **block diagram, explain the operation of function generator ......4M** **Explanation 3M**	**L1**	**CO4**	**7M**

Ans **Functiongenerator**

A function generator is a versatile instrument that delivers a choice of different waveforms whose frequencies are adjustable over a wide range. The most common output wave forms are the sine ,triangular, square ,and saw tooth waves . The frequencies of these wave forms may be adjusted from a fraction of a hertz to several hundred kilo hertz. The various outputs of the generator may be available at the same time. For instance ,by providing a square wave for linearity instruments in an audio system, a simultaneous saw tooth out put may be used to drive the horizontal deflection amplifier of an oscilloscope , providing a visual display of the measurement results .The capability of the function generator to phase lock to an external signal source is an other useful feature. One function generator may be used to phase lock a second function generator, and the two output signals can be displaced in phase by an adjustable amount. In addition, one generator may be phase locked to a harmonic of the sine wave of the another generator.

By adjusting the phase and the amplitude of the harmonics ,almost any wave form may be generated by the summation of the fundamental frequency generated by the one function generator and the and the harmonics generated by the other function generator. The function generator can also be phase locked to a frequency standard, and all its output wave forms are then generated with the frequency accuracy and stability of the standard source. The function generator can supply output wave forms at very low frequencies. Since the low frequency o f simple RC oscillator is limited, a different approach is used in the function generator of Fig.8.28.

This instrument delivers Sine , triangular and square waves with a frequency range of 0.01 Hz to 100kHz. The frequency control net work is governed by the frequency dial on the front panel control voltage regulate test two current sources. The upper current source supplies a constant current to the triangle integrate or whose output voltage increase linearly with time. The output voltage is given by the well known relationship.

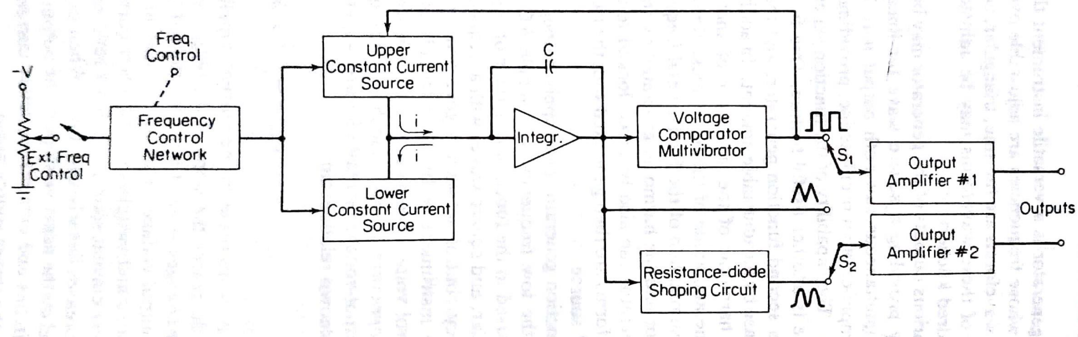


Figure 8-28 Basic elements of a function generator.

9.	**b)**	**Draw the block diagram of laboratory square wave generator and explain its operation.** **block diagram of laboratory square wave generator …….4M** **operation. ------3M**	**L2**	**CO4**	**7M**

Ans **Laboratory Square Wave and pulse generator**

The block diagram of a typical general–purpose generator providing negative pulses of variable frequency, duty cycle, and amplitude is given in Fig.8-26.The frequency range of the instrument is covered in seven decade steps from 1 Hz to 10 MHz , with a linearly calibrated dial for continuous adjustment on all ranges. The duty cycle can be varied from 25 percent to 75 percent. Two independent outputsareavailable:a50Ωsourcethatsuppliespulses with rise–and fall times of 5ns at5-Vpeak amplitude,anda600Ω source that supplies pulses with rise–and fall times 70ns at 30 –V peak amplitude .The instrument can be operated as a free-running generator or it can be synchronized with external signals. Trigger output pulses for synchronization of external circuits are also available.

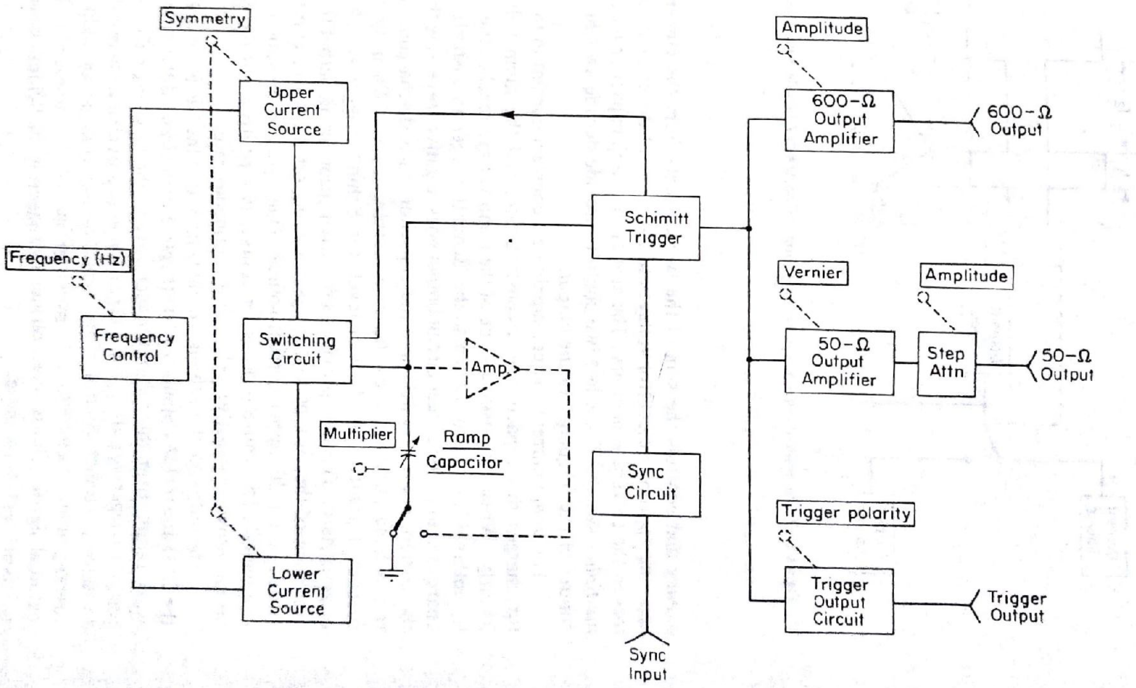


Figure 8-26 Block diagram of a pulse generator.

The basic generating loop , which is redrawn for greater clarity in Fig.8.27 consists of two current sources , the ramp capacitor ,the Schmitt trigger circuit , and the current–switching circuit indicated by a simple switch). T he two current sources provide a constant current for charging and discharging the ramp capacitor .The ratio of these two currents is determined by the setting of the symmetry control which then determines the duty cycle of the output wave form. The frequency dial controls the sum of the two currents from the current sources by applying appropriate control voltage to the bases of the current control transistors in the current generators .The size of the ramp capacitors is selected by the multiplier switch .These last two controls provide decade Switching and vernier control of the output.

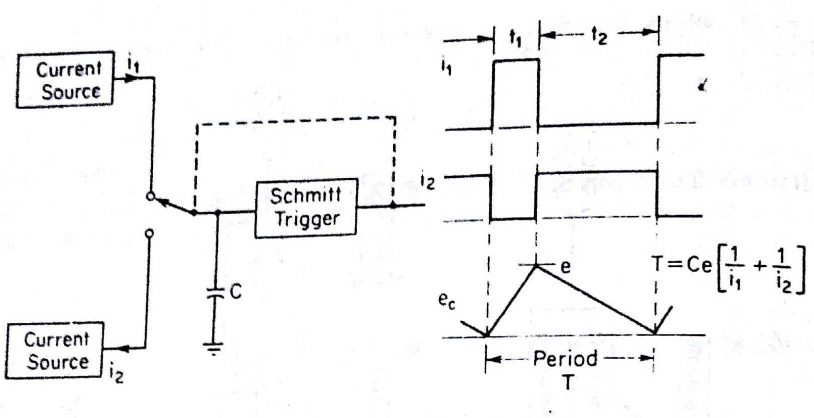


Figure 8-27 Simplified current source operation. (Courtesy of Hewlett-Packard Company.)