SUMMER– 2019 EXAMINATION

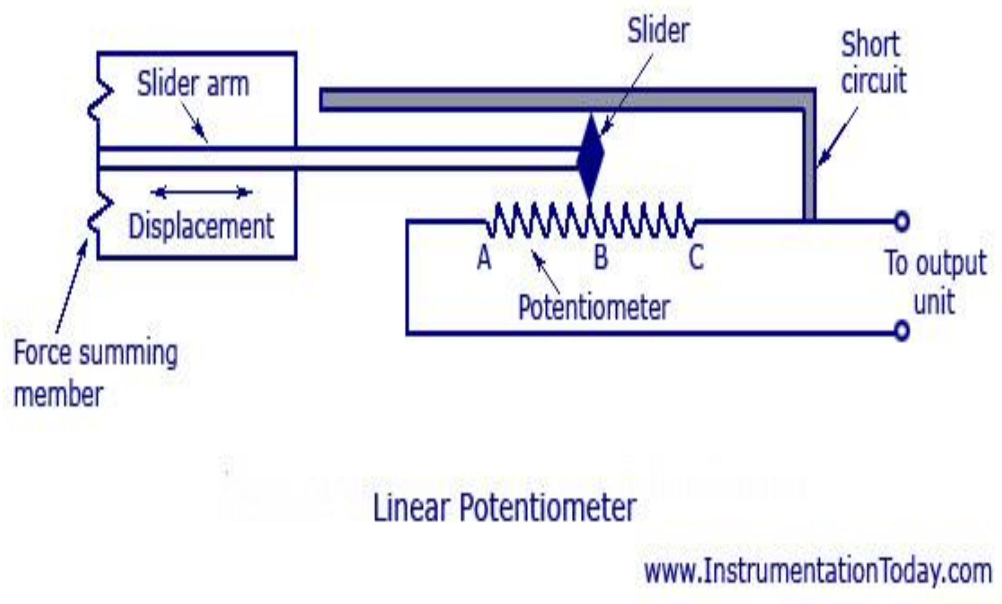
Model Answer

Subject Name: Electronics Instruments and Measurements **Subject Code: 22331**

Important Instructions to Examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by the candidate may vary, but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills)
4) While assessing figures, the examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of any questions credit may be given by judgement on the part of examiner of relevant answer based on candidate's understanding.
7) In programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 M**
	a)	**Define "error"** **Ans:** **Definition of error:** An error may be defined as the difference between the measured value and the actual value.	**02M**
	b)	**Write the specifications of an anolog multimeter.** **Ans:** **Specifications of an anolog multimeter:** A typical meter may have the following ranges (note that the figures indicate the FSD): • DC Voltage: 2.5V, 10V, 25V, 100V, 250V, 1000V • AC voltage: 10V, 25V, 100V, 250V, 1000V • DC Current: 50µA, 1mA 10mW, 100mA • Resistance: R, 100R, 10000R	**02M (any two)**
	c)	**State significance of Lissajous figure.** **Ans:** **Significance of Lissajous figure:** Two signals are fed into separate channels. One signal is applied to the vertical system as in the usual time domain hookup. When the oscilloscope is operating in the XY mode and a second, synchronous signal is fed into a different channel as specified on the scope, both signals trace out voltages, one on the X-axis, and as if the waveform were turned sideways, the other on the Y-axis. The resultant image is known as a Lissajous pattern.	**02M**
	d)	**List static and dynamic characteristics of an instrument.** **Ans:** **Static and dynamic characteristics of an instrument:** • Precision • Accuracy	

		• Linearity • Repeatibility • Sensitivity, • Threshold, • Resolution • Drift, Range • Stability • Tolerance	**02M (any two)**
	e)	**Sketch diagram of linear potentiometer.** **Ans:**  **Fig: Linear potentiometer**	**02M**
	f)	**State two application of AC Bridges.** **Ans:** **Application of AC Bridges:** • AC bridges are used to find unknown impedances along with associated parameters. • Communication system and complex electronics circuitry majorly make use of AC bridges. • AC bridge circuits are used in phase shifting and for the filtration of undesirable signals. • It is also used to measure the frequency of audio signals.	**02M**
	g)	**List the application of PMMC.** **Ans:** **Applications of PMMC:** i.) In the measurement of direct currents and voltage ii.) In d.c galvanometers to defect small currents. iii.) In ballistic galvanometers used mainly for measuring changes of magnetic flux linkages.	**02M**

2.		Attempt any THREE of the following:	12 M
	a)	**Compare analog instrument and digital instruments.** **Ans:** (see table below)	04 M (Any 4 point)

Analog instrument	Digital instrument
1. The instrument which gives output that varies continuously as quantity to be measured is known as analoginstrument.	1. The instrument which gives output that varies in discrete steps and only has finite number of values is known as digital instrument.
2. The accuracy of analog instrument is less.	2. The accuracy of digital instrument is more.
3.The analog instruments required more power.	3. The digital instruments required less power.
4. Sensitivity of analog instrument is more.	4. Sensitivity of digital instrument is less.
5. The analog instruments are cheap.	5. The digital instruments are expensive.
6. The analog instruments are extremely portable.	6. The digital instruments are not easily portable.
7. The resolution of analog instruments is less.	7. The resolution of digital instruments is more.

Table: Compare analog and digital instruments

b) Draw & explain block diagram of digital frequency meter.

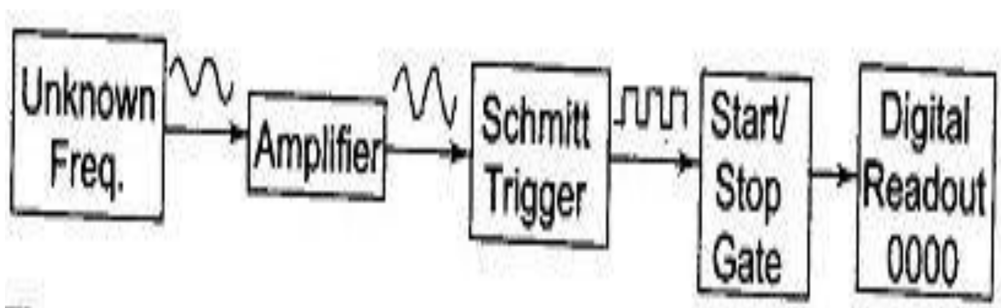


Fig: Digital frequency meter

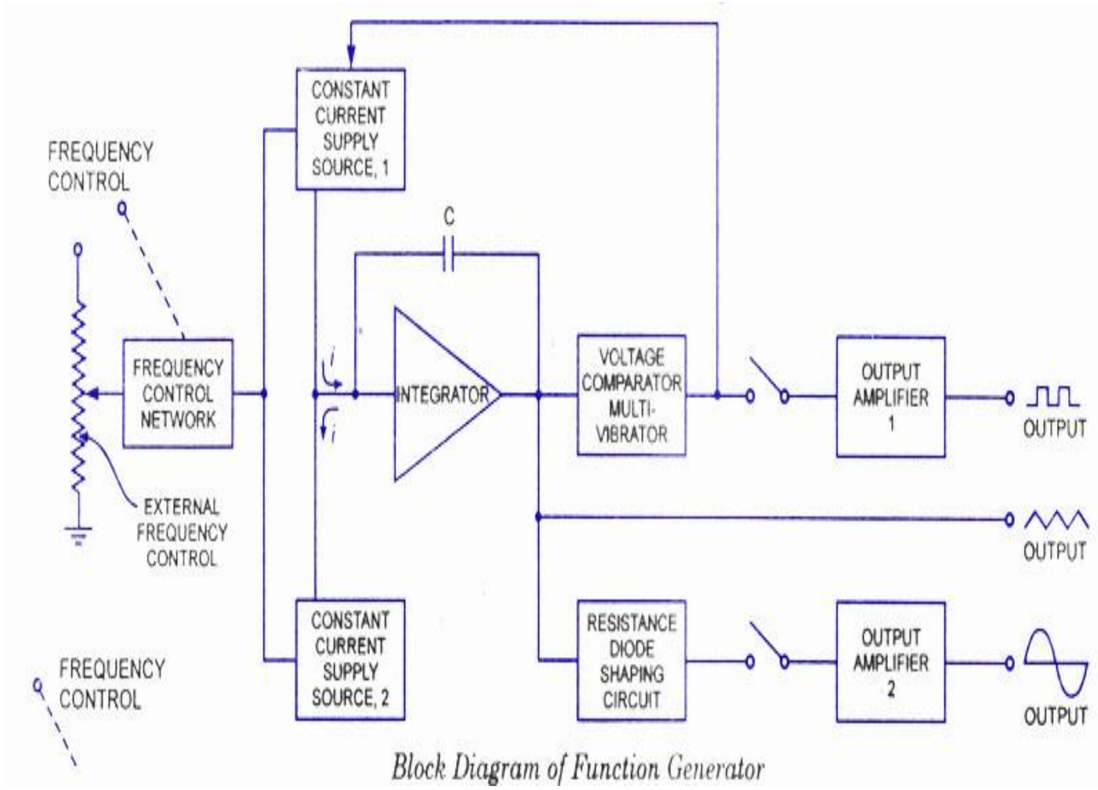
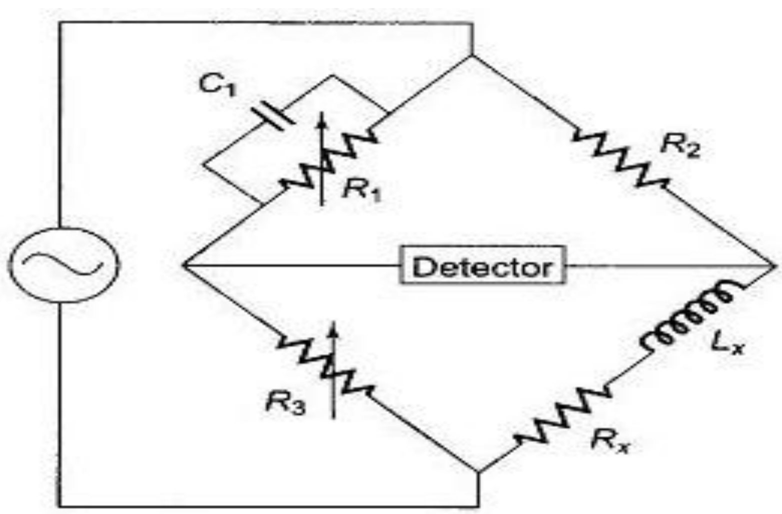
02M

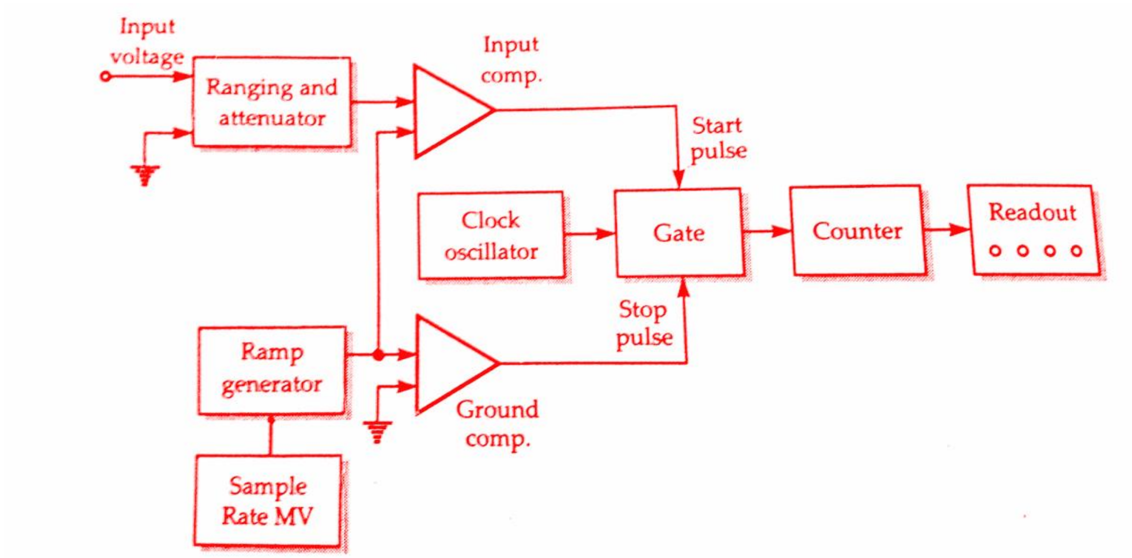
The basic block diagram of basic digital frequency meter (DFM) is shown in above figure. The signal whose frequency we have to be measured is first to be amplified through amplifier. The output of amplifier is applied to the Schmitt trigger. The Schmitt trigger is convert input signal into a square wave which has a fast rise and fall time. The square wave is then differentiated and clipped. Each pulse is proportional to each cycle of unknown signal. Now the output from Schmitt trigger is applied to a start and stop gate. The input pulses are allowed to pass through it, when the gate is open. The counter starts to count these pulses. The gate is closed the output pulses are not allowed to pass through the gate. The counter stops the counting. When the gate is open the number of pulse are counted by the counter. The interval between start and stop condition is the frequency of unknown signal which has to be measured.

02M

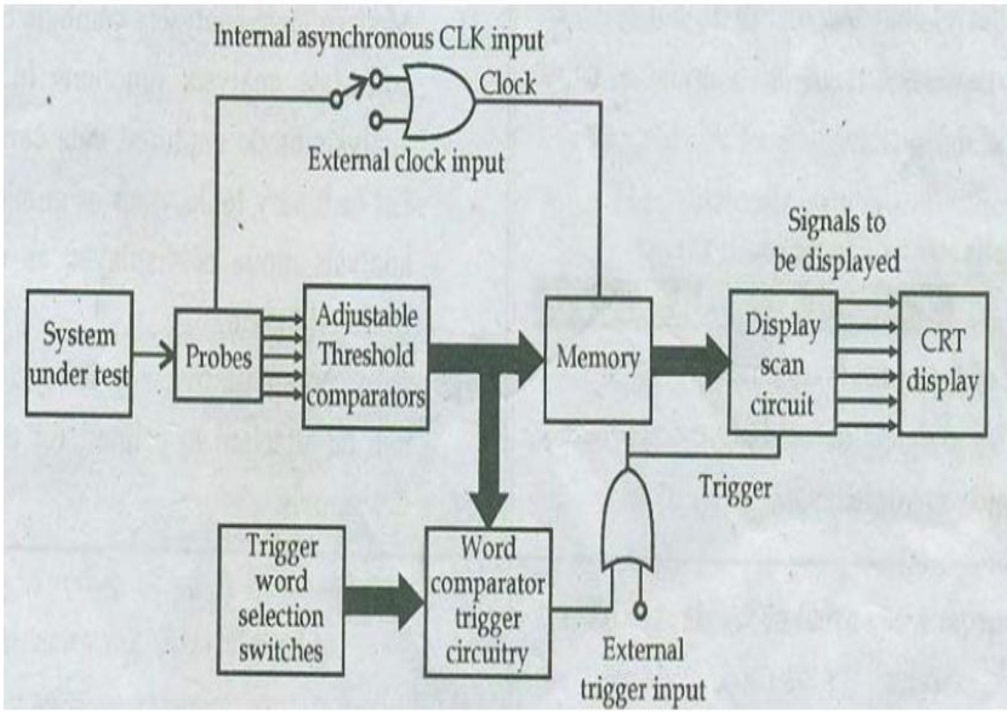
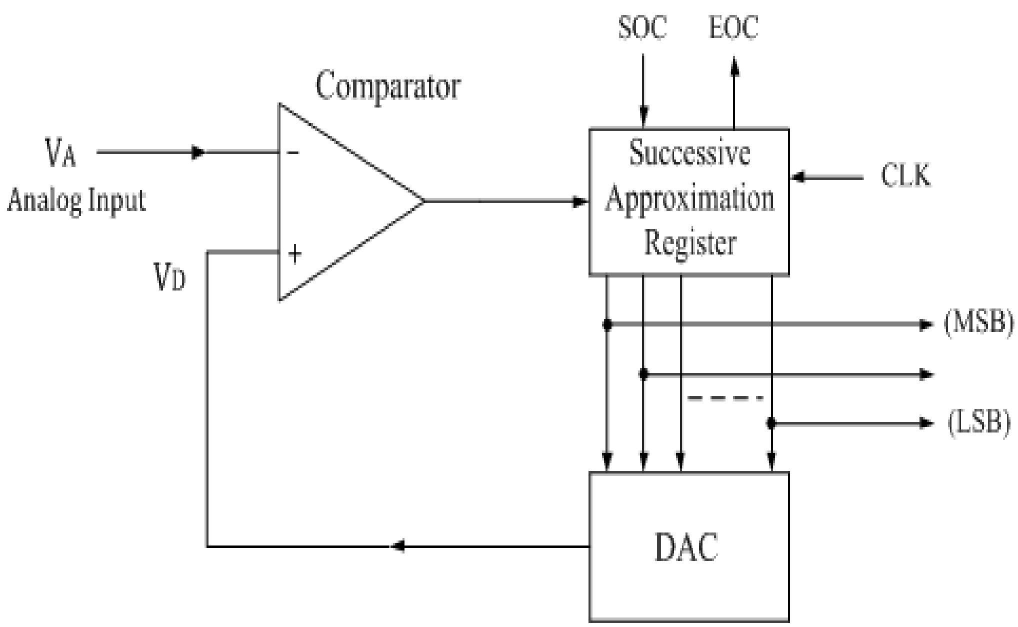
$$F = N/t$$

Where,
F = Unknown frequency.
N = Number of counts.
t = Time interval between start and stop condition of the gate.

	c)	**Draw & explain block diagram of function generator.** **Ans :**  The block diagram of a function generator is given in the figure. In this instrument, the frequency is controlled by varying the magnitude of the current that drives the integrator. This instrument provides different types of waveforms (such as sinusoidal, triangular and square waves) as its output signal with a frequency range of 0.01 Hz to 100 kHz.The frequency controlled voltage regulates two current supply sources. Current supply source 1 supplies a constant current to the integrator whose output voltage rises linearly with time. An increase or decrease in the current increases or reduces the slope of the output voltage and thus controls the frequency.	**02M** **02M**
	d)	**Explain with neat sketch the working principle of Maxwell bridge.** **Ans:**  **Fig: Maxwell bridge**	**02M**

		In such type of bridges, the value of unknown resistance is determined by comparing it with the known value of the standard self-inductance. The connection diagram for the balance Maxwell bridge is shown in the figure below. Let, L_1 – unknown inductance of resistance R_1. L_2 – Variable inductance of fixed resistance r_1. R_2 – variable resistance connected in series with inductor L_2. R_3, R_4 – known non-inductance resistance $$L_1 = \frac{R_3}{R_4} L_2$$ At balance, $$R_1 = \frac{R_3}{R_4}(R_2 + r_2)$$ The value of the R_3 and the R_4 resistance varies from 10 to 1000 ohms with the help of the resistance box. Sometimes for balancing the bridge, the additional resistance is also inserted into the circuit.	**02M**
3.		**Attempt any THREE of the following:**	**12 M**
	a)	**Explain with neat sketch the working of digital voltmeter.** **Ans:**  **Fig: Digital voltmeter** 1. Unknown voltage signal is fed to the pulse generator which generates a pulse 2. whose width is proportional to the input signal. 3. Output of pulse generator is fed to one leg of the AND gate. 4. The input signal to the other leg of the AND gate is a train of pulses. 5. Output of AND gate is positive triggered train of duration same as the width of the pulse generated by the pulse generator. 6. This positive triggered train is fed to the inverter which converts it into a negative triggered train. 7. Output of the inverter is fed to a counter which counts the number of triggers in the duration which is proportional to the input signal i.e. voltage under measurement. Thus, counter can be calibrated to indicate voltage in volts directly.	**02M** **02M**

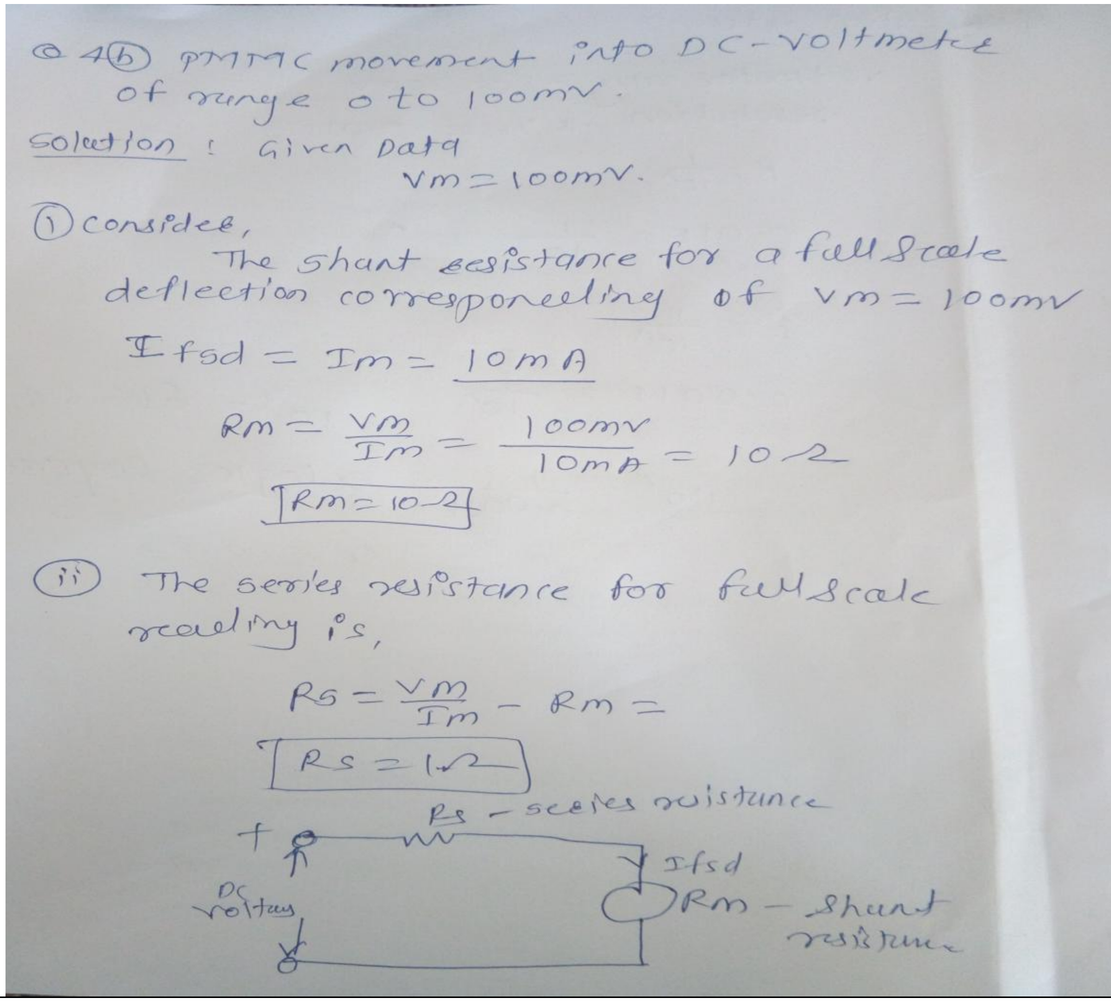
	b)	**List the main components of CRO.** **Ans:** **The main components of CRO:** 1. Cathode ray tube 2. Vertical amplifier 3. Delay line 4. Time base generator 5. Horizontal amplifier 6. Trigger circuit 7. Power supply **Cathode Ray Tube:** It is the heart of the oscilloscope. When the electrons emitted by the electron gun strikes the phosphor screen, a visual signal is displayed on the CRT. Vertical Amplifier - The input signals are amplified by the vertical amplifier. Usually, the vertical amplifier is a wide band amplifier which passes the entire band of frequencies. **Delay Line:** As the name suggests, this circuit is used to delay the signal for a period of time in the vertical section of CRT. The input signal is not applied directly to the vertical plates because the part of the signal gets lost, when the delay time is not used. Therefore, the input signal is delayed by a period of time. **Time Base (Sweep) Generator:** Time base circuit uses a uni-junction transistor, which is used to produce the sweep. The saw tooth voltage produced by the time base circuit is required to deflect the beam in the horizontal section. The spot is deflected by the saw tooth voltage at a constant time dependent rate. **Horizontal Amplifier:** The saw tooth voltage produced by the time base circuit is amplified by the horizontal amplifier before it is applied to horizontal deflection plates. **Trigger Circuit:** The signals which are used to activate the trigger circuit are converted to trigger pulses for the precision sweep operation whose amplitude is uniform. Hence input signal and the sweep frequency can be synchronized. **Power supply:** The voltages required by CRT, horizontal amplifier, and vertical amplifier are provided by the power supply block. It is classified into two types - (1) Negative high voltage supply (2) Positive low voltage supply The voltage of negative high voltage supply is from -1000V to -1500V. The range of positive voltage supply is from 300V to 400V.	**04M (any four)**
	c)	**Explain significance of ohm meter in instrumentation system.** **Ans:** **Significance of ohm meter in instrumentation system:** The purpose of an ohmmeter, of course, is to measure the resistance placed between its leads. This resistance reading is indicated through a mechanical meter movement which operates on electric current. The ohmmeter must then have an internal source of voltage to create the necessary current to operate the movement, and also have appropriate ranging resistors to allow just the right amount of current through the movement at any given resistance. When there is infinite resistance (no continuity between test leads), there is zero current through the meter movement, and the needle points toward the far left of the scale. In this regard, the ohmmeter indication is “backwards” because maximum indication (infinity) is on the left of the scale, while voltage and current meters have zero at the left of their scales.	**04M**

	d)	**Stecth labeled block diagram of logic analyser.** **Ans:**  **Fig: Logic analyser**	**04M**
4.		**Attempt any THREE of the following:**	**12 M**
	a)	**Sketch labeled diagram of successive approximation and give applications.** **Ans:**  **Fig: Successive approximation** **Applications of successive approximation:** 1) Data acquisition technique 2) High speed network	**03M** **01M**

b) **Convert the PMMC movement into DC-voltmeter of the range 0 to 100 mW.**

Ans:

Given data:



Q 4(b) PMMC movement into DC-voltmeter of range 0 to 100mV.

Solution : Given Data

$V_m = 100mV$.

(i) Consider,
The shunt resistance for a full scale deflection corresponding of $V_m = 100mV$

$I_{fsd} = I_m = 10mA$

$R_m = \frac{V_m}{I_m} = \frac{100mV}{10mA} = 10\Omega$

$R_m = 10\Omega$

02M

(ii) The series resistance for full scale reading is,

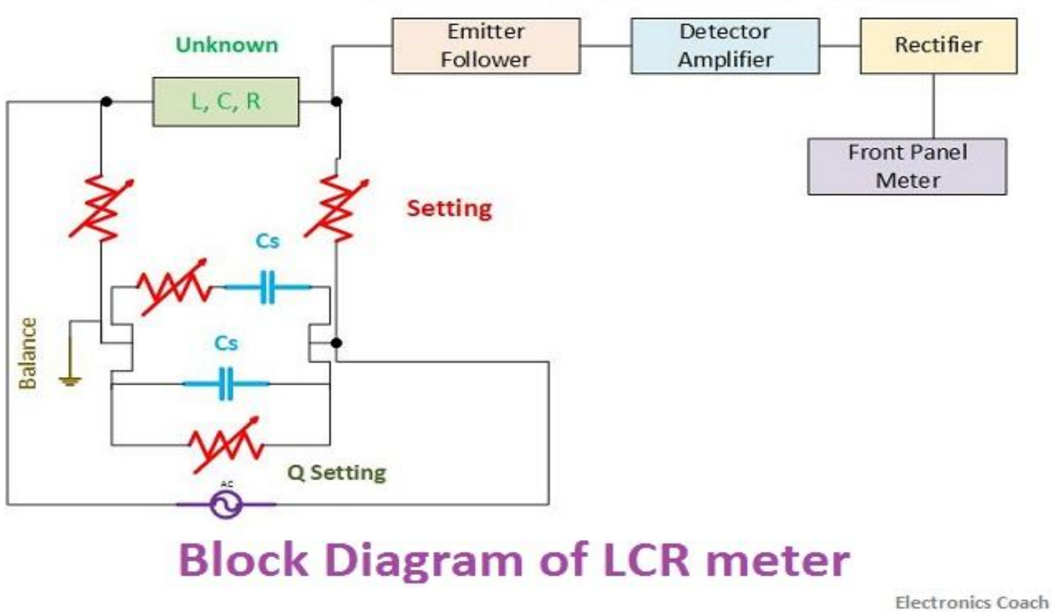
$R_s = \frac{V_m}{I_m} - R_m =$

$R_s = 1\Omega$

02M

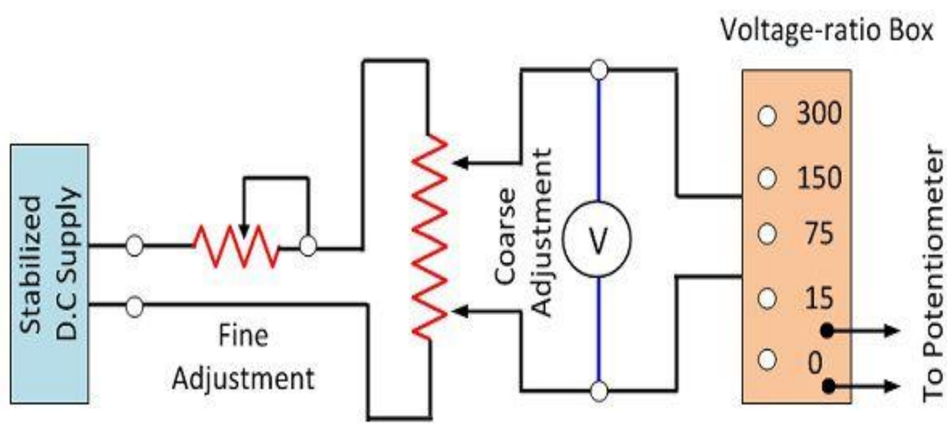
c) **Explain LCR-meter with sketch.**

Ans:



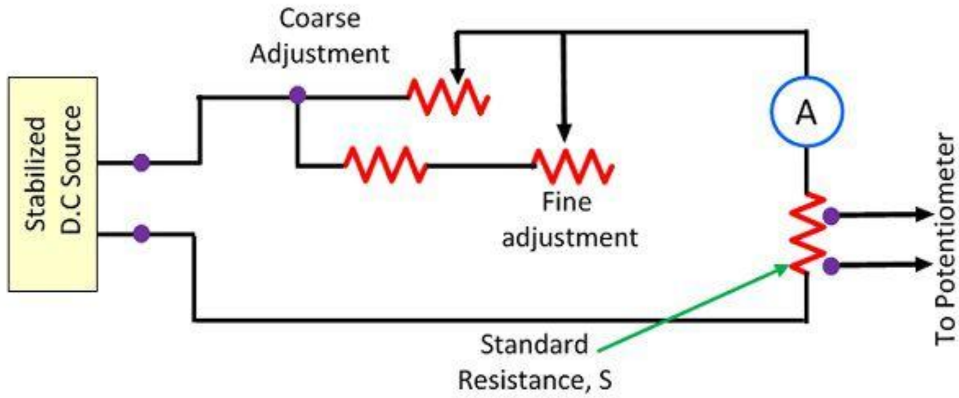
02M

Fig: LCR-meter

<table>
<tr><td></td><td></td><td>The above block diagram clearly defines the connection diagram of the LCR meter. The measurement of DC quantities will be done by exciting the bridge with DC voltage. On the contrary, the AC measurements require excitation of the Wheatstone bridge with AC signal.For providing AC excitation, the oscillator is used in the circuit. It generates the frequency of 1 kHz. The bridge is adjusted in null position in order to balance it completely. Besides, the sensitivity of the meter should also be adjusted along with balancing of the bridge. The output from the bridge is fed to emitter follower circuit. The output from emitter follower circuit is given as an input to detector amplifier.The significance of detector amplifier can be understood by the fact that if the measuring signal is low in magnitude, it will not be able to move the indicator of PMMC meter. Thus, in order to achieve the sustainable indication we need to have a high magnitude measuring signal.
But it is often observed that while dealing with the measurement process, the magnitude of the measuring signal falls down due to attenuation factor. The problem to this solution is to utilize an amplifier.The rectifier is used in the circuit to convert the AC signal into DC signal. When the bridge is provided with AC excitation then at the output end of the bridge the AC signal needs transformation into DC signal.</td><td>02M</td></tr>
<tr><td></td><td>d)</td><td>Explain with sketch procedure for calibration of given device.
Ans:


Calibration of Voltmeter with Potentiometer
Calibration of Voltmeter:
The calibration is the process of checking the accuracy of the result by comparing it with the standard value. In other words, calibration checks the correctness of the instrument by comparing it with the reference standard. It helps us in determining the error occur in the reading and adjusts the voltages for getting the ideal reading. The circuit for the calibration of the voltmeter is shown in the figure below.The circuit requires two rheostats, one for controlling the voltage and another for adjustment. The voltage ratio box is used to step-down the voltage to a suitable value. The accurate value of the voltmeter is determined by measuring the value of the voltage to the maximum possible range of the potentiometer.The potentiometer measures the maximum possible value of voltages. The negative and positive error occurs in the readings of the voltmeter if the readings of the potentiometer and the voltmeter are not equal.
OR</td><td>02M

02M</td></tr>
</table>



Calibration of an ammeter with Potentiometer

Calibration of Ammeter:

The figure below shows the circuit for the calibration of the ammeter. The standard resistance is connected in series with the ammeter which is to be calibrated. The potentiometer is used for measuring the voltage across the standard resistor. The below mention formula determines the current through the standard resistance.

$$I = \frac{V_s}{S}$$

Where,

V_s – voltage across the standard resistor as indicated by the potentiometer. S – resistance of standard resistor.This method of calibration of the ammeter is very accurate because in this method the value of standard resistance and the voltage across the potentiometer is exactly known by the instrument.

e) **Determine resolution, sensitivity and accuracy of given digital display.** (04M)

Ans:

1. Resolution can be expressed in two ways:

1. It is the ratio between the maximum signal measured to the smallest part that can be resolved - usually with an analog-to-digital (A/D) converter.
2. It is the degree to which a change can be theoretically detected, usually expressed as a number of bits. This relates the number of bits of resolution to the actual voltage measurements.

In order to determine the resolution of a system in terms of voltage, we have to make a few calculations. First, assume a measurement system capable of making measurements across a ±10V range (20V span) using a 16-bits A/D converter. Next, determine the smallest possible increment we can detect at 16 bits. That is, 2^{16} = 65,536, or 1 part in 65,536, so 20V÷65536 = 305 microvolt (uV) per A/D count. Therefore, the smallest theoretical change we can detect is 305 uV.

2. Sensitivity is an absolute quantity, the smallest absolute amount of change that can be detected by a measurement. Consider a measurement device that has a ±1.0 volt input range and ±4 counts of noise, if the A/D converter resolution is 2^{12} the peak-to-peak sensitivity will be ±4 counts x (2 ÷ 4096) or ±1.9mV p-p. This will dictate how the sensor responds. For example, take a sensor that is rated for 1000 units with an output voltage of 0-1 volts (V). This means that at 1 volt the equivalent measurement is 1000 units or 1mV equals one unit. However the sensitivity is 1.9mV p-p so it will

		take two units before the input detects a change. **3. Accuracy** can be defined as the amount of uncertainty in a measurement with respect to an absolute standard. Accuracy specifications usually contain the effect of errors due to gain and offset parameters. Offset errors can be given as a unit of measurement such as volts or ohms and are independent of the magnitude of the input signal being measured.	
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a)	**Draw the block diagram of DSO and List 4 application of DSO.** **Ans:**	

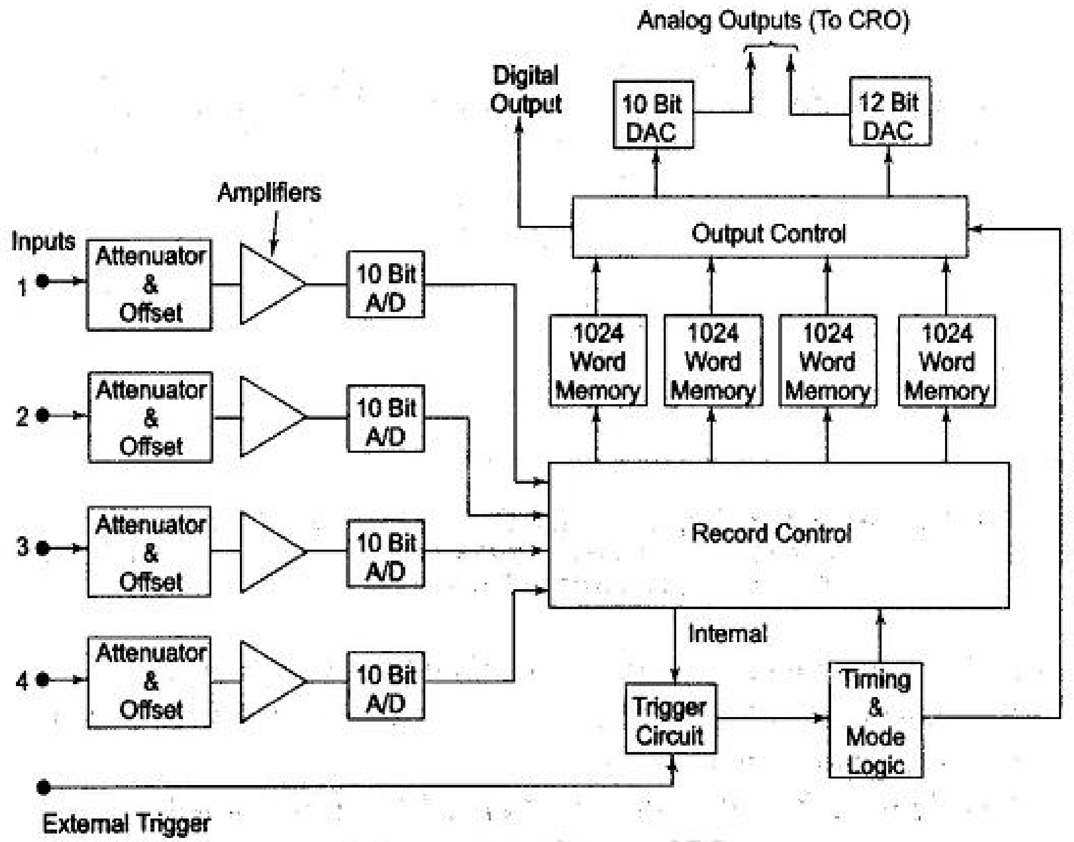


Fig: Block diagram of DSO (02M)

Applications of DSO:

There are some important application of digital storage oscilloscope (DSO) are given below,

- The DSO is used to give the visual representation for a target of radar such as aeroplane, ship etc.
- The DSO can be used to check the faulty components in various circuits.
- It can be used in medical field.
- The DSO can be used to measure ac as well as dc voltages and current.
- It can be used to analyze TV waveforms.
- The digital storage oscilloscope (DSO) is used to observe the radiation pattern generated by the transmitting antenna oscilloscope.
- The DSO used to save signals, so that it can be compared to or processed.
- The DSO can be used to measure the inductance, capacitor.
- It can be used to measure frequency, time period, time interval between signals etc.
- It can be used to observe the V-I characteristics of diodes, transistors.

(04M)

b) Sketch Lux metr and write steps to measure unknown resistance.

Ans:

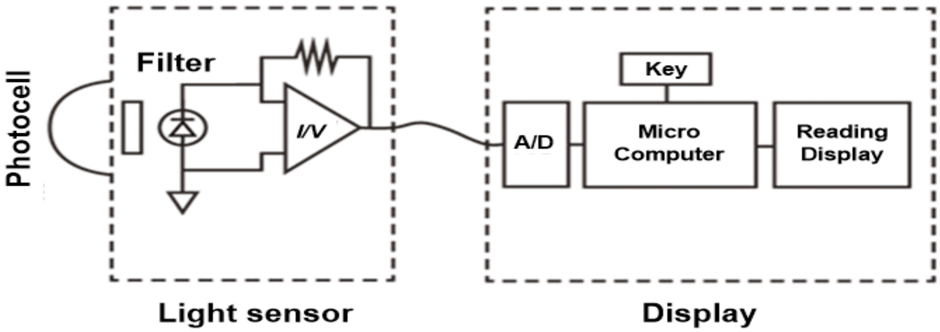


Fig: Sketch Lux meter

03M

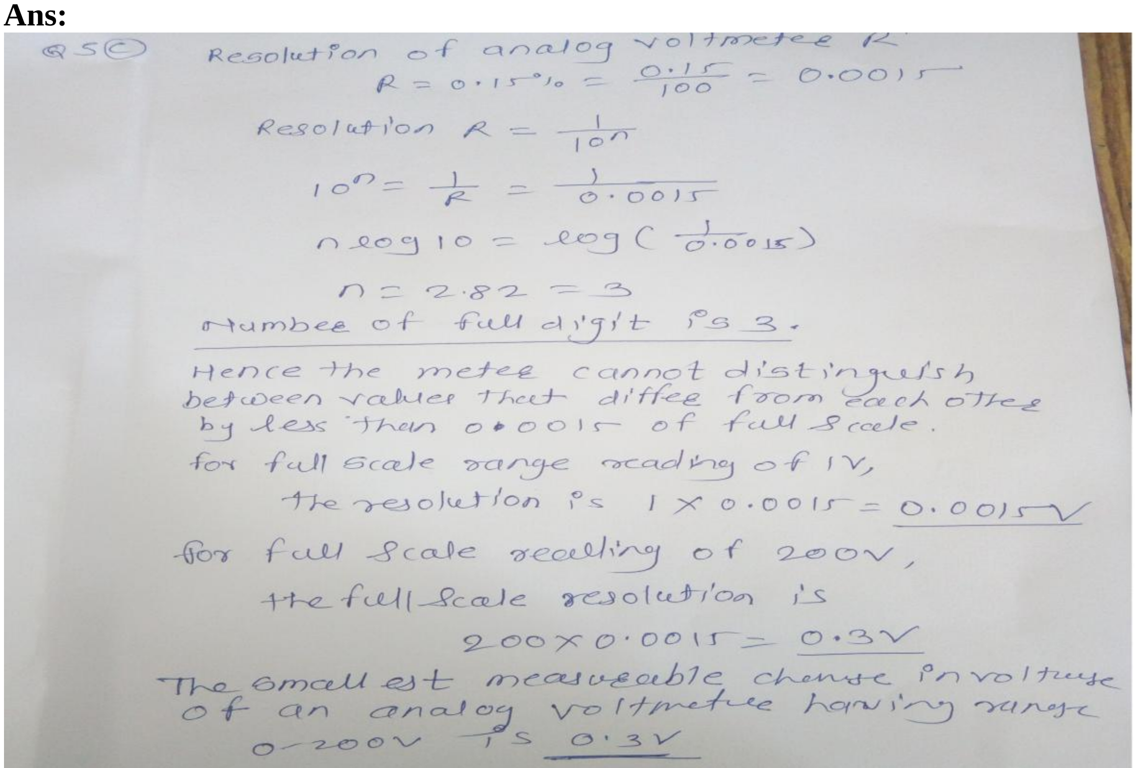
The lux is a unit of measurement of brightness, or more accurately, illuminance. The illumination is how level of luminous flux is falling on a surface area. The luminous flux is visible component that is defined in radiant flux (light power) divided by relative sensitivity of human eyes over the visible spectrum. This means the Lux is well fit to light level from sense of human eyes. Lux is ultimately derives from the candela, the standard unit of measurement for the power of light.

A candela is a fixed amount, roughly equivalent to the brightness of one candle.While the candela is a unit of energy, it has an equivalent unit known as the *lumen*, which measures the same light in terms of its perception by the human eye. One lumen is equivalent to the light produced in one direction from a light source rated at one candela. The lux takes into account the surface area over which this light is spread, which affects how bright it appears. One lux equals one lumen of light spread across a surface one square meter.

03M

c) Determine the smallest measurable change in the voltage of an analog voltmeter having range 0-200V with resolution of 0.15% of full scale.

Ans:



Q5(c) Resolution of analog voltmeter R

$R = 0.15\% = \frac{0.15}{100} = 0.0015$

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

$10^n = \frac{1}{R} = \frac{1}{0.0015}$

$n \log 10 = \log\left(\frac{1}{0.0015}\right)$

$n = 2.82 = 3$

Number of full digit is 3.

Hence the meter cannot distinguish between values that differ from each other by less than 0.0015 of full scale.

for full scale range reading of 1V,

the resolution is $1 \times 0.0015 = 0.0015V$

for full scale reading of 200V,

the full scale resolution is

$200 \times 0.0015 = 0.3V$

The smallest measurable change in voltage of an analog voltmeter having range 0-200V is 0.3V

06M

6. **Attempt any TWO of the following:** **12 M**

a) **Sketch the diagram of wheatstone bridge. Write procedure for measurement of unknown resistance.**

Ans:

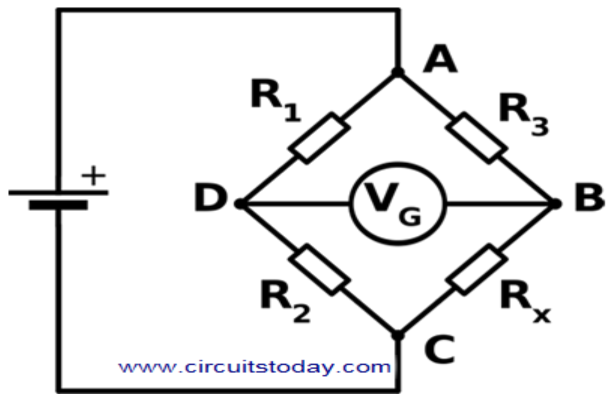


Fig: Wheatstone bridge

03M

Procedure for measurement of unknown resistance:

As shown in the circuit diagram, there are four resistances connected as a bridge circuit. The three resistors R1, R2 and R3 will have known values. The value of the resistance R_X will be unknown and has to be calculated. The value of resistance R2 is adjustable. A galvanometer has to be set between the points B and D. The condition to be satisfied at the point of balance is given below. If R2/R1 = R_X/R3, then $V_{BD} = 0$ and current through $V_G = 0$. To reach this condition, the adjustable resistor is varied. The direction of the current can be known from the value of the resistor R2. As soon as the balance condition is obtained the value of the resistance R_X is obtained. Thus, R_X = [R2/R1] x R3 This method is very accurate as the other values of resistors are of high precision.

03M

b) **Explain frequency measurement using Lissajous pattern.**

Ans:

Lissajous patterns may be used for accurate measurement of frequency.The signal, whose frequency is to be measured, is applied to the Y plates. An accurately calibrated standard variable frequency source is used to supply voltage to the X plates, with the internal sweep generator switched off. The two waves start at the same instant.Lissajous pattern may be constructed in the usual way and a 8 shaped pattern with two loops is obtained. If the two waves do not start at the same instant we get different patterns for the same frequency ratio.The Lissajous patterns for other frequency ratios can be similarly drawn. Some of these patterns are shown in the below figure.

02M

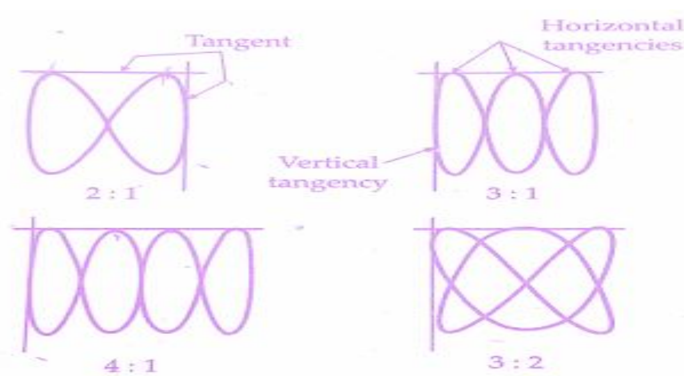


Fig: Lissajous pattern

02M

It can be shown that for all the above cases, the ratio of the two frequencies is

$$\frac{f_y}{f_x} = \frac{\text{number of times tangent touches top or bottom}}{\text{number of times tangent touches either side}}$$

$$= \frac{\text{number of horizontal tangencies}}{\text{number of vertical tangencies}}$$

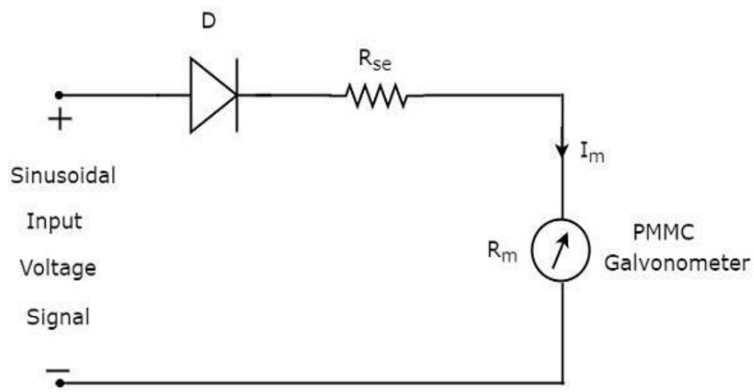
where fy = frequency of signal applied to Y plates
fx = frequency of signal applied to X plates
The above rule, however, does not hold for the Lissajous pattern with free ends.

02M

c) Describe the working of Half wave rectifier type AC voltmeter.

Ans:

AC Voltmeter using Half Wave Rectifier:



02M

If a Half wave rectifier is connected ahead of DC voltmeter, then that entire combination together is called AC voltmeter using Half wave rectifier. The block diagram of AC voltmeter using Half wave rectifier is shown in below figure. The above block diagram consists of two blocks: half wave rectifier and DC voltmeter. We will get the corresponding circuit diagram, just by replacing each block with the respective component(s) in above block diagram. So, the circuit diagram of AC voltmeter using Half wave rectifier will look like as shown in below figure.

The rms value of sinusoidal (AC) input voltage signal is

Vrms=Vm2–√Vrms=Vm2

⇒Vm=2–√Vrms⇒Vm=2Vrms

⇒Vm=1.414Vrms⇒Vm=1.414Vrms

Where,

VmVm is the maximum value of sinusoidal (AC) input voltage signal.

The DC or average value of the Half wave rectifier's output signal is

Vdc=VmπVdc=Vmπ

Substitute, the value of VmVm in above equation.

Vdc=1.414VrmsπVdc=1.414Vrmsπ

Vdc=0.45VrmsVdc=0.45Vrms

Therefore, the AC voltmeter produces an output voltage, which is equal to 0.45 times the rms value of the sinusoidal (AC) input voltage signal

04M