MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC – 27001 – 2005 Certified)

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WINTER – 12 EXAMINATION
Model Answer

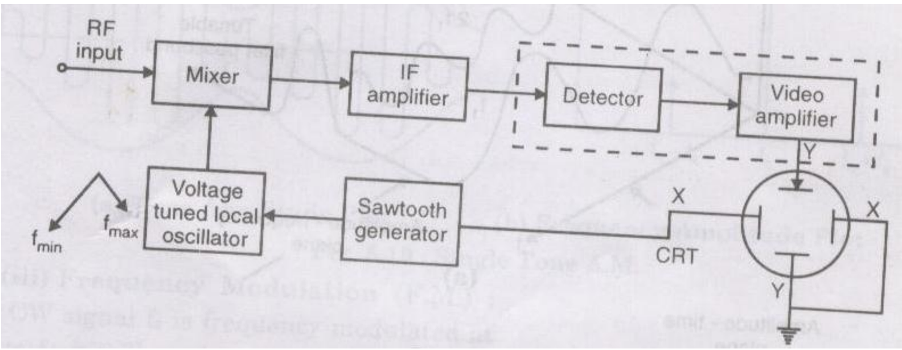
Subject Code : **12117**

Q1 .	**Attempt any FIVE**	**20 Marks**
Ans a.	The characteristics of instruments may be broadly divided into two groups, ‘static’ and ‘dynamic’ • Static characteristics • The performance criteria for the measurement of quantities that remain constant, or vary only quite slowly. Static Characteristics are:- (Any two) (i) Accuracy: It is the closeness with which an instrument reading approaches the true value of quantity being measured. (ii) Precision: It is a measure of reproducibility of the measurement. (iii) Sensitivity: It is the ratio of change in the output signal to the change in input signal. (iv) Resolution: the smallest increment in input that can be detected with certainty by an instrument. • Dynamic characteristics • The relationship between the system input and output when the measured quantity is varying rapidly. Dynamic characteristics are:- :- (Any two) (i) Speed of response: It is the rapidity with which an instrument responds to change in the measured quantity. (ii) Fidelity : It is the degree to which a measurement system is capable of faithfully reproducing the changes in the measured variable without any dynamic error. (iii) Lag: Retardation or delay in response. iv)Dynamic error: Difference between true value & indicated value if no static error assumed.	2 2
Ans b.	1. **Average value:** the average value of a signal is found when the voltages or currents at each points are measured & then average is taken $V_{avg} = \frac{V_1 + V_2 + V_3 + - - - + V_n}{n}$ 2. RMS value: The r.m.s value is given by measuring the current or voltage at equal intervals of time for one complete cycle of the waveform. Each quantity is squared. Finally all the terms are summed and square root is found.	2 2

	$$V_{rms} = \sqrt{\frac{V_1^2 + V_2^2 + V_3^2 + --- + V_n^2}{n}}$$	
Ans c.	Resolution :- Resolution is defined as the ratio of change in analog output voltage resulting from a change of 1 LSB at the digital input Sensitivity: - Sensitivity is the smallest change in input which a digital meter is able to detect. Hence, it is the full scale value of the lowest voltage range multiplied by the meter's resolution. Accuracy:-. It is a measure of closeness to which the converter tries to achieve the true value i.e. actual value of the output voltage.	1 1 2
Ans d.	Difference between single trace & Dual trace CRO.	**4**

Sr.No.	Single Trace CRO	Dual Trace CRO
1	It has one vertical input circuit.	It has two vertical input circuits.
2	It has slow electronic switching.	It has fast electronic switching.
3	Slow sweep rates.	Fast sweep rates.
4	Generates a single electron beam which is used for generating single trace.	Generates a single electron beam which is used for generating two traces.

Ans e.	Basic Spectrum Analyser:-	**4**



Ans f.

ADC: An analog to digital converter is a device that converts a continuous quantity to a discrete time digital representation. **1**

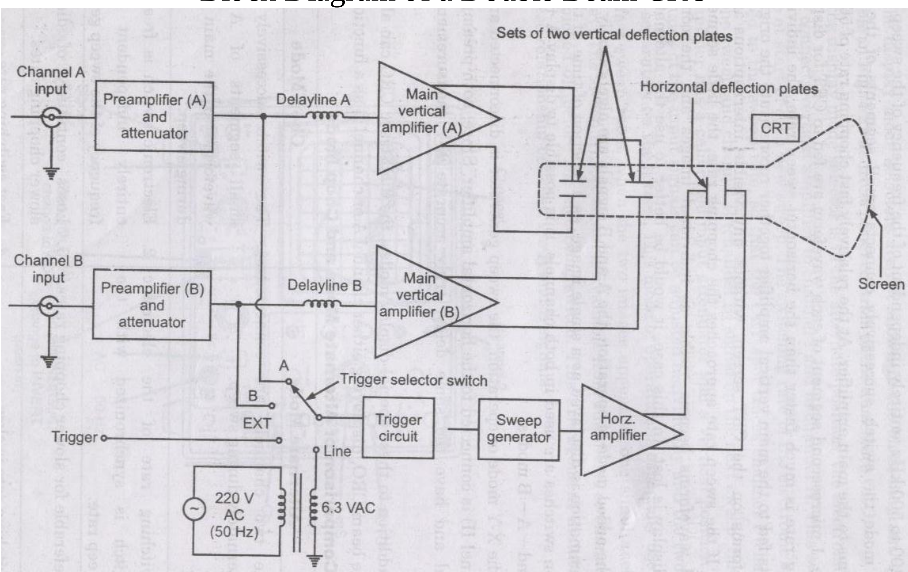
DAC: An digital to analog converter involves translating digital information in to equivalent analog information. **1**

Difference between ADC and DAC (any two) **2**

Sr. No	ADC	DAC
1	It converts analog information in to digital information	It converts digital information in to analog information
2	It is encoding device	It is decoding device
3	Less straight forward.	More straight forward

Ans g.

Block Diagram of a Double Beam CRO **4**



Q2. Attempt any FOUR **16 marks**

Ans a. 4

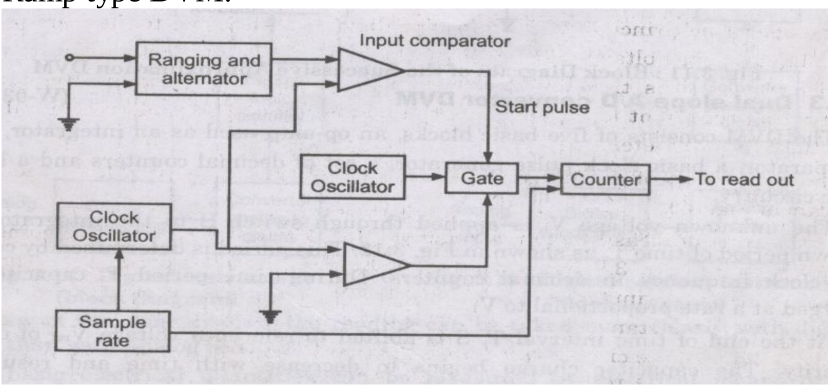
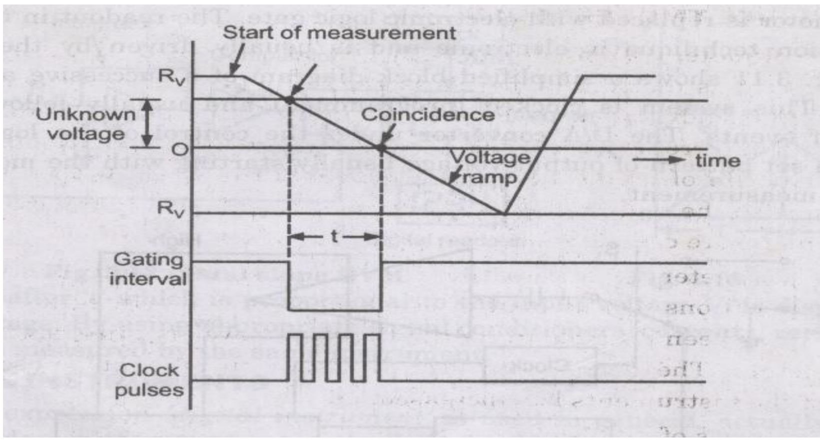
i)Grounding :- Electricity always tries to find a low resistance path to the ground. The route electricity takes its called its path to ground. Grounding refers to the connection of parts of a wiring installation to a common earth connection. Generally grounding is used to avoid fire and shock.

ii)A fire incidence occurs when current leaks from a broken live wire or connection & reaches a point of zero voltage by some path other than the normal one. Such a path offers low resistance, so the high current can generate enough heat to start a fire. If an exposed live wire touched the metal frame of an undergrounded piece of electrical equipments the voltage of the live wire would charge the metal frame, if a person then touches the metal frame then he could suffer a serious shock.

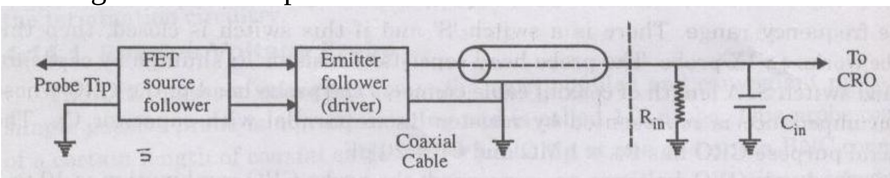
When the current starts from a positive terminal ,it moves through the load and ends up at zero potential .One end of earth terminal is connected to instrument and the other end is grounded .Therefore any leakage of current is grounded by low impedance path.Any person who is touching the instrument gets protected from getting a shock .

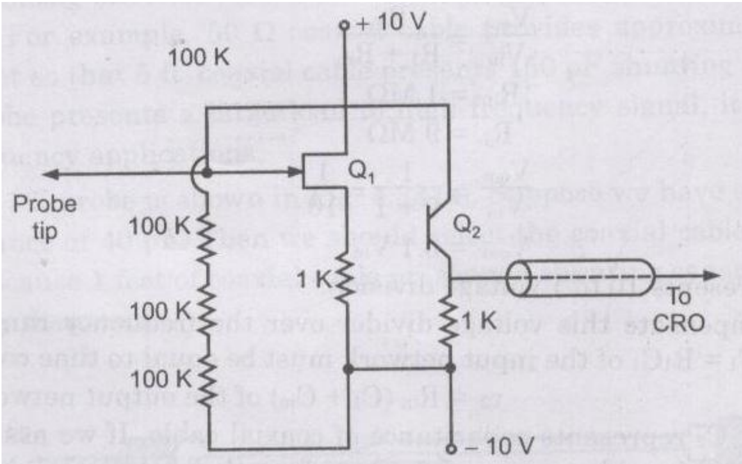
Importance of grounding

Grounding has nothing to do with the operation of electrical equipment. Its sole purpose is the protection of life & property.

Ans b.	Classification of analog instruments (i) Indicating :- those instruments which indicate the magnitude of a quantity being measured. Example : Voltmeter , Ammeter. They use dial and pointer .They are divided into two groups a) Electromechanical Instruments b) Electronic Instruments (ii) Recording : Recording instruments give a continuous recording of the quantity being measured over a specified period. The variations of the quantity being are recorded by pen , the moving system is operated by the quantity being measured on a sheet of paper fixed or moving .Example voltmeter. (iii) Integrating: these instruments totalize events over a specified period of time .The summation which they is the product of and an electrical quantity. Eg: Ampere hour Energy meter Analog Instruments may also be classified on the basis of method used for comparing the unknown quantity (measured) with the unit of measurement .The Types are : (i) Direct measuring Instruments : These instruments convert the energy of the measurand directly into energy that actuates the instruments and the value of the unknown quantity is measured .Example : ammeter , wattmeters ii) Comparison Instrument : They measure the unknown quantity by comparison with standard. Example AC & DC Bridges.	4
Ans c.	Ramp type DVM:-  Waveform:-  	2 2
Ans d.	Advantages of Active probe: (any two) (i) High Impedance therefore no loading effect (ii) Reduced cable and switching capacitances (iii) Active voltage probes can measure signal with fast rise times	2

<table>
<tr><td></td><td>Circuit diagram of active probe





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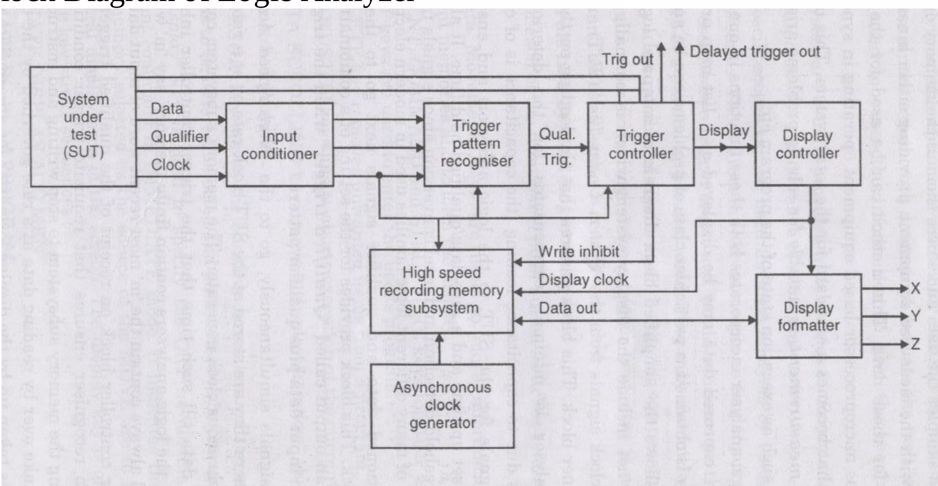
<tr><td>Ans e.</td><td>Block Diagram of Logic Analyzer



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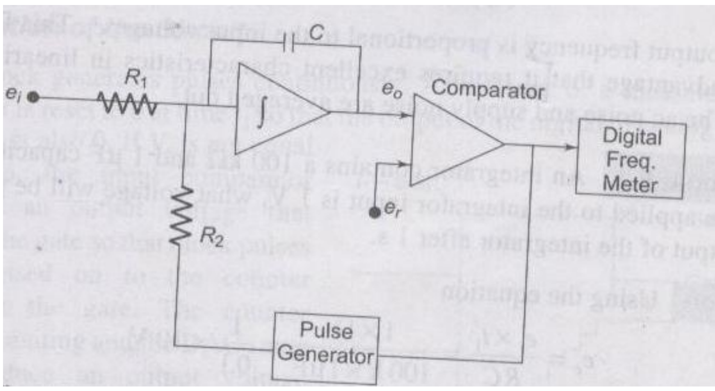
<tr><td>Ans f.</td><td>Block Diagram of integrating type DVM



Advantages: (any one)

i) In this DVM an integrator responds to the average value of input</td><td>2</td></tr>
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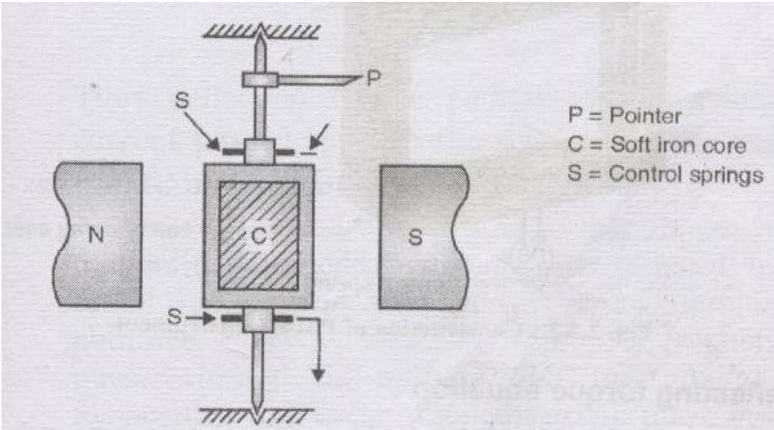
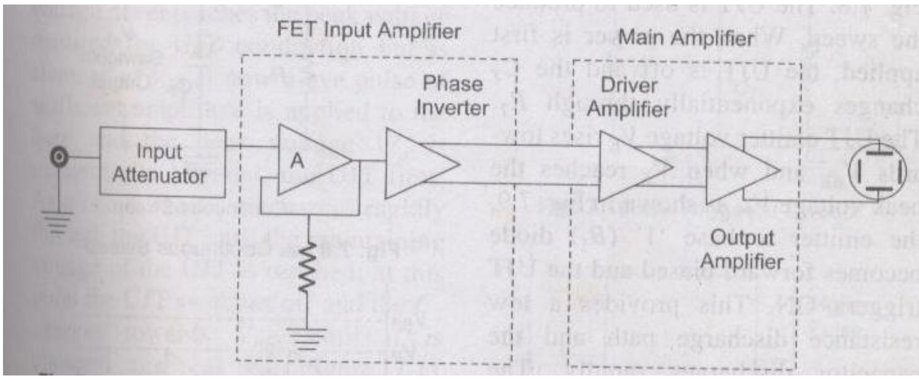
	voltage, it is not necessary to use sample and hold circuit. ii) If input voltage is changed, it will not cause the significant error. iii) It is having good noise rejection property. Disadvantages: (any one) i) Slow speed ii) It requires excellent characteristics in linearity of the ramp.	1 1
Q3	Attempt any two of the following	Marks 16
Ans a.	PMMC:  Working Principle:- A current carrying conductor placed in magnetic field experiences a force. It is given by the expression, **F = BIL** Where, F= Force in Newton B= Flux density in Tesla I= Current in ampere L= Length of conductor in meter. Construction:- • A light rectangular coil wound on a metal frame is pivoted within the air gaps between the two poles of a permanent and a cylindrical soft iron core. • This coil carries the current to be measured. Soft iron core provides formation of uniform magnetic field. • The aluminum frame supports the coil as well as provides eddy current damping. • Two phosphor- bronze springs coiled in opposite direction serve as leads for the current in the coil. • The springs are provide controlling torque. • The morning system is balanced by three balance weights. • The morning spindle is pivoted in jeweled bearings.	4 2 2

Ans b.	Digital frequency meter:-  Operation:- • The signal whose frequency is measured is first amplified. The output of amplifier is applied to the Schmitt trigger. • The Schmitt trigger converts the signal into square wave having fast rise and fall times. The square wave is then differentiated and clipped. Each pulse is proportional to each cycle of unknown signal. • The output from Schmitt trigger is applied to start and stop gate. When the gate is open , input pulse are allowed to pass through it. A counter will now start to count these pulses. • When the gate is closed input pulses are not allowed to pass through the gate. The counter will now stop counting. • The number of pulses during the period gate is open are counted by the counter. If this interval between start and stop condition is known, the frequency of unknown signal is measured. $F= \frac{N}{t}$ Where, F= Unknown frequency. N= Number of counts displayed by the counter. t= Time interval between start and stop condition of the gate.	4 4
Ans c)	Vertical deflection subsystems  • The main function of the vertical deflection system is to provide an amplified signal of proper level to drive the vertical deflection plates without any distortion. For amplification of the signal to appropriate level, it uses a vertical amplifier. • The vertical amplifier consists of a number of stages having fixed overall sensitivity or gains which is expressed in volts/ division. Because of fixed gain the amplifier can be designed in a manner such that it meets the requirements of stability and bandwidth. • The input stage of the preamplifier, consists of a n FET source follower. The FET source follower has high input impedance. This impedance isolates the FET amplifier from the attenuator. • The FET source follower input stage is followed by a BJT emitter	4 4

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follower. This is done in order to match the medium impedance of the FET amplifier with low input impedance of the phase inverter.

- Two antiphase output signals are provided by the FET amplifier, in order to drive the push- pull amplifier output.
- The push – pull output stage delivers equal signal voltages of opposite polarities to the vertical deflecting plates of the CRT. The advantages of using push- pull stage at the output are better cum cancellation, even harmonic suppression, reduced non- linear effects because none of the phases are at ground potential.

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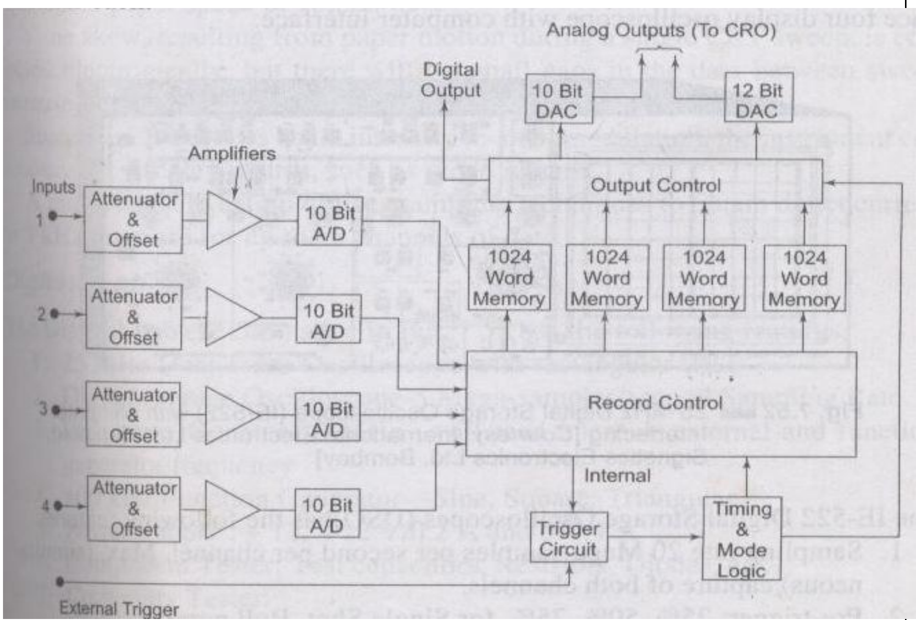
<tr><td>Q4</td><td>Attempt any two of the following:</td><td>Marks 16</td></tr>
<tr><td>Ansa.</td><td>

Digital Storage Oscilloscope:-



1. Consider a single channel. The analog voltage input signal is digitized in a 10 bit A/D converter with a resolution of 0.1 %.
2. The total digital memory storage capacity 4096 for a single channel, 2048 for two channel and 1024 for four channels each.
3. The analog input voltage is sampled at adjustable rates and data points are read onto the memory.
4. Once, the sampled record is captured in memory, manipulations are possible, since memory can be read out without being erased.
5. If memory is read out rapidly and repetitively, an input event which was a single shot transient becomes a repetitive or continuous waveform that can be observed or ordinary scope.
6. Pre- triggering recording allows the input signal preceding the trigger points to be recorded.
7. DSO can be set to record continuously (new data coming into memory pushes out old data, once memory is full), until the trigger signal is received, then the recording is stopped, thus, freezing data received prior to trigger signal.
8. Adjustable trigger delay allows operator control of the stop point.

Advantages:- (Any one)

(i) The storage time is infinite.
(ii) It is easy to operate and has compatibility with GPIB, RS 232, centronix parallel printer interface.
(iii) Cursor measurement is possible.
(iv) Pretriggering feature allows display of waveform, before the trigger pulse.

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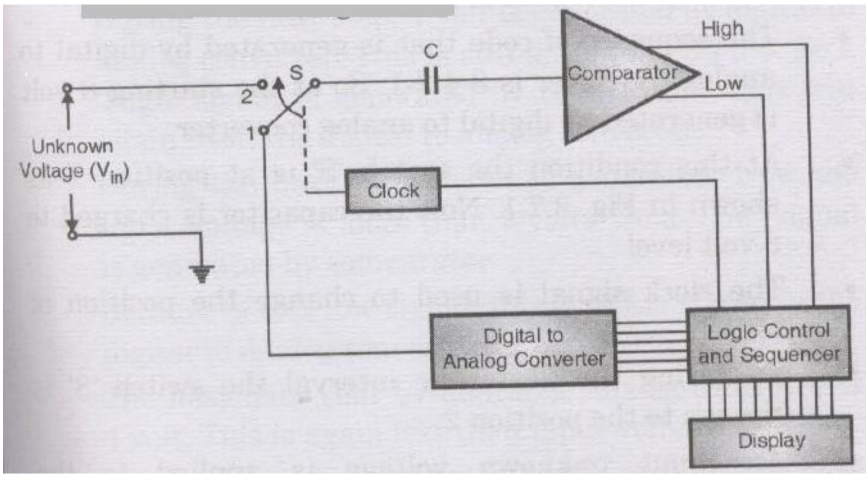
	Disadvantages (Any one):- 1. limited refresh rate of the screen 2. Bandwidth is limited.	1
Ansb.	Successive approximation type DVM:-  	4
	Working:- • Consider that unknown voltage to be measured is 3.2135 volts. • Also consider that digital to analog converter generates the codes 8-4- 2- 1. • Initially the digital to analog converter is reset. • The sequence of code that is generated by digital to analog converter is 8-4-2-1. So at the starting 8 volt is generated by digital to analog converter. • At this condition the switch 'S' is at position 1. Now the capacitor is charged to 8 volt level. • The clock signal is used to change the position of switch. • So during the next time interval the switch 'S' is thrown to the position 2. • An input unknown voltage is applied to the capacitor. • The capacitor was charged to 8 volt. If input voltage is more than the voltage stored across the capacitor then the current flows into the comparator. • However if this input voltage is less than the capacitor voltage then the current flows in opposite direction. • Now when the current flows into the comparator then 'High' signal is generated. And when the current flows in opposite direction then 'Low' signal is generated by the comparator. • The generation of 'High' signal causes the resetting of digital to analog converter. • While during the generation of 'Low' signal; the data generated by digital to analog converter is retained. • Here an input voltage to be measured is 3.2135. Initially the digital to analog converter generates 8 volts. • The comparator compares these two voltages. Now a 'High' signal is generated. This will reset the digital to analog converter. • During the next step, 4 volts is generated by digital to analog converter. This is still more than 3.2135. So a 'High' signal is generated by comparator. This will again reset the digital to analog converter. • Because of this low signal; this 2 volt is stored in the digital to	3

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analog converter.

- The next data sent by digital to analog converter is 1 volt. This is again less than input voltage.
- So a low signal is generated by the comparator. Now this 1 volt is retained in digital to analog converted, so the voltage level I it becomes 2 + 1 = 3 volts.
- This process takes place continuously until the signal in digital to analog converter becomes equal to unknown input voltage.
- Now this voltage is send to the display.

It is called so because the analog to digital conversion is done in successive steps by approximations till the signal in the digital to analog converter becomes equal to unknown input voltage
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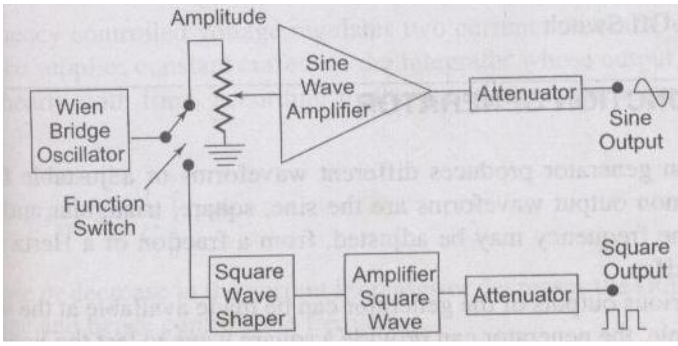
AF Sine wave and square wave Generator:-



Operation:-
The signal generator is called an oscillator. A wein bridge oscillator is used in this generator. The wein bridge oscillator is the best for the audio frequency range. The frequency of oscillations can be changed by varying the capacitance in the oscillator. The frequency can also be changed in steps by switching in resistors of different values.
The output of the Wein bridge oscillator goes to the function switch. The function switch directs the oscillator output either to the sine wave amplifier or to the square wave shaper. At the output, we get either a square or sine wave. The output is varied by means of an attenuator.
The instrument generates a frequency ranging from 10 Hz to 1 MHz, continuously variable in 4 decades with overlapping ranges. The output sine wave amplitude can be varied from 5 mV to 5v (rms). The output is takes through a push – pull amplifier. For low output, the impedance is 6000 Ω. The square wave amplitudes can be varied from 0 -20 V (peak). It is possible to adjust the symmetry of the square wave from 30-70%. The instrument requires only 7 W of power at 220V , 50Hz.
Concept of oscillator:
To generate sine / square waveform, we require a device called ‘oscillator’. The oscillator in conjunction with an’ attenuator’ forms the basic block of a sine wave generator.
The oscillator consists of an amplifier and a feedback network. The overall gain of the loop is designed to be equal to one (unity). Also, the phase shift around the complete loop should be zero. Various components such as R- C, R-L, R-L-C are suitably designed so that the resonant frequency of the circuit is,

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

Here,
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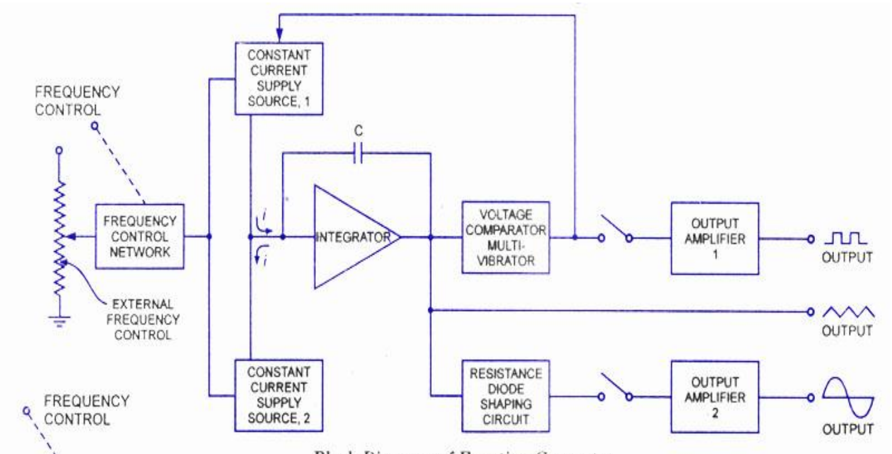
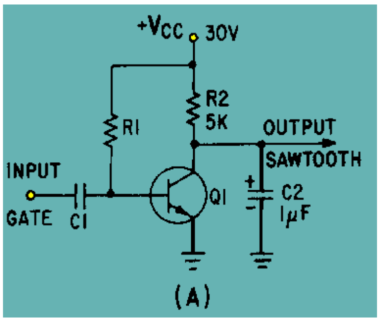
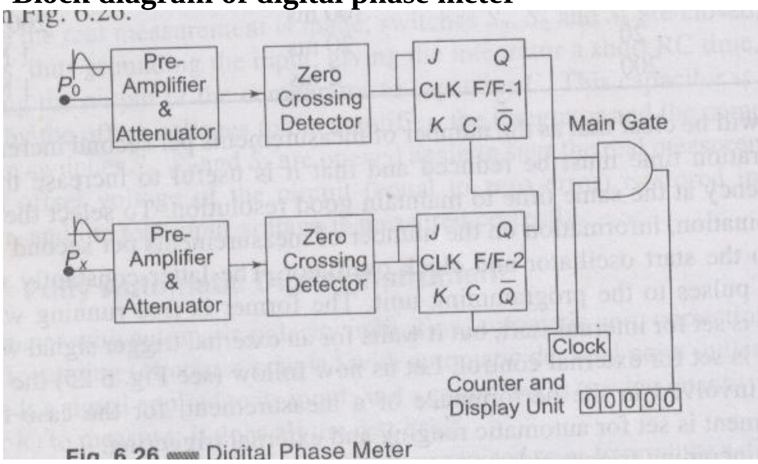
	F= frequency of generated waveform in Hertz. L= Inductance of the inductor in Henry C= Capacitor value in Farad. Wide number of oscillators such as Hartley oscillator, Colpitt's oscillator etc. can be used with attenuator to form a signal generator.	
Q5	Attempt any two of the following:	Marks 16
Ans a	Block diagram of function generator:-  *Block Diagram of Function Generator* Function generator is an instrument which produce different function at the output. Range of frequency is from few Hz to several MHz. Frequency control can be internal or external. This frequency controlled voltage regulates two current sources. The upper current source supplies constant current to integrator whose output voltage increases linearly with time,the output voltage is Eout= $-1/C\int_0^t i\ dt$ An increase or decrease in the current increases or decreases the slope of the output voltage and hence controls the frequency. The voltage comparator changes states at a predetermined maximum level. The lower current source supplies a reverse current to the integrator so that output decreases linearly with time. When Eout reaches the minimum voltage level again the comparator changes state and switches on the upper current source. The output of integrator is a triangular wave. This output when given to voltage comparator produces square wave. Whereas the resistance diode shaping network produces sine wave.	2 2

Ans.b	**Explain horizontal deflection sub systems** 	2
	Oscilloscopes are generally used to display a waveform that varies as a function of time. If the waveform is to be accurately reproduced, the beam must have a constant horizontal velocity. The voltage which gives this characteristics of increasing linearly with time is called a ramp voltage. If the voltage decreases rapidly to zero with waveform repeatedly reproduced, the pattern is generally called a sawtooth waveform. The circuit has a the capacitor C which charges through resistor R & discharges periodically through transistor Q, which causes the output waveform to be a sawtooth wave. The horizontal amplifier basically serves two purposes 1) when oscilloscope is being used in the ordinary mode of operation to display a signal applied to the vertical input, the horizontal amplifier will amplify the sweep generator output. 2) When the oscilloscope is being used in the X-Y mode, the signal applied to horizontal input terminal will be amplified by horizontal amplifier.It is push pull amplifier same as the vertical amplifier.	2
Ans.c	**Block diagram of digital phase meter** 	2
	A phase difference of two different signals can be measured by using 2 F/F's. For that the frequency of 2 signals must be same. As p_0 gives input signal, it increases in the +ve half cycle. The zero crossing detector changes its state & causes the J-K F/F 1 to set Q = 1. This high output from the F/F-1 enables the AND gates & the pulses from Clk oscillator are fed directly to the counters. The counter starts counting these pulses also at the same time its high o/p is applied to the clear i/p of F/F-2 which makes the o/p of F/F-2 to be low (Q=0) As the i/p p_x which has a phase difference with respect to P_0 process zero in + positive half cycle the zero crossing detector is activated its i/p go to high (Q=1). This o/p of F/F-2 is connected to the clear i/p of F/F-1 forcing the F/F-1 to reset. Hence the output of F/F-1 is 0. The AND gate is disabled and the counters stop counting. The number of pulses counted which enabling and disabling an AND gate is directly proportional to the phase difference.	2

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<td>Ans.d</td>
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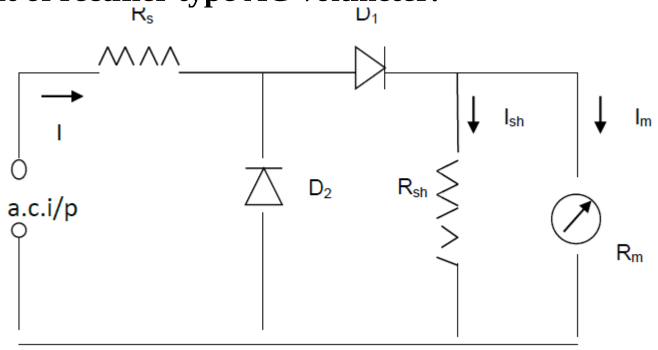
Circuit of rectifier type AC voltmeter:-



In the given circuit, diode D_1 conducts during the positive half of input cycle & causes the meter to deflect according to average value of this cycle.

The meter movement is in parallel with shunt resistance so that it is protected from any extra current through the meter.

In the negative half cycle, diode D_2 conducts and current flows in opposite direction & hence bypasses the meter movement.

In this way meter current conducts only in positive half cycle of ac voltage & gives average value of the same.

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<td>Ans.e</td>
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Types of errors:-

The error of an instrument is the algebraic difference between the observed value and true value of the quantity being measured.

1) Gross Errors -

These errors occur due to human mistakes while taking reading, handling instrument, incorrect setting or adjustment and improper used of instrument.
The complete elimination of gross errors is not possible but we can minimize it. These errors may be avoided by taking reading and recording it carefully.

2) Systematic Errors –

These errors occur due to shortcoming of the instrument, such as defective or worn part or aging or effect of environment on the instrument.
These errors are further classified as –

i) Instrumental errors – These errors arise due to inherent shortcoming of instrument, misuse of instrument, loading effect of instrument.
These errors can be removed by selecting suitable instrument for particular application.

ii) Environmental error- These errors occur due to external condition to the measuring instrument, such as temperature, pressure, humidity, dust and external magnetic field.
These errors can be avoided by keepingcondition constant with the help of air conditioning, temperatures control, enclosure etc.

iii) Observational error – observational error introduced by observer. The most common error is the parallax error introduced in reading a meter scale.

iv) Random Errors – These errors are due to unknown causes. These errors remain since the systematic and gross error are removed. Generally these errors are very small.

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Ans.f	**Standards:-** Standard is a physical representation of a unit of measurement. A known accurate measure of physical quantity is termed as standard.These standards are used to determine the values of other physical quantities by comparison method. **Classifications:-** 1) International standards: • International standards are fixed and develop by international agreement. • These standards are maintained at International Bureau of Weights and Measures in France. • This standard gives different unit having best accuracy. • To preserve best accuracy these standards are periodically check by absolute measurement. • These standards are used to calibrate primary standard only. • These are not available to ordinary user for measurement. 2) Primary standards • These standards are preserved and maintained by National Standard Laboratories which are located at different part of the world. e.g.-NBS (National Bureau of Standards) located at Washington. These standards are periodically calibrated by International standards. 3) Secondary standards • These standards are also called as basic standards. • These standards are used by industries and calibration laboratories. • Each industry has its own laboratory. 4) Working standards • These standards are used in general laboratories. • These standards are used to check components and calibrating laboratory instruments to achieve good accuracy and better performance.	1 3

Q6 .	**Attempt any four :**	16
Ans a.	Loading effects of an Instrument:- An ideal measuring instrument will draw no current from the circuit, thereby resulting in the true measurement of electronic parameters. Unfortunately, in the real world, all instruments draw current, and this is referred to as the "loading effect". This causes parameters being measured to change in value. So to minimize this "loading effect", the best you can do is to use a measuring instrument that has very high impedance so that the current it draws is minimal. Loading effects of an Instrument are the alternations that are caused in the circuit conditions such as voltage, current etc. when the instrument is introduced in the circuit for the purpose of measurement. In simple terms, loading effects of an instrument ends up distorting the signal they are supposed to measure. The instrument therefore reads the altered value of the quantity and thus an erroneous measurement is resulted. These loading effects can be better explained by the following two examples Let a voltage has to be measured across a resistance R in the circuit. For this purpose, a voltmeter V is connected across the resistor R in parallel. We know that a voltmeter has a very high resistance value. But since this value is finite, a fraction of the total current passing through R will pass through the Voltmeter V. This will lead to power dissipation in the Voltmeter. The voltmeter extracts this power out of the circuit and thus end up varying the values of the circuit parameters on being introduced. Another example of loading effects is found in the measurement of current by an Ammeter. An ammeter is a very low resistance device that is connected in series in a circuit for the measurement of current. When current passes through it, because of the low finite resistance of the ammeter, there is a small voltage drop across the ammeter which results in power dissipation. This power is again borrowed from the circuit and therefore affects the circuit parameters. Theoretically loading effects can be reduced to zero by:- Making the impedance of an instrument that is to be connected in parallel in a circuit as infinite. Making the impedance of an instrument that is to be connected in series in a circuit as zero.	4
Ans b.	**Frequency can be measured on CRO using Lissajous pattern.** Measurement of frequency The period and frequency of periodic signals are easily measured with an oscilloscope. The period is calculated as follows. T = (time/div)*(No. of div/cycle) The frequency is calculated as f = 1/T Measurement of frequency by lissajous pattern: Two sine waves are applied to Y plates and X plate of CRT. The unknown frequency is applied to one plate and known frequency is applied to another. The frequency ratio is given by Fy/fx = no. if horizontal tangents/no. of vertical tangents.	2

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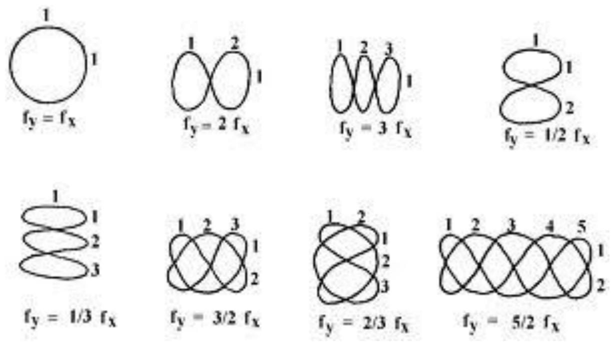

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<td>Ans c.</td>
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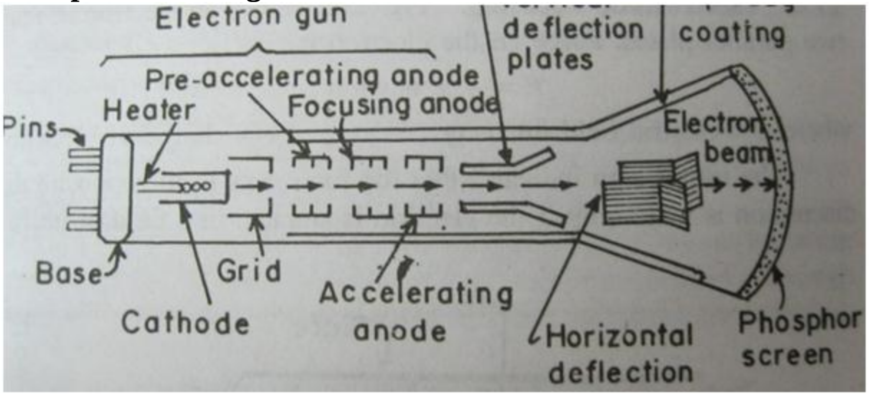
Draw and explain working of CRT.



The cathode ray tube is an important part of the CRO. The internal structure of CRT is shown below . It consists of -

1) Electron gun assembly
2) Deflection plate assembly
3) Fluorescent screen
4) Glass tube
5) Base.

1. Electron gun assembly –
    - An electron gun consists of a heater, focusing anodes and cathode.
    - The control grid is cylindrical in nature. It is made from nickel material. The grid is at negative bias. Intensity of the electron beam can be controlled by this grid by changing this negative bias.
2. Deflection plate assembly –
    - When the electron beam is accelerated by the accelerating anodes it passes through the deflection plate assembly.
    - The deflection plate assembly of the CRT consists of the two pairs of parallel plates. These plates are called as the vertical deflecting plate and the horizontal deflecting plate.
3. Fluorescent screen-
    - The screen is coated with Fluorescent material called phosphor. This consists of pure crystals of phosphor.
4. Glass Tube-
    - The components of a CRT are enclosed in an evacuated glass tube called the envelope. It allows the electrons which are emitted to move freely from one end of the tube to another.
5. Base-
    - The base is provided to the CRT through which the connections are made to the various parts.

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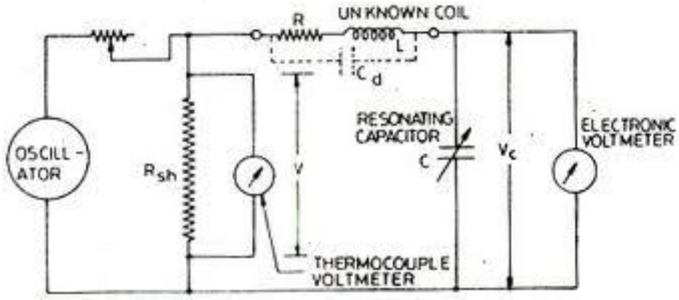
Ans. d

Circuit of basic Q meter:- 2



The Q factor is called as the quality factor or the storage factor.It is the ratio of energy stored in the device to energy dissipated in the device.
The series resonance circuit of Q meter is as shown above.
It consists of self contained variable frequency RF oscillator. The oscillator delivers current to a low value shunt resistance Rsh, a small value of E is applied to the resonant circuit, with a small internal resistance .This voltage is measured by a thermocouple voltmeter. A calibrated standard variable capacitor is used for tuning the circuit. An electronic voltmeter is connected across the capacitor whose scale is calibrated directly in Q values. It has acharacterstics that the voltage across the coil or capacitor is equal to the applied voltage times, the Q factor of the circuit. Therefore, 2

Q= Ec/E

Ans.e

Block diagram of standard signal generator:- 2

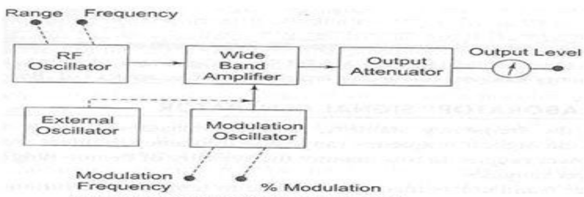


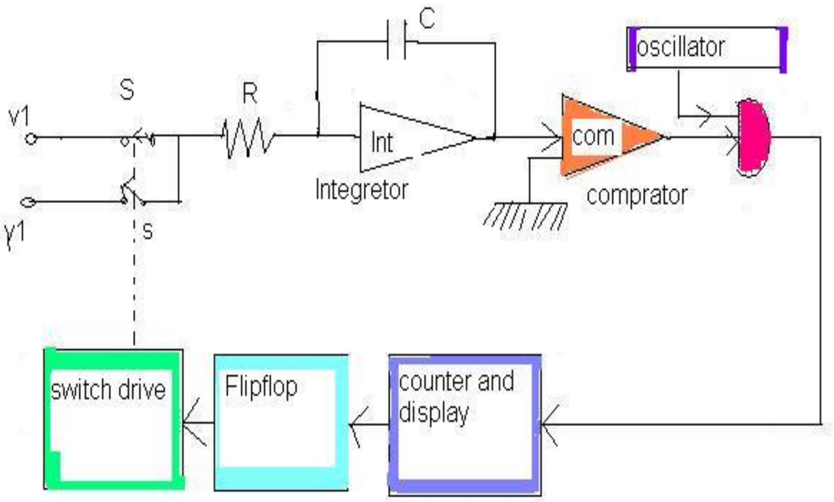
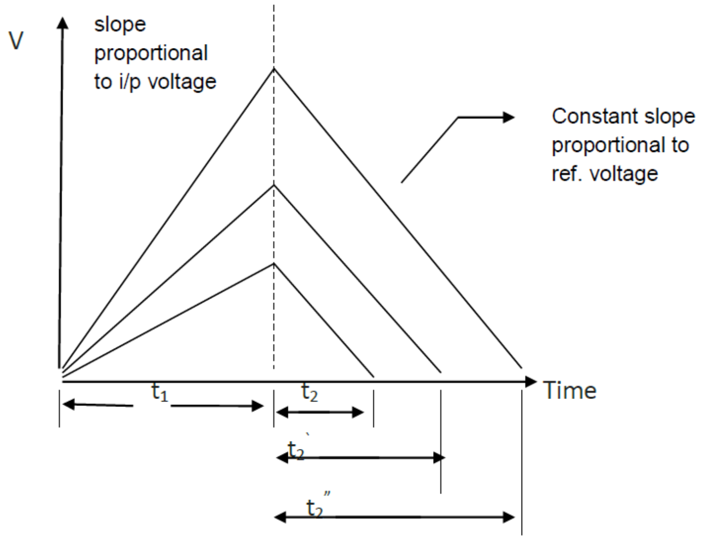
fig 1.1 Conventional standard signal generator

A standard signal generator produces known and controllable voltages. It is used as power source for the measurement of gain, signal to noise ratio (SN), bandwidth standing wave ratio and other properties. 2
It is extensively used in the measuring of radio receivers and transmitter instrument is provided with a means of modulating the carrier frequency, which is indicated by the dial setting on the front panel.
The modulation is indicated by a meter. The output signal can be amplitude modulated or frequency modulated. Modulation may be done by a sine wave, square, rectangular or a pulse wave

The elements of a conventional signal generator :

1) RF Oscillator
(2) Wide band amplifier.
(3) External Oscillator.
(4) Modulation Oscillator
(5) Output attenuator.

The carrier frequency is generated by a very stable RF oscillator using an LC tank circuit, having a constant output over any frequency range. The frequency of oscillations is indicated by the frequency range control and the venire dial setting. AM is provided by an internal sine wave generator or from an external source.

	The signal generator is called an oscillator. A Wien bridge oscillator is used in this generator. The Wien bridge oscillator is the best of the audio frequency range. The frequency of oscillations can be changed by varying the capacitance in the oscillator. The frequency can also be changed in steps by switching the resistors of different values. The output of the Wien bridge oscillator goes to the function switch. The function switch direct the oscillator output either to sine wave amplifier or to the square wave shaper. At the output we get either a square or sine wave. The output is varied by means of an attenuator.	
Ans.f	**Block diagram of dual slope DVM:-**  Fig.: Block diagram of dual slope integrating type Digital Voltmeter **Waveform:-**  	2 2