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

SUMMER – 2013 EXAMINATION

Subject Code: **12117** **Model Answer** Page No: 1

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 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, examiner may give credit for principal components indicated in the figure. The figures drawn by 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 model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q1. a) Attempt any SIX of the following **(12)**

i. Define Fidelity and Dead Zone.

Ans : **Fidelity** - It is defined as the degree to which a measurement system is capable of faithfully reproducing the changes in input, without any dynamic error. **(1)**

Dead Zone – It is the largest change of input quantity for which there is no output. **(1)**

ii. State the parameter that can be measured by Analog multimeter.

Ans : Voltage, current and Resistance can be measured by Analog multimeter. **(2)**

iii. Why grounding is provided for the instruments. **(2)**

Ans : The earth terminal has one end connected to the body of the instrument device and other end grounded. So, if current leaks into the body of the instrument, it is carried to the earth through the low impedance path. Any person who is touching the instrument gets protected from getting a shock.

iv. Define RMS value and average value for analog signal.

Ans : **Root Mean Square value (RMS value)** – **(1)**

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.

$$V_{rms} = 0.707\ V_{max}$$

Average Value – **(1)**

The average value of a signal is found when the voltages or currents at each point are measured and then the average is taken.

$$V_{avg} = \frac{V_1 + V_2 + V_3 + \ldots V_n}{n}$$

v. List out the advantages of Digital Voltmeter over Analog Voltmeter.

Ans : (any two) **(2)**

- It has high speed.
- Digital voltmeter can be programmed. So controlling by computer is achieved.
- It has automatic range selection.
- Accuracy can be made as high as $\pm$ 0.005 percent.
- It provides a good stability.

- It gives better resolution. For example can be read on 1 volt input range.
- The internal calibration does not depend on the measuring circuit.
- Output signal can be recorded.

vi. Define sensitivity and range of analog voltmeter.

Ans : **Sensitivity –** **(1)**

- The sensitivity of a voltmeter means the response given by a voltmeter to input signal.
- It is defined as the ratio of the total circuit resistance (R_T) to the voltage range.
- It is also defined as the reciprocal of the full scale deflection current of the basic movement.
- Sensitivity is denoted by 'S'.

$$\text{Therefore} \quad S = \frac{1}{I_{fsd}}$$

Range of analog voltmeter is 2.5 volt to 5000 volt. **(1)**

vii. Define quality factor. **(2)**

Ans : It is the ratio of energy stored in the device to energy dissipated in the device.

The Q factor is equal to $Q = \frac{\omega L}{R}$

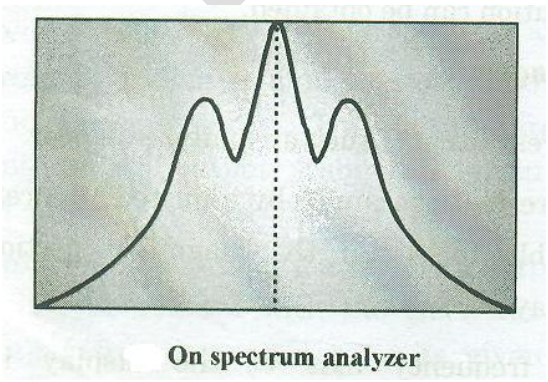
Where, ω = Angular frequency at resonance

L = Inductance

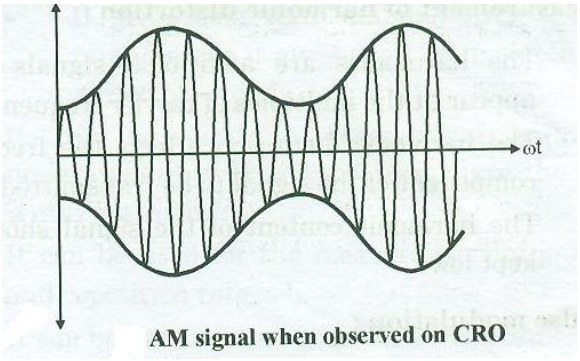
R = Effective resistance of coil.

viii. How AM signal will be displayed on spectrum analyser and on CRO?

Ans : **(1+1)**



On spectrum analyzer



AM signal when observed on CRO

b) Attempt any TWO of the following **(8)**

i) What is meant by calibration of an instruments? State its concept and need in detail.

Ans : **(2)**

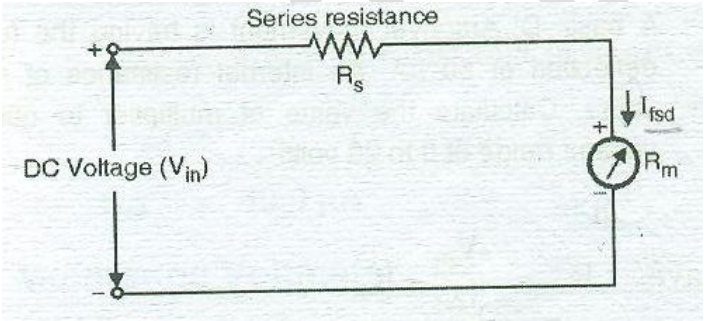
- Calibration is a process of estimating the value of a quantity by comparing that quantity with a standard quantity to determine its accuracy.

Concept- **(2)**

- The standard with which comparison is made is called as standard instrument.
- The unknown quantity is to be calibrated. This quantity is called as test quantity. If an instrument is to be calibrated, it is called as test instrument.
- For calibration, the test instrument will be compared with the standard instrument.

ii) Draw the circuit diagram of basic DC voltmeter. Explain how it can be converted into multirange DC voltmeter ?

Ans : **(2)**



(2)

- The basic meter is based on the PMMC D'Arsonval movement.
- In this case the current causes the deflection of meter.
- The current required to cause the full scale deflection of a meter is termed as full scale deflection current. It is denoted by I_{fsd}.
- The basic dc voltmeter is as shown in figure.
- The basic meter can be converted into dc voltmeter by adding a series resistance. This series resistance is called as multiplier.
- The function of this resistance is to control the current passing to the meter.
- It does not allow the current to exceed the value of full scale deflection current. This series resistance is denoted by R_s.
- The dc voltmeter is used to measure the voltage drop between two points in a dc circuit.

- To measure the dc voltage, the voltmeter is connected to these two points with proper polarity.
- We can write, $V_{in} = I_{fsd} (R_s + R_m)$

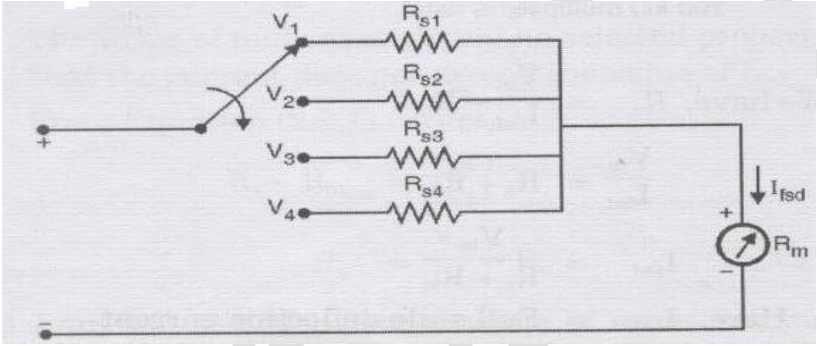
Here, I_{fsd} = Full scale deflection current.

R_s = Series resistance (multiplier)

R_m = Internal resistance of meter.

V_{in} = Input dc voltage.

To convert the basic dc voltmeter into the multirange voltmeter, the number of series resistances (multipliers) are used.

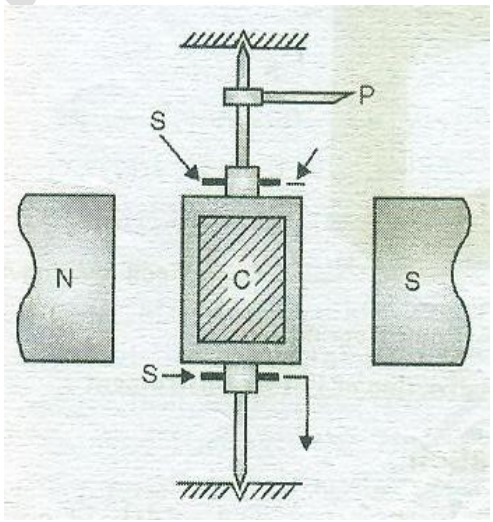


Rs1 , Rs2, Rs3, Rs4, are four series multipliers.

Rs1 = (V1/Ifsd)-Rm, Rs2 = (V/Ifsd)-Rm

iii) Draw the PMMC movement and explain its working principle. State the equation for torque developed by PMMC movement.

Ans : **(2)**



Working principle - **(1)**

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.

The PMMC instrument is most accurate type instrument for d.c. measurement. The working principle of PMMC is same as the D'Arsonval movement. If a current conductor is placed in permanent magnetic field perpendicular to it, then a force is experienced by a conductor which is proportional to the magnitude of current.

Deflecting torque equation: **(1)**

1. Let length of coil be 1 meter and width of coil be d meter. Assume I is the current flowing in coil having N turns. Assume B as the flux density in the air gap.

   Then, $F = BIL(N)$

   Torque on each side of coil = F x d/2

   Total torque = 2 [BIL N . d/2] = BIL d N … Newton-meter

2. For a given instrument, B, L, d and N are constants.

   Therefore, $T_{deflecting} \alpha I = G I$ (say)

   Where G = B.L.d.N

   Controlling torque = T_c

   = $C . \theta$

   Where C = control spring constant in N-m/rad

   θ = deflection of coil from zero position.

3. For steady state, the controlling torque is equal to the deflection torque

   Therefore, $T_c = T_d$

   i.e. $C \theta = GI$

   Therefore, $\theta \alpha I$

Q2. Attempt any FOUR of the following **(16)**

a) What is meant by primary standard and secondary standard ?

Ans : **Primary standards** : **(2)**

- They are highly accurate and can be used as ultimate reference standards.

- These standards are maintained by the NBSC (National Bureau of Standards) in different parts of the world.
- They are not available outside the national laboratories.
- The main function of the primary standards is the verification and the calibration of secondary standards.

Secondary standards : **(2)**

- Secondary standards are the basic reference standards used in the laboratories.
- These are the highest level of standards that a manufacturer has.
- Each industry has its own standards. The particular industry that maintains the secondary standards is responsible for the calibration of these standards.
- The secondary standards are periodically sent to the national standard laboratories for calibration and comparison against primary standards.

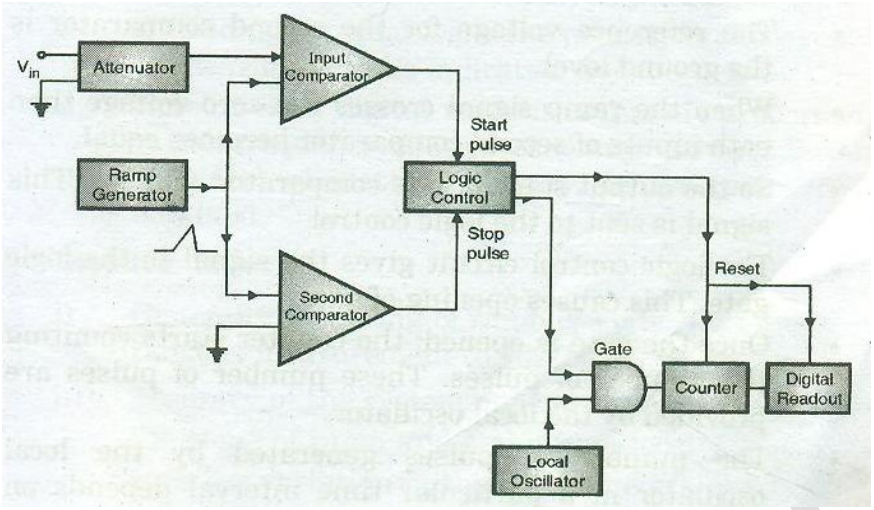
b) Why ammeter is never connected across a source of emf ? Justify your answer.

Ans : **(4)**

- While connecting an ammeter across the emf source always a series resistance should be used. This is necessary to limit the current passing through the meter. If this is not used then the meter movement may be damaged. This is because, the meter is having a small internal resistance. So it may draw a very high current from the emf source.
- The polarity of the meter should be first observed and then it should be connected accordingly. The reverse polarity may damage the pointer of meter.
- When using a multirange ammeter, first use the highest current range and then go on decreasing the range until a good upscale reading is obtained.

c) Explain the working of Linear Ramp type DVM.

Ans : **(2)**



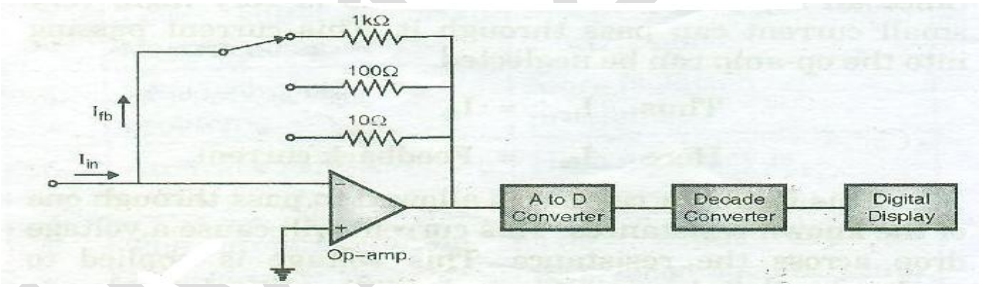
Working : **(2)**

- Unknown voltage to be measured is applied to the input side.
- Initially the logic circuit sends the reset signal to the counter and digital readout.
- Before the starting of measurement the counter and digital readout are resetted.
- The ramp generator, generates the ramp wave. This ramp may be positive going or negative going. Consider a positive going ramp. This ramp signal is applied to both the comparators.
- Here each comparator is designed in such a way that when both the input signals of a comparator are equal then the comparator changes its state. That means when both input signals are equal then the output voltage swing of a comparator takes place.
- In this system, one comparator is used to open the gate while other comparator is used to close the gate.
- In this case we have considered a positive going ramp pulse.
- The reference voltage for the second comparator is the ground level.
- When the ramp signal crosses the zero voltage then both inputs of second comparator becomes equal.
- So the output stage of this comparator changes. This signal is sent to the logic control.
- The logic control circuit gives the signal to the logic gate. This causes opening of gate.
- Once the gate is open; the counter starts counting the number of pulses. These number of pulses are provided by the local oscillator.

- The number of pulses generated by the local oscillator in a particular time interval depends on the frequency of local oscillator.
- The ramp signal is applied to both comparators. One input terminal of first comparator is connected to the input unknown voltage.
- When the ramp voltage becomes equal to input unknown voltage; then both input signals of first comparator are equal. So the output stage of this comparator changes.
- Now the signal from logic control circuit is used to close the gate.
- Once the gate is closed, the number of pulses will stop passing to the counter. So the counter will stop the counting operation.
- During the time interval between opening and closing of the gate; a definite number of pulses will be counted by the counter.
- This number is displayed by the digital readout.

d) Draw the block diagram of basic digital multimeter and explain its working.

Ans :



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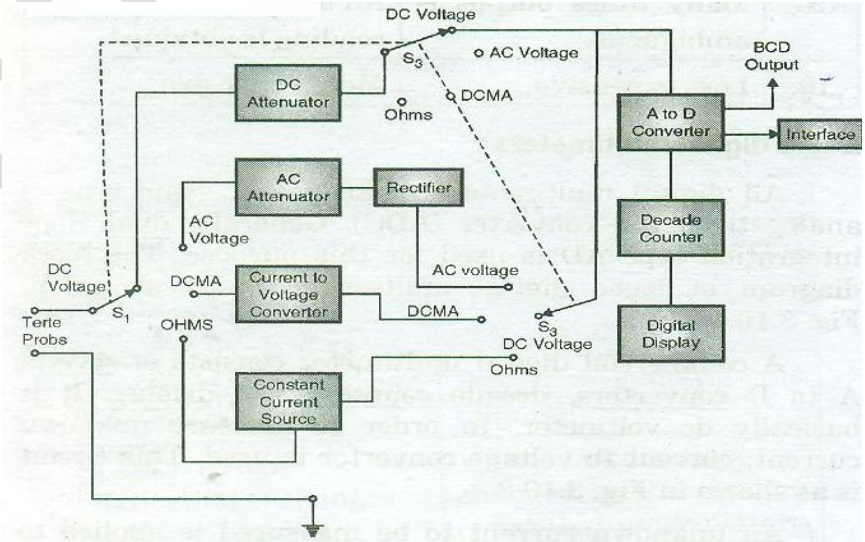


Working- **(2)**

An unknown current to be measured is applied to one of the input terminals of op-amp. Let this input is. Since an input impedance of op-amp is very high; very small current can pass through it. This current passing into the op-amp can be neglected.

Thus Iin = I_{fb}

Here I_{fb} = Feedback current.

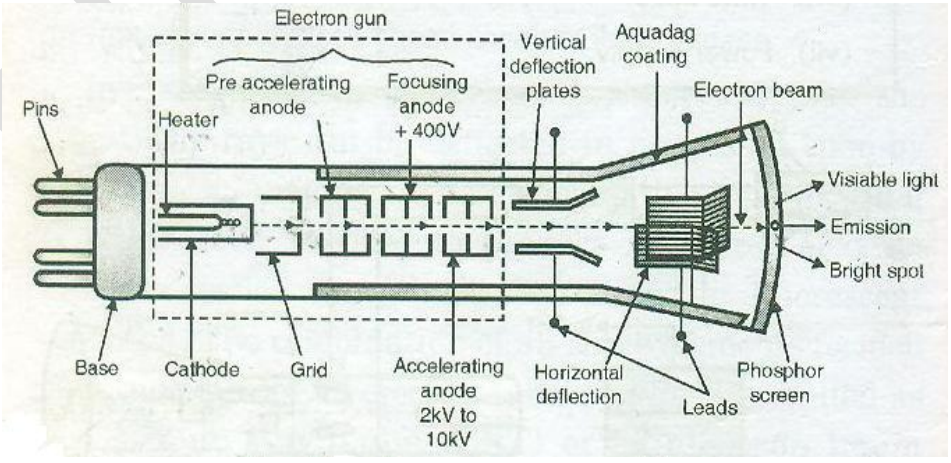
This feedback current is allowed to pass through one of the known resistances. This current will cause a voltage drop across the resistance. This voltage is applied to analog to digital converter and finally digital display is obtained. Thus output displayed on the digital display is directly proportional to unknown current.

In order to measure an unknown resistance; a constant current source is used. The current from this constant current source is allowed to pass through unknown resistance. Thus the proportional voltage is obtained. The output display is directly proportional to unknown resistance.

To measure the ac voltage; a rectifier and filter is used. This rectifier converts ac signal into dc signal. Now this dc signal is applied to A to D converter and to the digital display. The BCD output can be obtained from A to D converter. Similarly the output from digital multimeter can be used to interface with other equipments.

e) Draw a neat and labeled diagram of CRT. State which material is used for coating on fluorescent screen ?

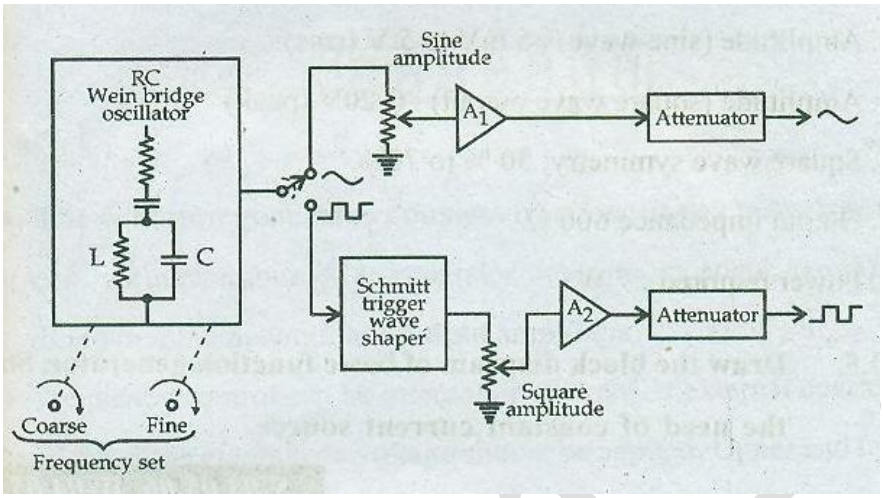
Ans : CRT **(3)**



An inner side of the screen is coated with phosphor. This consists of pure crystals of phosphor. **(1)**

f) Draw the labeled block diagram of AF sine wave and square wave generator. Describe its operation.

Ans : **(2)**



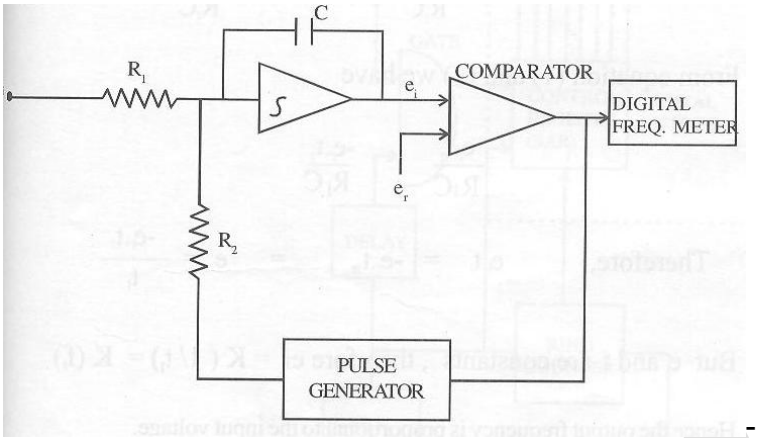
(2)

- It uses Wien bridge oscillator because it is best for audio frequency range.
- The frequency of signal generated by Wien bridge oscillator can be changed by varying the capacitance.
- The block diagram of AF sine, square wave generator is shown in figure.
- The signals are either given to the sine wave amplifier or Schmitt trigger.
- The amplifier A_1 can amplify the signal and then feed to attenuator which adjusts the strength of signal at the output.
- The Schmitt trigger can change the shape of signal from sine wave to square wave, which is amplified by amplifier A_2. Then the amplified signals are passed through the attenuator.
- Here the function of attenuator is to provide constant output impedance.
- The offset variation and duty cycle variation facilities also can be added into the design.

3. Attempt any four of the following: **(16)**

(a) Draw the block diagram of integrating type DVM & explain its working.

Ans:- **(2)**

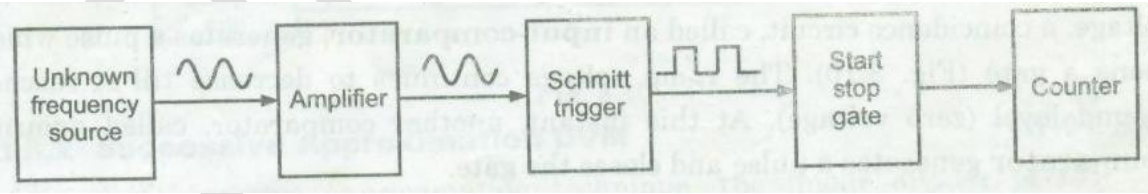


Working- **(2)**

The block diagram of the Integrating type Digital Voltmeter is shown in fig. Referring to fig. the input voltage produces a charging current given by ei/R1, which charges the capacitor to the reference voltage er is reached, the comparator changes state & triggers a precision pulse generator. The pulse generator produces a pulse of precision charge content that rapidly discharges the capacitor. The rate of charging and discharging produces the signal frequency, which is proportional to the input voltage ei, and voltage is converted to frequency.

(b) Explain how frequency is measured with the help of digital frequency meter?

Ans:- **(2)**



(2)

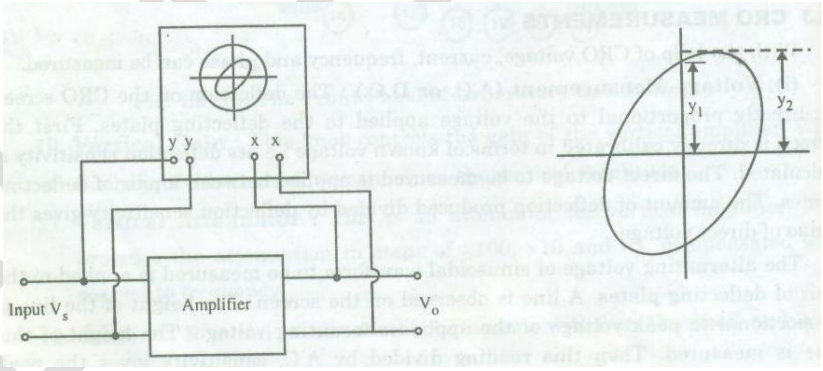
The signal whose frequency is to be measured is converted into a train of pulses, one pulse for each cycle of the signal. Then the number of pulses spearing in a definite interval of time is counted by means of an electronic counter. Since, the pulses represent the measure of unknown signal, the number appearing on the counter is a direct indication of frequency of unknown signal. Since the electronic counters are extremely fast, the frequency of high frequency signals may be known.

The block diagram of the basic circuit of a digital frequency meter is shown in fig. The unknown frequency source is connected to the input terminal of digital frequency meter. It is first amplified by the amplifier and then it is fed to the next stage known as Schmitt trigger. In a Schmitt trigger, the signal is converted into square wave with very fast rise and fall times, then differentiated and clipped. As a result, the output from Schmitt trigger is a train of pulses, one pulse for each cycle of the signal. The output pulses from the Schmitt trigger are fed to start/stop gate, When this gate is open (start), the input pulses pass through this gate and are fed to an electronic counter which starts registering the input pulses. When the gate is closed (stop), the input of pulses to counter cease and it stops counting. The counter displays the number of pulses that have passed through it in the time interval between start and stop.

If this interval is known, the pulse rate and hence frequency of the input signal can be known. Suppose 'f' is the frequency of unknown signal, 'N' is the number of counts displayed by counter and 't' is the time interval between start and stop gate, frequency of unknown signal f=N/t. The counter directly displays the frequency of the input signal, when its output is fed to readout/display.

(c) Explain how phase can be measured on CRO using Lissajous figures?

Ans:- **(2)**



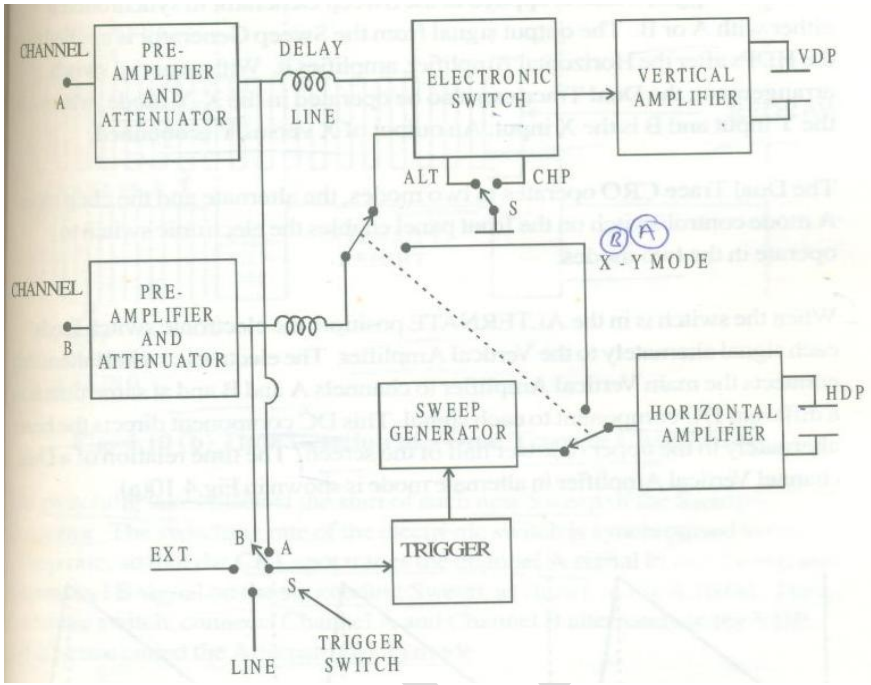
(2)

The oscilloscope can be used for the measurements of phase shift. Consider an example of measuring a phase shift in the case of amplifier as shown in fig. Apply, Vs and adjust vertical gain to give some convenient height to Vs. Then apply Vo and temporarily disconnect Vs. Then adjust horizontal gain for same width in cm as Vs
adjusted vertically. Then reapply Vs, the resulting display will be an ellipse or a straight line. When the phase shift is 0° or 360° or 180° we get a sloping line, whereas in other cases an

ellipse is obtained as shown in fig. Then sin θ = Y1/Y2, where θ is angle of phase shift OR θ = 1/ sin (Y1/Y2).

(d) Draw the labeled block diagram of dual trace oscilloscope and explain its working.

Ans:- **(2)**



Dual trace CRO:- **(2)**

The dual trace CRO consists of one electron gun, an electronic switch which switches the two signals to a single vertical amplifier and a single pair of horizontal deflection plates, as compared to a dual beam CRO.

The block diagram of a Dual Trace CRO is shown in fig. It consists of a single electron gun, whose electron beam is split into two by an electronic switch. There is one control for focus and another for intensity. The two signals are displayed simultaneously.
The signals pass through identical vertical channels or vertical amplifiers. Each channel has its own calibrated input attenuator and positioning control so that the amplitude of each signal can be independently adjusted.

As shown in fig., two channels A and B are used. Signals from A and B are applied through a pre-amplifier and attenuator, which brings the signal within an acceptable level for amplification. It is then passed through a delay line, to delay the signal to the vertical section so that the sweep or the horizontal section can start well in advance. The output from both channels A and B are applied to an electronic switch, which operates in two modes, alternate and chop mode. In the alternate mode, signals from the two channels are applied alternately

to the VDP and in the chop mode, small segments of the signal from the two channels are applied alternately to a single pair of VDPs.

The dual trace CRO operates in two modes, the alternate and the chop mode. A mode control switch on the front panel enables the electronic switch to operate in two modes.

When the switch is in the ALTERNATE position, the electronic switch feeds each signal alternately to the vertical amplifier. The electronic switch alternately connects the main vertical amplifier to channels A and B and at same time adds a different DC component to each signal. This DC component directs the beam alternately to the upper or lower half of the screen.

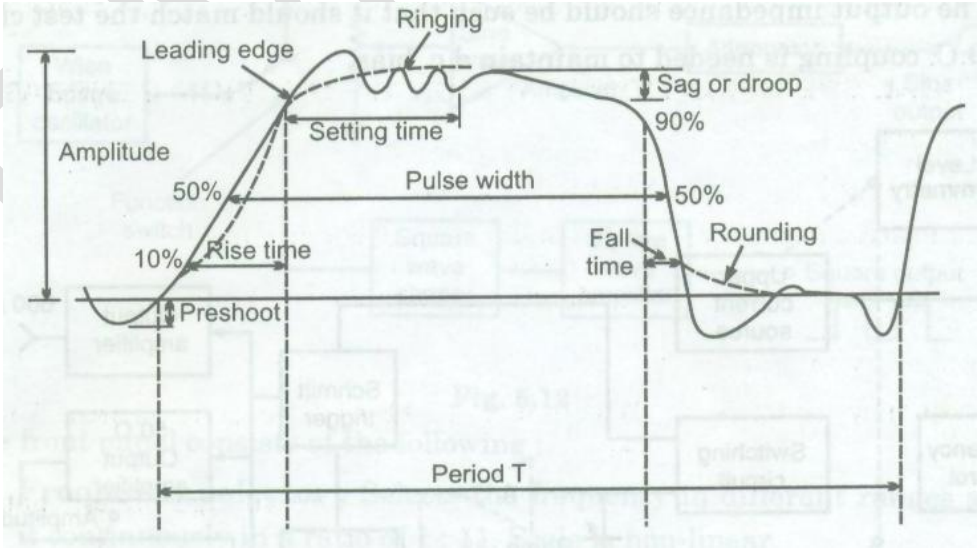
When the switch is in the CHOP mode position, the electronic switch is free and running at the rate of 100-500 KHz, entirely independent of the frequency of the Sweep Generator. The switch successively connects small segments of A and B waveforms to the main vertical amplifier at a relatively fast chopping rate of 500 KHz.

In the X-Y mode of operation, the Sweep Generator is disconnected and channel B is connected to the Horizontal Amplifier. Since both pre-Amplifier are identical & have the same delay time, accurate X-Y measurements can be taken.

(e) Draw the characteristics of the pulse generator & define.

(i) Rise time (ii) Fall time (iii) Droop (iv) overshoot

Ans:- **(2)**



(2)

(i) **Rise time**:- The time required for the pulse to reach from 10% to 90% of it's amplitude, is called Rise time.

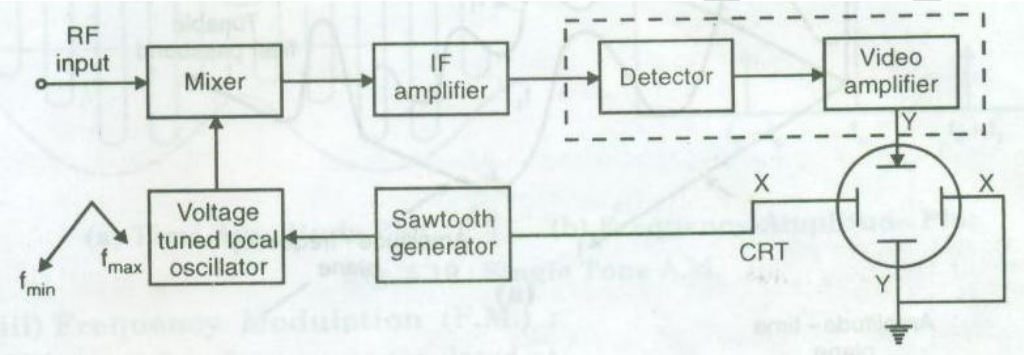
(ii) **Fall time**:- The time required for the pulse to reach from 90% to 10% of it's amplitude.

(iii) **Droop**:- Fall in pulse amplitude with time.

(iv) **Overshoot**:- overshoot occurs on rising and falling edges when waveforms exceeds the desired value.

(f) Draw the block diagram of spectrum analyser & explain its operation.

Ans: **(2)**



Basic Spectrum Analyser:- **(2)**

The basic spectrum analyser is specially designed to represent graphically, a plot of amplitude versus frequency of a selected portion of the spectrum under consideration. The modern spectrum analyser basically consists of narrow band super heterodyne receiver and a CRO. The receiver is electronically tuned by varying the frequency of the local oscillator. A simplified block diagram of swept frequency spectrum analyser in shown in fig.

The circuit incorporates a saw-tooth generator which supplies a ramp voltage to the frequency control elements of the voltage tuned local oscillator. Then local oscillator sweeps through its frequency band at a recurring linear rate. The same saw tooth voltage is simultaneously applied to the horizontal plates of the CRO. The RF signal to be tested is applied to the input of the mixer stage.

The saw tooth generator makes the local oscillator, sweep, through its frequency band to 'beat' with input signal and produce the desired Intermediate Frequency (I.F.).

An IF component is produced only when the corresponding component is present in the RF signal. The resulting IF signals are amplified and then detected. After detection it is amplified by video amplifier and then applied to the vertical deflection deflection plates of the CRO thereby producing a display of amplitude Vs. frequency on the screen.

4. Attempt any Four (16)

a) State any two types of systematic error. Give its source of generation.

Ans:- Systematic Error:-

This type of error is usually divided into two different categories:

(i) Instrumental error:- **(2)**

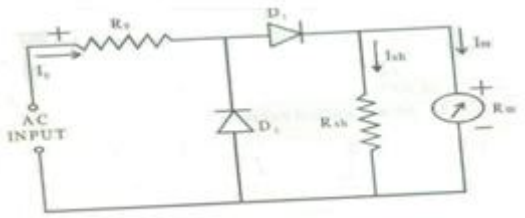
It is defined as inherent short comings of the instrument. Instrumental errors are errors inherent in measuring instruments because of their mechanical structure. For example, in the d'Arsonval movements friction in bearings of various moving components may cause incorrect reading. Irregular spring tension, stretching of the spring or reduction in tension due to improper handling or overloading of the instrument will result in errors. Other instrumental error are calibration errors, causing the instrument to read high or low along its entire scale (failure to set the instrument to zero before making a measurement has a similar effect).

(ii) Environmental Error:- **(2)**

It is occurred due to external conditions affecting the measurements. Environmental errors are due to conditions of external to the measuring device including conditions in the area surrounding the instrument such as the effects of changes in temperature, humidity, barometric pressure or of magnetic or electrostatic fields. Thus, a change in ambient temperature at which the instrument is used causes a change in the elastic properties of the spring in a moving coil mechanism and so affects reading the instrument. Corrective measures to reduce these effects include air conditioning hermecally sealing contain components in the instrument use of magnetic shields and the like.

b) Draw & explain the circuit of rectifier type AC voltmeter.

Ans: **(2)**

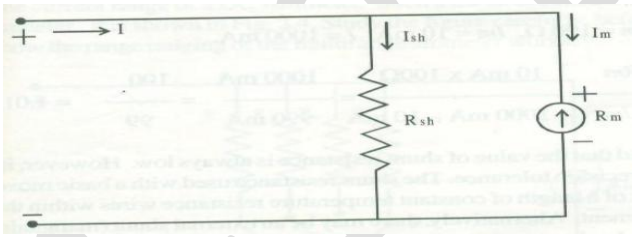


(2)

The general rectifier type AC voltmeter arrangement, using a half-wave rectifier is shown in fig. Analyze the figure carefully. Diode 'D1' is used as a rectifier which conducts during positive half of the input cycle and causes the meter to deflect according to the average value of this half cycle. Resistor Rsh, in order to draw more current through the diode 'D1' and move the operating point into the linear portion of the characteristics curve, shunts the meter movement. In the negative half cycle, diode 'D2' conducts and the current through the measuring circuit, which is in the opposite direction, bypasses the meter movement. The rectifier used, provides a half wave output due to the inertia of the movable coil. The meter indicates the steady deflection, proportional to average value of the current. The meter scale is usually calibrated to give RMS value of an alternating sine wave input.

c) Derive the equation for shunt resistance "Rshunt" for basic DC ammeter.

Ans:- **(2)**



(2)

The PMMC galvanometer constitutes the basic movement of DC ammeter. Since, the coil of a basic movement is small and light, it can carry only very small currents. When large currents are to be measured, it is necessary to bypass a major part of the current through a resistance called a Shunt. This is illustrated in fig.

The resistance value of the Shunt can be calculated using circuit analysis.

Referring to Fig.,

Rm = internal resistance of the movement

Ish = shunt current

I = total current (*Im* + *Ish*)

Im = full scale deflection current of the movement

Rsh = shunt resistance

Since, the resistance is in parallel with the meter movement, the voltage drop across the shunt and movement is the same.

Vsh = Vm

Ish . Rsh = Im . Rm

But, *Ish = I – Im*

(*I – Im*) *Rsh = Im . Rm*

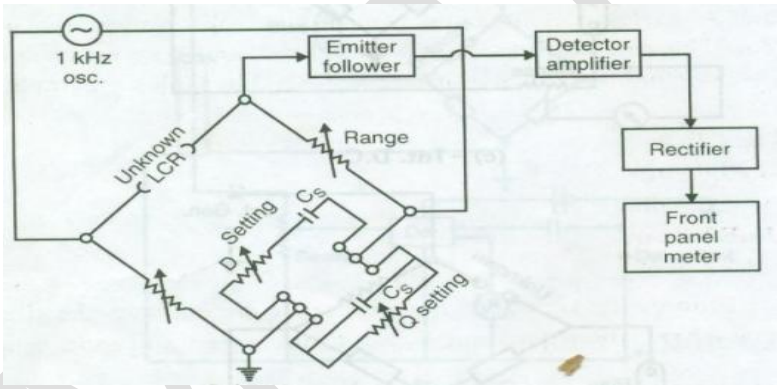
Rsh = Im . Rm / Ish

$$Rsh = Im \cdot Rm / (I - Im)$$

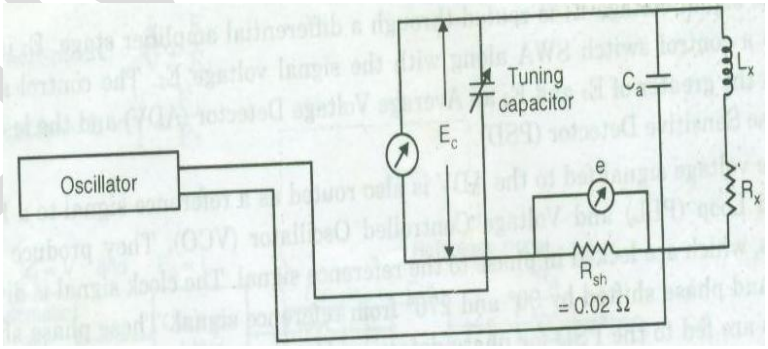
For each required value of full-scale meter current we can determine the value of shunt resistance.

d) Explain how LCR-Q meter is used to measure quality factor of passive components with diagram.

Ans:- **(2)**



OR



(2)

The Q-meter is an instrument used to measure some electrical properties of coils and capacitors. The operation of this useful laboratory instrument is based on the familiar characteristics of a series-resonant circuit, namely that the voltage across the coil or the

capacitor is equal to Q times the applied voltage of the circuit (where Q is the ratio of reactance to resistance, XL/R). If a fixed voltage is applied to the circuit, a voltmeter across the capacitor can be calibrated to read Q directly.

The voltage & current relationship of a series-resonant circuit is shown below.

At resonance, the following conditions are valid:

$$Xc = XL$$

$$Ec = I \cdot Xc = I \cdot XL$$

$$E = I \cdot R$$

$$EL = I \cdot XL$$

Where, E = Applied Voltage

I = Circuit Current

Ec = Voltage across the capacitor

EL = Inductive voltage

Xc = Capacitance reactance

XL = Inductive reactance

R = Coil voltage

$$Q = XL/R = Xc/R = Ec/E$$

In order to take measurement, the unknown coil is connected to the terminals of the instrument and the circuit is tuned to resonance by varying C until the electronic voltmeter gives maximum value. E (resonance output voltage) corresponding to Ec is,

$$E = Q * e$$

i.e., $\boxed{Q = E/e}$

Since, e is known, we can read the Q value directly on the electronic voltmeter.

e) Draw the block diagram of digital storage oscilloscope (DSO) with labels.

Ans: **(4)**

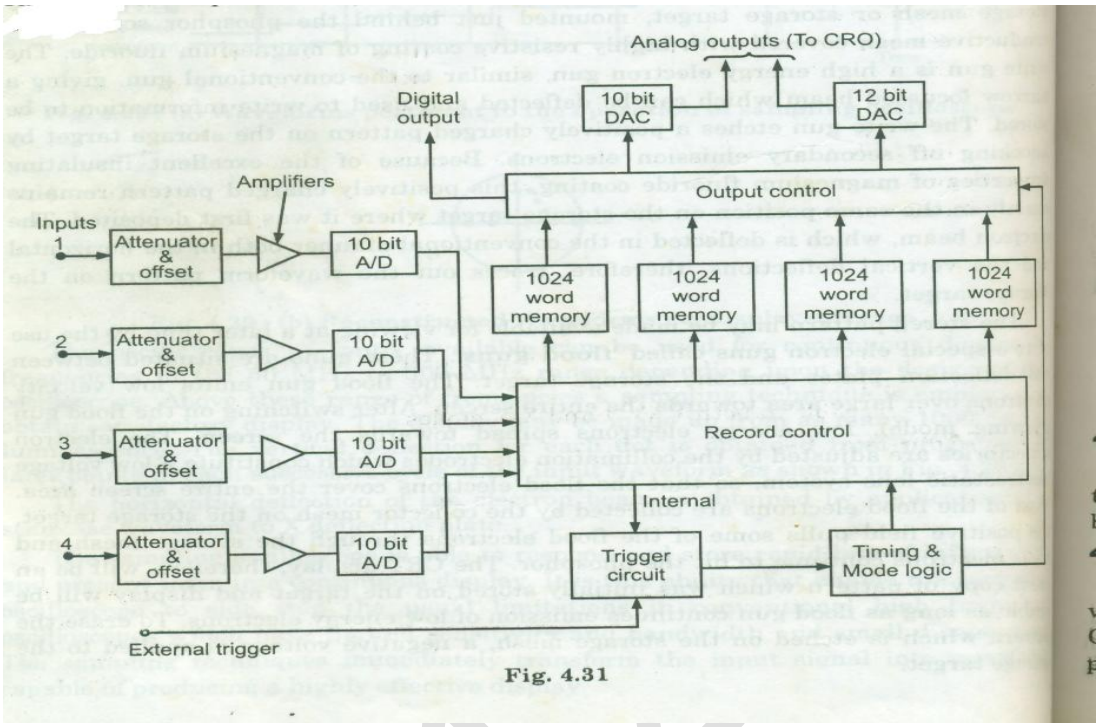
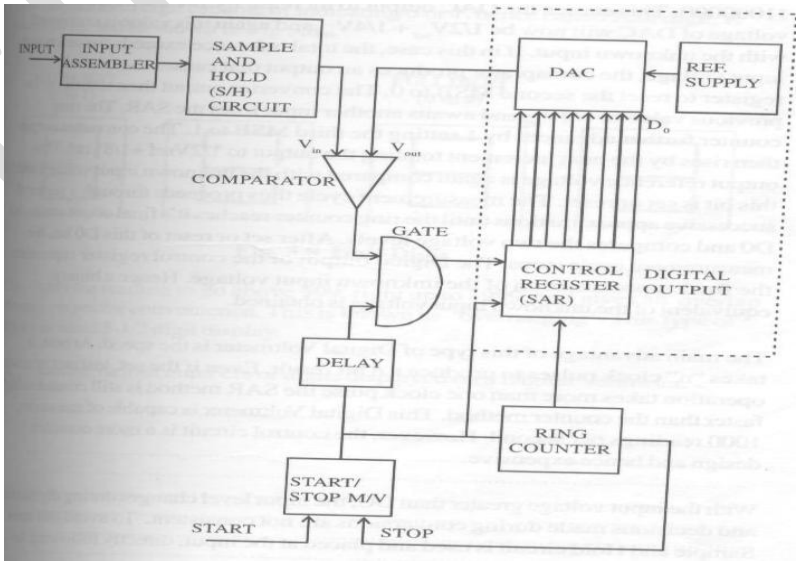


Fig. 4.31

5. Attempt any <u>TWO</u> of the following: **(16)**

a. Draw and explain the block diagram of successive approximation DVM. Why it is called so?

Ans. **(3)**



Explanation:- **(3)**

1) Input signal is applied to Input amplifier & attenuator section. The Input section is then amplified & attenuated as that in conventional oscilloscope. The signal is then applied to vertical amplifier.
2) The Output of vertical amplifier is connected to A to D converter.
3) Successive type A to D convertor is used.
4) Digitalizing the analog signal means to take samples of the input signal at period intervals of time.
5) The memory size is related to the amount of horizontal segments of the trace that can be divided into one sweep of the time base.
6) If 10bit ADC is used then frequency response of 25 KHz is obtained. The total memory storage capacity is 4096 for single CH, 2048 for two CH, 1024 for four channels.
7) The continuous storage oscilloscope consists of a feature called pritrigger view.
8) Three mode of operation:-
    a) Roll Mode: Used to observe the fast varying signal.
    b) Store mode: It is called as refresh mode.
    c) Hold or save mode: New contents can be over write by old contents automatically.

Working:-

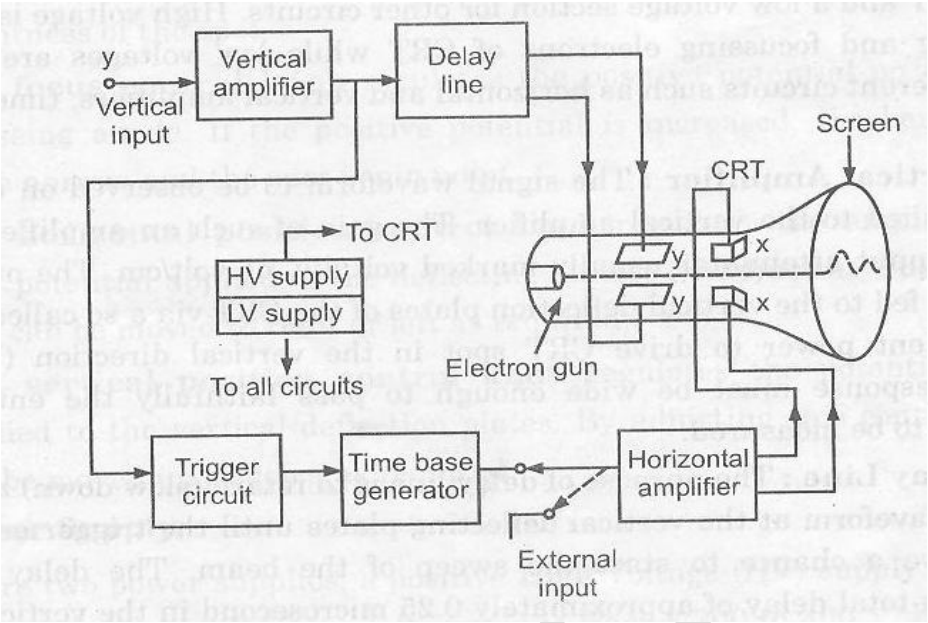
1. At start, start pulse is given to multivibrator.
2. This set in MSB of control register & 0 in all bits. Its reading would be 1000 0000.
3. This causes DAC O/P to be half of regulated voltage.
4. This O/P is compared with unknown I/P to comparator.
5. If I/P voltage is greater than DAC O/P the comparator produces a O/P that causes control register to retain the 1 in MSB & converter continuous to supply its reference O/P voltage of $V_{ref.}$
6. The ring counter then advances one count, shifting a '1'and 2^{nd} MSB of the SAR & again comparison has been made.

(2)

It is **called as Successive approximation type DVM** 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 .

b) Draw the block diagram of basic CRO. Explain the function of each block of Horizontal deflection system of CRO.

Ans: **(4)**



(4)

Time base Generator:

- A time base generator is used to generate the saw tooth voltage required to deflect beam in the horizontal section. The circuit used to generate the saw tooth is called the continuous sweep generator. But the disadvantage of the sweep generator is that, it cannot follow the variations of fast varying signals, like voice signals or music signals. Hence this circuit has to be modified. The modified circuit is called the triggered Sweep Generator. The timing circuit of the time based generator gives the time/div control on the front panel.

Horizontal Amplifier:

- The Horizontal amplifier is used to amplify the saw tooth voltage, before it is applied to the horizontal section. The block consists of a push- pull amplifier

Trigger circuit:

- A trigger circuit is used to convert the incoming signal into trigger pulses, so that the input signal and the sweep frequency can be synchronized.

- The trigger circuit is activated by signals of a variety of shapes and amplitudes, which are then converted to trigger pulses of uniform amplitude, for the precision sweep operation.

The signal in the horizontal section has to pass through the trigger circuit, time base generator, horizontal amplifier before it finally reaches the Horizontal Deflection Plates (HDP).

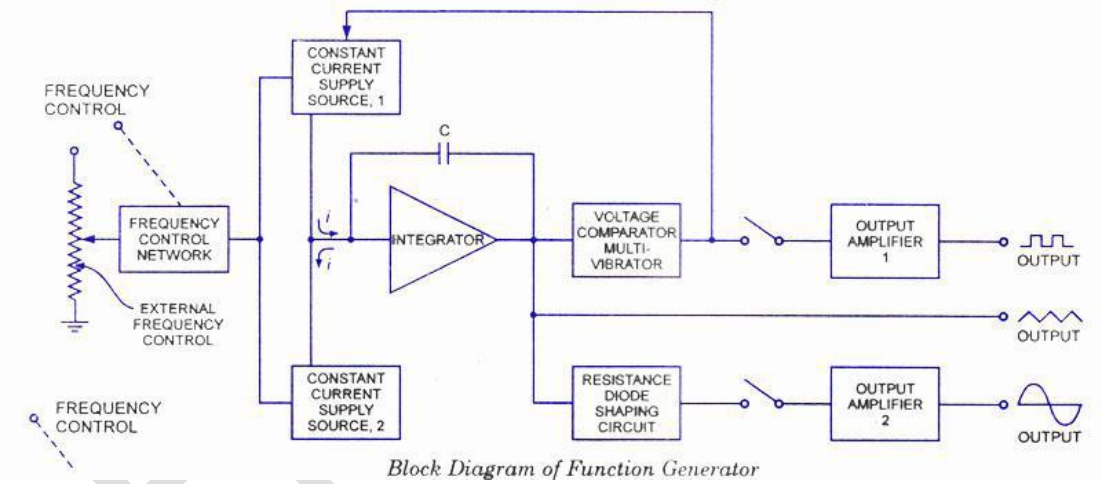
c) . Explain how function generator is different from signal generator? And how it is operates?

Ans Difference between Function generator and Signal Generator – **(2)**

In signal generator, varying the capacitance of the LC or RC circuit usually varies the frequency.

But in function generator, the frequency is varied by changing the magnitude of current, which drives the Integrator.

(3)



Block Diagram of Function Generator

Explaination— (3)

- A Function generator produces different waveforms of adjustable frequency. The frequency is adjustable from a fraction of a Hertz to several hundred KHz. The most common output waveforms produced by a function generator are sine, square, triangular and saw tooth.
- Varying the capacitor controls the frequency in a LC or RC circuit. In this instrument varying the magnitude of current, which drives the integrator, controls the frequency. The instrument produces sine , triangular and square waves with a frequency range of 0.01 Hz to 100 KHz.

- The frequency controlled voltage regulates two constant current sources. The upper current source supplies constant current to the integrator. The output voltage of the integrator increases linearly with time, according to the equation of the output signal voltage given $C_{out} = - 1 /C$
- An increase or decrease in the current increases or decreases the slope of the output voltage, which in turn controls the frequency.

  The voltage compartor multivibrator changes state at a predetermined maximum level of the integrator output voltage. This output from the voltage comparator is also applied simultaneously to the constant current source. As soon as this change in the voltage of the compartor occurs, the upper current source is cut off and lower current source is switched on.

  The lower current source supplies a reverse current to the integrator, the capacitor starts charging in the opposite direction and since the capacitor is already charged, the voltage across starts neutralizing and hence the capacitor output voltage decreases linearly with time. When the output reaches a predetermined minimum level, the voltage comparator again changes state and switches on the upper current source and cuts off the lower current source.

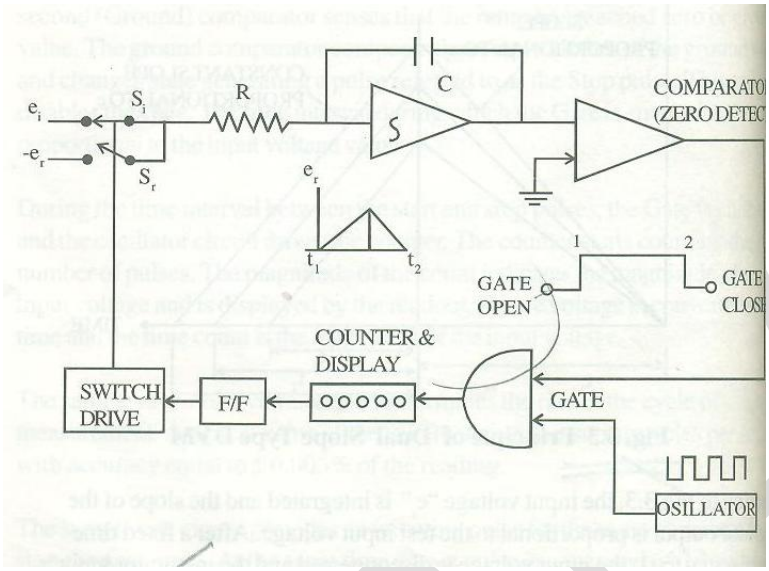
  The output of the integrator produces a triangular waveform, whose frequency is determined by the magnitude of the current, supplied by the constant current source.

  A comparator output delivers a square wave voltage of the same frequency. The resistance diode network alters the slope of the triangular wave as its amplitude changes and produces a Sine wave with less than 1% distortion.

6.Attempt any FOUR of the following: **(16)**

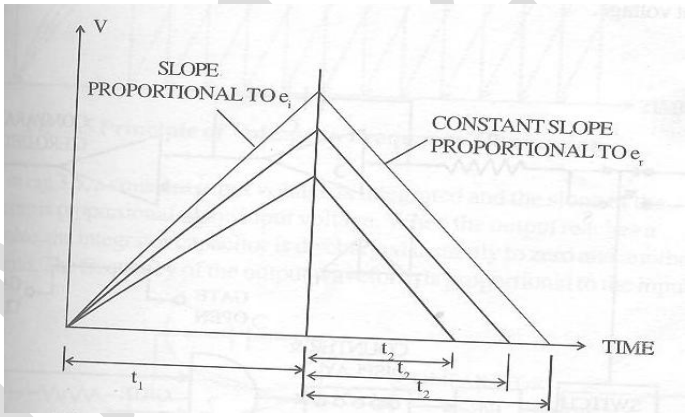
a. Draw labelled block diagram of dual slope type DVM and its voltage V/s time graph.

Ans: **(2)**



Dual slope type DVM

(2)



Voltage V/s time graph

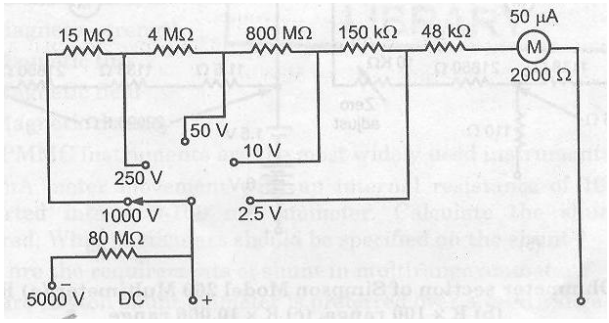
b) State advantages of analog multimeter. Draw DC voltmeter ammeter section of analog multimeter.

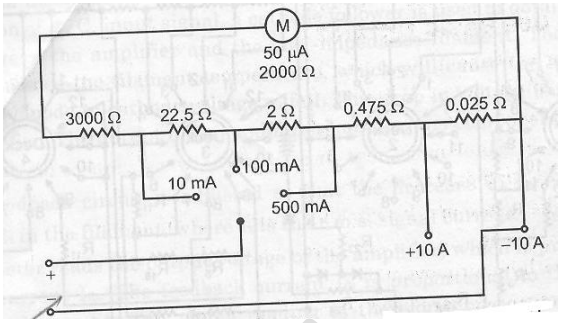
Ans (any two) **(2)**

Advantages of Analog Multimeter:-

- Better visual indications of changes in the readings is obtained.
- Less suffered from electric noise.
- Less Isolation Problems.
- Construction is simple.
- Less Expensive.

- Power supply is not required.





DC Voltmeter Section -- **1M**

DC Ammeter Section – **1M**

c) How much delay is caused by delay line in CRO? Draw practical delay line circuit.

Ans **(2)**

- A delay line is used to delay the signal in the vertical section. The signal in the horizontal has it pass through the trigger pick off circuit, Time Base. Generator and Horizontal amplifier it finally reaches the horizontal deflection plates (HDP).
- The signal therefore takes longer to reach the HDP as compared to the vertical section.
- The input signal reaches the VDP even before the saw- tooth waveform signal generated by the 'Time base' generator has begun. This gives an error, in which the initial portion of the input signal is lost.
- The distortion can be overcome by using a delay line in the vertical section.
- The time taken for the signal to pass through the horizontal section is 80ns.
- The delay line used has a delay of 200ns so that the horizontal sweep signals start in time. The loss of the initial signal is totally overcome.

(2)

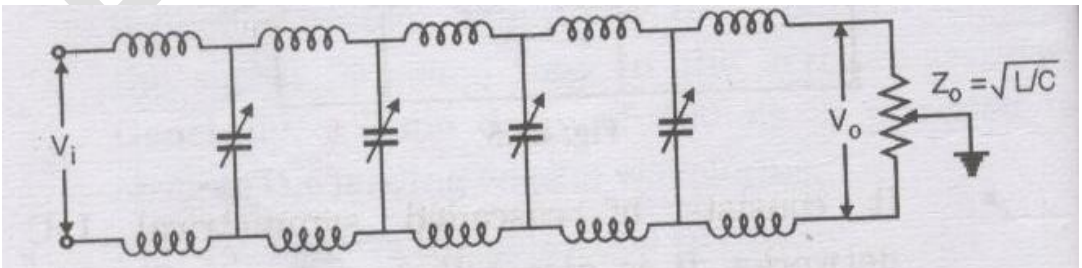
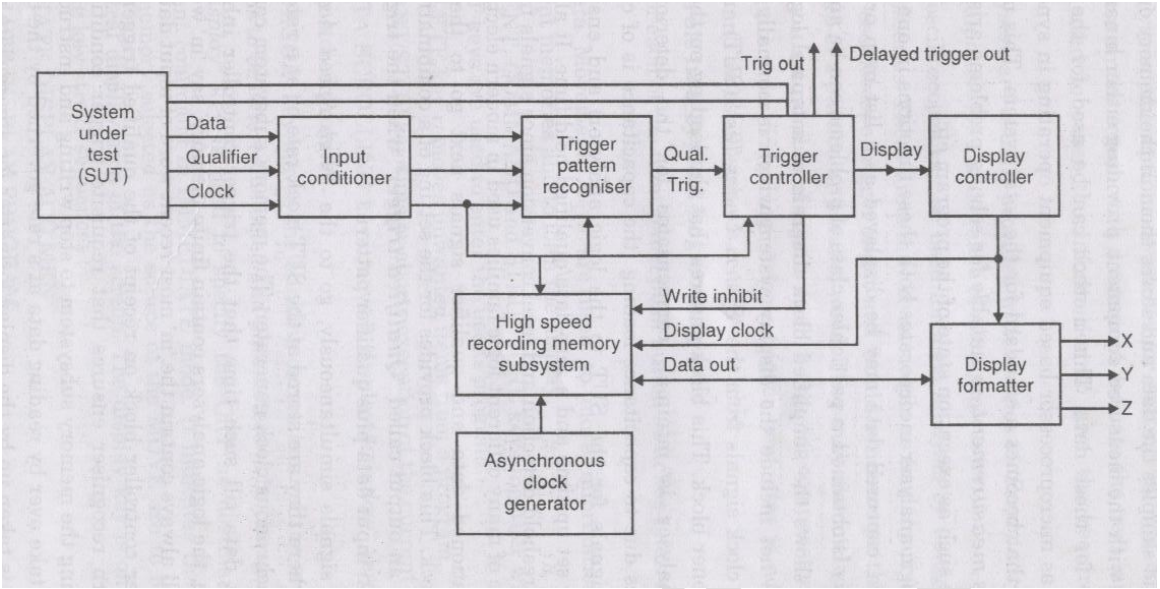


Fig. : Practical delay line circuit

d) . Draw the block diagram of Logic Analyzer. Explain its operation.

Ans: **(2)**



(2)

Data qualifier and clock signals from the system under test (SUT) are received at the input conditioner block. This block ensures that the loading on the SUT because of the logic analyser is minimal, compensates that the loading on the SUT because of characterisitcs due to capacitance loading (the capacitance is of cable carrying the high speed signals for the SUT to the logic analyser) and ensures a minimum data/ qualifier set up time and zero data/ qualified hold time. It also carries out the function of threshold detection and level conversion since signals from the SUT may confirm to one of many different logic families used in modern electronic equipment.

The conditioned data and qualifier signals next go the 'trigger pattern recognizer' block. This block provides for the setting of a combinational trigger word and produces an output called "Qualified trigger" when the trigger word pattern set matches an input data plus qualifier pattern.

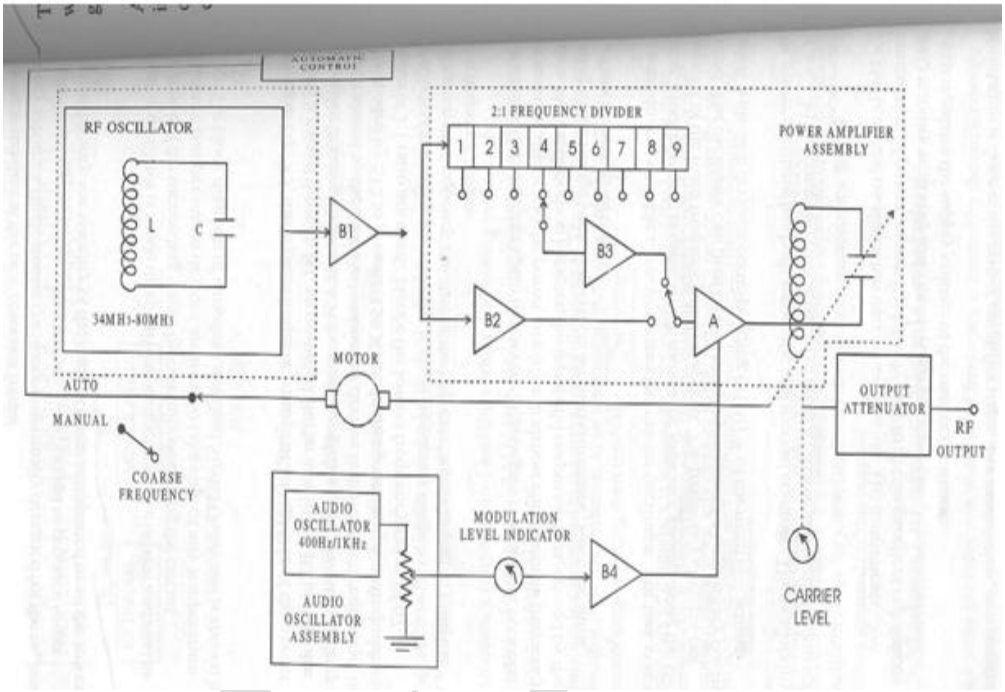
The data signals simultaneously, go to the "High Speed Acquisition Memory Subsystem" where they are stored at the SUT clock or at a rate governed by the internal Asynchronous clock generator. The memory subsystem continuously writes (stores) input data till such time that the trigger controller inhibits the writing process. Since, the logic analysers contain finite memory, say 'm' words, the memory subsystem will always contain the 'm' most recent word of input data.

The trigger controller block on receipt of the qualified trigger signal from the trigger pattern recognizer ensures that requisite trigger conditioners are satisfied before signaling the

memory subsystem to stop writing and instructing the "Display Controller" to take over by reading data at a rate governed by the display formatter for appropriate representation on the CRT screen.

e) Draw the block diagram of Modern signal generator.

Ans: **(4)**



f) List out any four front panel control of basic CRO with their functions.

Ans **(Any four)** **(4)**

- **Intensity**

  It controls the magnitude of the electron beam that is varying the cathode to grid bias voltage of the CRT. As a result, the electron emission is varied, which in turn changes the intensity. This achieved with a 500KΩ potentiometer.

- **Focus**

  Focus is the term used for concentrating the beam within itself to obtain a sharp electron beam and a sharp trace on the CRT screen.

  The focusing anode potential is adjusted with respect to the first and final accelerating anodes. This anode by varying the 2MΩ potentiometer. It adjusts the negative voltage on the focus ring between- 500V and 900V.

- **Astigmatism**

Astigmatism adjusts the voltage on the acceleration anode with respect to the VDP on the CRT. It forms a cylindrical lens that corrects any defocusing that might be present. This adjustment is made to obtain the roundest spot on the screen.

- **X- Shift or Horizontal Position Control**

  The X position of the spot is adjusted by varying the voltage between the Horizontal plates. When the spot is in the center, the two horizontal plates have the same potential.

- **Y- shift or vertical position Control**

  The Y position of the spot is adjusted by varying the voltage between the vertical plates. When the spot is in the centre, the two vertical plates have the same potential.

- **Time Base Control**

  This is obtained by varying the capacitor C_T and resistor R_T of the time base generator.

- **Amplitude Control**

  Amplitude control is used to change the amplitude of the input and is expressed in V/div.

- **Sync Selector**

  A sync selector, with the use of INT- EXT- LINE switch, can synchronize the sweep to internal signals from the vertical amplifier, external signals or the line supply.

- **Trigger Selector**

  The trigger selector is a3 position switch, INT- EXT- LINE and is used to obtain a precision sweep operation.

- **DC- GND- AC**

  DC-GND-AC is a 3 position switch used to adjust the level when DC or AC is measured. To adjust for zero level, the switch has to be in the GND position.