**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 judgment 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.

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**1. A) Attempt any six of the following: [12M]**

**(i) Define transducer**

**Ans:** (Defination 2M)

Transducer is defined as a device which converts energy from one form to another.

**or**

Transducer is defined as a device which is used to convert non-electrical quantity (like temperature, pressure, humidity etc.) into electrical quantity.

**(ii) Differentiate between sensitivity and resolution (Any two points)**

**Ans: ( two points 2M)**

| Sr. No. | Parameter | Sensitivity | Resolution |
|---|---|---|---|
| 1. | Definition | Ratio of change in output of an instrument to the change in the input. | The smallest change in the measured variable to which instrument will respond. |
| 2. | Quantity expressed in terms of | Absolute quantity | Relative quantity |
| 3. | Unit in terms of | In terms of millivolts, micro ohms, or tenths of a degree | As a fraction of an amount to which one can easily relate |
| 4. | Example | Like in Gas chromatography one column can detect minimum1 Nano gram level that is its sensitivity (Or) any suitable example can be considered. | Printer manufacturers often describe resolution as dots per inch. (Or) any suitable example can be considered. |

**(iii)State four applications of CRO. (Four Applications 2M)**
**Ans: (consider any four points)**

1. It is used in laboratory for measurement of AC/DC voltage, current, frequency, phase and study nature of waveform.
2. It is used in TV receiver for creation of images.
3. It is used in radar receiver for giving visual indication of target such as aero plane, ship etc.
4. It is used to test AF circuit for different distortion.
5. It is used to check faulty component.
6. It is used to check signals at radio and TV receiver.
7. It is used to check B-H curve of different ferromagnetic material.
8. It is used in medical equipment such as ECG, patient monitor.
9. It is used to check modulation percentage of modulated wave.
10. It is also used to check radiation pattern generated by antenna.

**(iv)Define flow.**
**Ans: (Defination 2M)**

Flow is defined as fluid in motion. Flow may be of Gas or Liquids.

**(v) State the functions of delay line in CRO.**
**Ans: ( Function 2M)**

The delay line is used in CRO to delay the signal for some time in the vertical sections. As horizontal channel consists of trigger circuit and time based generator. This causes more time to reach signal to horizontal plates than vertical plates. For synchronization of reaching input signal at same time to both the plates in CRT.

**(vi)State the need of function generator.**
**Ans: (Need 2M)**

The generation of signals is an important activity of electronic development and troubleshooting. Therefore a signal generator is a vital electronic instrument in laboratory test setup which provides signals for general test purposes (For eg. Frequency ranges as well as different shapes of waveform). It is used to provide known test conditions for the performance evaluation of various electronic systems and for replacing missing signals in systems being analyzed for repair.

**(vii) State the types of Inductive transducer and mention its uses.**
**Ans: (Types -1/2 mark for each, Uses- consider any two point, 1/2 mark for each point)**

**Types:**
1. Linear Variable Differential Transformer (LVDT).
2. Rotary Variable Differential Transformer (RVDT).

**Uses :**
1. To measure Linear and Angular Displacement.
2. To control thickness of metal sheet.
3. To measure tension in cord.
4. To determine direction of angular Displacement

**(vii) List the transducer selection criteria.**
**Ans** : **(Consider any two points) (Two points 2M)**

1. Operating Range
2. Operating Principle
3. Sensitivity
4. Accuracy
5. Frequency response &resonant Frequency
6. Errors
7. Environmental Compatibilities
8. Usage & Ruggedness
9. Electrical Aspect
10. Stability & Reliability
11. Loading Effect
12. Static characteristics
13. General Selection Criteria

**B) Attempt any TWO of the following. [8 M]**

**(i) Explain working principle of resistive transducer? State its applications.**
**Ans: (Working principle-2M, Applications- 2M, 1M each Application)**

**Working Principle:**

1. The operation of resistive transducer is based on change in resistance due to change in some physical phenomenon. These are the transducers which converts pressure or displacement into equivalent electrical signals i.e. Voltage or current.

2. It is generally seen that methods which involve the measurement of change in resistance are preferred to those employing other principle.

3. This is because both AC as well as DC currents and voltages are suitable for resistance measurements.

4. For eg. Resistance of metal conductor is expressed by a simple equation that involves a few physical quantities. The relationship is

$$R=\rho * L / A$$

Where R= resistance, L=Length of conductor, A= Cross sectional area of conductor & ρ is resistivity of Conductor material.

5. There are many ways in which resistance can be changed by a physical phenomenon like Potentiometer, Stain gauge, thermistor and so on.

**Applications:**

1. Used in measurement of Force, Pressure, Temperature.
2. Measurement of Angular Displacement.

**(ii) A 0-150V voltmeter has a guaranteed accuracy of 1% of full scale reading. The voltage measured by the instrument is75 V. Calculate the limiting error in percent on result.(Question is out of syllabus, so students formulas can be considered & marks can be given according to it)**

Ans :- The magnitude of limiting error of an instrument is,

$$\delta A = \epsilon_r A_s = 0.01 \times 150$$

$$\therefore \boxed{\delta A = 1.5V} \quad \text{..... (1 Mark)}$$

The Magnitude of Voltage being measured is 75V

The Relative error at this Voltage is

$$\therefore \left[\epsilon_r = \frac{\delta A}{A_s} = \frac{1.5}{75} = 0.02\right] \text{..... (1 Mark)}$$

Therefore the Voltage being measured is - between the limits of :

$$A_a = A_s (1 \pm \epsilon_r)$$

$$= 75 (1 \pm 0.02) = 75 \pm 1.5V$$

The % limiting error is

$$\% \epsilon_r = \frac{(1.5)}{75} \times 100$$

$$\boxed{\% \epsilon_r = 2 \text{ percent}} \quad \text{..... (1 Mark)}$$

- Comment on Result :- When meter reads 75V i.e. half the full scale value the limiting error is 2% (twice that of full scale deflection.

Therefore % limiting error will be greater if a smaller Voltage is measured. ..... (1 Mark)

**iii) Explain working of analog AC Ammeter with suitable diagram.**
**Ans: (Diagram-2 M, Explation-2M)**

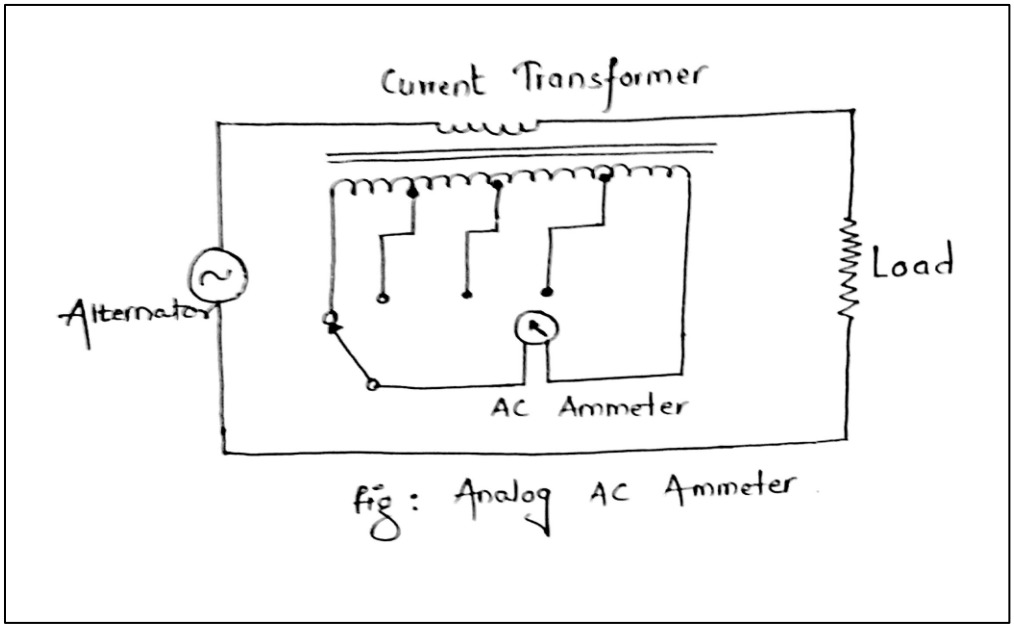


fig: Analog AC Ammeter

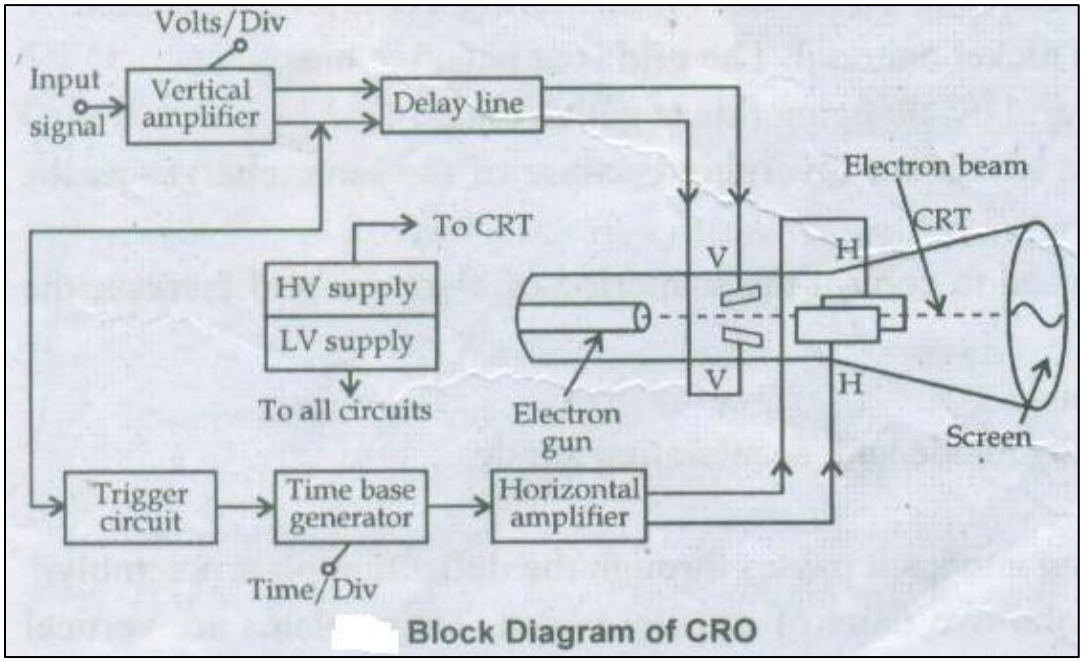
{Consider other relevant diagram}

**Explanation:**

1. Shunt can be used with A.C ammeter to increase their range but cannot be used to decrease their range.
2. Most AC ammeter use a current transformer instead of shunts to change the scale values. This type of Ammeter is shown in the diagram.
3. The primary of the transformer is connected in series with the load, and ammeter is connected to the secondary of the transformer.
4. The range of meter is changed by selecting different taps on secondary of transformer. The different taps on the transformer provides different turn's ratio between primary and secondary of the transformer.
5. The turn's ratio is the ratio of number of turns of wire on the primary as compared to the number of turns of wires in the secondary.

**Q.2. Attempt any FOUR of the following: [16 M]**

**a) Draw the basic block diagram of CRO and explain working of any two blocks.**
**Ans: (Diagram-2 M, Function of each block-1M, consider any two points)**



Block Diagram of CRO

**Function of each block:**

1. CRT: This is Cathode Ray Tube which emits the electrons that strikes the Phosphor screen internally to provide a visual display of signal. It is the heart of CRO.

2. Vertical Amplifier: It has a wide band of frequency. It amplifies the signals at vertical section.

3. Delay line: it is used to produce delay of sometime in the vertical sections.

4. Time Base: it is used to generate Saw tooth voltage waveform required to deflect the beam in horizontal section.

5. Horizontal Amplifier: Used to amplify the saw tooth voltage waveform before it is applied to horizontal deflection plates.

6. Trigger Circuit: it is used to convert incoming signal into trigger pulse so that input signal and sweep frequency can be synchronized.

7. Power supply: There are two power supplies 1. – ve high voltage 2. +ve low voltage supply. Two voltages are generated in CRO. +ve voltage supply is from +300v to +400v. & -ve voltage supply is from -1000v to -1500v.

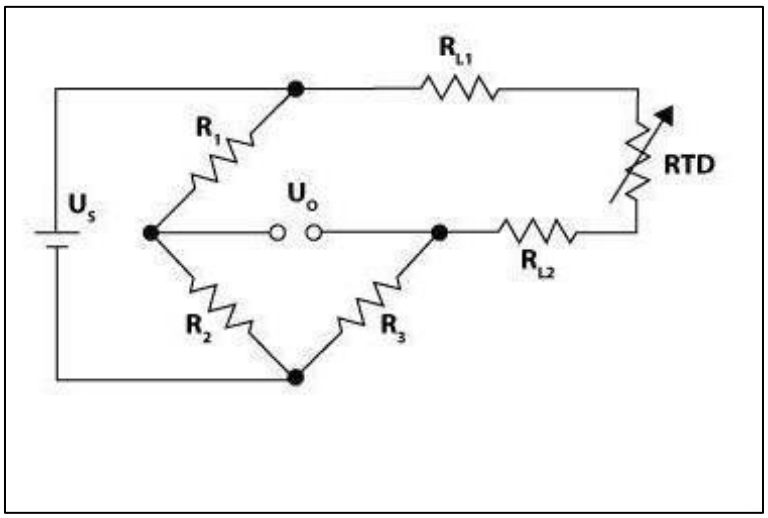
**b) Write the working principle of RTD, how temperature changes is measured using RTD.**
**Ans: (Working principle- 2M, Temperature measurement using RTD: 2M)**

An RTD (resistance temperature detector) is a temperature sensor that operates on the measurement principle that a material's electrical resistance changes with temperature.

**Temperature measurement using RTD: (Either Two or three or Four configuration can be considered)**

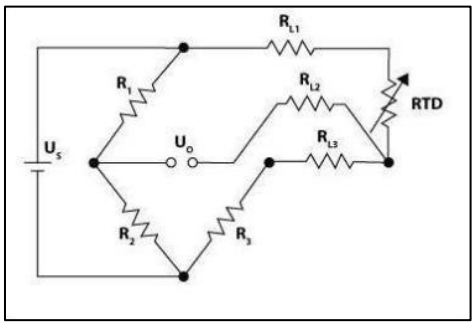
1. The relationship between an RTD's resistance and the surrounding temperature is highly predictable, allowing for accurate and consistent temperature measurement.
2. By supplying an RTD with a constant current and measuring the resulting voltage drop across the resistor, the RTD's resistance can be calculated, and the temperature can be determined
3. An RTD can be connected in a two, three, or four-wire configuration to calculate change in the temperature.

**Two-Wire Configuration:**




The four-wire configuration consists of two current leads and two potential leads that measure the voltage drop across the RTD. The two potential leads are high resistance to negate the effect of the voltage drop due to current flowing during the measurement. This configuration is ideal for canceling the lead wire resistances in the circuit as well as eliminating the effects of different lead resistances, which was a possible problem with the three-wire configuration. The four-wire configuration is commonly used when a highly accurate measurement is required for the application.

**Three-Wire Configuration**



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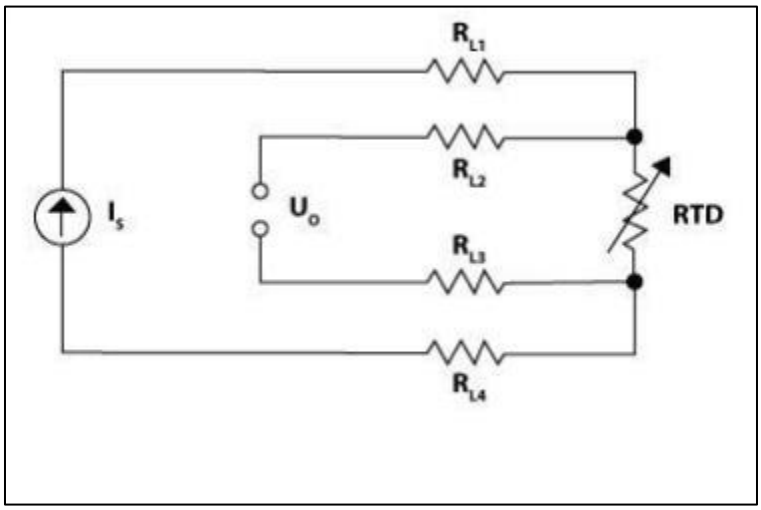
**Four-Wire Configuration**




In combination with the wiring diagrams shown, a more complex circuit is often employed. There are many different options for circuits when working with an RTD. The two most important features of this circuit are current generation and signal conditioning. For purposes of linearity, it is important that the current generation circuit supplies a stable excitation to the RTD. Once a stable excitation current is applied to the RTD, the signal conditioning path of the circuit cancels lead resistances, gains the signal and converts the signal to digital using an ADC, which can then be read by a controller.

**c) Explain how temperature is measured using thermocouple.**

**Ans: (Diagram-2M, Explanation-2M)**

1. Thermocouple is one of the simplest and most commonly used methods of measuring process temperatures.

2. The temperature measurement operation is based on Seeback Effect. Seed back discovered that when heat is applied to junction (hot junction) of two dissimilar metals, an emf is generated which can be measured at other junction (cold junction) .

3. Two dissimilar metals form an electric circuit, and current flows as a result of generated emf as shown in following figure.

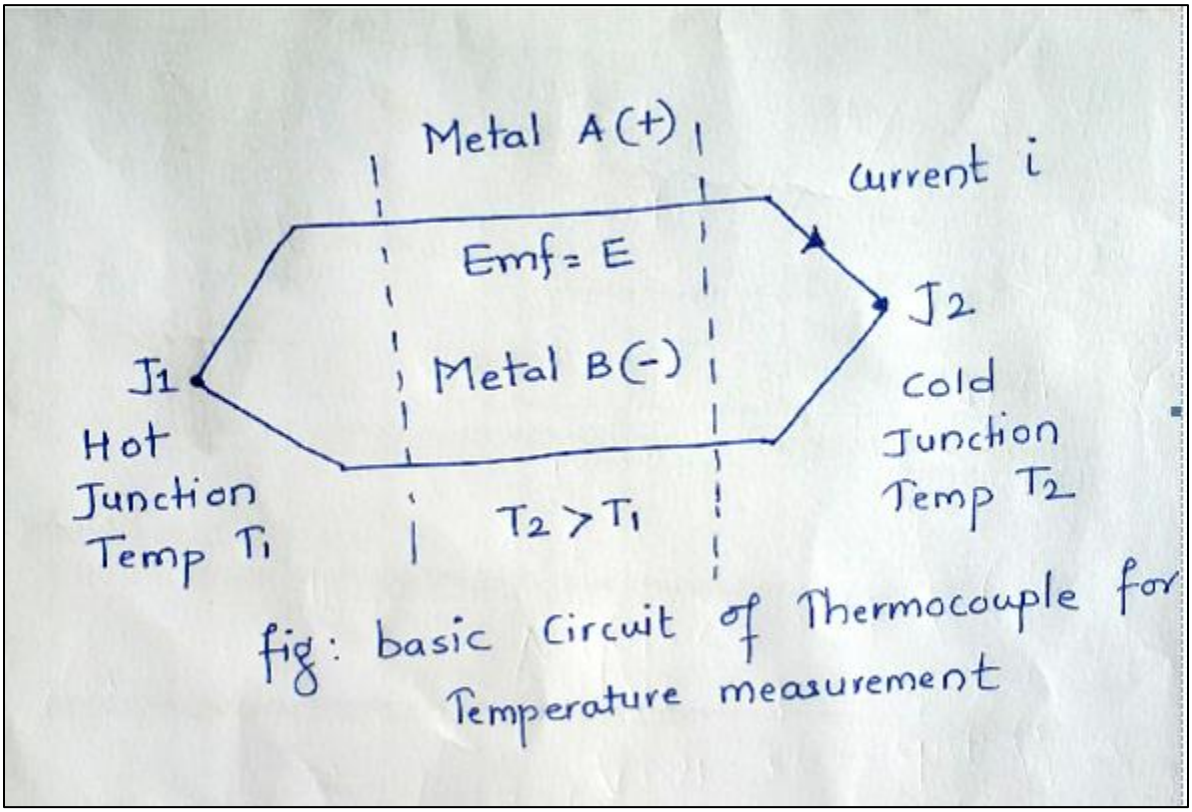


fig: basic Circuit of Thermocouple for Temperature measurement

3. This current continues as long as T1>T2. The emf produced is the function of the difference in temperature of hot and cold junctions given by

$$E = a \Delta\omega$$

Where E= emf, a=constant & $\Delta\omega$= difference between temperatures of hot and cold junctions.

**d) A moving coil instrument gives a full scale deflection of 10 mA. When potential difference across it's terminal is 100mV.**

**Calculate-**

**i) Shunt resistance for full scale deflection corresponding to 100A.**

**ii) The series resistance for full scale reading with 1000V.Calculate power dissipation in each case.**

**Ans:Correct solution 4M,Only formula 2M**

Ans :→ Meter current , $I_m = 10\,mA$

$\therefore$ meter Resistance, $R_m = \frac{V_m}{I_m}$ ( by ohms law)

$\left(R_m = \frac{100 \times 10^{-3}}{10 \times 10^{-3}} = 10\,\Omega\right)$

(a) shunt multiplying factor

i.e $\frac{I}{I_m} = \frac{100}{10 \times 10^{-3}} = 10{,}000.$

$\boxed{m = 10{,}000}$

$\therefore$ shunt Resistance, $R_{sh}$ is

$R_{sh} = \frac{R_m}{m-1} = \frac{10}{(10{,}000 - 1)}$

$\boxed{R_{sh} = 0.001\,\Omega}$

$\therefore$ Power Dissipation is

$P = V \times I$

$= (100 \times 10^{-3}) \times 100$

$\boxed{P = 10\ Watt}$

(ii) Voltage multiplying factor

$m = \frac{V}{v} = \frac{1000}{(100 \times 10^{-3})}$

$\therefore \boxed{m = 10{,}000}$

Multiplier Resistance, $R_s$ is

$R_s = (m-1) R_m$

$= (10{,}000 - 1) \times 10$

$\boxed{R_s \simeq 100{,}000\,\Omega}$

$\therefore$ Power Dissipation is

$P = V \times I_m$

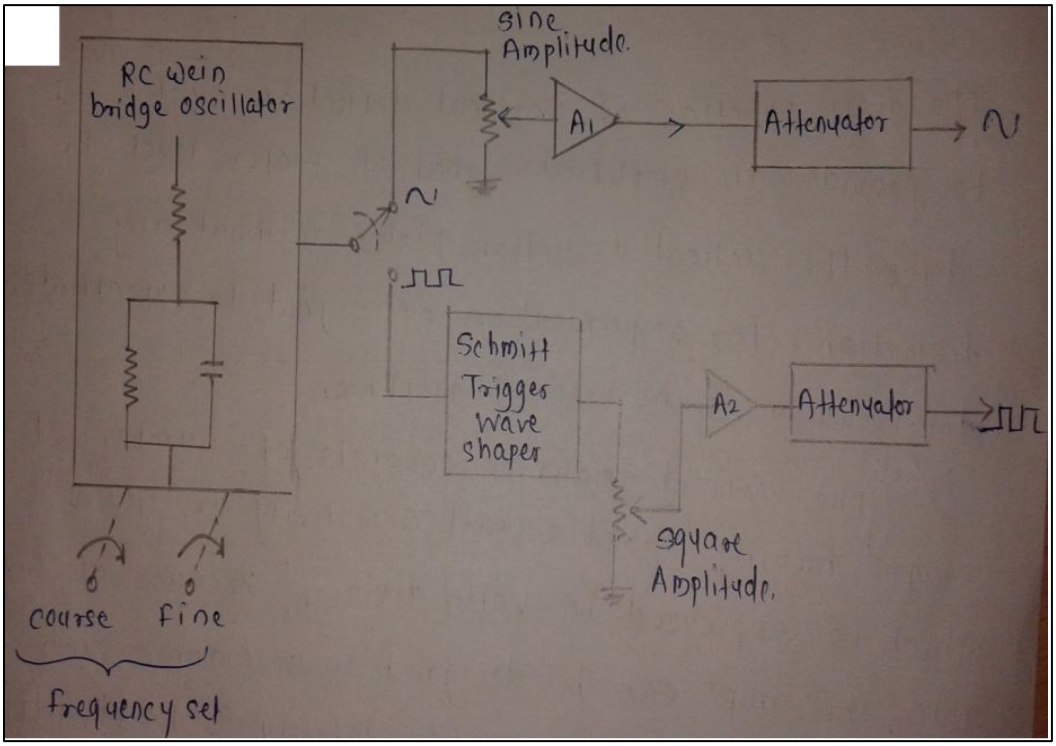
$= (1000) \times (10 \times 10^{-3})$

$\boxed{P = 10\ Watt}$

**e) Explain with block diagram working of AF signal generator.**

**Ans :( Diagram-2M, Explanation-2M)**

**Diagram:**

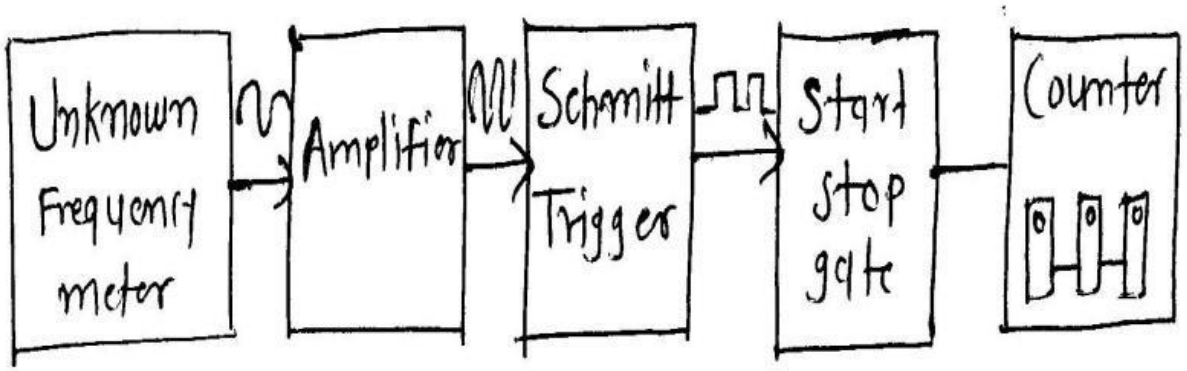



**Explanation:**

Fig. Illustrates AF signal generator. It consists of RC wein bridge oscillator, Schmitt trigger, Attenuator. In AF signal generator, the variable frequency wein bridge oscillator produces the frequency of interest set by user. It is amplified & available at o/p as since function. The type of oscillator circuit used depends on range of frequencies for which generator is designed.

The o/p of wein bridge oscillator i.e. Since wave applied to Schmitt trigger. So the same sine wave is converted to square by Schmitt trigger (square wave shaper) and available at o/p as square function.

**f) With neat schematic diagram illustrate the working principle of Digital frequency meter.**
**Ans: (Diagram-2M, Explanation-2M)**



The signal may be amplified before being applied to the Schmitt trigger. The Schmitt trigger converts the input signal into a square wave with fast rise and fall times, which is then differentiated and clipped. As a result the output from the 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 a START / STOP gate. When this gate is enabled, the input pulses pass through this gate and are fed directly to the counter which counts the number of pulses. When gate is disabled the counter stops counting the incoming pulses. 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 the frequency of the input signal cab be known. If 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 then, frequency of unknown signal is,

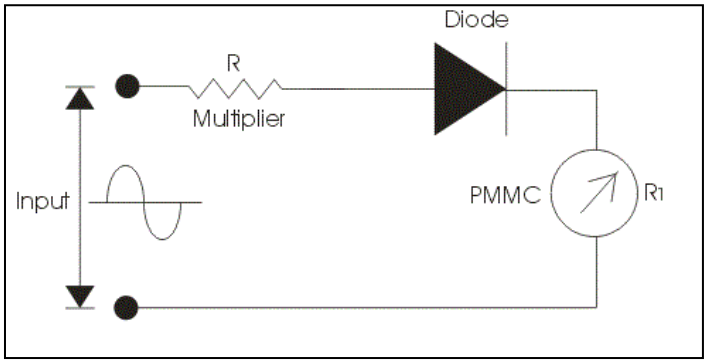
$$F = N / t$$

**Q.3. Attempt Any FOUR Of The Following. [16 M]**

**A) Explain Analog AC voltmeter half wave rectifier type.**

**Ans**: **(Diagram 2 M, Explanation: 2 M)**

**Diagram:**



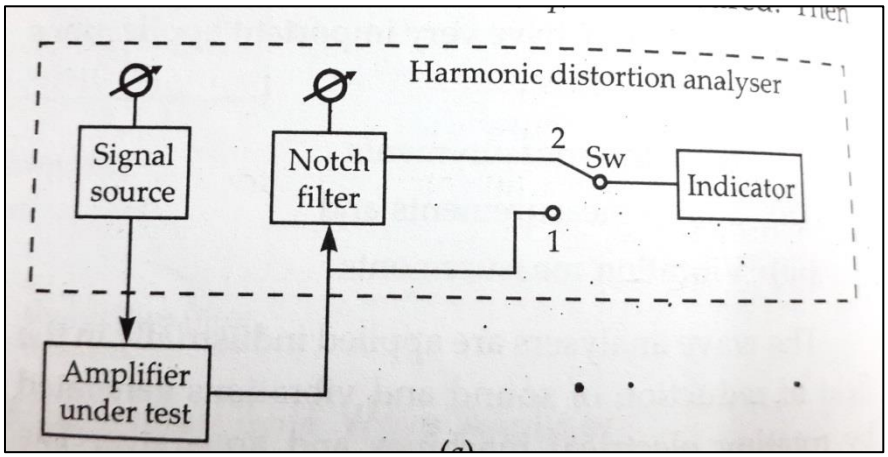

**Explanation**:

- The circuit given in which the rectifying element (diode) is connected in series with Sinusoidal voltage source, PMMC, and multiplier resistor.
- The Function of Multiplier is to limit the current drawn by the PMMC to ovoid it from damage.
- The diode conducts during positive half cycle and does not conduct during negative half cycle.
- The average current through the meter will be given by the expression.

**Iav = Vav / 2R = 0.45 * [Vrms/R]**

**B) Draw the neat block diagram of harmonic distortion analyzer and state function of each block.**

**Ans: (Diagram 2 M, Explanation: 2 M)**




- The signal has very low distortion and this can be checked by reading its o/p distortion by connecting directly into analyser
- The signal from source is fed to the amplifier under test. This generates harmonics and original fundamental frequency.
- The original fundamental frequency is removed by notch filter. The switch is first placed in position 1 and total content of fundamental & harmonics ($E_T$) is measured. Then the switch is moved to position 2 to measure just the harmonics ($E_H$). The value of THD total harmonic distortion is then found
- THD = $\frac{E_H}{E_T}$ X 100

**C) State advantages and disadvantages of digital Instruments (four each).**
**Ans*:* (Any four, for each point: 1/2 Marks)**

**Advantages**:

1. It indicates the readings directly in decimal numbers.
2. Human errors, observational error are eliminated.
3. It gives precise value of signal under measurement by positioning the decimal point.
4. The output obtain in digitized form so can be directly fed to memory devices like printer, recorder, hard disc and digital computers etc.
5. The power requirement of digital instrument is considerably smaller.
6. Accuracy of digital instruments is higher than Analog instruments.

**Disadvantages**:

1. The digital Instruments are complex in construction.
2. It requires external Energy sources and power sources.
3. These are not portable.
4. Cost of it is always higher than analog instruments.
5. The surrounding temperature and humidity may affect the performance of digital instruments.

**D) Give the method for frequency measurement using Lissagous pattern.**

**Ans: (for explanation 4 Marks)**

**Explanation:-**

One of the quickest methods of determining frequency is by using Lissagous patterns produced on the Screen. This pattern results when sine waves are applied simultaneously to both pairs of the deflection plates. If one frequency is an integral multiple (harmonic) of the other, the pattern will be stationary and is called a Lissagous figure.

In this method of measurement a standard frequency is applied to one set of deflection plates of the CRT tube while the unknown frequency is simultaneously applied to the other set of plates. The resulting pattern depends on the integral & phase relationship between two frequencies.

Keep frequency fh constant and vary frequency fv , noting that the pattern. Spins in alternate directions and change shape. The pattern will stand still whenever fv and fh are in an integral ratio.

The fv = fh pattern stands still and is a single circle or ellipse. (As per fig a)

When fv=2fh a two loop horizontal pattern is obtained. (As per fig b)

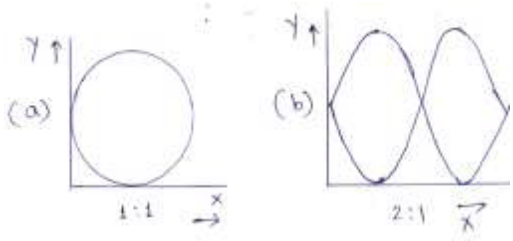



Fig.a Fig.b

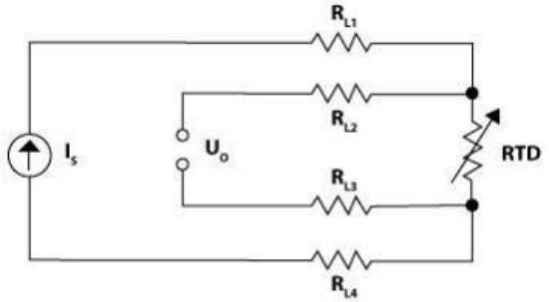
To determine the frequency from any Lissagous figure, count the number of horizontal loops in the pattern, Divide it by the number of vertical loops and multiply this quantity by fh (known frequency).

Fv = (fraction)× fh

Fraction= (No. Of loops touches to horizontal tangent) /(no of loops touches to vertical tangent)

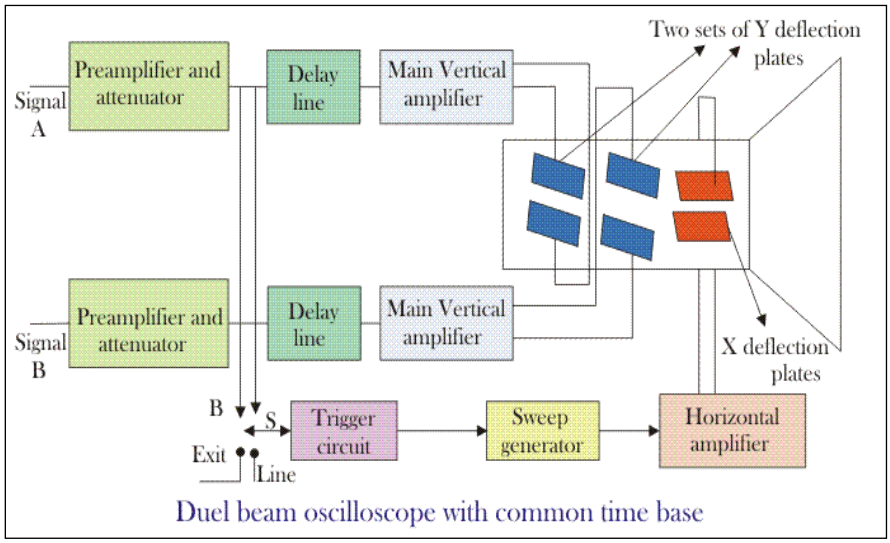
**E) Draw a neat diagram of 4 -wire RTD system.**

**Ans: (Consider Any other relevant diagram showing four wire RTD, Diagram 4 M)**



**F) Explain with neat diagram dual beam dual trace CRO**

**Ans: (Diagram 2 M, Explanation: 2 M)**

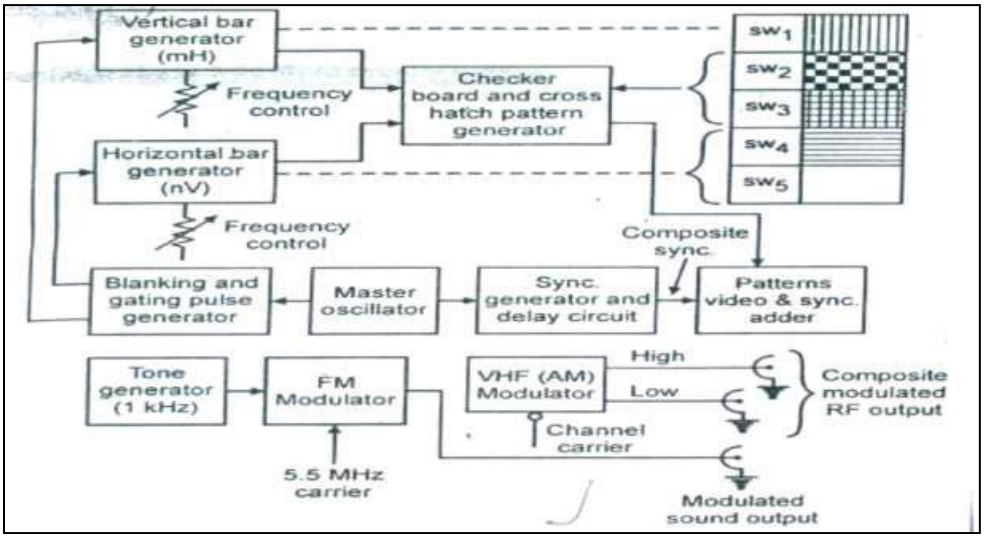


Duel beam oscilloscope with common time base

- The dual beam oscilloscope has 2 separate electron beams and therefore 2 completely separate vertical channels
- The two channels may have a common time base system or they may have independent time base circuits.
- An independent time base allows different sweep rates for the two channels but increases the size and weight of the oscilloscope.
- Two methods are used for generation of 2 electron beams with in the CRT. The first method uses a double gun tube. This allows the brightness and focus of each beam to be controlled separately but it is bulkier than a split beam tube.
- In the second method a known a split beam a single electron gun is used. A horizontal splitter plate is placed between the last anode and the y- deflection plates
- This plate is held at the same potential as the anode and it goes along the length of the tube between the two vertical deflection plates
- It therefore isolates the two channels. The split beam arrangement has half the brightness of a single beam which is disadvantageous at high frequency operations.

**Q.4. Attempt Any Four of the Following: [16 M]**

**A) Explain with suitable diagram, working of video pattern generator.**
**Ans: : (Diagram -2 M, Explanation -2 M)**




- A pattern generator provides video signals directly and with RF modulation on standard TV channels for alignment, testing and servicing of TV receivers. The output signal is designed to produce simple geometric patterns like vertical and horizontal bars, checker board, cross hatch dots etc. An FM sound is also provided in pattern generators for aligning sound sections of the receiver.
- The generator employs two stable chains of multivibrators , divider and pulse shaping circuits one below the line frequency to produce a series of horizontal bars and another above 15625hz to produce vertical bars . The signals are modified in to short duration pulses when fed to the video section of receiver along with the sync pulse train produce fine line on the screen.
- Multivibrators produce a square wave video signal at m times the horizontal frequency to provide m vertical black and white bars. After every m cycles the horizontal blanking pulse triggers the multivibrators for synchronizing the bar signal on every line. A control on the front panel of the pattern generator enables variation of multivibrators frequency to change the number of bars.

**B) Explain with suitable diagram how spectrum analyzer is used for observation of frequency spectrum of a signal.**
**Ans:** : **(Diagram- 2M, Explanation- 2M)**

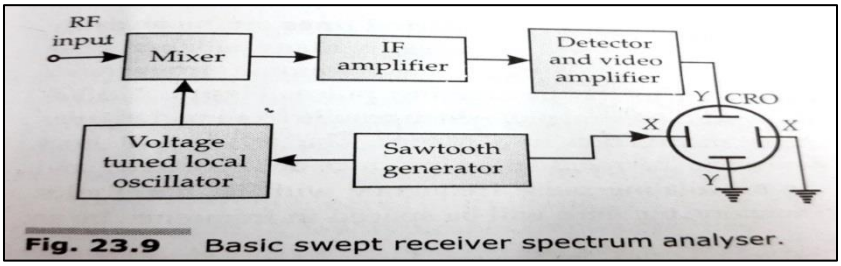
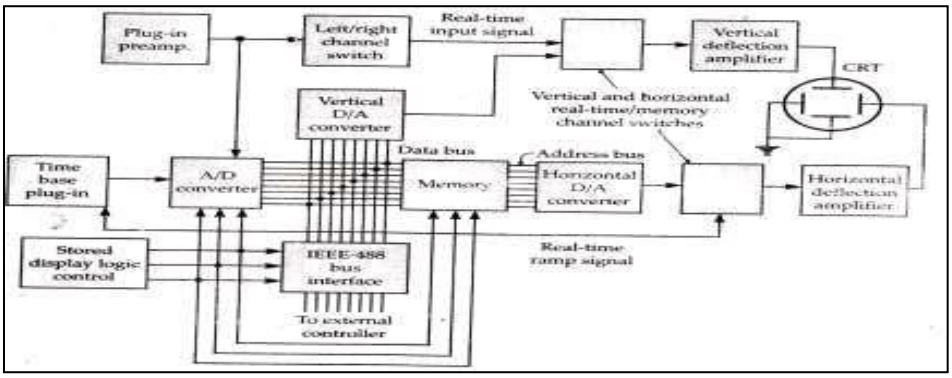



**Fig. 23.9** Basic swept receiver spectrum analyser.

- Referring to the block diagram of the basic spectrum analyser, the saw tooth generator provides the saw tooth voltage which drives the horizontal axis element of the scope and this saw tooth voltage is the frequency controlled element of the voltage tuned oscillator.
- As the oscillator sweeps from f min to f max of its frequency band at a linear recurring rate, it beats with the frequency component of the input signal and produce an IF, whenever a frequency component is met during its sweep.
- The frequency component and voltage tuned oscillator frequency beats together to produce a difference frequency, i.e. IF. The IF corresponding to the component is amplified and detected if necessary and then applied to the vertical plates of the CRO producing a display of amplitude versus frequency.
  Spectrum analysers are widely used in radar, oceanography and biomedical fields.

**C) Draw block diagram of Digital Storage oscilloscope (DSO). List its advantages (Any two).**
**Ans: (Diagram - 2 M, Advantages-2 M)**

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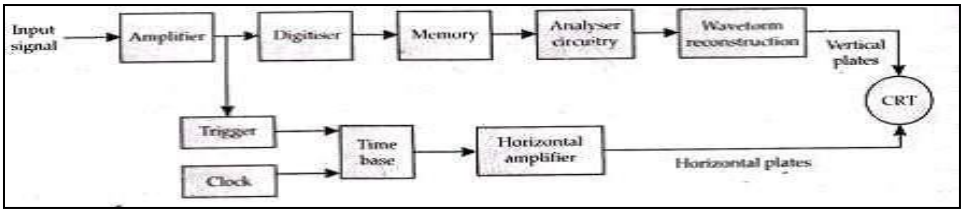
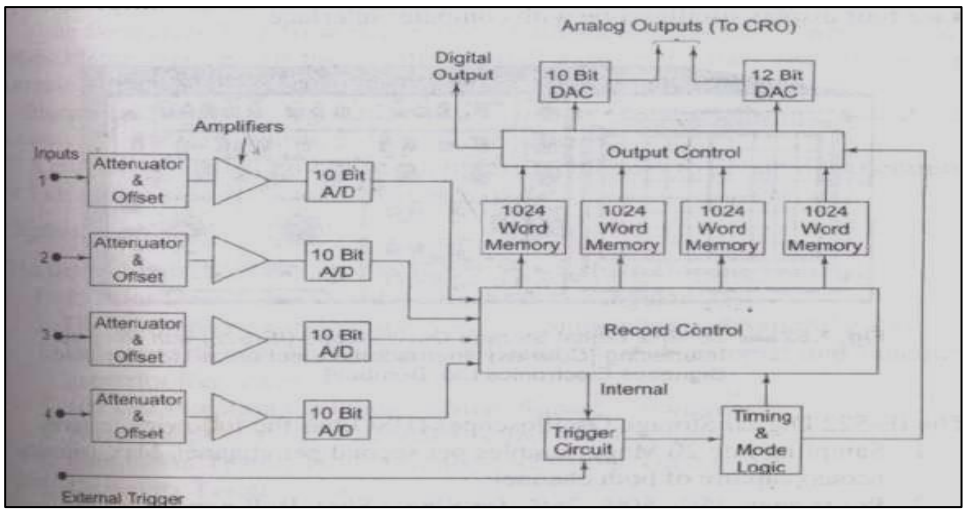



OR

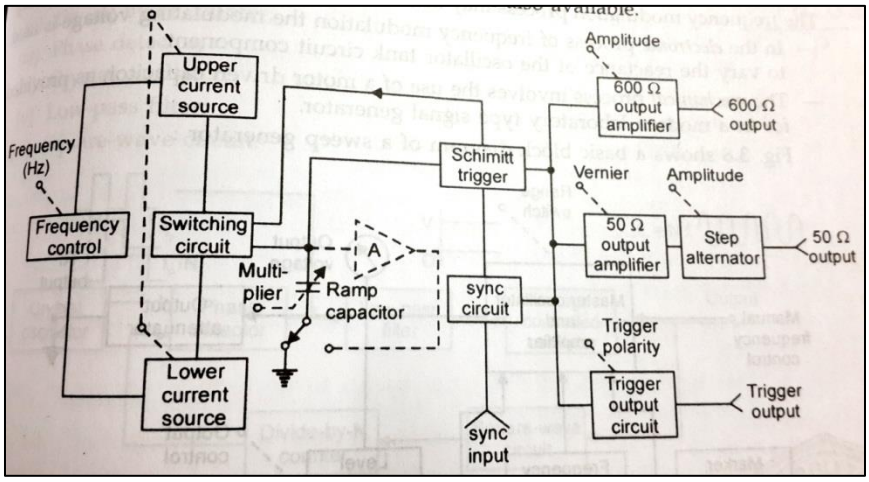


**Advantages:**

1. Digital storage oscilloscopes have the advantage of capturing and logging electronic events.
2. In DSO, the waveform to be stored is digitized, stored in a digital memory and retrieved for display on the storage oscilloscope.
3. DSO also uses for complex processing of the signal with high speed with the help of digital signal processing circuits.
4. In this, slow traces like the temperature variation across a day can be recorded

**D) Illustrate with suitable diagram working of pulse generator.**

**Ans:** : **(Diagram- 2 M, Explanation -2 M)**




- The block diagram of a typical general purpose generator providing pulse of variable frequency, duty cycle and amplitude is shown above
- The basic generating loop which is drawn below for clarity consists of two current sources the ramp capacitor the Schmitt trigger circuit and the current switching circuit.
- The two current sources provide a constant current for charging and discharging the ramp capacitor. The ratio of these two current is determined by the setting of the symmetry control which then determines the duty cycle o the output waveform.
- The frequency dial controls the sum of the two currents from the current sources by applying appropriate control voltages to the bases of the current control transistors in current generators. The size of the ramp capacitor is selected by the multiplier switch
- The upper current source, supplying a constant current to the ramp capacitor charges this capacitor at a constant rate and the ramp voltage increases linearly, when the positive slope of the ramp voltage reaches the upper limit set by internal circuit component the Schmitt trigger (a bi-stable multivibrator) changes state. The trigger circuit output goes negative reversing the condition of the current control

switch and the capacitor starts discharging. The discharge rate is linear, controlled by the lower current source.

- When the negative ramp reaches a predetermined lower level the Schmitt trigger switches back to its original state. This now provides a positive trigger circuit output that reverses the condition of the current switch again cutting off the lower current source and switches on the upper current source. One cycle of the operation has now been completed the entire process of course is repetitive and the Schmitt trigger circuit provides negative pulses at a continuous rate.
- In this way pulse is generated.

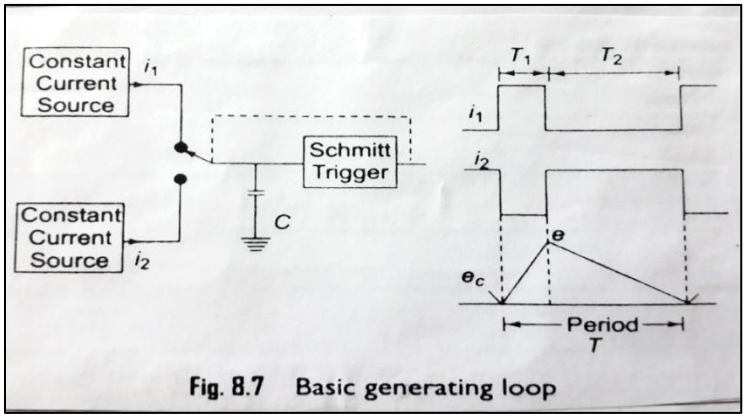



Fig. 8.7 Basic generating loop

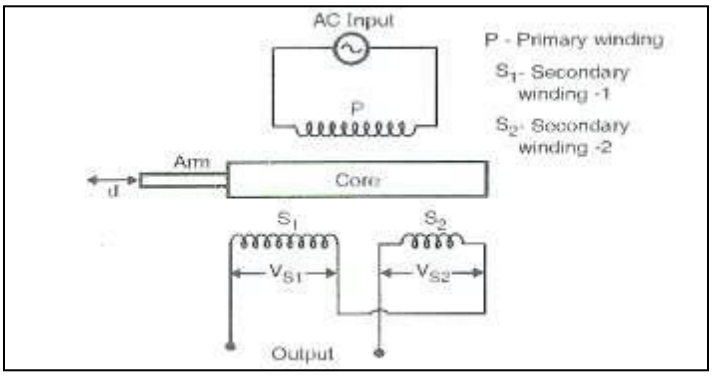
**E) Differentiate between primary and secondary transducers. (Any four points)**

**Ans:** : **(Any relevant point can be considered, for each difference:1 M)**

| Primary Transducer | Secondary Transducer |
|---|---|
| • The transducer which convert the Fundamental Quantity into mechanical Signal is called Primary Transducer. | • The transducer which convert the Mechanical signal into electrical Signal is called Secondary Transducer |
| • It is called as Mechanical transducer. | • It is also called as electrical Transducer. |
| • The output is in the form of Displacement. | • The output is in the form of electrical signal either in terms of voltage, current, resistance, inductance, capacitance. |
| • It does not require external energy to convert into mechanical displacement. | • It may require external energy source to convert mechanical displacement into electrical signal. |
| • Bourdon tube, diaphragm, bellows are the examples. | • LVDT, RVDT, strain gauge are the examples. |

**D) Explain working of LVDT with suitable diagram.**

**Ans: (Diagram-2 M, Working -2 M)**




**Working:**

**Case I**: When there is no displacement.

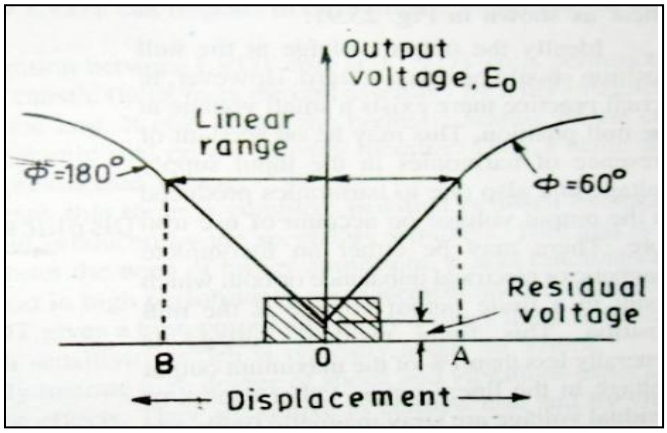
- When there is no displacement attached to the core the core is at normal position, the flux linking with both the secondary winding are equal.
- Equal e.m.f. Are induced in both secondary winding when the core is at null position VS1=VS2
- Hence the output voltage Vo at null position is zero.

**Case II:** When there is positive displacement

- When there is positive displacement applied to the core i.e. The core is moved to left of null position, more flux links with winding S1 than winding S2
- Here e.m.f. Induced with winding S1 is greater than winding S2 that is VS1>VS2
- Hence the output voltage Vo= VS1-VS2 and the output voltage is in phase with the input primary voltage.

**Case III:** When there is negative displacement

- When there is negative displacement applied to the core i.e. The core is moved to right of null position, more flux links with winding S2 than winding S1.
- Here e.m.f. Induced with winding S2 is greater than S1 that is VS2>VS1.
- Hence the output voltage Vo= VS1-VS2 and is $180^0$ out of phase with the input primary voltage.

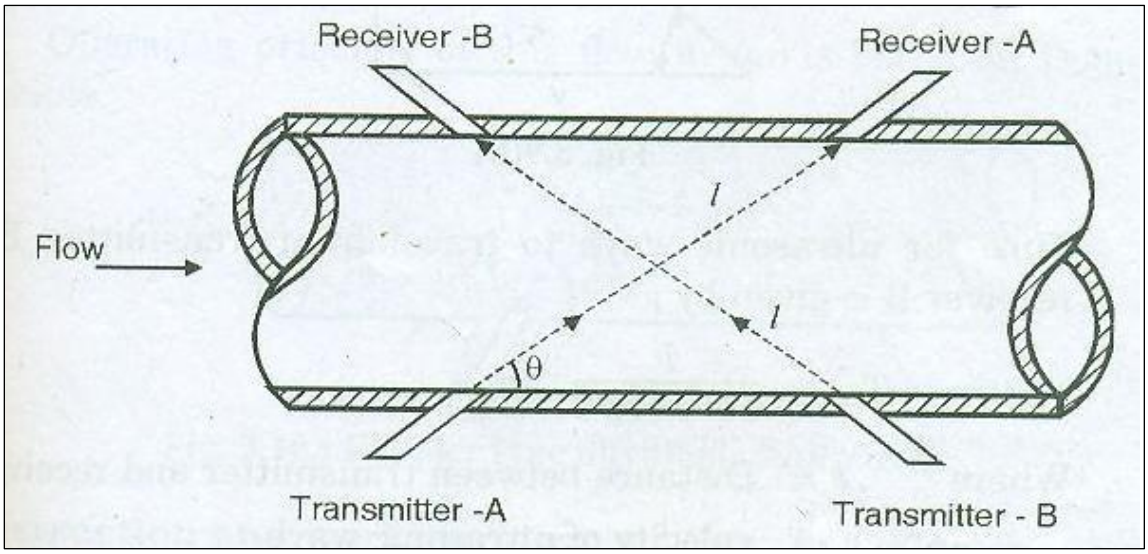


Q **5. Attempt any FOUR of the following** **[16M]**

**a) Explain how time difference type ultrasonic flow meter is used for flow measurement.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram :**




**Explanation:-**

- The operating principle of this flow meter is based on the apparent change in the velocity of propagation of ultrasonic wave pulses in a fluid with a change in velocity of fluid flow.
- This flow meter consists of two transmitters and two receivers. These are separated by distance l and mounted.
- Transmitter A transmits the waves pulsed of short duration in the direction of receiver A, this favor the wave as it is in direction of low.
- Transmitter B transmits the wave pulsed of short duration in the direction of receiver B, this do not favor the wave as it is opposite to the direction of low.
- The velocity of ultrasonic waves increased or decreased by the fluid velocity depending upon the direction of fluid.
- The detector measures the transit time from upstream to downstream and vice versa. The time for ultrasonic wave to travel from transmitter A to receiver A is given by
- $TA=\ell/( c+ v \cos \Theta )$

  Time for ultrasonic wave to travel from transmitter B to receiver B is given by,

- $TB=\ell/ (c- v \cos \Theta )$

Where ℓ= distance between transmitter and receiver
C= velocity of ultrasonic wave
Θ= angle of path with respect to pipe axis.
V= velocity of fluid flowing through pipe.

The difference in time between TA and TB is given by,

$\Delta T = TA - TB$
$\Delta T = (\ell / (c + v \cos \Theta)) - (\ell / (c - v \cos \Theta))$
$\Delta T = \ell / 2v \cos \Theta$
Therefore $v = \ell / (2\Delta T \cos \Theta)$

- The measurement is independent of velocity of ultrasonic wave (c )

By measuring the difference in reception frequency, and knowing the value of Θ and ℓ, the velocity of fluid can be counted.

**b) Explain with block diagram working of logic analyzer.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram:**

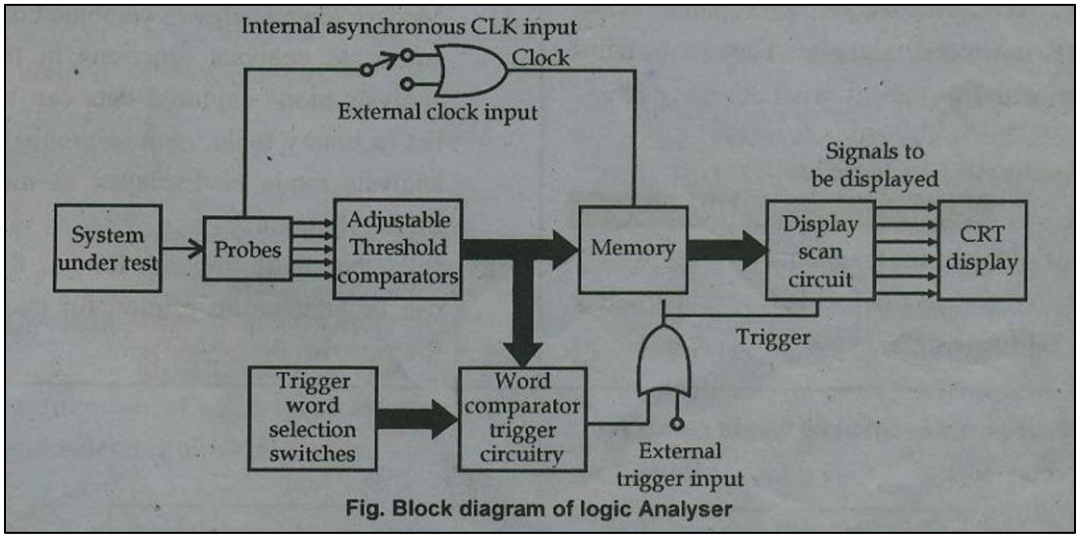


Fig. Block diagram of logic Analyser

**Explanation:**

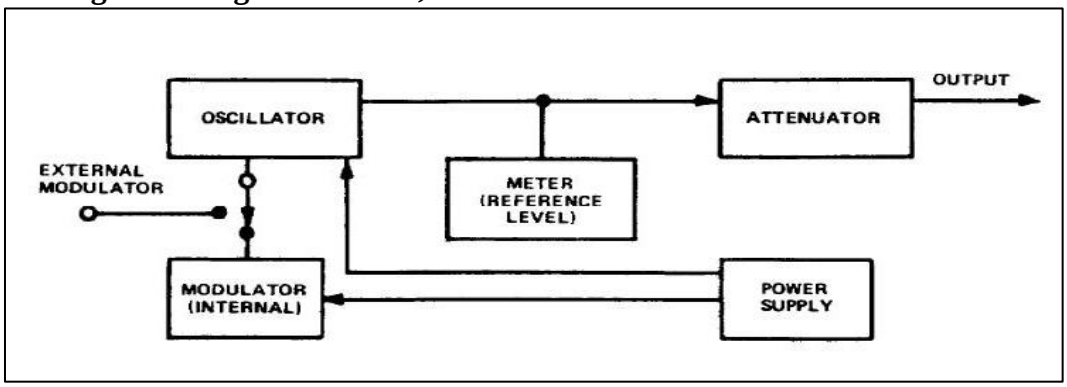
- Logic analyzer used to analyze digital signals. Logic analyzer deals with digital domain.
- This is basically multichannel oscilloscope. The probes connect the logical analyzer to system which is under test. The probes operates as voltage divides , the lowest possible s/w rate can be selected by dividing the i/p signal.
- The different logic families i.e, TTL, CMOS,NMOS…etc have different threshold voltage. Hence adjustable threshold comparators are used. Each signal is connected to each line of logic analyzer. The reference signal of each comparator is set to a voltage.
- The logic analyzer memory consists of a RAM. The clock signals I.e, internal or external clock i/p is connected to memory on receiving clock signal, the logic analyzer samples the data present on i/p signals.

- These samples are stored in memory. For each i/p channel the analyzer can store from 256 to 1024 samples.
- When memory receives trigger signal then samples are stored in it & displayed on CRT.

**c) Explain working of RF-type signal generator**.

**Ans**:- **[Diagram-2M, Explanation- 2M]**

**Diagram:**
**[Any equivalent dig consisting of oscillator, modulator and attenuator should be considered]**



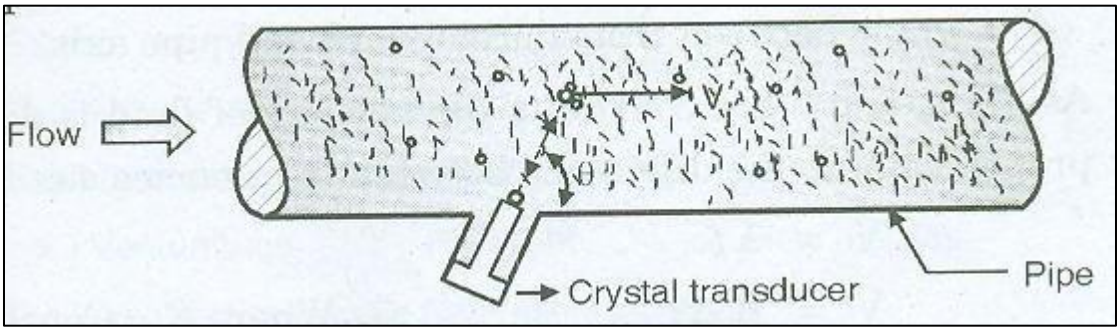

Radio frequency (RF) signal generators

a. A typical radio frequency signal generator contains, in addition to the necessary power supply, three main sections; an oscillator circuit, a modulator, and an output control circuit. The internal modulator modulates the radio frequency signal of the oscillator. In addition, most RF generators are provided with connections through which an external source of modulation of any desired waveform may be applied to the generated signal. Metal shielding surrounds the unit to prevent the entrance of signals from the oscillator into the circuit under test by means other than through the output circuit of the generator.
b. A block diagram of a representative RF signal generator is shown in Figure 3-3. The function of the oscillator stage is to produce a signal which can be accurately set in frequency at any point in the range of the generator. The type of oscillator circuit used depends on the range of the frequencies for which the generator is designed. In low frequency signal generators, the resonating circuit consists of a group of coils combined with a variable capacitor. One of the coils has a selector switch attached to the capacitor to provide an LC circuit that has the correct range of resonant frequencies.
c. The function of the modulating circuit is the production of audio (or video) voltage which can be superimposed on the RF signal produced by the oscillator. The modulating signal may be provided by an audio oscillator within the generator, or it may be derived from an external source. In some signal generators, either of these methods of modulation may be used. In addition, a means of disabling he modulator section is used whereby the pure demodulated signal from the oscillator can be used when it is desired.
d. The type of modulation used depends on the application of the particular signal generator. The modulating voltage may be either a sine wave, a square wave, or pulse of varying duration. In some specialized generators, provision is made for pulse modulation in which the RF signal can be pulsed over a wide range of repetition rates and at various pulse widths

**d) Illustrate with diagram working of Doppler type ultrasonic flow meter.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram:**

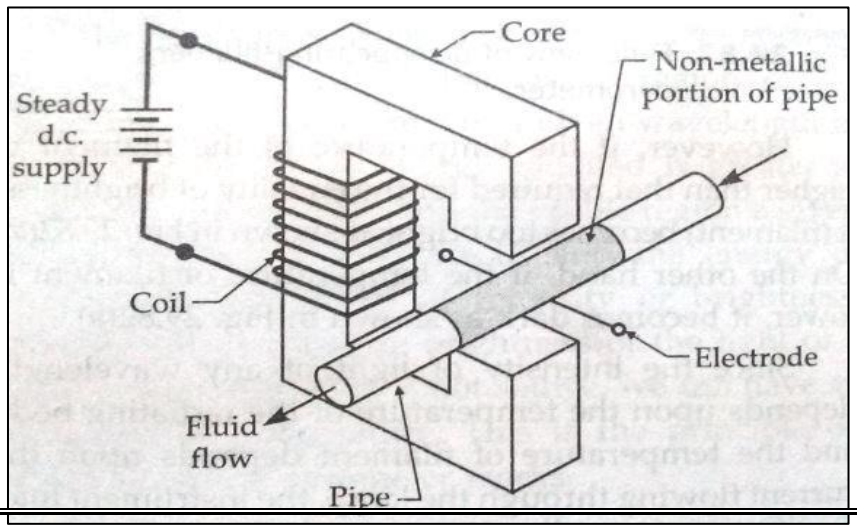



- Figure shows construction of Doppler flow meter, in which one crystal transducer emits an ultrasonic wave and the wave is projected at an angle through the pipe wall into the liquid.
- The transducer is basically piezoelectric crystal with a heavy backing to attenuate the unwanted rear movement.
- Some parts of the ultrasonic wave are reflected by the liquid particles and bubbles in the liquid and it is returned through the pipe wall towards the transducer.
- As the liquid flows through the pipe the particles and bubbled in the liquid also moves these particles act as reflectors for the ultrasonic wave.
- The particles and bubbles moving with the velocity of the fluid, the frequency of the reflected wave is shifted according to particle velocity, it is given by Doppler principle.
  Hence V α Δf.

**e) Explain the working of electromagnetic flow meter.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram:**

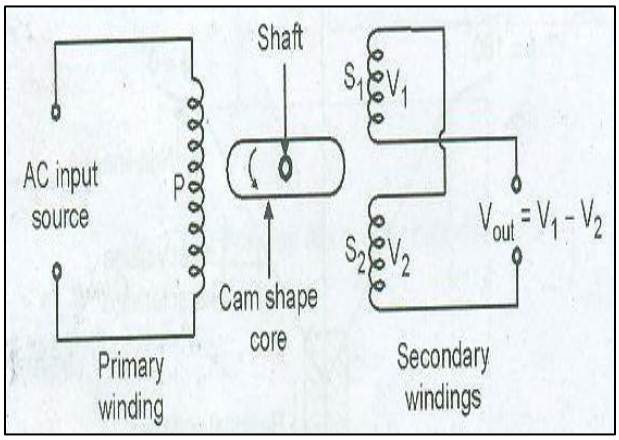


**Working principle:**

- The operation of this type of flow meter is based on Faraday's law of electromagnetic induction.
- The law state that whenever the conductor moves through a magnetic field, an emf is induced in the conductor proportional to the relative velocity between the conductor & the Magnetic field.
- It consists of a pipe, short section of which is subjected to a transverse magnetic field. The conductive fluid is passed through this pipe. As fluid passes, its motion relative to field produces an emf proportional to velocity according to Faraday's law.
- This output emf is collected by the electrodes (kept at points of maximum potential difference) and is given to external circuitry

**f) Illustrate the working of RVDT with the help of diagram.**

**Ans:- [Diagram-2M, Explanation- 2M]**
**Diagram:**




**Explanation:**

- RVDT is inductive transducer, which converts the angular displacement into electrical signal.
- If there is no angular displacement to the core i.e. Null position, the output voltage of secondary windings S1 and S2 are equal and in opposition. Hence output voltage is zero.
- If the core rotates in anticlockwise direction produces more voltage in winding S1 than S2. Hence output is
  Vo= Vs1- Vs2
- If the core rotates in clockwise direction it produces more voltage in windings S2 than S1

Hence output is,
Vo= Vs2- Vs1

- Thus by using RVDT one can determine the angular displacement and its direction.

**Q. 6. Attempt any four of the following** **[16M]**

**a) Differentiate between analog instrument and digital instrument**

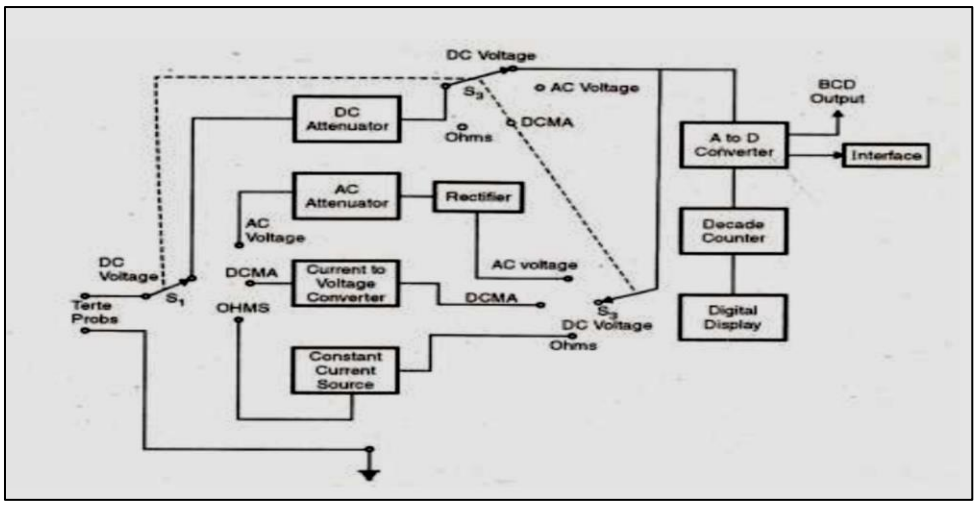
**Ans:- [Any proper four points 1M each ]**

| Sr NO | Analog Instrument | Digital Instrument |
|---|---|---|
| 1 | The instrument that displays analog signals is called as an analog instrument. | The instrument that displays digital signals is called as Digital Instrument. |
| 2 | Accuracy of analog instrument is less. | The accuracy of digital instrument is more compared to analog instrument. |
| 3 | The resolution of analog instrument is less. | The Resolution of Digital instrument is more. |
| 4 | Analog instruments are cheap. | Digital instruments are Expensive. |
| 5 | Example PMMC instrument. | Logical Analyzer. |

**b) Draw DMM block diagram and state function of any three blocks.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram:**




**Explanation:**

- In order to measure unknown current, current to vtg. (I to V) converter is used. An unknown current applied to op-amp. I/P impedance of op-amp is very high. So current passing through it is negligible.

Thus $I_{in} = i_{fb}$.

- This feedback current pass through resistance. This will cause a vtg. Drop across resistance. This vtg. Is applied to A to D converter & finally digital display is obtained. Thus o/p is directly proportional to unknown current.

- In order to measure unknown resistance; a constant current source is used. The current from this constant current source is allowed to pass through unknown resistance. Thus proportional vtg. Is obtained. This o/p directly proportional to unknown resistance.

To measure AC vtg, a rectifier & filter is used. This rectifier converts AC into DC signal & this DC signal is applied to A to D converter & to digital display.

**c) Explain with neat diagram single beam dual trace CRO.**

**Ans:- [Diagram-2M, Explanation- 2M]**

**Diagram:**

**2M**

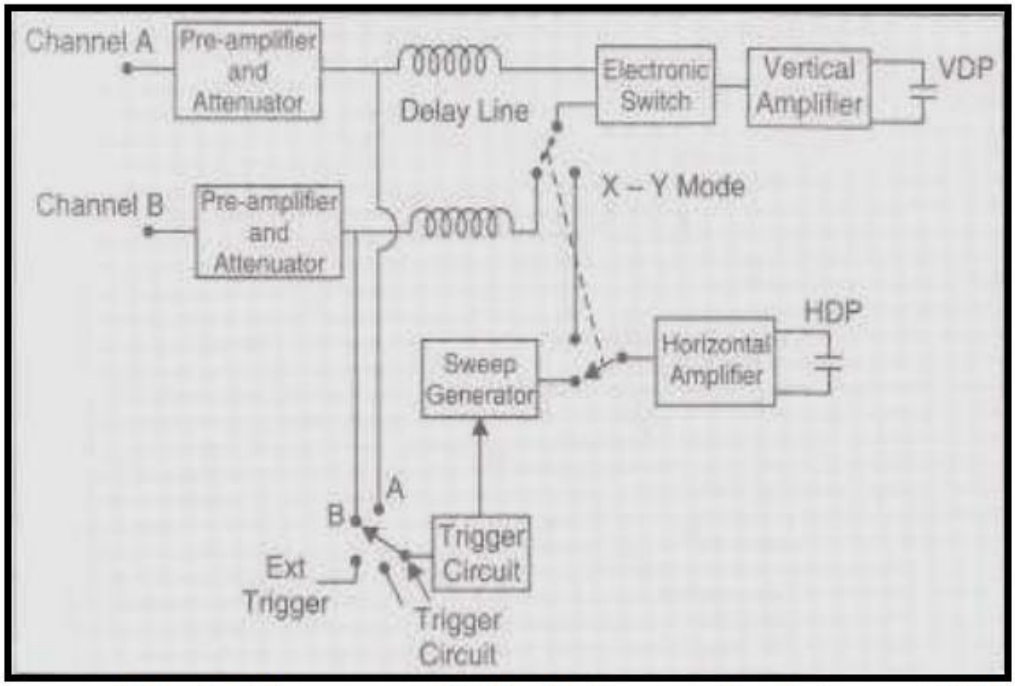



**Figure:- Block diagram of Single beam dual trace CRO**

**Working:-(consider explanation, Any two mode 1M each)**

- In this CRO a single beam is split into two to produce two images.
- A mode control system (s1) enables the electronic switch to operate in two modes Alternate and chop mode and x-y mode.

**Alternate mode:**

- When the switch (s1) is in alternate position, the electronic switch feeds each signal alternatively to the vertical amplifier.
- The electronic switch alternately connects the main vertical amplifier to channels A and B and adds a different dc component to each signal
- This dc component directs the beam alternately to the upper or lower half of the screen.
- The switching takes place at the start of each new sweep of the sweep generator.

- The switching rate of the electronic switch rate, so that the CRT spot traces the channel A signal on one sweep and the succeeding sweep.
- The sweep trigger signal is available from channels A or B and the trigger pick-off takes place before the electronic switch. This arrangement maintains the correct phase relationship between signal A and B.

**Chop mode:**

- When the switch (s1) is in the chop mode position .the electronic switch is free 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. E.g. 1 MS segments of each waveform are to the CRT display.
- If the chopping rate is slow, the continuity of the display is lost and it is better to use the alternate mode of operation.

**d) Define following.**

**Ans :- [1M each for correct definition ]**

**i) Speed of Response**:
It is the rapidity with which an instrument responds to changes in the measured quantity.

**ii) Lag:**
It is the retardation or delay in the response of an instrument to changes in the measured variable.

**iii) Fidelity:**
It is the degree to which an instrument indicates the changes in the measured variable without dynamic error.

**iv) Dynamic Error:**
It is the difference between true value of a quantity changing with time & the value indicated by the Instrument, if no static error is assumed. It is also called as measurement error.

**e) Explain with suitable diagram principle of working of PMMC instrument.**

**Ans:- [Diagram-2M, Explanation-2M]**

**Diagram:**

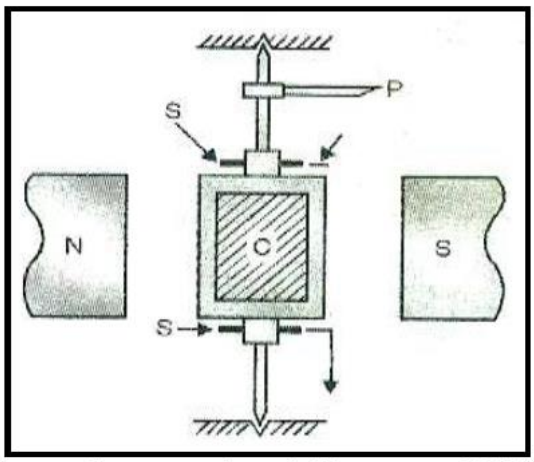



**Figure:- Constructional diagram of PMMC**

**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.

- 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.

**f) The expected value of voltage across the resistor is 50 volt. However measurement gives a value of 49 volt. Calculate relative accuracy and % accuracy.**

**Ans:-**