SET2

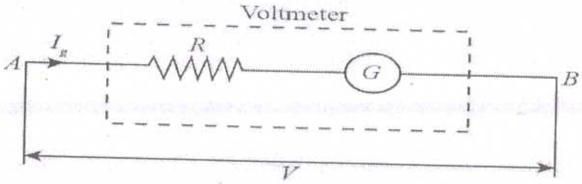
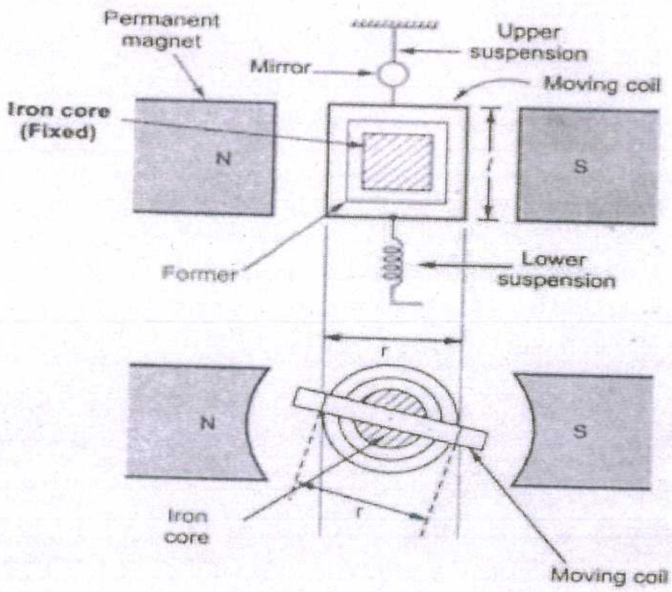
Scoring Indicators

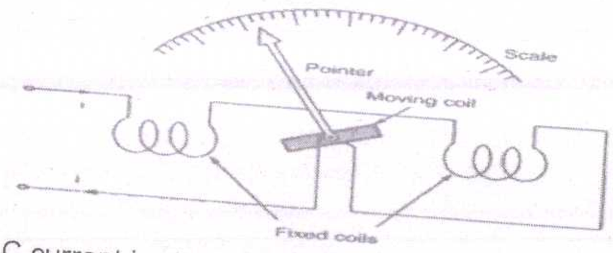
Course Name: **Electronic Measurements & Instrumentation**

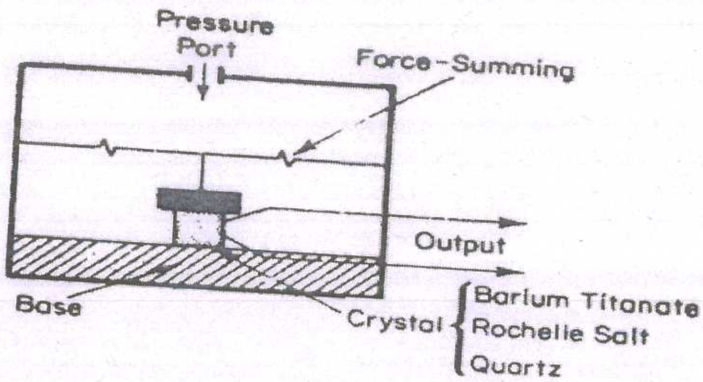
Course code:4042

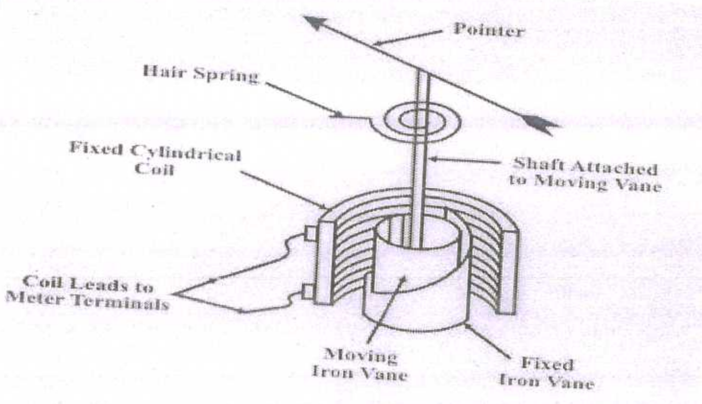
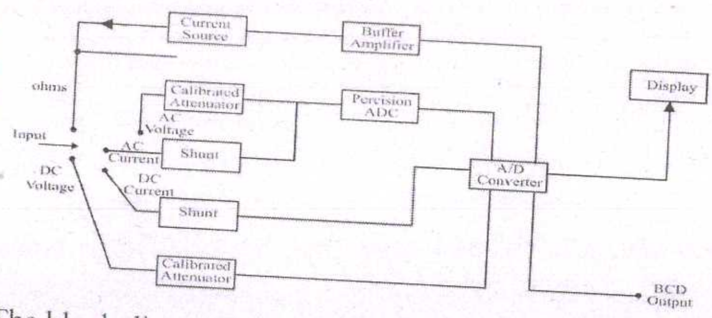
QID:2103230115

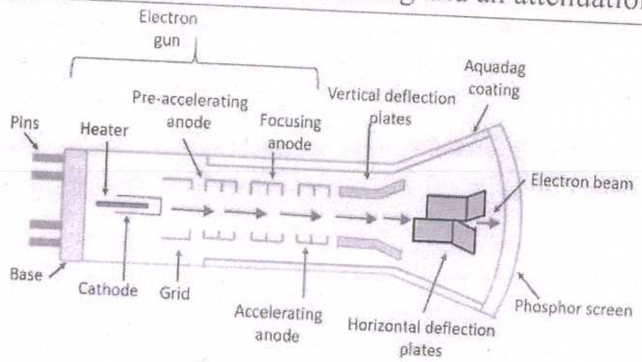
Question No:	Scoring Indicators	Split score	Sub Total	Total Score
	PART A			
I.1	Accuracy	1	1	9
I.2	Breaking system	1	1	
I.3	Graticule	1	1	
I.4	Control grid	1	1	
I.5	Spectrum analyzer	1	1	
I.6	Magnitude and phase	1	1	
I.7	Wave analyser is the instrument used to measure relative amplitudes of single frequency component in a complex waveform	1	1	
I.8	Load cell converts a force such as tension , compression, pressure or torque into an electrical signal that can be measured and standardized	1	1	
I.9	recorder	1	1	
	PART B			
II.1	The degree to which a measurement nears the expected value is expressed in terms of the error of measurement. Error is expressed either as absolute or as percentage of error. It is the difference between the exact and measured values of an instrument. It is used to determine the closeness of the measured value to the exact value. The error calculation formula consists of the difference between the measured and exact value divided by the exact value, further multiplied by 100 to obtain the percentage value. The Percent Error formula is given by: Absolute difference = Exact value - Experimental value Percent error= (Absolute difference/Exact value)*100	Defn:1 marks Expression:2 marks	1+2=3	3
II.2	Galvanometer is convert into a voltmeter by connecting a large resistance in series to the galvanometer. Let G and R the resistance of galvanometer and series resistance, V the potential difference to be measured by voltmeter, Ig the current flowing through circuit	Fig:1.5 marks Expln: 1.5 marks	1.5 + 1.5 =3	3

	 Potential difference between A and B is V=Ig.R + IgG= Ig(R+G) $\therefore R+G=\frac{V}{I_g}$ $R=\frac{V}{I_g}-G$ gives the value of series resistance to be connected			
II.3	Gross error: These are basically human errors caused by the operation on the person operating the instrument. The instrument may be good and may not give any error but still the measurement may go wrong due to the operator. Gross error occur due to 1)taking wrong reading 2)reading with parallax error 3) incorrect adjustments of zero and full scale (calibration is not done properly) 4)improper application of instruments 5)wrong computation: when power is to be determined V and I are measured. If computation goes wrong even though V and I are measured correctly measurement of power goes wrong Gross error can be corrected by taking readings correctly without parallax error, calibrating the instrument properly using proper instruments and doing calculations correctly	3 marks	3 marks	3 marks
II.4	 	3 marks	3 marks	3 marks

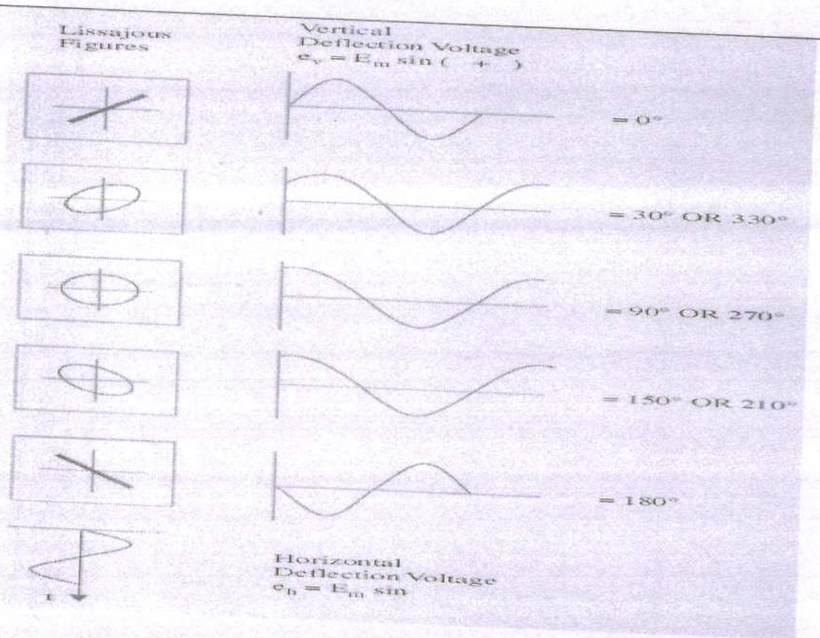
II.5	AC current is changing in each half cycle, so there will be a corresponding change in the direction of magnetic flux. Because of this change of magnetic flux, the torque on moving coil will also change in each half cycle of AC quantity to be measured The direction of Now if the direction of magnetic flux is reversed at each time the direction of AC quantity changes, through the moving coil then a unidirectional torque will developed so as to measure the AC quantity. To provide this as in figure above, the Fixed Coil as well as Moving coil is in series. Therefore, the direction of current in the moving coil is same as that in the fixed coil. This means that as the direction of magnetic field changes, the direction of current in moving coil also changes. Thus the torque on the moving coil will not change rather it will be unidirectional	Fig:1.5 marks Expln: 1.5 marks	1.5 + 1.5 =3	3
II.6	The bombarding electrons striking on the CRT screen releases secondary emission electrons. This of secondary electron should be removed to keep CRT screen in electrical equilibrium. This secondary electrons are collected by the aqueous solution of graphite called aquadag coated and connected to anode.	3 marks	3	3
II.7	Voltmeter calibration, ammeter calibration, wattmeter and energy meter testing, measurement of self reactance of a coil, magnetic testing, testing of instrument transformers	1*3 marks (any 3)	3	3
II.8	1. Temperature measurement – the thermistors large change in resistivity with change in temperature provides good accuracy and resolution 2. Temperature control- temperature control systems are very sensitive, stable, and fast acting requiring simple circuitry 3. Temperature compensation-due to the negative temperature coefficient of thermistors they are used to compensate temperature effects 4.Thermal conductivity measurements	Any3 1*3=3 marks	3	3
II.9	1. Fundamental transducer parameters : type, range of measurand, sensitivity, excitation 2. Physical condition- mechanical and electrical connections, mounting provisions, corrosion resistance 3.Ambient conditions nonlinearity effects, hysteresis effects,	0.5x6= 3 marks	3	3

	frequency response, resolution 4.Environmental conditions-temperature effects, acceleration, shock and vibration 5.compatibility of the associated equipment- zero balance provisions, tolerance, impedance matching, insulation resistance 6. Application basis			
II.10	 Asymmetric crystalline materials such as quartz, Rochelle salt produce an emf when they are placed under stress. This property is used in piezoelectric transducers where a crystal is placed between a solid base and force summing member as in figure. An externally applied force entering the transducer through its pressure port, applies the pressure to the top of the crystal. This produces an emf across the crystal proportional to magnitude of applied pressure	Fig:1.5 marks Expln: 1.5 marks	1.5 + 1.5 =3	3
	PART C			
III.1	Radial Vane Repulsion Type Instrument :construction A repulsion type instrument consists of a fixed field coil and two vanes present inside the coil, out of which one vane is fixed and the other vane is movable. The fixed vane is attached to the coil whereas the movable vane is mounted on the spindle of the instrument. The spindle carries the pointer which moves on a graduated scale	Fig: 3marks Construction: 2marks Working 2marks	3 + 2 + 2 =7	7

	 Repulsion type. If the vanes are radial, then it is called radial vane repulsion type instrument as shown below. It consists of two iron strips (vanes) are placed radially, in which one is fixed and the other is movable. Working; Initially, the current does not pass through the coil. Hence, the two vanes will touch each other and the pointer does not deflect Whenever current flows through the coil, a magnetic field is set up in it and two vanes are magnetized with the same polarities i.e., north poles are produced at one end in both the vanes and south poles are produced on their other ends. Due to this, a repulsive force exists between two vanes and the movable vane tries to move away from the fixed vane .The movable vane moves because of the repulsive force, and the pointer which is mounted on a spindle show deflection.			
III.2	A multimeter can be used to measure electrical functions such as voltage, current, resistance, continuity and some are able to measure electrical frequency.  The block diagram shows that the input terminal is connected to a mode selector switch. The mode selector switch has five positions. In the first position of the switch the input goes to ohms select. In this mode the input to the multimeter is an unknown resistance. The second position of the range switch is marked as Volts (A.C.).	Block diagram: 4marks Expln: 3marks	4+3=7	7

	The input signal as an unknown alternating voltage will go to the calibrated attenuator. The output of the attenuator will go to the precision AC to DC converter. The output of the AC/DC convener will go, to the DVM module. The third position of the switch is marked as current (A.C.). to measure unknown current. In the fourth position the direct current can be measured. The fifth position is marked as volts D.C. The input is the unknown voltage. This voltage passes through a calibrated attenuator. A basic digital multimeter (DMM) is made up of several AID converters, circuitry for counting and an attenuation circuit.			
III.3	 <u>Electron gun</u> The electron gun section provides a sharply focused electron beam directed towards the fluorescent coated screen. This section starts from thermally heated cathode which emits electrons. Control grid , controls the number of electrons in the beam going to the screen. Since the electron beam consists of many electrons, the beam tends to diverge .To compensate such repulsive forces an adjustable electrostatic field is created between two cylindrical anodes called focusing anodes. The high positive potential is also given to pre accelerating anode and accelerating anode which accelerates the electron beam The deflection system consists of 2 pairs of parallel plates- vertical and horizontal deflection plates. Fluorescent screen: The front portion of the CRT is the **faceplate**. The inner surface of the faceplate is coated with a **phosphor** which emits light when bombarded with electrons Aquadag- collects secondary electrons	Fig: 4marks Expln: 3arks	4 + 3 = 7	7
III.4	A Lissajous figure is displayed on the screen when sinusoidal signals are applied to both horizontal & vertical deflection plates			

	of CRO. From Lissajous figures based on their shape, the phase difference between the two sinusoidal signals can be easily calculated Lissajous figure is a straight line with inclination 45^0 with positive axis then phase difference between signals is 0 Lissajous figure is a straight line with inclination 135^0 with positive axis then phase difference between signals is 180 Lissajous figure is a circular then phase difference between signals is 90^0 or 270^0 Lissajous figure is a elliptical, if major axis having inclination between 0^0 and 90^0 with positive axis, then phase difference is $\phi = \sin^{-1}\left(\frac{x_1}{x_2}\right) = \sin^{-1}\left(\frac{y_1}{y_2}\right)$ Lissajous figure is a elliptical, if major axis having inclination between 90^0 and 180^0 with positive axis, then phase difference is $\phi = 180 - \sin^{-1}\left(\frac{x_1}{x_2}\right) = 180 - \sin^{-1}\left(\frac{y_1}{y_2}\right)$ **Where,** x1 is the distance from the origin to the point on x-axis, where the elliptical shape Lissajous figure intersects x2 is the distance from the origin to the vertical tangent of elliptical shape Lissajous figure various lissajous patterns are shown below	Fig: 3marks expln: 4marks	3 + 4 = 7	7



III.5

The basic advantage of digital operation is the storage capability, the stored waveform can be repetitively read out, thus making transients appear repetitively and allowing their convenient display on the scope screen.
The analog voltage input signal is digitized in a 10 bit A/D converter . The total digital memory storage capacity is 4096 for a single channel, 2048 for two channels each and 1024 for four channels each.
The analog input voltage is sampled at adjustable rates and data points are read onto the memory

Once the sampled record of the event is captured in memory, many useful manipulations are possible, since memory can be read out without being erased.

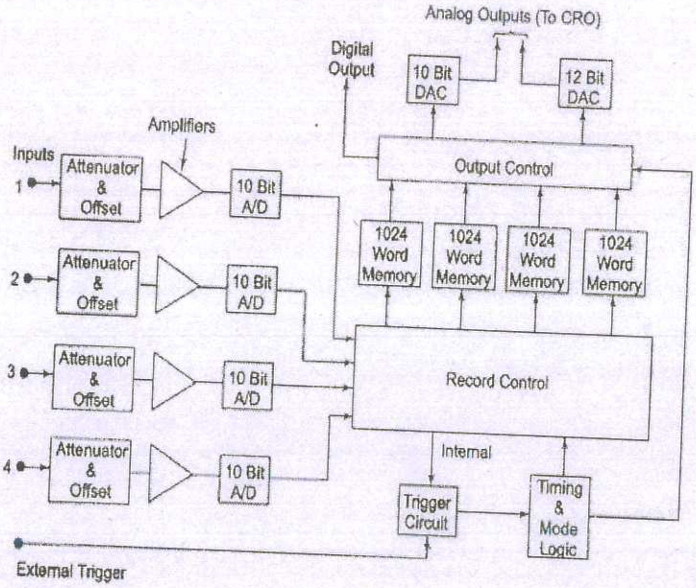


Fig:4marks
expln:3 marks

4+3=7

7

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<td>III.6</td>
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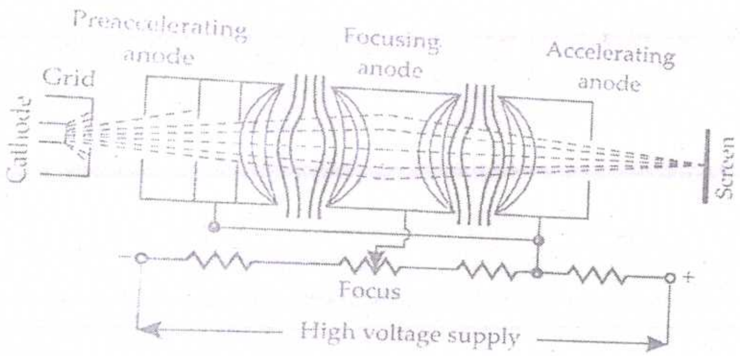

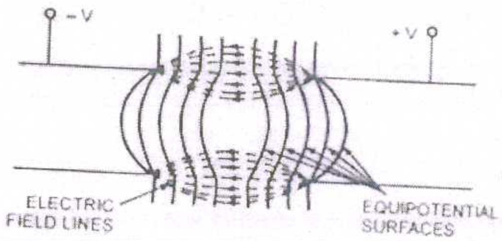

The pre-accelerating and accelerating anodes are connected to the same potential while the focusing anode is connected to a lower potential. On account of the difference of potential between focusing anode and the two accelerating anodes, a non-uniform field exists on each of the two ends of the focusing anode

Electrons entering at the centre line of the two anodes experience no force but electrons displaced from the centre line experience a force normal to the direction of equipotential surface and deflect.The electron beams entering the field at angles other than the normal to the equipotential surfaces will be deflected towards the normal and the beam is thus focused towards the centre of the tube axis.
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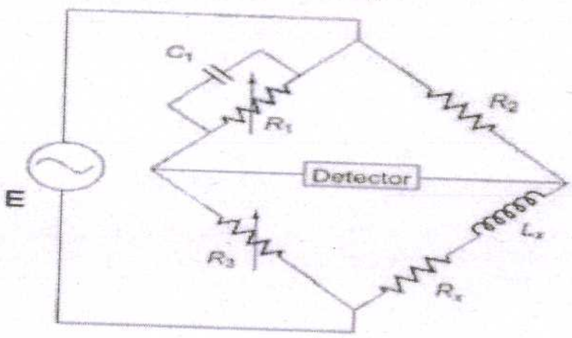
The bridge used for the measurement of self-inductance of the circuit is known as the Maxwell bridge.



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<td>Fig:
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$$Z_1 = \frac{R1}{1 + j\omega R_1 C1}$$

$$Z_2 = R2$$

$$Z3 = R3$$

$$Z4 = Rx + j\omega Lx$$

- At balance,

$$Z_1 Z_x = Z_2 Z_3$$

$$(\frac{R1}{1+j\omega R_1 C1})(Rx + j\omega Lx) = R2\ R3$$

$$(R1)(Rx + j\omega Lx) = R2\ R3(1 + j\omega R_1 C1)$$

$$R1Rx + j\omega R1Lx = R2\ R3 + j\omega R_1 R2R3C1$$

Equating real parts,

$$R1Rx = R2R3$$

$$Rx = \frac{R2R3}{R1}$$

Equating imaginary parts,

$$j\omega R1Lx = j\omega R_1 R2R3C1$$

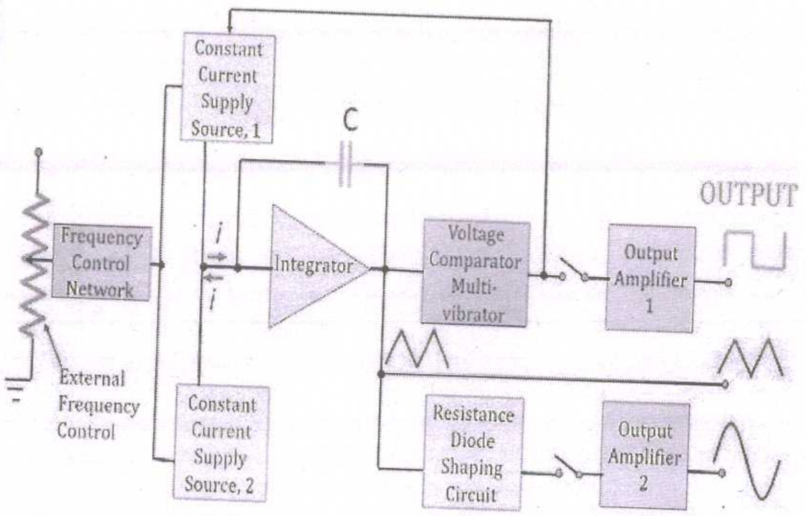
$$Lx = R2R3C1$$

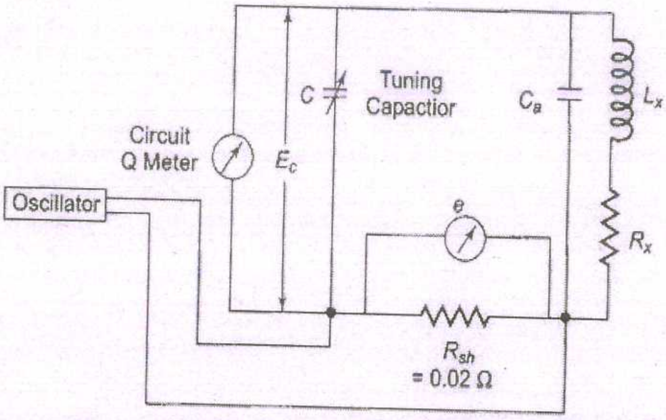
Also,

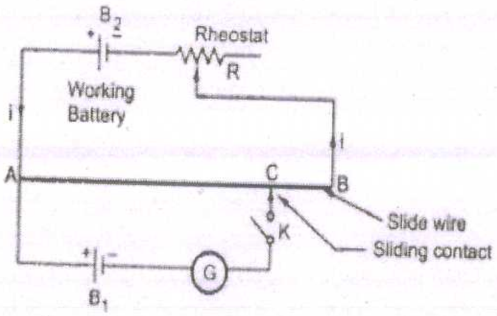
$$\text{Q factor of coil} = \frac{\omega Lx}{Rx}$$

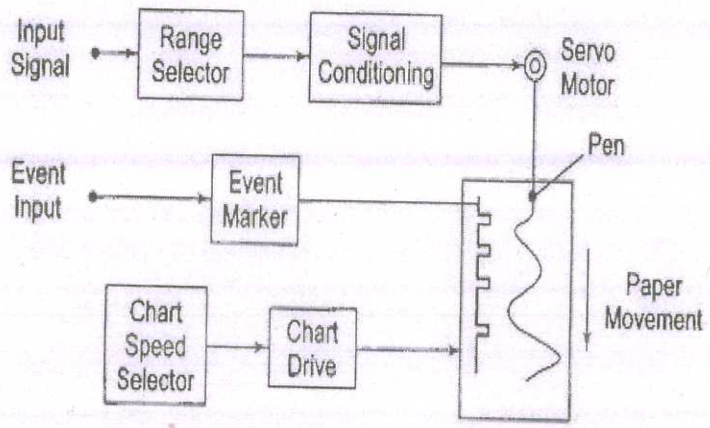
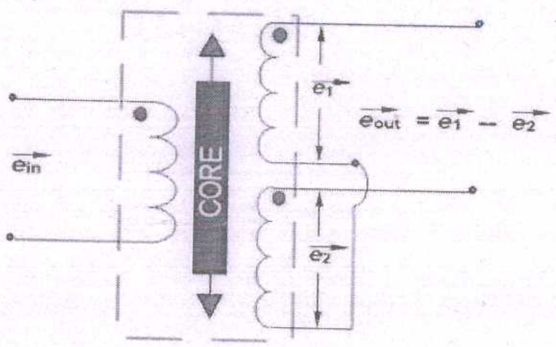
$$= \frac{\omega\ R2R3C1}{\frac{R2R3}{R1}}$$

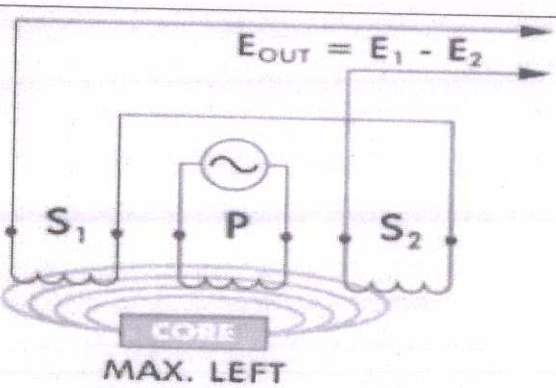
$$\text{Q factor of coil} = = \frac{\omega\ R1R2R3C1}{R2R3} = \omega R1C1$$

III.8	 A frequency control network used here whose frequency is controlled by the variation in the magnitude of current. The current sources 1 and 2 drives the integrator. A constant current is supplied to the integrator by current supply source 1. Due to this, the voltage of the integrator rises linearly with respect to time. This linear rise is according to the output signal voltage equation: $V_{out} = \frac{-1}{C}\int_0^t i\,dt$ Any increase or decrease in the current will resultantly increase or decrease the slope of the voltage at the output and thus controls the frequency. The Voltage Comparator Multi-vibrator present here cause variation in the state of the integrator output voltage at a previously determined maximum level. Due to this change of state, the current supply from source 1 cuts off and switches to supply source 2. A reverse current is supplied to the integrator by current source 2. This reverse current cause drops in the output of integrator linearly with time. As before this time also, when the output attains a predetermined level, the comparator again changes its state and switches to current supply source 1. Thus we will have a triangular wave at the output of the integrator whose frequency depends on current by the supply sources as we can see in the block diagram shown above. A square wave signal is obtained at the output of the comparator.	Block diagrm: 4marks Expln: 3marks	4 + 3 = 7	7

	The resistance diode network employed in the circuit changes the slope of that triangular wave with distortion less than 1%. The output amplifier thus helps to provide two waves at the output simultaneously. This captured signal can be displayed by using an oscilloscope.			
III.9	The Q Meter Working Principle is based on series resonant R,L,C circuit ie: the voltage drop across the coil or capacitor is Q times the applied voltage since, $Q = X_L/R$ At resonance $X_L = X_C$ and $E_L = IX_L$, $E_C = IX_C$, $E = I\,R$ Where E – applied voltage, E_C – capacitor voltage, E_L – inductive voltage ,X_L – inductance reactance, X_C – capacitive reactance, R – coil resistance, I – circuit current $Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{E_C}{E}$ if E is kept constant the voltage across the capacitor can be measured by a voltmeter calibrated to read directly in terms of Q. Circuit:  • The variable frequency RF oscillator delivers current to low resistance Rsh. This shunt resistance represents a voltage source of magnitude "e "to tank circuit. • The voltage across the shunt is measured with a thermocouple meter. The voltage across the capacitor is measured by an electronic voltmeter corresponding to Ec and calibrated directly to read Q. • The oscillator energy is coupled to the tank circuit. The circuit is tuned to resonance by varying C until the electronic voltmeter reads the maximum value • The resonance output voltage E, corresponding to Ec is E = Q x e, that is, Q = E/e. Since e is known, the electronic voltmeter can be calibrated to read Q directly.	Principle: 3mark Ckt: 2marks Expln: 2marks	3 + 2 + 2	7marks

III.10	 The basic potentiometer consists of slide wire AB of uniform cross section and length, resistance r. Battery B2 supplies current though side wire with rheostat. Battery B1 whose emf is to be measured is connected series with galvanometer n switch K When witch K is opened, current through slide wire is I, if the siding contact at position, let l the length of AC, then voltage drop across AC=irl When K is closed, battery B1 whose emfis to be measuredis connected such that voltage drop across slide wire and emf of B1 opposes each other Deflection of galvanometer depends on magnitude of voltage drop across AC. And emf of B1. If the voltage drop across AC is greater than B1 then current flow from A to C. If the voltage drop across AC is less than B1 then current flow from C to A.no currents flows when these two are equal. a scale is provided with slide wire to measure length AC. Hence to measure unknown emf fist adjust current thrroug slide wire with switch K open, then insert battery whose emf is measured. By closing switch adjust slide wire so to get null deflection in galvanometer. measure length of slide wire, then unknown emf= irl	Fig: 3marks Expln: 4marks	3 + 4 = 7	7
III.11	Strip Chart Recorder Working Principle is data is recorded on a continuous roll of chart paper moving at a constant speed. The basic element of a Strip Chart Recorder Working Principle consists of a pen (stylus) used for making marks on a movable paper, a pen (stylus) driving system, a vertically moving long roll of chart paper and chart paper drive mechanism and a chart speed selector switch Most strip chart recorders use a servo feedback system, to ensure that the displacement of the pen (stylus) across the paper tracks the input voltage in the required frequency range. A potentiometer system is generally used to measure the position of the writing head (stylus).	Block diagrm: 4marks Expln: 3marks	4 +3 =7	7

				
III.12	Linear Variable Differential Transformer (LVDT) is an Electromechanical type inductive transducer that converts rectilinear displacement into the AC Electrical Signal. The working principle of LVDT is based on the mutual induction principle.  When AC excitation is applied to the primary winding, then a magnetic field is produced. This magnetic field induces a mutual current in secondary windings. Let the induced voltages in secondary windings (S1 & S2) are E1 & E2 respectively. Since both the secondary windings are connected in series opposition, So the net output voltage will be the difference of both induced voltages (E1 & E2) in secondary windings. Hence Differential Output of LVDT will be E0 = E1 – E2 According to the position of the core, there are three cases Case:1 When the core moves towards S1 (Max Left).	Fig: 3marks Expln: 4marks	3+ 4= 7	7

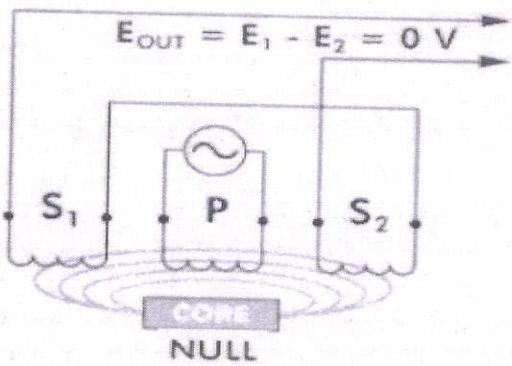


in this case, the flux linkage with S1 will be more as compared to S2. This means the emf induced in S1 will be more than the induced emf in S2. Hence E1>E2 and Net differential output voltage E0 = E1 – E2 will be positive. This means the output voltage E0 will be in phase with the primary voltage.

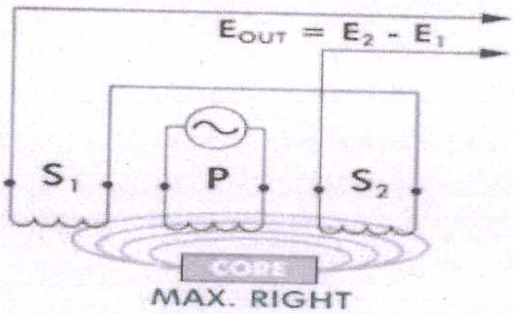
Case:2When the core is at Null position.

When the core is at the null position then the flux linkage with both the secondary windings will be the same.So the induced emf (E1 & E2) in both the windings will be the same. Hence the Net differential output voltage E0 = E1 – E2 will be zero (E0 = E1 – E2 = 0).

It shows that no displacement of the core.



Case:23 when the the core moves towards S2 (Max Right).



in this case, the flux linkage with S2 will be more as compared to S1.It means the emf induced in S2 will be more than the

	induced emf in S1. Hence E2>E1 and Net differential output voltage E0 = E1 – E2 will be negative. It means the output voltage E0 will be in phase opposition (180 degrees out of phase) with the primary voltage.				