MODEL ANSWER

WINTER– 18 EXAMINATION

Subject Title: Electronics Measurements &Instrumentation

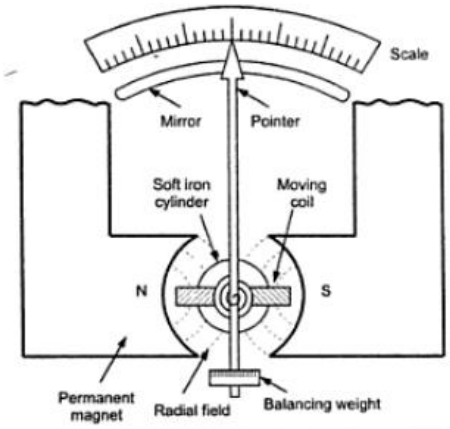
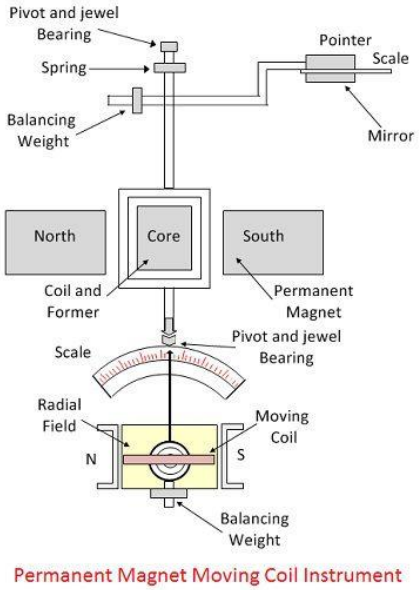
Subject Code: 22333

Important Instructions to examiners:

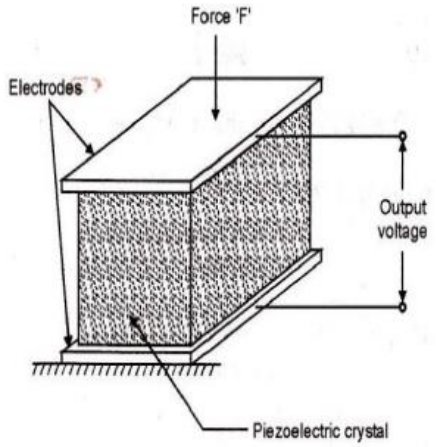
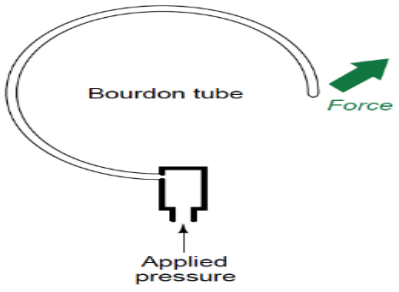
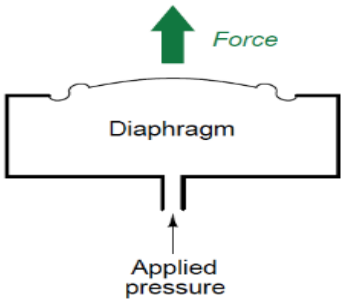
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

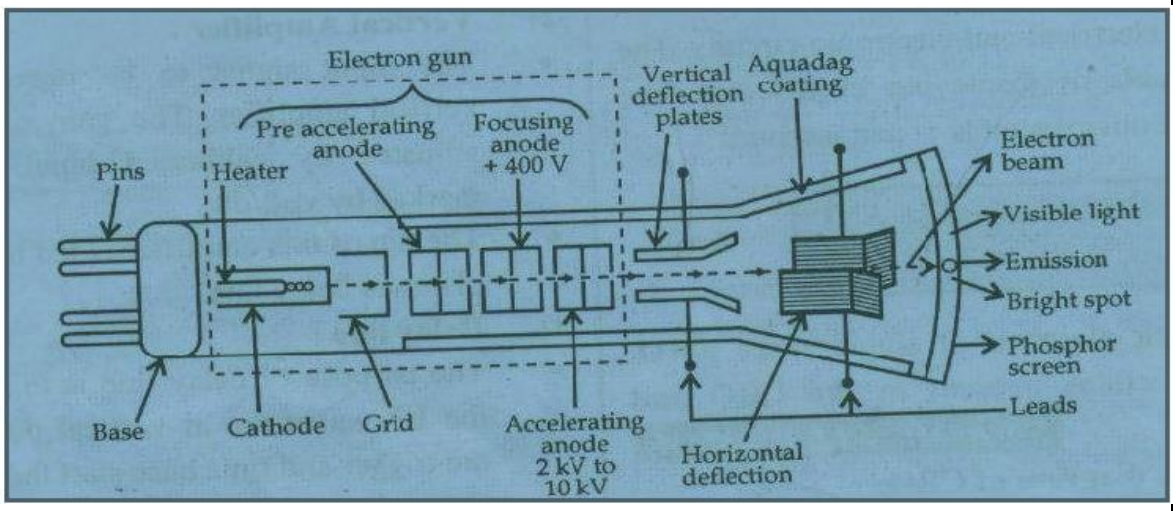
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following :**	**10-Total Marks**
	a)	**Define:** **(i) Absolute Instrument** **(ii) Secondary Instrument**	**2M**
	Ans:	**i)Absolute Instrument**:An instrument whose calibration can be determined by means of physical measurements on the instrument. **ii)Secondary Instrument**:Secondary instruments are those, in which the value of electrical quantity to be measured can be determined from the deflection of the instruments, only when they have been pre-calibrated by comparison with an absolute instrument.	**Each definition -1M**
	b)	**State the meaning of PT-100.**	**2M**
	Ans:	**PT** –Stands for platinum, **100**–stands for 100Ωat 0^0 centigrade. PT -100 is a RTD made up of platinum having 100Ω resistance at 0^0 centigrade.	**1M** **1M**
	c)	**List applications of ohmmeter.**	**2M**
	Ans:	**1.** The ohmmeter is a meter for measuring electrical resistance in ohm. **2.** It is used as Megger to measure high resistance.	**01M for each**

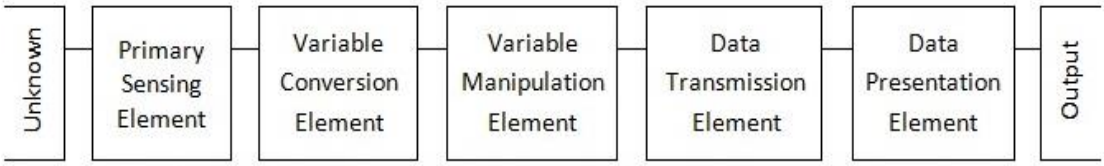
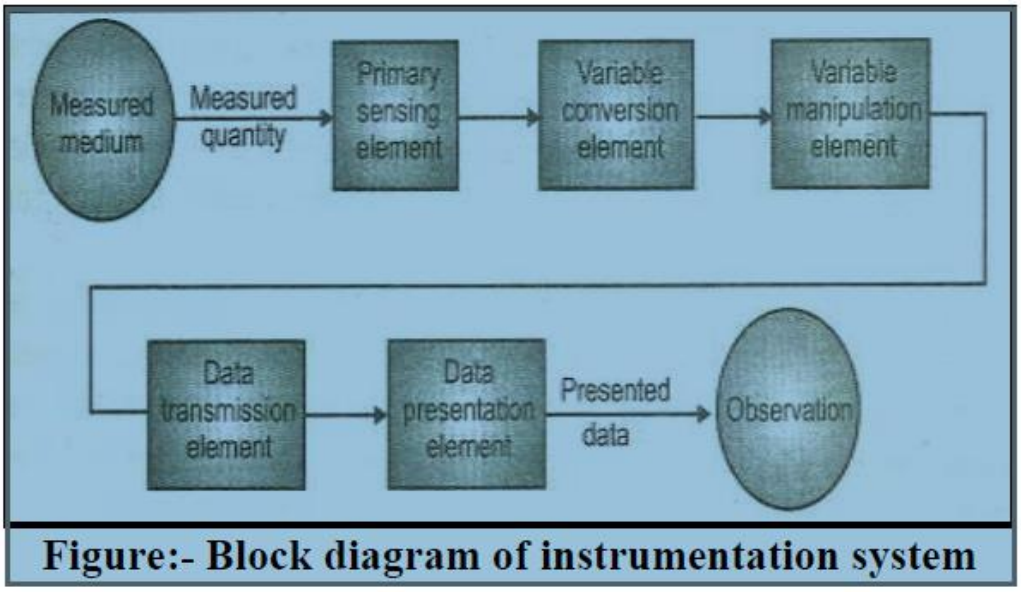
	3. It is used to test the power circuits.	
d)	**State different types of errors in Instruments.**	**2M**
Ans:	There are three types of error 1) **Gross Error**: These errors are mainly human mistakes in reading instruments and recording and calculating measurement results. 2) **Systematic Error** : These types of error are divided into three categories i) Instrumental Errors :Instrumental error is due to inherent shortcomings in the instrument, ii)Environmental Error:Environmental errors are due to conditions external to the measuring device including conditions in the area surrounding the instrument. iii) Observational Error: It is due to wrong method followed by operator to read analog meter used by operator 3) **Random Error**.:These errors are due to unknown causes which are not determinable.	**½ M - Gross** **1 M – Systematic** **½ - Random**
e)	**State need of delay line in CRO.**	**2M**
Ans:	The delay line is used in CRO to delay the signal for some time in thevertical sections. As horizontal channel consists of trigger circuit andtime based generator. This causes more time to reach signal tohorizontal plates than vertical plates. For synchronization of reachinginput signal at same time to both the plates in CRT.	**2 M**
f)	**Differentiate AC and DC signal conditioning.**	**2M**
Ans:	<table><tr><th>AC signal conditioning</th><th>DC signal conditioning</th></tr><tr><td>Excitation source is only AC for AC signal conditioning.</td><td>Excitation source can be ac or dc for DC signal conditioning.</td></tr><tr><td>AC signal conditioning is calibrated at comparatively high frequency.</td><td>DC signal conditioning easy to calibrate at low frequency.</td></tr><tr><td>Demodulation is present in AC.</td><td>Demodulation is absent in DC.</td></tr></table>	**Any 2 points – 1 mark each (Any relevant point marks can be given)**
g)	**State selection criteria of transducer.**	**2M**
Ans:	**The following points should be considered while selecting a transducer for particular application**. 1. Operating range 2. Operating principle 3. Sensitivity 4. Accuracy 5. Frequency response and resonant frequency 6. Errors	**Any 2 -2M**

		7. Environmental compatibility 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. General selection criteria	
Q 2		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Explain working principle of PMMC instrument with diagram.**	**4M**
	Ans:	**Diagram:**  **Or**  Permanent Magnet Moving Coil Instrument **Working: 2M** • When current passes through the coil a deflecting torque is produced. This deflecting torque is produced due to interaction between magnetic field produced by permanent magnet and magnetic field produced by moving coil.	**2M** **2M**

		• Due to this torque the coil deflects and this deflection is proportional to the current flowing through the coil. The pointer attached to the coil indicated the magnitude of quantity being measured. The another torque is developed by the hair spring known as controlling torque. • This torque helps to stabilize the pointer. The pointer becomes stable at equilibrium; this is possible only when the controlling torque becomes equal to the deflecting torque.	
	b)	**State and explain different types of standards.**	**4M**
	Ans:	1**. International Standards**: • These are defined on the basis of international agreement. • They represent the units of measurements which are closest to the possible accuracy attainable with present day technological and scientific methods. • International standards are checked and evaluated regularly against absolute measurements in terms of the fundamental units. • These standards are maintained at the International Bureau of Weights and Measures and are not available to the ordinary user of measuring instruments for the purposes of calibration or comparison. 2.**Primary Standards**: • 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. 3.**Secondary Standards**: • 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 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**.** **4.Working standards** • These standards are used to check and calibrate general laboratory instrument for their accuracy and performance. • The working standards of mass and length are available in a wide range of values so that, they suit any kind of application.	**1M each standard**

	c)	**Describe the working principle of Piezo-Electric Transducer.**	**4M**
	Ans:	**Diagram:**  **Fig. Piezoelectric Crystal**	**2M**
		Principle of operation: When a pressure or force or vibration applied to the crystalline material like quartz crystal or crystalline substances then an e.m.f. is generated across the material or vice versa.	**2M**
	d)	**Compare Bourdon tube with Bellows.**	**4M**
	Ans:	**Bourdon tube** / **Bellows**   Bourdon tube excels in Medium to high pressure applications / Bellows gauges excel in low pressure applications Bourdon tube is comparatively less sensitive to low pressure than bellows / Bellows are comparatively more sensitive to low pressure than Bourdon tube Bourdon tube are not used to ,measure differential pressure. / Bellows are useful to measure differential pressure.	**Consider other relevant point if any Each point – 1M**
Q.3		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Define calibration and state its need.**	**4M**
	Ans:	**Calibration:** Calibration is a process of estimating the value of a quantity by comparing	**2M**

		that quantity with standard quantity. The standard with which comparison is made is called as standard instrument. **Need:** 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. Calibration of your measuring instruments has two objectives. It checks the accuracy of the instrument and it determines the traceability of the measurement. In practice, calibration also includes repair of the device if it is out of calibration. A report is provided by the calibration expert, which shows the error in measurements with the measuring device before and after the calibration.	**definition** **2M -Need**
b)	**Draw labelled diagram of CRT.**		**4M**
Ans:			**4M for neat labeled Diagram**
c)	**Identify Active and Passive transducers from: RTD, Piezoelectric transducer, Strain gauge, LVDT.**		**4M**
Ans:	**Active transducer:** Piezoelectric transducer **Passive transducer:** RTD, LVDT, Strain gauge		**1 for Each**
d)	**Voltmeter never connected in series with source of emf. Justify it.**		**4M**
Ans:	1. The connecting of voltmeter in series is equivalent to connecting a very high resistance in series with the circuit. 2. By this only small insignificant amount of current flow through the circuit and nearly results in an open circuit. 3. So resultant power should be minimum or may be in other words saying zero power from the circuit. 4. Voltmeter when connected in parallel between a point and ground potential it takes in very less power because of the low current passing through it. If you connect it in series that would make your circuit transformed totally, which causes high potential difference across the voltmeter and you cannot measure the actual potential difference.		**4M for relevant justification**

Q.4	A)	Attempt any THREE of the following :	12-Total Marks
	a)	Describe function of each block of Instrumentation system.	4M
	Ans:	**Block Diagram:**  **(OR)**  **Figure:- Block diagram of instrumentation system** **Functions of each block:** **Primary sensing element:** This first receives energy from the measured medium and produces an output depending on measured quantity. **Variable conversion element:** Converts the output signal of the primary sensing element into a more suitable variable or condition useful to the Function of the instrument. **Variable manipulation element:** Manipulates the signal represented by some physical variable, to perform the intended task of an instrument. In the Manipulation process, the physical nature of the variable is preserved. **A data transmission unit:** Transmits the data from one element to the other.	**2M Diagram** **2M**

A data presentation element:
Performs the translation function, such as the simple indication of a pointer moving a scale or the recording of a pen Moving over chart.

b) **Compare Analog and Digital meters on:** **4M**

i) **Principle**
ii) **Accuracy**
iii) **Resolution**
iv) **Example**

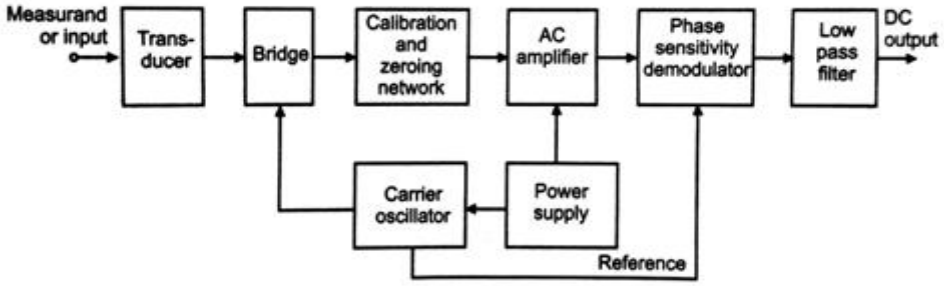
Ans: **1M for Each Parameter**

Parameter	Analog meter	Digital meter
Principle	The meter that displays analog signals is called as an analog meter	The meter that displays Digital signals is called as an Digital meter
Accuracy	Low	High
Resolution	Low	High
Example	PMMC instrument, analog ammeter, analog voltmeter.	DMM, DVM, Logic Analyzer, Spectrum Analyzer.

c) **Explain block diagram of AC signal conditioning.** **4M**

Ans:

Diagram: **2M**

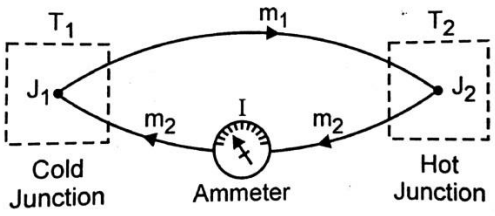
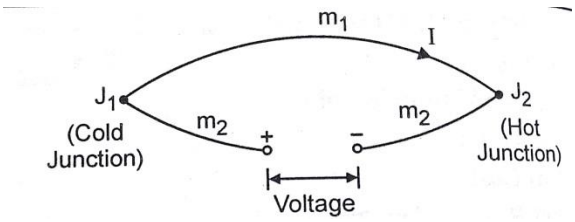


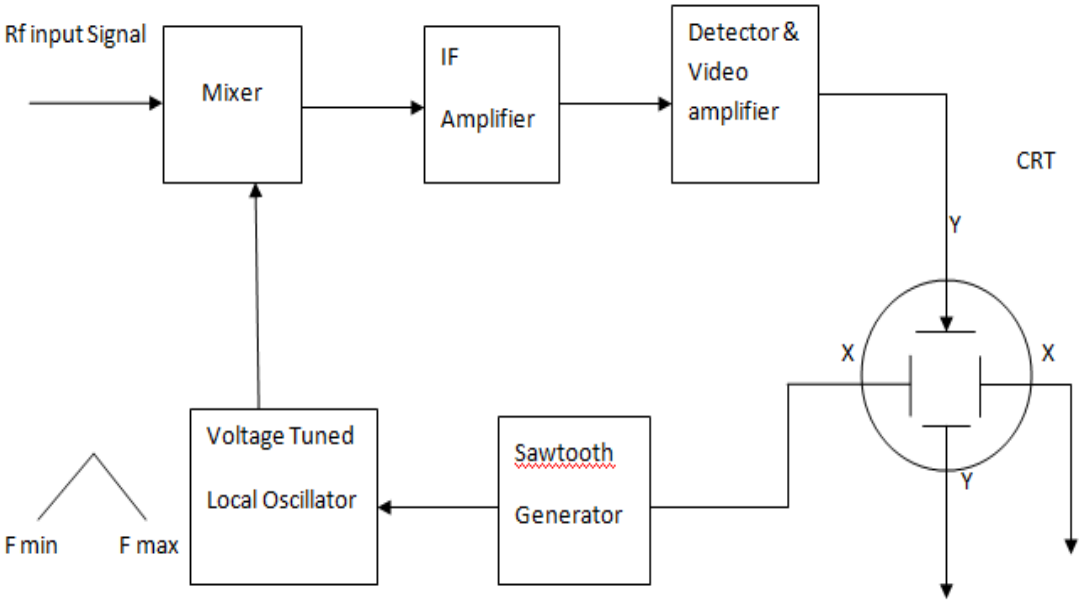
Explanation: **2M**

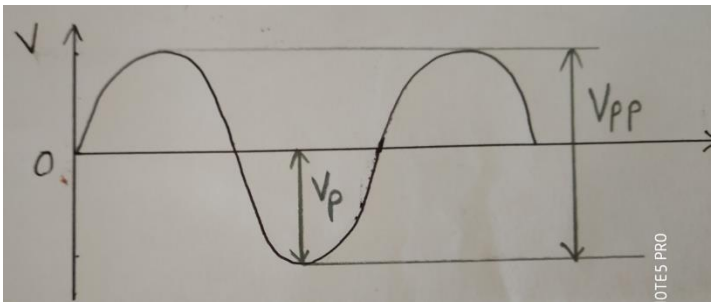
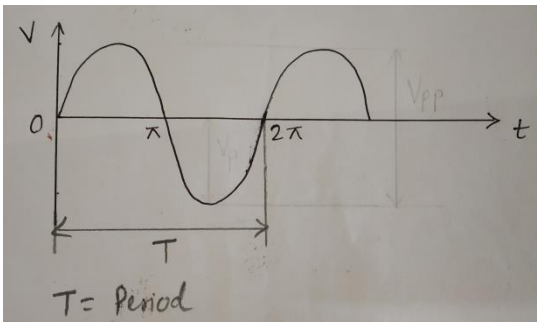
1. The transducers used are the variable resistance or variable inductance transducers. They are employed in the range of frequencies from 50 Hz to 200 KHz where the carrier frequency is much higher, and that are 5 to 1 times the signal frequency.

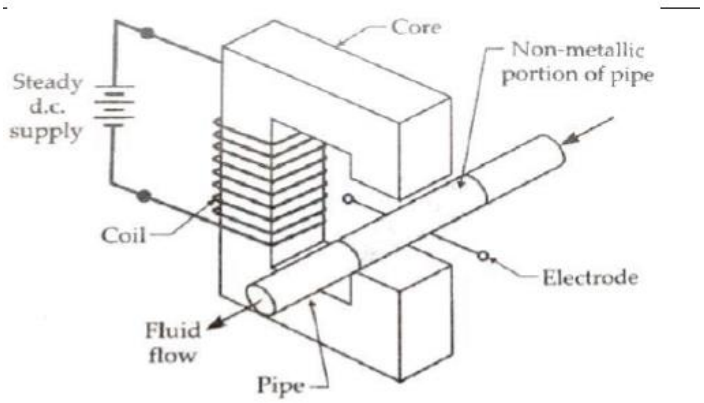
2. Transducer parameter variations amplitude modulate the carrier frequencies at the bridge output, the waveform is amplified and demodulated.

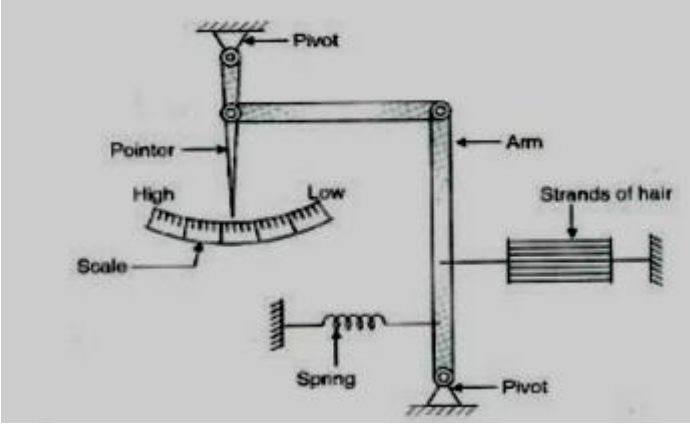
3. The demodulation is Phase sensitive, so that the polarity of the d.c. output indicates the

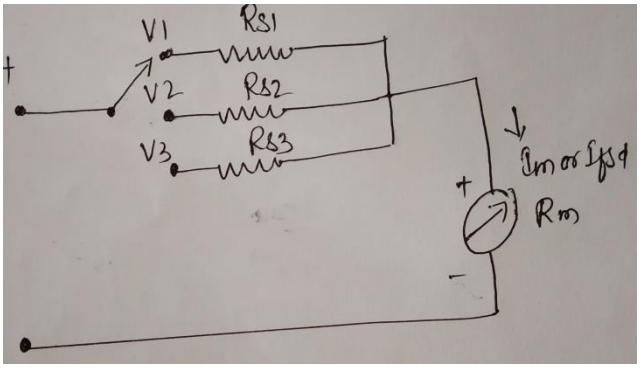
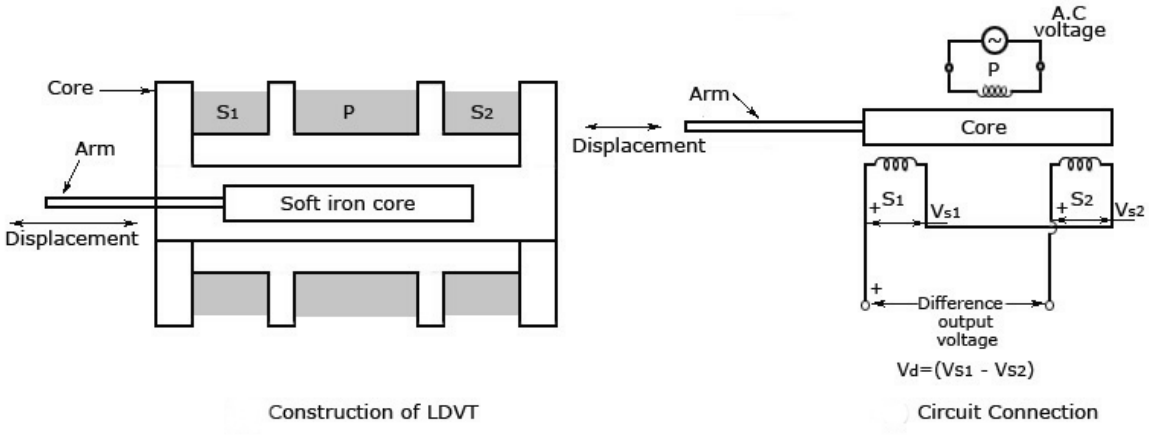
		direction of the parameter change in the bridge output. 4. It is difficult to achieve a stable carrier oscillator than the comparable d.c. stabilized source. 5. In carrier system it is easy to obtain high CMRR of mains frequency pick-up. 6. Active filters can be used to reject this frequency and prevent overloading of a.c. amplifier. 7. The Phase sensitive demodulators filter out the carrier frequency component of the data signal.	
	d)	**State and explain Seeback and Peltier effects.**	**4M**
	Ans:	**Seeback effect :** Seeback effect states that whenever two dissimilar metals are connected together to form two junctions, out of which, one junction is subjected to high temperature and another junction is subjected to low temperature then e.m.f is induced proportional to the temperature difference between two junctions. Shown in figure.  **Peltier effect :** Peltier effect state that two dissimilar metals closed loop, if currentis forced to flow through the closed loop then one junction will be heated and other will become cool. Shown in figure.  	**2M for Each effect**

	e)	**Explain spectrum analyzer with block diagram.**	**4M**
	Ans:	**Diagram:**  **Explanation:** 1. The main function of spectrum analyzer is to be obtaining the amplitude vs frequency plot from the frequency spectrum under test. They can be classified as scanning type & non-scanning type. 2. Thesawtooth generator generates the sawtooth waveform. This sawtooth waveform is applied to horizontal plates of CRO. The sawtooth signal also applied to voltage tuned local oscillator. 3. This act as frequency controlled element of local oscillator. When sawtooth signal is applied to voltage tuned local oscillator its frequency changes from Fmin to Fmax. 4. The RF i/p signal is applied to the mixer. The o/p of voltage tuned oscillator is used to beat with i/p signal in order to produce intermediate frequency. 5. This, If component is produced when corresponding component is present in i/p signal. The resulting, if signal is applied to detector &video amplifier .If the component is amplified &delectated& then it is applied to vertical deflecting plates of CRO, producing a plot of amplitude vs frequency.	**2M** **2M**

Q.5		Attempt any TWO of the following :	12-Total Marks
	a)	**Explain with sketch procedure to measure frequency and Amplitude using CRO.**	6M
	Ans:	**Amplitude measurement:** The most direct voltage measurement that can be made with the help of oscilloscope is the peak to peak value. In order to measure the voltage from the CRT display, one must observe the vertical attenuator expressed in volts/div and the number of division of the beam. The peak to peak value is then computed as, $$Vp-p=\left(\frac{Volts}{Div}\right)\times\left(\frac{number\ of\ divisions}{1}\right)$$ $Vp=\frac{1}{2}Vpp$ *is the peak value.*  **Time period measurement:** • This interval is the distance between two points within one cycle or several cycles of the waveform. • In order to do the measurement first align the reference point on a graticule line using horizontal position control. $$Period = Number\ of\ divisions\ \times poisition\ of\ \frac{time}{div}\ knob$$  **Frequency measurement:** • The period and frequency of periodic signals are easily measured. • The period is the time between two identical points of successive cycle of the waveform.	**frequency = 2 mark** **Amplitude = 2 marks** **Each sketch 1 mark**

		• The frequency is inversely proportional to the period. $$Frequency = \frac{1}{period}$$	
	b)	**i) Explain working principle of Electromagnetic flow meter.** **ii) Explain procedure to measure humidity using hygrometer.**	**3M** **3M**
	Ans:	**(i) Working principle of Electromagnetic flow meter:**  **Working principle:** Magnetic flow meters works based on Faraday's Law of Electromagnetic Induction. According to this principle, when a conductive medium passes through a magnetic field B, a voltage E is generated which is proportional to the velocity v of the medium, the density of the magnetic field and the length of the conductor. In a magnetic flow meter, a current is applied to wire coils mounted within or outside the meter body to generate a magnetic field. The liquid flowing through the pipe acts as the conductor and this induces a voltage which is proportional to the average flow velocity. This voltage is detected by sensing electrodes mounted in the Magflow meter body and sent to a transmitter which calculates the volumetric flow rate based on the pipe dimensions. The induced voltage E=B L V Where B=flax density wb/m2 L=length of Conductor i.e diameter of pipe in meter v= velocity of Conductor i.e flow m/sec	**Diagram 1 ½ marks** **working principle= 1 ½ marks**

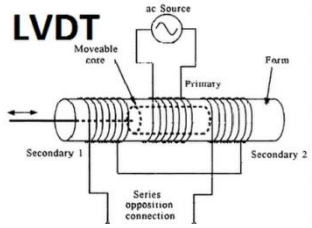
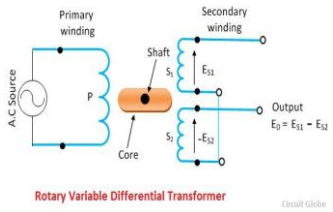
		(ii) Procedure to measure humidity using hygrometer  **Explanation:** • It consists of bunch of human hair which increases mechanical strength of the instrument, arm with pivot joints and points scale assembly. • The element is maintained at slight tension by a spring. The hair strands are generally arranged parallel to each other with sufficient space between them forgiving free access to the air sample whose humidity is to be measured. • The indicator scale is directly calibrated to give a direct indication of humidity. The pointer or recording pen is operated through mechanical linkage. • As the relative humidity surrounding to that of hygrometer increases, length of hair strands increases, which move the pointer on the calibrated scale for maximum value	**Diagram 1½ marks** **Explanation= 1 ½ marks**
	c)	**Design a 'D' Arsonval moment with internal resistance of 60Ω and full scale deflection current 3 mA into a multiranging dc voltage with voltage range of 0 – 20 V, 0 – 40 V, 0- 100 V.**	**6M**
	Ans:	Rm= 60Ω Ifsd= Im= 3mA To find: a) Rs1 b) Rs2 Solution: For range (0-20V), V1=20V Therefore, Rs1= (V1/ Ifsd) – Rm = (20/ $3x10^{-3)}$ - 60 = 6666.66- 60 = 6606.6Ω **Rs1= 6.6 KΩ** For range (0-40V), V2=40V Therefore, Rs2= (V2/ Ifsd) – Rm = (40/ $3x10^{-3)}$- 60	**02 M**

		= 13333.3 - 60 = 13273.3Ω **Rs2=13.273KΩ** For range (0-100V), V3=100V Therefore, Rs3 = (V3/ Ifsd) – Rm = (100/ $3x10^{-3}$)- 60 = 33333.3 - 60 = 33273.3Ω **Rs3=33.273KΩ** 	**02 M** **02 M**
Q.6		**Attempt any TWO of the following:**	**12-Total Marks**
	a)	**i) Explain the working of LVDT with neat diagram.** **ii) Compare LVDT with RVDT.**	**6M**
	Ans:	**i) Working of LVDT with neat diagram.**  Construction and Circuit Connection of LVDT **Working:** LVDT is the example of inductive transducer, in LVDT any physical displacement of the core cause the voltage of any secondary winding to increase while simultaneously reducing the voltage in the other secondary winding. The difference of the two voltages appears across the output terminal of the transducer and gives a measurement of	**LVDT diagram =1 mark**

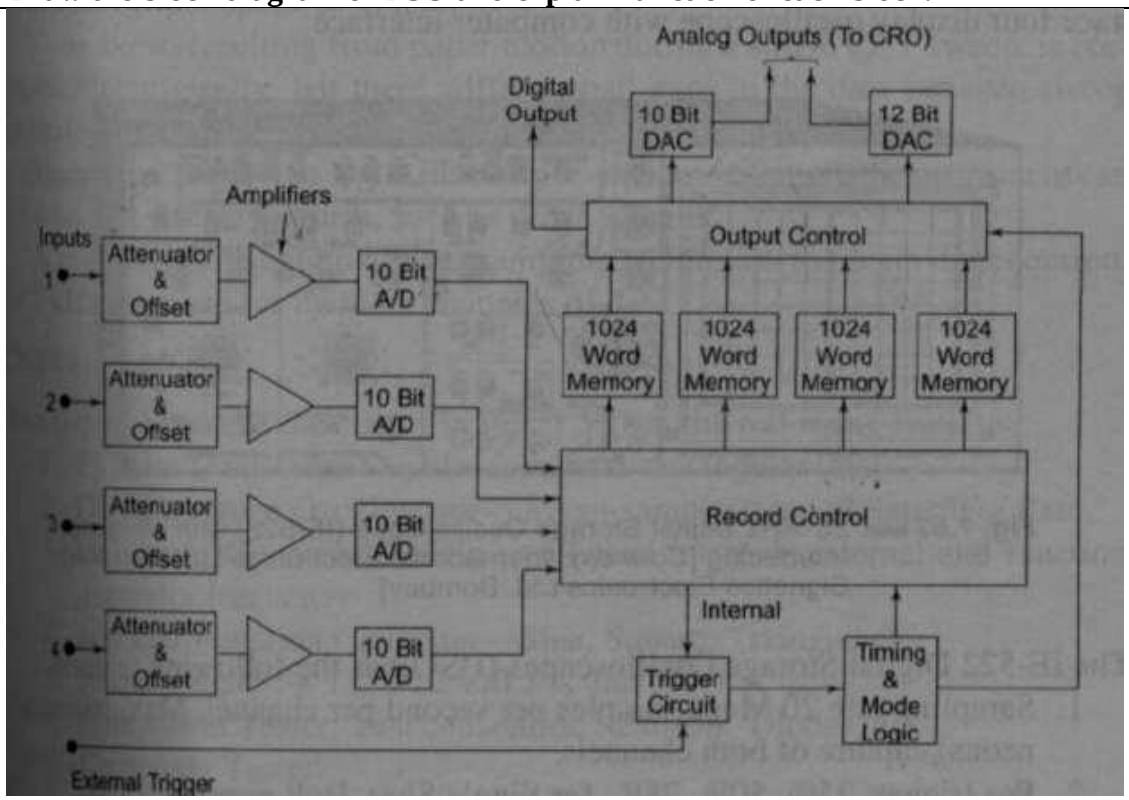
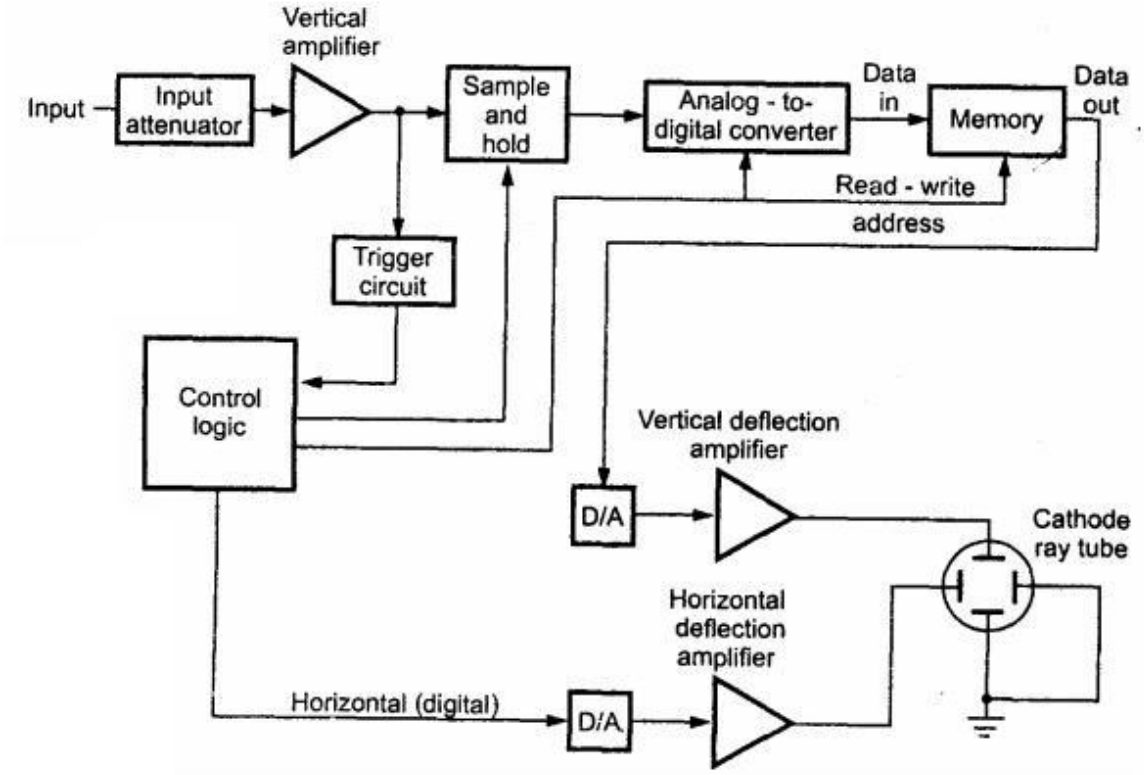
the physical position of the core.

Working= 1 mark

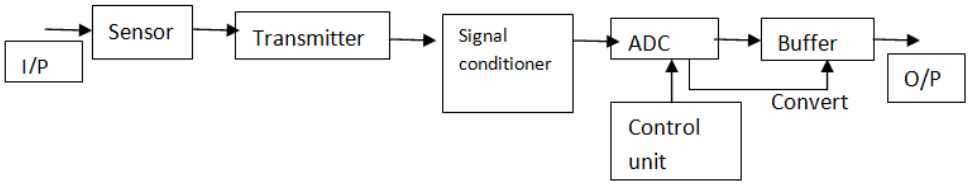
(ii) Compare LVDT with RVDT

Sr. No	Parameters	LVDT	RVDT
1	**Stands for**	Linear Variable Differential Transformer	Rotatory Variable Differential Transformer
2	**Definition**	Converts the linear motions into electrical signals.	Used for measuring the angular displacement
3	**Core shaped**	Rectangle	Cam
4	**Sensitivity**	2.4mv per volt per degree of rotation	2 to 3 mv per volt per degree of rotation
5	**Measuring Range**	±100µm to ±25cm	Upto ±40°
6	**Input Voltage**	1V to 24V RMS	upto 3V RMS
7	**construction**		

Any four points each of 1 mark

	b)	**Draw the block diagram of DSO and explain function of each block.**	**6M**
	Ans:	 OR 	**Block diagram =3 marks**

		The analog voltage input signal is digitized in a 10 bit A/D converter with a resolution of0.1% (1 part in 1024) and frequency response of 25 kHz. The total digital memory storagecapacity is 4096 for a single channel, 2048 for two channels each and 1024 for fourchannels each. The analog input voltage is sampled at adjustable rates (Upto 100, 000 samples per second) and data points are read onto the memory. A maximum of 4096 points are storable in thisparticular instrument. (Sampling rate and memory size are selected to suit the duration andwaveform of the physical event being recorded.) Once the sample record of the vent is captured in memory, many usefulmanipulations arepossible, since memory can be read out without being erased. If the memory is read out rapidly and repetitively, an input event which was a single shottransient becomes a repetitive or continuous waveform that can be observed easily on anordinary scope(without going through DAC) to say a computer where a stored program canmanipulate the data in almost anyway desired. Pre triggering recording allows the input signal preceding the trigger points to be recorded. In ordinary triggering the recording process is started by the rise of the input (or someexternal triggering) above some preset threshold value. As in digital recorder, DSO can be set to record continuously(new data coming into thememory pushes out the old data, once memory is full), until the trigger signal is received then the recording is stopped, thus freezing data received prior to the trigger signal in thememory. An adjustable trigger delay allows operator control of the stop point, so that the trigger mayoccur near the beginning, middle or end of the stored information.	**Explanation 3 marks**
	c)	**i) State need of signal conditioning.** **ii) Explain with sketch function of each block of Data Acquisition System (DAS).**	**2M** **4M**
	Ans:	**i) Need of signal conditioning** The Measured, which is basically a physical quantity as is detected by the first stage of instrumentation or measurement system. The first stage, "detector transducer Stage", the quantity is detected and is transduced into an electrical form. The output of the first stage has to be modified before it became usable and satisfactory to drive the signal presentation stage of the measurement stage may consist of indicating, recording,displaying, data processing element or control systems. Measurement of dynamic physical quantities requires faithful representation of their analog or digital output obtained from the intermediate stage i.e. signal conditioning stage and this places severe strain on the signal conditioning equipment. The signal conditioning equipment may be require doing linear processes like amplification, attenuation, integration, differentiation, addition and subtraction. They are also required to do nonlinear processes like modulation,demodulation,sampling,filtering,clipping,clamping etc.These functions are require to faithful reproduction of output signal for the final data presentation stage.	**2 M**

		(ii)Explain with sketch function of each block of Data Acquisition System (DAS).  Paste neat diagram A single channel DAS consists of a sensor, transmitter and signal conditioner followed by an ADC, performing repetitive conversions at a free running, internally determined rate. The outputs are in digital code. The digital outputs are further fed to storage or a printer, or a computer for analysis Sensor: It is used to detect the physical parameter. Transmitter: It convert output of sensor into electrical form, transmit it, and gives it to signal conditioning circuit Signal conditioning: It is used to shape the signal to require level by filtering , amplifying, removing noise of the signal ADC: It is used to convert analog signal into digital form. Buffer: It is used for impedance matching. Control unit: It is controller which will control conversion of analog signal into digital signal. Output: The output is visible form and can be stored, and retrieved when needed.	**Block diagram = 2M** **Explanation = 2M**