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MODEL ANSWER

WINTER– 18 EXAMINATION

Subject Title: Electronics Measurements &Instrumentation

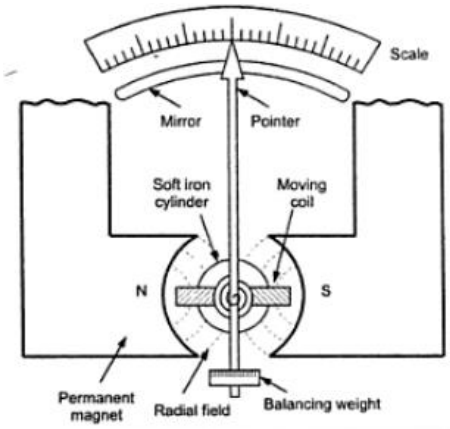
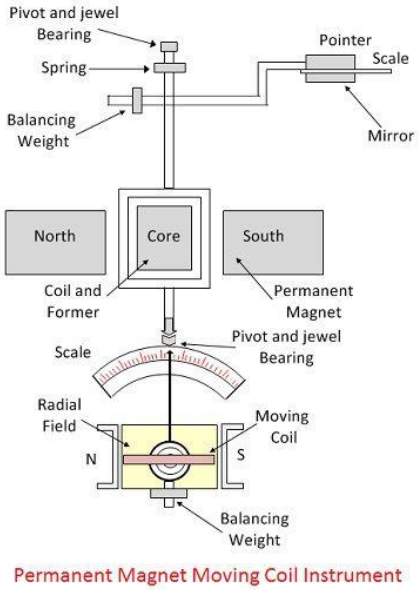
Subject Code: 22333

Important Instructions to examiners:

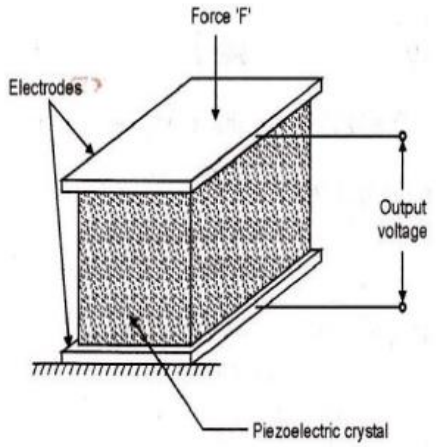
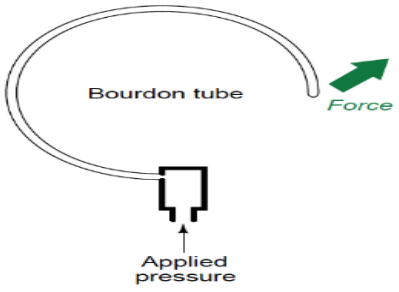
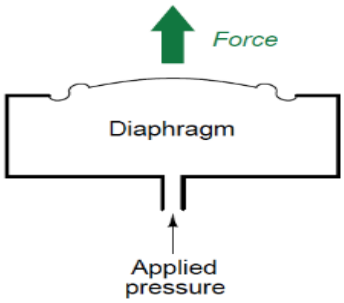
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling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

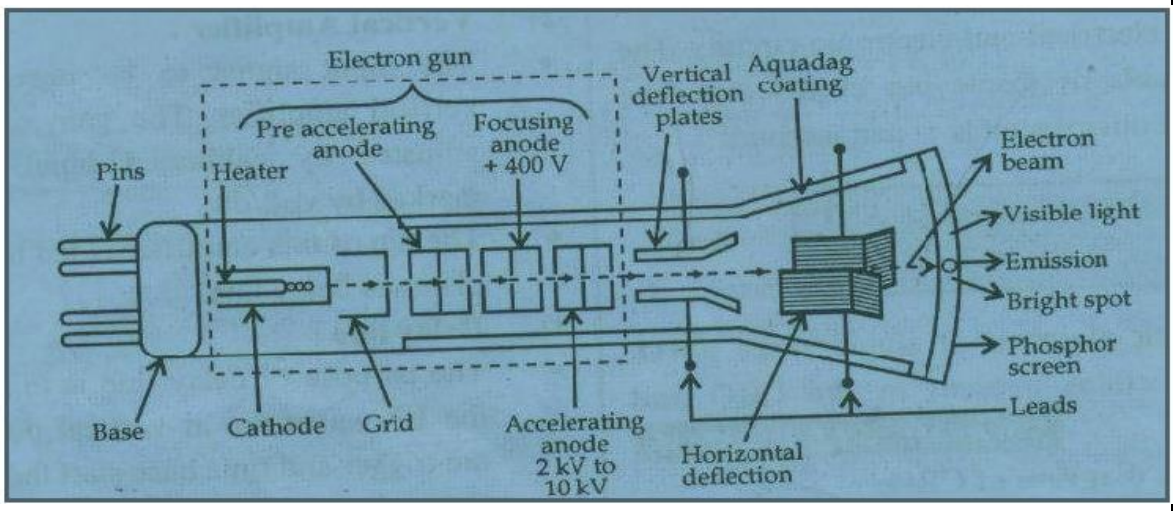
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following :**	**10-Total Marks**
	a)	**Define:** **(i) Absolute Instrument** **(ii) Secondary Instrument**	**2M**
	Ans:	**i)Absolute Instrument**:An instrument whose calibration can be determined by means of physical measurements on 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**

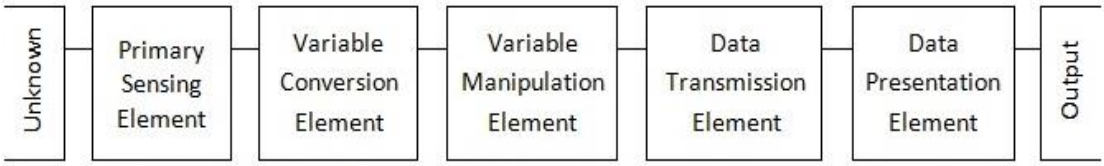
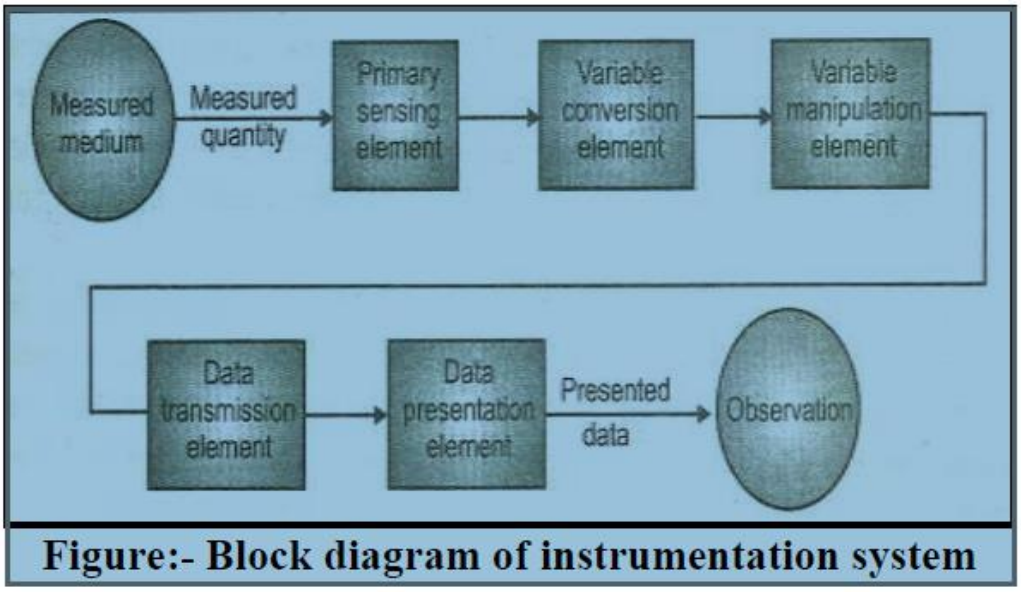
	3. It is used to test the power circuits.	
d)	**State different types of errors in Instruments.**	**2M**
Ans:	There are three types of error 1) **Gross Error**: These errors are mainly human mistakes in reading instruments and recording and calculating measurement results. 2) **Systematic Error** : These 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**

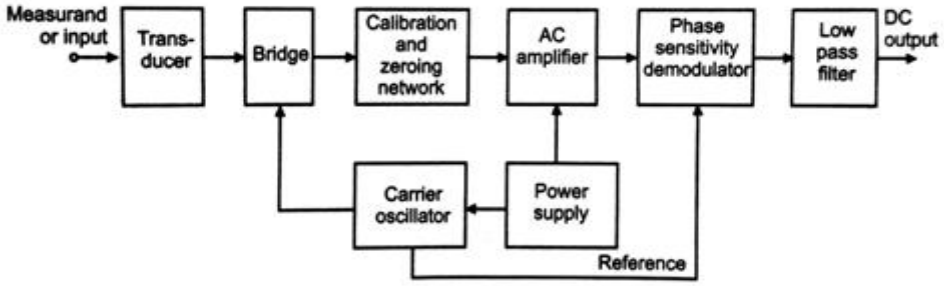
Ans: **1M for Each Parameter**

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**

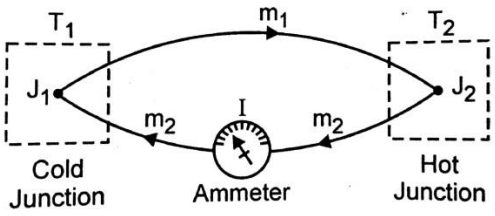
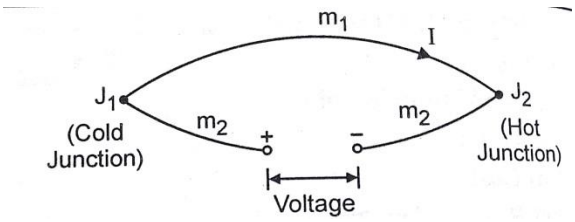


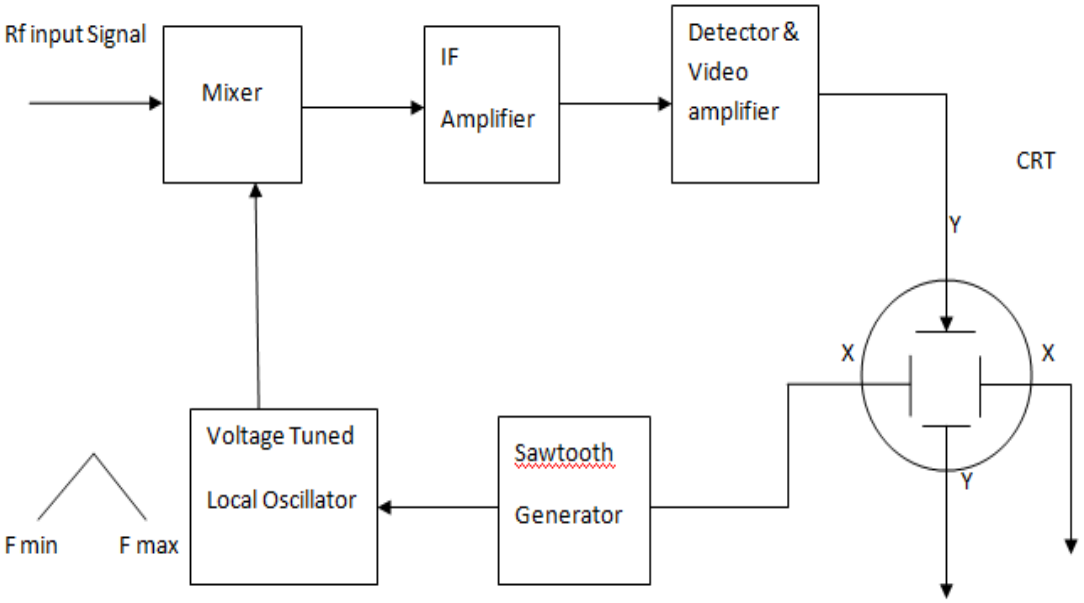
Explanation: **2M**

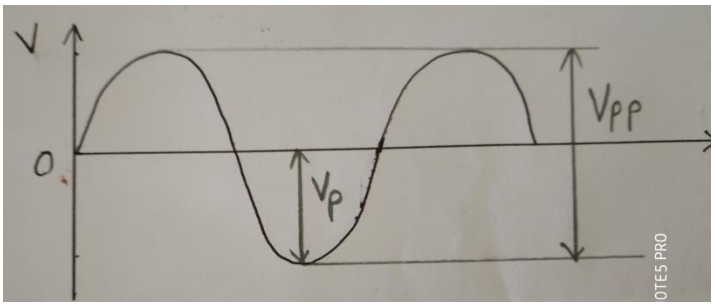
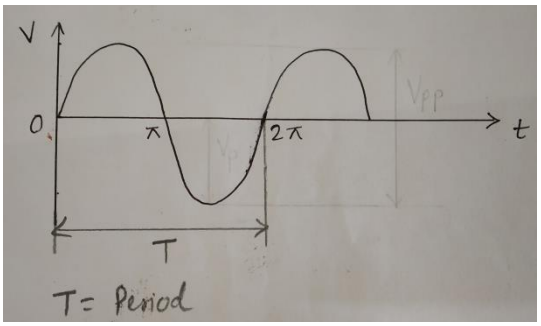
1. The transducers used are the variable resistance or variable inductance transducers. They are employed in the range of frequencies from 50 Hz to 200 KHz where the carrier frequency is much higher, and that are 5 to 1 times the signal frequency.

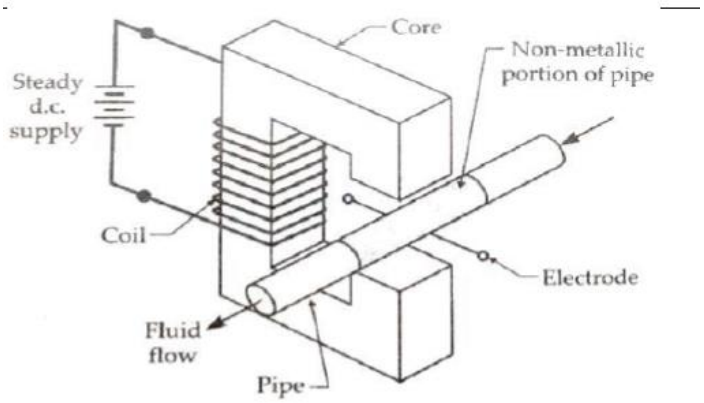
2. Transducer parameter variations amplitude modulate the carrier frequencies at the bridge output, the waveform is amplified and demodulated.

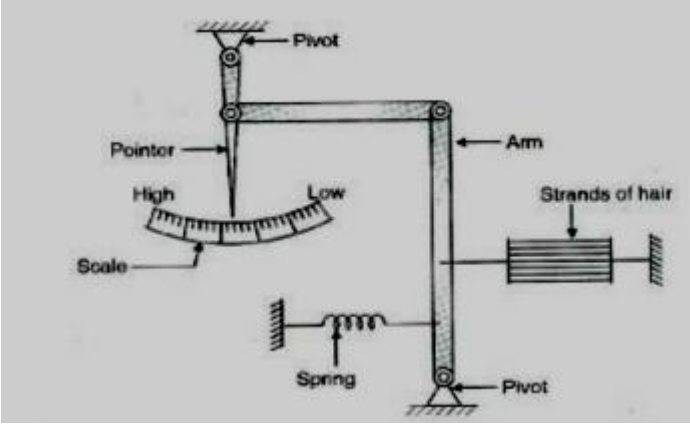
3. The demodulation is Phase sensitive, so that the polarity of the d.c. output indicates the

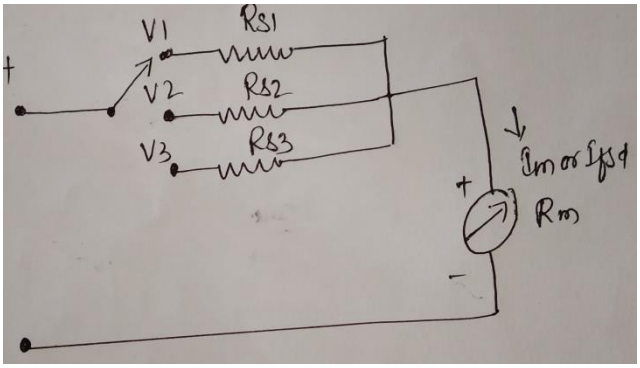
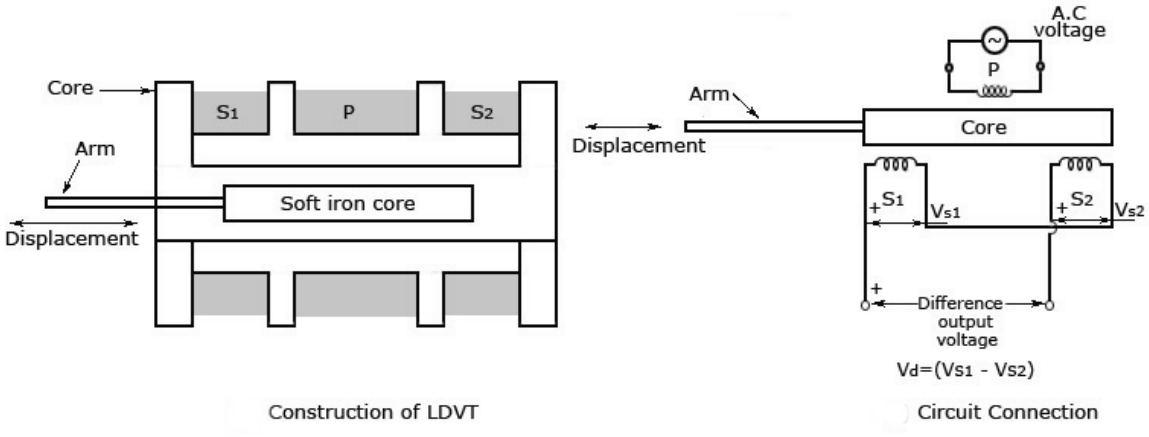
		direction of the parameter change in the bridge output. 4. It is difficult to achieve a stable carrier oscillator than the comparable d.c. stabilized source. 5. In carrier system it is easy to obtain high CMRR of mains frequency pick-up. 6. Active filters can be used to reject this frequency and prevent 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**

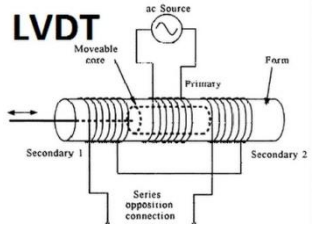
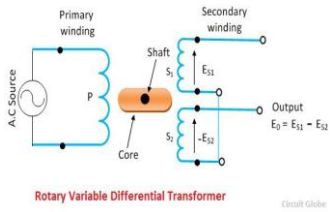
		(ii) Procedure to measure humidity using hygrometer  **Explanation:** • It consists of bunch of human hair which increases mechanical strength of the instrument, arm with pivot joints and points scale assembly. • The element is maintained at slight tension by a spring. The hair strands are generally 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**

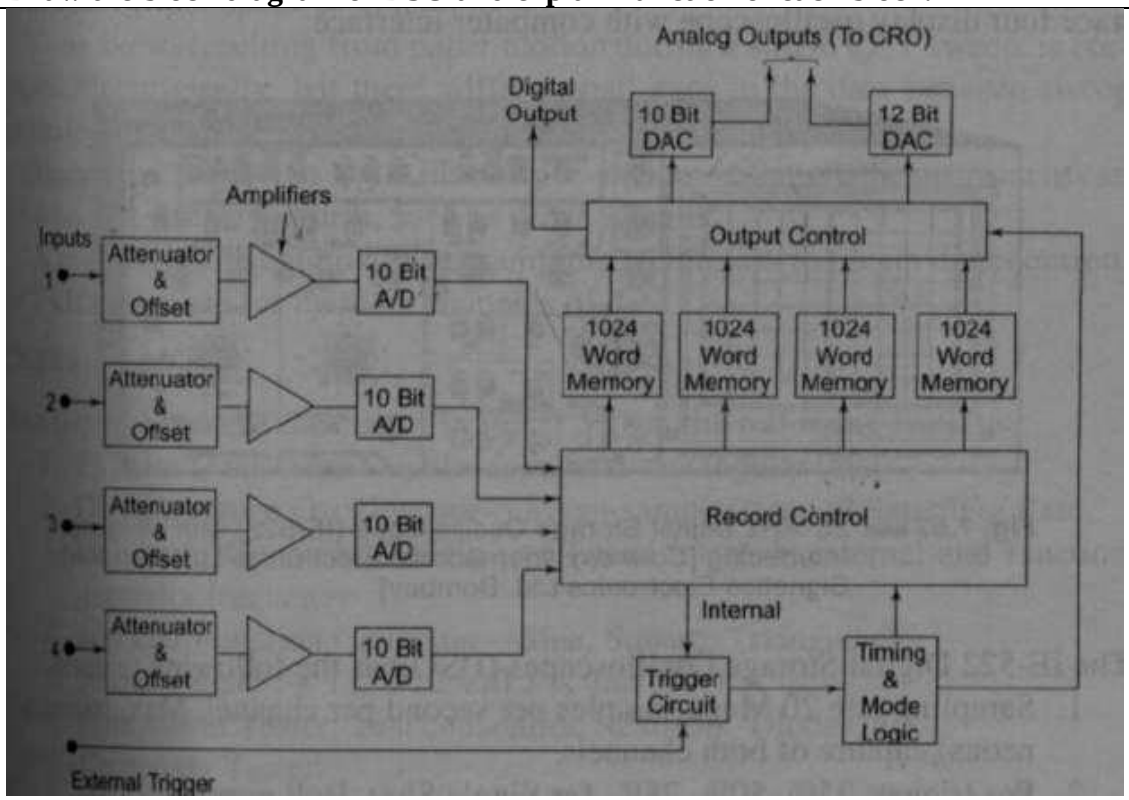
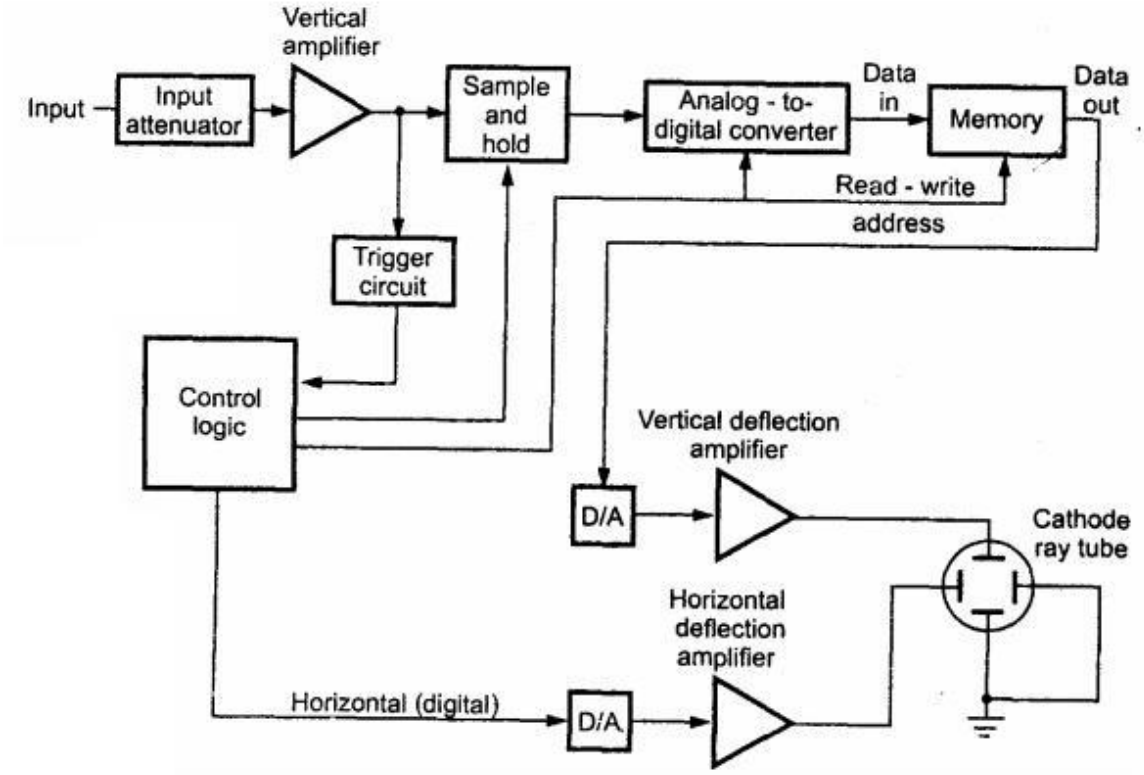
the physical position of the core.

Working= 1 mark

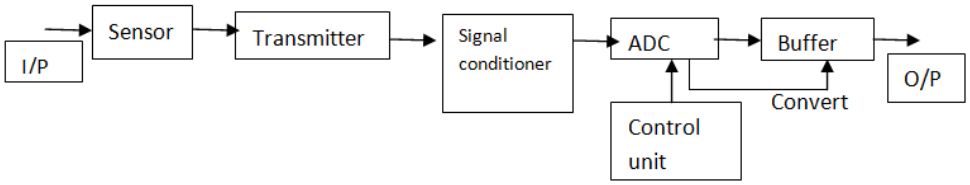
(ii) Compare LVDT with RVDT

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**

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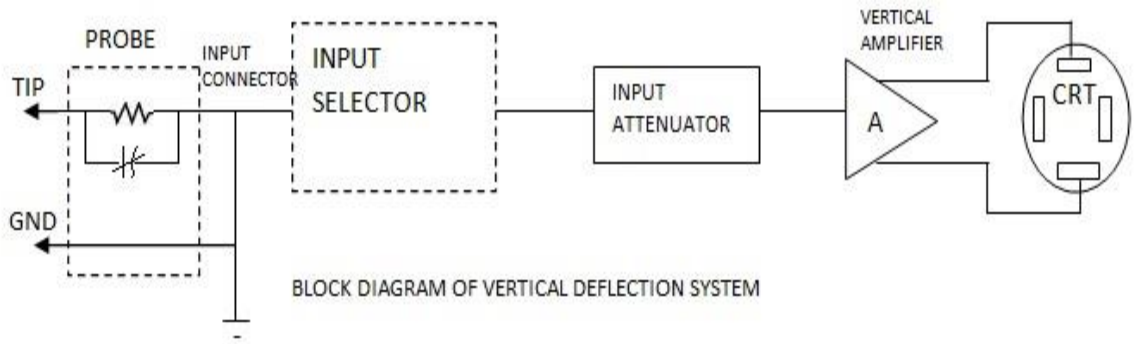
Model Answer
Subject Name: Electronic measurements and instrumentation Subject code: 22333

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto 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 thefigure. 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 constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1	(A)	**Attempt any FIVE of the following:**	**10- Total Marks**
	(a)	**Write any two applications of Instrumentation System.**	**2M**
	Ans:	Instrumentation is used to measure many parameters (physical values). These parameters include: • Pressure,either differential or static • Flow • Temperature • Levels of liquids, etc. • Density • Viscosity • Ionising radiation • Frequency	**(Any 2 correct pt. 2M)**

		• Current • Voltage • Inductance • Capacitance • Resistivity • Chemical composition • Chemical properties • Position • Vibration	
	(b)	**Define :** **(i) Resolution** **(ii) Accuracy**	**2M**
	Ans:	(i) **Resolution:** The smallest change in input to which instrument can respond is known as resolution. (ii) **Accuracy:** It is the degree of closeness with which an instrument reading approaches the true value of the quantity being measured. (any other relevant definition should also be considered)	**(1M for each definition)**
	(c)	**Sketch Block diagram of vertical deflection system used in CRO.**	**2M**
	Ans:	 BLOCK DIAGRAM OF VERTICAL DEFLECTION SYSTEM	**(2M for correct diagram)**

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	(d)	**Define :** **(i) Sensor** **(ii) Transducer**	**2M**
	Ans:	**(i) Sensor :** A device which detects or measures a physical property and records, indicates, or otherwise responds to it. **(ii) Transducer :** a device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa. (any other relevant definition should also be considered)	**(1M for each definition)**
	(e)	**List any four types of transducer.**	**2M**
	Ans:	**Types of Transducer based on Quantity to be Measured** • Temperature transducers • Pressure transducers • Displacement transducers • Flow transducers T**ypes of Transducer based on the Principle of Operation** • Photovoltaic • Piezoelectric • Chemical • Mutual Induction • Electromagnetic • Hall effect • Photoconductors **Types of Transducer based on Whether an External Power Source is required or not**	**(1M for each correct type)**

		• Active Transducer • Passive Transducer	
	(f)	**State need of level measurement.**	**2M**
	Ans:	In almost all industries, vast quantities of liquid such as water solvents, chemicals etc. are used in number of processes. It is widely employed to monitor as well as measure quantitatively the liquid content in the tanks, containers and vessels etc liquid level affects both pressure and rate of flow in and out of the container and therefore its measurement becomes important in a variety of processes encountered in modern manufacturing plants.	**(2M for need)**
	(g)	**Write objective of Data acquisition system.**	**2M**
	Ans:	**Objectives of Data Acquisition System:** • It must monitor the complete plant operation to maintain online optimum and safe operations. • It must provide an effective human communication system and be able to identify problem areas, thereby minimizing unit availability and maximizing unit through point at minimum cost. • It must be able to collect, summarize and store data for diagnosis of operation and record purpose • It must be able to compute unit performance indices using online,real time data. • It must be reliable, and not have a down time greater than 0.1%.	**(Any 2 correct pt. 2M)**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total Marks**

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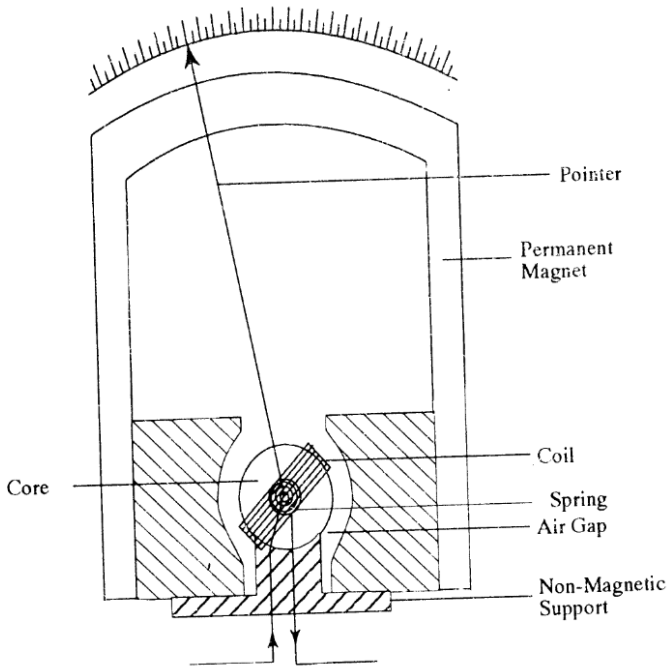
	(a)	**Define any two dynamic characteristics of measurements.**	**4M**
	Ans:	**1. Speed of response:** The rapidity with which instrument responds to make changes in the measured quantity is called as speed of response. **2. Fidelity:** The degree to which instrument indicates the change in measured variable without dynamic error is called as fidelity. **3. Lag:** The retardation on delay in the response of an instrument to make the change in measure quantity is known as lag. **4. Dynamic error:** The difference between the true value of a quantity changing with time and the value indicated by the instrument if no static error is assumed is called as dynamic error.	**(Any 2 correct pt. 2M each)**
	(b)	**Draw PMMC meter movement and describe it.**	**4M**
	Ans:		**2M for labeled diagram**

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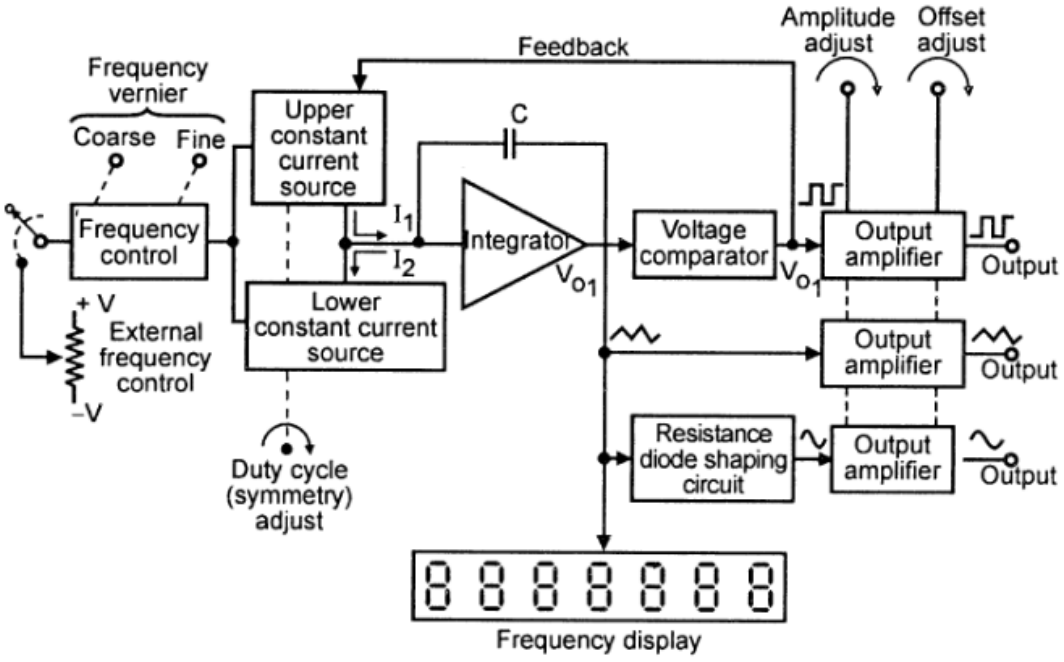
		OR **(Any other relevant diagram shall be considered)** **Working principle of PMMC:** 1. The working principle of PMMC is based on basic meter movement known as D'Arsonval principle stated as when current passes through the coil a deflecting torque is produced due to interaction between magnetic field produced by permanent magnet and magnetic field produced by moving coil. 2. Due to this torque coil deflects and this deflection is proportional to the current flowing through the coil. 3. The pointer attached with coil indicates the magnitude of quantity being measured. 4. Another torque is developed by spring known as controlling torque. This torque helps to stabilize the pointer 5. When controlling torque becomes equal to deflecting torque then pointer attached with scale become stable at equilibrium.	**2M for explanation**
	(c)	**Describe the block diagram of function generator.**	**4M**

Ans:



Block diagram of function Generator

OR

(Any other relevant diagram shall be considered)

02 marks for Diagram

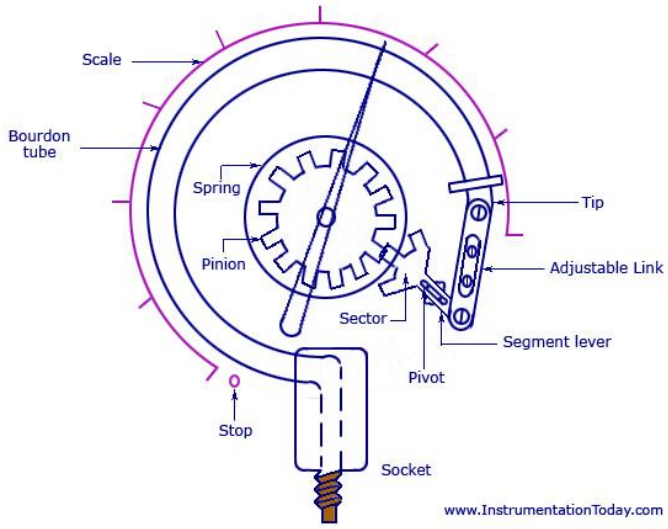
Principle of operation of function generator:

Function generator operates to produce different waveforms such as sine, square, triangular of adjustable frequency which is used to test functionality of various electronic circuits.

This has capability of phase lock with other function generator or to a frequency standard and its output waveforms will have same accuracy and stability as standard source.

02 mark For Explanation

In operation, frequency is controlled by varying the magnitude of current which drives the integrator. The frequency controlled voltage regulates two current sources the upper current source supplies constant current to the integrator whose output voltage increases linearly with time. Voltage comparator multivibrator changes states at a predetermined maximum level of the integrator output voltage. This change cuts off the upper current supply and switch on lower current supply. The lower current source supplies a reverse

		current to integrator so that] its output decreases linearly with time. When output reaches predetermined minimum level, voltage comparator again change state and switch on the upper current source. The output of integrator is triangular waveform whose frequency is determined by the magnitude of current supplied by constant current sources.	
	(d)	**Explain the sketches , the working principle of Bourdon tube.**	**4M**
	Ans:	 Bourdon Tube Pressure Gauge **OR** **(Any other relevant diagram shall be considered)** **Working principle of Bourdon tube:-** • C type bourdon tube is made up of an elliptically flattened tube bent in such a way as to produce the C shape as shown in the fig. One end free end of this tube is closed or sealed and the other end (fixed end) opened for the pressure to enter. • The free end connected to the pointer with the help of geared sector and pinion. Calibrated scale and pointer is provided to indicate the pressure.	**2M for correct diagram** **2M for working principle**

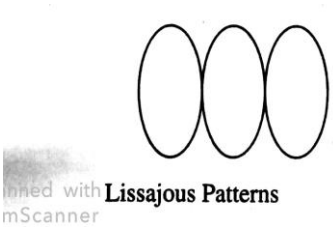
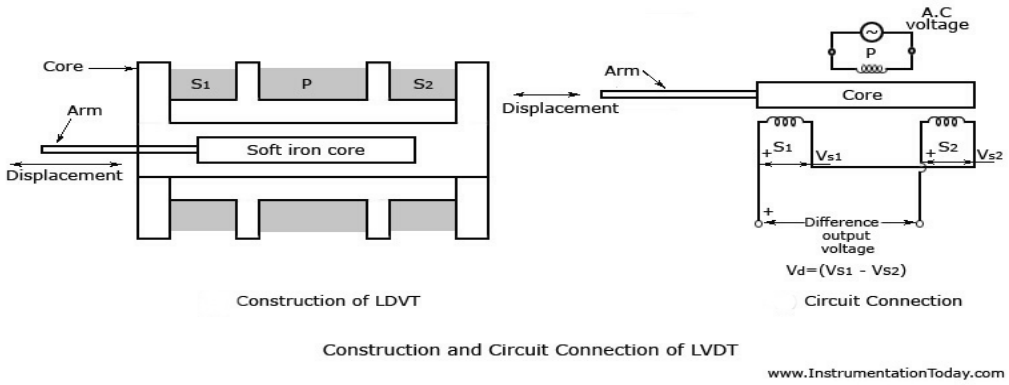
- The cross section view of C type bourdon tube under normal condition and pressurized condition is as shown in figure.
- The pressure which is to be measured is applied to the bourdon tube through open end. When this pressure enters the tube, the tube tends to straighten out proportional to applied pressure.
- This causes the movement of the free end and the displacement of this end is given to the pointer through mechanical linkage i.e. geared sector and pinion.
- The pointer moves on the calibrated scale in terms of pressure. The relationship between the displacement of the free end and the applied pressure is nonlinear.

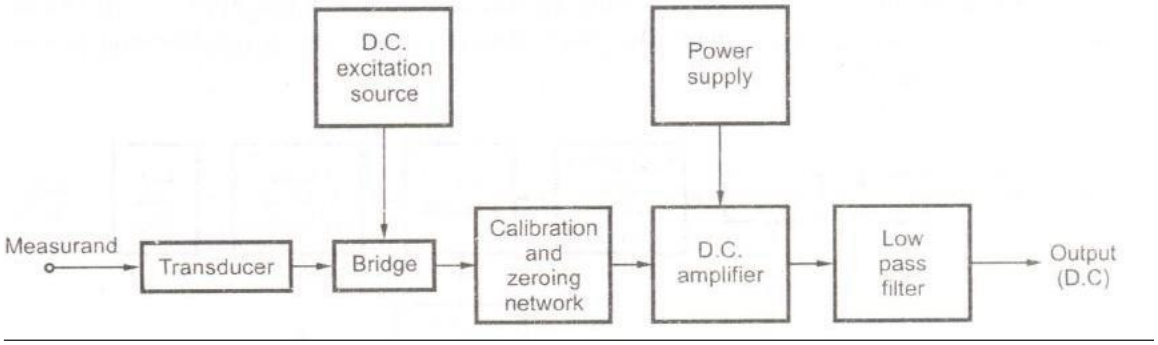
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	(a)	**Compare Analog meter and Digital meter.**	**4M**

Ans:

Sr.No.	Parameter	Analog meter	Digital meter
1	Principle	Meter that gives analog output	Meter that gives digital output
2	Accuracy	The accuracy is less	The accuracy is More
3	Resolution	The resolution is less	The resolution is More
4	Power	Requires more power.	Requires less power.
5	Cost	Analog are cheap	Digital meter are expensive.

1M each (any 4 points)

		6	Observational error	Have observational error	No observational error	
		7	Examples	Potentiometer, DC ammeter, PMMC	DMM , DSO	
	(b)	**Calculate the frequency of channel -1 input for an oscilloscope when shows the following Lissajous patterns. Assume the channel – 2 frequency 15kHz.**  Lissajous Patterns				**4M**
	Ans:	**Channel 1 Frequency/ Channel 2 frequency = 3/1** **Channel 1 frequency = 3 * 15khz** **= 45 khz**				**4M**
	(c)	**Sketch and describe the working principle of LVDT.**				**4M**
	Ans:	**Diagram**  **Explaintion:** 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 the physical position of the core. **Construction of LVDT:**				**2M** **2M**

		A differential transducer consists of a primary winding and two secondary winding. The windings are arranged concentrically and next to each other. They are wound over a narrow bobbin which is usually of a non- magnetic and insulating material. A core in the shape of road is attached to the transducer sensing a shaft. An AC source is applied across the primary winding and core varies the coupling between it and two secondary windings. **.:**E0=E1-E2	
	(d)	**(i) Define signal conditioning system.** **(ii) Draw the circuit diagram of DC signal conditioning circuit.**	**4M**
	Ans:	**(i)** **Signal conditioning** is the manipulation of a **signal in** a way that prepares it for the next stage of processing. Many applications involve environmental or structural measurement, such as temperature and vibration, from sensors. **(ii)** **Circuit** 	**2M** **2M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any THREE of the following :**	**12- Total**

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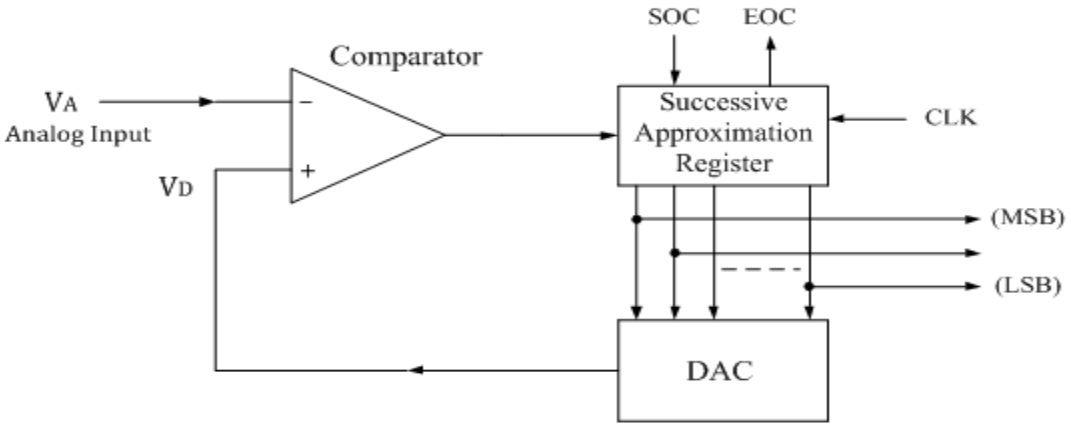
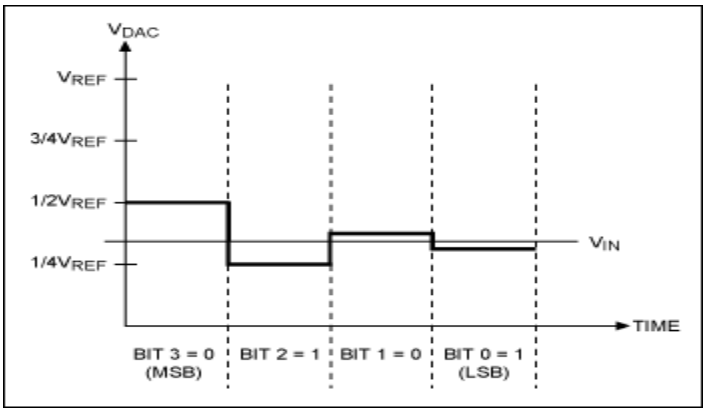
			Marks
	(a)	**Draw the block diagram of successive approximation type ADC.Draw the SAR register waveforms for unknown voltage . V_X = σ volts.**	**4M**
	Ans:	 **Block diagram of successive approximation type ADC** **SAR register waveforms**  **Note: Any relevant waveform must be considered**	**Block Diagram -2M** **Waveform-2M**
	(b)	**A 1 mA meters movement with an internal resistance of 100 Ω is to be converted into a 0-100mA. Calculate the value of shunt resistance required.**	**4M**
	Ans:	Im = 1mA, Rm=100Ω, I= 100mA **Rsh = Im Rm/ (I-Im)** **Rsh = 100/99** **Rsh = 1.01 ohms**	**1 M** **1M** **1M** **1M**

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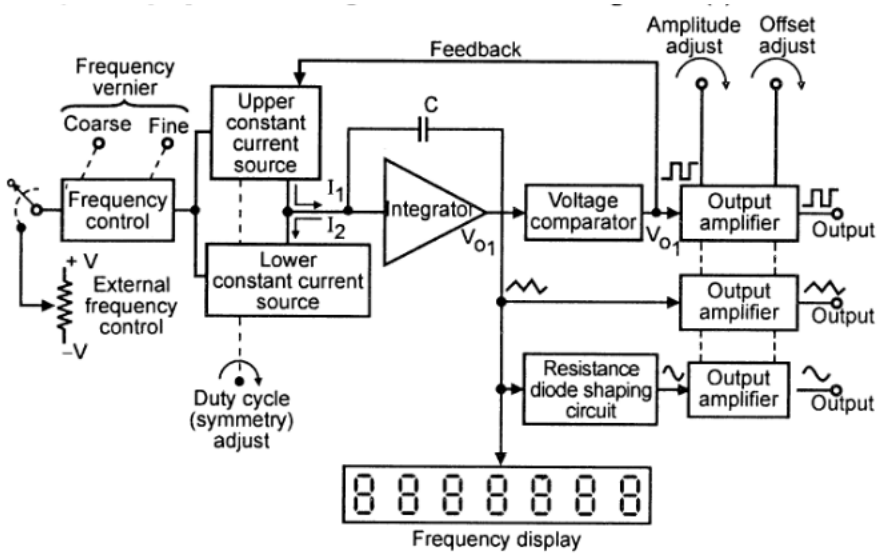
	(c)	**Sketch the block diagram of function generator & describe the circuit of sine wave generation.**	**4M**
	Ans:	**Block Diagram**  . Explanation- For generation of sinewave , out of the three knobs- sine, square and triangular , the sine knob is pressed, output is adjusted for required frequency and amplitude using frequency and amplitude	**3M** **1M**
	(d)	**Compare thermistor and thermocouple.**	**4M**
	Ans:		**1M each (any 4 points)**

Sr.No.	Parameter	Thermistor	Thermocouple
1	Materials	Metal oxides	Two dissimilar metals
2	Response	Nonlinear	Linear

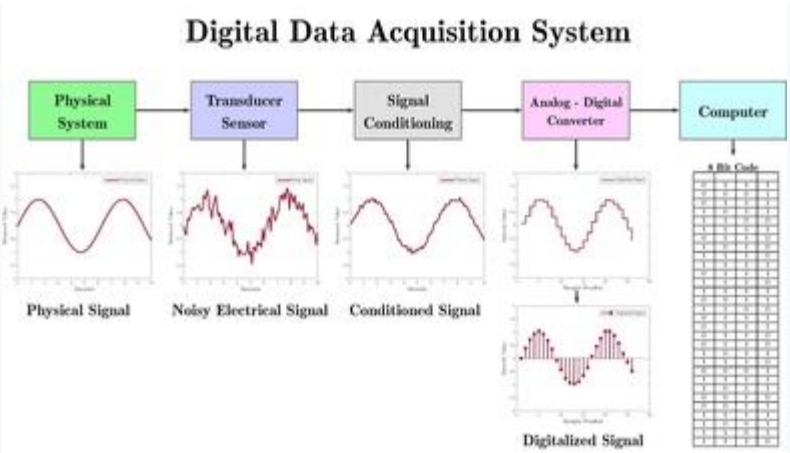
3	Range of temperature	-150^{0}C to 300^{0}C	-200 ^{0}C to 2000 ^{0}C	
4	Size	Small in size	Large as compared to thermistor	
5	Whether active or passive	Passive	**active**	
6	Transduction principle	Resistive transducer	Thermo electric effect	

(e) **Draw and describe general Data acquisition system .** **4M**

Ans: **2M**

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems, abbreviated by the acronyms *DAS* or *DAQ*, typically convert analog waveforms into digital values for processing. The components of data acquisition systems include: Sensors, to convert physical parameters to electrical signals. Signal conditioning circuitry, to convert sensor signals into a form that can be converted to digital values. Analog-to-digital converters, to convert conditioned sensor signals to digital values. Data acquisition applications are usually controlled by software programs developed using various general purpose programming languages

Digital Data Acquisition System Block Diagram **2M**



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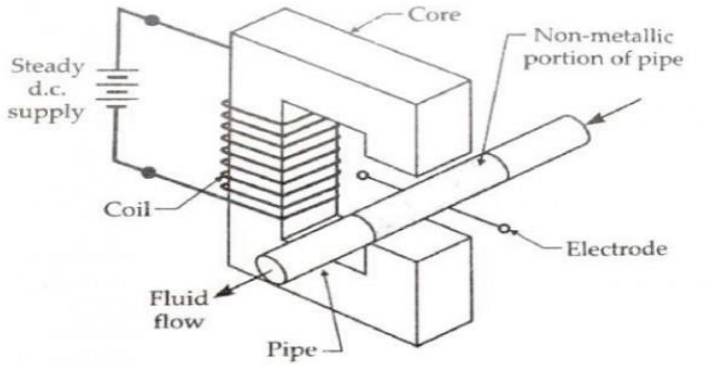
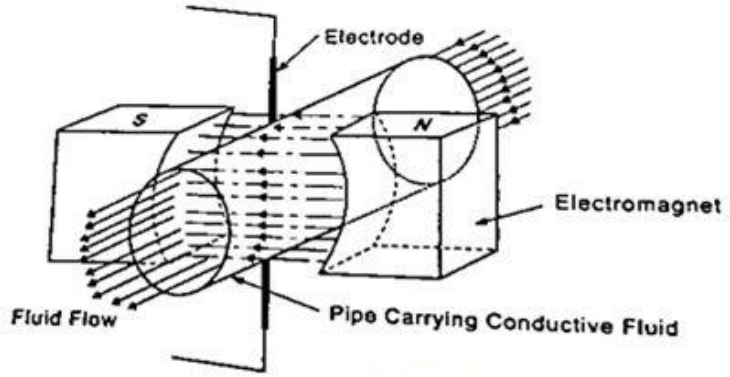
Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	(a)	**Describe the need for calibration.**	**6M**
	Ans:	Calibration is defined as the comparison of measured value with standard. Why required? The accuracy of all measuring devices degrade over time. This is typically caused by normal wear and tear. However, changes in accuracy can also be caused by electric or mechanical shock or a hazardous manufacturing environment (e.x., oils, metal chips etc.). Depending on the type of the instrument and the environment in which it is being used, it may degrade very quickly or over a long period of time. The bottom line is that, calibration improves the accuracy of the measuring device. Accurate measuring devices improve product quality. A measuring device should be calibrated: According to recommendation of the manufacturer. After any mechanical or electrical shock. Periodically (annually, quarterly, monthly)	**6M**
	(b)	**Explain the electro-magnetic flow meter with neat sketch and write it's application.**	**6M**
	Ans:	Electromagnetic flow meter: Principle of Operation: 1. The operation of an Electro-magnetic flow meter is based upon Faraday's Law, which states that the voltage induced across any conductor as it moves at right angles through a	(**Principle -1M** **Diagram -2M** **Working**

magnetic field is proportional to the velocity of that conductor.

2. E is proportional to B x L x V where: E = B x L x V E = The voltage generated in a conductor B = The magnetic field strength L = The length of the conductor V = The velocity of the conductor.



OR



Electromagnetic Flow Meter

Construction & Working:

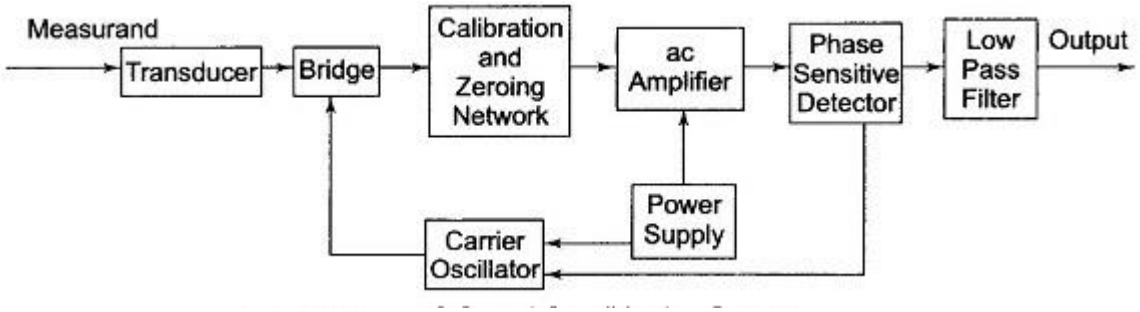
1. It consists of a pair of Electrodes mounted in opposite direction of a non-conducting, non-magnetic pipe carrying liquid whose flow is to be measured.

2. It is surrounded by an electromagnet which produces a magnetic field.

3. The conductive fluid is passed through the pipe.

4. As the fluid passes, its motion relative to field produces an e.m.f. proportional to velocity according to Faradays law.

-2m applicati on -1M)

		5. This output e.m.f. is collected by the electrodes and is given to external circuit. 6. The e.m.f. or voltages produced are small especially at low flow rates. 7. The pipe must be non-conductive, non-magnetic. Application:- • They can usually measure multidirectional flow, either upstream or downstream. • It used for measurement extremely low flow rates. • It can be also used for measurement of flow rate of slurries, greasy materials.	
	(c)	**Describe the circuit diagram of AC signal conditioning.**	**6M**
	Ans:	The block diagram of a.c. signal conditioning system:-  AC signal conditioning system **Working:-** This is carrier type a.c. signal conditioning system. The transducer used is variable resistance or variable inductance transducer. The carrier oscillator generates a carrier signal of the frequency of about 50 Hz to 200 kHz. The carrier frequencies are higher and are at least 5 to 10 times the signal frequencies. The bridge output is amplitude modulated carrier frequency signal. The a.c. amplifier is used to amplify this signal. A separate power supply is required for the a.c. amplifier. The amplified signal is demodulated using phase sensitive demodulator. The advantage of using phase sensitive demodulator is that the polarity of d.c. output indicates the direction of the parameter change in the bridge output. Unless and until spurious and noise signals modulate the carrier, they will not affect the data signal quality and till then are not important. Active filters are used to reject mains frequency pick up. This	Diagram-3M Working -3M

prevents the overloading of a.c. amplifier. Filtering out of carrier frequency components of the data signal is done by phase sensitive demodulator. The applications of such system are in use with variable reactance transducers and for the systems where signals are required to be transmitted through long cables, to connect the transducers to the signal conditioning system.

This type of signal conditioning includes the circuits like sample and hold, multiplexers ,analog to digital converters etc.

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	(a)	**(i) Compare CRO and DSO.** **(ii) State the formula for phase measurement using CRO with necessary diagram.**	**6M**
	Ans:	**(i)**	**(Any Three- 3M)**

CRO	DSO
Directly reads analog voltage and displays it on screen.	It reads the analog voltage and converts it into digital form before being displayed on the screen.
Do not require ADC, microprocessor and acquisition memory	Requires ADC, microprocessor and acquisition memory
Can only analyze signal in real time as there is no storage memory available.	Can analyze signal in real time as well as can analyze previously acquired large samples of data with facility of storage available.
Can not analyze high frequency sharp rise time transients	Can analyze high frequency transients due to advanced DSP algorithms available and ported on microprocessor which can

			operate on stored samples of input voltage.	

(ii)Phase measurement using CRO:

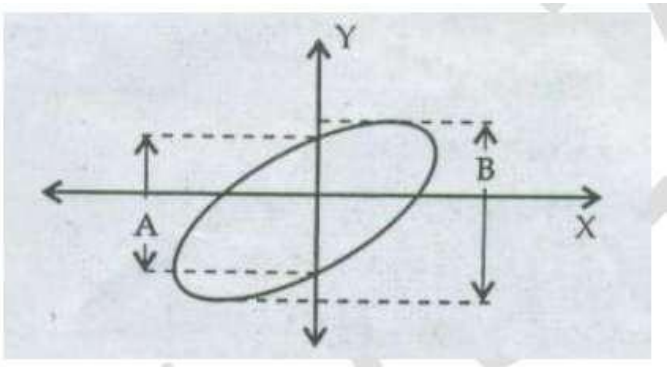
The phase measurement can be done by using Lissajous figures.

The CRO is set to operate in the X- Y mode, then the display obtained on the screen of a CRO is called Lissajous pattern, when two sine waves of the same frequency are applied to the CRO. (One vertical and one horizontal deflection plates). **3M**

Depending on the phase shift between the two signals, the shape of the Lissajous pattern will go on changing.

The phase shift is given by,

Θ = sin-1 (A/B)



A. The Lissajous pattern will be an ellipse if the sine waves of equal frequency but phase shift between 00 and 900 are applied to the two channels of CRO. The Lissajous pattern will be as shown below-

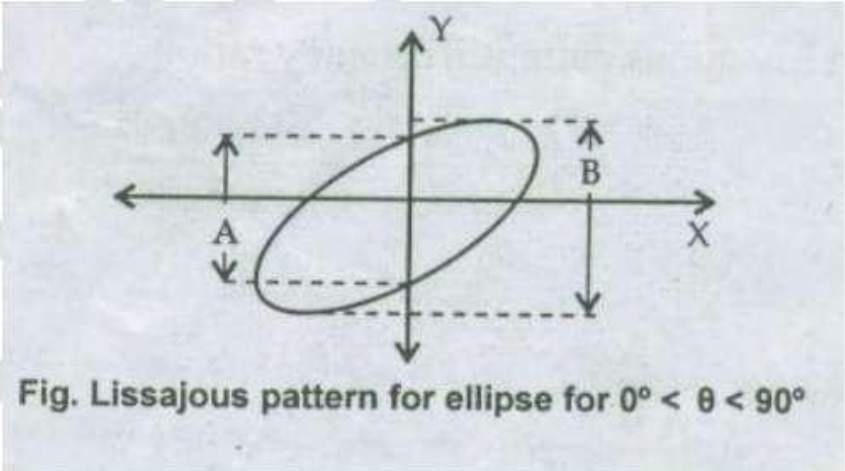
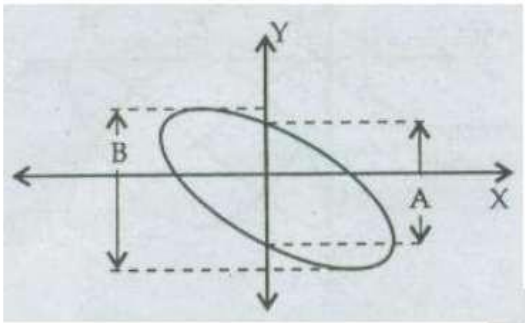
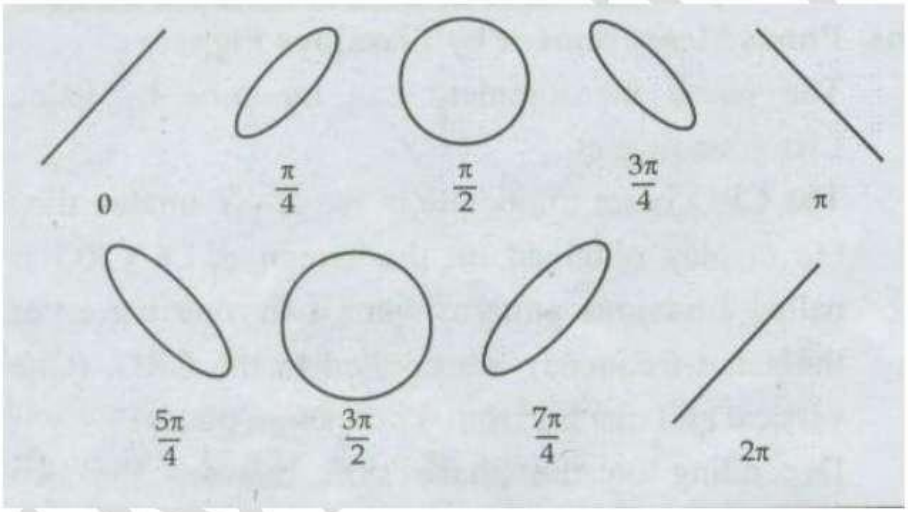


Fig. Lissajous pattern for ellipse for 0° < θ < 90°

B. For the phase difference above 90^0 and less than 180^0, the ellipse appears as shown



C. Different Lissajous figure for phase difference 0^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0, 360^0 are shown below respectively



(b) **(i) Write one example and application of thermal, optical, magnetic and electric sensor.** **6M**

(ii) State four selection criteria of transducer.

Ans: (i)

sensor	examples	application
Thermal Sensor	• Glass thermometer • Bimetallic thermometer • Thermocouples • Thermister • RTD • pyrometers	• The temperature sensors are used in the military/Defence. • It can be used in the home automation systems like air conditioners, refrigerators, microwave Owens • It can also use in the industries like warehouses, mushroom cultivation. • The temperature sensors are used to measure the temperature of the boilers in thermal power plants
Optical sensor	• Photoelectric tachometer • Optical pyrometers • Stroboscope • Photoelectric pressure transducer.	• Speed measurement • Temperature measurement • Pressure measurement. • Optical sensors are integral parts of many common devices, including computers, copy machines (xerox) and light fixtures

Any 1ex-1M

Any 1 app-1M

		that turn on automatically in the dark.
Magnetic sensor	• LVDT • RVDT • Electromagnetic flow meter • Inductive pick-up • Eddy current tachometer.	• Linear and angular displacement measurement • Flow measurement • Speed measurement.
Electric sensors	• Piezo-electric transducer • Resisitive transducer • Thermocouple • Strain gauge	• Pressure measurement • Linear and angular displacement measurement • Speed measurement • Temperature measurement • Strain measurement

(ii) selection criteria of transducer:

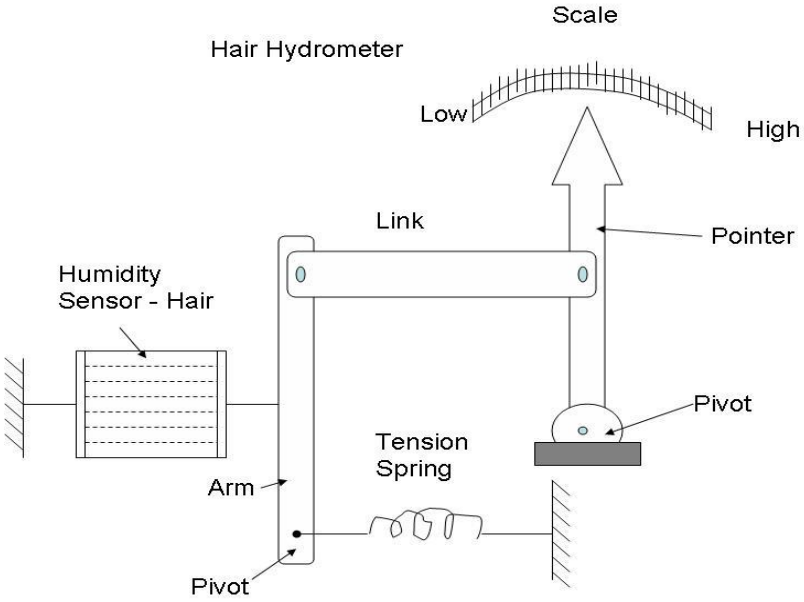
- **Operating Principle :** The transducers are selected on the basis of operating principle it may be resistive, inductive, capacitive, optical etc.
- **Operating range :** The range of transducer should be appropriate for measurement to get a good resolution.
- **Accuracy :** The accuracy should be as high as possible or as per the measurement.
- **Range :** The transducer can give good result within its specified range, so select transducer as per the operating range.
- **Sensitivity :** The transducer should be more sensitive to produce the output or sensitivity should be as per requirement.
- **Loading effect :** The transducer's input impedance should be high and output impedance should be low to avoid loading effect.
- **Errors :** The error produced by the transducer should be low as possible.
- **Environmental compatibility :** The transducer should maintain input and output characteristic for the selected environmental condition.

(Any four- 3M)

OR

1.Operating range

		2. Operating principle 3. Sensitivity 4. Accuracy 5. Frequency response and resonant frequency 6. Errors 7. Environmental compatibility 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. General selection criteria	
	(c)	**(i) State the principle of Humidity measurement using hygrometer.** **(ii) State the type of humidity measurement and range with it.**	**6M**
	Ans:	**(i) Principle of Hair hygrometer:-** Due to humidity, several materials undergo a change in physical, chemical and electrical properties. This property is used in a transducer designed and calibrated to directly read the relative humidity. Certain hygroscopic materials, such as human hair, animal membranes, wood, paper, etc., undergo changes in the linear dimensions when they absorb moisture from the surrounding air. This change in the linear dimension is used as the measurement of the humidity present in the air. **Construction of Hair hygrometer**	**Diagram -2M** **Working -1m)**



Human hair is used as a humidity sensor. The hair is arranged on a parallel beam and separated from each other to expose them to the surrounding air / atmosphere. Number of hairs are placed in parallel to increase the mechanical strength.

This hair arrangement is placed under a small tension by the use of a tension spring to ensure proper functioning.

The hair arrangement is connected to an arm and a link arrangement and the link is attached to a pointer rotated at one end. The pointer sweeps over a calibrated scale of humidity

Working of hair hygrometer:

When air humidity is to be measured, this air is made to surround the hair arrangement and the hair arrangement absorbs moisture from the surrounding air and expands or contracts in the linear direction.

This expansion or contraction of the hair arrangement moves the arm and the link and, therefore, the pointer to a suitable position on the calibrated scale and, therefore, indicates the humidity present in the air / atmosphere.

Any 3- 3m

(ii) **type of humidity measurement:-**

1.hygrometers:-

- Hair hygrometer
- Sling psychrometer
- Digital hygrometer

		• Dew point hygrometer. 2. Wet bulb and dry bulb thermometer. **Range with it.** • Hair hygrometer-humidity range 20to 90% over the temperature range 5 degree to 40 degree Celsius. • Sling psychrometer –humidity range 0 to 100% RH.	

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WINTER-19 EXAMINATION

Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1	**(A)**	**Attempt any FIVE of the following:**	**10- Total Marks**
	(a)	**Define the term 'Measurement'.**	**2M**
	Ans:	Measurement is the result or act of a quantitative comparison between a predetermined standard and an unknown magnitude. Or Measurement is the result of an opinion formed by one or more observers about the relative size or intensity of some physical quantity.	**Correctdef inition 2M**
	(b)	**List different types of errors.**	**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	½ M - Gross 1 M – Systematic ½ - Random

WINTER-19 EXAMINATION

Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

		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	
	(c)	**Give any two applications of LED and LCD each.**	**2M**
	Ans:	Two applications of LED (1) As an indicators and small display. (2) In digital thermometer, pulse rate meter. (3) In patient monitoring. Two applications of LCD (1) In video games (2) In calculators (3) In test equipments (4) In gauges and counters	**Any 2 correct applications of each 1/2M**
	(d)	**Define transducer. Give two examples of transducer.**	**2M**
	Ans:	It is a device which convert any form of physical energy in to electrical energy. Two examples of transducer (1) Strain gauge (2) Thermistor (3) Thermocouple (4) LVDT	**Definition 1M** **Any 2 examples 1M**

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	e)	**Define : (i) Laminar flow** **(ii) Turbulent flow**	**2M**
	Ans:	(i) Laminar flow : if the average velocity of the fluid is very low, then fluid particles will flow in parallel lines along the sides of the pipe. This type of flow is called as laminar flow. (ii) Turbulent flow: if velocity of fluid is increased beyond a certain limit, eddy current starts to form. And flow becomes turbulent flow.	**Each definition 1M**
	f)	**State significance of Lissajous figure.**	**2M**
	Ans:	Significance of Lissajous figure. The characteristics patterns that appear on the screen of a cathode ray tube, when sinusoidal voltages are simultaneously applied to horizontal and vertical plates .these patterns are called Lissaous figure. OR Two phase-shifted sinusoid inputs are applied to the oscilloscope in X-Y mode and the phase relationship between the signals is presented as a Lissajous figure. it is used for measurement of phase and frequency.	**2M**
	g)	**List the applications of DAS.**	**2M**
	Ans:	Applications of DAS: (I) In Aerospace (II) In biomedical (III) Telemetry industries (IV) When physical quantity being monitored	**1 applicati on ½ mark**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total**

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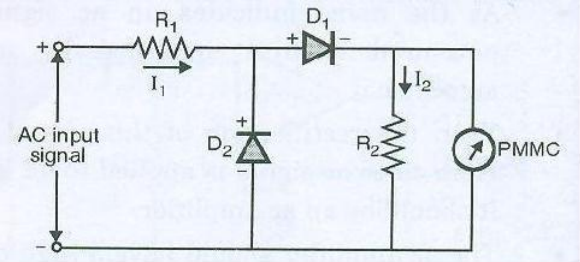
Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

			Marks
	a)	**Draw and explain working of half wave rectifier type AC voltmeter.**	**4M**
	Ans:	 **Fig: Circuit Diagram of rectifier type AC voltmeter** • Basic rectifier type AC voltmeter is a general rectifier type of voltmeter. In this case for the rectification action two diodes namely D1 and D2 are used. • An a.c input signal to be measured is applied. • If a current passing through the diode is small then there is a non- linearity problem. But for higher current the diode shows linearity. So to increase the current passing through diode; a resistance R2 is connected in parallel with the meter. • Now during positive half cycle of input signal diode D1 is forward biased • While the diode D2 is reversed biased. So during this cycle the current passes through diode D1 and the meter. Thus the meter shows deflection. • During the negative half cycle diode D1 is reversed biased and diode D2 is forward biased. So the current flows in opposite direction. In this case the meter is bypassed. • Because of the diode action an a.c input signal is converted into pulsating dc. Thus the meter shows **average value** of an input signal.	**2M for explanation** **&** **2 M for diagram**
	b)	**Explain D'Arsonal PMMC movement in detail.**	**4M**

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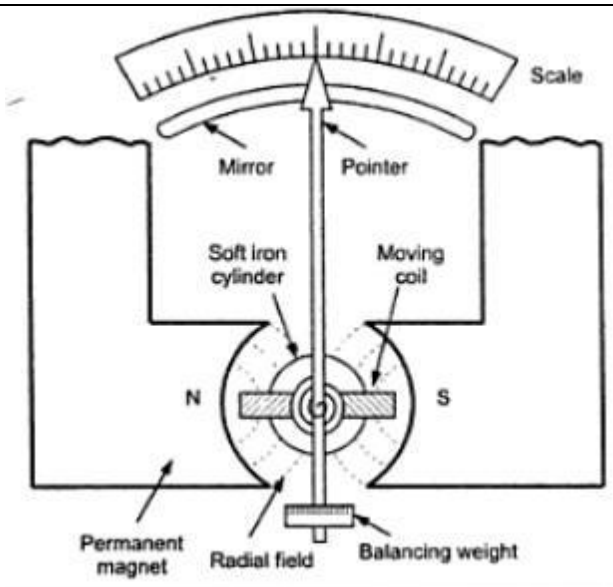
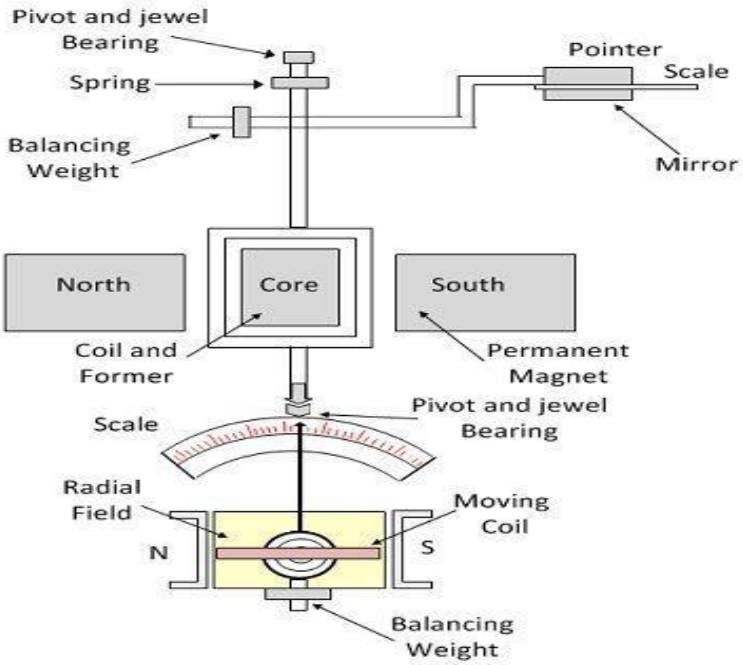
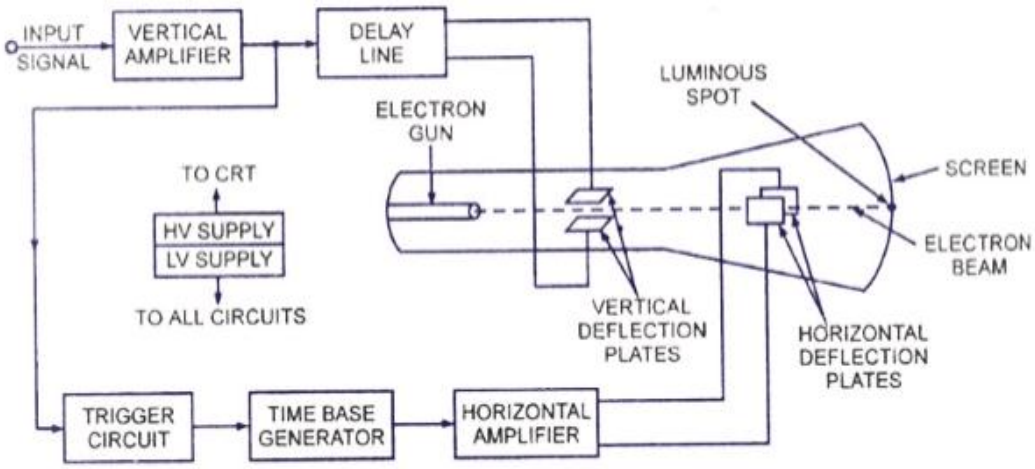
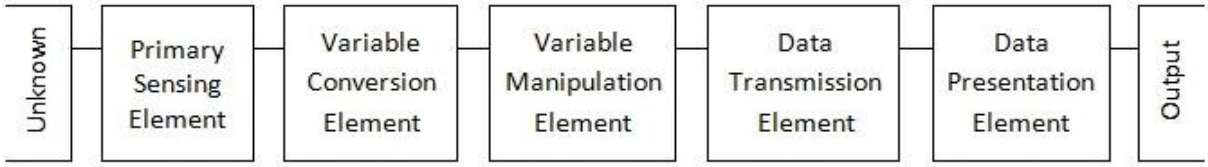
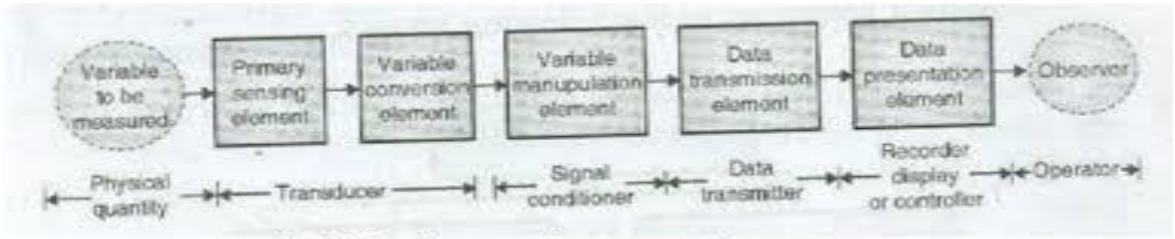
Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

	Ans:	 **OR**  Permanent Magnet Moving Coil Instrument	**2M for explanation** **&** **2 M for diagram**

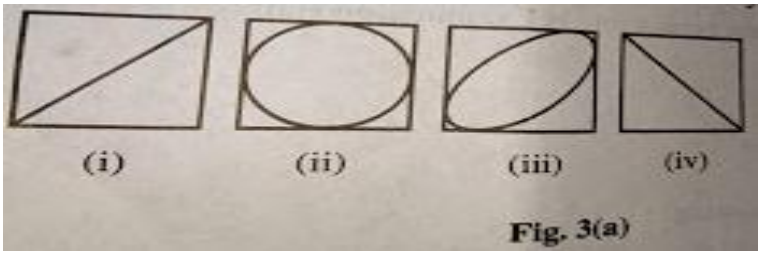
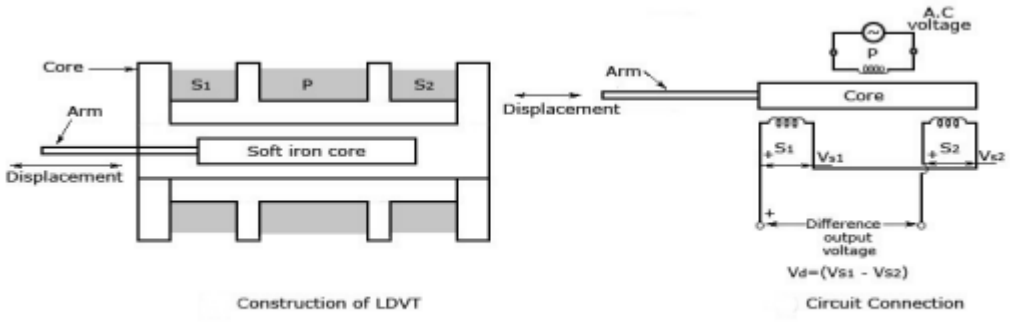
		Working: 2M When current passes through the coil a deflecting torque is produced. This deflecting torque is produced due to interaction between magnetic field produced by permanent magnet and magnetic field produced by moving coil. Due to this torque the coil deflects and this deflection is proportional 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.	
	c)	**Draw block diagram of CRO and explain function of each block of it.**	**4M**
	Ans:	 Figure - Block Diagram of General Purpose CRO The functions of various blocks are: 1) **CRT**: This is cathode ray tube which emits electrons that strike phosphor screen internally to provide visual display of signal. 2) **VERTICAL AMPLIFIER**: This is a wideband amplifier used to amplify signals in the vertical section. 3) **DELAY LINE**: It is used to delay the signal for some time in vertical section. 4) **TRIGGER CIRCUIT**: This is used to convert the incoming signals into trigger pulses so that input signal & sweep frequency can be synchronized. 5) **TIME BASE**: It is used the saw tooth voltage required to deflect the beam in the horizontal section.	**2M for explanation** **&** **2 M for diagram**

		6) **HORIZONTAL AMPLIFIER**: This is used to amplify the saw tooth voltage before it is applied to horizontal deflection plates. 7) **POWER SUPPLY**: There are two power supplies a high voltage supply for CRT & low voltage supply for all circuits.	
	d)	**Draw the block diagram of instrumentation system and explain function of each block.**	**4M**
	Ans:	 **OR**  **Fig: 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 **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.	**2M for explanation** **&** **2 M for diagram**

WINTER-19 EXAMINATION

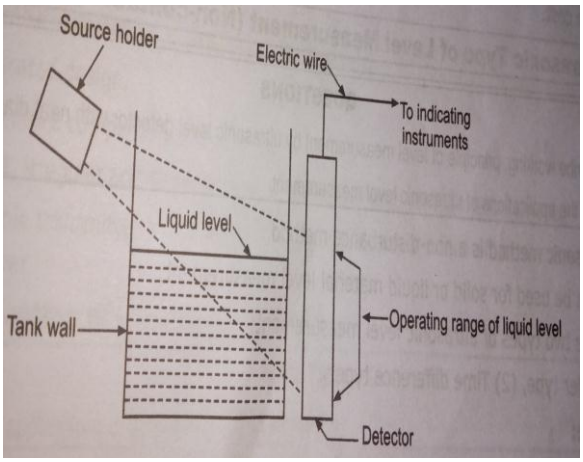
Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	a)	**What will be the phase shift for following Lissajous patterns?**  Fig. 3(a)	**4M**
	Ans:	(i) Phase shift = 0° (ii) Phase shift = 90° or 270° (iii) Phase shift = 30° or 330° (iv) Phase shift = 180°	**each correct answer 1M**
	b)	**Draw and describe the constructional diagram of LVDT.**	**4M**
	Ans:	 Construction of LDVT Circuit Connection Construction and Circuit Connection of LVDT	**Diagram and construction 2M each**

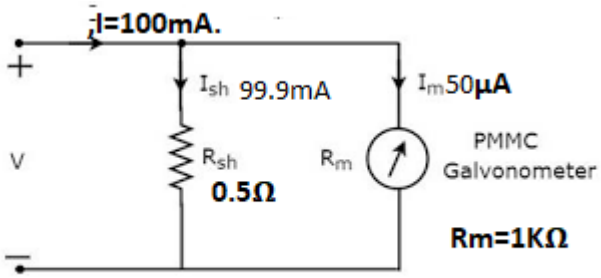
Construction of LVDT:

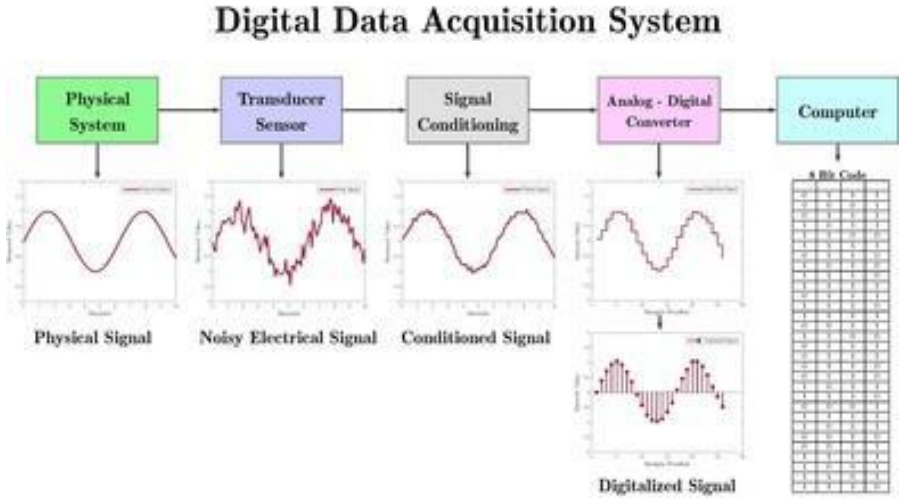
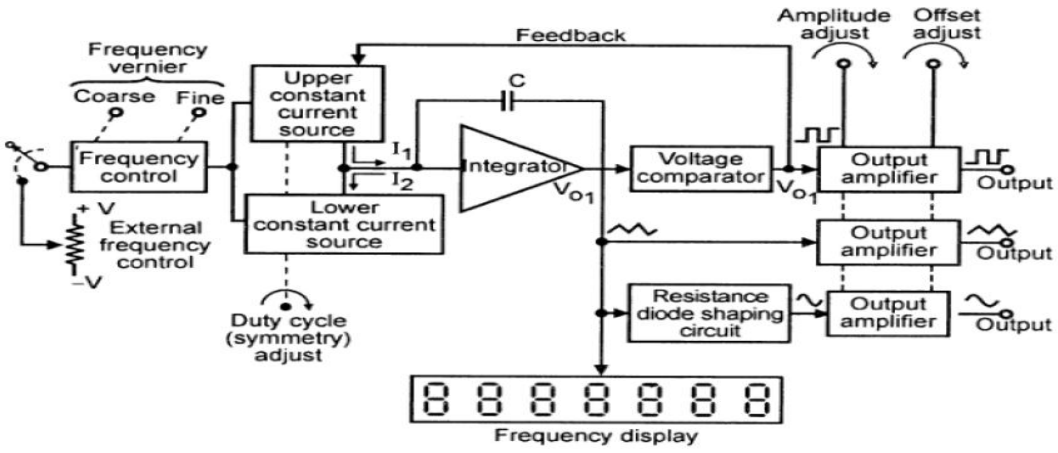
- A differential transducer consists of a primary winding and two secondary winding.
- The windings are arranged concentrically and next to each other. They are wound

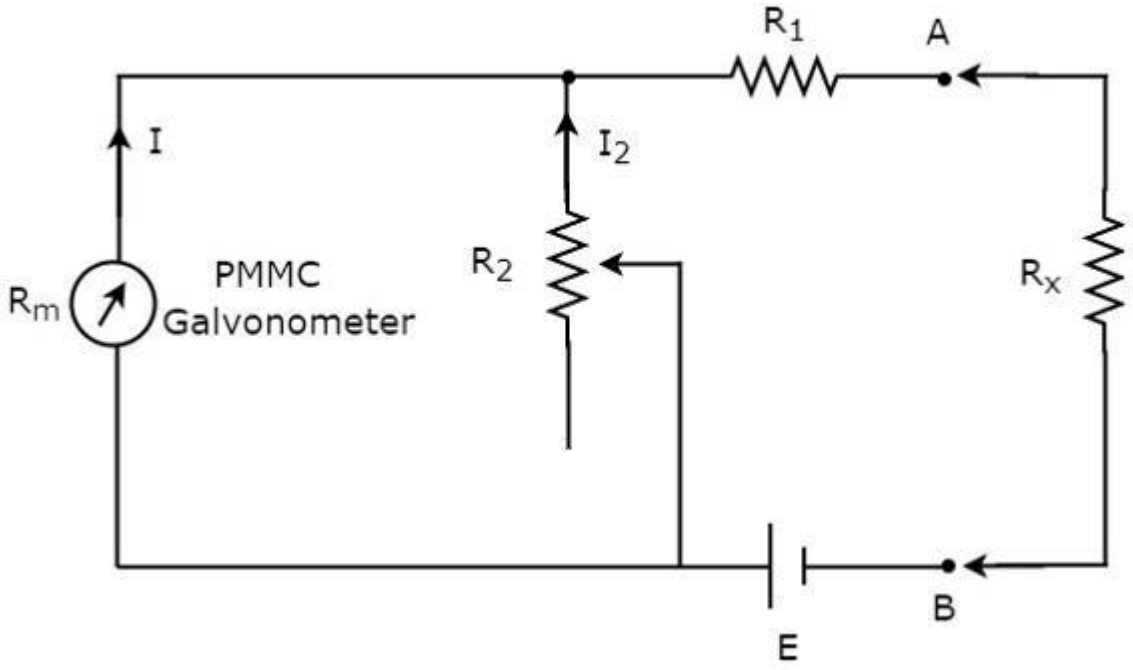
		over a narrow bobbin which is usually of a non- magnetic and insulating material. • A core in the shape of road is attached to the transducer sensing a shaft. • An AC source is applied across the primary winding and core varies the coupling between it and two secondary windings. E0=E1-E2	
	c)	**Describe working principle of radiation level measurement with neat diagram.**	**4M**
	Ans:	Radiation type level measurement. Is non contact type detector which is used where electrical method would not survive.  Radiation type Level Indicator working principle 1.It consist of gamma ray source holder on one side of the tank and a gamma detector on the other side of the tank. 2. The gamma rays from source are directed towards the detector in a thin band of radiation. 3. When gamma rays penetrate the thick wall of the tank, its energy level afterwards is greatly reduced. 4. The radiation received at the gamma detector is inversely proportional to the thickness of the walls and the medium between the radiation source and detector.	**For diagram & working 2M Each**

		5. The amount of radiation received is inversely proportional to the amount of liquid between the radiation source and detector. 6. The difference in the amount radiation received by detector, corresponds to the liquid level in the tank. 7. Thus, when liquid level rises, the amount of radiation received is reduced and vice versa.	
	d)	**Explain the need of signal conditioning.**	**4M**
	Ans:	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.	**4M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any THREE of the following :**	**12- Total Marks**
	(a)	**Suggest instrument to measure unknown frequency above 5 MHz and store result. Justify it.**	**4M**
	Ans:	For measurement of frequency CRO, DSO SPECTRUM ANALYZER & FREQUENCY COUNTER can be used. In above specification we can used CRO & DSO for measurement, but the data	**1M for suggesti**

		has to be stored so we cannot have used CRO for such application's DSO with 20 MHz band width or higher bandwidth can be used. Because DSO has measurement facility as well as storage facility. (ANY OTHER RELEVANT JUSTIFICATION MARKS CAN BE GIVEN)	**ng instrument** **& 3 M explanation**
	(b)	**Convert the PMMC movement into a dc – ammeter of the range 0 to 100 mA.**	**4M**
	Ans:	Assume: Rm=1KΩ, Im = 50µA, I=100mA. m=I/Im = $(100*10^{-3})/(50*10^{-}6)$ =2000 Rsh = 1/ (m – 1) *Rm =1/ (2000 -1) *1000 Rsh = 0.5Ω Ish =I –Im = ($100*10^{-3}$) – ($50*10^{-}6$) Ish = 0.09A =99.9mA 	**(1M)** **(2MARKS FOR CALCULATION)** **1M diagram**
	(c)	**Draw and explain the block diagram of DAS.**	**4M**
	Ans:	**Data acquisition** is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems, abbreviated by the acronyms *DAS* or *DAQ*, typically convert analog waveforms into digital values for processing. The components	**2M for explanation**

		of data acquisition systems include: Sensors, to convert physical parameters to electrical signals. Signal conditioning circuitry, to convert sensor signals into a form that can be converted to digital values. Analog-to-digital converters, to convert conditioned sensor signals to digital values. Data acquisition applications are usually controlled by software programs developed using various general purpose programming languages.  **(FOR ANY OTHER EQUIVALENT DIAGRAM APPROPRIATE MARKS TO BE GIVEN)**	**&** **2 M for diagram**
	(d)	**Draw the block diagram of function generator and explain its working.**	**4M**
	Ans:	 **Principle of operation of function generator:** Function generator operates to produce different waveforms such as sine, square, triangular of adjustable frequency which is used to test functionality of various electronic circuits.	**2M for explanation** **&** **2 M for diagram**

		This has capability of phase lock with other function generator or to a frequency standard and its output waveforms will have same accuracy and stability as standard source. In operation, frequency is controlled by varying the magnitude of current which drives the integrator. The frequency controlled voltage regulates two current sources the upper current source supplies constant current to the integrator whose output voltage increases linearly with time. Voltage comparator multivibrator changes states at a predetermined maximum level of the integrator output voltage. This change cuts off the upper current supply and switch on lower current supply. The lower current source supplies a reverse current to integrator so that] its output decreases linearly with time. When output reaches predetermined minimum level, voltage comparator again change state and switch on the upper current source. The output of integrator is triangular waveform whose frequency is determined by the magnitude of current supplied by constant current sources.	
	(e)	**Explain the calibration of series type ohmmeter.**	**4M**
	Ans:	Series Ohmmeter If the resistor's value is unknown and has to be measured by placing it in series with the ohmmeter, then that ohmmeter is called series ohmmeter. The **circuit diagram** of series ohmmeter is shown in below figure.  The part of the circuit, which is left side of the terminals A & B is **series ohmmeter**. So, we can measure the value of unknown resistance by placing it to the right side of terminals A &	**2M for explain** **&** **2 M for diagram**

		B. Now, let us discuss about the **calibration scale** of series ohmmeter. If Rx=0ΩRx=0Ω, then the terminals A & B will be short circuited with each other. So, the meter current gets divided between the resistors, R1 and R2. Now, vary the value of resistor, R2 in such a way that the entire meter current flows through the resistor, R1only. In this case, the meter shows full **scale deflection current**. Hence, this full scale deflection current of the meter can be represented as 0Ω. • If Rx=∞Ω Rx=∞Ω, then the terminals A & B will be open circuited with each other. So, no current flows through resistor, R1. In this case, the meter shows null deflection current. Hence, this null deflection of the meter can be represented as ∞Ω. • In this way, by considering different values of Rx, the meter shows different deflections. So, accordingly we can represent those deflections with the corresponding resistance value. The series ohmmeter consists of a calibration scale. It has the indications of 0 Ω and ∞Ω at the end points of right hand and left hand of the scale respectively. Series ohmmeter is useful for measuring **high values of resistances.**	

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Sketch DC signal conditioning circuit for pressure measurement using strain gauge. Justify it.**	**6M**
	Ans:	Diagram:	**3M**

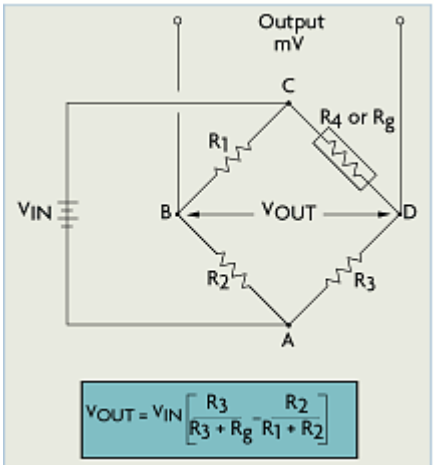


Figure: **DC signal conditioning circuit for pressure measurement using strain gauge**

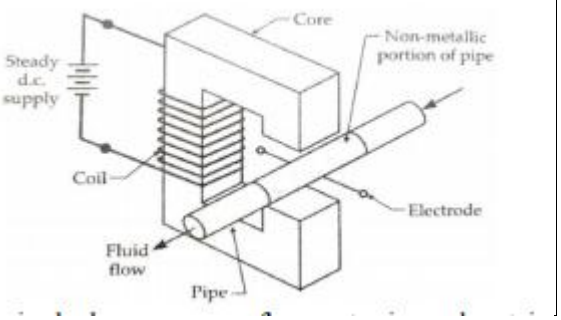
Where, Rg= strain gauge resistance.

Explanation:

- In order to measure strain with a bonded resistance strain gauge, it must be connected to an electric circuit called as wheatstone bridge.
- It is capable of measuring the minute changes in resistance corresponding to strain.
- Strain gauge transducers usually employ four strain gauge elements that are electrically connected to form a Wheatstone bridge circuit.
- The Figure shows a typical strain gauge diagram.
- A Wheatstone bridge is a divided bridge circuit used for the measurement of static or dynamic electrical resistance.
- The output voltage of the Wheatstone bridge is expressed in millivolts output per volt input. The Wheatstone circuit is also well suited for temperature compensation.

3M

	b)	**Draw the sketch of electromagnetic flow meter and explain it. State advantages, disadvantages and applications of it.**	**6M**
	Ans:	**Diagram:**	**1.5M**



1.5M

Explanation:

- Electromagnetic 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 an Electromagnetic 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 Electromagnetic flow 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=flux density wb/m^2

L=length of Conductor i.e diameter of pipe in meter

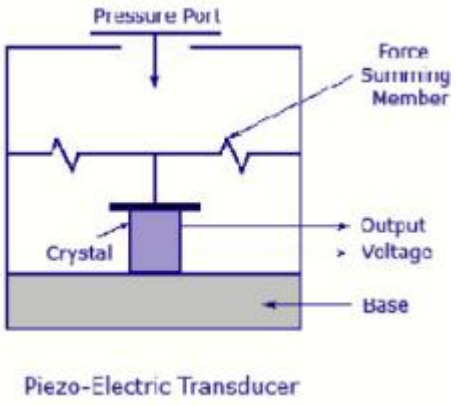
v= velocity of Conductor i.e flow m/sec

1M

Advantages: (Any One)

- It has ability to measure reverse **flow**.
- No additional pressure drops.
- No obstruction is created to **flow**.
- It is mainly suitable for hydraulic solid transport.
- It is unaffected by changes in temperature, density, viscosity, concentration and electrical conductivity.

1M

		Disadvantages: (Any One) • It is not suitable for low velocity. • It is more expensive. • It is suitable for fluids having conductivity greater than 20 micro ohm/cm. • Gas inclusion cause errors. Application: (Any One) • It is used for measurement of flow of portable water, raw water, chilled water. • Used for flow measurement of Corrosive liquids, slurries and pastes.	**1M**
	c)	**Explain Piezo-electric transducer with diagram. State its applications, advantages and disadvantages.**	**6M**
	Ans:	**Explanation:** 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. Diagram:  Piezo-Electric Transducer OR  Advantages: any one • These are active transducer i.e. they don't require external power for working and are	**1.5M** **1.5M**

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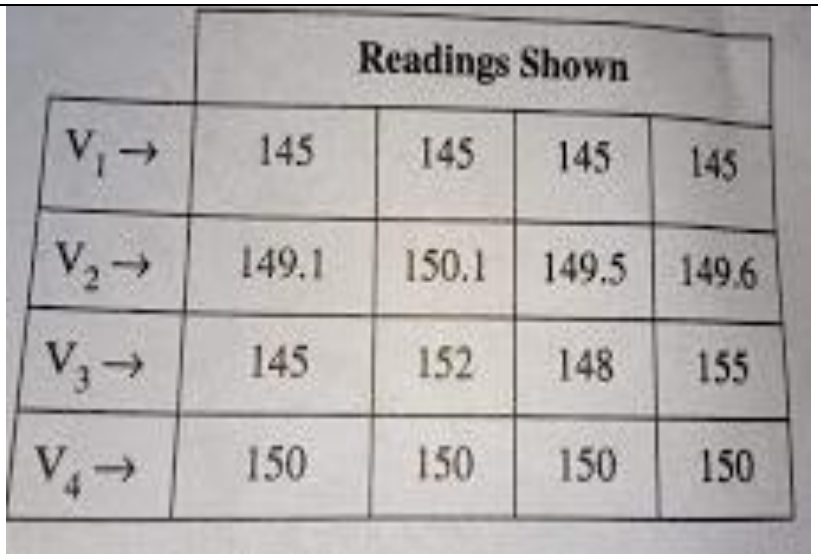
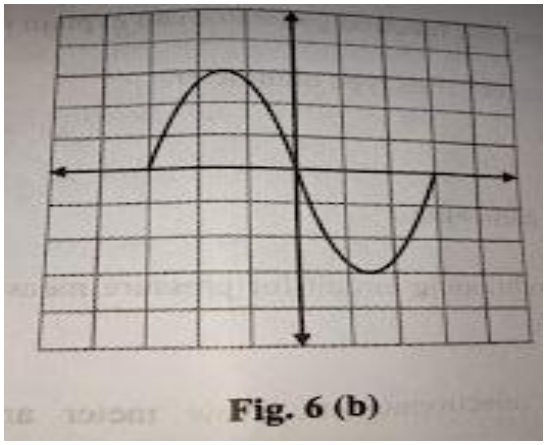
Model Answer

		therefore self-generating. • The high-frequency response of these transducers makes a good choice for various applications. Disadvantages: any one • Temperature and environmental conditions can affect the behavior of the transducer. • They can only measure changing pressure hence they are useless while measuring static parameters. Application**: any one** 1) It is used in under water detection system i.e. SONAR. 2) These are used in measurement of surface roughness in accelerometers and vibration picks ups. 3) It is used in ultrasonic flow meters, non-destructive test (NDT) equipment's 4) Piezoelectric materials are use in ultrasonic transducers.	**1M** **1M** **1M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**Define accuracy and precision. Voltmeters (V1, V2, V3 and V4) are used to measure a voltage of 150 volts (true value). The voltage is measured four times by each voltmeter as mentioned in below table:**	**6M**

		 **By observing the above performance of each voltmeter, comment on the accuracy and precision of each voltmeter.**	
	Ans:	Definition: **Accuracy is the ability of the instrument to measure the accurate value**. 0R it is the closeness of the measured value to a standard or true value. Precision: The **precision means two or more values of the measurements are closed to each other.** The value of precision differs because of the observational error **Voltmeter V1 –**shows error in measurement which is constant throughout all measurement. Voltmeter V1 is neither accurate nor precise. Voltmeter V2 – shows error in measurement which is not constant throughout all Measurement. But nearer to actual voltage. So V2 is not accurate but it is Precise. Voltmeter V3 – shows error in measurement which is not constant throughout all Measurement. But nearer to actual voltage. So V3 is neither accurate nor precise Voltmeter V4 –shows no error in measurement so it accurate and precise for all	**1M** **1M** **1M** **1M** **1M** **1M**

		measurement.	
	b)	**For the waveform shown in Fig 6(b) if vertical attenuation is 3mV/div.**  **Fig. 6 (b)** **Find, (i) Peak to peak voltage** **(ii) Amplitude** **(iii) rms value of the signal.**	**6M**
	Ans:	(i) Peak to peak voltage=(no. of vertical division from +ve peak to –ve peak)*(volts/div) = 6*3 mV/div =18 mV/div. (ii) Amplitude: 3*3 mV/div =9 mV/div. (iii) rms value of the signal.= $\frac{V_m}{\sqrt{2}} = \frac{9}{\sqrt{2}}$ =6.36V	**2M each**
	c)	**Sketch and describe pressure measurement system for 800 mm pressure, that contain Bourdon tube and LVDT.**	**6M**
	Ans:	Diagram:	**3M**

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		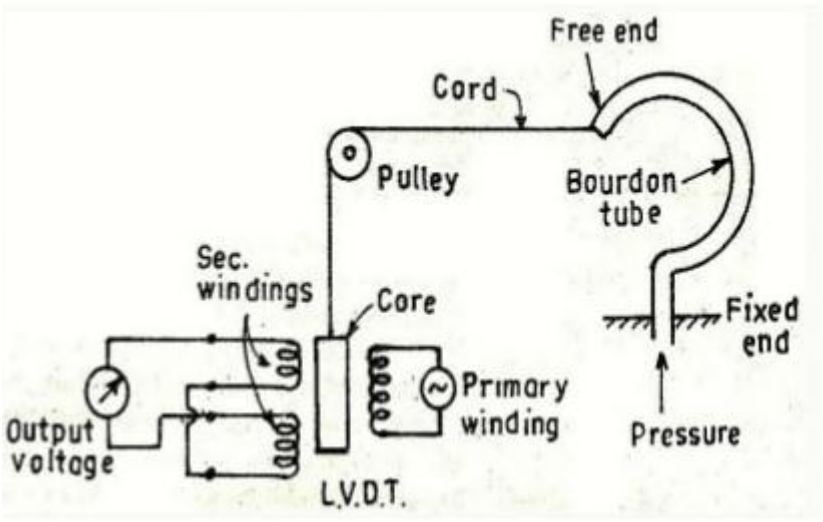 Explanation: • The pressure measurement using bourdon tube and LVDT is shown in above figure. • In this the, the bourdon tube act as primary transducer and LVDT which follows the output of bourdon tube act as a secondary transducer. • The bourdon tube senses the pressure and converts it into a displacement. • The free end of bourdon tube shows this displacement. A cord is used to connect the free end of bourdon tube to the core of LVDT as shown in figure. • When the free end shows the displacement, the core of LVDT also moves. • This movement of core is proportional to the displacement of free end, which is proportional to the applied pressure. • The LVDT gives analogues output which is a conversion of displacement into respective emf. • This set up is used for measurement of pressure which is converted into electrical signal by LVDT.	**3M**