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

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		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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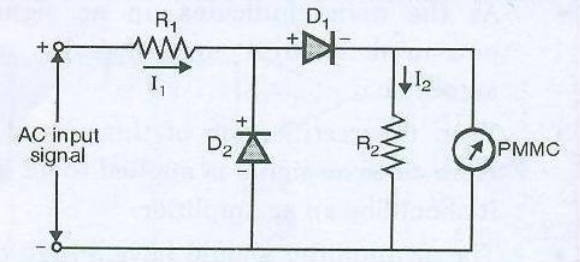
			Marks
	a)	**Draw and explain working of half wave rectifier type AC voltmeter.**	**4M**
	Ans:	 **Fig: Circuit Diagram of rectifier type AC voltmeter** • Basic rectifier type AC voltmeter is a general rectifier type of voltmeter. In this case for the rectification action two diodes namely D1 and D2 are 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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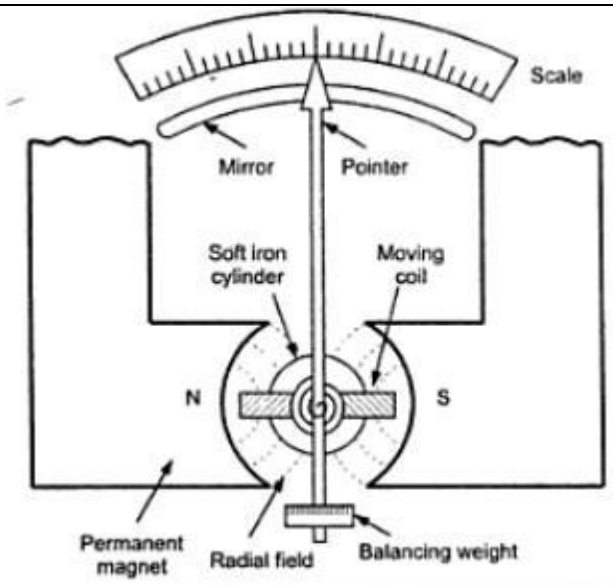
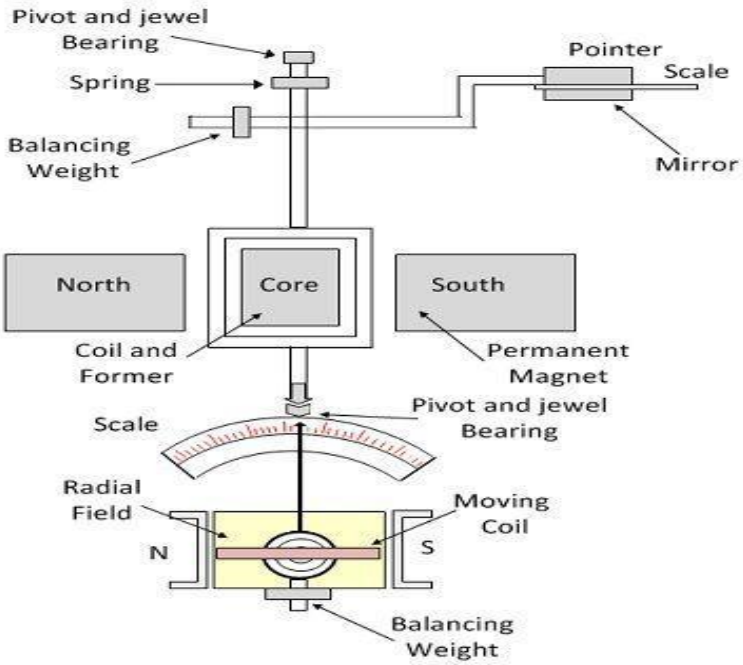
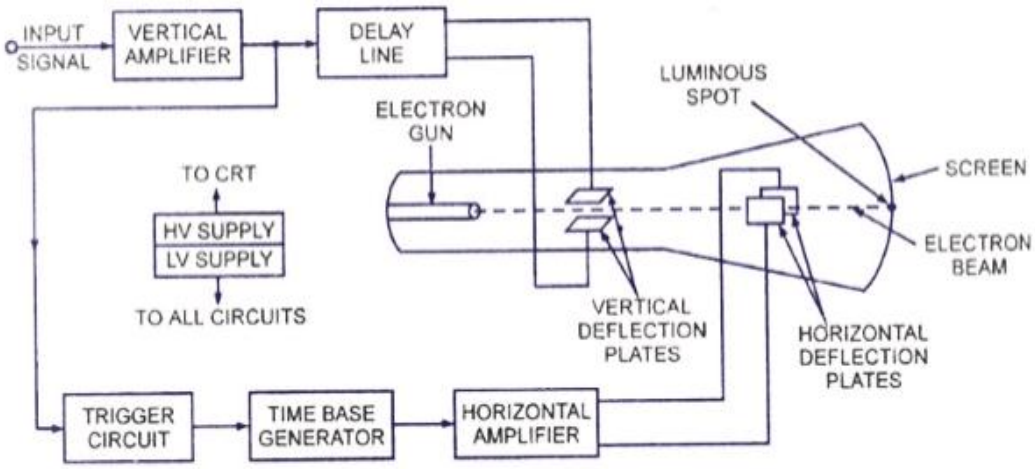
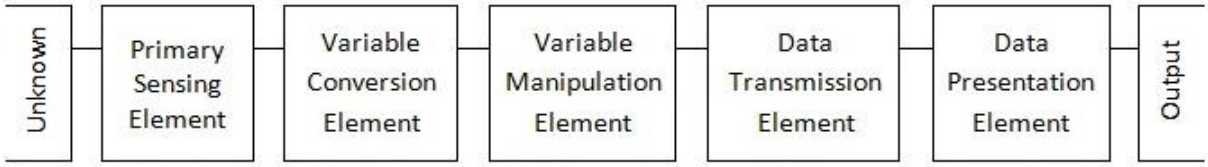
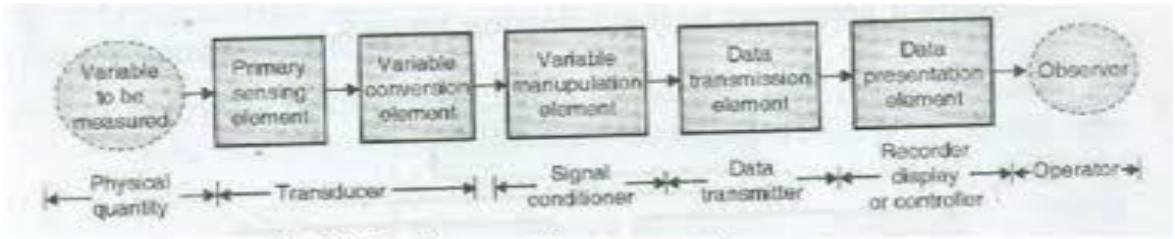
	Ans:	 **OR**  Permanent Magnet Moving Coil Instrument	**2M for explanation** **&** **2 M for diagram**

		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**

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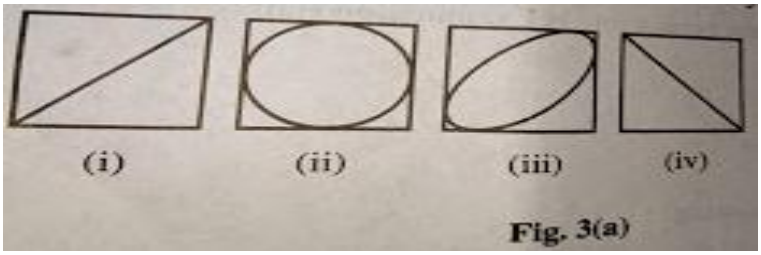
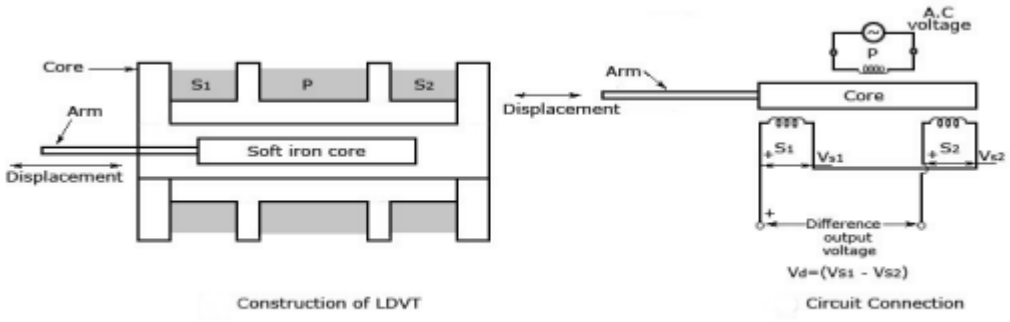
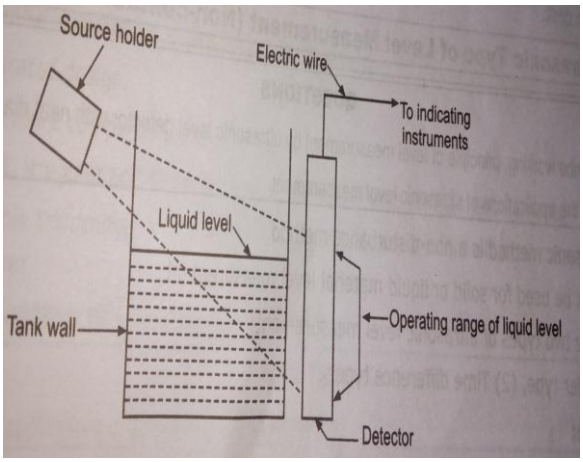
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	a)	**What will be the phase shift for following Lissajous patterns?**  Fig. 3(a)	**4M**
	Ans:	(i) Phase shift = 0° (ii) Phase shift = 90° or 270° (iii) Phase shift = 30° or 330° (iv) Phase shift = 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**

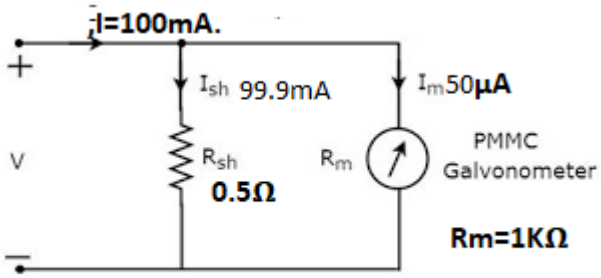
Construction of LVDT:

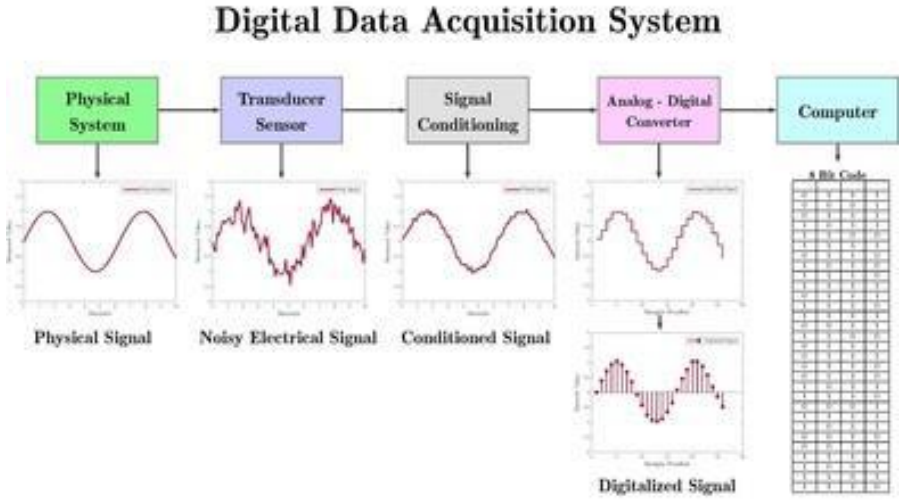
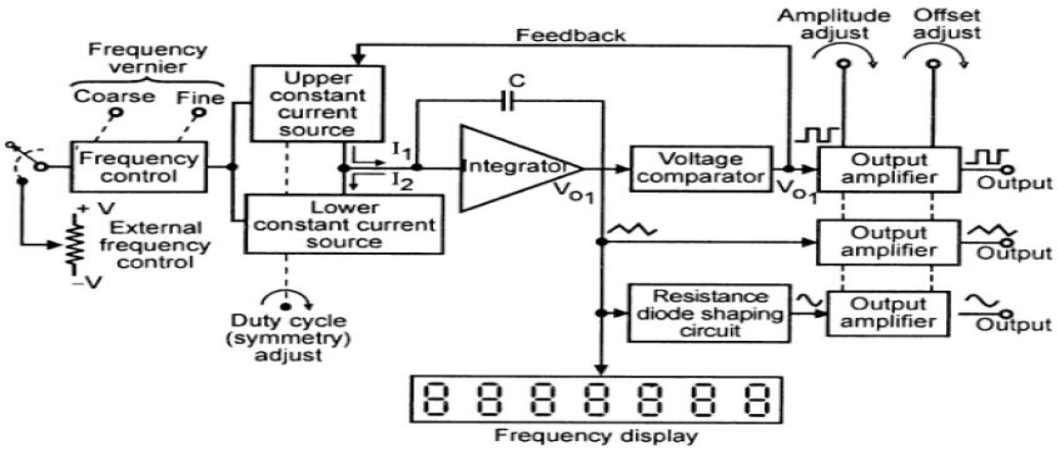
- A differential transducer consists of a primary winding and two secondary winding.
- The windings are arranged concentrically and next to each other. They are wound

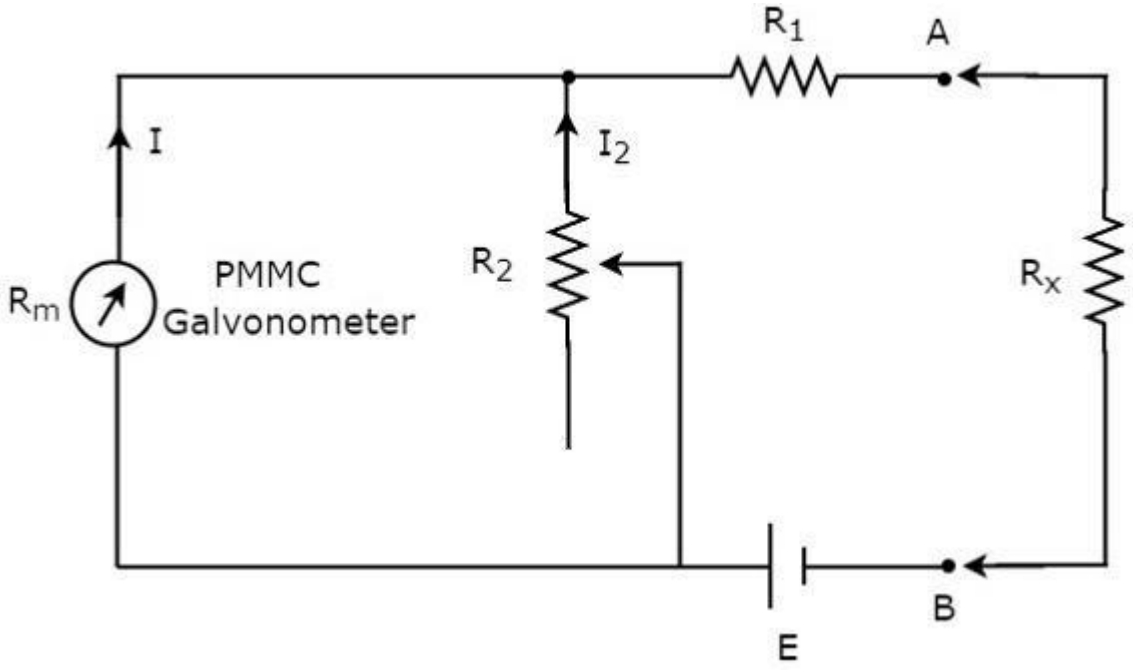
		over a narrow bobbin which is usually of a non- magnetic and insulating material. • A core in the shape of road is attached to the transducer sensing a shaft. • An AC source is applied across the primary winding and core varies the coupling between it and two secondary windings. E0=E1-E2	
	c)	**Describe 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**

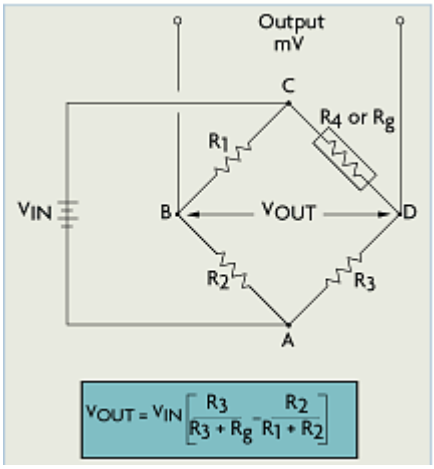


Figure: **DC signal conditioning circuit for pressure measurement using strain gauge**

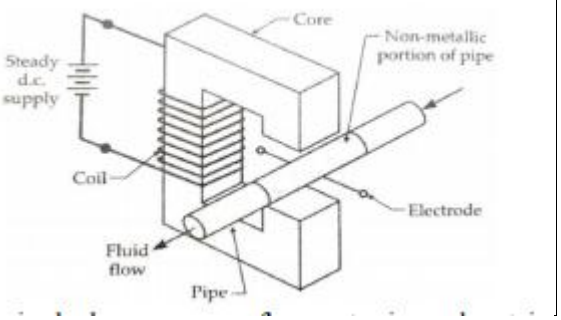
Where, Rg= strain gauge resistance.

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

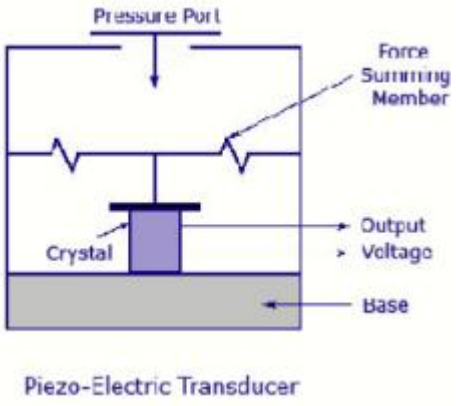
v= velocity of Conductor i.e flow m/sec

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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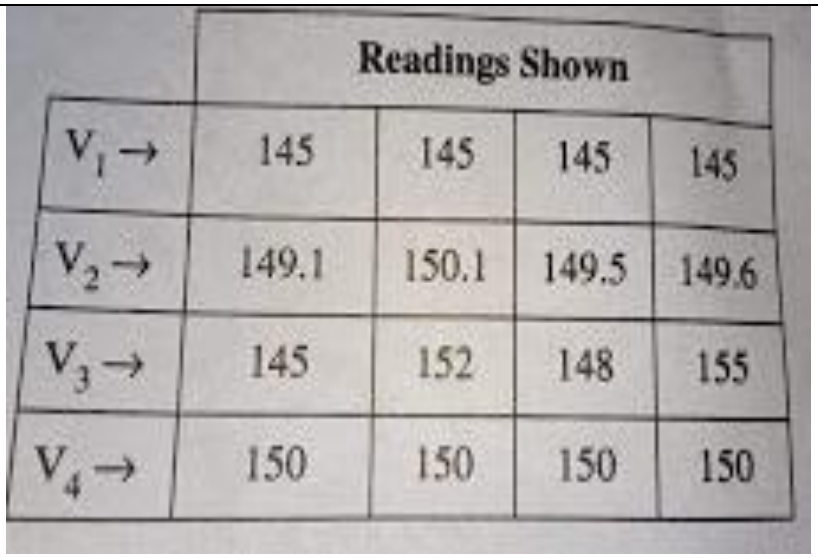
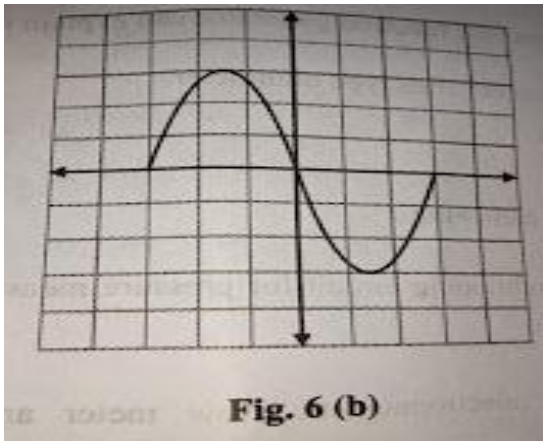
		therefore self-generating. • The high-frequency response of these transducers makes a good choice for various applications. Disadvantages: any one • Temperature and environmental conditions can affect the behavior of the transducer. • They can only measure changing pressure hence they are useless while 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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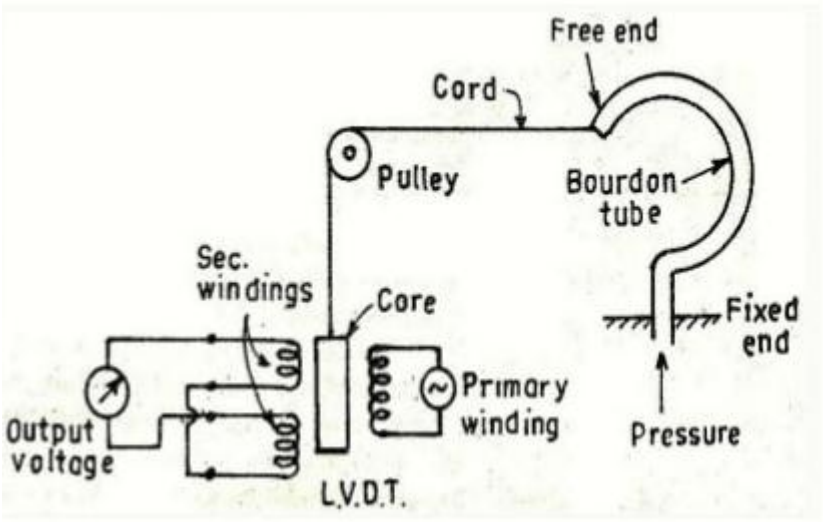
Subject Name: Electronic measurement and instrumentation **Subject Code:** 22333

Model Answer

		 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**