SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MEDICAL ELECTRONICS

QUESTION BANK

III SEMESTER

MD3361 –Sensors and Measurements

Regulation – 2023

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UNIT I – FUNDAMENTALS OF MEASUREMENTS

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis- methods of error analysis, -uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors– Calibration - Primary and secondary standards.

PART A

Q.No	Questions	CO	BT Level	Domain
1	Mention the purpose of measurement.	CO 1	BTL 1	Remembering
2	Sketch the functional block diagram of a Measurement system.	CO 1	BTL2	Understanding
3	What is meant by sensors	CO 1	BTL 1	Remembering
4	Define Transducers	CO 1	BTL 1	Remembering
5	Differentiate sensors from transducers	CO 1	BTL2	Understanding
6	The value of a resistance is 4.7 kΩ, while measurement of it, read a value of 4.63 kΩ. Calculate accuracy in %.	CO 1	BTL2	Understanding
7	List the different types of systematic errors.	CO 1	BTL2	Understanding
8	Express absolute errors and relative errors mathematically.	CO 1	BTL 1	Remembering
9	Compare Accuracy and precision.	CO 1	BTL2	Understanding
10	Define Sensitivity	CO 1	BTL 1	Remembering
11	What is the difference between threshold and resolution.	CO 1	BTL2	Understanding
12	Name the different methods of measurement.	CO 1	BTL 1	Remembering
13	Differentiate active and passive transducer with examples.	CO 1	BTL2	Understanding
14	List out the static characteristics of transducers.	CO 1	BTL2	Understanding
15	Define measuring lag and fidelity dynamic response of measurement.	CO 1	BTL 1	Remembering
16	The expected value of a voltage across a resistor is 40 V. However the measurement gives a value of 39 V. Calculate the absolute error.	CO 1	BTL2	Understanding
17	What is calibration?	CO 1	BTL 1	Remembering
18	Name the methods of calibration.	CO 1	BTL2	Understanding
19	Why do you need static and dynamic calibration?	CO 1	BTL 1	Remembering
20	The dead zone in a certain pyrometer is 0.125 percent of span. The calibration is 400°C to 1000°C. What temperature change might occur before it is detected?	CO 1	BTL2	Understanding
21	Define non-linearity and hysteresis of sensors.	CO 1	BTL 1	Remembering
22	What is minimum detectable signal?	CO 1	BTL 1	Remembering
23	Define the term "ODDS".	CO 1	BTL 1	Remembering
24	List the primary and secondary standards of measurement.	CO 1	BTL2	Understanding

PART B

1	Discuss about the types of errors in measurement system and explain how are they corrected?	(16)	CO 1	BTL4	Analyze

2	What is meant by error analysis? Explain statistical methods of error analysis with example.	(16)	CO 1	BTL4	Analyze
3	Compare and explain the static and dynamic characteristics of transducers measurement system.	(16)	CO 1	BTL4	Analyze
4	A multimeter having a sensitivity of 2000 Ω/V is used for the measurement of voltage across a circuit having an output resistance of 10 kΩ. Find the reading of the multimeter when it is set to its 10V scale. Find the percentage error.	(16)	CO 1	BTL 3	Apply
5	Measurements on a human nerve cell indicate an open circuit voltage of 80 mV and a current of 5 nA through a 6 MΩ load. What is a maximum power available from the cell?	(16)	CO 1	BTL 3	Apply
6	What is Drift? Explain the different types of drifts with sketches of input-output relationships in each case.	(16)	CO 1	BTL4	Analyze
7	Explain the phenomenon of hysteresis in measurement systems.	(16)	CO 1		
8	A certain resistor has a voltage drop of 110.2 V and a current of 5.3 A. The uncertainties in the measurements are: $\pm$ 0.2 V and $\pm$ 0.06 A respectively. Calculate the power dissipated in the resistor and the uncertainty in power.	(16)	CO 1	BTL 3	Apply
9	Three resistors of having resistances of 250 Ω, a 500 $\Omega$and a 375 Ω are connected in parallel. The 250 Ω resistor has a + 0.025 fractional error, 500 Ω resistor has a – 0.036 fractional error and a 375 Ω resistor has a +0.014 fractional error. Determine (a) the total resistance neglecting errors, (b) total resistance considering the error of each resistor and (c) the fractional error of the total resistance based upon rated values.	(16)	CO 1	BTL 3	Apply
10	Three resistors have the following ratings: R_1=37Ω $\pm$ 5%, R_2=75Ω $\pm$ 5%, R_3=50Ω $\pm$ 5%. Determine the magnitude and limiting error in ohm and in percent of the resistance of this resistance connected in series.	(16)	CO 1	BTL 3	Apply
11	Current was measuring during a test as 30.4 A, flowing in a resistor of 0.105 Ω. It was discovered later that the ammeter reading was low by 1.2 percent and the marked resistance was high by 0.3 percent. Find the true power as a percentage of the power that was originally calculated.	(16)	CO 1	BTL 3	Apply
12	A circuit was tuned for the resonance by eight different students, and the values of resonant frequency in kHz were recorded as 532,548,543,535,546,531,543 and 536. Calculate (a) the arithmetic mean, (b) deviations from mean, (c) the average deviation, (d) the standard deviation, and (e)variance	(16)	CO 1	BTL 3	Apply
13	A resistance is determined by voltmeter ammeter method. The voltmeter reads 100 V with a probable error of $\pm$12 V and ammeter reads 10 A with probable error of $\pm$2 A. Determine the probable error in the computed value of resistance.	(16)	CO 1	BTL 3	Apply
14	(i)Explain the errors in measurement by giving suitable examples and discuss the mean adopted to minimise these errors. (ii) Two resistors R_1 and R_2 are connected in series and then in parallel. The values of resistances are: R_1=100.0$\pm$0.1Ω, R_2=50$\pm$0.03Ω. Calculate the uncertainty in the combined resistance for both series and parallel arrangements.	(8) (8)	CO 1	BTL4	Analyze
15	Describe the method of treatment of single sample data with the help of uncertainty analysis by giving suitable examples.	(16)	CO 1	BTL4	Analyze

16	Discuss the primary and secondary standards in measurement. Explain the types of systematic errors with suitable examples and the steps taken to minimize the errors	(16)	CO 1	**BTL4**	**Analyze**
17	In a test, temperature is measured 100 times with variations in apparatus and procedures. After applying the corrections, the results are	(16)	CO 1	**BTL 3**	**Apply**

Temperature ^{o}C	397	398	399	400	401	402	403	404	405
Freq of occurence	1	3	12	23	37	16	4	2	2

UNIT II –DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gauge.Capacitive transducer - various arrangements, Inductive transducer, LVDT,Passive types: RTD materials & range, relative resistance vs. temperaturecharacteristics, thermistor characteristics, Active type: Thermocouple - characteristics.

PART A

Q.No	Questions	CO	BT Level	Domain
1	List the purpose of Strain Gauge.	CO 2	**BTL 1**	**Remembering**
2	Write the formula for Gauge factor.	CO 2	**BTL 1**	**Remembering**
3	A resistance wire strain gauge uses a soft iron wire of small diameter. The gauge factor is +4.2. Neglecting the piezo resistive effects, calculate Poisson ratio.	CO 2	**BTL 1**	**Remembering**
4	Mention the types of Strain Gauge.	CO 2	**BTL2**	**Understanding**
5	Write the requirements of a conductor material to be used in RTD's.	CO 2	**BTL 1**	**Remembering**
6	What is potentiometer?	CO 2	**BTL 1**	**Remembering**
7	A copper resistor at 20°C is used to indicate the temperature of bearings of a machine. What resistance should not be exceeded if the maximum bearing temperature is not to exceed 150°C? The resistance temperature co-efficient of copper is 0.00393/^{o}C at 20°C	CO 2	**BTL2**	**Understanding**
8	Why is the frequency of excitation of primary winding kept very high as compared to the frequency of the signal being detected?	CO 2	**BTL2**	**Understanding**
9	Sketch the variation of output voltage with linear displacement for an LVDT.	CO 2	**BTL 1**	**Remembering**
10	Draw the frequency response of capacitive transducers.	CO 2	**BTL 1**	**Remembering**
11	Compare Active and Passive transducers.	CO 2	**BTL2**	**Understanding**
12	Differentiate Thermistors and Thermocouple.	CO 2	**BTL2**	**Understanding**
13	What are the different types of errors?	CO 2	**BTL 1**	**Remembering**
14	Sketch the transducer hysteresis curve.	CO 2	**BTL2**	**Understanding**

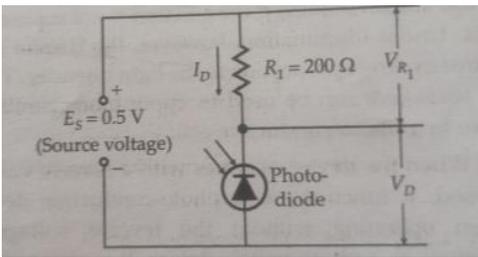| 15	Point out the factors influencing the choice of transducers.		CO 2	**BTL 1**	**Remembering**
16	Give the relationship for resistive transducer.		CO 2	**BTL2**	**Understanding**
17	Mention the advantages and disadvantages of resistive potentiometers.		CO 2	**BTL2**	**Understanding**
18	Draw the voltage-current characteristics of thermistors.		CO 2	**BTL2**	**Understanding**
19	Write the equation applied over a narrower temperature by Steinhart-Hart equation.		CO 2	**BTL2**	**Understanding**
20	A thermistor has a resistance temperature co-efficient of -5% over a temperature range of 25^0C to 50^0C. If the resistance of the thermistor is 100Ω at 25^0C, what is the resistance at 35^0C?		CO 2	**BTL2**	**Understanding**
21	List the various methods available for measurement of thermocouple output.		CO 2	**BTL 1**	**Remembering**
22	Calculate the thermoelectric sensitivity of a device using bismuth and tellurium as the dissimilar metals. Estimate the maximum output voltage for 100^0C temperature difference at room temperature using one junction. The sensitivity of bismuth is -72 $\mu V/^0$C and that of tellurium is 500 $\mu V/^0$C		CO 2	**BTL2**	**Understanding**
23	Sketch the temperature – resistor characteristics curve of RTD.		CO 2	**BTL 1**	**Remembering**
24	What is differential output in variable inductive transducers?		CO 2	**BTL 1**	**Remembering**
PART B					
1	Explain the construction, working, characteristics and application of Strain Gauge.	(16)	CO 2	**BTL4**	**Analyze**
2	Derive the equation for Gauge factor.	(16)	CO 2	**BTL4**	**Analyze**
3	Illustrate unbounded strain gauge and explain its operation.	(16)	CO 2	**BTL4**	**Analyze**
4	A strain gauge is bonded to a beam of 0.1 m long and has a cross-sectional area 4 cm^2. Young's modulus for steel is 207 GN/m^2. The strain gauge has an unstrained resistance of 240Ω and a gauge factor of 2.2. When a load is applied, the resistance of gauge changes by 0.013Ω. Calculate the change in length of the steel beam and the amount of force applied to the beam.	(16)	CO 2	**BTL 3**	**Apply**
5	A thermistor has a resistance of 10 kΩ at 25^oC. The resistance temperature co-efficient is -0.05/^{o}C. A Wien's bridge oscillator uses two identical thermistors in the frequency determining part of the bridge. The value of capacitance used in the bridge is 500 pF. Calculate the value of frequency of oscillations for (i) 20^oC (ii) 25^oC (iii) 30^oC. The frequency of oscillations is $f = 1/(2\pi RC)$ Hz where R and C are resistance and capacitance respectively.	(16)	CO 2	**BTL 3**	**Apply**
6	The output of an LVDT is connected to a 5V voltmeter through an amplifier whose amplification factor is 250. An output of 2 mV appears across the terminals of LVDT when the core moves through a distance of 0.5 mm. Calculate the sensitivity of the LVDT and that of the whole set-up. The milli-voltmeter scale has 100 divisions. The scale can be read to 1/5 of a division. Calculate the resolution of the instrument in mm.	(16)	CO 2	**BTL 3**	**Apply**
7	Design a circuit using a LM 335 to cover a range of -10V to +50V with a nominal temperature of 20^oC. Assume a supply voltage of 15 V. Also calculate the minimum recommended load resistance. The output of Zener diode is, $V_z = 2.73 + 10 \times 10^{-3} \Theta V$. The Zener current is limited to 1 mA.	(16)	CO 2	**BTL 3**	**Apply**

8	Describe the working and construction of resistance thermometers. Describe the materials used for RTDs, along with their properties. Sketch their typical characteristics.	(16)	CO 2	**BTL4**	**Analyze**
9	What are thermistors? Explain their different forms of construction. Draw their resistivity versus temperature characteristics and show that they have a very high value of sensitivity as compared with that of metal resistance thermometers. Describe their applications.	(16)	CO 2	**BTL4**	**Analyze**

10	Draw and describe the following for thermistors:
	    (i) Resistance-temperature characteristics
	    (ii) Voltage-current characteristics, and
	    (iii) Current-time characteristics.
		(5)
		(5)
		(6)
			CO 2	**BTL4**	**Analyze**

11	Discuss the different principles of working of capacitive transducers.	(16)	CO 2	**BTL4**	**Analyze**
12	(i)How is a differential output taken from an inductive transducer? (ii)Explain the advantages when transducers are used in push-pull configuration.	(6) (10)	CO 2	**BTL4**	**Analyze**
13	(i)Describe the construction and principle of working of a linear voltage differential transformer (LVDT). (ii)Explain how the magnitude and direction of the displacement of core of an LVDT detected?	(7) (9)	CO 2	**BTL4**	**Analyze**
14	Illustrate the construction, theory and working of thermocouples. List the different types of compensations used and also the methods of measurement of their output voltage.	(16)	CO 2	**BTL4**	**Analyze**
15	Give an overview of the inductive transducers explaining their principle of operation like variation of number of turns, geometric configuration and permeability. Draw neat sketches to show the above effects.	(16)	CO 2	**BTL 3**	**Apply**
16	Describe the method for measurement of temperature with use of (i) RTDs (ii) Thermistors With their advantages and limitations.	(8) (8)	CO 2	**BTL 3**	**Apply**

17	A parallel plate capacitive transducer uses plates of area 500 mm^2 which are separated by a distance 0.2 mm. Calculate the value of capacitance when the dielectric is air having a permittivity of 8.85 x 10^{-12} F/m.
	    (i) Calculate the change in capacitance if a linear displacement reduces the distance between the plates to 0.18 mm. Also calculate the ratio of per unit change of capacitance to per unit change od displacement.
	    (ii) Suppose a mica sheet 0.01 mm thick is inserted in the Gap. Calculate the value of original capacitance and change in capacitance for the same displacement. Also calculate the ratio of per unit change in capacitance to per unit change in displacement. The dielectric constant of mica is 8.
		(8)
		(8)
			CO 2	**BTL 3**	**Apply**

UNIT III –PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS

Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its characteristics.

PART A

Q.No	Questions	CO	BT Level	Domain
1	What is phototube?	CO 3	**BTL 1**	**Remembering**
2	Sketch the schematic diagram of Photovoltaic Cell.	CO 3	**BTL 1**	**Remembering**
3	State the principle of Photo emissive cell.	CO 3	**BTL 1**	**Remembering**
4	Differentiate photoelectric and radiant sensitivity.	CO 3	**BTL2**	**Understanding**
5	Name the classification of optic fibre sensors.	CO 3	**BTL 1**	**Remembering**
6	Define threshold wavelength.	CO 3	**BTL 1**	**Remembering**
7	List the commonly used materials for photo resistive light sensors.	CO 3	**BTL2**	**Understanding**
8	What is crystal voltage sensitivity?	CO 3	**BTL 1**	**Remembering**
9	Draw the equivalent circuit of piezo-electric transducers.	CO 3	**BTL2**	**Understanding**
10	Mention the classification of transducers.	CO 3	**BTL2**	**Understanding**
11	What is variable capacitance pressure gauge?	CO 3	**BTL 1**	**Remembering**
12	State the principle of Photomultiplier tube.	CO 3	**BTL 1**	**Remembering**
13	Define charge sensitivity	CO 3	**BTL 1**	**Remembering**
14	Name the properties of Barium Titanate and Quartz.	CO 3	**BTL2**	**Understanding**
15	List the modes of operation of Piezo – electric crystals.	CO 3	**BTL2**	**Understanding**
16	What is piezo resistive effect?	CO 3	**BTL 1**	**Remembering**
17	Differentiate self and mutual induction.	CO 3	**BTL2**	**Understanding**
18	Define eddy current.	CO 3	**BTL 1**	**Remembering**
19	List the two basic generic styles of optical encoders.	CO 3	**BTL2**	**Understanding**
20	Mention the classification of encoders.	CO 3	**BTL2**	**Understanding**
21	State the principle of optical displacement transducers.	CO 3	**BTL 1**	**Remembering**
22	Sketch the pattern of translucent and opaque sectors used in optical encoders.	CO 3	**BTL 1**	**Remembering**
23	A piezo-electric crystal having dimensions of 5 mm x 5mmx1.5 mm and a voltage sensitivity of 0.055 V-m/N is used for force measurement. Calculate the force if the voltage developed is 100V.	CO 3	**BTL2**	**Understanding**
24	Draw the symbol of LDR and its characteristics.	CO 3	**BTL2**	**Understanding**

PART B

1	Explain the principle of working, constructional details and application of light dependent resistors.	(16)	CO 3	**BTL4**	**Analyze**
2	Describe the principle of working, constructional details and applications of photo-diodes. Draw the characteristics.	(16)	CO 3	**BTL4**	**Analyze**
3	Discuss the principle of working constructional details and applications of photo-transistors. Explain why are they preferred for their digital applications. Draw their characteristics.	(16)	CO 3	**BTL4**	**Analyze**
4	Elaborate the principle of working constructional details of photo-voltaic cell. Explain why is it very useful for space applications.	(16)	CO 3	**BTL4**	**Analyze**
5	Describe the following the types of shaft encoders: (i) resistive type (8) (ii) optical type. (8)		CO 3	**BTL4**	**Analyze**
6	Discuss the properties of materials used for piezo-electric transducers. Derive expressions for voltage and charge sensitivities.	(16)	CO 3	**BTL 3**	**Apply**

7	Illustrate the different modes of operation of piezoelectric transducers. Define and sketch binders and twisters. Explain the applications of piezoelectric transducers.	(16)	CO 3	**BTL 3**	**Apply**
8	Derive the expressions for frequency response characteristics of piezo-electric transducers.	(16)	CO 3	**BTL4**	**Analyze**
9	Write short notes on (i) Phototube (ii) Scintillation Counter	(8) (8)	CO 3	**BTL4**	**Analyze**
10	Discuss the following (i) Photo Multiplier tube (ii) Resistive Transducer	(8) (8)	CO 3	**BTL4**	**Analyze**
11	Explain in detail on optical displacement Sensors.	(16)	CO 3	**BTL4**	**Analyze**
12	A barium titanate pickup has the dimensions of 5 mm x 5 mm x 1.25 mm. The force acting on it is 5 N. The charge sensitivity of barium titanate is 150 pC/N and its permittivity is 12.5×10^{-9} F/m. If the modulus of elasticity of barium titanate is 12×10^{6} N/m^2, calculate the strain. Also calculate the charge and capacitance.	(16)	CO 3	**BTL 3**	**Apply**
13	Describe the equivalent circuit of piezo-electric transducer and also explain the loading effects and frequency response.	(16)	CO 3	**BTL4**	**Analyze**
14	Discuss the applications of Photo-voltaic cell and Photoconductive cell.	(16)	CO 3	**BTL4**	**Analyze**
15	In a piezo- electric transducer a flat frequency response within 5% required. Find the value of minimum frequency in terms of time constant for which it can be used. If the time constant of the transducer is 1.5 ms, find the value of minimum frequency. Find the phase shift at this frequency.	(16)	CO 3	**BTL 3**	**Apply**
16	A photodiode with illumination characteristic is shown in the figure below. It is connected in series with a 200 Ω resistance and a 0.5 V supply. The supply polarity is reverse biases the device. Draw the d.c. load line for the circuit and determine diode currents and voltages at 1500, 10,000 and 20,000 lm/m^2 illumination. 	(16)	CO 3	**BTL 3**	**Apply**
17	The bridge circuit of the figure below is used for measurement of attenuation of light. R_1 and R_3 are resistors having a value of 1 kΩ each. R_2 and R_4 are two photo – conductive cells whose values of resistance depend upon the light incident upon them. The bridge input voltage is 10 V d.c and the output of the bridge is measured with a detector which can be considered to have an infinite input impedance.	(16)	CO 3	**BTL 3**	**Apply**
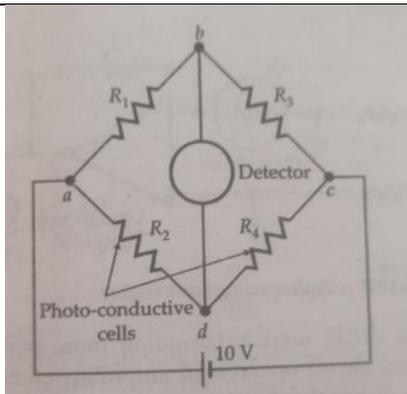
UNIT IV – SIGNAL CONDITIONING CIRCUITS AND METERS

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering, Q meter, PMMC, MI and dynamometer type instruments - DC potentiometer- Digital voltmeter – Multi meter.

PART A

Q.No	Questions	CO	BT Level	Domain
1	List the functions of signal conditioning circuit.	CO 4	**BTL2**	**Understanding**
2	What is sample and hold circuit?	CO 4	**BTL 1**	**Remembering**
3	Define Sample-to-hold offset.	CO 4	**BTL 1**	**Remembering**
4	Sketch the circuit of simple sample and hold circuit.	CO 4	**BTL 1**	**Remembering**
5	Draw the block diagram of digital DAC systems.	CO 4	**BTL2**	**Understanding**
6	Name the types of data acquisition system based on channel.	CO 4	**BTL 1**	**Remembering**
7	Compare Inverting and Non Inverting Amplifier.	CO 4	**BTL 1**	**Remembering**
8	What is an amplifier?	CO 4	**BTL 1**	**Remembering**
9	Draw the pin diagram of IC741 operational amplifier.	CO 4	**BTL2**	**Understanding**
10	Sketch the frequency response of ideal filters.	CO 4	**BTL2**	**Understanding**
11	Define full power bandwidth.	CO 4	**BTL 1**	**Remembering**
12	The slew rate of an operational amplifier is 20 V/µs. The OPAMP has saturation voltages of ± 10 V, calculate the maximum switching time from saturation region to the other.	CO 4	**BTL2**	**Understanding**
13	What is potentiometer?	CO 4	**BTL 1**	**Remembering**
14	A potentiometer that is accurate to ±0.00001 V is used to measure current through a standard resistance of 0.1 ± 0.1 Ω %. The voltage across the resistance is measured to be 0.2514 V. What is the current and to what accuracy it has been determined.	CO 4	**BTL2**	**Understanding**
15	List the different methods for measurement of low & high resistance.	CO 4	**BTL2**	**Understanding**
16	Mention the main source of errors in moving coil instruments.	CO 4	**BTL 1**	**Remembering**
17	State the principle of moving iron instruments.	CO 4	**BTL 1**	**Remembering**
18	The inductance of moving iron instrument is given by: $L = (10+5\Theta-\Theta^2)$ µH where Θ is the deflection in radian from zero position. The spring constant is 12×10^{-6} N, m/rad. Estimate the deflection for a current of 5A.	CO 4	**BTL2**	**Understanding**
19	Point out the advantages and disadvantages of electrodynamometer instruments.	CO 4	**BTL2**	**Understanding**
20	The inductance of a 25 A electrodynamic ammeter changes uniformly at the rate of 0.0035µH/degree. The spring constant is 10^{-6} N-m/ degree. Determine the angular deflection at full scale.	CO 4	**BTL2**	**Understanding**
21	What are the modifications and additional features incorporated in a low	CO 4	**BTL2**	**Understanding**

	voltage Schering bridge for it to be used on high voltages?				
22	Point out the need of preamplifier in signal conditioning circuit.		CO 4	**BTL 1**	**Remembering**
23	Write the expression for maximum power transfer in dc circuit.		CO 4	**BTL 1**	**Remembering**
24	Measurements on a human nerve cell indicate an open circuit voltage of 80 mV, and a current of 5 nA through a 6 MΩ load. What is a maximum power available from the cell?		CO 4	**BTL2**	**Understanding**
PART B					
1	Explain the block diagram of ac and dc signal conditioning system with a neat sketch.	(16)	CO 4	**BTL4**	**Analyze**
2	(i)A simple RC low-pass filter is to be so designed that the output voltage be attenuated by 3 dB at 500 Hz. Calculate the time constant and suitable values of R and C. (ii) A bandpass filter consists of two RC networks connected in cascade. The low pass filter consists of a resistor $R_1 = 10$ kΩ and $C_1 = 100$ pF and the high pass filter consists of resistor $R_2 = 1$ MΩ and $C_2 = 0.01$ μF. Find the lower and the upper cut-off frequencies and the passband gain.	(16)	CO 4	**BTL 3**	**Apply**
3	(i)A simple equal arm voltage sensitive bridge is initially in balance (null). Three of the arms consist of ordinary resistors, while the fourth is a thermistor. Each arm has a nominal resistance of 10,000 Ω, and the bridge is energised with a 6 V d.c. source. (a) If the temperature change causes a +5% change in thermistor resistance, what output voltage will be indicated from the bridge? (b) If a -5% change in resistance is caused, what will the bridge output? (ii)In a wheatstone bridge three out of four resistors have a value of 1 kΩ each, and the fourth resistor equals 1010 Ω. If the battery voltage is 100 V, what is the approximate value of the open circuit voltage? If the output of the bridge is connected to a 4 kΩ resistor, how much current would flow through the resistor.	(8) (8)	CO 4	**BTL 3**	**Apply**
4	(a) An analog transducer with a 0 -10 V input is able to distinguish a change of 10 mV in its input signal. Calculate its resolution. (b) Calculate the number of bits of an A/D converter so that the digital output has also the same resolution as the transducer. The A/D converter uses a binary code. (c) Find the quantization error and the number of decision levels.	(5) (5) (6)	CO 4	**BTL 3**	**Apply**
5	Describe the following types of passive RC filters (i) low pass (ii) high pass (iii) band pass and (iv) band stop. Sketch their ideal and practical characteristics.	(16)	CO 4	**BTL4**	**Analyze**
6	Derive the expression for current in the meter connected across the output terminals of a Wheatstone bridge when it is slightly unbalanced. Find the ratio of output voltage when the meter is not connected to the output voltage, when the meter is connected, when an equi-arm Wheatstone bridge is slightly unbalanced.	(16)	CO 4	**BTL4**	**Analyze**
7	(i)Explain the circuit and working of Q meter. Discuss its applications. (ii)A circuit consisting of a coil, a resistance and a variable capacitor connected in series is tuned to resonance using Q-meter. If the frequency is 500 kHz, the resistance 0.5Ω and the variable capacitor set to 350 pF. Calculate the effective inductance and resistance of the coil, if the Q meter indicates 90.	(8) (8)	CO 4	**BTL 3**	**Apply**

8	Elaborate the working of electronic voltmeters which use rectifiers. Explain the modes of operation and also discuss why negative feedback is used in them.	(16)	CO 4	**BTL4**	**Analyze**
9	Illustrate with the help of a block diagram, the various parts of an electronic multimeter.	(16)	CO 4	**BTL4**	**Analyze**
10	(i)Sketch the circuit diagram of a basic potentiometer circuit and explain its operation. (ii)A simple slide wire is used for measurement of current in a circuit. The voltage drop across a standard resistor of 0.1 Ω is balanced at 75 cm. Find the magnitude of the current if the standard cell emf of 1.45 V is balanced at 50 cm.	(8) (8)	CO 4	**BTL 3**	**Apply**
11	Derive the equations for balance in the case of Maxwell's inductance capacitance bridge. Draw the phasor diagram for balance conditions.	(16)	CO 4	**BTL4**	**Analyze**
12	(i)Describe the working of Hay's Bridge for measurement of inductance. (ii)Derive the equations for balance and draw the phasor diagram under conditions of balance. Why is the bridge suited for measurement of inductance of high Q coils?	(8) (8)	CO 4	**BTL4**	**Analyze**
13	Elaborate the working of a low voltage Schering bridge. Derive the equations for capacitance and dissipation factor. Draw the phasor diagram of the bridge under conditions of balance.	(16)	CO 4	**BTL4**	**Analyze**
14	Draw the circuit of a Kelvin's Double Bridge used for measurement of low resistances. Derive the condition for balance.	(16)	CO 4	**BTL4**	**Analyze**
15	(i) Describe the construction and working of PMMC instrument. (ii) Derive the equation for deflection if the instrument is spring controlled. Describe the method of dampling used in these instruments.	(8) (8)	CO 4	**BTL4**	**Analyze**
16	(i) Explain the working of attractive and repulsion type of moving iron instruments with the help of neat diagrams. (ii) Describe the methods of producing controlling and damping torques in them. Explain why these meters can be used on both ac and dc.	(8) (8)	CO 4	**BTL 3**	**Apply**
17	(i)Discuss the constructional details and working of an electrodynamometer type instrument. (ii) Derive the equation for deflection under ac conditions if the meter is spring controlled.	(8) (8)	CO 4	**BTL4**	**Analyze**

UNIT V – RECORDING DEVICES AND ADVANCED SENSORS

CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Biosensors: transduction mechanism in a biosensor and Classification - Electronic nose.

PART A			
Q.No	Questions	CO	BT Level	Domain
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1	Mention the main parts of a Cathode Ray Tube	CO 5	**BTL 1**	**Remembering**
2	List the two methods of focussing an electron beam	CO 5	**BTL 1**	**Remembering**
3	How is double concave lens is formed?	CO 5	**BTL2**	**Understanding**
4	What is deflection sensitivity?	CO 5	**BTL 1**	**Remembering**

5	Define deflection factor.		CO 5	**BTL 1**	**Remembering**
6	Point out the methods for accomplishing Synchronisation.		CO 5	**BTL2**	**Understanding**
7	State the principle of digital storage oscilloscope.		CO 5	**BTL 1**	**Remembering**
8	Compare analogue and digital storage oscilloscope.		CO 5	**BTL2**	**Understanding**
9	List the different types of probes available in oscilloscope.		CO 5	**BTL2**	**Understanding**
10	Calculate the maximum velocity of the beam of electrons in a CRT having a cathode anode voltage of 800 V. Assume that the electrons to leave the cathode with zero velocity. (Charge of electron = 1.6 x 10^{-19} C and mass of electron = 9.1 x 10^{-31} kg)		CO 5	**BTL2**	**Understanding**
11	Mention the advantages of magnetic tape recorders.		CO 5	**BTL2**	**Understanding**
12	State the principle of tape recorder.		CO 5	**BTL 1**	**Remembering**
13	Classify the categories of graphic recorders.		CO 5	**BTL 1**	**Remembering**
14	Differentiate transmittive and reflective type of Liquid crystal cells.		CO 5	**BTL2**	**Understanding**
15	Point out the pros and cons of LCDs		CO 5	**BTL2**	**Understanding**
16	List the classification of analog recorders.		CO 5	**BTL2**	**Understanding**
17	A tape receives 12,000 numbers per second. The tape speed is 1.5 m/s. Determine the number density of tape.		CO 5	**BTL2**	**Understanding**
18	Mention the use of recorders in digital systems.		CO 5	**BTL2**	**Understanding**
19	Sketch the block diagram of a digital data recording system.		CO 5	**BTL2**	**Understanding**
20	Define biosensor.		CO 5	**BTL 1**	**Remembering**
21	State the principle of inkjet recorder.		CO 5	**BTL 1**	**Remembering**
22	Name the different types of recorders used in biomedical instrumentation.		CO 5	**BTL2**	**Understanding**
23	How do electronic nose work?		CO 5	**BTL2**	**Understanding**
24	What is thermal recorder?		CO 5	**BTL 1**	**Remembering**
PART B					
1	An electrically deflected CRT has a final anode voltage of 2000 V and parallel deflecting plates 2 cm long and 5 mm apart. If the screen is 30 cm from the centre of deflecting plates, find (a) beam speed, (b) the deflection sensitivity of the tube, and (c) the deflection factor of the tube. (d) Find the input voltage required to deflect the beam through 3 cm. The input voltage is applied to the deflecting plates through amplifiers having an overall gain of 100.	(16)	CO 5	**BTL 3**	**Apply**
2	(i) Explain the block diagram of general purpose CRO and the functions of each block. (ii) Describe the different parts of a CRT	(8) (8)	CO 5	**BTL4**	**Analyze**
3	Derive an expression for vertical deflection of an electron beam in a CRT.	(16)	CO 5	**BTL4**	**Analyze**
4	(i) Illustrate the principle of working and circuit diagram of a digital oscilloscope. (ii) Explain how frequency and phase angle measurements can be made with the use of a CRO.	(8) (8)	CO 5	**BTL4**	**Analyze**
5	The sketches shown in the figure below display Lissajous pattern for cases where voltages of same frequency out of different phase are connected to Y and X plates of the oscilloscope. Find the phase difference in each case. The spot generating the patterns move in a clockwise direction. Calculate the angles if the spot generating the patterns moves in the anticlockwise direction.	(16)	CO 5	**BTL 3**	**Apply**

(a)   (b)   (c)   (d)

6	Elaborate the theory and working of LCDs. Describe the difference between light scattering and field effect types of LCDs. Also mention its advantages.	(16)	CO 5	**BTL4**	**Analyze**
7	Explain with the help of a diagram, the working of PMMC writing systems.	(16)	CO 5	**BTL4**	**Analyze**
8	Illustrate, with the help of a diagram the working of servo recorders and its applications	(16)	CO 5	**BTL 3**	**Apply**
9	Explain the working of photographic recorder and list the applications of it.	(16)	CO 5	**BTL4**	**Analyze**
10	Describe the basic components of magnetic tape recorder used for instrumentation applications using direct recording techniques and mention its advantages and disadvantages.	(16)	CO 5	**BTL4**	**Analyze**
11	Discuss how equalisation is carried out in a magnetic tape recorder using direct recording techniques.	(16)	CO 5	**BTL4**	**Analyze**
12	Explain the FM method of magnetic tape recording and its advantages and disadvantages.	(16)	CO 5	**BTL4**	**Analyze**
13	Describe the method of pulse duration modulation as used in magnetic tape recorders with its advantages and disadvantages.	(16)	CO 5	**BTL4**	**Analyze**
14	Sketch the schematic layout of inkjet recorder and explain the working of it.	(16)	CO 5	**BTL 3**	**Apply**
15	Draw the block diagram of Electronic Nose and explain the components of it. Mention the commonly used sensors in Electronic Nose. List the advantages and limitations.	(16)	CO 5	**BTL 3**	**Apply**
16	Explain the mechanism of thermal recorder with a neat sketch.	(16)	CO 5	**BTL 3**	**Apply**
17	Describe the working principle, components and classification of Biosensors in detail.	(16)	CO 5	**BTL4**	**Analyze**