SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF
ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

III SEMESTER

1907001 – Transducers Engineering

Regulation – 2019

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Prepared by

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DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING
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SUBJECT: 1907001 - Transducers Engineering

SEM/YEAR: III/II

UNIT I-SCIENCE OF MEASUREMENTS AND CLASSIFICATION OF TRANSDUCERS			
Units and standards – Static calibration – Classification of errors–Error analysis – Statistical methods – Odds and uncertainty – Classification of transducers – Selection of transducers.			
PART – A			
Q. No	**Questions**	**BTL Level**	**Competence**
1.	Mention the purpose of measurement.	**BTL-4**	**Analyze**
2.	Compare direct and indirect comparison methods in measurement.	**BTL-5**	**Evaluate**
3.	Classify the methods of measurement.	**BTL-3**	**Understand**
4.	Give the advantages of the MKS system of units.	**BTL-2**	**Understand**
5.	Summarize the drawbacks of CGS system of units.	**BTL-2**	**Understand**
6.	Define standards and classify their types.	**BTL-1**	**Remember**
7.	Define calibration of an instrument.	**BTL-1**	**Remember**
8.	What do you mean by static calibration?	**BTL-4**	**Analyze**
9.	What is dynamic calibration? Give an example.	**BTL-2**	**Understand**
10.	List any four calibration methods.	**BTL-1**	**Remember**
11.	Point out the types of instrumental errors.	**BTL-4**	**Analyze**
12.	Compare limiting errors & component errors.	**BTL-5**	**Evaluate**
13.	What are the two different means adopted to avoid gross error?	**BTL-4**	**Analyze**
14.	Show the relation between the probability of occurrence and odds.	**BTL-3**	**Understand**
15.	Generalize the significance of Odds.	**BTL-6**	**Create**
16.	Differentiate passive and active transducers. Give an example of each.	**BTL-2**	**Understand**
17.	Define an inverse transducer. Give an example.	**BTL-1**	**Remember**
18.	Classify the types of transducers.	**BTL-3**	**Apply**
19.	Classify the types of analog transducers.	**BTL-3**	**Apply**
20.	List the factors to be considered for the selection of a transducer for a particular application.	**BTL-1**	**Remember**

<table>
<tr><td>21.</td><td>Define transducer.</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>22.</td><td>Assess the desirable features of a transducer.</td><td>BTL-5</td><td>Evaluate</td></tr>
<tr><td>23.</td><td>Give any four measures of transducers.</td><td>BTL-2</td><td>Understand</td></tr>
<tr><td>24.</td><td>Predict how the transducer is differ from the sensor?</td><td>BTL-6</td><td>Create</td></tr>
<tr><td colspan="4">PART-B</td></tr>
<tr><td>1.</td><td>Identify the elements of a generalized measurement system and describe them with an example. (13)</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>2.</td><td>Briefly describe the type of Units. (13)</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>3.</td><td>(i) Distinguish fundamental and derived units with examples. (7)
(ii) Discuss international and primary standards of measurement. (6)</td><td>BTL-2</td><td>Understand</td></tr>
<tr><td>4.</td><td>Classify standards and give examples for each level of standard. (13)</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td>5.</td><td>What are the calibration methods? Describe static calibration in detail. (13)</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>6.</td><td>Explain the types of errors in the measurement system and explain how they are corrected? (13)</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td>7.</td><td>What is error analysis? Describe different statistical methods for error analysis. (13)</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>8.</td><td>In a test, temperature is measured 100 times with variations in apparatus and procedures. After applying the corrections, the results are:
<table><tr><td>Temp, °C</td><td>397</td><td>398</td><td>399</td><td>400</td><td>401</td><td>402</td><td>403</td><td>404</td><td>405</td></tr><tr><td>Freq</td><td>1</td><td>3</td><td>12</td><td>23</td><td>37</td><td>16</td><td>4</td><td>2</td><td>2</td></tr></table>Calculate the arithmetic mean, the average deviation, the standard deviation and the probable error. (13)</td><td>BTL-3</td><td>Apply</td></tr>
<tr><td>9.</td><td>Batches of resistors of value 100 KΩ were measured and were found to have the following values: 100.35, 100.20, 100.15, 100.10, 100.25, 100.20, 100.05, and 100.30 KΩ. Determine the mean, standard deviation and probable error. Can any resistor be discarded on the basis of ± σ limits? If so, deduce the resistor values. (13)</td><td>BTL-6</td><td>Create</td></tr>
<tr><td>10.</td><td>One hundred temperature readings were taken at small intervals of time and recorded to the nearest 0.5 ^{0}C. The frequency of occurrences of the readings is given below:
<table><tr><td>Temperature in ^{0}C</td><td>98.5</td><td>99</td><td>99.5</td><td>100</td><td>100.5</td><td>101.0</td><td>101.5</td></tr><tr><td>Frequency</td><td>4</td><td>13</td><td>19</td><td>35</td><td>17</td><td>10</td><td>2</td></tr></table>Estimate (i) arithmetic mean, (ii) average deviation, (iii) standard deviation, (iv) variance and (v) probable error. (13)</td><td>BTL-2</td><td>Understand</td></tr>
<tr><td>11.</td><td>The following 10 observations were recorded when measuring a voltage. 41.7, 42.0, 41.8, 42.0, 42.1, 41.9, 42.5, 42.0, 41.9, 41.8. Formulate (a) Mean (b) Standard Deviation (c) Probable error (d) Mode. (13)</td><td>BTL-3</td><td>Apply</td></tr>
</table>

12.	Discuss about the classifications of transducers based on the physical effect employed. **(13)**	**BTL-2**	**Understand**
13.	Explain about the classification of transducers based on the physical quantity they convert and based on the source of energy for their output. **(13)**	**BTL-3**	**Apply**
14.	Explain Primary and secondary transducers with suitable examples. **(13)**	**BTL-5**	**Evaluate**
15.	Discuss about the classification of electrical transducers in detail. **(13)**	**BTL-2**	**Understand**
16.	With neat diagram, explain Digital displacement transducers in detail. **(13)**	**BTL-5**	**Evaluate**
17.	Analyze the factors that are to be considered in the selection of a transducer. **(13)**	**BTL-4**	**Analyze**
	PART-C		
1.	A batch of colour resistors of value 5.6kΩ were measured and were found to have the following values. 5.75, 5.60, 5.65, 5.50, 5.70, 5.55, 5.80 and 5.55kΩ. Determine the mean and standard deviation. Can any resistor be discarded on the basis of 3σ limits.	**BTL-6**	**Create**
2.	A circuit was tuned for 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. Estimate (a) the arithmetic mean, (b) deviations from mean, (c) the average deviation, (d) the standard deviation and (e) variance. **(15)**	**BTL-5**	**Evaluate**
3.	**(i)** A Wheatstone bridge has ratio arms that are accurate within ± 0.025%, and a variable arm within ±0.05%. Estimate the possible error in a resistance measurement on this bridge**. (15)**	**BTL-5**	**Evaluate**
	(ii) How are standards classified? Recommend the international standards used for mass, length and time. **(15)**		
4.	A series circuit is having three resistances whose values are given by R1=37Ω ± 5%, R2= 75Ω ±5% and R3= 50Ω ±5%. Estimate total resistance and the limiting value. **(15)**	**BTL-6**	**Create**
5.	The following values were obtained from the measurement of current: 12.35A, 12.71 A, 12.48 A, 10.24 A, 12.63 A and 12.58 A. Estimate (a) The arithmetic mean (b) The average deviation (c) The standard deviation and (d) Variance. **(15)**	**BTL-6**	**Create**

UNIT II - CHARACTERISTICS OF TRANSDUCERS			
Static characteristics: - Accuracy, precision, resolution, sensitivity, linearity. Dynamic characteristics: Mathematical model of transducer, Zero, I and II order transducers, Response to impulse, step, ramp and sinusoidal inputs.			
Q. No	**Questions**	**BTL Level**	**Competence**
1.	Compare the static and dynamic characteristics of an instrument.	**BTL-5**	**Evaluate**
2.	Define Sensitivity and Linearity of an instrument.	**BTL-1**	**Remember**
3.	Distinguish between threshold and resolution of a transducer.	**BTL-2**	**Understand**
4.	Differentiate accuracy and precision.	**BTL-4**	**Analyze**
5.	State the importance of resolution for a measuring instrument.	**BTL-1**	**Remember**
6.	Distinguish Range and Span of an instrument.	**BTL-2**	**Understand**
7.	Define hysteresis of an instrument.	**BTL-1**	**Remember**
8.	Evaluate measuring lag and give its types.	**BTL-5**	**Evaluate**
9.	Examine speed of response.	**BTL-3**	**Apply**
10.	Analyze different test input signals.	**BTL-4**	**Analyze**
11.	What is damping ratio of an instrument?	**BTL-1**	**Remember**
12.	Give an example of zero-order transducer.	**BTL-2**	**Understand**
13.	Define transfer function.	**BTL-1**	**Remember**
14.	Give an example of first-order transducer.	**BTL-2**	**Understand**
15.	Label the step response of a first-order system.	**BTL-1**	**Remember**
16.	A thermometer has a time constant of 3.5 s. it is quickly taken from a temperature of 0 ^{0}C to a water bath having a temperature of 100 ^{0}C. what temperature will be indicated after 1.5 s?	**BTL-3**	**Apply**
17.	Sketch impulse response of I and II order transducers.	**BTL-2**	**Understand**
18.	A temperature-sensitive transducer is subjected to a sudden temperature change. It takes 10 s for the transducer to reach the equilibrium condition (5 time constant). How long will it take for the transducer to read half of the temperature difference?	**BTL-3**	**Apply**
19.	Generalize the importance of zero-order transducer.	**BTL-6**	**Create**
20.	Analyze the need for a mathematical model of a transducer in the field of control engineering.	**BTL-4**	**Analyze**
21.	Analyze the typical ramp response of I and II order transducers.	**BTL-4**	**Analyze**
22.	An instrument transfer function is given by $G(s)=4/(s^2+s+4)$. Assess the damping ratio and natural frequency of the system.	**BTL-5**	**Evaluate**
23.	When a step input is given to a second-order system, the measurements revealed that the system had an overshoot of 12%.Determine the damping ratio.	**BTL-6**	**Create**
24.	Calculate the settling time for 5% error in the step response of a first-order instrument with a time constant of 12 sec.	**BTL-3**	**Apply**

PART-B			
1.	Describe the following static characteristics of a transducer: Accuracy, Precision, Resolution, Hysteresis, Range and Span, Input impedance and loading effect. **(13)**	**BTL-1**	**Remember**
2.	Analyze the desirable dynamic characteristics of a measuring system. **(13)**	**BTL-4**	**Apply**
3.	Express the mathematical model of a zero-order transducer. **(13)**	**BTL-2**	**Understand**
4.	Express the mathematical model of a first-order transducer. **(13)**	**BTL-2**	**Understand**
5.	Infer the step response of I order system and explain the effect of different time constants on the response of the system. **(13)**	**BTL-4**	**Analyze**
6.	Derive the time response of a first order transducer for a ramp input. **(13)**	**BTL-3**	**Apply**
7.	Express in equation forms of the magnitude and phase of a first order transducer for sinusoidal input. **(13)**	**BTL-2**	**Understand**
8.	Illustrate the frequency response of a first order instrument. **(13)**	**BTL-3**	**Apply**
9.	Express the mathematical model of a second-order transducer. **(13)**	**BTL-2**	**Understand**
10.	Discuss about the time response specifications of transducers. **(13)**	**BTL-1**	**Remember**
11.	Derive expression for rise time and peak time of a second order transducer. **(13)**	**BTL-4**	**Analyze**
12.	Derive expression for maximum peak overshoot and settling time of a second order transducer. **(13)**	**BTL-6**	**Create**
13.	Derive the mathematical expression for output of the over damped second order transducer for a step input. **(13)**	**BTL-1**	**Remember**
14.	Examine about the time response of a second order critically damped transducer for a step input. **(13)**	**BTL-1**	**Remember**
15.	Deduce the mathematical expression for output of the under damped second order transducer for a impulse input. **(13)**	**BTL-5**	**Evaluate**
16.	Derive the equations for time response of under damped second order transducer when subjected to a step input. **(13)**	**BTL-3**	**Apply**
17.	Evaluate ramp response of a second order transducer. **(13)**	**BTL-5**	**Evaluate**
PART-C			
1.	For a first order instrument system is subjected to a sinusoidal input I=0.35 sin 25t, if the instrument has time constant of 0.3 second, develop an expression for corresponding output. **(15)**	**BTL-6**	**Create**
2.	Explain with suitable diagram of the impulse response of a first order instrument and analyze its characteristics. **(15)**	**BTL-6**	**Create**
3.	Modify the general differential equation describing the dynamic response of a II order measuring instrument and state the expressions relating the static sensitivity, undamped natural frequency and damping ratio to the parameters in this differential equation. Sketch the instrument response for the cases of heavy damping, critical damping and light damping and state which of these is the usual target when a II order instrument is being designed. **(15)**	**BTL-6**	**Create**
4.	A first order thermometer with a time constant of 5 sec is used to measure the temperature of a furnace fluctuating between 540^{o} C and 580^{o} C in a sinusoidal	**BTL-5**	**Evaluate**

	manner. The frequency of fluctuation is 0.04 Hz. Find the maximum and minimum readings of the thermometer. **(15)**		
5.	The transfer function of a first order transducer with dead time is given by exp(-1.5s)/(1+0.5s). Formulate the output of this system after 2 seconds for a unit step input. **(15)**	**BTL-5**	**Evaluate**

UNIT III- VARIABLE RESISTANCE TRANSDUCERS			
Principle of operation, construction details, characteristics and applications of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezo-resistive sensor and humidity sensor.			
PART – A			
Q. No	**Questions**	**BTL Level**	**Competence**
1.	Summarize the advantages and disadvantages of potentiometer.	**BTL-2**	**Understand**
2.	Define sensitivity in potentiometer.	**BTL-5**	**Evaluate**
3.	Examine resolution of a potentiometer.	**BTL-3**	**Apply**
4.	Give any four materials used in Strain gauge with their types.	**BTL-2**	**Understand**
5.	List the types of strain gauge.	**BTL-1**	**Remember**
6.	Define gauge factor.	**BTL-1**	**Remember**
7.	Why dummy strain gauges are used in measurement application which uses strain gauges? What will happen if it is not used?	**BTL-6**	**Create**
8.	Classify the factors to be considered for bonded strain gauge.	**BTL-4**	**Analyze**
9.	Calculate Young's Modulus.	**BTL-3**	**Apply**
10.	Point out any four applications of strain gauge in measurements.	**BTL-4**	**Analyze**
11.	What is strain of an instrument?	**BTL-1**	**Remember**
12.	Point out the use of resistance thermometer.	**BTL-4**	**Analyze**
13.	Give the advantages and disadvantages of resistance thermometer.	**BTL-2**	**Understand**
14.	List some applications of RTD.	**BTL-1**	**Remember**
15.	Generalize the requirements needed for the materials to be used in RTDs.	**BTL-6**	**Create**
16.	How is resistance of metals related with temperature? Write the equation for the relation.	**BTL-5**	**Evaluate**
17.	Point out the important merits and limitations of thermistor.	**BTL-4**	**Analyze**
18.	Write the principle of operation of thermistor.	**BTL-3**	**Apply**
19.	Distinguish between RTD and thermistor.	**BTL-2**	**Understand**
20.	Illustrate the principle of hotwire anemometer.	**BTL-3**	**Apply**
21.	What is piezoresistive effect?	**BTL-1**	**Remember**
22.	Compare absolute humidity and relative humidity.	**BTL-5**	**Evaluate**
23.	What is the basic principle used in humidity sensors?	**BTL-1**	**Remember**
24.	Summarize the types of humidity sensors.	**BTL-2**	**Understand**
PART - B			
1.	Describe the construction and working principle of Translational potentiometers with its characteristics. **(13)**	**BTL-1**	**Remember**

2.	Describe the construction and working principle of rotational potentiometers with its characteristics. **(13)**	**BTL-1**	**Remember**
3.	Discuss about the Loading effect on potentiometers in detail. **(13)**	**BTL-2**	**Understand**
4.	Analyze the characteristics of a Nonlinear potentiometer. **(13)**	**BTL-4**	**Analyze**
5.	Explain Unbonded type strain gauge with neat sketch. **(13)**	**BTL-3**	**Apply**
6.	Explain Bonded type strain gauge with neat sketch. **(13)**	**BTL-3**	**Apply**
7.	Evaluate Strain gauge circuit with temperature compensation with neat sketch. **(13)**	**BTL-5**	**Evaluate**
8.	Derive expression for gauge factor and express piezo-resistivity in terms of gauge factor. **(13)**	**BTL-2**	**Understand**
9.	Describe the principle of operation, constructional details of resistance thermometer. Also explain the characteristics of different metals for resistance thermometers. **(13)**	**BTL-6**	**Create**
10.	Describe the RTD and explain how it can be used to measure temperature. **(13)**	**BTL-1**	**Remember**
11.	List the requirements of the conductor material to be used in thermometers. Discuss about linear and quadratic approximation. **(13)**	**BTL-2**	**Understand**
12.	Summarize the construction, principle, working of thermistor and its resistance temperature characteristics. **(13)**	**BTL-2**	**Understand**
13.	Explain the functioning and any one linearization method for thermistor. **(13)**	**BTL-5**	**Evaluate**
14.	Explain the principle, sensitivity, practical problems and typical application areas of hot wire anemometer. **(13)**	**BTL-4**	**Analyze**
15.	Illustrate the construction and working of hot wire anemometer with a neat diagram. Also give its advantages and disadvantages. **(13)**	**BTL-3**	**Apply**
16.	Explain the functioning and typical application for piezo-resistive type of sensor. **(13)**	**BTL-4**	**Analyze**
17.	Describe the procedure for measuring humidity using hair hygrometer. **(13)**	**BTL-1**	**Remember**
	PART – C		
1.	Design the null balance bridge circuit and three wire circuits of resistance thermometer. Also give its advantages and disadvantages. **(15)**	**BTL-6**	**Create**
2.	A thermistor is assumed to have a linear resistance variation with a constant temperature co-efficient of resistance of -0.05Ω/°C. The resistance of the thermistor at 20°C is 1000Ω. **(i)** Evaluate the value of its resistance at 25°C. **(7)** **(ii)** If this thermistor is connected in series with a copper coil. Evaluate the value of resistance of copper coil if resistance at 20°C and 25°C are the same. The temperature co-efficient of resistance of copper is 0.004°C. **(8)**	**BTL-5**	**Evaluate**
3.	In a Wheatstone bridge, leg 1 is an active strain gage of advance alloy with 120Ω resistance, leg 4 is a similar dummy gage for temperature compensation, and legs 2&3 are fixed 120 ohm resistors. The maximum gage current is to be kept below 0.030A. **(i)** Evaluate the maximum permissible DC bridge excitation voltage? (Use this value in the remaining parts of this problem). **(7)** **(ii)** If the active gage is on a steel member, evaluate the bridge output voltage for 70kg/cm^2 of stress. **(8)**	**BTL-5**	**Evaluate**

4.	A thermistor has a resistance temperature coefficient of -5% over a temperature range of 25°C to 50°C. If the resistance of the thermometer is 100**Ω** at 25°C, evaluate the resistance at 35°C. **(15)**	**BTL-5**	**Evaluate**
5.	The resistance variation of a thermistor follows the equation $R_T = R_o e^{\beta\left(\frac{1}{T}-\frac{1}{T_0}\right)}$, Where T&T_0 are temperature in °K. R_T and R_o are resistances. β is the characteristic constant of the thermistor material. It is given that β=3140, R_{27}=1050**Ω**.This thermistor is used for temperature measurement and at a particular temperature the resistance is 2330 **Ω**. Evaluate temperature. **(15)**	**BTL-6**	**Create**

UNIT IV-VARIABLE INDUCTANCE AND VARIABLE CAPACITANCETRANSDUCERS			
Inductive transducers: – Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer – Variable reluctance transducers – EI pickup –Principle of operation, construction details, characteristics of capacitive transducers - Capacitor microphone, Proximity sensor.			
PART - A			
Q. No	**Questions**	**BTL Level**	**Competence**
1.	Assess the differential output with reference to LVDT.	**BTL-5**	**Evaluate**
2.	Sketch the equivalent circuit for LVDT.	**BTL-3**	**Apply**
3.	Point out any four applications of LVDT.	**BTL-4**	**Analyze**
4.	Point out the advantages of differential output.	**BTL-4**	**Analyze**
5.	Write the output equation for LVDT.	**BTL-2**	**Understand**
6.	What is induction potentiometer?	**BTL-1**	**Remember**
7.	Give the principle of operation of induction potentiometer.	**BTL-2**	**Understand**
8.	What is the principle of variable reluctance transducer?	**BTL-1**	**Remember**
9.	Define reluctance of coil.	**BTL-1**	**Remember**
10.	What is the working principle of EI pickup transducer?	**BTL-1**	**Remember**
11.	Generalize the applications of Variable reluctance transducers	**BTL-6**	**Create**
12.	What is meant by pt-100?	**BTL-1**	**Remember**
13.	How to increase the sensitivity of capacitive transducer?	**BTL-2**	**Understand**
14.	Show the frequency response of typical capacitor microphone.	**BTL-3**	**Apply**
15.	How a capacitive transducer is used as a pressure sensor?	**BTL-1**	**Remember**
16.	Generalize the features of capacitive transducers.	**BTL-6**	**Create**
17.	Summarize the uses of capacitive transducer as a pressure sensor.	**BTL-5**	**Evaluate**
18.	Classify different types of capacitive transducers.	**BTL-3**	**Apply**
19.	Give advantages and disadvantages of capacitive transducer.	**BTL-2**	**Understand**
20.	Illustrate the application of capacitive transducer.	**BTL-3**	**Apply**
21.	Analyze the function of capacitor microphone.	**BTL-4**	**Analyze**
22.	Give the principle of Proximity sensor.	**BTL-2**	**Understand**
23.	Classify different types of Proximity sensor.	**BTL-4**	**Analyze**
24.	Assess the applications of Proximity sensor.	**BTL-5**	**Evaluate**
PART - B			
1.	Develop the transfer function of LVDT with equivalent circuit and explain any two adjustment circuits for LVDT**. (13)**	**BTL-6**	**Create**
2.	Explain the principle of operation and construction details of LVDT**. (13)**	**BTL-3**	**Apply**
3.	Discuss the construction, operation and limitations of an induction potentiometer**.**	**BTL-2**	**Understand**

	(13)		
4.	Classify three types of variable inductance transducers. Explain the working on the principle of change in self-inductance. **(13)**	**BTL-5**	**Evaluate**
5.	Describe the principle of operation, construction and characteristics of variable reluctance transducer**. (13)**	**BTL-1**	**Remember**
6.	Explain the principle of operation, construction of EI pickup in detail. **(7)**	**BTL-3**	**Apply**
7.	**(i)** Describe the principle of operation of capacitive transducer and how pressure is measured using capacitive transducer. **(9)** **(ii)** List the merits and demerits of capacitive transducer. **(4)**	**BTL-1**	**Remember**
8.	Describe the methods by which capacitive transducers are used for the measurement of linear displacement. **(13)**	**BTL-1**	**Remember**
9.	Describe the methods by which capacitive transducers are used for the measurement of angular displacement. **(13)**	**BTL-1**	**Remember**
10.	Explain in detail about capacitive transducer and what are the types of Capacitive transducer**. (13)**	**BTL-5**	**Evaluate**
11.	Examine Capacitive transducer for the measurement of level in a non-conducting liquid. **(13)**	**BTL-3**	**Apply**
12.	Estimate the Frequency response of capacitive transducer. **(13)**	**BTL-2**	**Understand**
13.	Analyze the capacitive displacement transducers based on change in distance between plates. **(13)**	**BTL-4**	**Analyze**
14.	Analyze the capacitive displacement transducers based on change in overlapping area between plates. **(13)**	**BTL-4**	**Analyze**
15.	Analyze the capacitive displacement transducers based on change in dielectric constant between plates. **(13)**	**BTL-4**	**Analyze**
16.	Describe the Principle of operation, characteristics and applications of capacitor microphone. **(13)**	**BTL-2**	**Understand**
17.	**(i)** Describe the working of capacitor microphone with a neat schematic.**(8)** **(ii)** Give the desirable features of capacitive transducers.**(5)**	**BTL-2**	**Understand**
PART-C			
1.	A LVDT has an output of 6V rms when the displacement is 0.4×10^{-3} m. Calculate the sensitivity of this instrument in volt/mm. A 10V voltmeter with 100 scale divisions is used to read the output. Two tenths of a division can be estimated with ease. Calculate the resolution of voltmeter. The above arrangement is used in a pressure transducer for measuring the deflection of a diaphragm. The diaphragm is deflected through 0.5×10^{-3}m by a pressure of 1000 N/m^2. Calculate the sensitivity and resolution of this instrument. **(15)**	**BTL-6**	**Create**
2.	Summarize in detail about the characteristics of LVDT and any two applications of LVDT**. (15)**	**BTL-5**	**Evaluate**
3.	A LVDT output is recorded by a self-balancing potentiometric recorder having its natural frequency of 10 Hz and a damping ratio of 0.07. the LVDT is excited by 10V at 50 HZ power supply. Calculate the maximum frequency of the displacement signal that can be recorded with an error of ± 2%. **(15)**	**BTL-5**	**Evaluate**
4.	The output of an LVDT is connected to a 5V voltmeter through an amplifier whose	**BTL-5**	**Evaluate**

	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. The milli-voltmeter scale has 100 divisions. The scale can be read to 1/5 of a division. Calculate the sensitivity of LVDT and that of the whole setup. Also calculate the resolution of the instrument in mm**. (15)**		
5.	A pressure measuring instrument uses a capacitive transducer having a spacing of 4 mm between its diaphragms. A pressure of 600 kN/m^2 produces an average deflection of 0.3 mm of the diaphragm of the transducer. The transducer which has a capacitance of 300 pF before application of pressure and is connected in an oscillator circuit having a frequency of 100 kHz. Deduce the change in frequency of the oscillator after the pressure is applied to the transducer. **(15)**	**BTL-6**	**Create**

UNIT V - OTHER TRANSDUCERS			
Piezoelectric transducer – Hall Effect transducer – Magneto elastic sensor – Digital transducers – Smart transducers - Fiber optic sensors – Thick & Thin Film sensors (Bio sensor & Chemical Sensor) – Nano sensors			
PART - A			
Q. No	**Questions**	**BTL Level**	**Competence**
1.	Point out the modes of operation in piezoelectric systems.	**BTL-4**	**Analyze**
2.	List out any four materials by which piezoelectric transducers are made off.	**BTL-1**	**Remember**
3.	What is the principle of piezoelectric transducer?	**BTL-1**	**Remember**
4.	How a piezoelectric transducer could be used as an accelerometer?	**BTL-2**	**Understand**
5.	What is Hall effect transducer?	**BTL-1**	**Remember**
6.	Illustrate the principle of 'Hall effect' with a sketch.	**BTL-3**	**Apply**
7.	Discuss the operation of magneto elastic sensor.	**BTL-2**	**Understand**
8.	Identify any one digital transducer for speed measurement.	**BTL-1**	**Remember**
9.	What is the function of optical encoder?	**BTL-1**	**Remember**
10.	Show the block diagram of architecture of smart sensor.	**BTL-3**	**Apply**
11.	Combine smart sensor with reference to ordinary sensor in terms of four salient features.	**BTL-6**	**Create**
12.	Summarize the features of smart sensors.	**BTL-5**	**Evaluate**
13.	Name three advantages of fibre optic sensors	**BTL-1**	**Remember**
14.	Give the types of fibre commonly used.	**BTL-2**	**Understand**
15.	Compare photovoltaic and photo conductive transducer.	**BTL-5**	**Evaluate**
16.	Analyze the difference between biomedical sensors and bio sensors	**BTL-4**	**Analyze**
17.	Distinguish between thck film sensor and thin film sensor.	**BTL-2**	**Understand**
18.	List the Nano fabrication techniques	**BTL-2**	**Understand**
19.	Point out the applications of Nano materials in various fields.	**BTL-4**	**Analyze**
20.	What is Nano products?	**BTL-3**	**Apply**
21.	List the applications of Nano products.	**BTL-4**	**Analyze**
22.	What do you mean by NANO?	**BTL-5**	**Evaluate**
23.	What is Nano fabrication?	**BTL-6**	**Create**
24.	Identify any three applications of thin films.	**BTL-3**	**Apply**
PART – B			
1.	Consider a piezoelectric transducer which has capacitance of 1000 pF and a charge sensitivity of 40 X 10^{-3} C/m. the connecting cable has a capacitance of 300pF while the oscilloscope used for read out has a readout input resistance of 1MΩ with a parallel capacitance of 50Pf. **a.** What is the sensitivity of transducer alone? **(3)**	**BTL-6**	**Create**

	b. What is the high frequency sensitivity of the entire measuring system? **(3)** **c.** What is the lowest frequency that can be measured with 5% amplification error by the entire system? **(3)** Design the value of external shunt capacitance that can be connected in order to extend the range of 5% error down to 10Hz. **(4)**		
2.	Define piezoelectric effect. Draw the equivalent circuit of a piezoelectric crystal and obtain the transfer function of pieezoelectric transducer. **(13)**	**BTL-3**	**Apply**
3.	Discuss the principle of operation of piezoelectric transducers. What are the applications of this sensor? (13)	**BTL-3**	**Apply**
4.	Describe the principle of operation of hall transducer for displacement and current measurement. **(13)**	**BTL-1**	**Remember**
5.	Discuss the various types of applications that can be used with Hall effect sensor. **(13)**	**BTL-2**	**Apply**
6.	Explain the principle of Hall transducer for power measurement. **(7)**	**BTL-5**	**Evaluate**
7.	Explain the working principle of Magneto elastic sensor with neat sketch**. (6)**	**BTL-4**	**Analyze**
8.	Briefly discuss the principle and working of digital speed transducers**. (13)**	**BTL-2**	**Understand**
9.	Explain the construction and operation of shaft angle encoder and optical encoder with a neat diagram. (**13)**	**BTL-1**	**Remember**
10.	Explain with a neat block diagram the construction, operation and important characteristics of a smart sensor. **(13)**	**BTL-5**	**Evaluate**
11.	Explain Smart sensors with neat sketch in detail. **(13)**	**BTL-4**	**Analyze**
12.	Explain in brief the measurement of linear displacement, angular displacement, force and level of liquid in a tank using optic sensors. **(13)**	**BTL-4**	**Analyze**
13.	Describe the working principle and characteristics of micro-bend displacement sensor. **(13)**	**BTL-1**	**Remember**
14.	Explain the working principle of Bio sensor with neat sketch. **(13)**	**BTL-2**	**Understand**
15.	Explain the working principle of Chemical Sensor with neat sketch. **(13)**	**BTL-1**	**Remember**
16.	Explain the working principle of thick film sensor with neat sketch. **(13)**	**BTL-3**	**Apply**
17.	Discuss about nanotechnology and nano sensors in detail. **(13)**	**BTL-2**	**Understand**
PART - C			
1.	A barium titanate pick up has the dimensions of 5 mm X 5mm X 1.25 mm. The force acting on it is 5N. The charge sensitivity of barium titanate is 150 pC/N and its permittivity is 12.5 X 10^{-9} F/m. If the modulus of elasticity of barium titanate is 12 X 10^{6} N/m^{2}, Deduce the strain. Also calculate the charge and capacitance. **(15)**	**BTL-5**	**Evaluate**
2.	Design a nano sensor in any control application of your choice. **(15)**	**BTL-6**	**Create**
3.	Consider a fibre optic probe and design a displacement sensor for transducing displacement in to equivalent electric signal by making necessary assumptions and plot the characteristics curve of the designed sensor. **(15)**	**BTL-6**	**Create**
4.	Design a NANO sensor in any control application of your choice. **(15)**	**BTL-6**	**Create**
5.	Summarize the typical advantages and applications that needs NANO sensors. **(15)**	**BTL-5**	**Evaluate**