SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

OPEN ELECTIVE: V SEMESTER

1907503 –Sensors and Transducers

Regulation – 2019

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Prepared by

Mr. C. PRAVEEN KUMAR, M.E., (Ph.D)

ASSISTANT PROFESSOR / EIE

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SUBJECT CODE / NAME: 1907503 SENSORS ANDTRANSDUCERS

YEAR / SEM: III /V (Open Elective)

UNIT 1 – INTRODUCTION

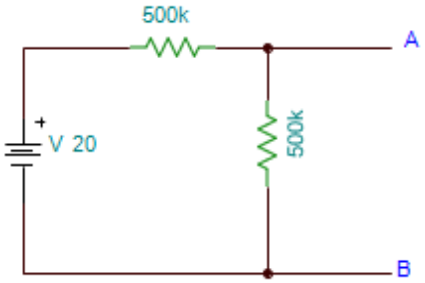
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

PART – A

Q.No	Questions	BT Level	Competence
1.	What do you understand by the term 'Steady State Error'?	BTL 1	Remember
2.	Conclude the purpose of measurement.	BTL 5	Evaluate
3.	The unknown resistance in a Wheatstone bridge is measured utilizing three known resistances such that $R_4 = R_2R_3/R_1$. If the values of $R_1 = 100 \pm 0.5\%\Omega$, $R_2 = 500 \pm 0.5\%\Omega$, and $R_3 = 292 \pm 0.5\%\Omega$, solve for the error in unknown resistance.	BTL 3	Apply
4.	List out the types of instrumental errors.	BTL 1	Remember
5.	Differentiate primary and derived standards	BTL 2	Understand
6.	Identify the types of errors in measurement.	BTL 3	Apply
7.	List out the sources of errors.	BTL 1	Remember
8.	What are the two different means adopted to avoid gross error?	BTL 1	Remember
9.	Contrast the needs between static calibration and dynamic calibration?	BTL 4	Analyze
10.	The following 10 observations were recorded when measuring a voltage: 41.7,42.0,41.8,42.9,42.1,41.9,42.0,41.9,42.5,41.8. Estimate (a) The mean (b) The standard deviation.	BTL 6	Create
11.	Differentiate between passive and active transducers. Give an example of each.	BTL 2	Understand
12.	Compare limiting errors & component errors	BTL 2	Understand
13.	List the differences between error and uncertainty. Contrast systematic and random errors?	BTL 4	Analyze
14.	What is the inference on term inverse transducer? Give an example.	BTL 4	Analyze
15.	Identify the factors to be considered for selection of transducer for a particular application.	BTL 3	Apply
16.	Elaborate the terms 'Selectivity' and 'Specificity' of sensors.	BTL 1	Remember
17.	What are the output signals of sensors?	BTL 1	Remember
18.	Explain the importance of two wire and three wire sensors? Give typical example for each type.	BTL 5	Evaluate
19.	Classify sensors based on order and give example.	BTL 2	Understand
20.	Define Minimum Detectable Signal (MDS).	BTL 1	Remember
21.	What is measurement?	BTL 2	Understand
22.	Identify the basic difference between analog and digital signals.	BTL 3	Apply
23.	Analyze why the importance of digital instruments is increasing?	BTL 4	Analyze
24.	Evaluate the purpose of Instrumentation.	BTL 5	Evaluate

PART – B

1.	Analyze various types of errors in measurement system and explain how they are corrected? **(13)**		BTL 6	Create
2.	**(i)**	Explain the Normal or Gaussian curve of errors. **(6)**	BTL 2	Understand
	(ii)	Explain about different types of systematic error. **(7)**		

<table>
<tr><td>3.</td><td>What is meant by error analysis? Explain statistical methods of error analysis with example. (13)</td><td>BTL 1</td><td>Remember</td></tr>
<tr><td>4.</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>Solve and obtain arithmetic mean, the average deviation, the standard deviation and the probable error. (13)</td><td>BTL 3</td><td>Apply</td></tr>
<tr><td>5.</td><td>The following values were obtained from the measurement of current: 12.35A, 12.71A, 12.48A, 10.24A, 12.63A and 12.58A. Apply proper methods and calculate:
a. The arithmetic mean
b. The average deviation
c. The standard deviation
d. Variance. (13)</td><td>BTL 3</td><td>Apply</td></tr>
<tr><td>6.</td><td>What are the classifications of instrument errors? Explain about the causes and remedies for each error in detail. (13)</td><td>BTL 1</td><td>Remember</td></tr>
<tr><td>7.</td><td>(i) Enumerate the various sources of errors encountered in a measurement system. (7)
(ii) Classify the standards and give example for each level of standard. (6)</td><td>BTL 4</td><td>Analyze</td></tr>
<tr><td>8.</td><td>Compare and explain static and dynamic characteristics of transducers or measurement system. (13)</td><td>BTL 4</td><td>Analyze</td></tr>
<tr><td>9.</td><td>Analyze the various performance measures of sensors. (13)</td><td>BTL 4</td><td>Analyze</td></tr>
<tr><td>10.</td><td>(i) List and discuss the desirable and undesirable static characteristics of transducers. (7)</td><td>BTL 1</td><td>Remember</td></tr>
<tr><td></td><td>(ii) What is the true value of the voltage across the terminals A and B? What would a voltmeter of 20kΩ/V sensitivity read on the 50 V and 10 V ranges? (6)
 
</td><td>BTL 5</td><td>Evaluate</td></tr>
<tr><td>11.</td><td>Explain the classification of transducers in detail. (13)</td><td>BTL 2</td><td>Understand</td></tr>
<tr><td>12.</td><td>(i) Measure the sensitivity of a pressure gauge as a ratio of scale length to pressure if the gauge has radius of scale line as 100mm and pressure of 0 to 50pascals if displayed over an arc of 270^0. The gauge has linear calibration curve. (4)</td><td>BTL 5</td><td>Evaluate</td></tr>
<tr><td></td><td>(ii) Explain statics characteristics of measuring instruments. (9)</td><td>BTL 2</td><td>Understand</td></tr>
<tr><td>13.</td><td>List the calibration methods. Explain about the static calibration in detail. (13)</td><td>BTL 1</td><td>Remember</td></tr>
<tr><td>14.</td><td>(i) List out the sensor output signal types. (3)</td><td>BTL 1</td><td>Remember</td></tr>
<tr><td></td><td>(ii) Explain various output signal types of sensors. (10)</td><td>BTL 2</td><td>Understand</td></tr>
<tr><td>15.</td><td>Explain the data measurement specification with example. (13)</td><td>BTL 2</td><td>Understand</td></tr>
<tr><td>16.</td><td>The following 10 observations were recorded when measuring a voltage:
41.7, 42.0, 41.8, 42.0, 42.1, 41.9, 42.0, 41.9, 42.5, 41.8. Find the Mean, Standard</td><td>BTL 3</td><td>Apply</td></tr>
</table>

	deviation, the probable error of one reading, the probable error of mean and the range. **(13)**		
17.	A set of independent 10 measurements were made to determine the weight of a lead shot. The weights in gramme were: 1.570, 1.597, 1.591, 1.562, 1.577, 1.580, 1.564, 1.586, 1.550, 1.575. Determine the arithmetic mean, average and standard deviation, variance and probable error of one reading. **(13)**	BTL 5	Evaluate
	PART – C		
1.	Two resistors have the following rating: $R_1 = 36\Omega \pm 5\%$ and $R_2 = 75\Omega \pm 5\%$. Deduce the limiting error when the resistors are connected in i) Series and ii) Parallel. **(15)**	BTL 5	Evaluate
2.	The following 10 observations were recorded when measuring a voltage in volts. 41.7, 42.0, 41.8, 42.0, 42.1, 41.9, 42.5, 42.0, 41.9, 41.8. Evaluate (1) Mean (2) Standard Deviation (3) Probable error (4) Mode. **(15)**	BTL 5	Evaluate
3.	The power factor in a circuit having sinusoidal voltage and current are determined by measuring current, voltage and power. The voltage is 150V on a voltmeter of 200V scale. The current is 7A on an ammeter of 10A scale. The power is 550W on a 1KW wattmeter. Ammeter and voltmeter are guaranteed to be accurate within $\pm$0.2% of full scale and wattmeter $\pm$0.5% of full scale. (i) To what % accuracy, the power factor obtained from the readings can be guaranteed? (ii) Estimate the amount of contribution of error by each instrument for the error obtained above in power factor reading. **(15)**	BTL 6	Create
4.	Discuss about the primary and secondary signals in sensor or transducer classification. Give examples of magnetic - electric sensors and chemical – electric sensors. **(15)**	BTL 6	Create
5.	Explain the "Art of Measurement" and the role of Instrumentation Systems in shaping the Measurement processes. **(15)**	BTL 5	Evaluate

UNIT 2 - MOTION, PROXIMITY AND RANGING SENSORS				
Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).				
PART – A				
Q.No	**Questions**		**BT Level**	**Competence**
1.	What is meant by Gray encoding? State the advantages of its.		BTL 1	Remember
2.	Compare features of different motion sensors.		BTL 2	Understand
3.	Explain the principle of POT.		BTL 2	Understand
4.	List out applications of the RF beacons.		BTL 1	Remember
5.	List the different arrangements of POT.		BTL 1	Remember
6.	Analyze the effects of loading in resistive Potentiometer.		BTL 4	Analyse
7.	Explain about microsyn.		BTL 2	Understand
8.	Define the functions of resolver.		BTL 1	Remember
9.	Identify any three applications of proximity sensors.		BTL 3	Apply
10.	Define synchros and list the types of synchro systems.		BTL 1	Remember
11.	Identify the applications of resolver.		BTL 3	Apply
12.	Compare capacitive and inductive transducers.		BTL 4	Analyse
13.	A Quartz piezo-electric Crystal having a thickness of 2 mm and voltage sensitivity of 0.055V-m/N is subjected to a pressure of 1.5 M N/m2. Evaluate the voltage output.		BTL 5	Evaluate
14.	Discuss the modes of operation of piezo-electric crystals.		BTL 6	Create
15.	Elaborate the applications of inductive transducers.		BTL 6	Create
16.	Explain the term LIDAR?		BTL 2	Understand
17.	Explain the importance of the need for accelerometer?		BTL 5	Evaluate
18.	Define GPS and list the applications.		BTL 1	Remember
19.	List the types of range sensing.		BTL 4	Analyse
20.	How to apply the principle of ultrasonic for ranging?		BTL 3	Apply
21.	What is meant by Magnetostriction?		BTL 2	Understand
22.	Develop and explain the sensor that is based on skin effect.		BTL 3	Apply
23.	State how Wiedemann effect is used in torque sensor.		BTL 4	Analyze
24.	Explain Villari effect and the sensor based on it.		BTL 5	Evaluate
PART – B				
1.	Explain the construction and working principle of potentiometer. Evaluate its application as motion sensor. **(13)**		BTL 2	Understand
2.	Develop a sensor and explain the principles behind it. **(13)**		BTL 2	Understand
3.	**(i)**	Explain the loading effect and the error caused in a POT. **(7)**	BTL 2	Understand
	(ii)	Contrast Linearity and sensitivity of resistive Potentiometers. **(6)**	BTL 4	Analyse
4.	What is an LVDT? What are the parameters that can be measured by this? Describe with neat diagram and output characteristics the principle of its construction and operation. **(13)**		BTL 1	Remember
5.	What is the principle of operation of capacitive accelerometer? With relevant diagram list its various applications. **(13)**		BTL 1	Remember
6.	**(i)**	Explain the working of capacitive transducer with neat schematic. **(7)**	BTL 2	Understand
	(ii)	Consider a non - conducting liquid in a tank and develop level measurement system of it using a capacitive transducer. **(6)**	BTL 3	Apply
7.	Analyze the construction and working principle of Synchros with the help of a neat diagram. **(13)**		BTL 3	Apply
8.	Discuss in detail the construction working and applications of RVDT. **(13)**		BTL 6	Create
9.	Explain the construction working and applications of resolver. **(13)**		BTL 2	Understand
10.	Discuss the principle of capacitive transducer and explain how it is utilized for		BTL 3	Apply

	motion sensing. **(13)**		
11.	Interpret the principle of accelerometer with neat sketches. **(13)**	BTL 5	Evaluate
12.	Define Piezoelectric principle and explain the working of piezoelectric transducer. **(13)**	BTL 1	Remember
13.	Compare translational and rotary encoders with necessary sketches. **(13)**	BTL 4	Analyse
14.	**(i)** What is meant by LIDAR? Explain its various components, functionalities and applications. **(7)**	BTL 1	Remember
	(ii) What is meant by ultrasonic ranging? **(6)**	BTL 1	Remember
15.	**(i)** Analyze the working of GPS as range sensors. **(7)**	BTL 4	Analyse
	(ii) Analyze the working of Bluetooth range sensors. **(6)**	BTL 4	Analyse
16.	Explain the working of variable inductance sensors. **(13)**	BTL 5	Evaluate
17.	State and explain the construction and working principle of Ultrasonic ranging sensor. **(13)**	BTL 3	Apply
	PART – C		
1.	A linear resistance potentiometer is 50mm long and is uniformly wound with a wire having a resistance of 10000Ω. Under normal conditions, the slider is at the centre of the potentiometer. Predict the linear displacement when the resistance of the potentiometer as measured by a Wheatstone bridge for the two cases are: (i) 3850 Ω (ii)7560Ω Test whether the two displacements in the same direction? If it is possible to measure a minimum value of 10Ω resistance with the above arrangement, choose the resolution of the potentiometer in mm. **(15)**	BTL 6	Create
2.	A Capacitive transducer uses two quartz diaphragms of area 75mm^2 separated by a distance of 3.5mm. A pressure 0f 900kN/m^2 when applied to the top diaphragm produces a deflection of 0.6mm. The capacitance is 370pF when no pressure is applied to the diaphragms. Evaluate the value of capacitance after application of pressure900kN/m^2. **(15)**	BTL 5	Evaluate
3.	A LVDT output is recorded by a self-balancing potentiometric recorder having its natural frequency of 10 Hz and damping ratio of 0.707. The LVDT is excited by 10V at 50 Hz power supply. Estimate the maximum frequency of the displacement signal that can be recorded with an error of $\pm$2%. **(15)**	BTL 5	Evaluate
4.	Propose a case study on comparison of various ranging methods. **(15)**	BTL 6	Create
5.	Develop a reflective beacon tracking system and explain the constructional features. **(15)**	BTL 6	Create

UNIT 3 - FORCE, MAGNETIC AND HEADINGSENSORS				
Strain Gauge, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.				
PART – A				
Q.No		**Questions**	**BT Level**	**Competence**
1.		Define gauge factor of strain gauge.	BTL 1	Remember
2.		Explain the various characteristic features of strain gauge load cell.	BTL 2	Understand
3.		Compare semiconductor strain gauges and metal wire strain gauges.	BTL 2	Understand
4.		Define piezo resistive effect.	BTL 1	Remember
5.		Identify the types of strain gauges.	BTL 3	Apply
6.		A resistive wire strain gauge uses a soft iron wire of small diameter. The gauge factor is +4.2. Neglecting the piezo resistive effects, solve and obtain Poisson'sratio.	BTL 6	Creating
7.		Sketch – how to make use of magnetic field sensor using ΔY- effect.	BTL 3	Apply
8.		Define ΔY- effect in magnetic sensors.	BTL 1	Remember
9.		What is meant by Villari effect?	BTL 1	Remember
10.		Define Magneto resistive effect.	BTL 1	Remember
11.		Infer the terms Matteucci effect, Villari effect and Wiedemann effect.	BTL 4	Analyze
12.		Illustrate the working of compass and state the principle behind it.	BTL 2	Understand
13.		Discuss the principle of current sensor.	BTL 6	Creating
14.		Define Hall effect and justify the applications of it.	BTL 1	Remember
15.		Interpret inclinometer and list the applications of it.	BTL 2	Understand
16.		What is the utilization of Compass? Assess the significance and applications of it.	BTL 3	Apply
17.		Compare different types of magnetic sensors.	BTL 4	Analyze
18.		What is meant by Heading Sensors? List out the types.	BTL 4	Analyze
19.		Asses the advantages of magnetic sensors.	BTL 5	Evaluate
20.		Assess the significance of Gyroscope?	BTL 5	Evaluate
21.		State the basic concept of an electrical resistance strain gauge.	BTL 2	Understand
22.		Assess the Young's Modulus of elasticity of a material.	BTL 3	Apply
23.		Express the longitudinal piezo resistance coefficient.	BTL 4	Analyze
24.		Infer the phenomenon of magnetostrictive effect.	BTL 5	Evaluate
PART – B				
1.	**(i)**	How to estimate the equation for gauge factor? **(3)**	BTL6	Create
	(ii)	Discuss the operation of strain gauge and how to make use of it as force sensor. **(10)**	BTL6	Create
2.		Illustrate about different types of strain gauges with neat sketch. **(13)**	BTL 2	Understand
3.	**(i)**	Examine the principle of operation of load cell and how it is applied in measurement of force. **(9)**	BTL 4	Analyze
	(ii)	What are the advantages of semiconductor strain gauges? **(4)**	BTL 1	Remember
4.		Define the principle of operation of a magneto resistive transducer with appropriate diagram. What are the various parameters that can be measured by this transducer? **(13)**	BTL 1	Remember
5.	**(i)**	What is gyroscope? Explain the principle of operation and properties of it with relevant diagrams. **(7)**	BTL 2	Understand
	(ii)	List the factors and parameters of the sensor does the Hall voltage output depend for a given field condition. **(6)**	BTL 4	Analyze
6.	**(i)**	What are the different types of magnetic sensors? On what principles do they work? Outline briefly. **(6)**	BTL 1	Remember
	(ii)	What is ΔY- effect? Propose a method in which it is used in practice for magnetic field sensing? What materials are specifically suitable for the purpose? **(7)**	BTL 1	Remember

7.		Describe with diagrams, the principle of operation of a coaxial type torque sensor. What is an inactive zone in such sensor? Why is it provided? **(13)**	BTL 1	Remember
8.		What is the basic principle of a Hall device? Show how can it be used as magnetic field sensor? **(13)**	BTL 1	Remember
9.	**(i)**	Identify and explain the operation of hall effect current sensor. **(7)**	BTL 3	Apply
	(ii)	List out and analyze the various effects governing magnetic sensing. **(6)**	BTL 4	Analyze
10.		Evaluate the need for magnetic sensors also explain the types, principle, requirement and advantages of magnetic sensors. **(13)**	BTL 5	Evaluate
11.	**(i)**	Elaborate the features and applications of compass. **(5)**	BTL 3	Apply
	(ii)	Identify and explain the principle of working of Active semi-conductor magnetic sensors. **(8)**	BTL 3	Apply
12.	**(i)**	Explain the principle behind Electrolytic spirit level transducer. **(6)**	BTL 2	Understand
	(ii)	Brief the features and applications of inclinometers. **(7)**	BTL 3	Apply
13.	**(i)**	Define the principle and operation of any one form of gyroscope. **(7)**	BTL 1	Remember
	(ii)	Distinguish Free gyroscope and Single-axis restrained gyro. **(6)**	BTL 4	Analyze
14.		Explain the working of inclinometers or tilt sensors. **(13)**	BTL 2	Understand
15.		List the various types of Heading Sensors and explain any one of its types. **(13)**	BTL 2	Understand
16.		With a neat schematic block diagram explain the construction and working principle of heading sensors. **(13)**	BTL 3	Apply
17.		Illustrate the various types of current sensors and explain any one of its type. **(13)**	BTL 5	Evaluate
		PART – C		
1.	**(i)**	Conclude that the gauge factor of a semiconductor strain gauge vary with doping level? Discuss with help of diagrams. **(8)**	BTL5	Evaluate
	(ii)	Describe a piezo resistive type strain gauge sensor appending appropriate diagrams. **(7)**		
2.		Develop the principle of anisotropic magneto resistive sensors. How is it used in sensing magnetic field? A metallic magneto resistor is placed in magnetic field with its length perpendicular to the field. How does the resistance vary with this field? **(15)**	BTL6	Create
3.	**(i)**	How is performance of Hall sensor evaluated? What are the primary and secondary sensitivities? **(7)**	BTL5	Evaluate
	(ii)	A Hall Effect element used for measuring a magnetic field strength gives an output voltage of 10.5mV. The element is made of silicon and is 2.5mm thick and carries a current of 4A. The Hall coefficient is $4.1x10^6$Vm/A-wb/m^2. Evaluate the magnetic field strength. **(8)**		
4.		Create a comparison of the performance measures of different heading sensors giving the merits, demerits and applications. **(15)**	BTL6	Create
5.		In a strain gauge shown in figure the resistances R_2 and R_4 are of 150 ohm each. The resistances of strain gauges under unstrained condition are 150 ohm each. The gauge factor is 2.2. Determine the bridge output voltage and bridge sensitivity if the current drawn from the battery under strained condition is of 100 Ma. The strain is 1×10^{-4} **(15)**	BTL6	Create

UNIT 4 - OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure –Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

PART –A

Q.No.	*Questions*	*BT Level*	*Competence*
1.	Define Dark resistance and list out some materials used for the construction of LDR.	BTL 1	Remember
2.	Estimate the advantages and disadvantages of Thermistor.	BTL 5	Evaluate
3.	Compare on how a thermistor differs from a thermocouple as a temperature sensor?	BTL 2	Understand
4.	What is meant by tactile sensor?	BTL 1	Remember
5.	Define the pin outs and the merits of IC used for temperature measurement.	BTL 1	Remember
6.	Determine the pressure sensitivity of a quartz piezoelectric transducer of thickness 2.5 mm. the voltage sensitivity of quartz is 50x 10^3Vm/N.	BTL 5	Evaluate
7.	State advantages of fiber optic sensors and how to make use of it for industrial/non-industrial applications.	BTL 3	Apply
8.	Discuss why the reference junction is needed in thermocouples.	BTL 6	Create
9.	Show how force summing devices help in pressure measurement.	BTL 2	Understand
10.	Define Seebeck effect and Thompson effect and state the significance of them.	BTL 1	Remember
11.	Identify the types of thermocouples and materials used for constructing thermocouples.	BTL 3	Apply
12.	Contrast the characteristics of RTD and Thermistor.	BTL 4	Analyze
13.	List out any two applications that need MEMS sensors.	BTL 1	Remember
14.	List the properties of piezoelectric crystals.	BTL 4	Analyze
15.	What is the principle of Piezoelectric transducer?	BTL 1	Remember
16.	Identify the important features of smart transducer.	BTL 3	Apply
17.	Compare MEMS sensors and Nano Sensors.	BTL 2	Understand
18.	List the advantages of MEMS.	BTL 4	Analyze
19.	Show the block diagram of architecture of smart sensor.	BTL 2	Understand
20.	Discuss the standards available for Smart transducer and its interface.	BTL 6	Create
21.	What is meant by thermocouple and explain its principle.	BTL 2	Understand
22.	State the law of homogeneous metals.	BTL 3	Apply
23.	Compare the law of Homogeneous metals with Intermediate metals.	BTL 4	Analyze
24.	Derive the expression for coil inductance for a Transducer operating on the principle of variation of self inductance.	BTL 5	Evaluate

PART –B

1.	**(i)**	Discuss the photovoltaic mode of operation of a photo diode with its diagram and volt-ampere characteristics. **(7)**	BTL 6	Create
	(ii)	Show the constructional and functional details of thermocouple with the relevant physical laws and diagrams. **(6)**	BTL 1	Remember
2.	**(i)**	Explain the working of different types of pressure diaphragms with diagrams. **(7)**	BTL 2	Understand
	(ii)	Discuss the principle of operation of fiber optic sensor with neat diagram. **(6)**	BTL 6	Create
3.	Brief some primary and secondary transducers involved in the measurement of pressure and explain how pressure is measured. **(13)**		BTL 2	Understand
4.	**(i)** Discuss the typical advantages and applications that need MEMS sensors. **(6)** **(ii)** What is meant by thick film and thin film technology? Explain. **(7)**		BTL 1	Remember
5.	Define piezoelectric effect. Draw the equivalent circuit of a piezoelectric crystal and derive the transfer function of piezo electric transducer. **(13)**		BTL 1	Remember
6.	**(i)** Discuss any one fibre optic sensor for displacement measurement. **(7)** **(ii)** What is MEMS technology? Explain different manufacturing. **(6)**		BTL 1	Remember

7.	Interpret the statement optical fibre is used for stress sensing. Explain about micro bend sensor and discuss its operation. **(13)**	BTL 5	Evaluate
8.	Identify the principle behind the use of LASER in flow measurement and explain how it is utilized in LASER Doppler Velocimeter. **(13)**	BTL 3	Apply
9.	Define RTD and explain how it is used to measure temperature. **(13)**	BTL 1	Remember
10.	Analyze the construction, principle, working of thermistor and its resistance temperature characteristics. **(13)**	BTL 4	Analyze
11.	Explain the principle, construction, working and applications of ultrasonic Flow meters with neat sketches. **(13)**	BTL 2	Understand
12.	With a neat block diagram develop the construction and operation of a smart transducer and outline its interface standard. **(13)**	BTL 3	Apply
13.	Analyze the construction, principle, working and features of Nano –sensors. **(13)**	BTL 4	Analyze
14.	Explain the construction and working principle of Ultrasonic Liquid Level Measurement System. **(13)**	BTL 2 BTL 1	Understand Remember
15.	**(i)** Explain the working of different types of bellows with diagrams. **(6)**	BTL 2	Understand
	(ii) Show the constructional and functional details of photo conductive cell with the relevant laws and diagrams. **(7)**	BTL 2	Understand
16.	Explain the construction and working principle of Electromagnetic Flow Meters with a neat sketch. **(13)**	BTL 3	Apply
17.	Briefly illustrate the properties possessed by Intelligent field devices and Justify the say why they are called smart sensors. **(13)**	BTL 5	Evaluate
	PART – C		
1.	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
2.	A thermistor has a resistance of 3980Ω at the ice point (0°C) and 794Ω at 50°C. The resistance temperature relationship is given by RT = a R_0exp (b/T). Evaluate the range of resistance to be measured in case the temperature varies from 40°C to 100°C. **(15)**	BTL 5	Evaluate
3.	Design a temperature monitoring system for pasteurization processing for milk and discuss the features of the system. **(15)**	BTL 6	Create
4.	Assess the different standards involved in Smart Transducer interface, and deduce the need for standardization. **(15)**	BTL 5	Evaluate
5.	Determine the thermoelectric sensitivity and emf developed in a thermocouple made of copper and constantan for a temperature difference of 25^0C between its junctions. Given that thermo-electric emfs of copper and constantan against platinum are 7.4 and -34.4 microV per ^{0}C temperature difference. **(15)**	BTL 5	Evaluate

UNIT 5 - SIGNAL CONDITIONING AND DAQ SYSTEMS			
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.			
PART – A			
Q. No	***Questions***	***BT Level***	***Competence***
1.	Contrast the types of amplifiers that can be used with sensors.	BTL 4	Analyze
2.	Assess the need of amplifiers in sensing applications.	BTL 5	Evaluate
3.	What is meant by aliasing?	BTL 1	Remember
4.	Organize the types and explain the need for filters.	BTL 3	Apply
5.	Distinguish the significance of Instrumentation amplifier with conventional amplifiers.	BTL 4	Analyze
6.	Estimate the aperture time required to digitize a 500 Hz signal to 10 bits resolution.	BTL 5	Evaluate
7.	Compare analog filters and digital filters.	BTL 2	Understand
8.	Discuss the function of sample and hold circuits.	BTL 6	Create
9.	Define PZT sensor. What for is it used?	BTL 1	Remember
10.	Demonstrate the application of static pressure sensors in aerospace applications.	BTL 2	Understand
11.	What are the sensors used and application areas in Home appliance systems?	BTL 1	Remember
12.	Illustrate the components of data acquisition system.	BTL 2	Understand
13.	Examine the need for sensors in automobiles.	BTL 4	Analyze
14.	Show the major areas where sensing is required in automobile systems.	BTL 1	Remember
15.	Identify the sensors involved in on-board automobile.	BTL 3	Apply
16.	Discuss the importance of position sensing in automobiles.	BTL 6	Create
17.	Compare sensors used for environmental monitoring.	BTL 2	Understand
18.	Define the term data logging evaluate the benefits of data logging.	BTL 1	Remember
19.	Define 'Ecological studies of Air'. List various parameters involved.	BTL 1	Remember
20.	Identify the sensors used in production processes.	BTL 3	Apply
21.	What is meant by data acquisition system?	BTL 2	Understand
22.	Draw and label the components of Sample and Hold circuit.	BTL 3	Apply
23.	List the sensors used for Home appliances.	BTL 4	Analyze
24.	Draw the block diagram of digital data acquisition system	BTL 5	Evaluate
PART – B			
1.	What is meant by signal conditioning and why it is required? Develop the block diagram of a DC signal conditioning system and explain the functions of each block. **(13)**	BTL 3	Apply
2.	Elaborate an Instrumentation amplifier with neat diagram and estimate its gain. **(13)**	BTL 6	Create
3.	**(i)** Draw and explain sample and hold circuit. **(8)** **(ii)** What is signal conditioning? And why is it required? **(5)**	BTL 1	Remember
4.	Define Q factor and discuss the working of different filter categories. **(13)**	BTL 1	Remember
5.	**(i)** Why ADC and DAC are needed? **(3)** **(ii)** Explain any one type of ADC with neat diagram **(10)**	BTL 1	Remember
6.	Identify the reason for using 4-20mA current loop in the 2-wire transmitter and explain the working of 4-20mA current loop converter. **(13)**	BTL 3	Apply
7.	Summarize the function of Single Channel Data Acquisition System with block diagram. **(13)**	BTL 2	Understand
8.	Analyze the importance of Data logging and explain the components of a Data logger with neat diagram. **(13)**	BTL 4	Analyze
9.	**(i)** Analyze the role of static pressure sensors in aerospace applications. **(6)** **(ii)** Analyze the sensing of direction of Air flow in aircrafts. **(7)**	BTL 4	Analyze

10.	**(i)** Draw the sketch of a pyro electric IR sensor as used in microwave oven. What is the material used for developing this sensor? **(7)** **(ii)** How water level is measured in washing machines? Sketch a sensor and explain its operation. **(6)**	BTL 1	Remember
11.	Assess three types of Oxygen sensors used in automobiles by comparing their advantages and operations with help of V-I characteristics. **(13)**	BTL 5	Evaluate
12.	Illustrate the importance of Environmental monitoring and explain the sensors involved in that. **(13)**	BTL 2	Understand
13.	**(i)** Define Eco Hazard and explain how it affects living being with help of a chart. **(7)** **(ii)** Brief about sensing of environmental pollution. **(6)**	BTL 2	Understand
14.	Analyze the functions of various sensors in an automated manufacturing process. **(13)**	BTL 4	Analyze
15.	With a neat block diagram explain the construction and working principle of General Data Acquisition System. **(13)**	BTL 2	Understand
16.	Briefly explain the objectives of Data Acquisition System. **(13)**	BTL 3	Apply
17.	Summarize the function of Multi-Channel Data Acquisition System with block diagram. **(13)**	BTL 5	Evaluate
	PART – C		
1.	Evaluate the importance, performance and applications of various sensors in Automobile industries. **(15)**	BTL 5	Evaluate
2.	Compose the case study on Medical diagnostic sensors giving the features and advantages. **(15)**	BTL 6	Create
3.	**(i)** A simple RC low-Pass filter is to be designed that the output voltage be attenuated by 3db at 50Hz. Estimate the time constant and suitable values of R and C. **(8)** **(ii)** A band pass filter consists of two RC networks connected in cascade. The Low pass Filter consists of a resistor R_1=10 kΩ and C_1=100pF and the high pass Filter consists of a resistor R_2=1MΩ and C_2=0.01μF.Solve the values of the lower and upper cutoff frequencies and the pass band gain**(7)**	BTL 6	Create
4.	Evaluate the applications of various sensors in aerospace applications and discuss the technique of computation of air speed on aircraft by measuring the static pressure, total pressure and temperature. **(15)**	BTL 5	Evaluate
5.	Evaluate the importance, performance and applications of various sensors in Aerospace and Manufacturing industries. **(15)**	BTL 5	Evaluate