QUESTION BANK - REGULATION 2017

SUBJECT : ***OAN 551 SENSORS AND TRANSDUCERS***

YEAR /SEM : III /V

UNIT- I 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

1. What do you understand by the term 'Steady State Error'?
2. Evaluate the purpose of measurement.
3. The unknown resistance in a Wheatstone bridge is measured utilizing three known resistances such that R4 = R2R3/R1 If the values of R1 = 100 $\pm$ 0.5% ohm,R2= 500$\pm$ 0.5% ohm, and R3 =292 $\pm$ 0.5% ohm, determine the error in unknown resistance
4. List out the types of instrumental errors.
5. Differentiate primary and Derived standards
6. Identify What are the types of errors?
7. List out the sources of errors.
8. What are the two different means adopted to avoid gross error?
9. Why do you need static calibration and dynamic calibration
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. Find (a) The mean (b) The standard deviation.
11. Differentiate between passive and active transducers. Give an example of each.
12. Compare limiting errors & component errors
13. Explain the differences between error and uncertainty. What are systematic and random errors?
14. Definean inverse transducer. Give an example.
15. Define selectivity and specificity of sensors
16. What are the output signals of sensors?
17. What is meant by two wire and three wire sensors ?Give typical example for each type.
18. Classify sensors based on order and give example.
19. Define Minimum Detectable Signal (MDS).

PART – B

1. Discuss about the types of errors in measurement system and explain how they are corrected?
2. What is meant by error analysis? Explain statistical methods of error analysis With example. 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. Calculate: The arithmetic mean, The average deviation,

The
standard deviation, Variance.

3. What are the classifications of instrument errors? Explain about the causes and remedies for each error in detail.
4. Classify the standards and give example for each level of standard.
5. Compare and Explain Static and dynamic characteristics of transducers / measurement system
6. Analyse the various Performance measures of sensors.
7. Explain classification of transducers in detail.
8. List the calibration methods. Explain about the static calibration in detail
9. Explain various output signal types of sensors

PART – C

1. 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.
2. What are the primary and secondary signals in sensor or transducer classification? Give examples of magnetic- electric sensors and chemical – Electrical sensors.
3. In a test, temperature is measured 100 times with variations in apparatus and procedures. After applying the corrections, the results are:
   Calculate the arithmetic mean, the average deviation, the standard deviation and the probable error.

Tem p °C	397	398	399	400	401	402	403	404	405
Freq	1	3	12	23	37	16	4	2	2

UNIT -II 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

1. What is meant by Gray encoding? State the advantages of its.
2. Compare features of different motion sensors.
3. Describe the principle of POT
4. List out applications of the RF beacons.
5. List the different arrangements of POT.
6. Analyse the effects of loading in resistive Potentiometer.
7. Describe what is microsyn.
8. Define the functions of resolver.
9. List any three applications of proximity sensors.
10. Define Synchros and list the types of synchro systems.
11. Compare capacitive and inductive transducers.

12. Write the modes of operation of piezo-electric crystals.
13. What is meant by the term LIDAR?
14. Why do we need accelerometer?
15. Define GPS and list the applications.
16. List the types of range sensing

PART – B

1. Explain the construction and working principle of potentiometer. Evaluate its application as motion sensor.
2. Explain the loading effect and the error caused in a POT
3. Discuss Linearity and sensitivity of resistive Potentiometers.
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.
5. Discuss the principle of operation of capacitive accelerometer with relevant diagram giving its various applications.
6. Explain the working of capacitive transducer with neat schematic.
7. With neat diagram Discuss in detail the construction working of Synchros.
8. Discuss in detail the construction working and applications of RVDT
9. Explain the construction working and applications of resolver.
10. Discuss the principle of capacitive transducer and explain how it is applied for motion sensing.
11. Define Piezoelectric Principle and Explain the working of piezoelectric transducer.
12. What is meant by LIDAR? Explain its various functionalities and applications.
13. Explain the working of GPS as range sensors.
14. Analyse the working of Bluetooth range sensors.

PART – C

1. A linear resistance potentiometer is 50 mm long and is uniformly wound with a wire having a resistance of 10000 Ω. Under normal conditions, the slider is at the centre of the potentiometer. Find the linear displacement when the resistance of the potentiometer as measured by a Wheatstone bridge for the two cases are: (i) 3850 Ω (ii)7560 Ω Are the two displacements in the same direction? If it is possible to measure a minimum value of 10 Ω resistance with the above arrangement , find the resolution of the potentiometer in mm.
2. A Capacitive transducer uses two quartz diaphragms of area 75- mm^2 separated by a distance of 3.5 mm. A pressure 0f 900 kN/m^2 when applied to the top diaphragm produces a deflection of 0.6 mm. The capacitance is 370 pF when no pressure is applied to the diaphragms. Find the value of capacitance after application of pressure 900 kN/m^2
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 10 V at 50 Hz power supply. Calculate the maximum frequency of the displacement signal that can be recorded with an error of $\pm$ 2%.

UNIT- III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gauge, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

1. Define gauge factor of strain gauge.
2. What are the various characteristic features of strain gauge load cell?
3. Differentiate semiconductor strain gauges and metal wire strain gauges.
4. Define piezoresistive effect.
5. List out various types of strain gauges.
6. A resistive wire strain gauge uses a soft iron wire of small diameter. The gauge factor is +4.2. Neglecting the piezoresisitive effects, calculate poisons ratio.
7. Sketch a magnetic field sensor using ΔY- effect.
8. Define ΔY- effect in magnetic sensors.
9. What is meant by Villari effect?
10. Define Magneto resistive effect.
11. Differentiate Matteucci effect, Villari effect and Wiedemann effect.
12. How does compass works and state the principle behind it?
13. State the principle of current sensor.
14. Define Hall effect and justify the applications of it.
15. What is an inclinometer? List the applications of it.
16. What is Compass? Assess the significance and applications of it.
17. Compare different types of magnetic sensors.
18. What is meant by Heading Sensors? List out the types.
19. Asses the advantages of magnetic sensors.
20. Assess the significance of Gyroscope?

PART-B

1. **(i)** Derive the equation for gauge factor.
   (ii) Discuss the operation of strain gauge and evaluate its applications as force sensor.
2. Illustrate about different types of strain gauges with neat sketch.
3. **(i)** Evaluate the principle of operation of load cell for the measurement of force.

   (ii) Analyze the advantages of semiconductor strain gauges.
4. Discuss the principle of operation of a magneto resistive transducer with appropriate diagram. What are the various parameters that can be measured by this transducer?
5. **(i)** What is gyroscope? Explain the principle of operation and properties of it with relevant diagrams.
   (ii) On What factors and parameters of the sensor does the Hall voltage output depend for a given field condition.

6. **(i)** What are the different types of magnetic sensors? On what principles do they work? Outline briefly.
   (ii) What is ΔY- effect? How is it used in practice for magnetic field sensing? What materials are specifically suitable for the purpose?
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?
8. Describe the basic principle of a Hall device and show how can it be used as magnetic field sensor?
9. **(i)** Describe the operation of hall effect current sensor.
   (ii) List out and analyze the various effects governing magnetic sensing.
10. Evaluate the need for magnetic sensors also explain the types, principle, requirement and advantages of magnetic sensors.
11. **(i)** Elaborate the features and applications of compass.
    (ii) Discuss the principle of working of Active semiconductor magnetic sensors.
12. **(i)** Explain the principle behind Electrolytic spirit level transducer.
    (ii) Brief the features and applications of inclinometers.
13. **(i)** Discuss the principle and operation of any one form of gyroscope
    (ii) Differentiate Free gyroscope and Single-axis restrained gyro.
14. Explain the working of inclinometers or tilt sensors.

PART –C

1 **(i)** How does the gauge factor of a semiconductor strain gauge vary with doping level? Discuss with help of diagrams.
(ii) Describe a piezoresistive type strain gauge sensor appending appropriate diagrams.

2 Develop the principle of anisotropic magnetoresistive sensors. How is it used in sensing magnetic field? A metallic magnetoresisitor is placed in magnetic field with its length perpendicular to the field. How does the resistance vary with this field

3 How is performance of Hall sensor evaluated? What are the primary and secondary sensitivities?

4 Analyse the performance measures of different heading sensors giving the merits, demerits and applications.

UNIT- IV 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.

1. Define Dark resistance and list out some materials used for the construction of LDR.
2. Estimate the advantages and disadvantages of Thermistor.
3. How a thermistor differs from a thermocouple as a temperature sensor?
4. What is meant by tactile sensor?

5. Define the pin outs and the merits of IC used for temperature measurement.
6. Determine the pressure sensitivity of a quartz piezoelectric transducer of thickness 2.5 mm. the voltage sensitivity of quartz is 50x 10^{3}Vm/N.
7. State advantages of fiber optic sensors and its application.
8. Discuss why the reference junction is needed in thermocouples.
9. Show how force summing devices help in pressure measurement.
10. Define Seebeck effect and Thompson effect and state the significance of them.
11. Determine the types of thermocouples and materials used for constructing thermocouples.
12. Differentiate the characteristics of RTD and Thermistor.
13. List out any two applications that need MEMS sensors..
14. State the properties of piezoelectric crystals.
15. What is the principle of Piezoelectric transducer?
16. Point out the important features of smart transducer.
17. Compare MEMS sensors and Nano Sensors.
18. State the advantages of MEMS.
19. Show the block diagram of architecture of smart sensor.
20. Give the standards available for Smart transducer and its interface.

PART – B

1. **(i)** Discuss the photovoltaic mode of operation of a photo diode with its diagram and volt- ampere characteristics.

   (ii) Give the constructional and functional details of thermocouple with the relevant physical laws and diagrams.
2. **(i)** Explain the working of different types of pressure diaphragms and bellows with diagrams.

   (ii) Discuss the principle of operation of fiber optic sensor with neat diagram.
3. Brief some primary and secondary transducers involved in the measurement of pressure and explain how pressure is measured.
4. **(i)** Discuss the typical advantages and applications that needs MEMS sensors.
   (ii) Describe what is meant by thick film and thin film technology.
5. Define piezoelectric effect. Draw the equivalent circuit of a piezoelectric crystal and derive the transfer function of piezoelectric transducer.
6. **(i)** Discuss any one fibre optic sensor for displacement measurement.

   (ii) Describe about MEMS technology. Explain different manufacturing.
7. How is optical fibre used for stress sensing? Describe a microbend sensor and discuss its operation.

8. Discuss the principle behind the use of LASER in flow measurement and Explain LASER Doppler Velocimeter.
9. Describe the RTD and explain how it can be used to measure temperature.
10. Summarize the construction, principle, working of thermistor and its resistance temperature characteristics.
11. Explain the principle, construction, working and applications of ultrasonic Flow meters with neat sketches.
12. Illustrate with a neat block diagram the construction and operation of a smart transducer and outline its interface standard.
13. Discuss the construction, principle, working and features of Nano –sensors.
14. **(i)** Explain Ultrasonic Liquid Level Measurement System.

    (ii) Discuss the principle and features of Electromagnetic Flow Meters

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.
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=aR0exp(b/T). Calculate the range of resistance to be measured in case the temperature varies from 40°C to 100°C.
3. Design a temperature monitoring system for pasteurization processing for milk and Discuss the features of the system.
4. Analyse the different standards involved in Smart Transducer interface, and also discuss about the need for standardisation.

UNIT- V 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.

1. List the types of amplifiers that can be used with sensors.
2. Point out the need for amplifiers in sensing applications.
3. What is meant by aliasing?
4. Describe the types and need for filters.
5. Generalize the significance of Instrumentation amplifier with conventional amplifiers.
6. Find the aperture time required to digitize a 500 Hz signal to 10 bits resolution.
7. Compare analog filters and digital filters.
8. Illustrate the function of sample and Hold circuits.
9. Define PZT sensor. What for is it used?

10. Demonstrate the application of static pressure sensors in aerospace applications.
11. What are the sensors used and application areas in Home appliance systems?
12. Illustrate the components of data acquisition system.
13. Justify the need for sensors in automobiles.
14. Point out the major areas where sensing is required in automobile systems.
15. Write the sensors involved in on board automobile.
16. Write the importance of position sensing in automobiles.
17. Compare sensors used for environmental monitoring.
18. Define the term data logging evaluate the benefits of data logging.
19. Define what is ecological studies of Air. List various parameters involved.
20. State the different sensors used in production processes.

PART – B

1. What is signal conditioning and why it is required? Develop the block diagram of a DC signal conditioning system and explain the functions of each block.
2. Draw and Explain Instrumentation amplifier with neat diagram and derive its gain.
3. **(i)** Draw and explain sample and hold circuit.

   (ii) What is signal Conditioning and why is it required.
4. Define Q factor and discuss the working of different filter categories.
5. **(i)** Why ADC and DAC are needed.

   (ii) Explain any one type of ADC with neat diagram
6. **(i)** Explain the reason for using 4-20 mA current loop in the 2 wire transmitter. **(5)**

   (ii) Explain the working of 4-20 mA current loop converter.
7. Discuss the function of Single Channel and Multi Channel Data Acquisition System with block diagram.
8. Discuss the importance of Data logging and Explain the components of a Data logger with neat diagram.
9. **(i)** Discuss the role of static pressure sensors in aerospace applications.

   (ii) Explain how Direction of Air flow is sensed in aircrafts.
10. **(i)** Draw the sketch of a pyroelectric IR sensor as used in microwave oven. What is the material used for developing this sensor?

    (ii) How water level is measured in washing machines? Sketch a sensor and Explain its operation.
11. Describe three types of Oxygen sensors used in automobiles comparing their advantages and operations with help of V-I characteristics.
12. Discuss the importance of Environmental monitoring and explain the sensors involved in that.
13. **(i)** Define Eco Hazard And Explain how it affects living being with help of a

chart.

(ii) Brief about sensing of environmental pollution.

14. Explain the functions of various sensors in an automated manufacturing process.

PART – C

1. Evaluate the importance, performance and applications of various sensors in Automobile industries.

2. Present a case study on Medical diagnostic sensors giving the features and advantages.

3. **(i)** A simple RC low-Pass filter is to be designed that the output voltage be attenuated by 3 db at 50 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=100pF and the high pass Filter consists of a resistor R_2=1MΩ and C_2=0.01μF.Find the lower and upper cutoff frequencies and the pass band gain.

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.