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PRESIDENCY UNIVERSITY BENGALURU

**SET-B**

SCHOOL OF ENGINEERING

**END TERM EXAMINATION – MAY/JUNE 2024**

**Semester :** Semester IV - 2022

**Course Code :** ECE3015

**Course Name :** Measuring Instruments and Sensors

**Program :** B. Tech.

**Date :** Jun 19, 2024

**Time :** 9.30 AM-12.30 PM

# Max Marks : 100

**Weightage :** 50%

# Instructions:

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

**PART A**

**ANSWER ANY THREE QUESTIONS (3 Q X 5 M = 15 M)**

1. A Wheatstone bridge is a circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit. With a neat diagram explain the operation of Wheatstone bridge configuration used in D.C. circuits for measuring resistance.

(CO3) [Knowledge]

1. Sensors and transducers play crucial roles in various fields and industries due to their importance in data acquisition, control systems, monitoring, and automation. Discuss the basic principles underlying sensors and transducers, emphasizing their role in converting physical quantities into electrical signals. Provide examples to illustrate these concepts.

(CO3) [Knowledge]

1. Each type of transducer has its own advantages, limitations, and suitable applications. The choice of transducer depends on factors such as the physical quantity being measured, required accuracy, environmental conditions, cost constraints, and interface compatibility with the measurement system.

Compare and contrast resistive, capacitive, and inductive transducers, highlighting their respective operating principles and applications.

(CO2) [Knowledge]

1. Inductive transducers find applications in various fields, including industrial automation, automotive systems, aerospace, robotics, position sensing, displacement measurement, and vibration monitoring. Explain the functioning of inductive transducers, focusing on how changes in the physical quantity induce variations in the inductance of the transducer. Provide examples of inductive transducers used in practice.

(CO2) [Knowledge]

1. Methods of measurement are tools that enable us to understand, quantify, and interact with the world around us. Distinguish between direct and indirect measurement methods, emphasizing their respective applications and advantages. Define the concept of the true value in measurements and elaborate on how it is determined in practice.

(CO1) [Knowledge]

**PART B**

**ANSWER ANY TWO QUESTIONS (2 Q X 20 M = 40 M)**

1. A strain gauge is a sensor used to measure strain (deformation) in an object due to an applied force or load. It operates on the principle that the electrical resistance of a conductor changes when it is stretched or compressed.

A strain gauge is bonded to a beam 0.5 m long and has a cross sectional area 5 𝒄entimeter square . Young’s modulus for steel is 𝟐𝟎𝟕 𝑮𝑵/ . The strain gauge has an unstrained resistance of 340 𝛀 and a gauge factor of 2.2. When a load is applied, the resistance of the gauge changes by 𝟎. 𝟎𝟏𝟑 𝛀. Calculate the change in the length of the steel beam and the amount of force applied to the beam. [10M]

A resistance wire strain gauge having a gauge factor is 2 is bonded to a steel structural member subjected to a stress of 200 𝑴𝑵/ . The modulus of elasticity of steel is 200 𝑮𝑵/ . Calculate the percentage change in the value of the gauge resistance due to the applied stress.

[10M]

(CO3) [Comprehension]

1. Digital voltmeters play a vital role in electrical measurement and testing across various industries, offering accuracy, precision, ease of use and versatility for a wide range of applications. Using block diagrams and detailed explanations, discuss the internal configurations and working principles of 3 and 3½ digit voltmeters.

(CO4) [Comprehension]

1. The capacitive transducers work on the principle of change in the capacitance of the capacitor. This change in capacitance could be caused by the change in the overlapping area, A of the plates, the change in the distance d between the plates d and the change in the medium between the plates 𝜖r, determine the change in the capacitance with respect to the variation of the all above factors and also calculate sensitivity. [10M] Consider a

Capacitive transducer using 5 plates. The dimensions of each plates are 35 mm X 35 mm and the distance between the plates is 0.35 mm. This arrangement is to be used for the measurement of displacement by observing the change in capacitance with the distance x. Calculate the sensitivity of the device. Assume that the plates are separated by air. The permittivity of air is .

[10M]

(CO3) [Comprehension]

**PART C**

**ANSWER ANY THREE QUESTIONS (3 Q X 15 M = 45 M)**

1. Strain gauges are indispensable instruments in engineering, manufacturing, research and safety-critical applications, providing valuable insights into mechanical behavior, structural integrity, and material performance across a wide range of industries and disciplines. Illustrate its working principle with the necessary equations. [10M]

A resistance wire strain gauge having a nominal resistance of 450 𝛀 is subjected to a strain of 500 micro – strain. Find the change in the value of resistance neglecting the piezoresistive effect. Given that the gauge factor is 2.

[5M]

(CO3,CO2) [Application]

1. Multimeters are versatile electronic instruments used to measure various electrical parameters such as voltage, current, resistance, and continuity. Discuss the principles of operation with a neat diagram, highlighting their significance and applications in electrical measurements.

(CO3) [Application]

1. For measuring the liquid pressure during an experiment, Bourdone tube is used to convert pressure into displacement. Identify a transducer that can be used to convert the displacement into electrical signal. Explain its principle, working, characteristics, advantages, and applications with a neat sketch.

(CO3) [Application]

1. Imagine you are assembling a CRT from scratch in a virtual simulation. Describe each component of the CRT and its role in generating the display on the oscilloscope screen.Provide real-world examples or analogies to understand the function of each component effectively.

(CO1) [Application]