

**B.E. Mechanical Engineering Third Year Second Semester Supplementary Exam
2023**

Subject: Measurements and Instrumentation

Time: Three hours

Full Marks: 100

Answer any **FIVE** questions.

Different parts of the same question should be answered together.

Use of Gaussian Error Function Tables permitted.

- [1] (a) Give a schematic of a spring-loaded pressure gauge and explain its function. Also draw a block diagram to indicate the different functional elements of the system.
 (b) Define generalized input impedance in the context of loading effects in measurement system. With an example show, that the ratio of input to output impedance must be high to minimize loading effect. [10+10]
- [2] (a) Considering input (q_i) and output (q_o) of a linear instrument, explain *static sensitivity*, *zero drift* and *sensitivity drift*. Give an example to illustrate the terms.
 (b) What will be (a) the undamped natural frequency, (b) the damping ratio, (c) the damped natural frequency, (d) the maximum percentage overshoot and (e) the 2% settling time for a measurement system that is represented by the following equation: $d^2q_o/dt^2 + 4dq_o/dt + 25q_o = 25q_i$ [10+10]
- [3] (a) With suitable sketches, explain the different types of filters used in measurement systems.
 (b) Draw a schematic of a static-pressure probe. Explain how the method of opposing inputs is applicable to the device.
 (c) A pressure transducer exhibits a temperature sensitivity of 0.1 units per °C and pressure sensitivity of 2.5 units per MPa. If the temperature changes by 20°C during a measurement of 120MPa pressure, determine the error due to dual sensitivity. [6+9+5]
- [4] (a) Describe the principle of operation of a resistance type strain gauge and obtain an expression for its gage factor.
 (b) With suitable examples explain what are active and passive transducers. [12+8]
- [5] (a) With respect to a measurement system distinguish between measured value and true value.
 (b) What are the different types of bias associated with calibration of an instrument?
 (c) What is meant by *static calibration*?
 (d) What are the necessary steps for calibration? [5+5+4+6]
- [6] (a) Derive the ramp response and steady state error of a first order system. Plot response and error with time.
 (b) A thermocouple, which responds as a first-order instrument, has a time constant of 20 ms. Determine its 90% rise time. (c) Explain the working principle of thermocouple. [8+6+6]
- [7] Write short notes on any **FOUR** of the following: (a) root-sum-square uncertainty from component errors; (b) stability of dynamic systems; (c) resolution and scale readability; (d) flow and effort variables; (e) confidence level and coverage factor; (f) time constant of 1st order systems. [5 X 4]