(6 Marks)

**Q. 1.**

Draw a neatly labelled schematic of an accelerometer that can be used in applications where a reference frame is not available. Write the second order equation of this accelerometer, and find the expression of its damping ratio and natural frequency.

**Q. 2.**

Design a second-order low-pass filter circuit such that following specifications are obeyed.

*Phase-shift of its output (with-respect-to input) will be equal to -90° and its amplitude response (i.e., gain) will be equal to 0.5, when the input frequency is 100 Hz.*

DC gain of the filter = 1

Assume 1 µF capacitors are available. Then, decide on the values of resistors needed.

Sketch the unit-step response of the designed filter.                              (8 Marks)

**Q. 3.** A thermometer with a time constant of 2 s is abruptly given an input of 160°C. What will be reading of thermometer after 1 s if initial temperature was 20°C.                              (5 Marks)

**Q. 4.** A Pt100 RTD sensor has following specifications:

    Nominal Resistance = 100 $\Omega$,

    Temperature coefficient = 0.0039 /°C,

    Dissipation Factor: 50 mW/°C

This sensor needs to be used for temperature estimation in the span of 20°C to 100°C, with error less than 0.1 %. What can be the maximum current that can be used to excite the RTD.                              (5 Marks)

**Q. 5.** Fill in the blanks. Write the final answers and important steps in the answer-script.          (6 Marks)

(a) Reliability of using four identical sensors (in redundancy configuration) will be _____ times that obtained with a single sensor, at the end of 1 year period. Assume failure-rate = 1 $yr^{-1}$.

(b) Limiting Error of parallel combination of three 100 $\Omega$ resistors, each of Limiting error 1$\Omega$ is _____

(c) Failure rate ($\lambda$) of 50 units of a given sensor was tested. Test was conducted for 2000 hours. It was found (at the end of the test) that 2 units have failed. Then, the value of $\lambda$ is _____

**************************************************************