VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

ECE DEPARTMENT Subject: (ECL 204 – Measurement and Instrumentation)
Mid Semester Exam (September -2021) ***MARKS: 25***

Instruction: (1) Attempt all questions (2) Make suitable assumption wherever necessary and clearly mention same

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>1</td><td>The resistance $\mathbf{R_\theta\,\Omega}$ of a thermistor varies with temperature $\boldsymbol{\theta}$ K according to the following equation: $\mathbf{R_\theta = 0.0785 \exp(3100/\theta)}$.
Design a deflection bridge (quarter bridge), incorporating the thermistor to the following specification: (a)Input range 0 to 75 °C. (b) Output range 0 to 1.0 V (c) Relationship between output and input to be approximately linear. Find supply voltage required for deflection bridge? (NOTE: deflection bridge produces output 0 to 1V)</td><td>CO1& 4M</td></tr>
<tr><td>2</td><td>Compute nonlinear regression ($\mathbf{Y = ae^{bx}}$) equation for following data
<table>
<tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Y</td><td>0.82</td><td>1.35</td><td>2.24</td><td>3.69</td><td>6.09</td><td>10.04</td><td>16.55</td></tr>
</table></td><td>CO2& 4M</td></tr>
<tr><td>3</td><td>A glass pH electrode with a sensitivity of 49 mV pH^{-1} and a resistance of $10^{10}\,\Omega$ is used to measure pH in the range 0 to 15. The electrode is to be connected to a recorder of input range0 to 100 mV and resistance 100 Ω using a buffer amplifier of unity gain and output resistance 100 Ω.
(i) Calculate the input impedance of the amplifier
(ii) The resistance of the electrode increases to $1 \times 10^9\,\Omega$ due to chemical action. Calculate the resulting measurement error in the above system, as a percentage of full scale, for a true pH</td><td>CO3& 3M</td></tr>
<tr><td>4</td><td>(A)A first-order pressure sensor must meet the following dynamic response specifications: Steady-state error of no more than 16 kPa for a ramp input of 0.8 MPa/s. Compute the transfer function of system

(B) Derive the peak overshoot for II order system for step input?</td><td>CO1, CO2& 4M

[2 +2 =4M]</td></tr>
<tr><td>5</td><td>A thermistor is to monitor room temperature. It has resistance of 3.5 KΩ at 20 ^{0}C with a slope of -10 % / ^{0}C. The dissipation constant is P_D=5mW/ °C. It is proposed to use the thermistor in the divider circuit shown in Figure 1 to provide a voltage of 5V at 20 °C. Find voltage across thermistor with effect of self-heating?</td><td>CO3& 4M</td></tr>
<tr><td>6</td><td>(A)Four strain gauges are bonded onto a cantilever as wheatstone full bridge arrangement. Given that the gauges are placed halfway along the cantilever and the cantilever is subject to a downward force of 0.5 N, use the data given below to calculate the resistance of each strain gauge.
Cantilever data
Length (l) = 30 cm
Width (w)= 6 cm
Thickness (t)= 3 mm
Young’s modulus (E) = 70×10^9 Pa
Strain gauge data
Gauge factor (G)= 2.1
Unstrained resistance (R_o)= 100 Ω</td><td>CO2, CO3& 6M

[2 +2 +2 =6M]</td></tr>
</table>

	(B)The emf at a thermocouple junction is 650 μV at the steam point, 3380 μV at the Zinc point and 9149 μV at the silverpoint. Given that the emf –temperature relationship is of the form $E(T)= aT + b T^2 + c T^3$ (T in °C) . Find a, b, c. (C) A force measurement system consists of linear elements and has an overall steady-state sensitivity of unity. The dynamics of the system are determined by the second order transfer function of the sensing element which has a natural frequency $w_n = 40$ rad $s^{-1}$and a damping ratio = 0.1. Calculate response of sensor the periodic input force signal : $F(t) = 50 \{\sin 10t + (1/3) \sin 40t \}$.	

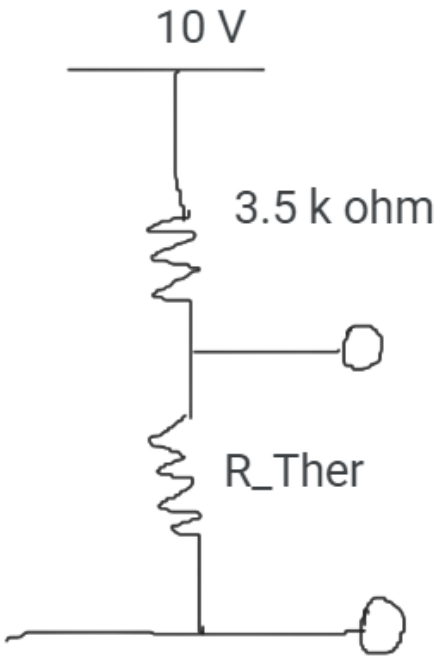

Figure 1