Unit 2 - Week 1

Week-1 Assignment on Static and Dynamic Characteristics

1) A temperature sensor can measure in the range 0 to 400 °C. Worst-case deviation from the best-fit straight line is found to be 5 °C. Find out the maximum non-linearity as a percentage of full-scale.

   - 1) 1.0
   - 2) 1.25
   - 3) 1.5
   - 4) None of these

Accepted Answers:
2) 1.25

2) Find out the maximum hysteresis as a percentage of full-scale deflection (f.s.d) from the following readings of a pressure sensor.

<table>
<thead>
<tr>
<th>True pressure (psi)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
<th>80</th>
<th>60</th>
<th>40</th>
<th>20</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge pressure (psi)</td>
<td>0</td>
<td>18</td>
<td>35</td>
<td>55</td>
<td>77</td>
<td>98</td>
<td>82</td>
<td>59</td>
<td>43</td>
<td>22</td>
<td>0</td>
</tr>
</tbody>
</table>

   - 1) 5 %
   - 2) 6 %
   - 3) 7 %
   - 4) 8 %

Accepted Answers:
4) 8 %

3) Assume, thermoelectric voltage versus temperature relationship of a thermocouple is given by, \( e(t) = a_1 t + a_2 t^2 + a_3 t^3 \). With the reference junction at 0°C, thermo-emf at 100°C is 33 µV, thermo-emf at 500°C is 1.24 mV and thermo-emf at 1000°C is 4.83 mV. Find \( a_1, a_2, a_3 \).
1) $a_1 = -0.245 \, \mu V/{ }^\circ C$; $a_2 = +0.005825 \, \mu V/{ }^\circ C$; $a_3 = -7.5 \times 10^{-7} \, \mu V/{ }^\circ C$

2) $a_1 = 0.245 \, \mu V/{ }^\circ C$; $a_2 = 0.005825 \, \mu V/{ }^\circ C$; $a_3 = -7.5 \times 10^{-7} \, \mu V/{ }^\circ C$

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**Accepted Answers:**
1) $a_1 = -0.245 \, \mu V/{ }^\circ C$; $a_2 = +0.005825 \, \mu V/{ }^\circ C$; $a_3 = -7.5 \times 10^{-7} \, \mu V/{ }^\circ C$

A sensor has an input–output relationship as $y = 4x^2$. Find its maximum static sensitivity in the range $0 \leq x \leq 100$.

1) 400 unit
2) 600 unit
3) 800 unit
4) None of these

**Accepted Answers:**
3) 800 unit

5) Calculate the percentage error in measurement of $I$, when $I$ is measured by inserting an ammeter of internal resistance $R_m = 1 \, \Omega$ suitably.

(Ignore the sign of error)

1) 0.5 %
2) 5 %
3) 1 %
4) 1.5 %

**Accepted Answers:**
1) 0.5 %

6) A first order instrument measures sinusoidal signals with frequency content up to $200 \, Hz$ with a dynamic error of 2%. What is the allowable time-constant?

1) 0.162 second
2) 0.162 millisecond
3) 1.62 millisecond
4) 16.2 millisecond
A first order temperature furnace is heating at the rate of 50°C/min. The time-constant of the system is 15 second. Find out,
(i) Steady-state error in the system.
(ii) Steady-state time lag of the system.

(Ignore the sign of error)
- 1) (i) 12.5 °C; (ii) 0
- 2) (i) 12.5 °C; (ii) 15 second
- 3) (i) 7.5 °C; (ii) 15 second
- 4) (i) 7.5 °C; (ii) 0

A first-order pressure sensor is suddenly subjected to 10 Pascal pressure. The sensor shows 6 Pascal after 2 second. Calculate the error after 3 second in sensor reading.

(Ignore the sign of error)
- 1) 25.3 %
- 2) 23.5 %
- 3) 26.5 %
- 4) 21.3 %

A first-order system is subjected to a unit step-change in input. The time-constant of the instrument is 1 second. Find out the time-instant when error is maximum.

- 1) Insufficient data
- 2) at 1 second
- 3) at 0.707 second
- 4) None of these

A sinusoidal signal is measured with a first-order instrument having time-constant of 5 ms. Find, the highest frequency of input signal that can be measured, if maximum tolerable dynamic error is ±2%.

- 1) 40.6 Hz
- 2) 6.46 Hz
- 3) 10.64 Hz
- 4) 45.64 Hz
11) An accelerometer that is 2\textsuperscript{nd} order in nature is to be selected to measure sinusoidal signal of frequency below 200 Hz. If dynamic error of ±6\% is allowed, find the natural frequency (\omega_n) of the sensor for damping ratio 0.7.

- 1) 1275.2 rad/sec
- 2) 1275.2 rad/sec
- 3) 2029.5 rad/sec
- 4) 1014.7 rad/sec

**Accepted Answers:**
3) 2029.5 rad/sec