Instructions:
• This quiz lasts 30 minutes. Answer all questions (on both sides of the sheet)
• You may have a 8.5” × 11” sheet of notes and a non-network-connected calculator

Q1a: (10 marks) Describe two facts about Canada’s classification system for medical devices (two sentences each). (e.g. What the levels are, criteria used to assess a device)

Q2a: (10 marks) Multiple measurements of a strain gauge sensor yield the following values (at right)

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>10.0</th>
<th>10.0</th>
<th>10.0</th>
<th>10.5</th>
<th>10.5</th>
<th>10.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (Ω)</td>
<td>81.0</td>
<td>80.0</td>
<td>79.0</td>
<td>89.5</td>
<td>89.5</td>
<td>91.0</td>
</tr>
</tbody>
</table>

(a) Estimate the sensitivity of this sensor (with units)
(b) Explain one situation in which it’s useful to have a sensitive strain gauge (1 sentence)
Q3a: (20 marks) In the circuit at right, $R_A = R_B = R_C = 100\, \Omega$. $R_D$ is a strain gauge which is currently at 101 $\Omega$. The amplifier is an AD620 instrumentation amplifier with a gain set to 100. The amplifier has a CMRR of 60 dB.

(a) What is $V_d = V_+ - V_-$?
(b) What is $V_{cm} = \frac{1}{2}(V_+ + V_-)$?
(c) What is $V_o$?
(d) Why is high CMRR important for this circuit?
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Q1b: (10 marks) From a regulation point of view, what is the key difference between a “medical device” and a consumer product (such as health / lifestyle wearables products). Briefly explain (two sentences) and give one example.

Q2b: (10 marks) Multiple measurements of a thermistor sensor yield the following values (at right)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>30.0</th>
<th>30.0</th>
<th>30.0</th>
<th>30.5</th>
<th>30.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (Ω)</td>
<td>41.0</td>
<td>40.0</td>
<td>39.0</td>
<td>59.5</td>
<td>59.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61.0</td>
</tr>
</tbody>
</table>

(a) Estimate the sensitivity of this sensor (with units)
(b) Explain one situation in which it’s useful to have a sensitive thermistor (1 sentence)
Q3b: (20 marks) In the circuit at right, \( R_A = R_B = R_C = 200 \, \Omega \). \( R_D \) is a strain gauge which is currently at 201 \, \Omega\. The amplifier is an AD620 instrumentation amplifier with a gain set to 100.

(a) What is \( V_d = V_+ - V_- \)?
(b) What is \( V_{cm} = \frac{1}{2}(V_+ + V_-) \)?
(c) What CMRR is required so that the contribution of \( V_{cm} \) to \( V_o \) is 100\,\times\ less than the contribution of \( V_d \)?
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Q1c: (10 marks) Describe two facts about Canada’s classification system for medical devices (two sentences each). (e.g. What the levels are, criteria used to assess a device)

Q2c: (10 marks) Multiple measurements of a strain gauge sensor yield the following values (at right)

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>10.0</th>
<th>10.0</th>
<th>10.0</th>
<th>10.5</th>
<th>10.5</th>
<th>10.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (Ω)</td>
<td>81.0</td>
<td>80.0</td>
<td>79.0</td>
<td>89.5</td>
<td>89.5</td>
<td>91.0</td>
</tr>
</tbody>
</table>

(a) Explain how would you estimate the precision of this sensor (numerical values and one sentence)?
(b) What is the difference between accuracy and precision for this sensor (one sentence)?
Q3c: (20 marks) In the circuit at right, $R_A = R_B = R_C = 2 \, \text{k}\Omega$. $R_D$ is a strain gauge which starts at $2 \, \text{k}\Omega$. The amplifier is an AD620 instrumentation amplifier with a gain set to 100, and infinite CMRR.

(a) What is $V_o$ under no strain?

(b) What is $V_o$ when an applied strain makes $R_D = 2.01 \, \text{k}\Omega$?

(c) What is the sensitivity (in $\Delta V / \Delta \Omega$?)

\[ V_o = \frac{6 \, \text{V}}{R_D + R_B + R_A + R_C} \]