**Test yourself on control signals**

1. A control valve had been calibrated to deliver 25 m$^3$/h of water at full opening. If the control valve has an equal percentage characteristic of FO-type (ATC), calculate the water flowrate when a controller transmits a 14 mA signal. Figure 1 can be used to assist your calculation.

![Figure 1 - Control valve characteristics.]

2. A pH sensor is connected to a transmitter which transmits a signal to a controller and a chart plotter. The chart plotter input signal is 1 to 5 V. If the transmitter displayed pH 4,

   a) Calculate the input voltage by the chart plotter.
   b) Calculate the mA signal received by the controller.

The transmitter had been calibrated at 0 to 14 pH for 4 to 20 mA signal.

![Figure 2 – A pH control system]
3. A computer is used as a SCADA system to control a pilot plant. It receives signals between 1 to 5 V from various transmitters via signal converters and transmits signals between 0 to 10 V to control valves via signal converters. Figure 3 shows a SCADA control of liquid flow loop.

![SCADA control system diagram](image)

**Figure 3 - A SCADA control system.**

a). If the flow transmitter had been calibrated for flow of 0 to 6 m³/hr, calculate the signal received by the computer, in volt, when 4.5 m³/hr of liquid flows through the pipe.

b) Assuming the control valve used is of linear type, calculate the pneumatic signal delivered to the control valve in order to maintain 4.5 m³/hr of liquid flow. Also, calculate the equivalent stem position.

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**Test yourself on controller-tyristor linearity study**

1. The following table shows the power output by a tyristor upon changes made by the manipulated variable (MV, %)

<table>
<thead>
<tr>
<th>MV, %</th>
<th>9.8</th>
<th>14.2</th>
<th>19.5</th>
<th>24.4</th>
<th>44.2</th>
<th>54.8</th>
<th>64.0</th>
<th>74.0</th>
<th>84.0</th>
<th>94.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power output, kW</td>
<td>0.50</td>
<td>0.80</td>
<td>1.00</td>
<td>1.30</td>
<td>2.50</td>
<td>3.20</td>
<td>3.50</td>
<td>4.05</td>
<td>4.60</td>
<td>5.05</td>
</tr>
</tbody>
</table>

a) Develop a mathematical relationship between MV and power output.

b) What is the power output when MV=30%?