Solutions

2.1

- 1 mA $\times$ 0.385 Ω/K $\times$ 40 = **15.4** mV/K.
- Step = 3.3/4096 = 0.806 mV; 0.806/15.4 = **0.0523** K.
- σ = step/$\sqrt{12}$ = **0.0151** K.

2.2

- $V = \Delta T \times S = 100 \times 15.4 =$ **1.54** V.
- Headroom for offset, drift and over-range (a fault reading above 100 °C should still be readable, not clipped).

2.3

- $1/\sqrt{1 + (5/1)^2} =$ **0.196**: 5 Hz noise is cut to about 20%.

3.1

- (a) Sensor: $0.3 + 0.005 \times 60 =$ **0.600** K.
- Gain: $0.002 \times 60 =$ **0.120** K.
- Self-heating: $I^2R = (10^{-3})^2 \times 123.1 = 0.123$ mW, and 0.123/2 = **0.062** K; ADC **0.015** K.
- RSS: $\sqrt{0.600^2 + 0.120^2 + 0.062^2 + 0.015^2} =$ $\pm$**0.62** K.
- (b) No: the ADC term is already negligible. A class A (or 1/3 DIN) sensor, or calibrating it, attacks the dominant term.
- (c) $P = T\omega = 0.314 \times 200.7 =$ **63** W.
- Voltage caps speed (24 V $\rightarrow$ 6.69 rad/s at the valve under load); current caps torque (6 A $\rightarrow$ 12.2 N $\cdot$ m at the valve).

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