Uncertainty Analysis

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QUESTIONS:

1. The manufacturer has given the calibration uncertainty of a pressure gauge as +/-0.1MPa at 95% confidence. Determine the standard uncertainty due to calibration.

2. Temperature readings were taken randomly from ten different positions in a room and the values obtained were 20.4, 20, 19.8, 20.7, 19.3, 20.7, 19.3, 21.1, 20.3, and 19^{o}C. Determine the standard uncertainty of the temperature due to variation in location.

3. A digital watch has a least count of 1 second. What is the standard uncertainty due to the resolution of the watch?

4. The diameter of a shaft is measured using a vernier caliper. The uncertainty due to misalignment of the beam with the shaft diameter may be modelled as a triangular distribution with limits +/-0.05mm. What is the standard uncertainty due to misalignment?

5. The voltage output of a stabilizer was measured and the mean value found to be 225V. The Type A evaluation of standard uncertainty was 1V and the Type B evaluation of standard uncertainty 2V. Determine the combined standard uncertainty.

6. Determine the Expanded Uncertainty interval for the measured voltage output at 95% for the data of problem 5.

7. A temperature measuring device was calibrated using a precision platinum resistance thermometer (reading x) with the following results:

x^{o}C	10	20	30	40	50	60	70	80	90	100
y^{o}C	8.25	18.99	30.20	39.49	47.37	60.32	72.31	79.75	90.09	98.81

   Determine the best fitting straight line using the method of least squares.

8. Determine 95% confidence intervals for the slope and intercept in Problem 7.

9. Determine standard uncertainties for the slope and intercept in Problem 7.

10. If the device in Problem 7 is kept at a temperature of 95^{o}C, determine a 95% confidence interval on the mean temperature that will be indicated.

11. In Problem 11, determine a 95% confidence interval on a single future indication.

12. In Problem 11, determine a 95% confidence interval on the average of three future indications.

13. The device in problem 7 is kept at an unknown temperature and a reading of 95.09 is indicated. Predict a 95% confidence interval on the unknown temperature.

14. The value of a resistance is known to be $2\Omega \pm 0.1\Omega(95\%)$. The current passing through it is measured as $2.5A \pm 0.1A(95\%)$. Determine the 95% expanded uncertainty interval on the power consumed by the resistor.

15. In problem 14, the current and resistance values are known to be correlated with correlation coefficient -0.5. Determine the 95% expanded uncertainty interval on the power consumed by the resistor.

ANSWERS:

1. Assuming the uncertainty to be normally distributed, 0.051MPa

2. Mean=20.062, Stdev=0.715, $t_{0.025,9}$=2.2622, $u_{location}$=0.261^oC

3. Assuming the uncertainty to be uniformly distributed, 0.289s

4. 0.0204mm

5. 2.236V

6. 220.53 to 229.47V, assuming the measured voltage to be normally distributed.

7. The regression equation is y_i (^oC)= -1.172 + 1.01327 x_i (^oC)

8. Intercept= (-3.316^oC, 0.972^oC), Slope= (0.979, 1.048)

9. $se_{intercept}$=0.9297^oC, se_{slope}=0.01498^oC

10. (93.38739^oC, 96.79043^oC)

11. (91.51894^oC, 98.65888^oC)

12. (92.60328^oC, 97.5745328^oC)

13. (92.5086^oC, 97.5866^oC)

14. (11.321W, 13.679W)

15. (11.625W, 13.375W)