Homework 10

ME 240: Fundamentals of Instrumentation & Measurement
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1. A voltmeter is used to measure a known voltage of 100 V. Forty percent of the readings are within 0.5 V of that mean value.

    (a) (2 points) Assuming a normal distribution for the error, estimate the standard deviation for the voltmeter.

    (b) (2 points) What is the probability that a single reading will have an error exceeding 1.0 V?

2. To estimate the average weight of a yogurt-cup batch, the weights, in ounces, of a sample of 12 cups are found to be 16.05, 16.14, 16.10, 16.04, 15.95, 16.08, 15.92, 16.02, 16.10, 15.90, 16.08, and 16.12.

    (a) (2 points) Calculate the mean and standard deviation of the sample.

    (b) (2 points) Estimate the standard deviation of the mean.

    (c) (2 points) Determine the 95% confidence interval on the mean of the weight of the yogurt cup.

3. A batch of machine parts is considered acceptable if the average tensile strength exceeds 41.0×10^6 N/m². In a manufactured batch, 10 samples were tested and found to have an average strength of 41.25×10^6 N/m², with a standard deviation of 0.30×10^6 N/m².

    (a) (3 points) Determine whether, with a 99% confidence level, the manufacturer can state that the product has an average strength exceeding 41.0×10^6 N/m².

    (b) (3 points) The manufacturer makes more measurements until a total of 20 samples have been tested. The mean and standard deviation remain unchanged. Can it now be said, with 99% confidence, that the product has an average strength exceeding 41.0×10^6 N/m²? Justify your answer.

4. (3 points) Rivet holes are punched in steel beams. To ensure that the rivets will fit and that the joint will have adequate strength, it is necessary to control the standard deviation of the diameter, and measurements are made periodically. Ten measurements are made of nominally 1-inch-diameter holes, and the standard deviation is found to be 0.0002 inches. What is the 95% confidence interval on the standard deviation?

5. (2 points) The air pressure P at a point near the end of an air supply line is monitored every hour in a 12-h period, and the resulting readings are listed below. Apply the Thompson τ test to determine if any of the data points can be rejected.

Reading	P (psi)
1	110
2	104
3	106
4	94
5	92
6	89
7	100
8	114
9	120
10	108
11	110
12	115