ENGI 4421 Probability and Statistics
Faculty of Engineering and Applied Science

Additional Exercises

[Topics after Test 2]

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1. [Devore, 6th ed., ex. 12.4, q. 50, p. 537 modified]

An experiment to measure the macroscopic magnetic relaxation time in crystals (in microseconds, μs) as a function of the strength of the external biasing magnetic field (in kiloGauss, kG) yielded the following data ("An Optical Faraday Rotation Technique for the Determination of Magnetic Relaxation Times", IEEE Trans. Magnetics, June 1968: 175-178, with data read from a graph that appeared in the article).

x	11.0	12.5	15.2	17.2	19.0	20.8	22.0	24.2	25.3	27.0	29.0
y	187	225	305	318	367	365	400	435	450	506	558

The summary statistics are:

$$n = 11 \qquad \sum x = 223.2 \qquad \sum y = 4116$$
$$\sum x^2 = 4877.50 \qquad \sum xy = 90096.1 \qquad \sum y^2 = 1666782$$

(a) Fit the simple linear regression model to these data.
(b) What proportion of the total variation in Y is explained by the linear regression model?
(c) Calculate a 95% confidence interval for the expected relaxation time when the field strength is 18 kG.
(d) Calculate a 95% prediction interval for a future relaxation time when the field strength is 18 kG.

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2. The true mean tensile strength of a new type of lightweight cable is claimed to be more than 20 kN. The distribution of actual strengths is known to be normal to a good approximation, with a standard deviation of 1.4 kN. A random sample of five of the new cables has a mean of 21.5 kN

(a) Is there sufficient evidence to support the claim?
(b) Now suppose that the standard deviation σ is unknown and that the measured standard deviation of the random sample is s = 1.4 kN. Is there sufficient evidence to support the claim?

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3. A study of company performance in two nearby cities was conducted to test for any significant difference between the companies in those cities. A random sample of ten companies in city A had a sample mean performance index of 74.3 with a standard deviation of 3.2 . A random sample of ten companies in city B had a sample mean performance index of 73.2 with a standard deviation of 2.9 .

Is there a significant difference in company performance index between these two cities? State carefully your assumptions and your hypotheses.

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4. [Devore 6th ed., Ch. 12 p. 551 q. 73 - parts (b) & (c) are bonus questions only]

The accompanying set of data is a subset of the data that appeared in the paper "Radial Tension Strength of Pipe and Other Curved Flexural Members" (*J. Amer. Concrete Inst.*, 1980, pp. 33-39). The variables are age of a pipe specimen (x in days) and load necessary to obtain a first crack (y in 1000 lb/ft).

x	20	20	20	25	25	25	31	31	31
y	11.45	10.42	11.14	10.84	11.17	10.54	9.47	9.19	9.54

(a) Calculate the equation of the estimated regression line.

(b)* Suppose that a theoretical model suggests that the expected decrease in load associated with a 1 day increase in age is at most .10 (× 1000 lb/ft). Do the data contradict this assertion? State and test the appropriate hypotheses at significance level .05 .

(c)* For purposes of estimating the slope of the true regression line as accurately as possible, would it have been preferable to make a single observation at each of the ages 20, 21, 22, ..., 30 and 31? Explain.

(d) Calculate an estimate of true average load to first crack when the age is 28 days. Your estimate should convey information regarding precision of estimation.

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5. [Bonus question; Devore 6th ed., Ch. 9.4 p. 398 q. 55]

Two different types of alloy, A and B, have been used to manufacture experimental specimens of a small tension link to be used in a certain engineering application. The ultimate strength (in ksi) of each specimen was determined and the results are summarized in the frequency distribution tabulated below.

Alloy:	***A***	***B***
26 - under 30	6	4
30 - under 34	12	9
34 - under 38	15	19
38 - under 42	7	10
sample sizes	40	42

(a) Compute a 95% confidence interval for the difference between the true proportions of all specimens of alloys A and B that have an ultimate strength of at least 34 ksi.
(b) Can you conclude that there is a significant difference between these two population proportions?

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6. [Devore 6th ed., ex. 14.3 q. 30 page 662]

Three different design configurations are being considered for a particular component. There are four possible failure modes for the component. An engineer obtained the following data on number of failures in each mode for each of the three configurations. Does the configuration appear to have an effect on type of failure?

		Failure mode			
Observed		**1**	**2**	**3**	**4**
	1	20	44	17	9
Configuration	**2**	4	17	7	12
	3	10	31	14	5

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