University of California, Davis
Department of Biomedical Engineering

Fall 2019	**Probability and Statistics**	**BIM 105**
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Homework Assignment 7
Due December 5, 2019
Always show your work.
Use MATLAB for all problems except number 1.

1. The article "Application of Analysis of Variance to Wet Clutch Engagement" (M. Mansouri, M. Khonsari, et al., Proceedings of the Institution of Mechanical Engineers, 2002:117–125) presents the following fitted model for predicting clutch engagement time in seconds (y) from engagement starting speed in m/s (x_1), maximum drive torque in Nm (x_2), system inertia in kg m^2 (x_3), and applied force rate in kN/s (x_4):

$$y = -0.83 + 0.017x_1 + 0.0895x_2 + 42.771x_3 + 0.027x_4 - 0.0043x_2x_4$$

The sum of squares for regression was SSR = 1.08613 and the sum of squares for error was SSE = 0.036310. There were 44 degrees of freedom for error.

   (a) Predict the clutch engagement time when the starting speed is 20 m/s, the maximum drive torque is 17 Nm, the system inertia is 0.006 kg m^2, and the applied force rate is 10 kN/s.

   (b) Is it possible to predict the change in engagement time associated with an increase of 2 m/s in starting speed? If so, find the predicted change. If not, explain why not.

   (c) Is it possible to predict the change in engagement time associated with an increase of 2 Nm in maximum drive torque? If so, find the predicted change. If not, explain why not.

   (d) Compute the coefficient of determination R^2.

   (e) Compute the F statistic for testing the null hypothesis that all the coefficients are equal to 0. Can this hypothesis be rejected?

2. The file `HW7-2.csv` presents measurements of mean noise levels in dBA (y), roadway width in m (x_1), and mean speed in km/h (x_2), for 10 locations in Bangkok, Thailand, as reported in the article "Modeling of Urban Area Stop-and-Go Traffic Noise" (P. Pamanikabud and C. Tharasawatipipat, Journal of Transportation Engineering, 1999:152–159). Construct a good linear model to predict mean noise levels using roadway width, mean speed, or both, as predictors. Provide the standard deviations of the coefficient estimates and the P-values for testing that they are different from 0. Explain how you chose your model.

3. The file `HW7-3.csv` consist of yield measurements from many runs of a chemical reaction. The quantities varied were the temperature in °C (x_1), the concentration of the primary reactant in % (x_2), and the duration of the reaction in hours (x_3). The dependent variable (y) is the fraction converted to the desired product.

   (a) Fit the linear model predicting y from the three variables without interactions or quadratic terms.

   (b) Two of the variables in this model have coefficients significantly different from 0 at the 15% level. Fit a linear regression model containing these two variables.

   (c) Compute the product (interaction) of the two variables referred to in part (b). Fit the model that contains the two variables along with the interaction term.

   (d) Based on the results in parts (a) through (c), specify a model that appears to be good for predicting y from x_1, x_2, and x_3.

   (e) Might it be possible to construct an equally good or better model in another way?