Problem 1: An animal study is designed to address the effects of a set of different drugs on the amount of immuno-response to an allergen. It is believed that the age of the animal may effect this response, and to address this, eight animals from each of three ages (young, adolescent, adult) are used in the study. Each animal will receive the four drugs of interest, and measures of their immuno-response will be taken. Hypothetical data from a study of this sort are included in the attached file. Address the following questions:

a. Describe an appropriate model for this data. First, define the model for $Y_{ijk}$ and describe which terms in the model are fixed and which are random. Also indicate how we could write this model in the mixed model form, by finding the forms of $Z$ and $X$.

b. What assumptions do you think are reasonable about the structure of the covariance within an animal? To test your intuition, run your model in SAS for CS, AR(1), and unstructured covariance matrices. Which model(s) do the fit statistics suggest are best? When possible, perform likelihood ratio tests to compare the models.

c. For your favorite model, interpret the output in SAS. Be sure to mention which of your fixed effects are significant, and describe which drug(s) are best (smallest response).

d. What would have happened if you had ignored the correlation within the animals? To answer this question, consider a model which does not involve any correlation between the observations on a particular animal. What are the conclusion for this model, and how are they different from your results in part (c)?

Problem 2: The power of rechargeable camera batteries is of interest to a major photographer. To understand which batteries are the best, it is desired to measure the length of time that batteries will run a camera on the first charge. Additionally, it is desired to
study the loss of power over time, and so the length of time is also measured after the 50th charge, 100th charge, and 150th charge. 10 batteries of each of three types are used in the experiment. Hypothetical data are in the attached file.

a. Describe an appropriate model for this data. First, define the model for $Y_{ijk}$ and describe which terms in the model are fixed and which are random. Also indicate how we could write this model in the mixed model form, by finding the forms of $Z$ and $X$.

b. What assumptions do you think are reasonable about the structure of the covariance within a battery? To test your intuition, run your model in SAS for CS, AR(1), and unstructured covariance matrices. Which model(s) do the fit statistics suggest are best? When possible, perform likelihood ratio tests to compare the models.

c. For your favorite model, interpret the output in SAS. Be sure to mention which of your fixed effects are significant, and describe which battery type you feel would be the best purchase.

d. This data could also be analyzed using the methods of profile analysis. Find an appropriate model for a profile analysis of this data. Think about the conclusion that can be drawn from the two analyses. How is the profile analysis similar to the LMM analysis? How do they differ?