Homework # 9—Due Mon 24 Apr

1. Below are some descriptions of actual or possible experiments. Your job is to clearly state the experimental design in words and symbols. Part of your description could identify subsets of the design which have structures you readily grasp. Your "answer" should include a model in notation form with all terms identified and a table of degrees of freedom and `E(MS)`. You may assume designs are balanced unless otherwise indicated. It is not important per se to use the "right" buzz words for a particular design. Better to identify the design structure and treatment structure in your own words.

(a) An experiment with cows examined carbohydrate digestion in their rumen (stomach). There were five treatment levels of casein infusion (0, 500, 1000, 1500, 2000) which were assigned to cows in 5*5 Latin squares. That is in each set, five cows were assigned the five treatment levels over 5 periods in such a way that exactly one of the five cows received any given treatment level in any period. Fifteen cows were grouped into 3 sets of 5 based on prior milk production. [Do not worry about possible correlation or carryover of effect over time within cow.]

(b) A company wants to measure the "quality" of a product by using the ratio of the maximum to minimum diameter of a particular hole punched in plastic (the ratio should ideally be 1.000). A number of products have this hole, although they are made at different stations depending on the product. The statistician selects 5 worker stations and 3 different products at each station. The same product is measured every Monday in February at those stations.

(c) A biotechnology student wants to fill a 96-well plate (8 rows and 12 columns) with samples from 12 genetic lines. She is concerned that the edges of the plate may be dryer than the middle. Therefore she makes sure all 12 lines appear in the top and in the bottom row, and that another set of 12 use the remaining wells along the 2 edges. The other "copies" are put in the middle wells.

(d) A plant scientist is measuring the amount of soluble sugars in cranberries in a bog in northern Wisconsin. The rectangular bog is divided along its length into 6 "samples" (her term). On 6 dates throughout the reproductive season (July–October) a branch from each sample is randomly selected to be measured. Soluble sugar is measured in the vegetative and flowering parts of each branch. The researcher wants to examine the time course of sugar production to document differences between vegetative and flowering parts. [Ignore possible correlation over time.]

(e) Research for putting plants in space to feed astronauts is conducted at the UW Biotron. In one such experiment, 4 chambers are employed to compare the effects of light, relative humidity (RH) and variety of potato for total biomass. Five plants of each variety are placed in each chamber (10 plants per chamber). Two levels of light and two of RH are selected for study. The chambers are randomly assigned to the environmental treatment combinations. Three weeks later the plants are measured for total biomass.

2. Researchers at the National Wildlife Health Research Center conducted an experiment to investigate the effect of a disease (mycoplasma) and cold stress on the growth of young ducklings (birds). A batch of eggs (EGG) was divided at random into two groups, with one half being innoculated before hatching with mycoplasma (MYCO) and the other half not (CTRL). Many innoculated with the disease did not survive (hatch as ducklings). Therefore a second set of eggs (INO) was hatched and randomly assigned to be innoculated as ducklings (MYCO) or not (CTRL). Thus there were 4 treatment combinations so far (although in a sense the two controls are the same).

Cold stress levels (Warm/Cold) could only be controlled for a whole room. However, because of the danger of infection, MYCO and CTRL birds were kept in separate rooms. In fact the eight treatment combinations (EGG/INO by MYCO/CTRL by W/C) were each kept in separate rooms. Ducklings were randomly assigned to cages in the 8 rooms.

Measurements were take every 1–2 days. The data available here are bill length and leg length at 21 or 22 days for each duckling; ignore leg length and focus on the effect of treatments on bill length. Your job involves the following: (a) determine the experimental design (what is the experimental unit for each factor?); (b) write out an appropriate model with assumptions; (c) test for main effects and interactions, reducing the model accordingly; (d) use tables and/or interaction plots of estimates (with appropriate SEs) to illustrate your findings.

The design is tricky so be careful. Data and a SAS setup are in the usual place as `hwk9.dat` and `hwk9.sas`.