Statistics 5303 — Exam 2 Sketched Solutions NAME ____________________
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Gary W. Oehlert ID# ____________________

1. What response or transformation of the response did you analyze? Why did you choose that form of the response?

I believe that the interesting issue is how the measured OD260 compares with the theoretical OD260 based on concentration, thus I used as my response the measured OD260 divided by the theoretical OD260 computed from concentration. With this response, residuals look fine (you need a transformation if you work with measured OD260).

2. Theory says that volume should have no effect on the response. Do the data support the theory? If not, in what way do the data diverge from the theory?

Reality does not match theory over the entire range of volumes. As volume increases, the OD260 decreases, although the order is not always consistent at the lower concentrations, and the differences between low volume and high volume are greater at low concentrations. This effect is highly significant ($p < .0001$).

We were warned that volumes below $40\mu$l could lead to anomalous results. If we limit ourselves to volumes of $40\mu$l or greater, then there are no significant volume effects or volume by concentration interactions.

3. Were user effects or interactions statistically important terms in the model?

User itself was not a significant random effect (estimated as 0, in fact), but the user:volume:concentration random effect is highly significant and estimated to be slightly larger than residual variation. The user:volume and user:concentration effects are intermediate in size; the Bayesian interval method says these effects could easily be zero, but the using the RLRT test (via exactRLRT) shows these effects as moderately significant (p values in the .01 to .03 range).

4. We want to study factors affecting the per-fruit production of orange juice. In practice, you select an orange and then use a juicer to extract the juice. We can use oranges of three different varieties, and we can use small oranges or large oranges. Finally, we can use two different kinds of juicers.

What we did was randomly sample four oranges from each variety by size combination. We then cut each fruit in half and randomly assigned one half to each juicer. We use the juicer and measure the extracted juice.

Draw a Hasse diagram for this experiment.

5. Proteins can be stored frozen for periods of months to years, but they may undergo degradation if subjected to repeated freeze/thaw cycles. This experiment seeks to understand the effects of freezing temperature and repeated freeze/thaw cycles. . . .

This is a 2x10 factorial (temperature by freeze/thaw cycles) run in three complete blocks (i.e., a randomized complete block design).

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Source        DF
Blocks         2
Temperature    1
Cycles         9
T:C            9
Error         38
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6. Motor oil in an automotive engine will change viscosity over time. We wish to study if the viscosity change depends how much time the oil spends at an elevated temperture. Our basic idea is to take a sample of oil, measure its viscosity, heat it to one of four temperatures and hold it at that temperature for 72 hours, and then measure the viscosity again. The response is the change in viscosity.

We suspect that there will be brand-of-oil differences in viscosity change, with the name brand oils expected to change viscosity less; we will have to deal with this, but this is not of interest. We also expect that there will be differences in viscosity change based on the original viscosity of the oil; this is also not of interest. We have available oil of four different label viscosities (5W30, 10W30, 5W40, and 10W40) from eight different brands (three are name brands and five are private store labels). We have the capacity to run 32 viscosity-drop trials.

How should we design the experiment? Describe treatments, blocks, units, etc.

We need to block on brand and viscosity, we have four temperature treatments, four viscosities, and eight brands. Two replications of a 4x4 Latin Square would be appropriate. Row blocks are viscosities; column blocks are brands; units are oils. Temperatures are treatments.

7. A French press device is one possible choice for brewing coffee. However, one drawback of this device is that the coffee produced can contain some coffee grounds that affect the flavor of the coffee. We would like to run an experiment to investigate the effects of three factors on the flavor of French press-made coffee. Factor A is the amount of grounds put into the press (.1 pound or .12 pound); factor B is the type of roast (French roast of Full City roast); factor C is whether the coffee is stirred once while it is brewing (yes or no).

I am the one who will rate the flavor, and I have time in the morning to make and taste four different brews of coffee. I am not a trained coffee rater, and I think it is likely that my ratings will not be consistent from day to day. I can taste sixteen cups, because I can only do this Monday through Thursday (needing to submit my analysis on Friday).

How should I design my experiment?

We need to block on day, and with eight treatments and four runs per day we need an incomplete block design. Confounding would make sense because we have a two series design and blocks of size 4. We can use four days for 16 units. I would use a partially confounded design, confounding ABC in the first replication and BC in the second replication. I choose not to confound AB or AC, because my gut tells me they are more likely to be present than BC or ABC.