Math 740/840 Homework Assignment #3 Fall 2019

Due 10/30/2019

I want the completed assignment handed in electronically through myCourses as a PDF document. You can upload the completed assignment through the Assignment page on myCourses. Do note email your completed assignment to the instructor they must be submitted through myCourses (Canvas). **Important**: in the **name of the file** that you submit please be certain to include your name (last name, then first name), the course number, and the assignment number; this helps greatly with grading.

You may discuss the homework with each other; however, you must turn in your own original solutions – no copying. The intent is that you may participate in a study group, but you must do your own work. Remember, copying someone else’s work and presenting it as your own is cheating (and stealing from them). If you have any questions about cheating, then I suggest that you read the student handbook section on academic honesty. Access the handbook at <https://www.unh.edu/student-life/09-academic-honesty>. The rules will be enforced.

Also, in order to get full credit, where asked to use JMP to answer questions you must turn in a copy of the portion of the JMP output that is relevant to your solution. **Do Not just write down answers**, I need to see where you got the information from the JMP output. Remember the selection tool (fat plus sign) on the Cursor Tool Bar can be used to copy paste output from JMP to other applications.

This homework assignment covers **incomplete blocking designs** and **mixture experiments**. You should have read the notes on the two topics of incomplete block designs and mixture experiments as well as watch the associated recordings before attempting this assignment.

1. (15 pts.) Engineers are developing a new paint formulation for automobile applications. The new formulation has strict performance requirements and the engineers what the cured paint surface to have a **Knoop Hardness** > 25 and a **Percent Solids** < 30; these are the two primary responses in the experiment. There are three components in the formulation that are manipulated in an experiment and each has the following constraints on the allowable range used in the experiment.  
     
   A: **Monomer** 0.05 to 0.25  
   B: **Crosslinker** 0.25 to 0.40  
   C: **Resin** 0.50 to 0.70  
     
   note that A + B + C =1.0 is a requirement for the settings on each trial. Use the dataset **Paint Formulation Experiment.JMP** to answer the following questions.  
   1. What type of experimental design has been employed by the engineers? Be specific.
   2. For the response Y1-Hardness use the Fit Model platform to fit a special cubic model to the data. You are shown how to do this in the Mixture Design 1 notes. Focus only on the Y1 response at this point. Once you fit the model, do not attempt to simplify the model by removing terms. What terms appear most dominant to the Harness response? Be sure to include the Parameter Estimates table screenshot with your answer. Finally, save the estimated prediction equation to the data table. To do this click on the main report (red arrow) at the top of the window to the left of Response, next click on the Save Columns submenu and select Prediction Formula. A column with the prediction formula now appears in your data table.
   3. Repeat part b, but this time do the analysis for the Y2-%Solids response. Once you complete parts b and c you should have two formula columns in your data table; one for each of the two responses.
   4. We now ready to find an optimum formulation that meets the specification requirements for both responses. To do this, first go to the Graph menu and select Profiler (**Graph 🡪 Profiler**). In the Profiler launch dialog window place both formula columns in the Y columns box and click OK to open the Profiler report. Once in the report window select Maximize Desirability from the Prediction Profiler report. Note, I have already specified the desirability settings for both response as Column Properties, so the Desirability Functions automatically appear in Prediction Profiler display. Be certain to include a screenshot of your optimized settings for the three formulation components and the predicted responses. Does your optimized formulation meet the constraints on each of the 3 components? Do the predicted values for each of the two responses meet the specifications for the paint formulation? Explain.
   5. Finally, using your Prediction Profiler report, do the relationships between each of the two responses and three formulation components appear to be the same or different? You can answer this qualitatively by simply looking at the response traces or profiles for each of the components for each of the response.
2. (15 pts) Material scientists are studying a process to make ceramic parts. They are independently varying 3 factors at two levels each: %Silicon in the ceramic, %Calcium in the ceramic, and two Cooling Processes. The scientists elected to perform three replicates of the experiment which requires 24 total runs. The firing furnaces available to the scientists can only accommodate a set of 4 parts in a single cycle. So, in order to perform all of the runs simultaneously a set of 6 furnaces were required (4 parts per furnace); the furnaces are the same type, but scientists are concerned that some differences could exist among the furnaces. Use the data set **Ceramic Sintering.JMP** to answer the following questions. Hint: you should review the **Soda Fill** case study starting on page 20 of the Incomplete Blocking notes before attempting a solution to this problem.  
   1. What is the blocking factor?
   2. What interaction is used to create blocks 1 and 2; blocks 3 and 4; blocks 5 and 6?
   3. What is the effect of the blocking scheme on the standard errors of the different effect estimates in the full model?
   4. Find the best model for hardness, using the Fit Model platform in JMP. Be certain to include a screenshot of the Parameter Estimates table for your final model.
   5. Does the blocking factor appear to be needed in the model (use a relative efficiency argument, discussed in the Blocking Designs for One Factor notes starting on slide 19)? Explain.
   6. Based upon your model, use Desirability Functions in the Prediction Profiler to determine the settings of the experimental factors that would you recommend to the Engineer in order to achieve maximum hardness? Again, be certain to include a screenshot of your Profiler showing the optimized settings.