Assignment 2

1. The Center for Exascale Radiation Transport at Texas A&M University reported an experiment where a radioactive source emits neutrons through graphite bricks, and the response is the ratio number of the number neutrons counted by a detector (i.e., the number of neutron not absorbed by the graphite) to the number of neutrons counted by the detector when no graphite is present (call this ratio the *absorption rate*). To understand the impact of graphite properties on the absorption rate, the graphite density was varied. The levels of the factor were labelled low and high. The data can be found in the file question1.txt.

    a. Plot the data and comment on the results. The idea is to construct the plots that might give you some intuition about the potential patterns in the data.
    b. Write down a suitable model for this experiment.
    c. Experiments are often repeated to verify results. Suppose the entire experiment were to be repeated so that the number of observations for each factor level combination is the same (a nicely balanced design). Furthermore, suppose that the aim is to discover if the mean at the low and high level of the factor differ by 1 ratio unit or more. How many observations are required for the experiment so that a mean difference of 1 ratio unit, or more, can be detected 80% of the time for each factor (or more) with significance level 0.05?

2. Many people report sleep difficulties after a night of social drinking. To investigate this problem, an experiment was run where ethanol was administered to rats. A sample of 36 rats was selected and each rat was given a dose of ethanol (none, 2g and 4g). The sleep time (minutes) for each rat was then recorded. The data can be found in the file sleep.csv.
    a. Plot the data and comment on the results. The idea is to construct the plots that might give you some intuition about the potential patterns in the data.
    b. What are the null and alternate hypotheses in words and mathematical symbols?
    c. Test the appropriate hypotheses to see if the factor impacts the response.
    d. A reviewer noted that more rats died at higher doses. Under what conditions could this present a problem in analysis and interpretation for this experiment? Why?
    e. The rats were of different masses and it is well known that the effect of alcohol depends upon body mass. Explain how you could modify the experimental design to account for this (propose a randomized complete block design). All else being equal, such designs have increased power. Why?

3. Clear cutting forests is the most economical way to harvest trees. Unfortunately, it looks unsightly, and may have other environmental consequences - for example, there may be damage to salmon bearing streams. Critics of clear cutting have called for selective harvesting where trees are selected for harvest but the surrounding forest remains basically intact.

   In a review of existing clear cut and selectively cut areas, it was found that streams in clear cut areas produced less salmon, on average, than streams in selectively cut areas. Critics of this report noted that this was based on observational data.

   a. Briefly, why is this a problem?

   A new experiment was planned for the next season to investigate the effects of clear cutting or selective harvesting. There were a total of 12 harvest locations and 6 locations will have clear cut harvesting and 6 will get selective harvesting. Within each location, ten streams were examined and the total amount of salmon (kg/km of spawning area) for the entire location was recorded. It is known that six of the locations have a very fine, silty, soil that is easily washed into streams and six of the locations have a coarse sand soil that tends not to wash into streams.

   b. Identify (i) the factor of interest, (ii) the factor levels, (iii) the experimental unit, (iv) the observation unit, and (v) the response variable.

   c. Design a new experiment to compare the amount of salmon produced under clear cutting or selective harvesting regimes. Give enough details so that a technician can follow your plan. Draw a sketch of the experimental layout. Hint: Be sure to account for the different soil types in your design.