- (2.5 pts.) 1. State Farm Insurance Company would like to estimate the proportion of volunteer firefighters across the country who are full-time teachers. The 25 largest volunteer fire companies in the United States are identified. Each is contacted and asked to complete a short survey regarding the number of volunteers and the occupation of each volunteer.
- (1 pt.) a) Is this an observational or an experimental study? Please explain your answer.
- (0.5 pts.) b) Describe the sample in this problem.
- (1 pt.) c) Is this a SRS? Justify your answer. If this is not a SRS, how would you change the sampling technique so that it would be random.
- **(3.5 pts.) 2**. The Faber Floral Company in Kankakee, Illinois, claims to have developed a special spray for roses that causes the blossom to last longer than an untreated flower. Fifty long-stemmed roses are obtained and randomly assigned to one of two groups: treated versus untreated. The treated roses are sprayed, and the lifetime of each blossom is carefully recorded.
- (1 pt.) a) Is this an observational or an experimental study? Please explain your answer.
- (0.5 pts.) b) What is the unit or population in this study?
- (0.5 pts.) c) What is the factor or treatment in this study?
- (0.5 pts.) d) What is the outcome of this study?
- (1 pt.) e) State one possible source of bias in this study.
- (2 pts.) 3. We often see players on the sidelines of a football game inhaling oxygen. Their coaches think this will speed their recovery. We might measure recovery from intense exercise as follows:

Have a football player run 100 yards three times in quick succession. Then allow three minutes to rest before running 100 yards again. Finally, we time the final run.

Because players vary greatly in speed, you plan a matched pairs experiment using 20 football players as subjects.

- (1 pt.) a) Draw the correct experimental design of this study. Hint: please read the complete question before you do this part.
- (1 pt.) b) Describe a possible methodology that could be used to decide which players will get oxygen on their first trial.

(1 pt.) 5. A coffee house wants to compare two new varieties of coffee. For this study, there are two experiments under consideration. In experiment 1, different customers evaluate each variety. In experiment 2, each customer evaluates both varieties of coffee.

Experiment 1

Flip a coin for each customer to choose which variety (s)he will taste. To evaluate preferences, we would need to design some scale for customers to rate the coffee they tasted, and then compare the ratings.

Experiment 2

- Flip a coin for each customer to choose which variety (s)he will taste first. Ask which of the two coffees (s)he preferred.
- Which of the two given designs can be considered as the stronger design? Please explain your answer.
- (1 pt.) 6. Adults need to eat foods or supplements that contain enough calcium to maintain healthy bones. Calcium intake is generally measured in milligrams per day (mg/d) and one measure of healthy bones is total body bone mineral density measured in grams per centimeter squared (TBBMD, g/cm2). Suppose that you want to study the relationship between calcium intake and TBBMD. For this study, you consider an observational study and an experiment as given:

Observational study

Select (or recruit) a sample and assess each person's calcium intake (perhaps by having them record what they eat for a week), and measure his/her TBBMD.

Experiment

- Measure each subject's TBBMD, then randomly assign half the subjects to take a calcium supplement and the other half to take a placebo. After a suitable period, measure TBBMD again.
- Which of the two, the given observational study or the given experiment, gives better information about the relationship between these variables? Please explain your answer.
- (1 pt.) 7. A drug manufacturer is studying how a new drug behaves in patients. Investigators compare two doses: 5 milligrams (mg) and 10 mg. The drug can be administered by injection, by a skin patch, or by intravenous drip. Concentration in the blood after 30 minutes (the response variable) may depend both on the dose and on the method of administration. The drug may behave differently in men and women. Draw the correct experimental design to take this into account?

- **(2.5 pts.) 8.** A study showed that women who work in the production of computer chips have abnormally high numbers of miscarriages. The union claimed that exposure to chemicals used in production caused the miscarriages. Another possible explanation is that these workers spend most of their work time standing up.
- (0.5 pts.) a) What is the explanatory variable in this study?
- (0.5 pts.) b) What is the response variable in this study?
- (0.5 pts.) c) What is the lurking variable in this study?
- (1 pt.) d) Draw a diagram that explains your choice. (Possible diagrams are causation, common response or confound).
- (2 pts.) 9. A group of college students believes that herbal tea has remarkable powers. To test this belief, they make weekly visits to a local nursing home, where they visit with the residents and serve them herbal tea. The nursing-home staff reports that after several months many of the residents are healthier and more cheerful. We should commend the students for their good deeds but doubt that herbal tea helped the residents.
- (1 pt.) a) What is a possible lurking variable in this informal study?
- (1 pt.) b) Draw a diagram that explains your choice. (Possible diagrams are causation, common response or confound).
- (2.5 pts.) 10. A study shows that there is a positive correlation between the size of a hospital (measured by its number of beds x) and the median number of days y that patients remain in the hospital.
- (0.5 pts.) a) Is the following statement true or false: Does this mean that you can shorten a hospital stay by choosing a small hospital?
- (1 pt.) b) What is a possible lurking variable in this situation?
- (1 pt.) c) Draw a diagram that explains your choice. (Possible diagrams are causation, common response or confound).