

You may submit a formula sheet (1 sheet, 2 pages, hand-written), worth up to 5% extra.

In addition to a written test, you are expected to submit a computer file with all your work.

**Part I: You will be given 2 out of the following 3 types of problems.**

1. (25 pts) Recently married, a young couple plans to continue having children until they have their first girl. Suppose the probability that a child is a girl is  $1/2$ , the outcome of each birth is an independent event, and the birth at which the first girl appears has a geometric distribution. What is the couple's expected family size? Is the geometric pdf a reasonable model here? Discuss. (Geometric)
2. (25 pts) A machine has a 1% probability of producing a defective item. Each day, the machine is run until a defective item is produced and then it undergoes an extensive adjustment which requires the rest of the working day. What is the average number of items that will be produced in that work week? In a given 5-day workweek, what is the probability that a machine will produce 500 or more usable items? (Negative binomial)
3. (25 pts) The next generation of space shuttle will include three fuel pumps—one active, the other 2 in reserve. If the primary pump malfunctions, a second is automatically brought on line. Suppose a typical mission is expected to require that fuel be pumped for at most 50 hours. According to the manufacturer's specifications, pumps are expected to fail once every 100 hours. If the pumps were allowed to go until all 3 failed, on average how many hours will that be? What are the chances that such a fuel pump system would not remain functioning for the full 50 hours that might be required? (Gamma)

**Part II No picture no credit for this section. You will be given 2 out of the following 3 types of problems.**

4. (25 pts) A poll taken on Tuesday 11/24/15  
<http://www.quinnipiac.edu/news-and-events/quinnipiac-university-poll/iowa/release-detail?ReleaseID=2305>  
has Trump leading the Iowa Caucus polls 25% to Rubio's 23%. However, the lead is within the claimed margin of error of  $\pm 4\%$ . Focus just on Trump's numbers.
  - a. Find the standard deviation for whether one voter is a supporter of Trump or not.
  - b. Given that the sample size was 600, find the standard error (the standard deviation for the sample mean). Draw the appropriate normal curve and label the horizontal axis with both  $\bar{Y}$  and Z labels.
  - c. The margin of error is  $\pm 1.96 * \text{standard error}$ . Find it. Is it roughly what the polltakers claim?
  - d. By what factor will the sample size need to be increased (assuming that results will stay the same) for us to conclude that Trump is definitely leading.
5. (25 pts) A previous sample of fish in Lake Michigan indicated that the mean polychlorinated biphenyl (PCB) concentration per fish was 11.2 parts per million with a standard deviation of 2 parts per million. Suppose a new random sample of 10 fish has the following concentrations: 11.5, 12.0, 11.6, 11.8, 10.4, 10.8, 12.2, 11.9, 12.4, 12.6  
Test hypothesis that mean PCB concentration has remained unchanged.  
Don't forget to make a histogram to verify that the data are from a normal distribution.  
NOTE: this is a 2-tailed test.
6. (25 pts) A farmer claims to be able to produce larger tomatoes. To test this claim, a tomato variety that has a mean diameter size of 8.2 centimeters with a standard deviation of 2.4 centimeters is used. A sample size of 36 tomatoes will be used to test claim. If the actual mean is 9.1 centimeters, calculate the power of the test to show that the mean size is indeed larger? Assume that the population standard deviation remains equal to 2.4.  
NOTE: this is a 1-tailed test.