Stat 333
Lab Assignment #2

1. A consumer organization estimates that over a 1-year period 17% of cars will need to be repaired once, 7% will need repairs twice, and 4% will require three or more repairs.
   (a) What is the probability that a car chosen at random will need
      (1) no repairs? (.72)
      (2) No more than one repair? (.89)
      (3) Some repairs? (.28)
   (b) If you own two cars, what is the probability that
      (1) neither will need repair? (.5184)
      (2) Both will need repair? (.0784)
2. There's a meeting that is attended by 10 doctors and 5 psychologists. If a committee of 3 is selected at random, find the probability that at least 1 psychologist is selected for the committee. (.7363)
3. Does advertising influence buying? A random sample of 500 people were asked whether they bought a new product and whether they saw an advertisement for that product before the purchase. 280 in the sample did not purchase the product. 225 people did not see the advertisement for the product. 175 people saw the advertisement and purchased the product. One person is selected at random from the sample.
   (a) Find the probability that the person purchases the product (.44)
   (b) Find the probability that they did not see the advertisement and did not purchase the product. (.36)
   (c) Find the probability that they purchased the product or saw the advertisement. (.64)
   (d) Find the probability that given they saw the advertisement, they then purchase the product. (.6364)
   (e) Does advertisement affect the probability that a person buys the product? Explain using probability. Interpret results
4. A meeting is held with 10 individuals. If each person shakes hands with another person only once, how many handshakes occurred at the meeting? Note: you only shake hands with each person once. (45)
5. The failure rate of a heart attack alarm is 0.001. For improved safety, a duplicate alarm is installed. If alarms work independently of one another,
   (a) What is the probability that a heart attack will not be signaled? (0.000001)
   (b) What is the probability that at least one of them does not detect a heart attack? (.001999)
6. Police report that 78% of drives stopped on suspicion of drunk driving are given a breath test, 36% a blood test, and 22% both test. What is the probability that a randomly selected DWI suspect is given
   (a) a test? (.92)
   (b) A blood test or a breath test, but not both? (.7)
   (c) Neither? (.08)
7. You play tow games against the same opponent. The probability you win the first game is 0.4. If you win the first game, the probability you also win the second is 0.2. If you lose the first game, the probability that you win the second is 0.3
   (a) Are the two games independent? Explain your answer using probabilities.
   (b) What's the probability you lose both games? (.42)
   (c) What's the probability you win both games? (.08)
   (d) Let the random variable X be the number of games you win. Find the probability distribution for X
   (e) What are the expected number and standard deviation for the number of games won? ($\mu = .66$, $\sigma = .62$)
8. A consumer organization inspecting new wheelchairs, found that many had defects. While none had more than three defects, 7% had three, 11% two, and 21% one defect. Find the expected number of defects in a new wheelchair, and the standard deviation. ($\mu = .64$, $\sigma = .9330$)

Do more questions on probability and probability distributions from the text book for review.

Binomial Distribution

1. The probability that a person who undergoes a kidney operation will recover is 0.6. Find the probability that of 5 patients who undergo similar operations,
   (a) none will recover
   (b) one will recover
   (c) not more that one will recover
   (d) not more that two
   (e) at least 3 will recover

MINITAB Instructions for Binomial
From the **MENU BAR** select **Calc>Probability Distributions>Binomial…** A dialog box will then appear.

(i) If a single probability is needed as in part (a) and (b) of the example:
Select **Probability** from the options listed (click on circle)
In the box by **Number of Trials,** type **5**
In **Probability of Successes**, type **0.6**
In **Input Constant**, specify the "x" value from the question (**0** for part (a), **1** for part (b)). Click **OK** or hit enter.
(a) $P(x=0)= .01024$
(b) $P(x=1) = 0.0768$

(ii) When a sum of probabilities is involved, as in part (c), begin in the same way except this time select **Cumulative Probabilities** instead of **Probability**.
In **Input Constant**, specify the "x" value from the question (**1** for part (c), **2** for part (d)). Click **OK** or hit enter
(c) $P(x \le 1) = .08704$ from MINITAB **note**: if you added by hand from above
$P(x \le 1) = P(x=0)+P(x=1) = .01024+.0768= .08704$
(d) $P(x \le 2) = .31744$

(iii) This method for (ii) could also be used for part (e), but the required probabilities would have to be expresses in terms of the cumulative probability and the complement.
(e) $P(x \ge 3) = 1 – P(x \le 2)$ Find the $P(x \le 2)$ from the computer and then subtract this value from 1. $P(x \le 2) = .31744$ (from MINITAB)
$P(x \ge 3) = 1 – P(x \le 2)$
$= 1-.31744$
$= 0.68256$

2. Assume that 13% of people are left-handed. If we select 5 people at random, find the probability of each outcome described below.
   (a) there are exactly 3 lefties in the group (.0179)
   (b) there are no more than 3 lefties in the group (.9987)
   (c) How many lefties do you expect? ($\mu = .65$)
   (d) With what standard deviation? ($\sigma = .7520$)
3. A wildlife biologist examines frogs for a genetic trait he suspects may be linked to sensitivity to industrial toxins in the environment. Previous research had established that this trait is usually found in one of every 8 frogs. He collects and examines a dozen frogs. If the frequency of the trait has not changed, what's the probability he finds the trait in
   (a) none of the frogs?
   (b) at least 2 frogs?
   (c) 3 or 4 frogs?
   (d) No more than 4 frogs?
   (e) 6 frogs? If he actually observes 6 frogs with this trait, should he suspect that the frequency of the trait has changed?
4. About 8% of males are colorblind. A researcher needs some colorblind subjects for an experiment, and begins checking potential subject. If 100 men are randomly selected,
   (a) What's the probability that she won't find at least 6 that are colorblind? (0.1799)
   (b) Find the expected number and standard deviation for the number of colorblind men. ($\mu = 8$, $\sigma = 2.7129$)

MINITAB INSTRUCTIONS
CALC ⇒Probability Distributions⇒normal.

Finding the area above and below a Z-value under the Standard Normal Curve
For a given Z-value, you are required to find a probability. In the dialog box, which corresponds to the Normal distribution, you have three choices:

Probability
Cumulative probability
Inverse cumulative probability

Click **Cumulative probability**. This will calculate the cumulative probability associated with a specific Z-value (or the area under the Standard Normal Curve to the **left** of a specific Z-value.)
The middle of the dialog box has 2 options:

Mean
Standard Deviation

The default values for the **Mean** and **Standard Deviation** are **0** and **1**, respectively. There is no need to change these values, so just leave these as is.

In the bottom portion of the dialog box, select **Input constant.** It is in this box that you enter a specific Z-value. Once you have completed this, either press return or "click" on **OK**. In the upper portion of your screen, or the command module, MINITAB will return the area to the **left** of the Z-value you have entered. Note that when this routine is employed, the probability returned is **ALWAYS THE AREA TO THE LEFT OF** the Z-value entered above or $P(Z<z)$

For practice, try question 1 using this routine.

NOTE: Answers may vary due to rounding and whether or not you use the computer or tables.

1. Given that Z is a standard normal random variable, compute the following probabilities:

(a) $P(-0.72 \leq Z \leq 0)$ (.2642)
(b) $P(-0.35 \leq Z \leq 0.35)$ (.2736)
(c) $P(0.22 \leq Z \leq 1.87)$ (.3822)
(d) $P(Z \leq -1.02)$ (.1539)
(e) $P(Z \geq -0.88)$ (.8106)
(f) $P(Z \geq 1.38)$ (.0838)
(g) $P(-0.34 \leq Z \leq 2.33)$ (.6232)

Finding a Z-value for a given area (or probability under the Standard Normal Curve)
For a given probability, you are required to find a Z-value that corresponds to this probability. This requires the use of the **Inverse cumulative probability** routine in the dialog box employed above.

"Click" on the circle which corresponds to **Inverse cumulative probability** and just as was done previously, do not touch the box labeled **Mean** and **Standard Deviation**.

This routine needs an area, and will subsequently find the Z-value which matches up with the area entered. Just as was done above, move your mouse down to the bottom portion of the dialog box and "click" on the circle which corresponds to **Input constant**. Previously you entered a Z-value here. But now you want to find a Z-value for a given area, or probability. So the number you will enter in the **Input constant** box is a probability, or an area to the left of the Z-value in question. Once you have entered the correct probability, either press return or "click" on **OK.** MINITAB will return a Z-value in the command module on the upper portion of your screen.

A good rule-of-thumb in these types of problems is to draw your standard normal curve and piece together the areas given. The Z-value will be given when you specify the area to the left of that value. Practice this routine on question 2.

2. Given that Z is a standard normal random variable, determine Z_o if it is known that:

(a)	$P(-Z_o \le Z \le Z_o) = 0.90$	(1.645)
(b)	$P(-Z_o \le Z \le Z_o) = 0.10$	(.1257)
(c)	$P(Z \ge Z_o) = 0.20$	(.842)
(d)	$P(-1.66 \le Z \le Z_o) = 0.25$	(-.529)
(e)	$P(Z \le Z_o) = 0.40$	(-.253)
(f)	$P(Z_o \le Z \le 1.80) = 0.20$	(.720)

3. Statistics from Cornell's Northeast Regional Climate Center indicate that Ithaca, NY, gets an average of 35.4" of rain each year, with a standard deviation of 4.2". Assume that a Normal Model applies
   (a) During what percentage of years does Ithaca get more than 40" of rain? (.1368)
   (b) Less than how much rain fall in the driest 20% of all years? (31.87")
   (c) A Cornell University student is in Ithaca for 4 years. What's the probability that those four years average less than 30" of rain? (.0051)

4. Carbon Monoxide (CO) emissions for a certain model of car vary with a mean 2.9gm/mi and standard deviation of 0.4 gm/mi.
   (a) Estimate the probability that a randomly chosen car of this model has CO emissions between 3.0 and 3.1 gm/mi.
   (b) A company has 80 of these cars in its fleet.
      (i) Estimate the probability that the mean CO emission of this fleet is between 3.0 and 3.1 gm/mi. (0.0127)
      (ii) There is only a 55% chance that the fleet's mean CO level is greater than what value? (2.89gm/mi)

5. Although most of us buy milk by the litre, farmers measure daily production in kilograms. Ayrshire cows average 21.36 kg of mild a day, with a standard deviation of 2.73 kg
   (a) We select an Ayrshire at random. What's the probability that she averages more than 22.73 kg of milk a day? (.3079)
   (b) A farmer has 20 of these cows. What's the probability that the average production for this small her exceed 20.45 kg of mild a day? (.9320)

6. Assume that the duration of human pregnancies can be described by a normal model with a mean of 266 days and a standard deviation of 16 days.
   (a) What percentage of pregnancies should last between 270 and 280 days? (21.1%)
   (b) At least how many days should the longest 25 % of all pregnancies last? (276.8 days or more)
   (c) Suppose a certain obstetrician is currently providing prenatal care to 60 pregnant women. What's the probability that the mean duration of pregnancy for the women will be less than 260 days? (.0018)
7. A company has been production a 60 watt-bulb with a mean life of 750 hours and a standard deviation of 30 hours. An engineer developed a new process for production the bulb. It was believed that bulbs produced by the new process would show the same standard deviation but possibly a longer mean lifetime. Thirty-six bulbs produced by the new process were tested and showed a mean lifetime of 765 hours.
   (a) If the mean lifetime of bulbs produced by the new process were still 750 hours, find the probability of getting a value of the sample mean as large as or larger than 765. (.0013)
   (b) What conclusions might be drawn from the answer to part (a)?

Normal Approximation to the Binomial

1. A state wished to study the death rate from cancer in a Massachusetts town situated near a toxic waste dump. The death certificates of 200 randomly selected individuals in this town were examined, and it was found that 58 had died of cancer. It is known that 23% of all deaths in the state are due to cancer.
   (a) If the death rate from cancer in this town were the same for the state, find the probability that more than 57 out of 200 people in the town would die of cancer. (.0267)
   (b) What conclusions would you draw?

2. A hospital administrator claimed that an unusually large number of girls were born at the hospital in the preceding year. A check of the records showed that 120 girls and 75 boys had been born at the hospital the previous year. Do you think the administrator's claim is reasonable? Why? (.0008)

3. Suppose 65% of 45-year –olds with a diagnosed illness die between the ages of 45 to 50. Assume that 500 45-year-olds have the disease.
   (a) What is the probability that between 305 and 345 inclusive will die within the next 5 years? (.9454)
   (b) The 500 were given a new treatment, and 295 died instead of the expected 325. Do you think 65% is still a plausible percentage for a population receiving the treatment? (Hint: If 65% were still correct, how likely is it that fewer than 296 would die?) (.0028)

4. A diastolic blood pressure reading of less than 90 mm is considered normal. Assume that 2/3 of the participants in the Framingham Heart Study have diastolic blood pressure reading of less than 90 mm. In a random sample of 75 participants, what is the probability that 45 or more will have normal diastolic readings? (.9110)