

**For Questions 1-4, circle *one* answer. (5 points each)**

1. A set of test scores are normally distributed. Their mean is 100 and standard deviation is 20. These scores are converted to standard normal Z scores. What are the mean and standard deviation of the new distribution?
  - (a)  $\mu = 0$  ;  $\sigma = 1$
  - (b)  $\mu = 1$  ;  $\sigma = 0$
  - (c)  $\mu = 1$  ;  $\sigma = 5$
  - (d)  $\mu = 100$  ;  $\sigma = 20$
  - (e)  $\mu = 0$  ;  $\sigma = 20$
2. If the occurrence of one event does not influence the outcome of another event, then two events are:
  - (a) conditional
  - (b) disjoint
  - (c) independent
  - (d) interdependent
  - (e) mutually exclusive
3. A bowl contains 100 well-mixed candies. 20 yellow, 50 red, and 30 blue. Without looking, Carmen pulls out 10 candies, and counts the number of reds. Then she puts the candies back into the bowl, and mixes them up. She repeats this four more times. The number of reds in Carmen's five pulls is most likely to be:
  - (a) 8,9,7,10,9
  - (b) 3,7,5,8,5
  - (c) 5,5,5,5,5
  - (d) 2,4,3,4,3
  - (e) 3,0,9,2,8.
4. A student population is 30% from Phoenix. For samples of 100 students, the sampling distribution of the proportion of students from Phoenix is approximately
  - (a) Binomially distributed, with mean 30 and standard deviation 4.6
  - (b) Binomially distributed, with mean 0.3 and standard deviation 0.46
  - (c) Binomially distributed, with mean 0.3 and standard deviation 0.046
  - (d) Normally distributed, with mean 30 and standard deviation 4.6
  - (e) Normally distributed, with mean 0.3 and standard deviation 0.46
  - (f) Normally distributed, with mean 0.3 and standard deviation 0.046

5. (10 points) A random sample is selected from a population with mean  $\mu$  and standard deviation,  $\sigma$ . The Central Limit Theorem tells us that (mark each statement T (true) or false (F)):

\_\_\_ The sample mean  $\bar{x}$  gets closer to the population mean  $\mu$  as the sample size increases.

\_\_\_ If the sample size  $n$  is sufficiently large, the sample will be approximately normal.

\_\_\_ The sample mean  $\bar{x}$  will be  $\mu$  if the sample size  $n$  is sufficiently large.

\_\_\_ If the sample size is sufficiently large, the distribution of  $\bar{x}$  will be approximately normal with mean  $\mu$  and standard deviation,  $\sigma/\sqrt{n}$ .

\_\_\_ The distribution of  $\bar{x}$  will be normal for samples of size 2 if the population from which the samples are selected is normal.

6. (18 points) An architect may have to show a drawing to a client up to five times before the client accepts it. Based on past experience, an architect knows the probability distribution for  $X$ , the total number of times a drawing is shown to the client, has the distribution given in the table:

Total number of times shown, $X$	1	2	3	4	5
Probability has to be shown $X$ times		0.2	0.3	0.2	0.2

(a) Is  $X$  discrete \_\_\_ or continuous \_\_\_? (check one)

(b) What is the probability that a drawing is shown only once?

(c) Is the function shown the pdf \_\_\_ or the cdf \_\_\_? (check one)

(d) Put the values of the other function (cdf or pdf) in this table:

Number of times shown, $X$	1	2	3	4	5

(e) What is the average number of times a drawing must be shown to a client before it is accepted?

(f) If the architect changes his method of work, making drawings more likely to be accepted in one to three showings, does the mean increase \_\_\_ or decrease \_\_\_ or stay the same \_\_\_? (check one)  
Reason:

(g) Mr. Klein is a client of this architect who has already inspected his drawing twice and not accepted it. What is the probability that Mr. Klein will accept the drawing on the third showing?

7. (20 points) The temperatures of healthy humans are approximately normally distributed with mean  $98.6^{\circ}\text{Fahrenheit}$  and standard deviation  $0.8^{\circ}\text{Fahrenheit}$ .

(a) What is the probability that a randomly selected healthy person has a temperature of over  $99^{\circ}\text{Fahrenheit}$ ?

(b) What is the probability that a random sample of 16 healthy people have an average temperature of over  $99^{\circ}\text{Fahrenheit}$ ?

(c) If the standard deviation of the population were larger, how would your answer to part (b) change?  
It would Increase \_\_\_ Decrease \_\_\_ Remain the same \_\_\_ (check one)  
Explain.

(d) If the sample size were larger, how would your answer to part (b) change?  
It would Increase \_\_\_ Decrease \_\_\_ Remain the same \_\_\_ (check one)  
Explain.

8. (19 points) A 2005 article reported on an anti-seizure drug, Valproate, given to bi-polar alcoholics.<sup>1</sup> Some participants were given the drug, some a placebo, and all were questioned six months later to see if they were drinking heavily (five drinks a day for me, four for women); the results are in the table:

	Heavy drinking	No heavy drinking	Total
Valproate (anti-seizure drug)	14	18	32
Placebo	15	7	22
Total	29	25	54

Using the data in the table, answer the questions. *You can leave numerical answers as fractions.*

- (a) What proportion of the people who remained heavy drinkers had taken Valproate?
- (b) What proportion of the people who did not continue heavy drinking had taken Valproate?
- (c) What is the probability that someone who took Valproate continued to be a heavy drinker?
- (d) What is the probability that someone who took the placebo continued to be a heavy drinker?
- (e) Are your answers to parts (a) and (c) the same? Explain whether you would expect them to be the same or different, and why.  
 Same \_\_\_\_\_ Different \_\_\_\_\_ (check one)  
 Explain in words:
- (f) From the data given, are having taken Valproate and continuing to be a heavy drinker independent?  
 Yes \_\_\_\_\_ No \_\_\_\_\_ (check one)  
 Reason:
- (g) In general, if a drug is effective in alleviating a condition, would you expect taking the drug and having the condition to be independent?  
 Yes \_\_\_\_\_ No \_\_\_\_\_ (check one)  
 Explain in words:

<sup>1</sup> "Study: Anti-Seizure Drug Reduces Drinking in Bi-Polar Alcoholics" in *Bipolar Central* (online), Jan 6, 2005. Reported by N. Pfenning, *Elementary Statistics*, Brookes/Cole, 2011.

**9. (10 points)** Mr. Aaron is about to interview four candidates for a particular job. He hopes all the candidates turn off their cell phones, because he does not like to be interrupted by a ringing cell phone. Suppose all four candidates own cell phones and none turn his/her cell phone off. Each candidate has a 30% chance of receiving a call during the interview.

(a) If there is only one candidate whose cell phone rings during the interview, Mr. Aaron will immediately not hire this candidate. What is the probability of this? Show work.

(b) If there is only one candidate whose cell phone does not ring during the interview, he will immediately hire this candidate. What is the probability of this? *Show work.*

**10. (12 points)** The circumferences of women's upper thighs are normally distributed with mean 22.30 inches and standard deviation 1.88 inches; for men they are normally distributed with mean 22.00 inches and standard deviation 1.88 inches.<sup>2</sup> A woman and a man are randomly selected.

(a) For the randomly selected man and woman, what is

(i) The mean of the difference in their upper thigh sizes?

(ii) The standard deviation of the difference in their upper thigh sizes?

(b) Assuming that the difference in upper thigh sizes is normally distributed (which it is), what is the probability that the man's upper thigh is larger than the woman's?

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<sup>2</sup> Data from *Elem Statistics* by N. Pfenning, Brooks/Cole 2011

**11. (16 points)** On a previous Excel assignment, you simulated the results on the New Haven firefighter's lieutenants' exam. We now look at the captains' exam. For the captains' exam, there were 41 candidates: 25 White, 8 Black, and 8 Hispanic. Consider the following two distributions:

- I. The distribution of the proportion of minorities (Blacks and Hispanics) in a simulation of 500 random samples of 5 firefighters drawn from this group.
- II. The distribution of the proportions of minorities in all possible samples of 5 firefighters drawn from this group.

In addition, you are told that the mean proportion of *one* of these distributions is 0.382 and its standard deviation is 0.233.

For this question, assume the Central Limit Theorem (CLT) applies even though the sample size is less than 30.

- (a) Which of these two distributions is the sampling distribution? How do you know?
- (b) What is the mean and standard deviation of the sampling distribution?
- (c) What is the mean and standard deviation of the other distribution?
- (d) In this simulation, the proportions of the 500 samples with (i) all minority candidates and (ii) no minority candidates is 0.01 and 0.11, not necessarily in that order. Which number is which? Justify your choice.