MTH 245, Final Exam, Spring 2023 Name KEY

Instructions: Show all work to receive full credit. You should note any formulas used or calculator functions used, their inputs and outputs, or attach a spreadsheet with your calculations. I cannot grade work if I don't know where an answer came from. Be sure complete all parts of each question, including requests for interpretation and explanations. Be as thorough as possible.

This exam will be submitted in 2 parts. Part 1 are numerical or multiple-choice responses that will be submitted separately and graded by the computer. The second part will consist of explanatory responses, working with graphs and other questions that will be submitted as scanned documents and graded by hand.

Part 1: Answer these questions using your calculator or Excel. Show your work on this page or in Excel and submit along with part 2. Then submit your answers to these questions in the Final Exam Part 1 submission tool in Canvas.

1. A charity sells 800 tickets for a raffle, costing $20 per ticket. The top prize is $1500, a second prize of $600, and two third prizes of $150. For someone purchasing a ticket, what is the expected value? Interpret the value in the context of the problem. (10 points)

Value	1480	580	130	-20
Probability	1/800	1/800	2/800	796/800

$(1480)(\frac{1}{800}) + 580(\frac{1}{800}) + 130(\frac{2}{800}) - 20(\frac{796}{800}) = -17$

the average ticket buyer can expect to lose $17 per ticket purchased

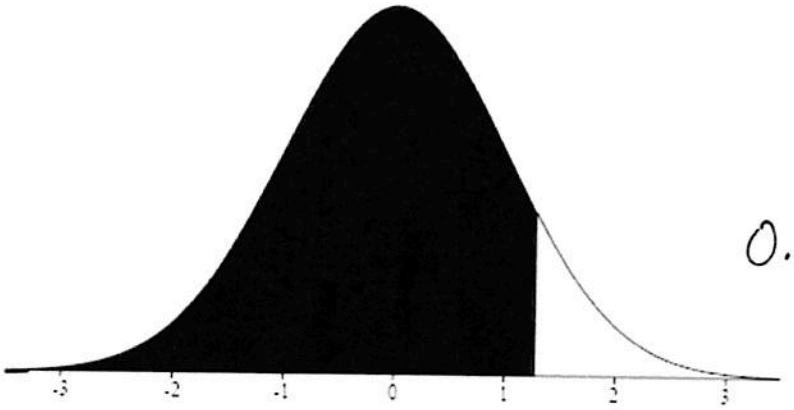
2. Three fifths of drivers put their seat belt on when they get into a driving simulator. Use that fact to answer the following questions. (7 points each)
   a. If 15 people get into the simulator, what is the probability that exactly 10 of the people will put on their seat belts?

$\binom{15}{10}(3/5)^{10}(2/5)^5 = 0.1859\ldots$

   b. If 15 people get into the simulator, what is the probability that at least than 14 people will put on their seat belts?

$\binom{15}{14}(3/5)^{14}(2/5)^1 + \binom{15}{15}(3/5)^{15}(2/5)^0 = 0.005172\ldots$

3. Find the probability under the curve of the given normal distributions. Standard normal distribution. Z-score at the boundary is 1.19. (6 points)



$0.882976\ldots$

4. The SAT has a mean score of 1498 and a standard deviation of 199. (6 points each)
   a. What is the z-score of 1250?

$$\frac{1250-1498}{199} = -1.246\ldots$$

   b. What score represents the 75th percentile of the distribution? Round your answer to the nearest 10 points.

$$\approx 1632.22 \Rightarrow 1630$$

   c. If a school wants to admit only students with the top 20% of SAT scorers, what cut-off score is needed? Round your answer to the nearest 10 points.

$$\approx 1665.48\ldots$$

$$\Rightarrow 1670$$

   d. The mean score on the ACT is 21 with a standard deviation of 5.2. Which student scored higher: Abby with a score of 30 on the ACT, or Barbara with a score of 1930 on the SAT?

$$z_A = \frac{30-21}{5.2} = 1.7307\ldots$$

$$z_B = \frac{1930-1498}{199} = 2.17085\ldots$$

Barbara's score is better

5. For each of the following variables, determine i) is the variable qualitative or quantitative? ii) the level of measurement: nominal, ordinal, interval, or ratio? iii) if the variable is quantitative, is it discrete or continuous? (6 points each)
   a. Time it takes to complete a test

quantitative, ratio, continuous

   b. Brand of computer processor

qualitative, nominal, NA

   c. School ID number

qualitative, nominal, NA (can't be averaged)

   d. Decibel level

quantitative, interval, continuous

6. Using the data on Sheet 1 in the data file **245final_data.xlsx**, find the following statistics of the Amount column:
   a. The mean, median and mode (9 points)

mean = 565.05
median = 501
mode = more than 2 modes, so no mode

   b. The standard deviation and range (6 points)

St.dev = 407.79
range = 1778

   c. Calculate the five-number summary for this data. (5 points)

min = 92
Q1 = 238.5
median = 501
Q3 = 694
max = 1870

Part 2: Answer these questions in this file, using Excel (copy and paste solutions into this document), show work, etc. Don't make me hunt through Excel looking for answers to these questions! Submit your work for Part 1, work and solutions for Part 2, and any Excel file(s) you used to get your answers in the Final Exam Part 2 submission folder.

7. Using the data on Sheet 1 in the data file **245final_data.xlsx**, find the following for the Amount column:
   a. Use that information to construct a simple box plot. Paste your graph here. (7 points)

See Excel

   b. Construct a comparative box plot that shows the different company sizes. (7 points)

See Excel

8. Complete the table below. Two of the boxes are labeled "Correct Decision"; label the other two boxes Type I Error or Type II Error as appropriate. (8 points)

	H_0 True	H_0 False
Reject H_0	Type I Error	Correct
Fail to Reject H_0	Correct	Type II Error

For each of the problems that follow, you will be asked to conduct hypothesis tests. For each problem clearly state the hypothesis test to be conducted using proper notation. State the test score and the p-value. Say whether to reject or fail to reject the null hypothesis. Then clearly, in plain English and in the context of the problem, state your conclusion. Use $\alpha = 0.05$ unless stated otherwise in the problem.

9. In a survey conducted by the American Animal Hospital Association, 42% of respondents stated that they talk to their pets on the answering machine or telephone. A vet found this hard to believe so he questioned 120 pet owners and discovered that 54 of them spoke to their pets on the answering machine or telephone. Does the vet have sufficient evidence to maintain his skepticism? (10 points)

$H_0: p = 0.42$

$H_a: p \neq 0.42$

$z = 0.6658$

p value $= 0.5055 > 0.05$

fail to reject H_0

this is not sufficient evidence to prove it is not 42%

10. In 2000, the mean height of women 20 years of age or older was 63.6 inches based on data from the CDC, with a standard deviation of 3.3 inches. Suppose that a random sample of 55 women who are 20 years old or older today produced a mean of 63.8 inches. Is this strong evidence that women are taller now than 20 years ago? (10 points)

$H_0: \mu = 63.6$

$H_a: \mu > 63.6$

$t = 0.449$

p-value $= 0.327\ldots > 0.05$

fail to reject null.

There is not sufficient evidence to think women are taller now

11. An experiment was conducted on patients with bipolar disorder. 65 patients received a new medication, while the control group of 60 patients received a placebo. Both patients were rated on the Young-Mania scale to measure their improvement. The experimental group had a mean improvement of 14.7 with a standard deviation of 12.3, while the control group had a mean improvement of 8.3 with a standard deviation of 12.9. Determine if the experimental group had a larger mean improvement than the control group with significance level $\alpha = 0.01$. (13 points)

$H_0: \mu_1 = \mu_2$

$H_a: \mu_1 > \mu_2$

$t = 2.8336\ldots$

p-value $= 0.00269\ldots > 0.01$

fail to reject null

This is not sufficient evidence at $\alpha = 0.01$ to think the experimental group did better.

12. Use the data in the table below to conduct a two-sample proportion test to determine if there is sufficient evidence to think that rates left-handedness is lower for women than for men. (10 points)

Gender compared to handedness

	Handed		
	Left	Right	
Female	7	46	53
Male	5	63	68
	12	109	121

fail to reject null
there is not sufficient evidence to think left-handedness is less common in women than in men.

$H_0: p_1 = p_2$

$H_a: p_1 < p_2$

$z = 1.069\ldots$

p-value $= 0.857\ldots > 0.05$

13. Using the data on Sheet 2 of the data file **245final_data.xlsx**, conduct a paired t-test to determine if Ad A was scored differently than Ad B. (10 points)

$H_0: \delta = 0$

$H_a: \delta \neq 0$

$t = -9.78$

p-value $= 4.16 \times 10^{-13} < 0.05$

reject null
there is sufficient evidence to think the ads are scored differently

14. Using the data on in the table below, conduct a test of independence to determine if the likelihood of purchase is independent of the commercial viewed. (10 points)

Commercial Viewed

Opinion		Version 1	Version 2	Version 3	**Total**
	Likely to buy	25	20	54	**99**
	Unsure or unlikely to buy	40	10	31	**81**
	Total	**65**	**30**	**85**	**180**

H_0: the variables (likely to buy) and commercial viewed are independent

H_a: the variables are dependent

reject null
the variables are dependent

$\chi^2 = 11.33$

p-value $= 0.00346\ldots < 0.05$

15. Using the data on Sheet 1 of the data file **245final_data.xlsx**, conduct an ANOVA test to see if there are meaningful differences in the ~~number of ounces produced~~ amount spent by each ~~filling machine~~ company size. (10 points)

$H_0: \mu_i = \mu_j$ for all $i \neq j$

$H_a:$ at least one mean is different

$F = 180.9264$

p-value $= 6.64 \times 10^{-32} < 0.05$

reject null

at least one mean is different from the others.

16. Using the data on Sheet 3 of the data file **245final_data.xlsx**, perform the following: (5 points each)

a. Construct a scatterplot of the data using units to predict cost. Paste your graph here.

See Excel

b. Does the data appear to have a linear or nonlinear relationship?

fairly linear

c. Construct a regression line for the data. Report the equation here.

$y = 30.533x + 23651$

d. What is the correlation coefficient?

$r = 0.857857$

e. What is the proportion of variability in quantity sold that can be explained solely by advertising?

73.59% (R^2)

f. Construct a residual plot of the data and paste it here.

See Excel

g. Do there appear to be any outliers? If so, which observation is it?

There do not appear to be any

h. Conduct a hypothesis test on the slope of the regression line. Is there strong evidence to conclude that the slope is different from 0?

$H_0: \beta_1 = 0$

$H_a: \beta_1 \neq 0$

$t = 9.733...$

p-value $= 2.3169 \times 10^{-11} < 0.05$

reject null

There is sufficient evidence to think the slope is not zero.