MATH 338

MIDTERM 2

THURSDAY, NOVEMBER 3, 2016

Your name: _____

Your scores (to be filled in by Dr. Wynne):

Problem 1: ____/10

Problem 2: ____/9

Problem 3: ____/8

Problem 4: ____/16

Problem 5: ____/12

Total: ____/55

You have 75 minutes to complete this exam. This exam is closed book and closed notes with the exception of your single sheet of notes (front and back).

For full credit, show all work except for final numerical calculations (which can be done using a scientific calculator).

Problem 1. For each of the following scenarios, determine whether it is appropriate to do inference of the types we have learned in Chapters 6-8. If it is appropriate, identify the design (one sample, two independent samples, or matched pairs) and type of critical value (z* or t*) and that should be used. If it is not appropriate, explain why.

A) [2 pt] The state of California wants to know how long it takes people to drive to work. They design their study so that people from large cities are disproportionately likely to be included in the sample.

B) [2 pt] A group of 100 gamblers wants to know whether gamblers win more money in Las Vegas or Atlantic City. Half the group is randomly sent to Las Vegas and the other half goes to Atlantic City.

C) [2 pt] A company wants to know if its salaries are competitive. It compares the mean starting salary of a simple random sample of 5 recent hires to the estimated mean salary of all employees in its industry.

D) [2 pt] An integrated circuit manufacturer randomly selects 200 silicon wafers from a shipment and accepts the shipment if it believes at least 90% of the wafers in the shipment are acceptable.

E) [2 pt] A researcher wants to know whether the picture or sound of a television program is more distracting. The researcher measures how long it takes the same set of 45 subjects to complete a series of tasks when the picture is on and sound is off, compared to when the sound is on and picture is off.

Problem 2. Katie wants to make some money tutoring high school students. She asks 10 of her sister's friends' moms what they would be willing to pay per hour of statistics tutoring. She computes a 95% confidence interval for the mean amount parents are willing to pay per hour as (22.47, 27.53).

A) [1 pt] Katie claims that she is 95% confident that the true mean amount parents will pay is between $22.47 and $27.53. Circle the letter corresponding to the most correct interpretation of her statement.

(a) 95% of population means will be between 22.47 and 27.53

(b) The probability that the population mean is between 22.47 and 27.53 is 95% (or 0.95)

(c) 95% of samples will produce a confidence interval containing the population mean, which may or may not be between 22.47 and 27.53

B) [4 pt] Katie's confidence interval was computed from a sample mean of 25 dollars and a sample standard deviation of 4.08 dollars. Did Katie use a z* or a t* critical value? How do you know?

C) [2 pt] What concerns, if any, do you have any concerns about Katie's method of determining the amount parents will pay per hour for statistics tutoring?

D) [2 pt] If Katie does a new study to satisfy your concerns, which of these steps could she take in order to most likely <u>decrease</u> the variability of her CI? Circle the letter corresponding to each correct step.

(a) Increase the confidence level to 99%

(b) Decrease the confidence level to 90%

(c) Increase the sample size to 20 parents

(d) Decrease the sample size to 5 parents

Problem 3. In 2012, Microsoft commissioned the "Bing it On" Challenge. In one test of the challenge, a simple random sample of 1,000 Internet users indicated whether they preferred the left or right screen of search results, without knowing which set of results came from Bing and which came from Google. Of the roughly 880 who had a preference, 60% preferred Bing's results and 40% preferred Google's results.

A) [5 pt] Assuming that the assumptions for inference are met, construct a 95% confidence interval for the true proportion of Internet users (with a search engine preference) who prefer Bing's search results. Do you agree with Microsoft's claim that people who take the challenge prefer Bing over Google?

B) [2 pt] For this study, explain what would be a Type I Error and a Type II Error.

C) [1 pt] In response to a competing study that showed a different result, a Bing researcher asked, "Which has greater statistical power: [a sample of] 1,000 people or 333 people?" Answer the question.

Problem 4. It is generally accepted that Intelligence Quotient (IQ) test scores are normally distributed with a mean of 100 and population standard deviation of 15. You suspect that an online IQ test is giving people higher scores than their true IQ. You obtain a simple random sample of 100 subjects and find that their mean test score is an IQ of 103. Assume that the population standard deviation does not change among different IQ tests, and that the assumptions for inference are met.

A) [7 pt] At the 1% significance level, can you conclude that the online test is giving higher IQ scores?

B) [1 pt] What would happen to the value of the test statistic if the significance level increased? (circle one answer below)

increase decrease stay the same unable to determine

C) [1 pt] What would happen to the probability of Type I Error if the significance level increased? (circle one answer below)

increase decrease stay the same unable to determine

D) [5 pt] What is the power of this test under the alternative $\mu_a = 105$, that is, that the online IQ test truly inflates scores by, on average, 5 points? (Keep the 1% significance level)

E) [2 pt] What is the probability of Type II Error under this alternative?

Problem 5. In a 2011 study, researchers compared nitrogen oxide emissions of a Volkswagen Passat under EPA testing conditions and under real-world conditions driving along the 10 Freeway between Los Angeles and Ontario. Assume that nitrogen oxide emissions, in grams per kilometer driven (g/km), are normally distributed across multiple repetitions of the same test, and that each repetition is independent, so we can perform statistical inference with even a small number of emissions tests.

In 3 repetitions under EPA test conditions, the Passat averaged 0.016 g/km of nitrogen oxide emissions with a standard deviation of 0.002 g/km. In 2 repetitions of the drive along the 10 Freeway, the Passat averaged 0.344 g/km of nitrogen oxide emissions with a standard deviation of 0.096.

A) [3 pt] Compute the standard error of the mean nitrogen oxide emissions under real-world conditions.

B) [8 pt] Do you believe, at the 5% significance level, that this Passat performs differently under EPA test conditions compared to real-world driving conditions? (Hint: this is not a matched pairs design)

C) [1 pt] Do you believe you can generalize your findings to all Volkswagen Passats? Why or why not?

Extra Space. The tables below show a number of critical values *z* for the standard normal variable $Z \sim N(0, 1)$ and the corresponding cumulative proportions, corresponding to P(Z ≤ z).

z-score	Cumulative Proportion
-3.00	0.0013
-2.00	0.0228
-1.65	0.0495
-1.28	0.1003
-1.00	0.1587
-0.43	0.3336

z-score	Cumulative Proportion
0.43	0.6664
1.00	0.8413
1.28	0.8997
1.65	0.9505
2.00	0.9772
3.00	0.9987

Refer to the following tables for t* and z* critical values for confidence intervals:

Degrees of freedom	C = 0.90 (90%)	C = 0.95 (95%)	C = 0.98 (98%)	C = 0.99 (99%)
1	6.314	12.71	31.82	63.66
2	2.920	4.303	6.965	9.925
3	2.353	3.182	4.541	5.841
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	2.764
≈100	1.660	1.984	2.364	2.626
≈1000	1.646	1.962	2.330	2.581

	C = 0.90 (90%)	C = 0.95 (95%)	C = 0.98 (98%)	C = 0.99 (99%)
z* values	1.645	1.960	2.326	2.576

For a two-sided hypothesis test, use the column corresponding to C = 1 – α

For a one-sided hypothesis test, use the column corresponding to C = 1 - 2α

The rest of this space to be used for extra work: