Quiz 1: Mark the the following statements True or False:

(a) _____F_____: If you take a SRS of size n from *any* distribution with mean μ and standard deviation σ, the sampling distribution is approximately $N(\mu, \sigma/\sqrt{n})$.

(b) _____T_____: If you take a SRS of size n from *any* normally distributed population with mean μ and standard deviation σ, the sampling distribution is approximately $N(\mu, \sigma/\sqrt{n})$.

(c) _____F_____: The margin of error, $m := z^* \dfrac{\sigma}{\sqrt{n}}$, in a confidence interval accounts for *all* possible error.

(d) _____F_____: All other things the same, the margin of error for a 99% confidence interval is smaller than the margin of error for a 95% confidence interval.

Quiz 2: Mark the the following statements True or False:

(a) _____T_____: The power of a statistical test is essentially the ability of the test to detect alternative values of the parameter being examined.

(b) _____T_____: There is no sharp border between "significant" and "insignificant", only stronger and stronger evidence against the null hypothesis.

(c) _____T_____: You cannot test a hypothesis on the data which suggested that hypothesis.

(d) _____F_____: The greater the significance level, the lower the chance of making a Type I error.

Quiz 3: A student is performing the following hypothesis test:

$$\begin{cases} H_0 : \mu = 84 \\ H_a : \mu > 84 \end{cases}$$

Given $\alpha = 0.05$, $\sigma = 10$, and based on a sample of size $n = 30$, they were asked to compute the power of this test against the alternative $\mu = 86$. They did the following:

$$z = \frac{\overline{x} - \mu}{\sigma/\sqrt{n}} \Longrightarrow 1.645 = \frac{\overline{x} - 84}{10/\sqrt{30}} \Longrightarrow \overline{x} = 87.00$$
$$z = \frac{87.00 - 86}{10/\sqrt{30}} = 0.55 \rightsquigarrow 0.7088$$
$$\therefore \text{Power } = 0.7088$$

Is the student correct? Explain why or why not. [Assume all the arithmetic is correct.]

The student is not correct. Drawing the appropriate power diagram, we see what they have computed is not the power but the probability of making a Type II error.

Quiz 4: A local government is considering improvements to their storm drainage systems. The systems were designed to handle annual rainfalls of approximately 42 in/year, but recently the system seems to have been taking in more rain. Taking the average rainfall over the past 8 years, they find an average yearly rainfall of 45 in/year with standard deviation of 5.6 in/year. Fill in the blanks for the hypothesis test below at the 5% significance level:

$$\begin{cases} H_0 : \mu = 42 \\ H_a : \mu > 42 \end{cases}$$

(a) A t-procedure is required (True or False): T

(b) $n =$ 8

(c) A t-procedure would be appropriate if only if the data is approximately normal (True or False): T

(d) Degrees of Freedom: 7

(e) Test Statistic: 1.515

(f) p-value range: 0.05 $< p <$ 0.10

(g) Reject the Null Hypothesis (True/False): F

Quiz 5: A sports analytics team is trying to determine the best NBA basketball team. They could measure wins and losses, but even when a team plays extremely well, they may still lose. This will decrease any measurement of 'goodness' of a team using Win/Loss records. Seeing other problems with this metric, the team decides to use average points per game. Over 23 games, they find the Las Diablas Oceaners scored an average of 120.7 with standard deviation of 13.2. They also find over their past 33 games, the Miami Meat scored 113.1 games with standard deviation 11.4. To determine which of these two teams is better, they test the following hypothesis at the 1% significance level:

$$\begin{cases} H_0 : \mu_O = \mu_M \\ H_a : \mu_O > \mu_M \end{cases}$$

(a) A t-procedure is required (True or False): T

(b) A t-procedure would be appropriate if only if the data is approximately normal (True or False): F

(c) $n_O =$ 23 $\quad \overline{x}_O =$ 120.7 $\quad s_O =$ 13.2

$n_M =$ 33 $\quad \overline{x}_M =$ 113.1 $\quad s_M =$ 11.4

(d) For a standard 2-sample t-procedure, what is the degrees of freedom for this test?

df= 22

(e) Test Statistic: 2.240

(f) p-value range: 0.01 $< p <$ 0.02

(g) Reject the Null Hypothesis? (True/False): F

Quiz 6: A medical research team is examining the role of cholesterol in contributing to heart attacks. They examine 62 hospital patients—34 who had a heart attack and 28 who did not (the control group). Those who had a heart attack were found to have an average cholesterol of 263.7 mg with standard deviation 51.8 mg while the control group had an average of 181.9 mg with standard deviation 24.1 mg.

(a) A t-procedure is required (True or False): T

(b) A pooled 2-sample t-procedure would be appropriate (True or False): F

(c) If you were to *not* use a 2-sample t-procedure, the degrees of freedom would be 27

(d) If you were to use a pooled t-procedure, the degrees of freedom would be 60

(e) If you were to use a pooled t-procedure, the pooled sample standard deviation, s_p, would be 41.68

x

Quiz 7: Researchers are trying to determine if there is a weight difference between female and male Emperor penguins. Taking a sample of 125 female penguins and 87 male penguins, they determine that the weights of the samples are approximately normally distributed with means 32.4 kg and 39.1 kg, respectively, and standard deviations 4.9 kg and 2.4 kg, respectively. They will test the following hypothesis at the 1% significance level:

$$\begin{cases} H_0 : \mu_F = \mu_M \\ H_a : \mu_F < \mu_M \end{cases}$$

(a) A t-procedure is required (True or False): T

(b) Is a pooled 2-sample t-procedure appropriate?: No

(c) If you were to *not* use a pooled 2-sample t-procedure, the degrees of freedom would be 86

(d) If you *were* to use a pooled 2-sample t-procedure, the degrees of freedom would be 210

(e) The critical value(s) for this test is/are: -2.374

Quiz 8: The Federal Trade Commission (FTC) monitors pricing accuracy in stores to ensure customers are charged correctly while checking out. In a study of checkout scanners, the FTC found in an inspection of 1,669 scanners, 1,185 were found to pass inspection (*Price Check II: A Follow-Up Report on the Accuracy of Checkout Scanner Prices, 1998*). The FTC is going to construct a 99% confidence interval for the proportion of scanners in retail stores which will pass inspection.

(a) A p-procedure is required (True/False): T

(b) A p-procedure is *appropriate* (True/False): T

(c) $X =$ $1,185$

(d) $n =$ $1,669$

(e) $\hat{p} =$ 0.7100

(f) $z^* =$ 2.576

(g) The confidence interval is then $0.681 < p < 0.739$.

Quiz 9: Complete the following parts:

1. The number of hours I plan to study for the exam is ∞ .
2. This sentence is False. (True/False): $[Impossible]$
3. If you randomly guessed an answer to this question, the probability of getting it correct is...
   (a) 0%
   (b) 25%
   (c) 25%
   (d) 50%

   [Impossible.]

Quiz 10: Is it correct to write the following for the conclusion of a hypothesis test, "... there is statistically significant evidence to fail to reject the null hypothesis that..." or "... fail to reject the null hypothesis that there is a significant difference between...."

No (Yes/No)

x

Quiz 11:
A university is trying to determine if the elective courses law students take in their first year influence the type of law the students eventually choose at the university. They survey the students, and collect the following data:

Table of Counts

Law/Class	Torts	Contracts	Civil P.	Criminal Law	Const. Law	Total
Property Law	3	7	1	8	2	21
Corporate Law	5	10	3	4	3	25
Criminal Law	9	5	5	15	8	42
Const. Law	7	10	5	6	11	39
Labour Law	5	7	3	3	1	19
Total	29	39	17	36	25	146

Table of Expected Values

Law/Class	Torts	Contracts	Civil P.	Criminal Law	Const. Law
Property Law	4.17	5.61	2.45	5.18	3.60
Corporate Law	4.97	A	2.91	6.16	4.28
Criminal Law	8.34	11.22	4.89	10.36	C
Const. Law	7.75	10.42	4.54	9.62	6.68
Labour Law	3.77	5.07	B	4.69	3.25

Fill in the missing entries in the Table of Expected Counts.

(a) $A = \dfrac{39 \cdot 25}{146} = 6.678$

(b) $B = \dfrac{17 \cdot 19}{146} = 2.212$

(c) $C = \dfrac{25 \cdot 42}{146} = 7.192$

Quiz 12: Behavioral researchers are researching parenting, specifically parental discipline. A literature review leads the researchers to believe that families with lower incomes physically discipline their children more than parents in higher income homes. They survey 200 respondents and count the number that answer 'Yes' to the question, "Were you ever physically disciplined as a child?." They use recent government data to find the percent of US families in each income range. The data is summarized below. They perform a χ^2-analysis and find $X^2 = 9.71667$.

	0–20K	21–40K	41–60K	60K+
% US Families	18.01	15.21	15.89	50.89
# Responded 'Yes'	42	32	40	76

(a) Write an appropriate null and alternative hypothesis for this Chi-squared analysis in the context of the problem.

$$\begin{cases} H_0 : \text{the data is consistent with the distribution} \\ H_a : \text{the data is not consistent with the distribution} \end{cases}$$

(b) Find a range for the p-value.

We have $X^2 = 9.71667$ with degrees of freedom $4 - 1 = 3$. Then we know $0.02 < p < 0.025$.

(c) Write your conclusion at the 5% significance level.

Because $p < \alpha$, we reject H_0. There is sufficient evidence to suggest that the data does not fit the distribution, i.e. that there is a relationship between income level and physical discipline.

x

Quiz 13: When testing the slope for a simple linear regression, a null and alternative hypothesis could be as follows:

$$\begin{cases} H_0 : \beta_1 = 0 \\ H_a : \beta_1 \neq 0 \end{cases}$$

If one rejects the null hypothesis for this test, what does this mean about the slope β_1? What does that mean about the two variables being compared?

That the coefficient β_1 is significant, i.e. that there is some (linear) association between the variable corresponding to β_1 and the response variable.

Quiz 14: A researcher is trying to determine the amount of embarrassment suffered by a coworker who makes a joke about a goose that does not land in terms of how funny the joke was [. . . it wasn't]. The researcher uses a linear regression. A sample of some of the statistics from the model are given below:

SSM $= 1851374668$	MSE $= 1851374668$	$s = 1249.53$	$s_x = 2.973$
SSE $= 76504886$	$b_0 = 30093$	$\overline{x} = 5.00$	$s_y = 6209$
SST $= 1927879554$	$b_1 = -2046.6$	$\overline{y} = 19860$	$F = 1185.77$

What is the value of r, i.e. the (Pearson) correlation coefficient?

We know $r^2 = \dfrac{SSM}{SST} = \dfrac{1851374668}{1927879554} = 0.9603$. *Then* $r = \sqrt{0.9603} = \pm 0.9799$. *The correlation coefficient* r *always has the same sign as* b_1. *Therefore,* $r = -0.9799$.

x

Quiz 15: A researcher is trying to predict the length of snails based the total age (in terms of rings) of the snail, as the longer the snail, the more growth time that snail must have had. They preform a linear regression. They obtain the following data from their model:

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	13.582	13.5817	2058.52	0.000
Rings	1	13.582	13.5817	2058.52	0.000
Error	4175	27.546	0.0066		
Total	4176	?			

Model Summary

S	R-sq	R-sq (adj)	R-sq (pred)
?	33.02%	33.01%	32.93%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.23217	0.00407	57.02	0.000	
Rings	0.017688	0.000390	45.37	0.000	1.00

The regression equation is

Length = 0.23217 + 0.017688 Rings

Find the following:

(a) $n =$ 4177

(b) SST = 41.128

(c) Coefficient of Determination: 33.02

(d) $S =$ 0.0812269

x

Quiz 16: You are performing a multilinear regression using a sample size of 28 and using 4 variables. You find SSM $= 114$ and SST $= 336$. What is the range for the p-value for the corresponding F-test?

We know that DFT $= n - 1 = 28 - 1 = 27$*, DFM* $= p = 4$*, and DFE* $= n - p - 1 = 28 - 4 - 1 = 23$*. Then we have MSM* $= \dfrac{114}{4} = 28.5$*, and (noting SSE* $= 336 - 114 = 222$*) MSE* $= \dfrac{222}{23} = 9.652$*. Then* $F = \dfrac{28.5}{9.652} = 2.952$*. We have degrees of freedom* $(DFM, DFE) = (4, 23)$ *so that this gives* $0.025 < p < 0.05$*.*

x

Quiz 17: Academic researchers are examining students that are most successful in STEM programs to determine which factors play the biggest role in STEM retention. Because GPA is an important factor to whether students drop majors, they focus on this issue. By examining 56 students across STEM fields at their university, they will try to predict students' final university GPA using their first-year GPA, the number of STEM courses they take, and their high school GPA. If the researchers use a multilinear regression, then based on this information...

DFT = 55

DFR = 3

DFE = 52

Quiz 18: If a Chi-Squared Test is performed on a table with 4 rows and 3 columns, what is the critical value at the 5% significance level?

Critical Value $=$ 12.59

If an ANOVA F-test is performed on a multilinear regression using 7 predictors, and constructed using 37 observations, what is the critical value at the 1% significance level?

Critical Value $=$ 3.33

x

Quiz 19: For each of the following, place a check next to the correct answer.

Problem 1: Who was Dr. Frances Kelsey?

(a) ____ A plant.

(b) ____ A 'petty bureaucrat'.

(c) ✓ A physician, pharmacologist, statistician, and American heroine who worked at the Food and Drug Administration. She prevented the drug Thalidomide from being approved in the United States for 19 months while being maligned as a 'petty bureaucrat'. It turned out Thalidomide caused severe deformities, affecting over 10,000 children. She received the President's Award for Distinguished Federal Civilian Service from John F. Kennedy for her persistence and service in the face of pressure.

Problem 2: Who was Gertrude Mary Cox?

(a) ____ The inventor of the ice cube.

(b) ____ A professional lucha libre.

(c) ✓ A statistician who was the first woman elected to the International Statistical Institute, and was the founder of the Experimental Statistics Department at North Carolina State University. She was also elected as President of the American Statistical Association and was elected to the prestigious National Academy of Sciences.

Problem 3: Who was Dr Florence Nightingale David?

(a) ____ A human lizard hybrid.

(b) ____ A nurse during the Crimean War.

(c) ✓ A statistician who started off as an actuary but was unable to find a job because only men were hired as actuaries. She then worked for Karl Pearson (the Pearson correlation coefficient), and create a table of correlation coefficients, computing everything on a hand-cranked mechanical calculator like a badass. She created statistical models to predict the effects of bomb explosions in high population areas during WWII, and later became a Professor and chair of the Department of Statistics at the University of California, Riverside.

Problem 4: Who is Dr Xihong Lin?

(a) _____ A child's imaginary friend.

(b) _____ One of the girls from *The Chronicles of Narnia*.

(c) ____✓____ A Chinese-American statistician who has contributed to mixed models, non-parametric regressions, and statistical genetics, and is currently the chair of the Department of Biostatistics at the Harvard T.H. Chan School of Public Health.

Quiz 20: Researchers are trying to determine if there is a difference between the average hourly shift length at various local fast food chains. They examine 5 different restaurants, asking 4 employees from each restaurant how many hours they work per week, on average. A partial ANOVA table from their analysis is found below.

Source	DF	SS	MS	F
Groups	*4*	193.6	*48.4000*	*2.849*
Error	*15*	254.8	*16.9867*	—
Total	*19*	418.4	—	—

Complete the following:

$F =$ ____2.849____

p-value range: ____$0.05 < p < 0.10$____