Continuing Education Course #276
What Every Engineer Should Know
About Engineering Probability and Statistics II

1. Statistical inference is the idea of assessing the properties of an underlying distribution through the method of inductive analyses
- a. True
- b. False

2. Which of the following statement (s) is (are) true
- a. Sample statistics can be used as an estimate of the population parameter
- b. While probability and statistics both deal with questions involving parameters and statistic, they do so in an "inverse manner"
- c. Probability deals with the sample with its parameters (parent values) while statistical inference deals with the population and its statistic
- d. Both a and b

3. Statistical inference is the process through which information about the parameters of a population can be deduced based on certain characteristics obtained from a sample of data drawn from that population. The three fundamental approaches of statistical inference are:
- a. Point estimates, test of hypothesis and design of experiments.
- b. Point estimates, interval estimates, and tests of hypotheses
- c. Intervals Estimates, Simulation, and the design of experiments
- d. Confidence analyses, modeling, and probability testing

4. Parameters of a population are easy to come by more so than the statistic from the sample because they are easily available
- a. True
- b. False

5. As engineers, it is important to understand that experiments are conducted solely for the sake of the estimates because that is really all that we have at hand.
- a. True
- b. False

6. We always seek the best estimators for the parameter that we want to estimate so we can get as close as possible to the true value.
- a. True
- b. False

7. Given the nature of a random experiment it is expected that each realization of the experiment will most likely.
- a. Produce different statistic(s)
- b. Produce the same statistic regardless of the randomization
- c. All of the above

8. Ultimately, at the end of a statistical inference analyses, the decision is always to act or not to act.

- a. True
- b. False

9. There are two specific types of estimators in Statistical Inference. These are:

- a. Hypothesis estimator and experimental estimators
- b. Interval estimators and correlation estimators
- c. Point estimators and Interval estimators
- d. None of the above

10. Which of the following method(s) is (are) used for generating estimators of parameters

- a. Method of maximum likelihood
- b. Method of moments
- c. both a and b

11. A statistic $\overline{X}$ is called 'best unbiased estimator (BUE) for the parameter θ if

- a. It is unbiased and random
- b. It is efficient and random
- c. unbiased and efficient
- d. All of the above

12. Which of the following is true?

- a. The issue of the efficiency of an estimator has to do with its mean and variance values.
- b. In terms of the BUE, the smaller the variance of an estimator, the more efficient the estimator.
- c. The variance of the mean is 1.57 times the variance of the median
- d. None of the above is true

13. Which of the following are the main principles of the Central Limit Theorem (CLT)?

- a. The central limit theorem (CLT) states that given a sufficiently large sample from a population with a finite variance, the mean of all samples from that population would be approximately equal to the mean of the population
- b. According to CLT, even though the individual measurements have a distribution that is not the normal distribution, the distribution of the sample mean as n becomes large, (i.e. $n \to \infty$), tends to be approximately Normally distributed
- c. According to CLT, the sampling distribution of the sample means is the normal distribution.
- d. All of the above

14. According to Central Limit Theorem (CLT), the sampling distribution of the sample mean $\overline{X}$ has

- a. Mean $\mu_{\overline{X}} = \overline{\overline{X}}$, and $\sigma^2_{\overline{X}} = \dfrac{\sigma^2}{n}$
- b. Mean $u = \overline{X}$ and $\sigma^2_X = \dfrac{\sigma^2}{n}$
- c. None of the above

15. Point Estimates are

- a. Parameters from the population
- b. Statistic from the sample
- c. A single data point used to estimate the population parameter
- d. both b and c

16. The main difference between the normal distribution and the student-t distribution is:

- a. The student-t distribution is used when the sample size is small and/or the population variance or standard deviation is unknown

○ b. The tails of the student-t distributions are "smaller" than the tails of the normal distribution.
○ c. The student-t distribution is a skewed distribution and is useful only when the sample size is >30.
○ d. None of the above

17. The sampling distribution of the sample variance is
○ a. Is the normal distribution
○ b. Is the student-t distribution
○ c. Is the Chi-square distribution
○ d. The F distribution

18. The sampling distribution of two variances from independent populations is the
○ a. The normal Distribution
○ b. The Chi-square distribution
○ c. The student -t distribution
○ d. The F distribution

19. Confidence Intervals are established
○ a. For the population parameter
○ b. For the sample statistic
○ c. All of the above

20. Which of the following is true of Confidence Intervals?
○ a. We use confidence intervals because we know that the estimator is subject to both the error of measurement and variability
○ b. Due to the variability and the error in measurement, we want to establish an interval within which we would reasonably expect the value we seek to lie.
○ c. In repeated sampling and using the same methods to select the different samples, we would expect the true parameter value to fall within the specified interval a given percent of the time.
○ d. All of the above

21. In the equation for estimating the sample size, given by $n = \left[\frac{Z_{\alpha/2}\sigma}{E}\right]^2$ what is the effect or the purpose of E, namely the error on the sample size n?
○ a. It does not have any effect on the sample size
○ b. The smaller the error, the larger the sample size
○ c. The larger the error, the larger the sample size
○ d. None of the above

22. The type II error is defined as
○ a. The type of error committed when the null Hypothesis (H_0) is not rejected
○ b. The type of error committed when the null Hypothesis (H_0) is rejected
○ c. The type of error committed when the alternative Hypothesis (H_1) is not rejected
○ d. None of the above

23. The acceptance of a statistical hypothesis does not necessarily imply that it is true.
○ a. True
○ b. False

24. A null Hypothesis is a Hypothesis formulated with the intent or hope of not rejecting

○ a. True
○ b. False

25. To compute the sample size for a two-sided test of hypothesis under the normal distribution, what value of Z-score goes into the equation for given values of α and β?

○ a. $Z_\alpha + Z_\beta$
○ b. $Z_{\alpha\,/\,2} + Z_\beta$,
○ c. $Z_{\alpha\,/\,2} + Z_{\beta\,/\,2}$
○ d. None of the above

26. In a test of hypothesis for the mean with variance known, the alternative hypothesis for a one-sided test of hypothesis is: $H_1 : \mu < \mu_0$ with the Reject Criteria as: Reject if: $Z < -Z_\alpha, \alpha = 0.05, \text{ and } Z_{0.05} = 1.645$. If the computed value of Z=-1.28. What is your decision with regard to the null hypothesis

○ a. Do not Reject H_0
○ b. Reject H_0
○ c. Neither a or b. Not enough information for a decision

Questions 27-30
You are required to perform a Hypothesis test for two means. Because we are not sure of the equality of the variances, we wanted to test that first before we go on to do the means test. Let
i.) $H_0 : \sigma_1^2 = \sigma_2^2; \mu 2 : H_1 : \sigma_1^2 \neq \sigma_2^2$
ii). $n_1 = n_2 = 21, \alpha = 0.01$
iii). Test Statistics: $F = \left(S_1^2 \,/\, S_2^2\right) = 1.24, S_1 > S_2$

27. What will be the critical value of F for this two-sided test?

○ a. $F_{0.01,\ 21,21}$ = F(0.01,21,21)
○ b. $F_{0.001,\ 20,20}$ = F(0.001,20,20)
○ c. $F_{0.005,\ 20,20}$ = F(0.005,20,20)
○ d. $F_{0.05,\ 21,21}$ = F(0.05,21,21)

28. In problem 27, suppose, the critical value from the table is F = 2.12. Would you Reject or not Reject the null hypothesis H_0?

○ a. Reject H_0
○ b. Do not reject H_0
○ c. Not enough information to take a decision

29. Assuming that you did NOT REJECT the null hypothesis, what test statistic will you use to do a test for the means, that is: $H_o : \mu_1 = \mu_2; H_1 : \mu 1 > \mu 2$, at $\alpha = 0.01$

○ a. $t = \dfrac{\left(\overline{X}_1 - \overline{X}_2\right) - 0}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

○ b. $t = \dfrac{\left(\overline{X}_1 - \overline{X}_2\right) - 0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$

○ c. $Z = \dfrac{(\overline{X}_1 - \overline{X}_2) - \delta}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$

○ d. None of the above

30. Assuming that you did REJECTED the null hypothesis, what test statistic will you use to do a test for the mean, that is: $H_o : \mu 1 = \mu 2; H_1 : \mu 1 > \mu 2$, at $\alpha = 0.01$

○ a. $t = \dfrac{(\overline{X}_1 - \overline{X}_2) - 0}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

○ b. $t = \dfrac{(\overline{X}_1 - \overline{X}_2) - 0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$

○ c. $Z = \dfrac{(\overline{X}_1 - \overline{X}_2) - \delta}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$

○ d. None of the above