Continuing Education Course #283
What Every Engineer Should Know About
The Design and Analysis of Engineering Experiments I

1. A good experimental design is one that furnishes required information with minimum experimental effort. Which of the following are some of the requirements of a good experiment?

○ a. The questions that are to be answered by the experiment must be clearly and carefully formulated.
○ b. Correct choice of experimental methods must be made in light of the required accuracy and the various pitfalls likely to be encountered.
○ c. The general pattern of experiment (sample size, spacing, the interrelationship of the observations must be clearly identified.
○ d. All of the above.

2. In general, experiments are designed in an attempt to increase the noise and to decrease the volume of the signal in order to maximize the quality of information obtained from the experiment without regard to cost.

○ a. True
○ b. False

3. Two culprits have been identified as being the major hindrances to product and process quality improvement more than any other. They are:

○ a. Deviations from specifications.
○ b. Excessive variability and noise around target or specifications.
○ c. Excessive too much experimentation.
○ d. All of the above.
○ e. Both a and b.

4. DMAIC is:

○ a. A data-driven quality strategy for improving processes.
○ b. An integral part of a company's Six Sigma Quality Initiative.
○ c. Each step in the cyclical DMAIC process is necessary to ensure the best possible results.
○ d. All of the above.

5. Life testing of product performance is important and can serve as a substitute for design of experiments.

○ a. True
○ b. False

6. If after thorough analysis we decide to reject or not reject a hypothesis we are conceding that such a hypothesis is true beyond doubt.

○ a. True
○ b. False

7. Data analysis, modeling, and inference are given much less emphasis at the expense of the activities that embrace the planning and execution of experiments.

○ a. True
○ b. False

8. Which of the following statements about estimators is (are) NOT true
○ a. There are two types of estimators, namely point estimators and interval estimators.
○ b. Two general methods are used in generating estimators of parameters, namely, the methods of moments and maximum likelihood.
○ c. Both moments estimators and maximum likelihood estimators always lead to exactly the same estimators.
○ d. None of the above.

9. Based on the Central Limit Theorem (CLT), the sampling distribution of the sample mean is:
○ a. The normal distribution.
○ b. The Student-t distribution if the sample is large enough.
○ c. Both a and b.
○ d. None of the above.

10. The sampling distribution of the means from two populations is:
○ a. The Chi-Square distribution.
○ b. Uniform distribution.
○ c. The normal distribution.
○ d. The F-distribution.

11. The sampling distribution of the variance from one population is:
○ a. The Chi-Square distribution.
○ b. Student-t distribution.
○ c. The normal distribution.
○ d. The F-distribution.

12. The sampling distribution of the variance from two populations is:
○ a. The Chi-Square distribution.
○ b. Student-t distribution.
○ c. The normal distribution.
○ d. The F-distribution.

13. Which of the following about an experiment IS true?
○ a. Not all study is research but all research is experimental.
○ b. A true experiment is one in which certain independent variables are manipulated and their levels assigned at random in order to determine their effect on one or more response variables.
○ c. A change in the independent variable most likely will cause a direct change in the dependent variable.
○ d. b and c.
○ e. None of the above.

14. Which of the following is TRUE about a Quasi- Experiment?
○ a. The group or restriction(block) is already in place and it is not possible to randomize.
○ b. The treatment can be randomized but the restriction is fluid and can be manipulated.
○ c. For instruction purposes, a shift (or block) can be assigned to a class that is most convenient or desirable.
○ d. None of the above.

15. The study of the effect of rainfall on the yield of a plot of land can be represented as a:
○ a. Quasi- Experiment.
○ b. Ex-post-Facto Experiment.

○ c. Both a and b.
○ d. None of the above.

16. In Design of Experiments, Blocking is used as a scheme to:
○ a. Reduce the effect of nuisance factors.
○ b. Reduce the possible inflation and masking of the variability or error.
○ c. Isolate known sources of variability.
○ d. All of the above.

17. Randomization is used in an Experiment to:
○ a. Uniformly and randomly distribute variations across the trials conducted.
○ b. Counteract the effect of unknown systemic variation in the experiment.
○ c. None of the above.
○ d. both a and b.

18. Which of the following is true of Replication?
○ a. Replication is used to obtain an estimate of pure error (σ_e).
○ b. Replication ensures that everything else being equal, separate readings taken at the same setting would be the same but for pure error.
○ c. None of the above.
○ d. Both a and b.

19. You have completed data collection from your Designed Experiment. After data 'snooping' you decided to develop two linear combinations of the means (each combination consisting of three different means) that you feel are useful into two separate contrasts. What specific method would you use to analyze the contrasts?
○ a. Orthogonal Contrasts Tests.
○ b. Scheffe's Tests.
○ c. Test of means.
○ d. None of the above.

20. You have developed a set of contrasts and you believe they are orthogonal. How would you show that they are orthogonal?
○ a. For each pair of contrasts, the sum of the product of the coefficient of each pair must be zero.
○ b. The sum of the coefficient of each contrast must be zero.
○ c. Any two contrasts must be orthogonal because the coefficient is zero.
○ d. None of the above.

21. Orthogonal Contrasts for a given experiment are unique.
○ a. True
○ b. False

22. The sum of all the Sum of Squares (SS) for a set of orthogonal Contrasts is:
○ a. The same as the Treatment Sum of Squares (SS Treatment).
○ b. Less than the Treatment Sum of Squares.
○ c. Equal to the Total Sum of Squares.
○ d. None of the above.

Questions for Problems 23-24

A single factor (treatment) with 6 (six) levels was used in a completely randomized experiment with 8 (eight) observations per treatment.

23. How many orthogonal contrasts are possible?
- a. 6
- b. 8
- c. 7
- d. 5

24. What is the degree of freedom for the error?
- a. 47
- b. 46
- c. 45
- d. 42
- e. 41

25. How do you compute the Mean Square on an ANOVA table?
- a. The SS for each term divided by the Mean Square Error.
- b. The SS for each term divided by its corresponding degrees of freedom.
- c. The SS for each term divided by the degree of freedom for error.
- d. The SS for each term divided by total degree of freedom.

Questions for Problems 26-27

A single factor (treatment) with 5 (five) levels with two restrictions on randomization design was used in an experiment with 5 observations per treatment. One restriction (Day of the week) had 5 levels. The other restriction (machine) had 5 levels.

26. What is the name of the design described above?
- a. Latin Square Design.
- b. Greco Latin Square Design.
- c. Youden Square.
- d. Incomplete Randomized Design.

27. The degrees of freedoms are
- a. Treatment=4, Machine=5, Day of the Week =4, and Error =20
- b. Treatment=4, Machine=4, Day of the Week =4, and Error =20
- c. Treatment=4, Machine=5, Total =24, and Error =10
- d. Treatment=4, Day of the week =4, Error =12

28. A test of significance on an ANOVA table requires:
- a. The normal Test.
- b. The F-Test.
- c. A Chi-Square Test.
- d. None of the above.

29. In a Balanced Incomplete Block Design experiment;
- a. We can carry out an ANOVA on both the Block and the Treatment all at once.
- b. We can carry out an ANOVA on the Treatment after adjustment.
- c. If the design is symmetric (t=b), then we can carry out an ANOVA for each (Block and Treatment) after adjustment.
- d. Both b and c.

30. Which of the following about the Residual scatter plot or the Normal plot is true?

○ a. If the residual scatter plot shows a discernible trend, then the model is considered adequate.

○ b. If the Normal plot shows a linear (straight line), trend then the normality assumption about the error variance is acceptable.

○ c. None of the above.