Continuing Education Course #293
What Every Engineer Should Know About
Reliability Engineering II

1. Which is NOT TRUE of a typical Test Analyze and Fix (TAAF) process?

○ a. These are tests or procedures that are carried out in the design and development phase of a product to remove defects and to enhance reliability growth.

○ b. They are a set of engineering activities that are incorporated into the reliability growth process during the product development stages

○ c. The TAAF process is an OPEN loop methodology.

○ d. 'Fix' refers only to correction through re-design and modification to eliminate the cause of failure and does not imply repair.

2. In MIL-HDBK-217, Part Stress Analysis is used a majority of the time. Which of the following is true of part Stress Analysis?

○ a. It is applicable when the design is near completion and a detailed parts list, or BOM (Bill of Materials), plus component stresses are available.

○ b. Component stresses refer to the actual operating conditions such as environment, temperature, voltage, current and power levels under consideration.

○ c. The Parts Stress Method will usually result in a lower failure rate or lower system reliability, a more conservative result than the Parts Count Method would produce

○ d. All of the above

3. The **MIL-HDBK-217** or MIL-217 standard was developed for military and aerospace applications; however, it has become widely used for industrial and commercial electronic equipment applications throughout the world.

○ a. True

○ b. False

4. Which of the following is true of the MIL-217 Parts Count Analysis

○ a. The MIL-217 Parts Count Reliability Prediction is normally used when accurate design data and component specifications are not yet determined.

○ b. The method is typically used during the proposal and bid process or early in the design process

○ c. Minimal information is required for a Parts Count Reliability Prediction Method

○ d. All of the above

QUESTIONS 5-7 are with respect to the failure times of vehicles A-E as shown in the table below:
NOTE: The failure rates are constant. Also, the failures are independent of each other and all vehicles are from the same population

	VEHICLE IDENTIFICATION LABEL				
	A	**B**	**C**	**D**	**E**
	25	**50**	**5**	**100**	**25**
HOURS	**105**	**130**	**80**	**150**	**170**
TO	**150**	**300**	**105**	**300**	**375**

FAILURE	**600**	**340**	**125**	**475**
			275	**750**

5. Which vehicle experienced infant mortality failures?
- a. A
- b. B
- c. C
- d. D
- e. E

6. Which vehicle has the largest sample MTBF?
- a. A
- b. B
- c. C
- d. D
- e. E

7. Generally speaking, the failures shown for vehicle C are attributable to what problem:
- a. Poor design
- b. Manufacturing inconsistencies and inspection errors if inspected
- c. An incorrect early apportionment
- d. Moor maintenance policy
- e. Bad design reviews

NOTE: The following question was revised on 25 June 2018

8. For the three-parameter Weibull Distribution, the minimum life is given as δ. Which of the following is true of the minimum life δ?
- a. It is often used in warranty specifications.
- b. It is used to ensure that initial failures can only occur at a specified time beyond time zero
- c. When the minimum life is nonzero, the plot of the data on an appropriate graph paper produces a population line that is not a straight line, that is, a line that has some curvature.
- d. All of the above

9. What is the approximate usual point estimate for reliability of an item at 850 hours if 1600 items averaged 400 hours of operation each and the total number of failure were 160. Assume an exponential distribution.
- a. 9%
- b. 36%
- c. 81%
- d. 47%

10. The MTTF of certain equipment is 500 hours. Assuming a constant failure rate, its chance to fail in 500 hrs of operation is
- a. 40%
- b. 37%
- c. 100%
- d. 50%

11. In reliability testing, a Type I test is used in those cases where:
- a. The focus is on the failure times for a specified failure count.
- b. It is desired to truncate the test after a given failure has occurred.

○ c. It is of interest to determine the number of failures in a specified interval of product life.
○ d. The run time is difficult to determine and so the Chi-Square distribution is used
○ e. all of the above

12. In reliability testing, a Type II test is used in those cases where:
○ a. The focus is on the failure times for a specified failure count.
○ b. It is desired to truncate the test after a given time τ has elapsed.
○ c. It is of interest to determine the number of failures in a specified interval of product life.
○ d. a and b
○ e. all of the above

NOTE: The following question was revised on 25 June 2018

13. Which of the following about the Bartlett's test is true?
○ a. The Bartlett's test is useful for detecting either increasing or decreasing failure rates
○ b. It is used to determine whether or not an underlying distribution is the exponential
○ c. The test statistic for Bartlett's follows the chi-square distribution
○ d. Both a and b
○ e. All of the above

NOTE: The following question was revised on 25 June 2018

14. Which of the following most nearly describes the characteristic life parameter of a Weibull distribution?
○ a. It is that point on the time axis which indicates the failure of 63.2% of the population
○ b. It is a specific point in the life profile of a system beyond which about 37.8% of the population is expected to survive.
○ c. The characteristic life is different for different probability distribution failure modes
○ d. All of the above

15. The degrees of freedom in a reliability test are based on:
○ a. The time duration of the test
○ b. The number of failures during the test
○ c. The number of cycles for accelerated or compressed time tests
○ d. The type of instrumentation used to acquire the data
○ e. All of the above are important determinants of the degree of freedom

16. For Type II censored test, the degrees of freedom (df):
○ a. Is greater than the Degrees of Freedom for the Type I test for both the upper and lower limits
○ b. Is the same as the Degrees of Freedom for the Type I test for only the upper limit
○ c. Is less than the Degrees of Freedom for the Type I test for the upper limit
○ d. Is greater than the Degrees of Freedom for the Type I test for only the upper limits
○ e. both b, d

17. Under what condition(s) does the Weibull distribution behave like the exponential distribution?
○ a. When the characteristic lives are the same
○ b. When the characteristic life of the Weibull distribution goes to zero.
○ c. When the shape of the Weibull distribution is zero
○ d. When the shape parameter (slope parameter) of the Weibull distribution is unity
○ e. All of the above

18. In reliability tests based on the exponential distribution, why is the Chi-Square distribution the sampling distribution used to carry out the confidence interval tests for MTBF or MTTF?

○ a. The sum of the failure times is the chi-square distribution
○ b. The ratio of two exponential distributions is the chi-square
○ c. The sampling distribution of the quantity $\frac{2T}{\theta}$, where T is defined as total test time, is chi-square distributed with the degrees of freedom equal to 2r
○ d. This is only a simplifying assumption that does not depend on the underlying distributions
○ e. All of the above

19. Assuming we are interested at the kilometers at which 20% of certain device population will fail under the Weibull Process with minimum life δ=0. If the Characteristic life η (or θ) = 120 km, and the slope β=3.7, then the kilometers at which 20% of that population will fail is approximately:
○ a. 27 km
○ b. 20 km
○ c. 80 km
○ d. 60 km
○ e. None of the above

20. In an accelerated test, the failures for a prototype test vehicle occurred at the following kilometers: 18,800; 25,600; 38,400; 45,200; 68,345. As failures occured the vehicle was fixed and testing continued until the schdeuled distance was reached. The test was **scheduled for 100,000 km**. Assuming a constant failure rate process, the estimate for θ (MTBF) is:
○ a. 39,269 km
○ b. 100,000 km
○ c. 20,000 km
○ d. 40,000 km
○ e. None of the above

21. In an accelerated test, the failures for a prototype test vehicle occurred at the following kilometers: 18,800; 25,600; 38,400; 45,200; 68,345. As failures occured the vehicle was fixed and testing continued until the schdeuled distance was reached. **The test was scheduled for 100,000 km**. Assuming a constant failure rate process, the reliability function is given by:
○ a. $R(t) = e^{-\frac{t}{39269}}$
○ b. $R(t) = e^{-\frac{t}{20000}}$
○ c. $R(t) = e^{-\frac{5t}{\theta}}$
○ d. $R(t) = e^{-\frac{t}{40000}}$
○ e. $R(t) = e^{-\frac{t}{100000}}$

22. In an accelerated test, the failures for a prototype test vehicle occurred at the following kilometers: 18800, 25600, 38400, 45200, 68345. The test is scheduled for 100,000 km. Assuming a constant failure rate process, the two sided lower and upper confidence interval degrees of freedom are respectively:
○ a. 5, 7
○ b. 10, 10
○ c. 5,12
○ d. 10, 12
○ e. 5,5

23. Six (6) spring cables were cycle tested to failure on an accelerated life test without replacement with failure occurences as follows: 30200, 58500, 20900,120000, 110200, 200200.
Assuming the failure occurrences are in hours and a constant failure rate process. The estimate for the mean-time-to-failure (MTTF) is:

○ a. 90000 hrs
○ b. 200200 hrs
○ c. 33677 hrs
○ d. 84350 hrs
○ e. 110000 hrs

24. Ten (10) spring cables were cycle tested to failure on an accelerated life test without replacement with failure occurences as follows:
30200, 58500, 20900, 110000, 224,900, 100200, 200200
Failed cables were not replaced and the test was suspended after the 7th failure occurred. Assuming the failure occurrences are in hours and the failure rate is constant. Find an estimate for the mean-time-to-failure (MTTF) is:
○ a. 209,000 hrs
○ b. 200,200 hrs
○ c. 202,800 hrs
○ d. 744,900 hrs
○ e. 224,900 hrs

25. Which of the following about Censoring is true
○ a. Censoring is a major and frequent accelerated testing technique in which the tests are terminated before all the specimens have failed **either** because the predetermined test time has elapsed **or** because of the occurrence of specific number of failures.
○ b. Multiply Censoring are of two types, namely, Type I, Type II
○ c. In Singly Censored Test, items are removed or replaced at various times during the test. Such removal or replacement happens when the mechanism that is not under study fails **or** because the unit is no longer available for testing.
○ d. a and c
○ e. All of the above