Continuing Education Course #290
What Every Engineer Should Know About
Reliability Engineering I

1. Which of the following does not enter into the definition of reliability?
- a. mission time
- b. stress level
- c. age
- d. conditional probability
- e. all of the above is essential

2. Which of the following is/are not specific failure type(s):
- a. catastrophic
- b. drift
- c. intermittent
- d. degradation
- e. all are specific failure types

3. The hazard rate function of any continuous probability density function (Pdf) is:
- a. The reciprocal of the MTTF (or MTBF)
- b. The instantaneous failure rate or the conditional failure rate for a given instant
- c. The probability of survival to time t
- d. The measure of safety for a given period of time greater than zero

4. Secondary failure is defined as:
- a. The failure of an item due to the failure of another item
- b. The second malfunction of an item
- c. Failure of an item which does not affect the intended function of an item
- d. The failure of an item due to the inherent characteristic of the item

5. In general, which of the following about reliability is true?
- a. In reliability analysis, no distinction is made between failure and failure types.
- b. As part of design reliability, an appliance maker is concerned about frequent failures because of the cost of maintenance and replacement but more so because such failures could become a safety hazard.
- c. For some systems there is little or no distinction between reliability and safety
- d. All of the above

6. Exponential density has several useful properties that makes it useful as a distribution, and especially in reliability modeling. Which one of the following is not one of the properties?
- a. The failure rate is constant
- b. The occurrence of failure is not affected by failure history (that is, no memory)
- c. The failure rate follows the familiar "bathtub curve"
- d. The number of failures in a given interval follows a Poisson distribution.

7. In describing a need for reliability improvement to top management, the best terminology to use to address the problem is usually:

- a. Weibull distribution
- b. failure modes-effects
- c. dollars and cents
- d. dislocation of the mean
- e. uncontrolled variance

8. Failure rates in the exponential case:

- a. are multiplied together for independent events
- b. are summed to combine independent series elements in reliability analysis
- c. increase to the mean value and then decrease
- d. None of the above

9. A component has a constant failure rate of 0.0005 failures per hour. What is its reliability for 1,000 hours of operation?

- a. 0.6065
- b. 0.9950
- c. 0.5340
- d. 0.3667

10. The MTTF of equipment is 500 hours. Assuming a constant failure rate, its change to fail in 500 hrs of operation is

- a. 100%
- b. 37%
- c. 63%
- d. 50%

11. Availability is always:

- a. Expressed as a probability
- b. Related to operating time and downtime
- c. Considers both free time and idle time
- d. Both a and b
- e. All of the above

12. Mathematical models of reliability may be quite complex because of:

- a. Differences in component failure distributions and variations in the different component and systems
- b. Complex nature of the interference between load and capacity
- c. Variations in equipment usage
- d. Uncertainty about environmental stresses
- e. All of the above

13. Which of the following is the best general advice to a designer to meet a high reliability requirement?

- a. Use a safety factor of 1.25
- b. Design for an upper three-sigma limit
- c. Use of interference analysis for stress-strength
- d. Always design for worst case
- e. Design for a lower limit of reliability at the 90% confidence level

14. Which of the following about PM (Preventive Maintenance) is NOT true.

- a. Greatest benefits are realized when the maintenance intervals are chosen such that for a given system the positive effects of wearout time is greater than the negative effects of wear-in time.

○ b. Typically, PM is performed on those components where wearout and wear-in effects dominate.
○ c. Even when wearout is present, a constant failure rate model may be a reasonable approximation.
○ d. Maintenance is one of the primary causes of common-mode failures.

15. Which of the following is true of periodic tests?
○ a. Increases in repair rate increases availability
○ b. If the test interval is longer than the optimum, the undetected failures will lower availability.
○ c. Decrease in test time decreases availability.
○ d. None of the above

16. Given the following parameters about the repairable system with repair rate of 0.8/day, and failure rate =0.6/day . What is the steady state availability?
○ a. 0.4295
○ b. 0.6705
○ c. 0.5714
○ d. none of the above.

17. In general low-level redundancies yield higher reliability values than higher-level redundancies if the following conditions are met.
○ a. The reliabilities of the component cannot depend on the configuration in which they are located.
○ b. The failure process must be truly independent for both configurations.
○ c. The component reliabilities are the same for both configurations.
○ d. a and c
○ e. All of the above.

18. Which of the following formula is the most appropriate for determining the probability associated with each ordered failure data set?
○ a. $\widehat{F}(oT_i) = i/(n+2)$
○ b. $\widehat{F}(oT_i)i = \dfrac{i-0.5}{n}$
○ c. $\widehat{F}(oT_i) = (i-0.3)/(n+0.4)$
○ d. a and c above
○ e. None of the above.

19. Which of the following is true about the asymptotic availability expression given by?
$A(\infty) = \dfrac{\text{MTTF}}{\text{MTTF+MTTR}}$
○ a. It is used for system availability in those situations where both the failure and repair processes are driven by the exponential distribution.
○ b. It may also be used even when the failure and repair distributions are not exponential.
○ c. It could be used to evaluate the overall availability since for a reasonable time period T, availability is insensitive to the details of repair and failure process.
○ d. All of the above.

20. Benefits of Preventive Maintenance include the following, <u>except</u>:
○ a. Increases life of equipment
○ b. Reduces failures and breakdowns
○ c. Does not increase downtime
○ d. Reduces costly down time
○ e. Decreases cost of replacement

21. Predictive Maintenance(PdM) techniques are techniques that help determine the condition of in-service equipment in order to predict when maintenance should be performed. PdM activities include all, but:

- ○ a. Data Analytics
- ○ b. Infrared Thermography
- ○ c. Mathematical and probabilistic analysis
- ○ d. Physical examinations
- ○ e. All of the above are PdM activities

22. For which distribution is the probability equal to 50% that the population would have failed by the time the MTTF is reached?

- ○ a. The normal distribution
- ○ b. The lognormal distribution
- ○ c. The Weibull distribution
- ○ d. The exponential distribution

23. For which distribution is the probability equal to 63.2% that the population would have failed by the time the MTTF is reached.

- ○ a. The normal distribution
- ○ b. The lognormal distribution
- ○ c. The Weibull distribution
- ○ d. The exponential distribution

24. A useful definition of MTTF with respect to the reliability function, is the following:

- ○ a. The reliability function is the average life of the system or component over all possible values of the component or system life profile
- ○ b. The MTTF cannot be estimated from the reliability function
- ○ c. The MTTF is distribution independent
- ○ d. None of the above

25. Why is it important to insist on a legitimate or viable hazard function?

- ○ a. It is the basis for developing the other probability distributions functions that characterize the failure process
- ○ b. Not every hazard function necessarily leads to a probability density function
- ○ c. Since both the reliability function and failure density are probability functions this means that the hazard function must be a probability function or it does not exist.
- ○ d. All of the above