PG Even Semester Examination, May 2025

STATISTICS

4th Semester

Course No. : STS - 653(ii)

(Reliability and Survival Analysis)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

(Answer five questions taking one from each unit)

Unit - I

1. (a) Define reliability and reliabiity function. If R(t) is the reliability function and $\lambda(t)$ is the hazard function, then show that 2+5=7

$$R(t) = e^{-\int_0^t \lambda(t)\,dt}$$

(b) Show that if the hazard rate of a component is constant then the failure distribution of the component follows exponential distribution. 7

2. (a) Derive the expression for the reliability function of Weibull distribution and gamma distribution and comment on the results. 7

(b) The density function of the time to failure in years

(Turn Over)

of a particular component is given by

$$f(t) = \frac{100}{(t+10)^3} \; ; \; t \geq 0$$

Find the reliability of the component after 2 years. 7

Unit - II

3. (a) Define the structure function of the system. When the component of a system is said to be relevant or irrelevant? Show that coherent system is a binary system. 7

   (b) Define hazard rate and reverse harzard rate and their expression. Explain the real meaning of hazard rate and reverse hazard rate. 7

4. (a) What do you mean by increasing failure rate and decreasing failure rate? Define constant failur rate (CFR) and provide at least two practical example of CFR. 7

   (b) Define minimal path set and minimal cut set with examples. Exaplain the importance of minimal path set and minimal cut set in reliability theory. 7

Unit - III

5. (a) What is complex system in reliability? What are the methods to compute the reliability of a

8. Define the following and derive their relationship with survival function. 14
   (a) distribution function
   (b) hazard function
   (c) mean residual life function
   (d) survival function

Unit - V

9. Define the following in terms of competing risks as bivariate random variables. 14
   (a) Sub distribution
   (b) Sub survivor function
   (c) Sub density function
   (d) Cumulative sub hazard function

10. Define the following terms in context of competing risks at latent failure times. 14
    (a) Survivor function
    (b) Sub density function
    (c) Marginal survivor function
    (d) Sub distribution function
    (e) Sub hazard function
    (f) Cause specific hazard function.

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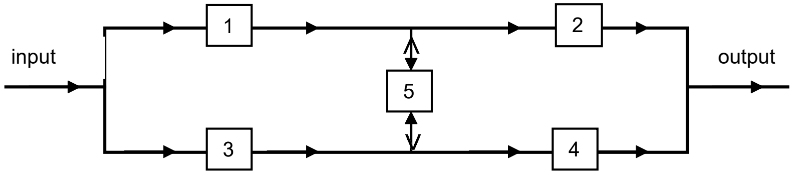
complex system? Using the conditional probability approach, compute the reliability of the system having the following reliability block diagram for a mission of 1000 hours.



Assume that each component has a reliability of 0.95 for a mission of 1000 hours. Also assume that the components are independent.

3+7=10

(b) Define series system and parallel system configuration of a system and discuss their advantages and disadvantages with examples.

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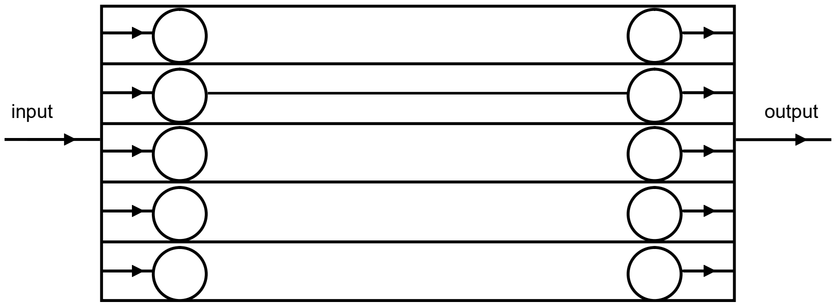
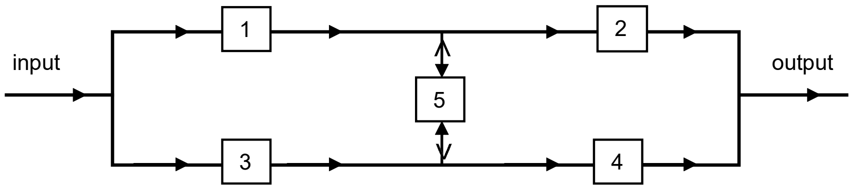
6. (a) What do you mean by reliability fo k-out-of-n system? How it is related with series system and parallel system? Consider a pipeline system having 5 pipes connected in parallel as shown in the following figure



Assume that all pipes are identical and independent. If the reliability of smooth flow of the liquid from each pipeline is 0.80 for a missioin of 1 year, evaluate the reliability of the system working successfully. The system is said to work successfully if at least 3 pipelines perform their intended function successfully. 10

(b) Using the cut set method, evaluate the reliability of the system, which has the reliability block diagram for a mission of 1000 hours as follows



It is given that each component has reliability of 0.95 for a mission of 1000 hours. Assume that the components are independent. 4

Unit - IV

7. (a) Derive the variance of Kaplan Meier estimate using Green Wood's method. 7

(b) Given the following survival times data (in weeks) for n = 15 subjects; 1, 1, 1^+, 1^+, 2, 2, 2, 2^+, 2^+, 3, 3, 3^+, 4^+, 5^+, where + denotes the censored data, compute the Kaplan-Meire estimator of survival function and its variance at t = 3. 7