

Indian Statistical Institute, Bangalore

M.S. (QMS) First Year

Second Semester – Reliability Maintainability and Safety II

Mid Term Exam

Date: March 16, 2022

Duration: 2 Hrs

Max Marks: 50

Answer as much as you can. Maximum you can score is 50.

- 1) Consider the following system with four components with their states and structure function as below:

x_1	x_2	x_3	x_4	$\phi(x)$
0	0	0	0	0
1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
1	1	0	0	0
1	0	1	0	0
1	0	0	1	0

x_1	x_2	x_3	x_4	$\phi(x)$
0	1	1	0	0
0	1	0	1	0
0	0	1	1	0
1	1	1	0	0
1	1	0	1	1
1	0	1	1	1
0	1	1	1	1
1	1	1	1	1

- i) Find the minimum path sets (mps) and minimum cut sets (mcs).
- ii) Draw the reliability block diagram.
- iii) Name the system.
- iv) Find the simplified structure function of the system using mps or mcs.
- v) Assuming components are independent, if all the components has reliability $p_i = 0.95$ at 100 hours, find the exact system reliability at 100 hours.

(2+2)+1+1+2+2=10

- 2) Consider a system with 3 components and the structure function is given below.

$$\phi(x) = \max \{ \min(x_1, x_3), \min(x_3, x_2), \min(x_1, x_2) \}$$

- i) Find the minimum path sets (mps) and minimum cut sets (mcs).
- ii) Draw the reliability block diagram.
- iii) Name the system.
- iv) Find the simplified structure function of the system using mps or mcs.
- v) Assuming components are independent, if all the components has reliability $p_i = 0.90$ at 50 hours, find the exact system reliability at 50 hours.

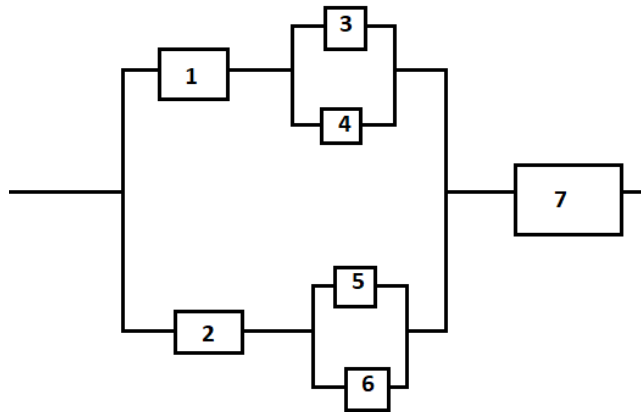
(2+2)+1+1+2+2=10

- 3) Consider a system with 3 components. The system functions iff components 1 functions and at least one of the remaining components functions.

- i) Find the reliability block diagram.

- ii) If T_i is the lifetime of the components where hazard rates of the components are constant = λ_1, λ_2 , and λ_2 . Find the reliability and hazard rate of the system at time t.
- iii) Check whether the system lifetime is IFR or DFR. 2+(2+2)+4=10

4) Consider a system with seven components.



- i) Find the exact reliability of the system assuming components are independent with reliabilities $p_1 = p_2 = 0.95, p_3 = p_4 = p_5 = p_6 = 0.9$ and $p_7 = 0.85$.
 - ii) Again for another system with same reliability block diagram, assume that $p_i = 0.95$, for $i = 1, 2, \dots, 7$. Compare the reliability of the system with the reliability of a parallel system and series system with seven components each having reliability p. 6+(2+2)=10
- 5) A very lazy person was left to observe an experiment. The experiment was like this: 50 IOT devices were put into operation and the observer had to write down the failure time of each IOT devices. But due to the nature of the personality he was 5 hours late at the work and then he observed that out of 50 IOT devices, 12 IOT devices stopped working. Out of guilt he immediately stopped the experiment. But due to lack of money the company did not want to re-conduct the experiment. Instead of that they wanted to use the only available information to estimate the parameters. They assumed that the lifetime of the IOT device follows exponential distribution with some unknown parameter. Can you help the company by estimating the parameter of the distribution as well as the reliability of the IOT device at 10 hours? 7+3=10
- 6) Write a short note on the following:
- i) FMEA
 - ii) FTA
- (5+5)=10