Total No. of Questions : 10]

SEAT No. :

P3048

[Total No. of Pages : 4

[5354]-536

B.E. (Mechanical Engineering) (Semester - I)

RELIABILITY ENGINEERING

(2012 Pattern) (Elective - I)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:-

1) *All questions are compulsory i.e. Solve Q.1 or Q. 2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8. Q.9 or Q.10.*
2) *Figures to the right indicate full marks.*
3) *Assume suitable data, if necessary.*
4) *Use of electronic pocket calculator is allowed.*
5) *Neat diagrams must be drawn wherever necessary.*

Q1) a) Compare weibull and exponential probability distributions. **[4]**

b) Following table shows test results for 1050 bearings tested for 480 hours under severe conditions. The following data was obtained for number of bearings failed out of 1050. Calculate the failure density and hazard rate and tabulate the results. **[6]**

Time interval (hrs.)	0-80	80-160	160-240	240-320	320-400	400-480
Number of bearings failed	377	292	175	103	65	38

OR

Q2) a) Define **[4]**

i) Warranty management and

ii) Life cycle cost.

P.T.O.

b) Find the reliability of the system shown by the block diagram in Fig. 1, using tie-set method. All the elements are independent and the reliability of each element is as given in the figure. Draw an equivalent block diagram for the minimal tie-sets. **[6]**

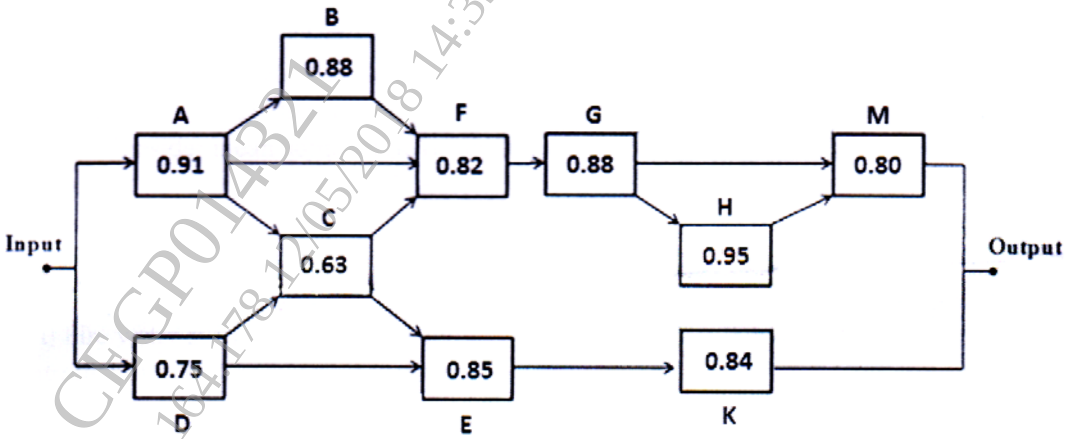

Fig. 1

Q3) a) Explain with illustration reliability analysis of series, parallel and mixed configuration systems. **[4]**

b) A system of four elements 1, 2, 3 and 4 are having failure rates λ_1=0.005, λ_2 = 0.008, λ_3 = 0.006 and λ_4 = 0.004 per hour respectively. Find failure rates as well as reliability of each sub system for the entire mission period using ARINC apportionment technique assuming mission time of 60 hours and desired system reliability of 0.88. **[6]**

OR

Q4) a) Explain central limit theorem with suitable example. **[4]**

b) A Pump assembly consists of four critical components having reliabilities of 0.72, 0.65, 0.78, 0.84 connected in series. The reliability of a pump is desired as 0.63. Find for which critical components the reliability values are to be improved and also find the values of individual reliabilities of the critical components by using minimum effort method. **[6]**

Q5) a) A refrigeration system has to be designed with a reliability value of 0.93 for 600 hours. Find the operational and inherent availability if maintainability of the refrigeration system over the same period of time is 0.85. Administrative and logistic time is 120 hrs. Assume that the repair time follows an exponential distribution and a constant hazard rate for failure of refrigeration system. **[8]**

b) State the objectives and types of maintenance. State the relationship between the availability, reliability and maintainability. **[8]**

OR

Q6) a) Operational availability of the heat treatment furnace over 1200 hours is 0.93. If failure of the heat treatment furnace follows an exponential distribution with the probability of failure within 1200 hours is 0.06. find mean time to repair (MTTR). mean down time (MDT) and inherent availability of the heat treatment furnace ignoring the preventive maintenance downtime. Consider mean administrative and logistic time as 30% of MTTR. **[8]**

b) Successful implementation of reliability centered maintenance (RCM) will lead to increase in cost effectiveness, machine uptime, and a greater understanding of the level of risk that the organization is managing. Comment on the statement in brief. **[8]**

Q7) a) Fire water system supplies continuous water at its output. The flow of the water at output is controlled by a Valve (V). Fire water system receives water at its input from two supply pipe lines A and B held parallel with each other. A fire water pump (FP1) lifts the water from the tank and supplies to system by pipe line A. Similarly, a fire water pump (FP2) lifts the water from the tank and supplies to system through pipe line B. Each of the pump run by a common engine (E) shaft. To have a continuous water supply, it is necessary that engine, valve and at least one of the fire water pump functions satisfactorily. Draw the block diagram for the complete system and also, construct the fault tree for the condition no water from the system. Calculate the reliability of the system if the reliabilities of fire water pumps, valve and engine are as given below. **[10]**

Component	Fire water pump		Engine	Valve
	FP1	FP2	E	V
Reliability	0.965	0.932	0.889	0.965

b) State the basic concepts of FMEA and FMECA and explain in what way FMECA is different than FMEA. Also, state the basic analysis procedure for FMEA/FMECA. **[8]**

OR

Q8) a) A lubrication system is used to lubricate the machine using two parallel supply lines. A supply line 1 is fitted with valve A and oil pump P_1. A supply line 2 is fitted with valve B and oil pump P_2. Both pumps P_1 and P_2 are run by a common prime mover (PM).To have lubrication at least from one supply line, it is necessary that prime mover, valve and pump from one of the supply line, function satisfactorily. Draw the block diagram for the lubrication system. Construct the fault tree for the condition 'no lubrication at all'. Calculate the reliability of the lubrication system. The probability of failure of the prime mover, valves and pumps is as given below. **[10]**

Component	Valve		Pump		Prime mover
	A	B	P_1	P_2	PM
Failure Probability	0.002	0.007	0.004	0.003	0.005

b) State the basic concept and assumptions of Taguchi method. Also state. the properties of orthogonal array. Explain its application with an example. **[8]**

Q9) a) The following data refers to a certain test of equipment:

Failure number	1	2	3	4	5	6	7	8
MTTF (hrs.)	12	24	34	27	31	23	16	25

Find out the reliability of the equipment and plot the variation of reliability against time using: **[8]**

i) Mean ranking method and

ii) Median ranking method

b) State and explain seven steps for implementation of an effective FRACAS. **[8]**

OR

Q10) a) The stress developed in a rotor shaft is known to be normally distributed with a mean value of stress is 320 N/mm^2 and standard deviation of 27 N/mm^2. The mean material strength of rotor shaft is 438 N/mm^2 and standard deviation is 39 N/mm^2. Assuming that the material strength of rotor shaft and induced stresses are independent, determine the probability of survival of rotor shaft, average, minimum and maximum values of factor of safety. Extract the data from the following table which shows the normal variant (Z) and ϕ (Z). **[8]**

Z	2.1	2.2	2.3	2.4	2.5	2.6
ϕ (Z)	0.9642	0.9722	0.9786	0.9836	0.9876	0.9906

b) State and explain accelerated life testing (ALT) and highly accelerated stress screening (HASS) techniques. **[8]**