Total No. of Questions : 10]

SEAT No. :

P3649

[Total No. of Pages : 6

[4859] - 1019
B.E. (Mechanical) (Semester - I)
Reliability Engineering
(2012 Pattern)

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) State and explain the relationship between MTTF and Reliability. **[4]**

b) In a test conducted for 48 hours under severe conditions on 500 pressure relief valves (PRVs), the following data was obtained for number of failed PRVs out of 500. Calculate the hazard rate as well as reliability and tabulate the results. **[6]**

Time interval (hrs.)	0-8	8-16	16-24	24-32	32-40	40-48
Number of failed PRVs	153	81	63	27	18	09

OR

Q2) a) Define central limit theorem. State its importance in several engineering applications. **[4]**

b) For the block diagram shown in Fig.1, derive the equation using tie-set method to obtain the reliability of the system assuming the elements to be independent. Also, draw an equivalent block diagram for the minimal tie-sets and hence, find the reliability of the system if reliability of all elements is of 0.9. **[6]**

P.T.O.

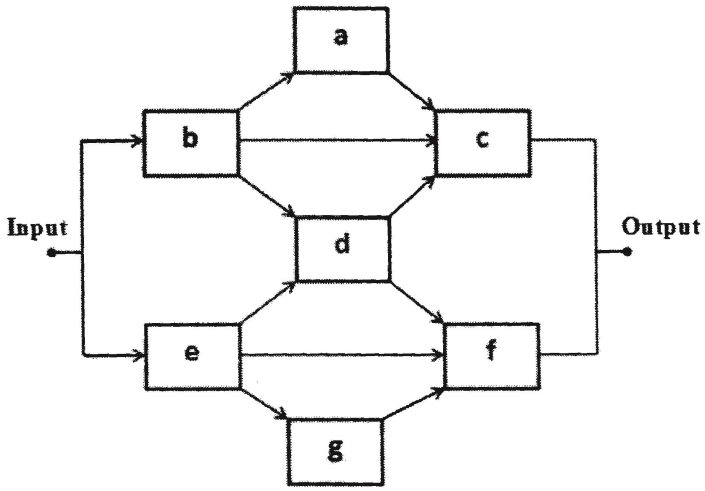

Fig. 1 Block diagram

Q3) a) What is k-out of n structure (k, n) system? Give two practical examples of a (k, n) system. **[4]**

b) A system S consists of sub-systems of A and B, each having reliability 'p'. In order to improve the reliability of the system, following three configurations of sub-systems are suggested as shown in Fig. 2. Obtain the reliability of each sub-system and determine amongst three which configuration has the highest reliability? Assume that the elements are independent. **[6]**

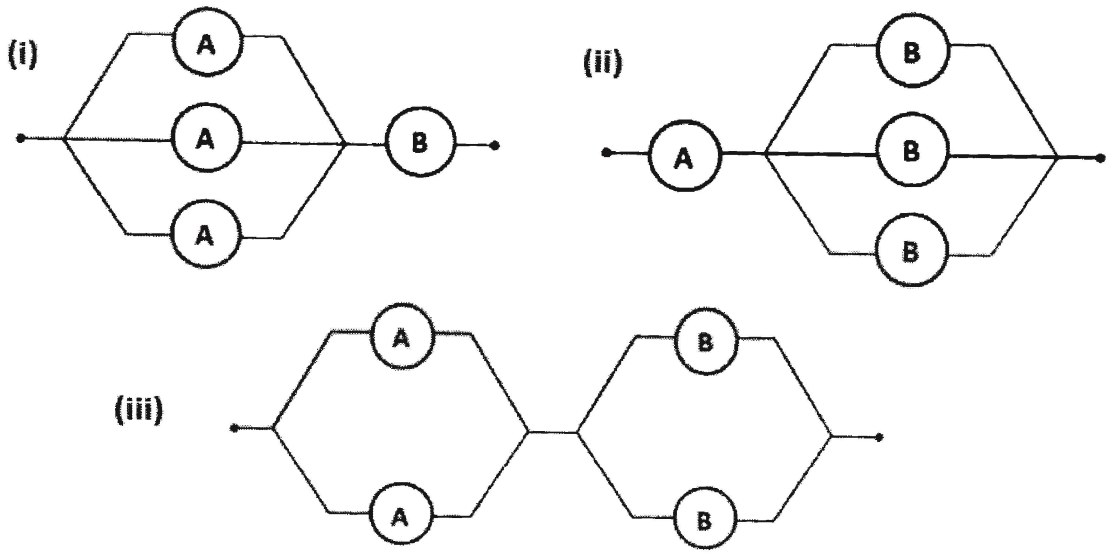

Fig. 2 Different configurations of sub-systems (i, ii and iii)

OR

Q4) a) A critical electronic instrument in a measurement laboratory goes out of order on an average once per 1000 hours of use. Assuming a constant hazard rate model, find out the probabilities of the instrument failing in 100, 500 and 700 hours of use as well as the reliabilities. **[4]**

b) A system consists of 4 subsystems in series. Each subsystem consists of some number of modules. Determine the mean lives and reliabilities of various subsystems so as to have system reliability of 0.95 for 30 hours mission time using "AGREE" method of allocation. The necessary information for subsytem is given below: **[6]**

Subsystem	Number of modules (in each subsystem)	Importance factor	Operating time (hours)
1	45	0.95	28
2	60	0.97	29
3	25	1.00	30
4	80	0.90	27

Q5) a) It has been observed that a failure pattern of an electronic system follows an exponential distribution with the probability of failure within 900 hours as 0.425. Obtain the inherent availability of the system over the same period of time if maintainability of the whole system over the same period of time is 0.85. Also, obtain the operational availability if administrative and logistic time is 240 hrs. Assume that the repair time follows an exponential distribution. **[8]**

b) Specify the functions to be performed by the reliability department to obtain the desired reliability. **[4]**

c) Availability is a complex function of reliability, maintainability and supply effectiveness. Comment on the statement. **[4]**

OR

Q6) a) A material handling system has to be designed with a reliability value of 0.9 for 1000 hours. An operational availability over the same period of time is required to be 0.85. If preventive maintenance downtime is ignored

and mean administrative and logistic time is 50% of mean time to repair, find **[8]**

i) Mean Time To Repair (MTTR).

ii) Mean Down Time (MDT) and

iii) Inherent availability. Assume a constant hazard rate for failure.

b) State at least eight applications of Built-In-Testing technique. **[4]**

c) Classify the cost of reliability and describe how an accurate estimation of cost of unreliability provides benefit to the reliability engineer. **[4]**

Q7) a) Progress in tool wear is continuously monitored by three digital microscopes namely A, B and C, functioning independently. Each of the microscopes receives power supply from independent sources. Microscope A receives power from D and E sources and the power from any one source is sufficient for operation of microscope A. Microscope B receives power from F source. Microscope C receives power from G and H sources and the power from any one source is sufficient for operation of microscope C. To effectively monitor the tool wear, it is necessary that at least one of the microscope functions satisfactorily. Draw the block diagram for the complete system. Also, construct the fault tree and based on this, calculate the reliability of the system. The reliabilities of microscopes and failure rates of power sources can be referred from following table. **[10]**

Characteristics	Microscopes			Power sources				
	The reliability			The probability of failure				
	A	B	C	D	E	F	G	H
Components	0.989	0.996	0.975	0.003	0.003	0.005	0.006	0.006

b) State the importance of **[8]**

i) Consideration of human factors in design and design principles (Any four).

ii) Design of Experiments.

OR

Q8) a) A hydraulic circuit (system) is shown in Fig. 3. There are two supply lines having various valves (A, B, C, D and E) and gear pumps (P1and P2) through which oil is supplied to machine from oil tank.

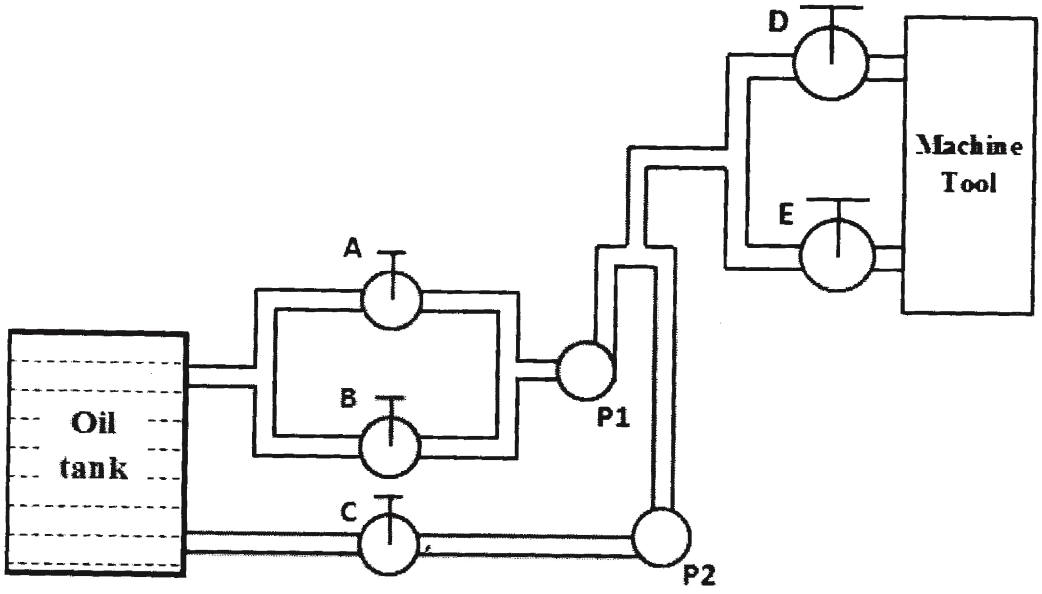

Fig.3 Hydraulic circuit to supply oil from oil tank to machine tool

The probability of failure of the valves and reliability of the gear pumps is given in following table. Draw the block diagram for the complete system. Also, construct the fault tree and based on this, calculate the reliability of the hydraulic circuit (system). **[10]**

Characteristics	Valves					Gear Pumps	
	The probability of failure					The reliability	
	A	B	C	D	E	P1	P2
Components	0.002	0.002	0.004	0.005	0.003	0.996	0.996

b) State the purpose and applications of **[8]**

i) MIL - Handbook 217F.

ii) Monte Carlo Simulation

Q9) a) The following data refers to a certain test of equipment: **[8]**

Failure number	1	2	3	4	5	6	7	8
MTTF (hrs.)	25	14	34	24	27	33	18	36

Find out the reliability of the equipment and plot the variation of reliability against time using :

i) Mean ranking method and

ii) Median ranking method.

b) What is FRACAS? State its application in manufacturing industry and explain how FMECA benefits the FRACAS. **[8]**

OR

Q10) a) The stress developed in a machine component is known to be normally distributed with a mean stress of 200 N/mm^2 and standard deviation of 30 N/mm^2. The mean material strength of machine component is 330 N/mm^2 and standard deviation of 45 N/mm^2. Assuming that the material strength of machine component and induced stresses are independent, determine :

i) The probability of survival of machine component.

ii) Average factor of safety and

iii) Minimum and maximum values of factor of safety.

Extract the data from following table which shows the normal variant (Z) and $\varnothing(Z)$.

Z	2.1	2.2	2.3	2.4	2.5	2.6
$\varnothing(Z)$	0.9642	0.9722	0.9786	0.9836	0.9876	0.9906

[8]

b) What is meant by accelerated test in evaluating reliability? Give at least six points of differences between Highly Accelerated Life Testing (HALT) and Accelerated Life Testing (ALT). **[8]**