Code No: R05410208 **Set No. 1**

IV B.Tech I Semester Regular Examinations, November 2008
RELIABILITY ENGINEERING AND APPLICATION TO POWER SYSTEMS
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A coin is tossed five times. Evaluate the probability of each possible outcome and draw the probability density function and the probability distribution function.[16]

2. Consider the system shown ion figure 1 in which success requires that at least one of the paths, AB, CD, AED, CEB is good. Evaluate a general expression for system success and the reliability of the system if each component has a reliability of 0.9 using cut set method. [16]

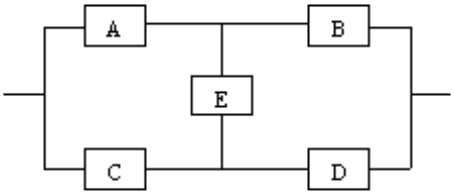

Figure 1:

3. A system is composed of three elements. Component 1 is in series with the parallel redundant combination of components 2 and 3 which are identical. $\lambda_1 = 1$ f/yr, λ_2=$\lambda_3 = 3$ f/yr, $\mu_1 = 98$ r/yr, μ_2=m μ_3=50 r/yr.

   (a) Calculate the reliability of this system for a mission of 1000 hr.

   (b) What is the mean time to failure for this system? [16]

4. (a) Explain what is meant by limiting state probability and how it is evaluated for discrete Markov chain model of a single component repairable system.

   (b) Given initial transitional rate of one component repairable model:

   $$P = \begin{bmatrix} 1/2 & 1/2 \\ 1/4 & 3/4 \end{bmatrix}$$

   Evaluate the probability of being in state 2 after '3' time intervals given that it is started in state 1 initially. [8+8]

5. Use the frequency balance approach to evaluate the frequency of encountering and duration of residing in each of the states shown in figure 2 where rates are expressed in occ/yr. [16]

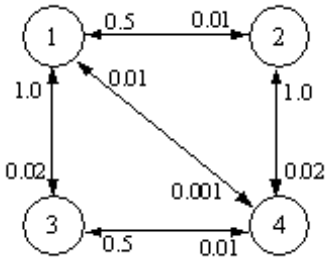

Figure 2:

6. (a) Define LOLP and LOLE.
   (b) Explain how loss of load probability can be estimated using load duration curve. [6+10]

7. (a) A load is served by two independent transmission lines A and B under two-weather environment. Draw the state diagram and explain how the probability of failure of power supply to the load can be calculated.
   (b) Discuss various performance indices that are used for the composite system reliability analysis. [8+8]

8. Consider the radial distribution system with circuit breaker, lateral distributor protection and disconnects as shown in figure 3.

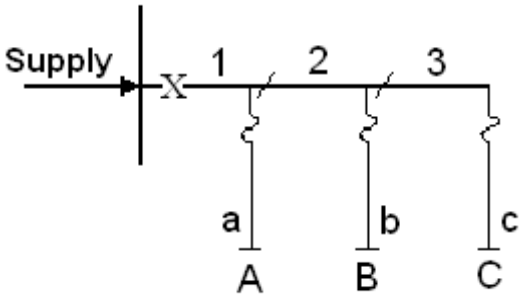

Figure 3:

The failure rates and repair times of various components and the number of customers and average load connected to each load point are given below:

Component	λ **(f/yr)**	**r (hrs)**
Section		
1	0.20	5
2	0.10	5
3	0.10	5
Distributor		
a	0.30	5
b	0.20	5
c	0.20	5

Load Point	**Number of Customers**	**Average load connected (KW)**
A	1000	5000
B	800	4000
C	700	3000

Evaluate the basic reliability indices and additional interruption indices for the system. [16]

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Code No: R05410208 **Set No. 2**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Derive the expressions for the expected value and standard deviation of binomial distribution.?
   (b) A telephone exchange contains 10 lines. A line can be busy or available for calls and all lines act independently. If the probability that a line will be busy during the noon period is 0.8, what is the probability of there being at least three free lines at any given time during this period? What is the expected number of free lines during this period? [8+8]

2. A system consists of four components in parallel. System success requires that at least three of these components must function. What is the probability of system success if the component reliability is 0.9? What is the system reliability if five components are placed in parallel to perform the same function? [16]

3. (a) Calculate the reliability of the system shown in figure 1 for a 1000hr mission with λ_1=1×10^{-5} f/hr,λ_2=10×10^{-5} f/hr, λ_3=2×10^{-4} f/hr and λ_4=5×10^{-5} f/hr. What is the mean time to failure for this system.

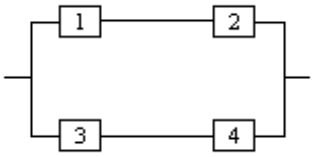

Figure 1:

   (b) Consider th e probability density function

$$f(t) = \begin{cases} 0.002e^{-0.002t} & t \geq 0 \\ 0 & otherwise \end{cases}$$

   with t in hours. Find R(t) and MTTF. [8+8]

4. (a) Explain Markov analysis for state space dependent systems.
   (b) Define STPM and explain its significance in evaluating limiting state probabilities of various states. [8+8]

5. The state space diagram and transition rates in f/yr of a continuous Markov process is shown in figure 2. Evaluate the frequency of encountering and duration of residing in each of the three states. [16]

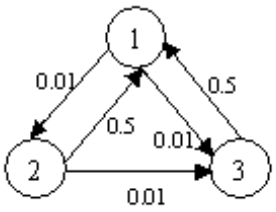

Figure 2:

6. (a) Explain the method of calculating LOLP of a generating system. What are the inadequacies of LOLP as an index of unreliability.
   (b) A power system contains three 40 MW and one 60 MW capacity units each having a forced outage rate of 0.02. The annual daily peak load variation curve is a straight line from 100% to 40% points. Estimate LOLE for a peak load of 200 MW. [8+8]

7. Write short notes on:
   (a) Two weather environment - weighted average rate model.
   (b) Decompositions method. [8+8]

8. Consider a three load point radial distribution system with circuit breaker shown in figure 3.

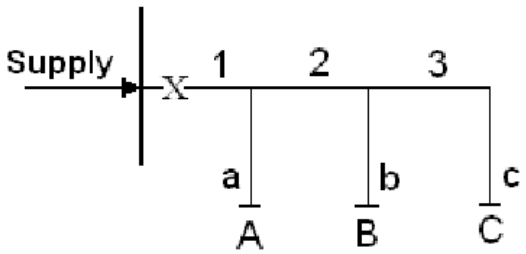

Figure 3:

The failure rates and repair times of various components are given below.

Component	λ **(f/yr)**	**r (hrs)**
Section		
1	0.20	5
2	0.10	5
3	0.10	5
Distributor		
a	0.30	5
b	0.20	5
c	0.20	5

Evaluate the basic reliability indices of the system. [16]

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Code No: R05410208 **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. A die is thrown 6 times. Evaluate the probability of getting two spots on the upper face 0,1,2...,6 times and draw the probability density function and the probability distribution function. [16]

2. Consider the system shown ion figure 1 in which success requires that at least one of the paths, AC, BD, AED, BEC is good. Evaluate a general expression for system success and the reliability of the system if each component has a reliability of 0.95 using tie set method. [16]

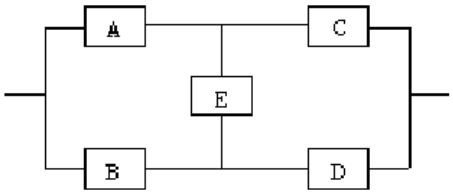

Figure 1:

3. (a) Show that the expected value and standard deviation of an exponential distribution are equal.
   (b) The hazard rate of a device is $\lambda(t) = \frac{1}{\sqrt{t}}$. Deduce:
      i. The probability density function
      ii. The survivor function
      iii. The expected value, and
      iv. The variance. [8+8]

4. (a) Explain the two state Markov process of a single component with repair.
   (b) Derive the expression for limiting state probabilities of a two component repairable model with identical capacities and identical transitional rates. [8+8]

5. Develop the state space model of four identical units having capacity of 50 MW each and unavailability of 0.04. Mark the various transitional rates of combined capacity state model if failure rate of each unit is 0.4 failures/ year and 9.6 repairs per year. Hence evaluate the cumulative probability and cumulative frequencies of various combined capacity states. [16]

6. (a) Explain how loss of load probability can be estimated using Load duration curve.

   (b) The daily peak distribution of load is described by the relative frequency diagram shown in Figure 2. Consider that there are three units of 20 MW each and one unit of 40 MW, each having a forced outage Rate of 0.04. Compute the loss of load probability of the system. [8+8]

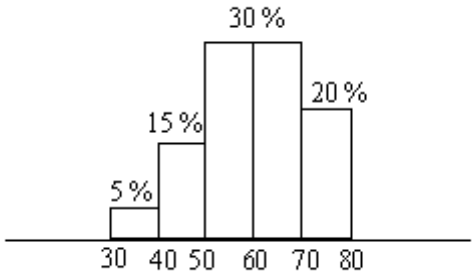

Figure 2:

7. (a) Describe with state space diagram, the Morkov model for a single transmission line under two weather environment.

   (b) Two transmission lines A and B with λ_N=2×10^{-4} f/day in normal weather and λ_W=5×10^{2} in severe weather and with repair rate, μ, of 1 r/day in both the weather supply a load. The mean duration of normal weather is 0.1 day. Calculate the probability of failure of supply to the load. [8+8]

8. Consider the radial distribution system shown in figure 3.

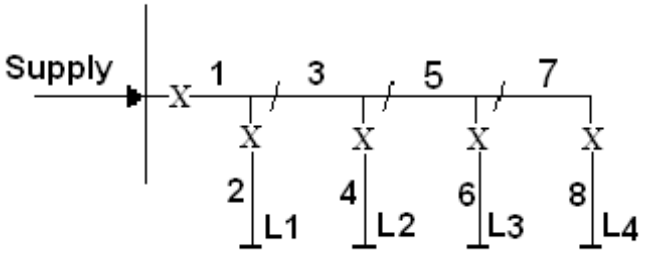

Figure 3:

The failure rates and repair times of various components are as given below.

Component	λ (f/yr)	r (hrs)
1	0.20	5
2	0.10	5
3	0.10	5
4	0.30	5
5	0.30	5
6	0.20	5
7	0.20	5
8	0.10	5

The total isolation and switching time is 1 hour. Evaluate the basic load point reliability indices. [16]

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Code No: R05410208 **Set No. 4**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the general characteristics of the binomial distribution?
   (b) A product is claimed to be 90% free of defects. What is the expected value and standard deviation of the number of defects in a sample of 4? [8+8]

2. (a) A series system has 10 identical components. If the overall system reliability must be at least 0.99, what is the minimum reliability required of each component?
   (b) Define minimal cut set. Explain the reliability analysis of complex systems using minimal cutest method. [8+8]

3. (a) Derive the expressions for the expected value and standard deviation of the exponential distribution.
   (b) Consider the following reliability function, where t is in hours:
   R(t) = $1/(0.001t+1) t \geq 0$
      i. Find the reliability after 100 operating hours and after 1000 operating hours.
      ii. Derive the hazard rate function. Is it an increasing or a decreasing failure rate. [8+8]

4. The following STPM shows the transitional rates in per hour of a continuous Markov process.

$$P = \begin{bmatrix} 0.90 & 0.05 & 0.05 \\ 0 & 0.95 & 0.05 \\ 0 & 0 & 1 \end{bmatrix}$$

   (a) Construct state space diagram.
   (b) Evaluate the MTTF given that the system starts in state 1. [8+8]

5. A pumping station has two identical pumps connected in parallel, each capable of supplying 3000 gallons/hr. The failure rate and repair rate of each is 0.5 f/hr and 4 r/hr respectively. Evaluate the frequency of encountering and duration of residing in each possible throughput state. [16]

6. A system consists of 12 units of 20 MW each having a forced outage rate of 0.01. Develop the capacity outage probability table and hence determine the cumulative probability of various capacity states. [16]

7. (a) Explain how probability of failure and expected frequency of failure at a bus can be estimated for radial configuration of composite generation and transmissions system.

   (b) Define and explain the various annualized Load Point Reliability Indices used for Bulk Power Systems Reliability analysis. [16]

8. Consider the radial distribution system with circuit breaker, lateral distributor protection and disconnects as shown in figure 1.

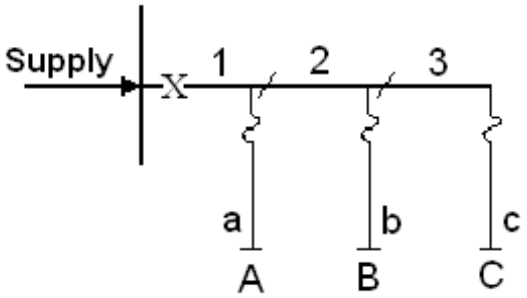

Figure 1:

The failure rates and repair times of various components are given below.

Component	λ **(f/yr)**	**r (hrs)**
Section		
1	0.20	4
2	0.10	4
3	0.10	4
Distributor		
a	0.30	5
b	0.20	5
c	0.20	5

Evaluate the basic reliability indices of the system if fuse gear operates with a probability of 0.8. [16]

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