Code No: RR410211 **Set No.1**

IV B.Tech. I Semester Regular Examinations, November -2005
RELIABILTY 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) Show that for discrete finite trials, the probability density function follows binomial coefficients. State the assumptions made. [6+2]
   (b) In a generating station there are 5 units of 20 MW each having identical probability of success of 0.85. Develop the capacity outage probability table and hence evaluate
      i. the probability of the station supplying at least 60 MW
      ii. the probability of the stations not able to supply 20 MW. [8]

2. (a) Derive symbolic reliability expression for the following Reliability.Logic Diagram shown in Figure1:

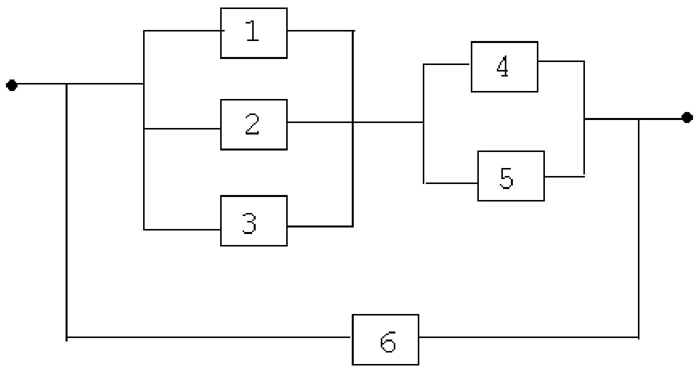

Figure 1:

Now if in the diagram, if atleast two of components 1,2,3 must function for system success what is the expression for symbolic reliability? Hence evaluate the probability index, if each component has a probability of success of 0.7 in each case.

   (b) Evaluate the symbolic unreliability expressions for the following network shown in Figure 2 using network partitioning approach: [8+8]

3. (a) For each of the following redundant configurations of Figure, determine the MTTF necessary to provide a system reliability of 0.9 after 100 hours of operation. Assume each component has same failure rate.(Figure 3)

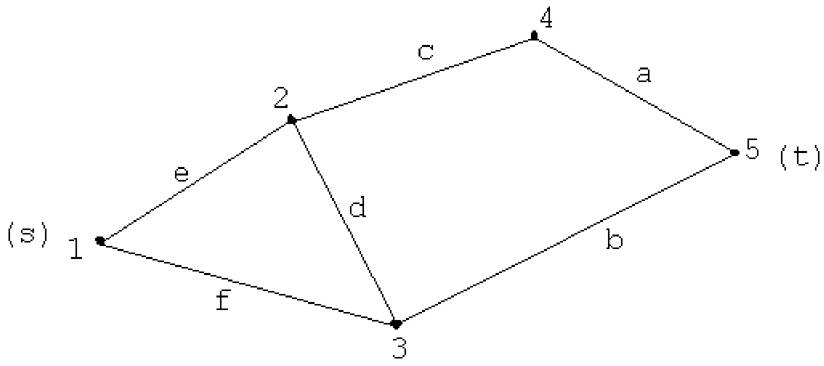

Figure 2:

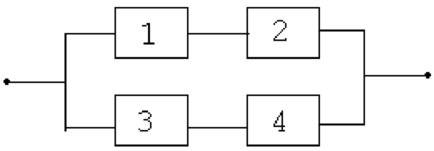

Figure 3:

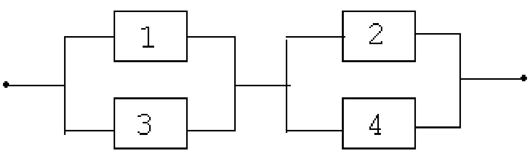

Figure 4:

(b) Develop the expressions for MTTF of series and parallel connected systems (of two components) which are having constant hazard rates.(Figure 4) [8+8]

4. A generating station has three generators two rated for 10 MW and the third one rated for 20 MW. The failure and repair rates of each unit are 0.35 failures per year and 9.65 repairs per year. Obtain the state diagram and mark the various equivalent transitional rates of the equal capacity states combined. Hence evaluate the cumulative probability of various combined states. [16]

5. (a) Define the terms LOLP, LOLE, EFNS, LOFF and FIR and explain.

   (b) Consider the load duration curve shown in Figure 5 for 100 hours.

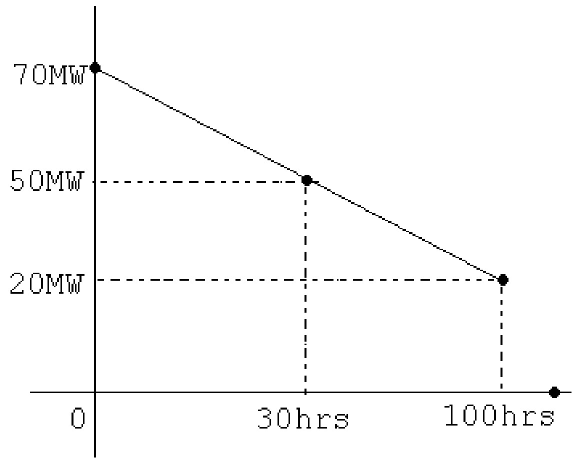

Figure 5:

There are three generating units having capacities of 25, 30 and 20 MW, each having a probability of success of 0.95, 0.96 and 0.93 respectively. Estimate the Energy index of reliability for the system. [6+10]

6. (a) Explain the decomposition method of evaluation of bulk power system for reliability analysis.

   (b) Explain the mathematical models of weather effects of transmission lines.[8+8]

7. (a) Explain the loss of load and energy indices that are described for distribution system reliability analysis.

   (b) Consider a 3 load point radial system shown in Figure 6.

   Component data for the system is:

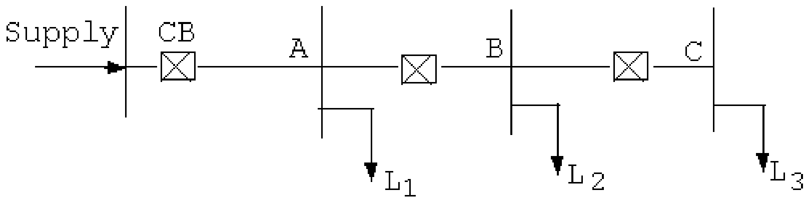

Figure 6:

Line	λ failures / year	r repairs / yr	Number of customers	Average Load Demand in kW
A	2	10	300	1500
B	1	8	250	1000
C	4	6	150	500

(a) Evaluate the basic reliability indices of each load point.

(b) Obtain the customer, load and energy indices of the above system. [8+8]

8. Write short notes on:

(a) Batch tub curve

(b) 2-Level daily load representation

(c) Distinguish between mutually exclusive and complementary events

(d) Reliability measures [4×4]

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Code No: RR410211 **Set No.2**

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1. (a) With the help of suitable examples, distinguish between
   i. Dependent and independent events.
   ii. Mutually exclusive and complementary events.

   (b) Distinguish between Union rule and summation rule with suitable examples.

   (c) The probability of an electric bulb failure during a transport is 0.05. In a random sample of 20 bulbs, determine the probability of
   i. Getting just two defective components
   ii. Five or more of them being non-defective. [6+4+6]

2. (a) Consider the following configurations shown in Figure 7 and 8. Derive the expressions for the symbolic reliability and hence evaluate the system reliability if each component has a probability of failure of 0.15. which is better configuration? Why?

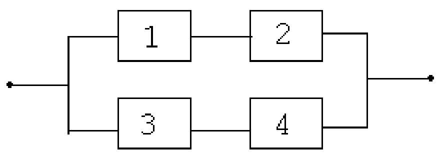

Figure 7:

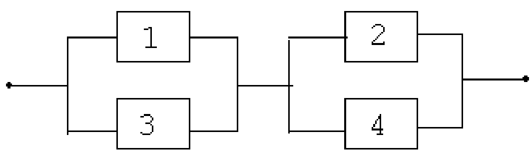

Figure 8:

   (b) The Reliability Logic Diagram of a system is shown in Figure 9. Develop the system unreliability if all the components have a probability of failure of 0.2 and out of components 3,4,5 atleast two must function for system success. [8+8]

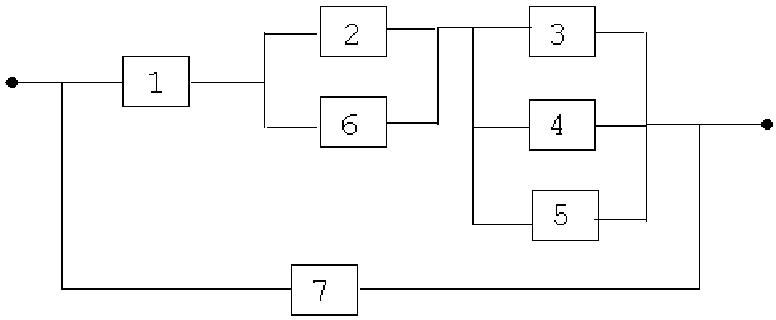

Figure 9:

3. (a) Show that the mean value and standard deviation of a distribution function whose hazard rate is constant is the reciprocal of constant hazard rate itself.
   (b) Define the reliability functions f(t), F(t), G(t), R(t) and develop the relationship between them. [8+8]

4. (a) Derive the expressions for Limiting State Probabilities of a 2-component repairable model with identical capacities and identical transitional rates.
   (b) For the following state-space diagram shown in Figure 10, the transitional rates are marked. Determine the Limiting State Probability of each state. [8+8]

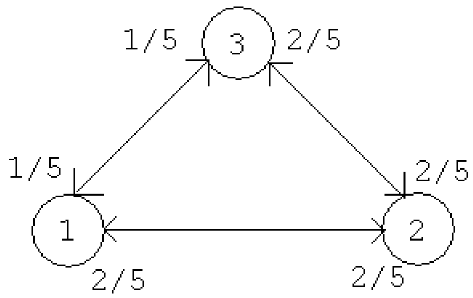

Figure 10:

5. (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 11. Consider that there are three units of 20 MW each and one of 40 MW each having a forced outage rate of 0.04. Compute the Loss-of-Load probability of the system. [6+10]

6. A generating station consists of two 3 MW units with a forced outage rate of 0.02 and one 5 MW unit with a forced outage rate of 0.015. Determine

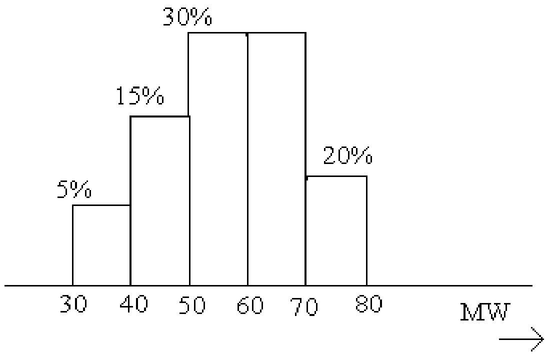

Figure 11:

(a) The capacity outage Probability table and hence determine the cumulative probability of various capacity states.

(b) Use sequential addition method to obtain cumulative probabilities of various capacity states.

(c) At the end of (b) above, if one unit of 3 MW is now deleted, determine the cumulative probabilities of various capacity states. [5+6+5]

7. (a) Explain the various indices that are used for composite system reliability analysis.

   (b) Explain various indices that are used for radial distribution system reliability analysis. [8+8]

8. Write short notes on:

   (a) Decomposition method for network reliability analysis
   (b) Stochastic transitional probability matrix
   (c) Weather effects models
   (d) Bernoulli's trials [4×4]

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Code No: RR410211

Set No.3

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1. (a) Develop the expressions for standard deviation and mean value of a component whose probabilities are binomially distributed.
   (b) Explain the principle of Baye's theorem.
   (c) Distinguish between conditional events and independent events with suitable examples. [8+4+4]

2. (a) Explain what is meant by 'product rule' of reliability/ unreliability? Explain its significance in evaluating the reliability/ unreliability of network configurations
   (b) Find the system reliability for the following configuration shown in Figure 12 with full redundancy having R_1=R_4=0.9, R_2=R_5=R_6=R_7=0.8 and R_3=0.95. Now if in this configuration, out of the components 5,6,7, atleast two must function, what is the system reliability with the above reliability values of the components.

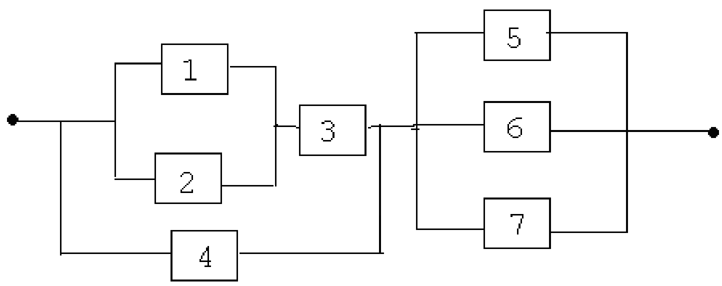

Figure 12:

[8+8]

3. (a) Define the following terms and explain:
   i. MTTF
   ii. MTTR
   iii. MTBF
   iv. Hazard rate function
   v. Reliability function
   vi. Probability density function
   vii. Probability distribution function

(b) Derive the relationship between reliability function and hazard rate function.

(c) A system is composed of three components.
Component 1 is in series with the parallel combination of components 2 and 3.
Given λ_1=2 failures per year and λ_2=λ_3 = 3 failure per year.
Calculate the reliability and MTTF of the system for a mission time of 1000 hours.

[4+4+5]

4. (a) Derive the expressions for the time dependent probabilities of one component repairable model, whose probabilities are exponentially distributed.

   (b) Explain how cumulative probability and cumulative frequencies are evaluated of various combined equal capacity states by finding equivalent transitional rates.

[8+8]

5. A generating station consists of two units of 50 MW and 70 MW each with a forced outage rate of 0.06 and 0.05 respectively. If the Mean-time-to-repair of each unit is 20 days, calculate loss of load probability and frequency of failure of a system if it has to deliver a steady load of 80 MW. [16]

6. (a) Explain how loss of energy indices are computed for generation system reliability analysis.

   (b) Explain how sequential method is used to develop cumulative capacity outage probability table for unit addition/ removal, with suitable expressions. [8+8]

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

   (b) Define and explain various annualised load point indices used for bulk power system reliability analysis. [8+8]

8. Write short notes on:

   (a) Determination of MTTF for parallel connected components

   (b) Recursive relation for discrete Markov Chain

   (c) Energy oriented indices for radial distribution systems

   (d) Merging of generation and Load model. [4×4]

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Code No: RR410211 **Set No.4**

IV B.Tech. I Semester Regular Examinations, November -2005
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) State and explain the probable distribution function that satisfies discrete random behaviour of two possible outcomes of an event. Derive the necessary expressions to substantiate the same and state the assumptions for repeated trails. [2+4+2]

   (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 atleast three free lines at any given time during this period? What is the expected number of free lines during this period. [6+2]

2. (a) Distinguish between fully redundant and partially redundant configurations with suitable examples and explain how network reliability/ unreliability is evaluated.

   (b) A system consists of four components in parallel. system requires that at least three of them must function. What is the probability of system success if the component reliability is 0.8? What is the probability of system success if five components are placed in parallel to perform the same function. [8+8]

3. (a) Calculate the reliability of the system whose reliability logic diagram is shown in Figure 13 if at least two out of the components 4,5,6 must function for system success. Assume the component reliabilities of all components equal to 0.9.
   Compare the above result with fully redundant configuration.

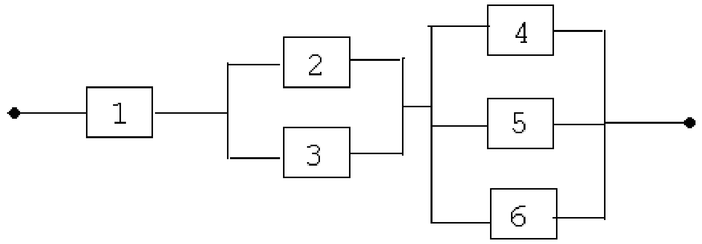

Figure 13:

   (b) For the above configuration, if the component probabilities are assigned with a failure rate of 15 × 10^{-5} failures/hour, evaluate the system reliability for 1000 hours. [8+8]

4. (a) Develop the state space diagram for two unit repairable system with the probabilities assigned with hazard rate functions, and hence evaluate the limiting state probabilities of the states, if the units have the same identical capacities and transitional rates.

   (b) The following stochastic transitional matrix P shows the transitional rates in a discrete Markov chain.

      i. Construct the state space diagram
      ii. Evaluate the limiting state probabilities.

$$P = \begin{array}{c} \\ 1 \\ 2 \\ 3 \end{array} \begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} 0.35 & 0.25 & 0.4 \\ 0.1 & 0.5 & 0.4 \\ 0.15 & 0.25 & 0.6 \end{bmatrix} \end{array}$$

[8+8]

5. (a) Explain how loss of load expectation is computed with daily peak load exceeding the available capacity.

   (b) Consider that there are two generating units of 25 MW each with a forced outage rate of 0.01 failures per day and repair rate of 0.49 repairs per day. The load data is:

Daily Peak Load in MW	57	52	46	41	34
Number of occurrences	42	83	107	116	47

   Compute the Loss of Load Expectation. [6+10]

6. (a) Explain loss of load indices and any one method of computation of LOLE.

   (b) Explain loss of energy indices and any one method of computation of LOEE.

[8+8]

7. (a) Explain the weighted average rate model for considering weather effects on transmission line for reliability analysis.

   (b) Discuss the various load point reliability indices that are used for radial distribution networks.

   (c) Discuss the various performance indices that are used for the composite system reliability analysis. [4+6+6]

8. Write short notes on:

   (a) Mean value of binomial distribution
   (b) Decomposition method in network reliability evaluation
   (c) Sequential addition method
   (d) Standard deviation of exponentially distributed function. [4×4]

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