Code No: NR420204 **Set No.1**

IV B.Tech. II Semester Supplementary Examinations, July -2005
POWER SYSTEM RELIABILITY
(Electrical & Electronic Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define the expected value of a random variable x when
   i. x is discrete and
   ii. x is continuous.
   (b) Let x be the random variable that denotes life in hours of a certain electronic device . The probability density function is $f(x) = \begin{cases} 2000/x^3 \ , \ x > 100 \\ 0 \quad , elsewhere \end{cases}$ find the expected life of this device.

2. (a) From fundamentals establish that Poisson distribution is a limiting case of binomial distribution .
   (b) The life in hours of an electronic gadget is normally distributed with parameters $\mu = 160$ hours and some σ , what would be the maximum allowable value for s if the life of the gadget is to have a probability 0.80 of being between 120 hrs and 200 hrs.

3. (a) Distinguish between fully redundant and partially redundant configurations with suitable examples
   (b) A system consists of two sub-stations in series. System 1 has four possible operating levels and System 2 has three possible operating levels as shown in the following table.

SYSTEM 1		SYSTEM 2	
Output	Probability	Output	Probability
100%	0.80	100%	0.7
75%	0.10	50%	0.1
25%	0.05	0%	0.2
0%	0.05		

   Develop an operating level probability table for the system

4. (a) Develop the symbolic reliability expression of a bridge network using paths and hence evaluate the reliability if the probability of success of each component is 0.7.
   (b) Suppose that for the same network mentioned above, if principle of decomposition is to be used to evaluate the above expression, what will be the difference?

5. (a) Explain how load is represented in a 2-state model. Develop the mathematical model for the same for determining the probability of load available.

   (b) Explain how combined generation-load model is developed and hence develop the expressions for cumulative probability and cumulative frequency of various combined capacity states.

6. A system consists of two 80 MW and one 100 MW generating units with forced outage rates of 0.03 for all. The monthly load duration curve is assumed to be a straight line, varying from 100% to 20% of peak load in 100 hrs. The peak load is 200 MW. Find the loss of load probability.

7. (a) Explain how the failure probability and failure frequency are calculated given the system and load models.

   (b) For a 3-state device, deduce the expression for the reliability of a low-level redundant system.

8. (a) Consider the following two systems
   System A: 6×50 MW —FOR= 4%
   Peak load 240 MW
   System B: 6×100 MW —FOR= 6%
   Peak load = 480 MW
   The two systems are interconnected by a 50 MW tie line. Calculate the loss of load expectation in each of the system on a one-day basis for the above data.

   (b) Explain the factors in brief affecting emergency assistance available through the interconnections.

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Code No: NR420204 **Set No.2**

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

Answer any FIVE Questions
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1. (a) Write a brief note on continuous and discrete random variables.

   (b) If a random variable has the probability density $f(x) = \begin{cases} 2e - 2x \ for x > 0 \\ 0 \qquad for x < 0 \end{cases}$

   Find the probabilities that it will take on a value

   i. Between 1 and 3

   ii. less than 0.5

2. (a) From fundamentals establish that Poisson distribution is a limiting case of binomial distribution .

   (b) The life in hours of an electronic gadget is normally distributed with parameters $\mu = 160$ hours and some σ , what would be the maximum allowable value for s if the life of the gadget is to have a probability 0.80 of being between 120 hrs and 200 hrs.

3. (a) The system shown in fig. is made of 10 components. Components 3,4,5 are not identical and it is fully redundant configuration. Components 8,9,10 are identical and at least two of these must function for the system success. Develop the expression for the system reliability , and hence evaluate the probability of success of each component is 0.8.(figure1)

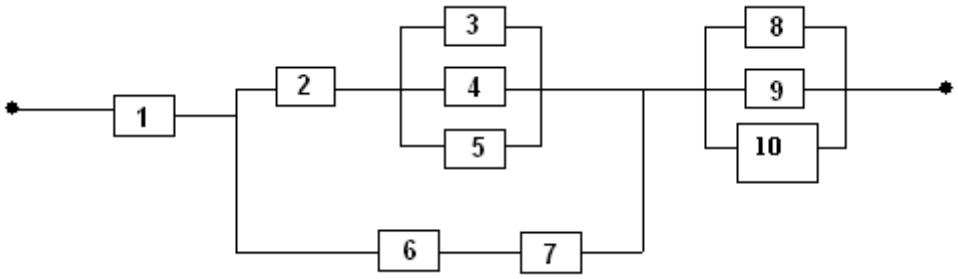

Figure 1:

   (b) A parallel system has 10 identical components having a reliability of 0.6. What is the minimum number of components required if the system reliability must be 0.96.

4. (a) Develop the relationship between paths and cut sets of a graph.

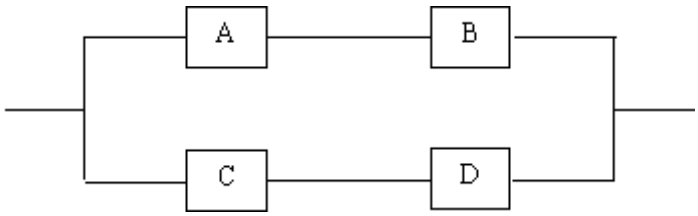

Figure 2:

(b) For the reliability logic diagram (figure2) , develop the symbolic unreliability expression using cut sets and hence evaluate the reliability of the systems , if each component has a probability of success of 0.8.

5. (a) Explain the recursive equation for developing generating capacity model building.

   (b) Explain how rounding off of capacities is considered for computing probabilities.

   (c) Explain how recursive equation is developed for computing cumulative probabilities when a unit is removed.

6. (a) Develop the state space model for rapid start units with the following data of transition rates per hour: $\lambda_{12} = 0.005$, $\lambda_{21} = 0.0033$, $\lambda_{14} = 0.03$, $\lambda_{41} = 0.015$, $\lambda_{23} = 0.0008$, $\lambda_{34} = 0.025$, $\lambda_{32} = 0.02$, $\lambda_{42} = 0.025$.

   (b) Explain the development of space model for hot reserve units

7. (a) Explain the MARKOV analysis for the state space dependent systems

   (b) Derive the probability and frequency of failure expression using two weather model using the state space model.

8. (a) Consider a system having G generating units and L transmission units and number of unavailability of generating units are A_G and unavailability of lines is A_L. compute the expressions for the failure probability.

   (b) Explain Monte Carlo simulation technique for the reliability assessment of bulk power system.

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1. (a) What is a random variable? Discuss briefly any two continuous distributions applicable in reliability engineering ?
   (b) A lot containing 7 components is sampled by a quality inspector ; the lot contains 4 good components and 3 defective components. A sample of 3 is taken by the inspector . Find the probable value of number of good components in this sample.
2. (a) From fundamentals establish that Poisson distribution is a limiting case of binomial distribution .
   (b) The life in hours of an electronic gadget is normally distributed with parameters $\mu = 160$ hours and some σ , what would be the maximum allowable value for s if the life of the gadget is to have a probability 0.80 of being between 120 hrs and 200 hrs.
3. (a) Classify various types of redundant configurations and explain.
   (b) Derive a general expression for the reliability of the system whose reliability logic diagram is shown in figure3.
      i. Consider the case in which out of the components 4,5,6 at least two of them must function for the system success. Hence evaluate the system reliability if each component has a probability of success of 0.8
      ii. if all the components were to be fully redundant , what will be the system reliability?

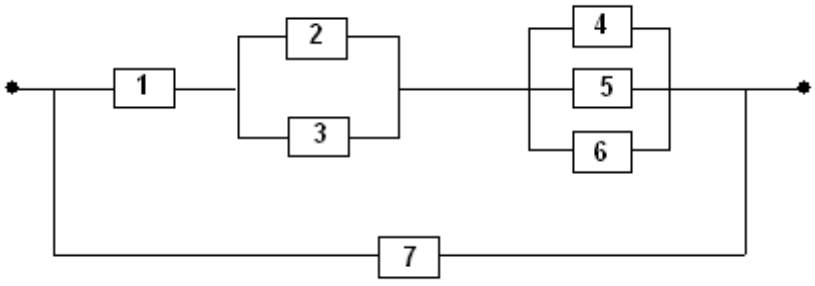

Figure 3:

4. (a) Explain how cut sets are used for evaluation of symbolic unreliability expression?

(b) Evaluate the symbolic unreliability expression of the system using cutest method for the network shown in figure and hence evaluate the unreliability of the system if each component has a probability of failure of 0.2.(figure4)

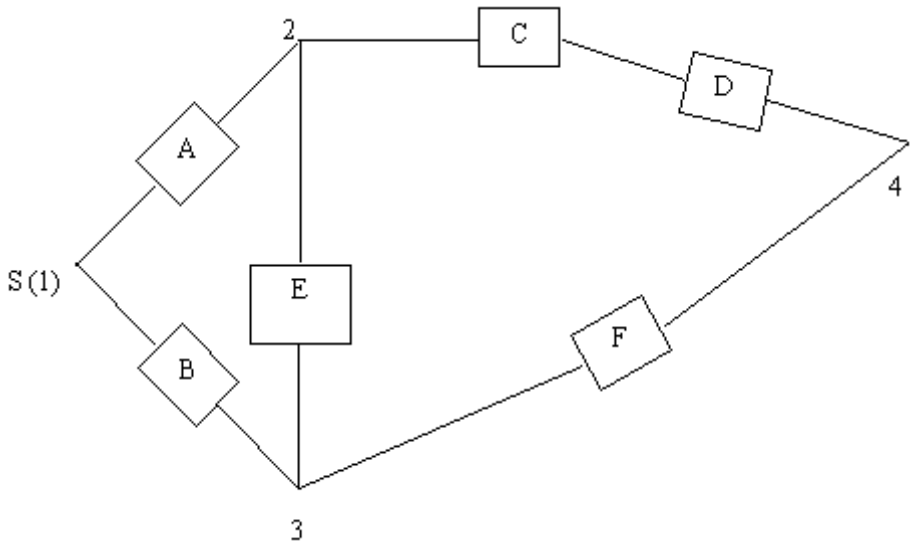

Figure 4:

5. A hypothetical generating station has three generators two rated for 10MW 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 respectively. Obtain the state space diagram and mark the various equivalent transition rates of the equal capacity states combined. Hence evaluate the cumulative probability and cumulative frequency of various combined states.

6. A generating system contains three 25 MW generating units each of 4% forced outage rate and are 30 MW unit with a 5% forced outage rate. If the peak load for a 100 days period is 75 MW, what is loss of load expectation and expected index of reliability for this period? Assume that the appropriate load characteristic is a straight line from the 100% to 60% points.

7. (a) Explain the MARKOV analysis for the state space dependent systems
   (b) Derive the probability and frequency of failure expression using two weather model using the state space model.

8. (a) Consider a system having G generating units and L transmission units and number of unavailability of generating units are A_G and unavailability of lines is A_L. compute the expressions for the failure probability.
   (b) Explain Monte Carlo simulation technique for the reliability assessment of bulk power system.

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

Answer any FIVE Questions
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1. (a) Write a brief note on continuous and discrete random variables.
   (b) If a random variable has the probability density $f(x) = \begin{cases} 2e-2x & for x > 0 \\ 0 & for x < 0 \end{cases}$
   Find the probabilities that it will take on a value
   i. Between 1 and 3
   ii. less than 0.5

2. (a) If the probability is 0.40 that steam will condense in a thin-walled aluminum tube at 10 atm pressure, use the formula for binomial distribution to find the probability.
   (b) A shows that a computer firm answers 70% of all inquiries within 6 days. Find the probabilities that the firm will answer 0,1,2 - - - - - or 10 of 10 inquiries within 6 days.

3. (a) Explain what is meant by 'Product rule' of reliability/unreliability? Explain its significance in evaluating the reliability of network configurations.
   (b) A series system has 10 identical components. If the overall system reliability shall be 0.8, what is the minimum reliability required for each component. If these elements are now connected in parallel, with the same probability obtained above, what will be the overall reliability of the system?

4. (a) Develop the symbolic reliability expression of a bridge network using paths and hence evaluate the reliability if the probability of success of each component is 0.7.
   (b) Suppose that for the same network mentioned above, if principle of decomposition is to be used to evaluate the above expression, what will be the difference?

5. A hypothetical generating station has three generators two rated for 10MW 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 respectively. Obtain the state space diagram and mark the various equivalent transition rates of the equal capacity states combined. Hence evaluate the cumulative probability and cumulative frequency of various combined states.

6. A generating station has three generators 2 rated for 15 MW and the third one for 25 MW. The failure and repair rates of each unit are 0.35 failures/year and 0.65 repairs per year. Obtain the state space diagram and mark the various transitional rates. Hence evaluate the cumulative probability and cumulative frequencies of various combined states.

7. (a) Explain the MARKOV analysis for the state space dependent systems
   (b) Derive the probability and frequency of failure expression using two weather model using the state space model.

8. Two power systems are interconnected by a 20 Mw tie line.. System A has three 20 Mw generating units with forced outage rate of 10% .system B has two 30Mw with forced outage rate of 20%. Calculate the LOLE in the system A for a one-day period given that the peak load in both the systems A and B is 30 Mw.

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