Registration No : | | | | | | | | | | |

Total Number of Pages : 03 **M.Tech.**
P2PRCC06

2nd Semester Regular Examination 2017-18
POWER SYSTEM RELIABILITY
BRANCH: ELECTRI & ELECTRO ENGG (POWER SYSTEM ENGG), ELECTRICAL ENGG., ELECTRICAL POWER SYSTEM, INDUS. POWER CONTROL AND DRIVES (PT), POWER AND ENERGY ENGG, POWER ENGG AND ENERGY SYSTEMS, POWER SYSTEM ENGG, POWER SYSTEMS
Time : 3 Hours
Max Marks : 100
Q.CODE : C863
Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.
Answer all parts of a question at a place.

Q1 **Answer the following questions: *Short answer type :*** **(2 x 10)**

a) Express unit forced outage rate (FOR) as a function of expected failure rate and expected repair rate. Hence justify in terms of modern reliability that, FOR is not a rate function.

b) Name and explain any two notable differences existing between individual state load model and cumulative state load model in view of estimation of system risk indices.

c) Which form of representation may be suitable for modeling of the random variation of tie-capacity uncertainty?

d) Draw the capacity outage probability table by using the probability array method to illustrate the four operating conditions of a two area system with a tie line interconnection.

e) Explain the function described by “lead time”. How does lead time affect the outage replacement rate (ORR). Justify your answer.

f) Which index assists the evaluation ofunit commitment risk by way of evaluating probability of achieving a certain response or regulating margin within the response time? Explain.

g) What are the advantages of distributing spinning reserve between two or more units than allocating the same reserve to a particular unit?

h) Write the expression for probability of occurrence of an event A, which is dependent on n-number of mutually exclusive events B_i, (i=1 to n).

i) Explain the interruption index described by customer average interruption frequency index (CAIFI) and indicate its dissimilarity from that of system average interruption frequency index (SAIFI).

j) What are the various components of overall failure rate associated with overlapping forced outages subject to effect of weather on the reliability indices? Explain briefly.

Q2 **a)** Draw the two state model for base load unit and four state model for planning studies applicable for estimation of the generating unit unavailability and compare their performance. Also derive the conventional FOR of these models by use of Markov process. **(10)**

b) A generating system consists of four single units having capacity 10 MW, 20 MW, 30 MW, and 40 MW respectively. The first three units have a forced outage rate of 0.08 each, whereas the fourth unit has a full forced outage rate of 0.08 along with a 50% derated state with probability of 0.06. Calculate the loss of load expected (LOLE) for this system for a single daily peak load of 60 MW. **(10)**

Q3 **a)** Explain the cumulative state load model with the help of a load-frequency characteristic and a typical load data and hence derive the formula for the appropriate system risk indices described by cumulative state probability index (*P*) and cumulative state frequency index (*F*). **(10)**

b) A generating plant has three identical 40 MW generating units and delivers a constant load of 82 MW. If the unit failure time is three failures per year and the average repair time is eight days for the same, calculate the following indices for the system. **(10)**

i) Frequency risk index,
ii) Duration risk index, and
iii) Probability risk index.

Q4 **a)** Describe the condition prevalent for loss of load in a single system and an interconnected system. Also indicate the process for accommodating the capacity deficiency in interconnected systems. Hence explain all the factors which may affect the emergency assistance available through interconnections. **(10)**

b) In a two area (Area-1 and Area-2) power system network with tie line interconnectivity, calculate the loss of load expected (LOLE) for Area-1 for a single day, given that the peak load for both areas are 30 MW each. Also assume that Area-1 contains three generating units of 20 MW capacity each with FOR 10% and Area-2 contains two generating units of 30 MW capacity each with FOR 20%. Assume any other data selectively. **(10)**

Q5 **a)** What is the basis on which the PJM method is formulated for evaluation of spinning requirements of interconnected systems? Also explain the various components of this method for study of ORR, generation model, and unit commitment risk with the help of the state models. **(10)**

b) A given power generating station has ten numbers of identical generating units of 60 MW capacity each. For a lead time of two hours and loads of 540 MW and 480 MW, find the unit commitment risk assuming an average up time for each unit to be 1750 hours. **(10)**

Q6 **a)** What are the limitations of reliability evaluation with the assumption that component failures within a fixed environment are independent events? How could these limitations be overcome with the help of conditional probability approach? Justify the merits of conditional probability approach for reliability evaluation of a simple radial network structure as shown in the figure 1. **(10)**

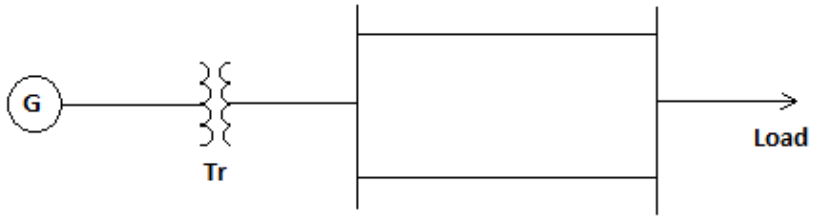

Fig.1 Simple radial generation transmission system layout

b) Explain the three basic reliability parameters (average failure rate, average outage time, and average annual outage time) characterizing the reliability evaluation of radial distribution systems. Considering a three load point radial distribution system having line sections A, B, and C in series with loads L_1, L_2, and L_3 respectively being tapped intermediately from each of these line sections, derive the expression for the three parameters of the system as indicated below. **(10)**

i) average failure rate (λ)
ii) average outage time (r)
iii) average annual outage time (U)

Q7 **a)** Explain the following reliability indices in brief and represent a mathematical expression for each. **(10)**

i) Average service availability/unavailability index (*ASAI/ASUI*)
ii) Energy not supplied index (*ENS*)
iii) Average Energy not supplied index (*AENS*)
iv) Average customer curtailment index (*ACCI*)
v) System average interruption duration index (*SAIDI*)

b) Explain the event describing temporary and transient failures in view of reliability of distribution systems with parallel and meshed networks. Also explain the evaluation techniques applied for identifying the failure modes of these systems using minimal cut set method for the case of temporary/transient failures overlapping with a permanent failure. **(10)**