Reliability evaluation of engineering systems

Problems

1 What is the probability of getting a total of 8
   (a) exactly three times in four tosses of a pair of dice
   (b) at least twice in four tosses of a pair of dice?
   (c) Draw the probability distribution of the number of times a total of 8 is obtained in four tosses of two dice?

2 The foreman of a casting section in a factory finds that on the average 1 in every 5 castings made is defective. If the section makes 8 castings a day what is the probability that exactly 2 castings will be defective?

3 A system has a continuous load of 80 MW. Find the expected load loss and the expected number of hours that any curtailment will exist if the generation is composed of
   (a) five 20 MW hydro-generating units each with an unavailability of 0.5%.
   (b) nine 10 MW thermal units each with an unavailability of 1.5%.

4 A pumping station has two 20 000 gal/hr pumps and is to have one 40 000 gal/hr pump installed. Draw up a pumping capacity outage probability table for this system given that the unavailabilities for the 20 000 and 40 000 gal/hr pumps are 0.2 and 0.1 respectively.

5 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?

6 The following transformer systems are to be compared:
(a) 3 transformers each rated at 100% of full load,
(b) 3 transformers each rated at 90% full load,
(c) 3 transformers each rated at 50% of full load, and
(d) 4 transformers each rated at $33\frac{1}{3}$% of full load.
Compare the adequacy of these systems in terms of the expected percent load curtailed and the expected hours of load curtailment, if the transformer unavailability is 0.01.

7 A small manufacturing company is operated by 4 employees. The company can still operate if only 3 are present but the income drops to 60% of the income at full production. If more than one employee is away production stops. It is known that 1 particular employee misses an average of 10 days out of 100 and that each of the others miss an average of 5 days out of 100. Absences are random and independent. The expenses of the company are \$500/day when operating and \$400 when shut down. The income at full production is \$800/day. What is the expected daily profit for the company?

8 An experiment consists of testing 12 units for a specified period of time. The probability of unit failure in this time is 0.08. The experiment is considered a success if 10 or more units survive the time period. The experiment is repeated 8 times. What is the probability of there being 6 or more successful experiments?

9 The design of a pumping station calls for 6 identical 15,000 litre/hour (l/hr) pumps to be installed. Each pump has a probability of not being available of 0.05.

(a) What is the probability of having all six pumps available?

(b) If the demand on the pumping station is 74 kl/hr, what is the probability of not meeting it?

(c) What is the expected available pumping capacity?

(d) What is the expected pumping load not supplied if the load is 74 kl/hr?

Repeat (a), (b), (c) and (d) if two of the 15,000 l/hr pumps are replaced by one 30,000 l/hr pump with an unavailability of 0.10.