Assignment 10

This assignment consists of 6 problems. Problems 2, 3, 9, 10, 11 and 12 from 518 - 519 pages.

Problem #2:
Compute the MTTF for Example 8.34 assuming that state 1 is the initial state. You may use the τ method. Next compute $MTTF_{eq}$ of the model in Figure 8.27 using the technique for Example 8.11. Show that they are identical. Explain the reason for this equivalence.

Problem #3:
Solve Example 8.37 using the τ method [equation(8.119)].

Problem #9:
Consider a two-component parallel redundant system with distinct failure rates λ_1 and λ_2, respectively. On failure of a component, a repair process is invoked with the respective repair rates μ_1 and μ_2. First assume that a failure of a component while another is being repaired causes a system failure. In this case set up the differential equations describing system behaviour. Derive the reliability and the MTTF of the system.

Problem #10:
Continuing with problem 9 above, assume that the failure of a component while another is being repaired is not catastrophic. Now compute the steady-state availability of the system.

Problem #11:
Modify the reliability model of Example 8.37 to allow for a repair to occur from states (3, 0) and (2, 0) at a constant rate γ. State F is still assumed to be an absorbing state. Recompute the system MTTF.

Problem #12:
Our assumption that the coverage probability is a given number is often un-

justified in the modeling of the fault-tolerant computers. In this problem we consider a "coverage model" of intermittent faults. (This is a simplified version of the model proposed by Stiffler[STIF 1980].) The model consists of five states as shown in Figure 8.P.4. In the active state A, the intermittent fault is capable of producing errors at the rate ρ and leading to the error state E. In the benign state B, the affected circuitry temporarily functions correctly. In state D the fault has been detected, and in the failure state F an undetected error has propagated so that we declare the system to have failed. Set up the differential equations for the five state probabilities. If we assume that all transition rates are greater than 0, then states A, B, and E are transient while states D and F are absorbing states. Given that the process starts in state A, it will evantually end up in either state D or state F. In the former case the fault is covered; in the latter it is not. We can, therefore, obtain an expression for coverage probability, $c = lim_{t \to \infty} \pi_D(t)$. Using the final value theorm of Laplace transforms(see Appendix D), show that

$$c = lim_{s \to 0} s \bar{\pi}_D(s) = \frac{\delta + \rho q}{\delta + \rho}.$$

Having obtained the value of c, we can then use an overall reliability model such as those in Example 8.35 and 8.37. Such a decomposition is intuitively appealing, since the transition rates in the coverage model will be orders of magnitude larger than those in the overall reliability model. For a detailed study of this decomposition approach to reliability modeling, see the paper by Dugan and Trivedi[DUGA 1989].