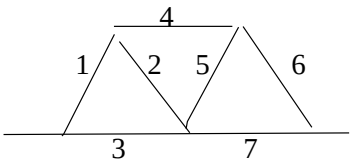
CS 5214 Modeling and Evaluation Fall 2023

Homework #1

Due 9/14 3:30pm in class

1. (25 points.) Consider an M/M/3/10 queuing system equipped with one fast server with a service rate of μ_1=5 customers/sec and two slow servers each with a service rate of μ_2=3 customers/sec. Assume that the customer arrival rate λ is 15 customers/sec and a customer will always choose the fast server if it is available. Write an smpl simulation program for this M/M/3/10 queueing system to compute (1) the customer turned-away probability, (2) average number of customers waiting in the system (excluding the ones in service), (3) response time per client for those served by the fast server, (4) response time per client for those served by any one of the two slow servers, and (5) throughput. Make sure that the reported response time for those served by the fast server is within 95% level of confidence with 5% confidence accuracy based on the batch mean analysis method. Also report the confidence accuracy obtained from your simulation program. Show the smpl program source code and output.

2. (10 points.) Consider a system consisting of 1 workstation and 3 file servers. The network connecting them is assumed to be fault-free. Assume that all components obey the exponential failure law, with the failure rate of λ_w for a single workstation and the failure rate of λ_f for a single file server. The system is operational as long as one workstation and one file server are operational. Derive the mathematical expressions for the reliability $R(t)$ and mean time to failure (MTTF) of the system as a function of λ_w and λ_f.



3. (25 points.) A network topology with 7 components is shown above. Assume that components 1 through 7 all obey the exponential failure law, with the failure rates of 1×10^{-5} hr^{-1}, 2×10^{-5} hr^{-1}, 3×10^{-5} hr^{-1}, 4×10^{-5} hr^{-1}, 5×10^{-5} hr^{-1}, 6×10^{-5} hr^{-1}, and 7×10^{-5} hr^{-1}, respectively.

   (a) (10 points.) write a Sharpe code based on a reliability graph model to compute the system reliability after 12 weeks of operation.

   (b) (5 points.) Find the minimal path and minimal cut sets.

   (c) (10 points.) Build a fault tree model based on the minimal path set identified in (b) and then write a Sharpe code based on your fault tree model to compute the system reliability after 12 weeks of operation. The answer obtained here should be the same as that obtained from part (a).