Ministry of Higher Education
Cairo Higher Institute
Computer and Electronic Systems Engineering Department

Time Allowed: 2 Hours
Open-Book/Notes

Simulation Systems Practice Exam

May 2012

Solve As Much As You Can – Maximum Grade: 40 Points

1. [3 points] Write the algorithm that implements the following random number generator:

$$Ran = A2_r(C1) \wedge B9$$

2. [15 points] Mark the following questions as either True or False and give reasons:
   a. Good random number generators may not use LCG parts in their formulas.
   b. Comparison function in transformation method must have an indefinite integral that is a strict upper bound to desired distribution.
   c. It is possible to use rejection method to generate samples from discrete distributions.
   d. Simulated annealing optimization is a direct application of Metropolis sampling.
   e. Gibbs sampling is similar in steps to importance sampling but with different weights.
   f. For a Markov model, if the transition matrix does not have at least one nonzero eigenvalues, then the model does not have a stationary distribution.
   g. Metropolis Markov models always have unique stationary distributions.

3. [3 points] Is it always possible to use the Rejection method to obtain samples from any distribution? Explain your answer.

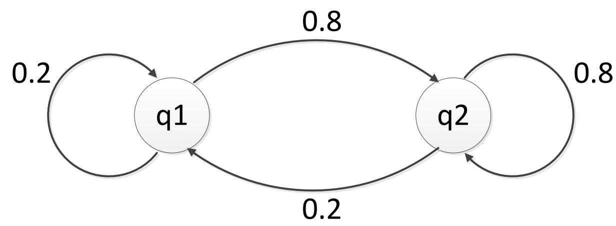
4. [5 points] In random sampling using the rejection method, the first random deviate was obtained from a uniform distribution ~[0, 100] and came out to be 67. This corresponds to a value of x=3.1 with value of desired probability density function p(x)=0.2 and with value of comparison function f(x)=0.5. If the second random deviate was found to be 0.3, determine whether x will be accepted or rejected and why.

5. [5 points] In the rejection method, if the area under the comparison function f(x) is 2.1 such that it upper bounds the desired distribution p(x), determine how many uniform samples are required to generate 1000 samples from the desired distribution p(x).

6. [4 points] For a Markov model with eigenvalues of 1, 0.9, 0.5 and 0.4, determine whether or not the model has stationary states.

7. [5 points] For the shown Markov model, determine if it is ergodic or not and write its transition matrix P. If the initial distribution is p=[1 0], compute 3 time steps of this model. If the output matrix is given as below, determine the outputs of the system in the simulated 3 steps.

$$B = \begin{bmatrix} 0.8 & 0.1 & 0.1 \\ 0.2 & 0.4 & 0.4 \end{bmatrix}$$



Best of Luck