



SYSTEM SIMULATION AND
MODELLING

LECTURE 2

Section D

TOPIC COVERED: Techniques for
Generating Random Numbers, Inverse
transform Techniques, Convolution
Methods,

TECHNIQUES FOR GENERATING RANDOM NUMBERS

A random number generator (RNG) is a computational or physical device designed to generate a sequence of numbers or symbols that lack any pattern, i.e., appear random.

There are following methods used for generating random numbers:

1. Linear Congruential Generators.
2. Lagged Fibonacci Generators.

Linear Congruential GENERATORS

A Linear congruential generator (LCG) is an algorithm that yields a sequence of randomized number calculated with a liner equation.

Linear congruential method is widely used technique for generating random number. This technique is based on linear recurrences of the following form:

$$X_i = (a_i X_{i-1} + \dots + a_k X_{i-k}) \text{ mod } (m) \quad \dots(4.1)$$

where modulus m and the order k of the recurrence are positive integers and the coefficient a_i belong to the set $\{0, 1, \dots, m-1\}$.

If m is a prime number and if the a_i 's satisfy certain conditions the sequence $\{x_i, i \geq 0\}$, has the maximal period of length $\rho = m^k - 1$.

- The random number returned at each step is given by $R_i = \frac{X_i}{m}$. The linear congruential method generates a sequence of integers $X_1, X_2 \dots$ between zero and $m - 1$ by following a recursive relationship

$$X_{i+1} = (aX_i + C) \bmod m, \text{ where } i = 0, 1, 2, \dots \quad \dots(4.2)$$

where the initial value X_0 is called the *seed*, a is called the *multiplier*, C is the increment and m is the modulus.

NOTE:

- (I) Equation 4.2 is known as the multiplicative congruential method for $C = 0$
- (II) Equation 4.2 is known as the mixed congruential method for $C \neq 0$

TESTS FOR RANDOM NUMBER

We know that uniformity and independence are the desirable properties of random numbers.

To check on whether these desirable properties have been obtained, a number of tests have been developed. The tests can be placed in two categories based on the properties of interest:

Uniformity and independence. These tests are as follows:

- (I) Frequency Test: Uses the Kolmogorov – Smirnov or the chi-square test to compare the distribution of the set of numbers generated to a uniform distribution.
- (II) Auto Correlation Test: Tests the correlation between numbers and compares the sample correlation to the expected correlation zero.