



United International University (UIU)
Dept. of Computer Science & Engineering (CSE)

Final: Fall - 2023

Course: CSI 423 || Simulation and Modeling

Marks: 30, Time: 2 hours

Figures in the right-hand margin indicate full marks.

Any examinee found adopting unfair means will be expelled from the trimester/ program as per UIU disciplinary rules.

1. (a) Suppose an LCG has the following equation: [3]

$$Z_i = (29Z_{i-1} + 5) \bmod 7, \text{ where } Z_0 = 1$$

Justify whether this LCG has full period or not.

- (b) We know, Tausworthe Random Bit Generator works according to the following equation:

$$b_i = (b_{i-r} + b_{i-q}) \bmod 2 \quad [3]$$

Now, using this method, generate 6 new bits. Consider $r=3$ and $q=2$. And the first 3 bits are: 1,0,1.

- (c) Generate three (3) random numbers in the range of (0,1) using quadratic congruential generator with - [3]

$$Z_i = (5Z_{i-1}^2 + 2Z_{i-1} + 7) \bmod 16 \text{ and } Z_0 = 1$$

- (d) Suppose G1, G2 and G3 are three congruential generators with following properties:

$$G1 \Rightarrow Z_{1,i} = (12 Z_{1,i-1}^2 + Z_{1,i-2}) \bmod 12, \text{ Here: } Z_{1,0} = 2 \text{ and } Z_{1,1} = 5 \quad [6]$$

$$G2 \Rightarrow Z_{2,i} = (Z_{2,i-1}^2 + 2 Z_{2,i-1} + 5) \bmod 16, \text{ Here } Z_{2,0} = 3$$

$$G3 \Rightarrow Z_{3,i} = (13 Z_{3,i-1} + 13) \bmod 15, \text{ Here } Z_{3,0} = 7$$

Apply Wichman/Hill to generate 6 new random numbers between [0,1]

2. Imagine a newspaper seller buys 60 newspapers everyday for 25 cents each. He sells his newspapers at 50 cents each. Any paper that he cannot sell throughout the day is sold as scrap paper for 2 cents each. On the other hand, if the demand for the day exceeds his stock of newspaper, then he suffers a lost profit.

There are three types of newsdays - "good," "fair," and "poor," with probabilities of 0.6, 0.3, and 0.1, respectively. And the demand probability distribution for various demands are as following:

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Demand	Demand Probability Distribution		
	Good	Fair	Poor
40	0.03	0.10	0.44
50	0.05	0.18	0.22
60	0.15	0.40	0.16
70	0.20	0.20	0.12
80	0.35	0.08	0.06
90	0.15	0.04	0.00
100	0.07	0.00	0.00

Consider the following random numbers:

i. to determine the type of newsday: 02, 67, 45, 23, 88, 15.

ii. to determine demands from demand distribution: 75, 70, 20, 89, 12, 98.

(a) Simulate the above scenario for 6 days. Mention the revenue from sales, lost profits, salvage from sales, and daily profits for each day. **[8]**

(b) Considering the simulation above, what suggestions would you give to the newspaper seller for optimal profit? **[2]**

3. Mention one advantage and one disadvantage for each of the following:

(a) Generating random bits by tossing a coin and assigning bit 0 for Head and bit 1 for Tail. **[2]**

(b) Generating random numbers by applying an Algorithmic (sequential) approach.

4. A probability density function is defined with the following equation–

$$f(x) = 0.3 f_1(x) + 0.5 f_2(x) + 0.2 f_3(x)$$

Where,

$$f_1(x) = \begin{cases} \frac{1}{D} & 0 \leq x < D \\ 0 & \text{otherwise} \end{cases}$$

$$f_2(x) = \begin{cases} D e^{-Dx} & x \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

$$f_3(x) = \begin{cases} \frac{x-1}{4} & 2 \leq x < 4 \\ 0 & \text{otherwise} \end{cases}$$

Now use the composition method to generate 3 random variates from the given PDF. A random table has been attached. Read column-1 for the values of U_1 and read column-2 for the values of U_2 . Here $D=4$.

[6]

Random Number Table:

52	50	60	52	05
37	27	80	69	34
82	45	53	33	55
69	81	69	32	09
98	66	37	30	77
96	74	06	48	08
33	30	63	88	45

5. A country is expected to be well-educated if 10% of people have High School education, 50% have a Bachelors, 30% have a Masters, and 10% have a Ph.D. The country of Inisherin claims that they are well-educated.

[7]

To verify their claim, randomly 500 people were surveyed and each person was asked to report the highest education level they obtained. The data from the survey is summarized in the following table:

Education Level	Reported From Survey
High School	300
Bachelors	100
Masters	50
Ph.D.	50

If the significance level is 5%, then verify the claim made by the country Inisherin using Chi Square Testing.

The table for Critical Value for degree of freedom and corresponding significance is given below:

Table for Chi Square Testing

Degree of Freedom	Significance Level ()					
	0.99	0.95	0.90	0.10 α	0.05	0.01
1	---	0.004	0.016	2.706	3.841	6.635
2	0.02	0.103	0.211	4.605	5.991	9.21
3	0.115	0.352	0.584	6.251	7.815	11.345
4	0.297	0.711	1.064	7.779	9.488	13.277
5	0.554	1.145	1.61	9.236	11.07	15.086
6	0.872	1.635	2.204	10.645	12.592	16.812
7	1.239	2.167	2.833	12.017	14.067	18.475

