United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Final Exam: Spring - 2022

Course: CSE 4523 | Course Name: Simulation and Modeling

Marks: 40, 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.

Answer all the FIVE questions.

1. UIU transportation has four different routes: Dhanmondi, Mohammadpur, Mirpur and Arambagh. The transportation authority reported that 32% of the students come from Dhanmondi route, 21% from Mohammadpur route, 29% from Mirpur route and the other 18% from Arambagh route. Today you have monitored the number of students coming to UIU campus using the transportation facility. The number of students observed in the buses from different routes are as follows: 7

Route	Number of students
Dhanmondi	189
Mohammadpur	92
Mirpur	270
Arambagh	107
Total	658

Use Chi-squared test with 10% level of significance to determine whether the distributions of students are different or not. Necessary table is attached at the end of the question.

2 We have three random number generators (RNGs) as specified below. 2+2+7

G1: A linear congruential generator.

$$Z_{1,i} = (15Z_{1,i-1} + 3) \ mod \ 28; \ Z_{1,0} = 10$$

G2: A quadratic congruential generator.

$$Z_{2,i} = (2Z_{2,i-1}^2 + 5Z_{2,i-1} + 7) \ mod \ 19; \ Z_{2,0} = 9$$

G3: A Blum Blum Shub (B/B/S) generator.

$$p = 11, \ q = 23, \ l = 3, \text{ seed} = 12$$

Now, answer the following questions.

a) Using full period theorem, determine if G1 shows full period or not.
b) Describe the Wichmann-Hill algorithm for building a composite RNG.
c) Generate 3 (three) random numbers from a composite RNG built by Wichmann-Hill algorithm with G1, G2 and G3.

3. A probability density function is defined with the following equation. 8

$$f(x) = 0.32\, f_1(x) + 0.68\, f_2(x)$$

Where,

$$f_1(x) = \begin{cases} \frac{1}{32}x^2 & 0 \le x < 4 \\ \frac{1}{3} & 4 \le x < 5 \\ 0 & \text{otherwise} \end{cases}$$

$$f_2(x) = \begin{cases} \frac{2}{9}(x-1) & 1 \le x < 3 \\ \frac{2}{9}(5-x) & 3 \le x < 4 \\ \frac{2}{9} & 4 \le x < 5 \\ 0 & \text{otherwise} \end{cases}$$

Now use the composition method to generate 3 random variates from the given PDF. A random table has been attached at the end of the question paper. Read column-1 for the values of U1 and read column-2 for the values of U2.

4. You are going to simulate an inventory with maximum capacity 18 and review period 4 days. The probability distributions of daily demands and lead time are given at the end of this question paper in tabular format. Simulate the inventory for 3 cycles and find the average ending inventory and the number of days with shortage. In your simulation table, show beginning and ending inventory, daily demand, shortage amount, days until next arrival for each day and also order quantity on review day. 7

Start the simulation with the beginning inventory level at 8 units. An order of 10 units is scheduled to arrive on the 3rd day of first cycle.

From the random table attached at the end of the question paper, read column-3 and column-4 for ***daily demand*** *and read column-5 for* ***lead time.***

5. Three objects A, B, C are involved in a serial chase. B is chasing A, C is chasing B and A is chasing C. 7

The initial positions of A, B and C are (0,0), (200,20) and (20, 200) respectively. Each of the objects has the same speed of 5 m/s.

Simulate the serial chase for 1 second and report the final positions and pairwise distances (at t=1) for all the objects.

[All the distances are measured in meter and the time unit is second]

Table 1: (Referred in Question #1)

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15
60	37.485	43.188	46.459	52.294	59.335	66.98	74.40	79.08	88.38

Table 2: (Referred in Question #3 and #4)

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