5. Simulation of single server queue system using GPSS.

i. Barber Shop simulation to simulate one day of operation of a barber.

Problem: Customers arrive at barber shop at the rate of 18 ± 6. Mechanic serves each customer at the rate of 16 ± 4 minutes. Simulate system for queue of customer and measure of waiting time for 25 customers.

Model:

```
GENERATE 18,6          ;Customer arrive every 18+/-6 mn
QUEUE Chairs           ;Enter the line
SEIZE Joe              ;Capture the barber
DEPART Chairs          ;Leave the line
ADVANCE 16,4           ;Get a hair cut in 16+/-4 mn
RELEASE Joe            ;Free the barber
TERMINATE 1            ;Leave the shop
```

Output:

```
               GPSS World Simulation Report - 1_Barbar_Shop_oneDayOperation.5.1


                    Thursday, January 11, 2024 20:27:07

             START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
                  0.000            466.570     7        1          0


                NAME                     VALUE
             CHAIRS                   10000.000
             JOE                      10001.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE            25             0       0
                    2    QUEUE               25             0       0
                    3    SEIZE               25             0       0
                    4    DEPART              25             0       0
                    5    ADVANCE             25             0       0
                    6    RELEASE             25             0       0
                    7    TERMINATE           25             0       0


FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 JOE                25    0.860      16.057  1        0    0    0     0       0


QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 CHAIRS              1    0     25     14     0.080      1.499      3.407   0


FEC XN    PRI         BDT      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
    26    0         467.353     26      0      1
```

ii. Barber Shop simulation (simple).

Problem: Customers arrive at barber shop at the rate of 300 ± 100. Mechanic serves each customer at the rate of 400 ± 200 minutes. Simulate system for queue of customer and measure of waiting time for 1000 customers.

Model:

```
GENERATE 300,100          ;Create next customer
QUEUE Barber              ;Begin queue time
SEIZE Barber              ;Own or wait for barber
DEPART Barber             ;End queue time
ADVANCE 400,200           ;Haircut takes a few minutes
RELEASE Barber            ;Haircut done. Give up the barber.
TERMINATE 1               ;Customer leaves
```

Output:

```
                GPSS World Simulation Report - 2_Barbar_shop(simple).2.1


                    Thursday, January 11, 2024 20:32:33

             START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
                  0.000         401931.114     7        1          0


                NAME                       VALUE
              BARBAR                     10000.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE          1347             0       0
                    2    QUEUE             1347           346       0
                    3    SEIZE             1001             1       0
                    4    DEPART            1000             0       0
                    5    ADVANCE           1000             0       0
                    6    RELEASE           1000             0       0
                    7    TERMINATE         1000             0       0

FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 BARBAR            1001    0.999     401.161  1     1001    0    0     0    346

QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 BARBAR            347  347   1347      1   174.888  52184.845  52223.615   0

CEC XN    PRI          M1      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
  1001     0      298909.662   1001      3      4

FEC XN    PRI          BDT     ASSEM  CURRENT  NEXT  PARAMETER    VALUE
  1348     0      402257.310   1348      0      1
```

iii. Mechanic Shop simulation.

Problem: Customers arrive at mechanic shop at the rate of 300 ± 200. Mechanic serves each customer at the rate of 200 ± 50 minutes. Simulate system for queue of customer and measure of waiting time for 1000 customers.

Model:

```
GENERATE 300 200          ;create next customer
QUEUE MECHANIC
SEIZE MECHANIC            ;Own mechanic(resource)
DEPART MECHANIC
ADVANCE 200 50            ;Mechanic Takes some Time
RELEASE MECHANIC          ;Release the resource
TERMINATE 1               ;end simulation
```

Output:

```
                GPSS World Simulation Report - 3_Mechanic_shop.2.1


                     Thursday, January 11, 2024 21:15:27

           START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
                0.000         302200.785     6        1          0


              NAME                       VALUE
            MECHANIC                   10000.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE          1000             0       0
                    2    QUEUE             1000             0       0
                    3    SEIZE             1000             0       0
                    4    ADVANCE           1000             0       0
                    5    RELEASE           1000             0       0
                    6    TERMINATE         1000             0       0


FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 MECHANIC          1000    0.660     199.321  1        0    0    0     0      0


QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 MECHANIC         1000 1000   1000       0   502.346 151809.256 151809.256   0


FEC XN    PRI         BDT      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
  1001     0       302264.348   1001      0      1
```

iv. Telephone System Simulation.

Problem: A simple telephone system has two external lines. Calls, which originate externally, arrive every 100±60 seconds. When the line is occupied, the caller redials after 5±1 minutes have elapsed. Call duration is 3±1 minutes. A tabulation of the distribution of the time each caller takes to make a successful call is required. How long will it take for 200 calls to be completed?

Model:

```
Sets        STORAGE     2
Transit     TABLE       M1,.5,1,20      ;Transit times
            GENERATE    1.667,1         ;Calls arrive
Again       GATE SNF    Sets,Occupied   ;Try for a line
            ENTER       Sets            ;Connect call
            ADVANCE     3,1             ;Speak for 3+/-1 min
            LEAVE       Sets            ;Free a line
            TABULATE    Transit         ;Tabulate transit time
            TERMINATE   1               ;Remove a transaction
Occupied    ADVANCE     5,1             ;Wait 5 minutes
            TRANSFER    ,Again          ;Try again
```

Output:

```
                GPSS World Simulation Report - 4_Telephone_system.5.1


                    Thursday, January 11, 2024 21:17:58

          START TIME          END TIME  BLOCKS  FACILITIES  STORAGES
               0.000           359.156     9        0          1


             NAME                       VALUE
          AGAIN                          2.000
          OCCUPIED                       8.000
          SETS                       10000.000
          TRANSIT                    10001.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE           216             0       0
AGAIN               2    GATE               762             0       0
                    3    ENTER              201             0       0
                    4    ADVANCE            201             1       0
                    5    LEAVE              200             0       0
                    6    TABULATE           200             0       0
                    7    TERMINATE          200             0       0
OCCUPIED            8    ADVANCE            561            15       0
                    9    TRANSFER           546             0       0


STORAGE             CAP. REM. MIN. MAX.  ENTRIES AVL.  AVE.C. UTIL. RETRY DELAY
 SETS                 2    1    0     2      201   1    1.677  0.839    0     0
```

TABLE	MEAN	STD.DEV.	RANGE			RETRY	FREQUENCY	CUM.%
TRANSIT	14.268	17.274				0		
			1.500	-	2.500		20	10.00
			2.500	-	3.500		41	30.50
			3.500	-	4.500		24	42.50
			4.500	-	5.500		0	42.50
			5.500	-	6.500		2	43.50
			6.500	-	7.500		9	48.00
			7.500	-	8.500		14	55.00
			8.500	-	9.500		12	61.00
			9.500	-	10.500		1	61.50
			10.500	-	11.500		0	61.50
			11.500	-	12.500		2	62.50
			12.500	-	13.500		9	67.00
			13.500	-	14.500		3	68.50
			14.500	-	15.500		1	69.00
			15.500	-	16.500		2	70.00
			16.500	-	17.500		4	72.00
			17.500	-	18.500		7	75.50
			18.500	-	_		49	100.00

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
179	0	359.251	179	8	9		
196	0	359.367	196	8	9		
217	0	359.676	217	0	1		
161	0	359.972	161	8	9		
215	0	360.201	215	8	9		
167	0	360.580	167	8	9		
195	0	360.656	195	4	5		
197	0	360.826	197	8	9		
187	0	362.292	187	8	9		
210	0	362.403	210	8	9		
216	0	362.513	216	8	9		
205	0	363.396	205	8	9		
203	0	363.487	203	8	9		
211	0	363.852	211	8	9		
208	0	364.028	208	8	9		
207	0	364.827	207	8	9		
214	0	364.883	214	8	9		

v. Turnstile of Football Stadium.

Problem: Spectators arrive at a turnstile of a football stadium every 7±7 seconds and queue for admittance. The time to pass through is evenly distributed at 5±3 seconds. A model is required to determine the time taken by 300 people to pass through the turnstile.

Model:

```
In_use      EQU         5           ;Mean time
Range       EQU         3           ;Half range
            GENERATE    7,7         ;People arrive
            QUEUE       Turn        ;Enter queue
            SEIZE       Turn        ;Acquire turnstile
            DEPART      Turn        ;Depart the queue
            ADVANCE     In_use,Range ;Use turnstile
            RELEASE     Turn        ;Leave turnstile
            TERMINATE   1           ;One spectator enters
```

Output:

```
                GPSS World Simulation Report - 5_Football_Stadium.3.1


                     Thursday, January 11, 2024 21:20:44

           START TIME          END TIME  BLOCKS  FACILITIES  STORAGES
                0.000          2134.023     7        1          0


              NAME                       VALUE
          IN_USE                          5.000
          RANGE                           3.000
          TURN                        10002.000


 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                    1    GENERATE           300             0       0
                    2    QUEUE              300             0       0
                    3    SEIZE              300             0       0
                    4    DEPART             300             0       0
                    5    ADVANCE            300             0       0
                    6    RELEASE            300             0       0
                    7    TERMINATE          300             0       0

FACILITY         ENTRIES  UTIL.   AVE. TIME AVAIL. OWNER PEND INTER RETRY DELAY
 TURN              300    0.690       4.906  1        0    0    0     0       0

QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 TURN                3    0    300    150     0.319      2.270      4.540   0

FEC XN   PRI         BDT      ASSEM  CURRENT  NEXT  PARAMETER    VALUE
   301    0        2135.381    301      0      1
```

vi. Manufacturing Shop.

Problem: A machine tool in a manufacturing shop is turning out parts at the rate of every 5 minutes. As they are finished, the parts are turned over to an inspector who takes 4±3 minutes to examine each one and rejects about 10% of the parts as faulty. Each part will be represented by an transaction and the base time unit for the system is chosen as 1 minute. Simulate for 100 parts to leave the system.

Model:

```
        GENERATE 5
        QUEUE Insq
        ENTER Ins,1
        DEPART Insq
        ADVANCE 4,3
        LEAVE Ins,1
        TRANSFER 0.1,Acc,Rej
Acc     TERMINATE 0
Rej     TERMINATE 0
        GENERATE 480
        TERMINATE 1
Ins     STORAGE 3
```

Output:

```
            GPSS World Simulation Report - 6_Manufacturing_shop.13.1


                 Thursday, January 11, 2024 19:53:34

 START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
      0.000          48000.000    11        0          1


    NAME                         VALUE
ACC                               8.000
INS                           10000.000
INSQ                          10001.000
REJ                               9.000
```

LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	9600	0	0
	2	QUEUE	9600	0	0
	3	ENTER	9600	0	0
	4	DEPART	9600	0	0
	5	ADVANCE	9600	2	0
	6	LEAVE	9598	0	0
	7	TRANSFER	9598	0	0
ACC	8	TERMINATE	8691	0	0
REJ	9	TERMINATE	907	0	0
	10	GENERATE	100	0	0
	11	TERMINATE	100	0	0

QUEUE	MAX	CONT.	ENTRY	ENTRY(0)	AVE.CONT.	AVE.TIME	AVE.(-0)	RETRY
INSQ	1	0	9600	9600	0.000	0.000	0.000	0

STORAGE	CAP.	REM.	MIN.	MAX.	ENTRIES	AVL.	AVE.C.	UTIL.	RETRY	DELAY
INS	3	1	0	2	9600	1	0.796	0.265	0	0

FEC XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
9699	0	48000.099	9699	5	6		
9700	0	48003.516	9700	5	6		
9701	0	48005.000	9701	0	1		
9702	0	48480.000	9702	0	10		

```
PS C:\Users\user\OneDrive - College of Applied Business\Desktop\CAB\Lab\5th_sem_lab> cd "c:\Users\user
imulation_and_Modeling\" ; if ($?) { gcc 5_chi_square.c -o 5_chi_square } ; if ($?) { .\5_chi_square }
Enter total number of random numbers to generate: 7

Random numbers generated:
0.001251
0.563585
0.193304
0.808741
0.585009
0.479873
0.350291


Chi-square value: 5.857143
The random numbers pass the chi-square test at 5% significance level.
```

```
PS C:\Users\user\OneDrive - College of Applied Business\Desktop\CAB\Lab\5th_sem_lab> cd "c:\Users\
ion_and_Modeling\" ; if ($?) { gcc 4_k_s_Test.c -o 4_k_s_Test } ; if ($?) { .\4_k_s_Test }
Kolmogorov Test
Enter number of elements to compute for tets:   6
0.65
0.73
0.77
0.32
0.45
0.91
D+ = 0.090000
D- = 0.320000
D = 0.320000
```

```
PS C:\Users\user\OneDrive - College of Applied Business\Desktop\CAB\Lab\5th_sem_lab> cd "c:\Users\user\OneDrive - C
ollege of Applied Business\Desktop\CAB\Lab\5th_sem_lab\Simulation_and_Modeling\" ; if ($?) { gcc 6_poker_test.c -o
6_poker_test } ; if ($?) { .\6_poker_test }
The generated 100 random numbers are:
422     342     327     149     422     156     230     169     321     390     573     139     759     284     559
     582     113     789     429     601732      396     732     148     218     211     267     100     177     68
1     296     656     645     279     303     163     233     398     528     238237      167     588     198     6
22     394     332     517     117     476     469     639     217     620     191     789     631     656     595
     329407      645     134     720     256     207     472     676     692     561     281     664     465     493
     131     470     444     759     396     344192      404     138     269     717     652     756     358     35
3     755     254     159     642     444     132     399     246     747     339     777
Chi-square statistic: 478.200000
The test failed (i.e., the numbers do not appear to be independent).
```

```
PS C:\Users\user\OneDrive - College of Applied Business\Desktop\CAB\Lab\5th_sem_lab> cd "c:\Users\user\OneDriv
ion_and_Modeling\" ; if ($?) { gcc 3_Monte_carlo_method.c -o 3_Monte_carlo_method } ; if ($?) { .\3_Monte_carl
Enter number of iterations: 9
HHTHTHHHHH
TTHTHHHTTH
HHTTTHHTHT
HTTHHHTTHT
HTHTTTTTHT
HHTTHHHHHH
THHTHHHTTH
HTTTTTHHTH
TTTHTHTTHH

Probability of getting 3, 6, 9 heads in 10 flips of a coin is: 0.222222
```

```
PS C:\Users\user\OneDrive - College of Applied Business\Desktop\CAB\Lab\5th_sem_lab> cd "c:\Users\u
ion_and_Modeling\" ; if ($?) { gcc 2_Linear_congruential_method.c -o 2_Linear_congruential_method }
Enter random number to generate: 5
ENter valur of a: 45
Enter value of c: 4
Enter value of m: 100
Enter value of seed: 41
Random numbers are:
0.490000
0.090000
0.090000
0.090000
0.090000
```

COLLEGE OF APPLIED BUSINESS AND TECHNOLOGY

Kathmandu, Nepal

Laboratory Assignment Log Sheet of B.SC. CSIT 5th Semester
Subject: CSC 317:Simulation & Modeling

Task No.	Title			Signature
1.	Implement application of Markov Chain.			
2.	Implement application of Monte Carlo Method			
3.	Testing of Random Numbers			
	A.	Testing of Uniformity		
		i	Implementation of Kolmogorov-Smirnov Test (K-S Test)	
		ii.	Implementation of Chi Square Test.	
	B.	Testing of Independence		
		i.	Implementation of Poker Test.	
4.	Implement Linear Congruential Method for random no. generation			
5.	Simulation of single server queue system using GPSS			
	i.	Barber Shop simulation to simulate one day of operation of a barber		
	ii.	Barber Shop Simulation (simple)		
	iii.	Mechanic Shop simulation		
	iv.	Telephone System Simulation		
	v.	Turnstile of Football Stadium		
	vi.	Manufacturing Shop		