Scheme of Evaluation
Internal Assessment Test 1 – March.2019

Sub:	System Modeling and Simulation							Code:	15CS834
Date:	07/03/2019	Duration:	90mins	Max Marks:	50	Sem:	VIII	Branch:	ISE

Note: Answer Any Five Questions

Question #		Description	Marks Distribution		Max Marks
1		• For finding the cumulative probability and random numbers for IAT • For finding the cumulative probability and random numbers for service times • For finding the Inter-arrival times and arrival times • For finding the service times from the random numbers • For finding the time service begins, time service ends, waiting time etc. • For finding the average waiting time and Probability of idle time of server	1 M 1 M 1 M 1M 5M 1M	10 M	10 M
2		• For Finding the cumulative probability and random numbers for inter-Arrival Times • For Finding the Cumulative probability and random no for service times of Able and Baker • -Main Simulation Table-5M. • The Marks Split up for this table is as shown below. o -For Finding the Inter-Arrival Times from the random numbers o -For Finding the arrival Times o -For Finding the Service Times from the random numbers o -For Finding the available server and time service begins o -For Service completion time and time in the system • For finding average time customer spends in system	1 M 2M 1M 1M 1M 1M 2M 1M	10 M	10 M
3	a)	• Old system snapshot for time advance algorithm • New System snapshot for time advance algorithm • Steps for time advance algorithm	1.5 M 1.5 M 2 M	5 M	10 M
	b)	• Definition of simulation • Defining and Explaining Models • Examples of models	1M 2M 2M	5M	

4		• For defining the system states like LQ(t),LS(t) • -For defining the Future Event List • -For Updating the Cumulative statistics like B and MQ • -For Simulation table defining all the above entities	2 M 4 M 2 M 2 M	10 M	10 M
5		For Simulation table for dump-truck problem-8M *The Marks split up is as shown below • For defining the system states like LQ(t),L(t),WQ(t),W(t)-2M • For defining the lists like loader queue and weighing queue-2M • For Defining the Future event list-3M • For updating the cumulative statistics and counters-2M For calculating the loader utilization and scale utilization-1M	2 M 2 M 3M 2M 1M	10 M	10 M
6		• Flowchart with respect to arrival event • Flowchart with respect to departure event	5 M 5 M	10 M	10 M
7	a)	• Explaining the system components with examples Each component carries 1 Mark	5 M	5 M	10 M
	b)	• Defining and analyzing the components w.r.t given systems • Justification	4 M 1 M	5 M	

Internal Assessment Test 1 Solutions– March.2019

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1. Inter arrival time ranges from 1 to 8 min with equal probability.
So probability = 1/8 =0.125

IAT	Probability	Cumulative Probability	Random No Assessment
1	0.125	0.125	1-125
2	0.125	0.250	126-250
3	0.125	0.375	251-375
4	0.125	0.500	376-500
5	0.125	0.625	501-625
6	0.125	0.750	626-750
7	0.125	0.875	751-875
8	0.125	1.000	876-1000

ST	Probability	Cumulative Probability	Random No Assessment
1	0.10	0.10	1-10
2	0.20	0.30	11-30
3	0.30	0.60	31-60
4	0.25	0.85	61-85
5	0.10	0.95	86-95
6	0.05	1.00	96-100

Main Simulation table:

Customer	IAT	AT	ST	Time Service Begins	Waiting Time	Time Service Ends	Time customer Spend in system	Idle time of server
1	-	0	2	0	0	2	2	0
2	5	5	2	5	0	7	2	3
3	5	10	4	10	0	14	4	3
4	4	14	4	14	0	18	4	0
5	2	16	3	18	2	21	5	0
6	8	24	2	24	0	26	2	3
7	7	31	3	31	0	34	3	5
8	8	39	5	39	0	44	5	5
9	5	44	1	44	0	45	1	0
10	2	46	6	46	0	52	6	1
	Total		32		2			20

Average WT = Total WT/Total No of customers =7/10
Probability of idle time of server = Total idle time/Total run time of simulation = 20/52
Probability that a customer has to wait in queue = No of customers who wait/Total No of customers = 1/10
Average ST = Total ST/Total no of customers = 32/10

2. For Finding the cumulative probability and random numbers for inter-Arrival Times-1M

Inter-Arrival time	Probability	Cumulative Probability	Random No Assessment
1	0.25	0.25	1-25
2	0.40	0.65	26-65
3	0.20	0.85	66-85
4	0.15	1.00	86-00

-For Finding the Cumulative probability and random no for service times of Able and Baker-2M

ST of Able	Probability	Cumulative Probability	Random No Assessment	ST of Baker	Probability	Cumulative Probability	Random No Assessment
2	0.30	0.30	1-30	3	0.35	0.35	1-35
3	0.28	0.58	31-58	4	0.25	0.60	36-60
4	0.25	0.87	59-87	5	0.20	0.80	61-80
5	0.17	1.00	88-00	6	0.20	1.00	81-100

-Main Simulation Table-6M.

Caller ID	IAT	AT	Server Choosen	ST	Time Service Begins	Time Service Ends		Caller Delay	Time customer Spend in system
						Able	Baker		
1	-	0	Able	5	0	5	-	0	5
2	2	2	Baker	3	2	-	5	0	3
3	4	6	Able	3	6	9	-	0	3
4	4	10	Able	5	10	15	-	0	5
5	2	12	Baker	6	12	-	18	0	6
6	2	14	Able	3	15	18	-	1	4
7	3	17	Able	2	18	20	-	1	3
8	3	20	Able	4	20	24	-	0	4
9	3	23	Baker	4	23	-	27	0	4
10	1	24	Able	3	24	27	-	0	3
Total	24							2	40

- For finding the following times – 1 Mark

Time customer spend in the system = 40

3.a) Old system snapshot for time advance algorithm-1.5M

CIK	System State		Future Event List
T	(5,1,6)		(3, t1)— Type 3 event to occur at time *t1* (1, t2)— Type 1 event to occur at time *t2* (1, t3)- Type 1 event to occur at time t_3 (2, *tn*)— Type 2 event to occur at time t_n

New System snapshot for time advance algorithm-1.5M

OCK	System State		Future Event List
t1	(5,1,5)		(1, *t2*)— Type 1 event to occur at time *t1* (4, t*)— Type 4 event to occur at time t* (1, t_3)— Type 1 event to occur at time t_3 (2, tn)— Type 2 event to occur at time *tn*

-Steps for time advance algorithm-2M

Step 1. Remove the event notice for the imminent event (event 3, time t\) from PEL
Step 2. Advance CLOCK to imminent event time (i.e., advance CLOCK from r to t1).
Step 3. Execute imminent event: update system state, change entity attributes, and set membership as needed.
Step 4. Generate future events (if necessary) and place their event notices on PEL ranked by event time. (Example: Event 4 to occur at time t*, where t2 < t* < t3.)
Step 5. Update cumulative statistics and counters.

3. b) Definition: Simulation is the imitation of the real world or system over time – 1 Mark
Defining and explaining models with examples – 4 Marks
1. Static Model represents a system at a particular point of time and also known as Monte-Carlo simulation.
Ex: Timetable
2. Dynamic Model Represents systems as they change over time. Ex: Simulation of a bank
3. Deterministic Model contains no random variables. They have a known set of inputs which will result in a unique set of outputs. Ex: Arrival of patients to the Dentist at the scheduled appointment time.
4. Stochastic Model has one or more random variable as inputs. Random inputs leads to random outputs. Ex: Simulation of a bank involves random inter arrival and service times.
5. Discrete and Continuous Model: A discrete system is one in which state variable changes only at discrete set of points in time.
Ex: Bank and machine repair problem
A continuous system is one in which the state variables changes continuously over time.
Ex. Head of water behind the dam, airplane moving continuously.

4. For defining the system states like LQ(t),LS(t) – 2M
-For defining the Future Event List-4M
-For Updating the Cumulative statistics like B and MQ-2M
-For Simulation table defining all the above entities-2M

C1-AT:0, DT-5
C2-AT:4,DT-8
C3-AT:9,DT-13
C4-AT-11,DT-19
C5-AT:19,DT-21
C6-AT:22,DT-29

Clock	System State		Future Event List	Comments	Cumulative Statistics	
	LQ(t)	LS(t)			B	MQ
0	0	1	(A,4)(D,5)(E,30)	1st Customer arrived	0	0
4	1	1	(D,5)(A,9)(E,30)	2nd Customer arrived	4	1
5	0	1	(D,8)(A,9)(E,30)	1st Customer departured	5	1
8	0	0	(A,9)(E,30)	2nd Customer Departured	8	1
9	0	1	(A,11)(D,13)(E,30)		8	1
11	1	1	(A,19)(D,13)(E,30)	4th Customer Arrived	10	1
13	0	1	(D,19)(A,19)(E,30)	3rd Customer Departured	12	1
19	0	1	(D,21)(A,22)(E,30)	4th Customer Departured 5th Customer Arrived	18	1
21	0	0	(A,22)(D,29)(E,30)	5th Customer Departured	20	1
22	0	1	(A,29)(D,29)(E,30)	6th Customer arrived	20	1
29	0	1	(E,30)	6th Customer Departured End of simulation time	27	1

5. For Simulation table for dump-truck problem-9M

For calculating average loader and scale utilizations -1M

Clock	System State				Loader Queue	Weighing Queue	Future Event List	Cumulative Statistics	
	LQ(t)	L(t)	WQ(t)	W(t)				B	MQ
0	3	2	0	1	D4,D5, D6	-	(EL,D2,5) (EL,D3,10) (EW,D1,12)	0	0
5	2	2	1	1	D5,D6	D2	(EL,D3,10)(EW,D1,12) (EL,10,D4)	10	5
10	0	2	3	1	-	D2,D3,D4	(EW,D1,12) (EL,D5,5+10) (EL,10+10,D6)	20	10
12	0	2	2	1	-	D3,D4	(EL,D5,5+10)(EL,10+10,D6) (EW,12+12,D2)(ET,D1,80+12)	24	12
15	0	1	3	1	-	D3,D4,D5	(EL,20,D6)(EW,24,D2) (ET,92,D1)	30	15
20	0	0	4	1	-	D3,D4,D5 ,D6	(EW,24,D2)(ET,92,D1)	30	20
24	0	0	3	1	-	D4,D5,D6	(EW,D3,12+24)(ET,92,D1) (ET,80+24,D2)	30	24
36	0	0	2	1	-	D5,D6	(EW,36+12,D4)(ET,92,D1) (ET,104,D2)(ET,36+100,D3)	30	36

Average loader utilization = $\frac{30/2}{36}$ = 0.46

Average Scale Utilization = 36/36 = 1

6) Flowchart w.r.t execution of arrival event and explanation– 5 Marks

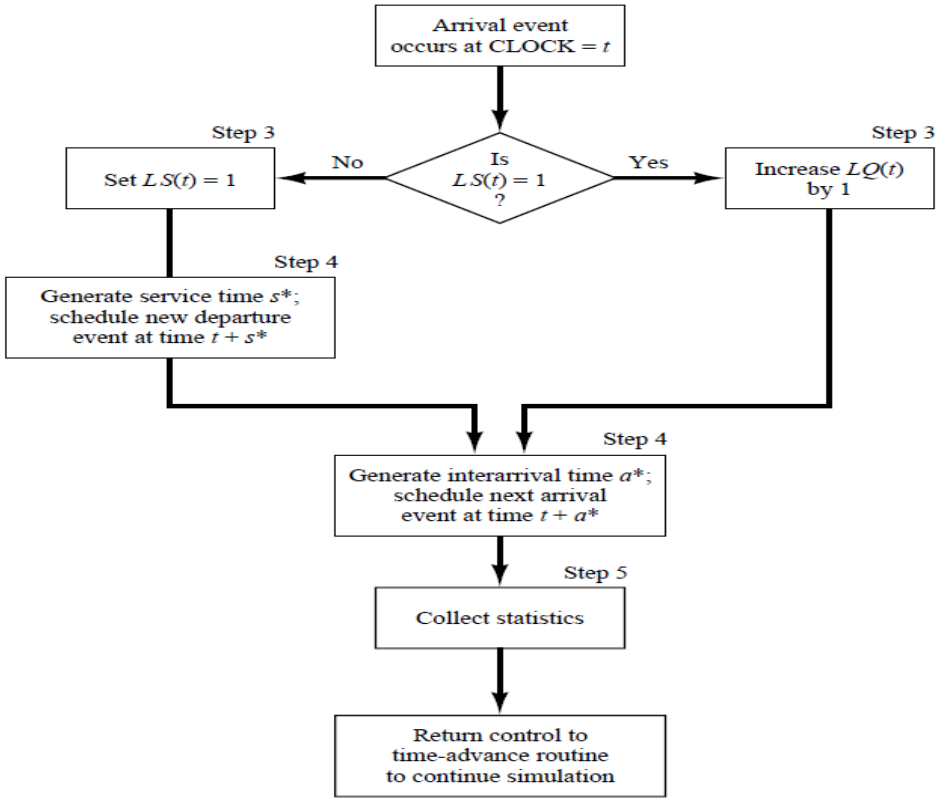

Figure 3.5 Execution of the arrival event.

Flowchart w.r.t execution of departure event and explanation– 5 Marks

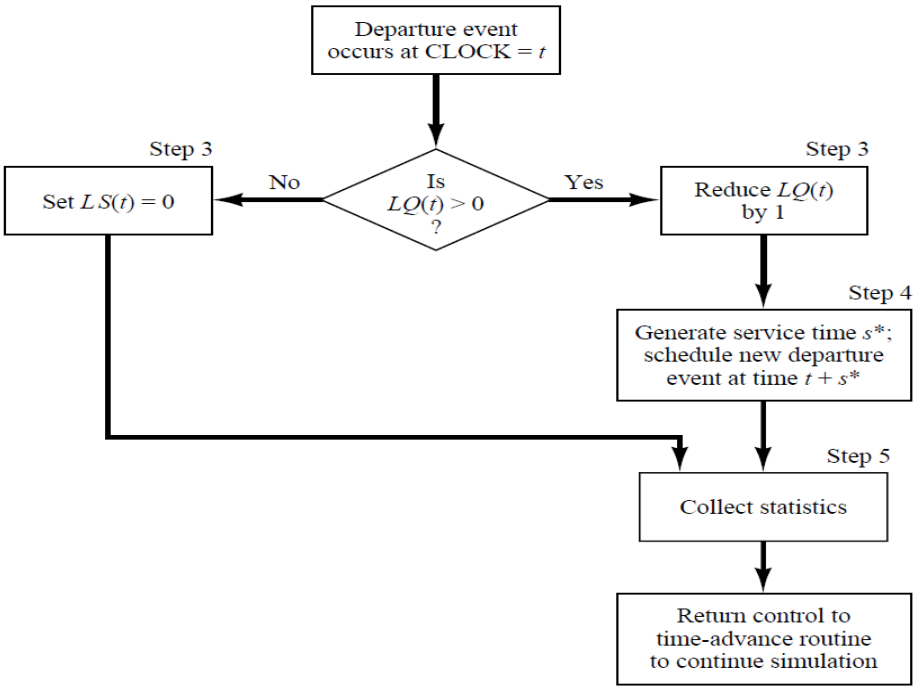

Figure 3.6 Execution of the departure event.

7)a) Components of Discrete event simulation

1. System: A collection of entities (e.g., people and machines) that together over time to accomplish one or more goals.
2. Model: An abstract representation of a system, usually containing structural, logical, or mathematical relationships which describe a system in terms of state, entities and their attributes, sets, processes, events, activities, and delays.
3. System state: A collection of variables that contain all the information necessary to describe the system at any time.
4. Entity: Any object or component in the system which requires explicit representation in the model (e.g., a server, a customer, a machine).
5. Attributes: The properties of a given entity (e.g., the priority of a v customer, the routing of a job through a job shop).
6. List: A collection of (permanently or temporarily) associated entities ordered in some logical fashion (such as all customers currently in a waiting line, ordered by first come, first served, or by priority).
7. Event: An instantaneous occurrence that changes the state of a system as an arrival of a new customer).
8. Event notice: A record of an event to occur at the current or some future time, along with any associated data necessary to execute the event; at a minimum, the record includes the event type and the event time.
9. Event list: A list of event notices for future events, ordered by time of occurrence; also known as the future event list (FEL).
10. Activity: A duration of time of specified length (e.g., a service time or arrival time), which is known when it begins (although it may be defined in terms of a statistical distribution).
11. Delay: A duration of time of unspecified indefinite length, which is not known until it ends (e.g., a customer's delay in a last-in, first-out waiting line which, when it begins, depends on future arrivals).
12. Clock: A variable representing simulated time.

7b) Examples of system and components

System	Entities	Attributes	Activities	Events	State variables
Banking	Customers		Checking-account balance Making deposits	Arrival; departure	No. of busy tellers; no. of customers waiting
Hospital	Patients, Doctors	Patent ID, Doctor Name	Checkup,Emergency	Arrival, Departure	No of Patients waiting, No of doctors busy/idle
College	Students, Teachers	Student Id, Teacher ID	Teaching, Learning	Arrival, Departure	No of students coming, Teacher busy/idle
Railways	Riders		Traveling	Arrival at station; arrival at destination	No. of riders waiting at each station; No. of riders in transit

Among all the components state variable plays a major role because the entire performance of any system depends on the state variable itself. For example in the case of banking system if more number of customers are waiting or if server is idle then it decreases the performance of bank.