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Internal Assessment Test I

Sub:	**SYSTEM MODELING AND SIMULATION**							Code:	10CS82
Date:	27/03/ 2017	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	CSE & ISE

Answer Any FIVE FULL Questions

Question	Marks	OBE CO	OBE RBT
1. Explain the steps in simulation study with the help of a flowchart.	[10]	CO1	L1
2 .a) What is simulation. Write the different system components for the following systems. i) A Cafeteria ii) A grocery Store iii) A hospital emergency room	[5]	CO1	L1
b) Charlie tosses a coin for her friends Harry and Tom exactly 100 times. Harry wins $1.00 when a head lands up and Tom loses $1.00.Tom wins when the coin lands with tails up and Harry paying $1.Charlie tracks their respective wins and losses as they play the game. The probability for coin tosses are as follows.	[5]	CO2	L2

Coin Toss	Head	Tail
Probability	0.50	0.50

Simulate for 10 tosses by noting down the result of the toss each time. Consider the following random numbers.
Random numbers: 30, 25, 60, 80, 90, 5, 75, 10, 20, 80

3. Consider the following inter arrival times and service times. Using time advance algorithm prepare a simulation table based on the following activities and stop the Simulation when clock reaches 20. [10] CO2 L3

Interarrival Time	3	2	6	2	4	5
Service Time	2	5	5	8	4	5

4. Let the arrival distribution be uniformly distributed between 1 to 10 min. Develop. a simulation table for 5 customers. The service time distributions are as follows. [10] CO2 L2

Service Time	1	2	3	4	5
Probability	0.10	0.20	0.30	0.25	0.15

Consider the following random numbers for inter Arrival Times and Service Times.
Random No for IAT: 9, 7, 1, 9 and 3
Random No for Service Times: 84, 10, 74, 53, 17.
Find the average waiting time and probability of idle time of server from the simulation table.

5. a) Explain time advance/event scheduling algorithm with the help of a snapshot at clock=t t1 [5] CO2 L1

b) Explain simulation of queuing systems with the help of flow diagrams. [5] CO2 L1

6. Develop a simulation table for Able-baker call center problem assuming that able. can do the job better than baker. The time between arrivals and service times are as shown below. Simulate for 5 days. [10] CO2 L2

Service Time of Able	2	3	4	5
Probability	0.30	0.28	0.25	0.17
Service Time of Baker	3	4	5	6
Probability	0.35	0.25	0.20	0.20

Time b/n arrivals	1	2	3	4
Probability	0.25	0.40	0.20	0.15

Consider the following random numbers.
Random no for Arrivals: 26,98,90,26
Random no for Service Time: 95,21,51,92,89

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Internal Assessment Test 1 – March. 2017- SOLUTION

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Date:	28/ 03/2017	Duration:	90 mins	Max Marks:	50	**Sem:**	VIII	**Branch:**	ISE/CSE

Note: Answer any five questions:

1. Explain the steps in simulation study with the help of a flowchart.

Solution:

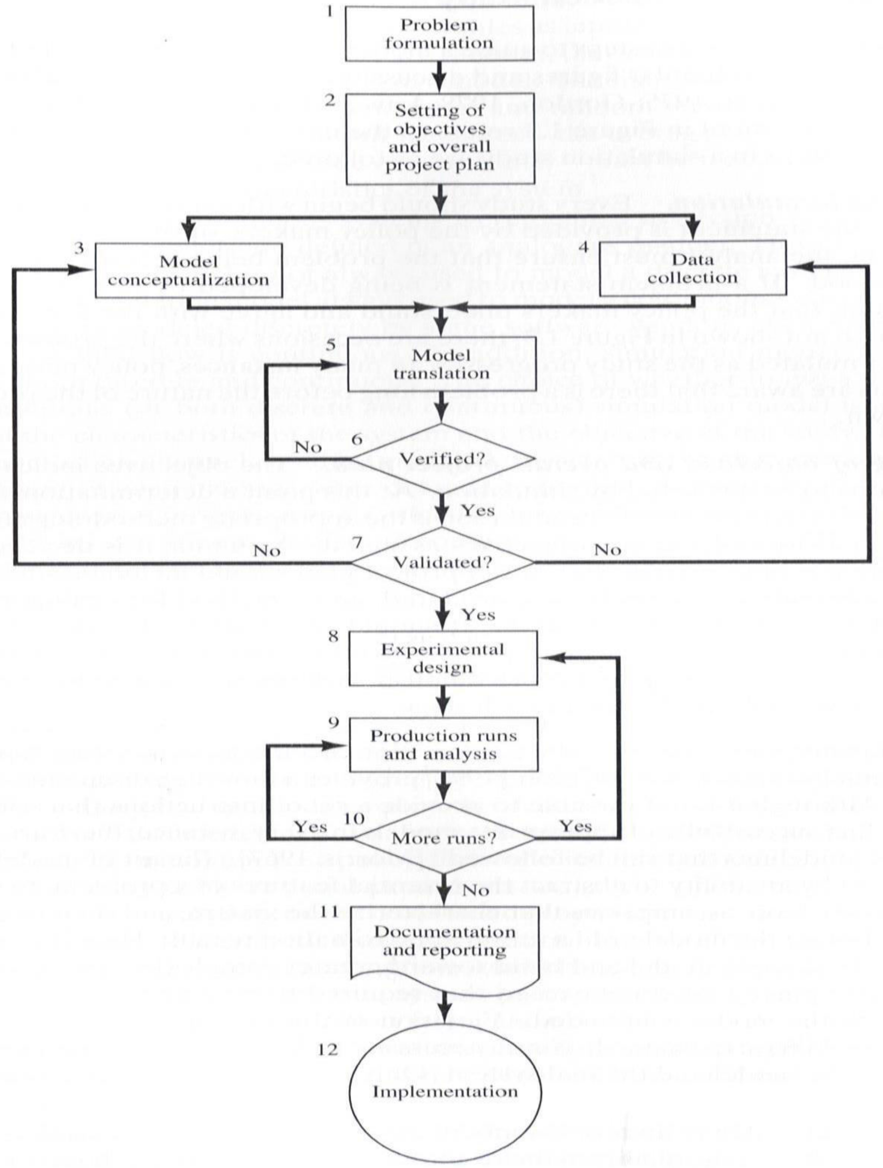


Figure 1.3. Steps in a simulation study.

1. Problem formulation

Every study begins with a statement of the problem, provided by policy makers. Analyst ensures its clearly understood. If it is developed by analyst policy makers should understand and agree with it.

2. Setting of objectives and overall project plan

The objectives indicate the questions to be answered by simulation. At this point a determination should be made concerning whether simulation is the appropriate methodology. Assuming it is appropriate, the overall project plan should include

- A statement of the alternative systems
- A method for evaluating the effectiveness of these alternatives
- Plans for the study in terms of the number of people involved
- Cost of the study
- The number of days required to accomplish each phase of the work with the anticipated results.

3. Model conceptualization

The construction of a model of a system is probably as much art as science. The art of modeling is enhanced by an ability

- ➢ To abstract the essential features of a problem
- ➢ To select and modify basic assumptions that characterize the system
- ➢ To enrich and elaborate the model until a useful approximation results

Thus, it is best to start with a simple model and build toward greater complexity. Model conceptualization enhance the quality of the resulting model and increase the confidence of the model user in the application of the model.

4. Data collection

There is a constant interplay between the construction of model and the collection of needed input data. Done in the early stages.

Objective kind of data are to be collected.

5. Model translation

Real-world systems result in models that require a great deal of information storage and computation. It can be programmed by using simulation languages or special purpose simulation software.

Simulation languages are powerful and flexible. Simulation software models development time can be reduced.

6. Verified

It pertains to he computer program and checking the performance. If the input parameters and logical structure and correctly represented, verification is completed.

7. Validated

It is the determination that a model is an accurate representation of the real system. Achieved through calibration of the model, an iterative process of comparing the model to actual system behavior and the discrepancies between the two.

8. Experimental Design

The alternatives that are to be simulated must be determined. Which alternatives to simulate may be a function of runs. For each system design, decisions need to be made concerning

- □Length of the initialization period
- Length of simulation runs
- Number of replication to be made of each run

9. Production runs and analysis

They are used to estimate measures of performance for the system designs that are being simulated.

10. More runs

Based on the analysis of runs that have been completed. The analyst determines if additional runs are needed and what design those additional experiments should follow.

11. Documentation and reporting

Two types of documentation.

□□Program documentation

□□Process documentation

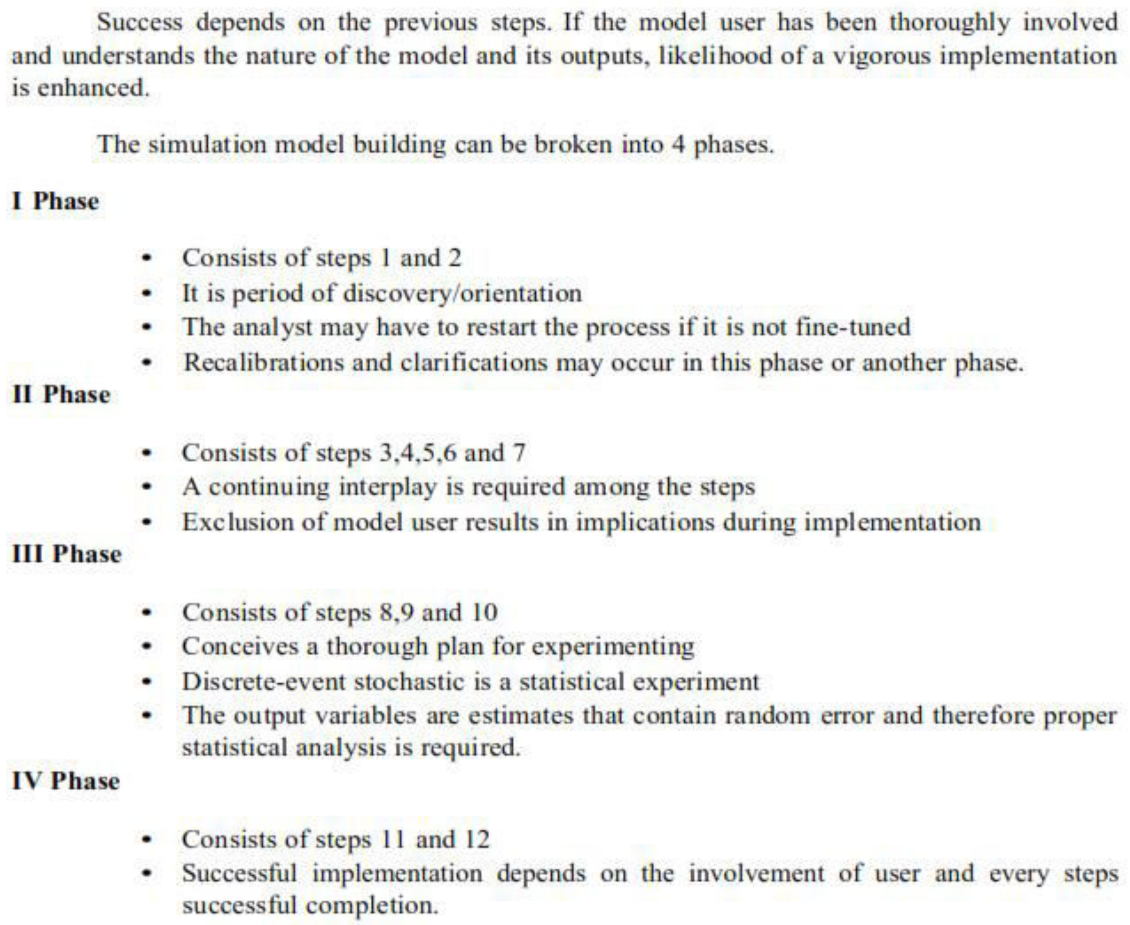
Program documentation

Can be used again by the same or different analysts to understand how the program operates. Further modification will be easier. Model users can change the input parameters for better performance.

Process documentation

Gives the history of a simulation project. The result of all analysis should be reported clearly and concisely in a final report. This enables to review the final formulation and alternatives, results of the experiments and the recommended solution to the problem. The final report provides a vehicle of certification.

12. Implementation



Success depends on the previous steps. If the model user has been thoroughly involved and understands the nature of the model and its outputs, likelihood of a vigorous implementation is enhanced.

The simulation model building can be broken into 4 phases.

I Phase

- Consists of steps 1 and 2
- It is period of discovery/orientation
- The analyst may have to restart the process if it is not fine-tuned
- Recalibrations and clarifications may occur in this phase or another phase.

II Phase

- Consists of steps 3,4,5,6 and 7
- A continuing interplay is required among the steps
- Exclusion of model user results in implications during implementation

III Phase

- Consists of steps 8,9 and 10
- Conceives a thorough plan for experimenting
- Discrete-event stochastic is a statistical experiment
- The output variables are estimates that contain random error and therefore proper statistical analysis is required.

IV Phase

- Consists of steps 11 and 12
- Successful implementation depends on the involvement of user and every steps successful completion.

2 a) What is simulation? Write the different system components for the following systems.
i) A Cafeteria ii) A grocery Store iii) A hospital emergency room

Solution:

Definition : Simulation is the imitation of the real world or system over time

System	Entities	Attributes	Activities	Events
A Cafeteria	Customers	Customer No	Having Food, Drinking	Ordering Event Servicing Event
A grocery Store	Customers	Item No	Purchasing	Arrival, Departure
A Hospital Emergency Room	Patients, Doctors	Patient id ,Type of disease	Surgery	Arrival event, Service event

b) Charlie tosses a coin for her friends Harry and Tom exactly 100 times. Harry wins $1.00 when a head lands up and Tom loses $1.00.Tom wins when the coin with tails up and Harry paying $1.Charlie tracks their respective wins and losses as they play the game. The probability for coin tosses are as follows.

Coin Toss	Head	Tail
Probability	0.50	0.50

Solution:

Coin Toss	Probability	Cumulative Probability	Random No Assessment
Head	0.50	0.50	1-50
Tail	0.50	1.00	51-100

Coin Toss	Result Of the Toss	Harry's Winnings	Tom's Winnings
1	Head	$1	-$1
2	Head	$2	-$2
3	Tail	$1	-$1
4	Tail	0	0
5	Tail	-$1	$1
6	Head	0	0
7	Tail	-$1	$1
8	Head	0	0
9	Head	$1	-$1
10	Tail	0	0

3 Consider the following inter arrival times and service times. Using time advance algorithm prepare a simulation table based on the following activities and stop the simulation when clock reaches 20**.**

Interarrival time	3	2	6	2	4	5
Service Time	2	5	5	8	4	5

Solution:

Clock	System State		Future Event List	Comments	Cumulative Statistics	
	LQ(t)	LS(t)			B	MQ
0	0	1	(D,2)(A,3)(E,10)	1st Customer arrived	0	0
2	0	0	(A,3)(D,8)(E,10)	1st Customer departured	2	0
3	0	1	(A,5)(D,8)(E,10)	2nd Customer arrived	2	0
5	1	1	(D,8)(A,11)(E,10)	3rd Customer Arrived	4	1
8	0	0	(A,11)(D,13)(E,10)	2nd Customer Departured	7	1

4. Let the arrival distribution be uniformly distributed between 1 to 10 min. Develop a simulation table for 5 customers. The service time distributions are as follows.

Service Time	1	2	3	4	5
Probability	0.10	0.20	0.30	0.25	0.15

Consider the following random numbers for inter Arrival Times and Service Times.
Random No for IAT: 9, 7, 1, 9 and 3
Random No for Service Times: 84, 10, 74, 53, 17.
Find the average waiting time and probability of idle time of server from the simulation table.

Solution:

IAT	Probability	Cumulative Probability	Random No Assessment
1	0.1	0.1	1
2	0.1	0.2	2
3	0.1	0.3	3
4	0.1	0.4	4
5	0.1	0.5	5
6	0.1	0.6	6
7	0.1	0.7	7
8	0.1	0.8	8
9	0.1	0.9	9
10	0.1	1	0

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	0.15	1	86-00

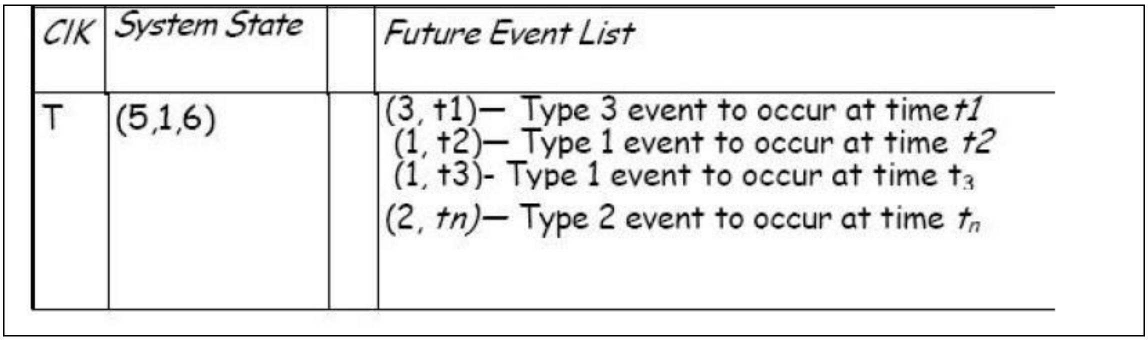
Customer	IAT	AT	ST	Time Service Begins	Waiting Time	Time Service Ends	Time Customer Spend in system	Idle time of server
1	-	0	4	0	0	4	4	0
2	9	9	1	9	0	10	1	5
3	7	16	4	16	0	20	4	6
4	1	17	3	20	3	23	6	0
5	9	26	2	26	0	28	2	3
Total					3			14

Average WT = Total WT/Total No of customers =3/5 =0.6 Min
Probability of idle time of server = Total idle time/Total run time of simulation = 14/28 = 0.5Min

5. a) Explain time advance/event scheduling algorithm with the help of a snapshot at clock=t t1

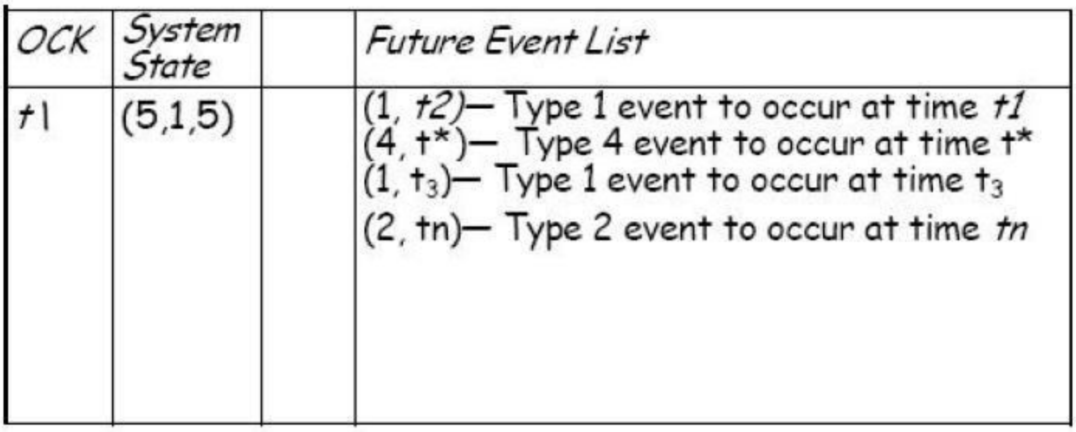
Solution:

-Old system snapshot for time advance algorithm



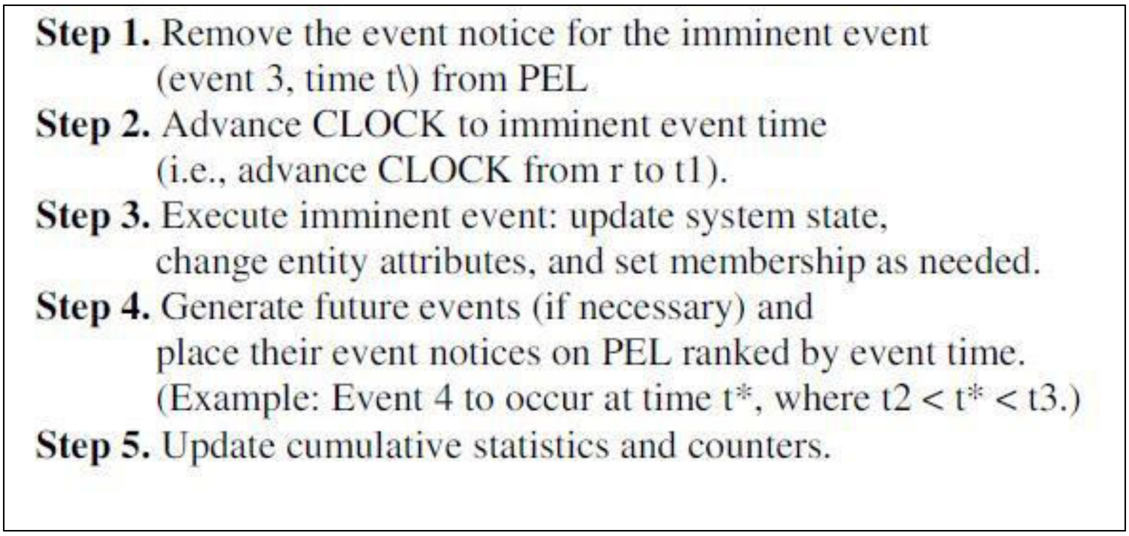
CIK	System State		Future Event List
T	(5,1,6)		(3, t1)— Type 3 event to occur at time t1 (1, t2)— Type 1 event to occur at time t2 (1, t3)- Type 1 event to occur at time t_3 (2, tn)— Type 2 event to occur at time t_n

-New System snapshot for time advance algorithm



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



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.

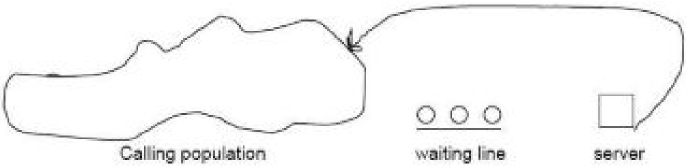
b) Explain simulation of queuing systems with the help of flow diagrams.

Solution:

Simulation of Queuing systems

- A queueing system is described by its calling population, the nature of the arrivals, the service mechanism, the system capacity, and the queueing discipline. A single-channel queueing system is portrayed in figure1.

Figure 1: Queueing System



- In the single-channel queue, the calling population is infinite; that is, if a unit leaves the calling population and joins the waiting line or enters service, there is no change in the arrival rate of other units that may need service.
- Arrivals for service occur one at a time in a random fashion; once they join the waiting line, they are eventually served. In addition, service times are of some random length according to a probability distribution which does not change over time.

- The system capacity; has no limit, meaning that any number of units can wait in line.

- Finally, units are served in the order of their arrival by a single server or channel.

- Arrivals and services are defined by the distributions of the time between arrivals and the distribution of service times, respectively.

- For any simple single or multi-channel queue, the overall effective arrival rate must be less than the total service rate, or the waiting line will grow without bound. When queues grow without bound, they are termed "explosive" or unstable.

- The state of the system is the number of units in the system and the status of the server, busy or idle.

- An event is a set of circumstances that cause an instantaneous change in the state of the system. In a single –channel queueing system there are only two possible events that can affect the state of the system.
    - They are the entry of a unit into the system.
    - The completion of service on a unit.
- The queueing system includes the server, the unit being serviced, and units in the queue. He simulation clock is used to track simulated time. If a unit has just completed service, the simulation proceeds in the manner shown in the flow diagram of figure.2. Note that the server has only two possible states: it is either busy or idle.

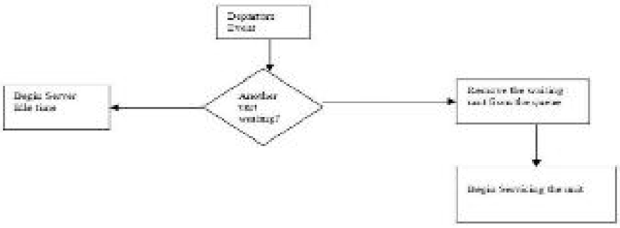


Figure 2: Service-just-completed flow diagram

- The arrival event occurs when a unit enters the system. The flow diagram for the arrival event is shown in figure 3. The unit may find the server either idle or busy; therefore, either the unit begins service immediately, or it enters the queue for the server. The unit follows the course of action shown in fig 4.

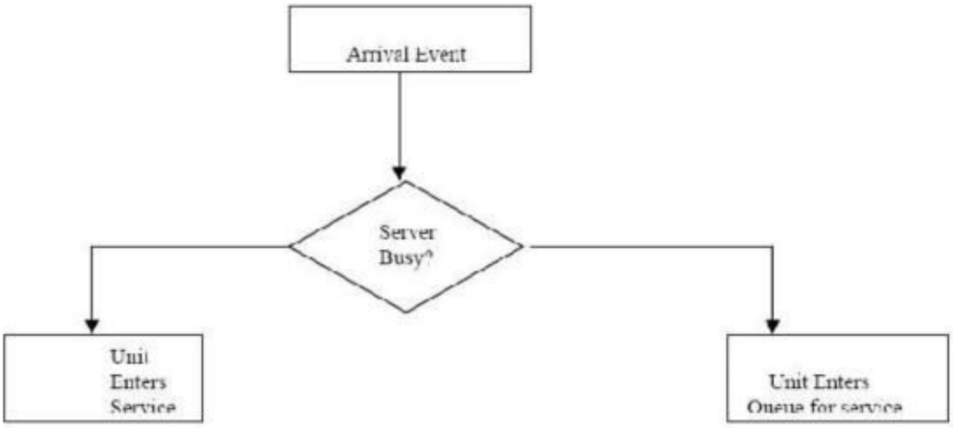
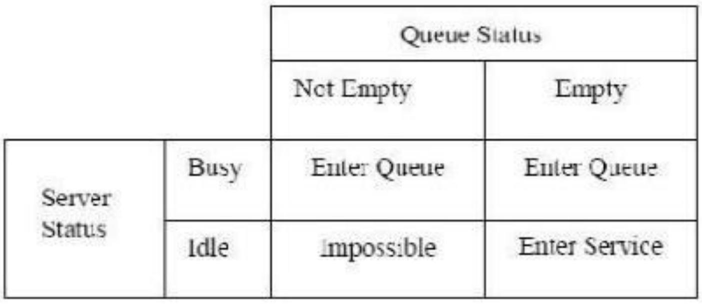


Figure 3: Unit-Entering system flow diagram

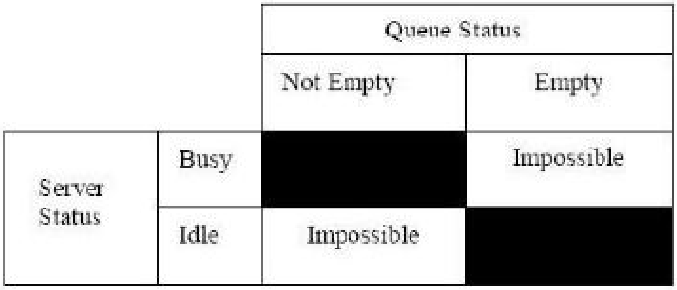
- If the server is busy, the unit enters the queue. If the server is idle and the queue is empty, the unit begins service. It is not possible for the server to be idle and the queue to be nonempty.



		Queue Status	
		Not Empty	Empty
Server Status	Busy	Enter Queue	Enter Queue
	Idle	Impossible	Enter Service

Figure 4: Potential unit actions upon arrival

- After the completion of a service the service may become idle or remain busy with the next unit. The relationship of these two outcomes to the status of the queue is shown in fig 5. If the queue is not empty, another unit will enter the server and it will be busy. If the queue is empty, the server will be idle after a service is completed. These two possibilities are shown as the shaded portions of fig 5. It is impossible for the server to become busy if the queue is empty when a service is completed. Similarly, it is impossible for the server to be idle after a service is completed when the queue is not empty.



		Queue Status	
		Not Empty	Empty
Server Status	Busy	■	Impossible
	Idle	Impossible	■

Figure 5: Server outcomes after service completion

6 Develop a simulation table for Able-baker call center problem assuming that able can do the job better than baker. The time between arrivals and service times are as shown below. Simulate for 5 days.

Service Time of Able	2	3	4	5
Probability	0.30	0.28	0.25	0.17
Service Time of Baker	3	4	5	6
Probability	0.35	0.25	0.20	0.20

Time b/n arrivals	1	2	3	4
Probability	0.25	0.40	0.20	0.15

Consider the following random numbers.
Random no for Arrivals: 26,98,90,26 Random no for Service Time: 95,21,51,92,89

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

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

Caller No	IAT	AT	When Able Available	Whwn Baker Available	Server Choosen	ST	Time Service Begins	Service Completion time		Caller Delay	Time in the system
								Able	Baker		
1	-	0	0	0	Able	5	0	5	0	0	5
2	2	2	5	0	Baker	3	2	5	5	0	3
3	4	6	5	5	Able	3	6	9	5	0	3
4	4	10	9	5	Able	5	10	15	5	0	5
5	2	12	15	5	Baker	6	12	15	18	0	6