8/14/30,000

K. J. SOMAIYA COLLEGE OF ENGINEERING

(AFFILIATED TO THE UNIVERSITY OF MUMBAI)

Module 1-3

1

Candidate Roll No. ______________ (In figures)

Time Advance. Algorithm. Test Exam.

Name: ______________

Date: ______________ 20

Examination: ______________ Branch/Semester ______________

Subject: ______________

Junior Supervisor's full Signature with Date

Question No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Marks Obtained													

* Manual Simulation using Event- Scheduling.

→ In Conducting of an event - Scheduling Simulⁿ. a Simulⁿ table is used to record the Successive system snapshots as time advances.

Single channel Queue

→ Reconsider the grocery store with one checkout counter that was simulated by an ad-hoc method. The system consists of those customers in waiting line plus the one (if any) checking out. A stopping time of 60 minutes is set for this example.

Model has following components

System state :- (LQ(t), LS(t)), where LQ(t) is no of customers in waiting line and LS(t) is no being served (0 or 1) at time t.

Entities :- The server and customers are not explicitly modeled, except in terms of state variables

Event :-

Arrival (A);

Departure (D);

Stopping event (E), Scheduled to occur at time 60

Activities :-

Interarrival time, given in table.

Service time "

Delay :- customer time spent in waiting line.

Interarrival Times :- 1 1 6 3 7 5 2 4 1 ...
Service Times :- 4 2 5 4 1 5 4 1 4 ...

Simulation Table

Clock	LQ(t)	LS(t)	Future event list	Comment	Cumulative Statistics B	Cumulative Statistics MQ
	System state Waiting	System state Served				
0	0	1	(A,1) (D,4) (E,60)	First A occurs (a* = 1) Schedule next A (s* = 4) Schedule first D.	0	0
1	1	1	(A,2) (D,4) (E,60)	Second A occurs, (A,1) (a* = 1) Schedule next A, (Customer delayed)	1	1
2	2	1	(D,4) (A,8) (E,60).	Third A occurs (A,2) (a* = 6) Schedule next A. (Two customers delayed).	2	2
4	1	1	(D,6) (A,8) (E,60)	First D occurs :(D,4) (s* = 2) Schedule next D. (Customer delayed).	4	2
6	0	1	(A,8) (D,11) (E,60).	Second D occurs ; (D,6). (s* = 5) Schedule next D.	6	2
8	1	1	(D,11) (A,11) (E,60).	Fourth A occurs (A,8). (a* = 3 Schedule next A) Customer delayed.	8	2

11	1	1	(D,15) (A,18) (E,60)	Fifth A occurs (A,11) (a* = 7) Schedule next A. Third D occurs (D,11) (s* = 4) Schedule next D. Customer delayed.	11	2
15	0	1	(D,16) (A,18) (E,60)	Fourth D occurs (D,15). (s* = 1) Schedule next D.	15	2
16	0	0	(A,18) (E,60)	Fifth D occurs (D,16)	16	2
18	0	1	(D,23) (A,23) (E,60)	Sixth A occurs. (a* = 5) Schedule next A. (s* = 5) Schedule next D.	16	2
23	0	1	(A,25) (D,27) (E,60)	Seventh A occurs (A,23) (a* = 2) Schedule next arrival. Sixth D occurs. (D,23).	21	2

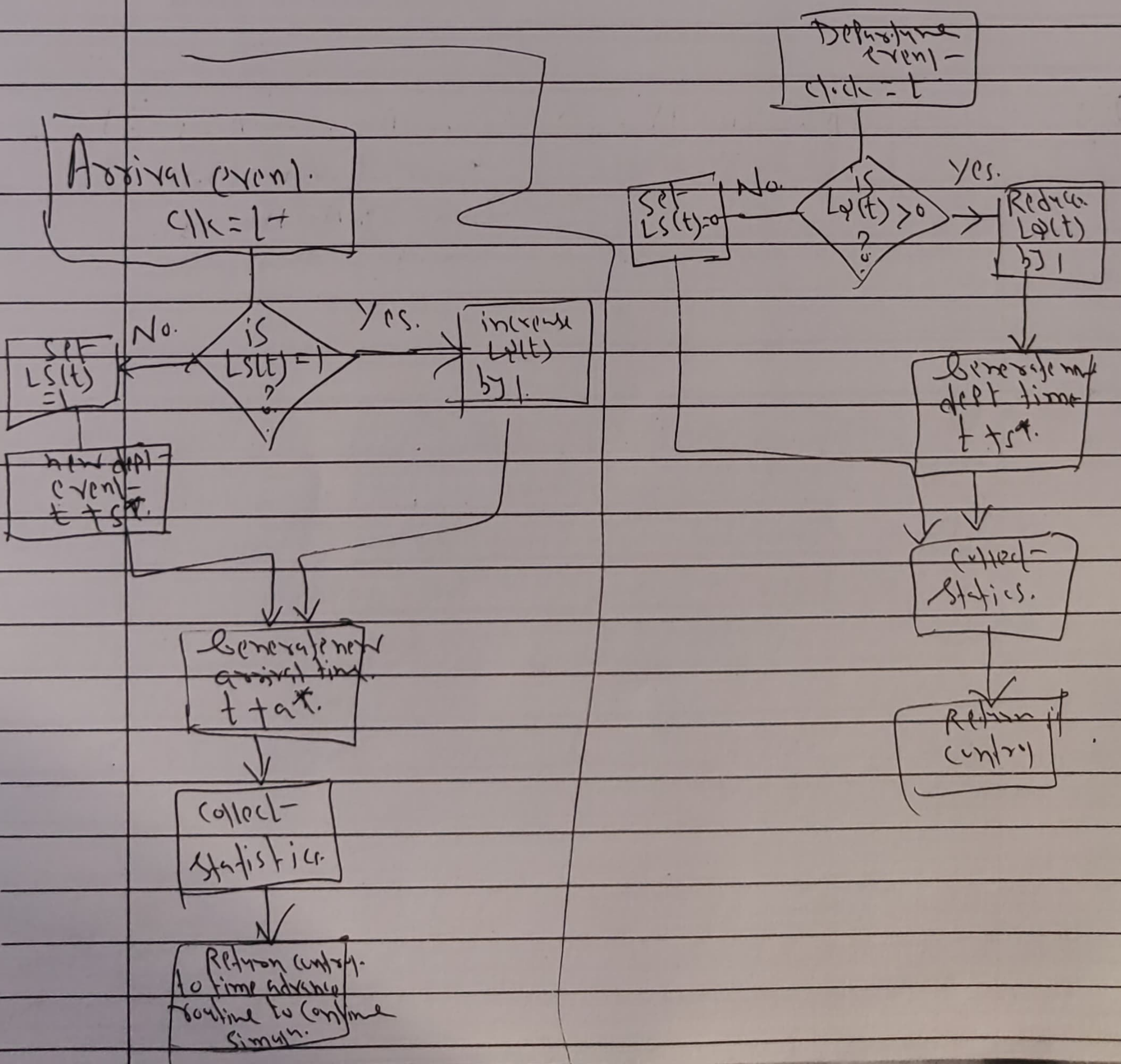
* Initial conditions are that the first customer arrive at time 0 and begin service. This is reflected in table by system snapshot at time zero (clock = 0), with $LQ(0) = 0$, $LS(0) = 1$ and both the departure event and arrival event on FEL. Also the simulation is scheduled to stop at time 60. Only two statistics, server utilization and max queue length, will be collected.

Server utilization is defined by total server busy time (B) divided by total time (T_E). Total busy time B and maximum queue length, MQ will be accumulated as simulation progresses.

As soon as system snapshot at time clock = 0 is complete, the simn begins. At time 0, the imminent event is (A,1). The clk is advanced to time 1, and (A,1) is removed from FEL.

Bcoz LS(t) = 1 for $0 \le t \le 1$ (i.e server was busy for 1 minute) the cumulative busy time is increased from B = 0 to B = 1.

By event logic flow chart, set LS(t) = 1 (the server becomes busy). The FEL left with three future events, (A,2) (D,4) and (E,60). The simuln clock is next advanced to time 2, and arrival event is executed. ---



8/14/30,000

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2

Time Advance
Also
Test Exam.

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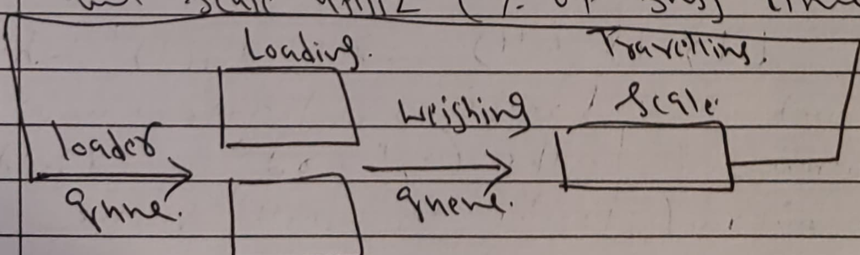
The Dump Truck Problem

→ Six dump trucks are used to haul coal from the entrance of a small mine to the railroad. Fig. Provides a schematic of dump truck operⁿ. Each truck is loaded by one of two loaders. After a loading the truck immediately moves to the scale to be weighed as soon as possible. Both the loaders and scale have a first come - first served waiting line (or queue) for trucks. Travel time from a loader to the scale is considered negligible. After being weighed a truck begins a travel time (during which ~~the~~ time the truck unloads) and then afterward return to the loader queue. The distribⁿ of loading time, weighing time and travel time are given in table, together with random digit assignment for generating three variables by using random digits. The purpose of simuⁿ is to estimate the loader and scale utilizⁿ (% of busy time).



* Distribution of Loading time for Dump trucks

Loading Time	Probability	Cumulative Probability	Random digit Assignment
5	0.30	0.30	1 – 3
10	0.50	0.80	4 - 8
15	0.20.	1.00.	9 - 0.

* Distribution of weighing time for Dump trucks

Weighing Time	Probability	Cumulative Probability	Random digit Assignment
12	0.70	0.70	1 - 7
16	0.30	1.00	8 - 0.

* Distribution of Travel time for Dump trucks

Travel Time	Probability	Cumulative Probability.	Random digit Assignment
40	0.40	0.40	1 - 4.
60	0.30	0.70	5 - 7
80	0.20	0.90	8 - 9
100	0.10	1.00.	0.

System State [LQ(t) L(t), WQ(t) W(t)] where.
LQ(t) - number of trucks in loader queue.
L(t) - number of trucks (0, 1, or 2) being loaded.
WQ(t) - number of trucks in weigh queue.
W(t) = number of trucks (0 or 1) being weighed, all at simulation time t.

Event notices :-
(ALQ, t, DTi) dump truck i arrives at loader queue (ALQ) at time t.
(EL, t, DTi), dump truck i ends loading (EL) at time t.
(EW, t, DTi), dump truck i ends weighing (EW) at time t.

Entities :- The six dump trucks (DT1, --- DT6).

Lists :-
Loader queue all trucks waiting to begin loading ordered ~~Weigh queue~~ on first come first served lists.

Weigh queue all trucks waiting to be weighed ordered on first come, first served basis.

Activities Loading time, weighing time and travel time.
Delay Delay at loader queue and delay at scale.

* It has been assumed that five of the trucks are at the loaders and one is at the scale at time 0. The activity times are taken from the following list as needed.

Loading Time	10	5	5	10	15	10	10.
Weighing Time	12	12	12	16	12	16.	
Travel time	60	100	40	40	80.		

When an end loading (EL) event occurs say for truck i at time t other events might be triggered. If the scale is idle [W(t) = 0], truck i begins weighing and an end weighing event (EW) is scheduled on the FEL.

Otherwise truck j joins the weigh queue. If at this time there is another truck waiting for a loader, it will be removed from loader queue and will begin loading by scheduling of end loading event (EL) on the FEL.

→ Both this logic for occurence of end loading event and appropriate logic for the other two events should be incorporated into an event diagram.

→ In sim' table, whenever a new event is scheduled, its event time is written as "t + (activity time)". For e.g, at time 0 imminent event is an EL event with event time 5. The clock is advanced to time t = 5 dump truck 3 joins the weigh queue (bcoz the scale is occupied) and truck 4 begins to load. Thus an EL event is scheduled for truck 4 at future time 10, computed by (Present time) + (loading time) = 5+5 = 10

→ In order to estimate the loader and scale utiliz^n two cumulative statistics are maintained.

BL = total busy time of both loaders from time to time t.

BS = total busy time of scale from 0 to time t.

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3

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→ Both loaders are busy from time 0 to 20 so B_L = 40 at time 20, but from time 20 to 24, only one loader is busy then B_L increases by only 4 minutes over the interval [20, 24]. Similarly from time 25 to 36, both loaders are idle. L(25) = 0, so B_L does not change.

From table

∴ Avg loader utilizn = $\frac{49/2}{76}$ = 0.32

Avg scale utilizn = 76/76 = 1.00

Simulation Table :-

Clock t	System state $LQ(t)$	$L(t)$	$WQ(t)$	$W(t)$	Lists: loader queue	Lists: weigh queue	FEL	Cumulative Statistics B_L	B_S
0	3	2	0	1	DT4 DT5 DT6.		(EL,5,DT3) (EL,10,DT2) (EW,12,DT1)	0	0
5	2	2	1	1	DT5 DT6	DT3	(EL,10,DT2) (EL,5+5,DT4) (EW,12,DT1).	10	5

clk t	LQ(t)	L(t)	WQ(t)	W(t)	loader queue	weigh queue	FEL	BL	BS
0	1	2	2	1	~~DT5~~ DT6	DT3 DT2	(EL,10,DT4) (EW,12,DT1) (EL,10+10,DT5)	20	10
10	0	2	3	1	–	DT3 DT2 DT4	(EW,12,DT1) (EL,20,DT5) (EL,10+15,DT6)	20	10
12	0	2	2	1	–	DT2 DT4	(EL,20,DT5) (EW,12+12,DT3) (EL,25,DT6) (ALQ,12+60,DT1)	24	12
20	0	1	3	1	–	DT2 DT4 DT5	(EW,24,DT3) (EL,25,DT6) (ALQ,72,DT1)	40	20
24	0	1	2	1	–	DT4 DT5	(EL,25,DT6) (EW,24+12,DT2) (ALQ,72,DT1) (ALQ,24+100,DT3)	44	24
25	0	0	3	1	–	DT4 DT5 DT6	(EW,36,DT2) (ALQ,72,DT1) (ALQ,124,DT3)	45	25
36	0	0	2	1	–	DT5 DT6	(EW,36+16,DT4) (ALQ,72,DT1) (ALQ,36+40,DT2) (ALQ,124,DT3)	45	36

52	0	0	1	1	-		DT6 (EL, 52+12, DT5) (ALQ, 72, DT1) (ALQ, 76, DT2) (ALQ, 52+40, DT4) (ALQ, 124, DT3)	45	52
64	0	0	0	1	-	-	(ALQ, 72, DT1) (ALQ, 76, DT2) (EW, 64+16, DT6) (ALQ, 92, DT4) (ALQ, 124, DT3) (ALQ, 64+80, DT5)	45	64
72	0	1	0	1	-	-	(ALQ, 76, DT2) (EW, 80, DT6) (EL, 72+10, DT1) (ALQ, 92, DT4) (ALQ, 124, DT3) (ALQ, 144, DT5)	45	72
76	0	2	0	1	-	-	(EW, 80, DT6) (EL, 82, DT1) (EL, 76+10, DT2) (ALQ, 92, DT4) (ALQ, 124, DT3) (ALQ, 144, DT5)	49	76