19-MAY-2021

ASSIGNMENT - 1

QUESTIONS :-

1. Customers arrive at a checkout counter at random from 1 to 10 mins apart with equal probabilities. The service time have the following distribution

service time	3	5	6	8
Probability	0.2	0.35	0.2	0.25

Simulate the checkout counter for 10 customers using following data

Random digits for Inter Arrival time

91	72	15	94	30	92	75	23	30

Random digits for service time are given below

84	10	74	53	17	79	91	67	89	38

~~2. Optimize~~

2. Organize the situations when simulation is appropriate and when it is not.

3. Identify the categories of systems with examples.

4.a. Construct Event scheduling time advance algorithm with relevant snap shots.

4.b. Develop different methods to generate events.

5. Develop a cumulative distribution function to measure the probability of a random variable.

ANSWERS :-

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1. INTER - ARRIVAL TIME - RDA GENERATION

IAT	PROBABILITY	CUMULATIVE PROBABILITY	RDA
1	0.1	0.1	01 - 10
2	0.1	0.2	11 - 20
3	0.1	0.3	21 - 30
4	0.1	0.4	31 - 40
5	0.1	0.5	41 - 50
6	0.1	0.6	51 - 60
7	0.1	0.7	61 - 70
8	0.1	0.8	71 - 80
9	0.1	0.9	81 - 90
10	0.1	1.0	91 - 00

SERVICE TIME - RDA GENERATION

SERVICE TIME	PROBABILITY	CUMULATIVE PROBABILITY	RDA
3	0.2	0.20	01 - 20
5	0.35	0.55	21 - 55
6	0.2	0.75	56 - 75
8	0.25	1.00	76 - 00

INTER - ARRIVAL TIME GENERATION, ARRIVAL TIME GENERATION.

CUSTOMER No.	RDA	IAT	ARRIVAL TIME
1	-	-	0
2	91	10	10
3	72	8	18
4	15	2	20
5	94	10	30
6	30	3	33
7	92	10	43
8	75	8	51
9	23	3	54
10	30	3	57

SERVICE TIME GENERATION

CUSTOMER NO.	RDA	SERVICE TIME
1	84	8
2	10	3
3	74	6
4	53	5
5	17	3
6	79	8
7	91	8
8	67	6
9	89	8
10	38	5

SIMULATION TABLE :-

A	B	C	D	E	F	G	H	I
1	-	0	8	0	0	8	8	0
2	10	10	3	10	0	13	3	2
3	8	18	6	18	0	24	6	5
4	2	20	5	24	4	29	9	0
5	10	30	3	30	0	33	3	1
6	3	33	8	33	0	41	8	0
7	10	43	8	43	0	51	8	2
8	8	51	6	51	0	57	6	0
9	3	54	8	57	3	65	11	0
10	3	57	5	~~65~~ 65	5	~~70~~ 70	13	0

NOTE:

A → Customer Number
B → Inter Arrival time (IAT)
C → Arrival time
D → Service time
E → Time Service Begins
F → Time customer waits
G → Time Service Ends
H → Time spent in system by Customer
I → Time system was Idle.

2. WHEN SIMULATION IS THE APPROPRIATE TOOL:

Simulation is appropriate under following scenario's

i> If it enables study of internal interaction of Subsystem without complex system.

ii> Informational, Organizational and Environ-mental changes can be simulated and find their effects.

iii> Simulation can be used with new design and policies before implementation.

iv> A plan can be visualized with animated simulation.

v> Finding important input parameters with changing simulation inputs.

WHEN SIMULATION IS NOT APPROPRIATE TOOL:

i> When problem can be solved with common sense.

ii> If the cost exceed savings.

iii> If resource or time is not available.

iv> When problem can be solved analytically.

v> If direct experimenting is easier.

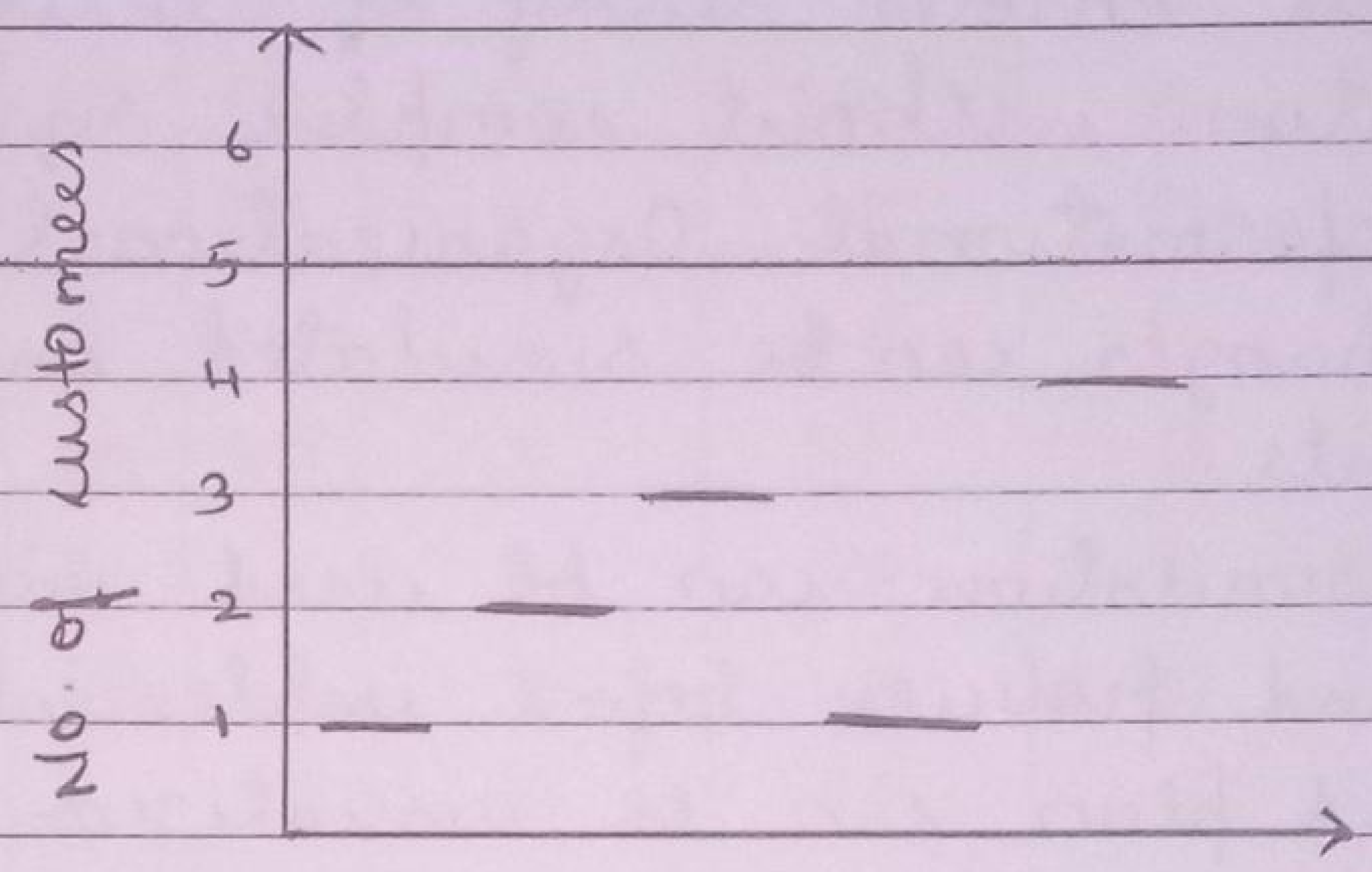
3. CATEGORIES OF SYSTEMS:

Based on the state variable response systems are classified into two types

i> Discrete systems.

ii> Continous system

DISCRETE SYSTEM :

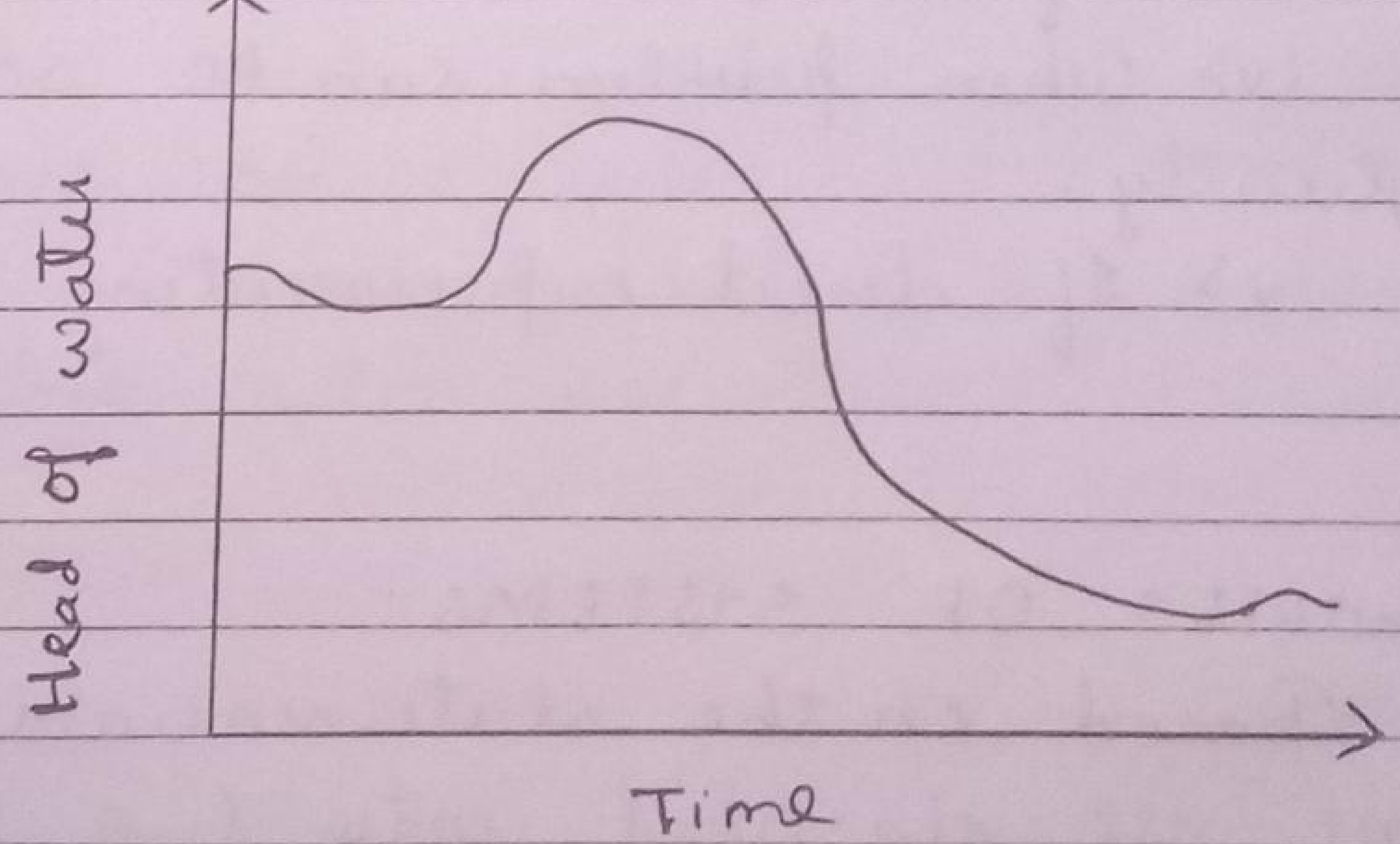


(Bank)

The systems in which the state variables change only at a discrete set of points in time ~~table~~ are called discrete systems.

Eg: Bank

CONTINOUS SYSTEM :



(Dam)

The systems in which the state variables change continously over time are called continous systems.

Eg:

Head of water behind dam.

4.a. ALGORITHM:

i> Remove event notice for imminent event.

ii> Advance clock to imminent event time.

iii> Execute the imminent event, update system state, change entity attribute and set membership as needed.

iv> Generate future events and place their event notice on Future Event List (FEL), ranked by event time.

v> Update the cumulative statistics and counters.

Eg:

Old system snapshot at time 't'

Clock	State	. . .	FEL
t	$(5,1,6)$		$(3, t_1)$ - Type 3 event occurs at t_1. $(1, t_2)$ - Type 1 event occurs at t_2 ⋮

New system snapshot at time 't_i'

Clock	State	...	FEL
t_1	(5,1,5)		$(1, t_2)$ - Type 1 event occur at t_2 $(4, t^*)$ - Type 4 event occur at t^* ⋮

4.6. GENERATION OF EVENTS :

i> ARRIVAL OF A CUSTOMER

a> At $t = 0$ first arrival is generated and scheduled.

b> When the clock is advanced to first arrival, a second arrival is generated.

c> An interval time a^* is generated.

d> $t^* = \text{clock} + a^*$ is calculated.

e> Place

Step a to e are called bootstraping.

ii> Service completion of customer

a> A customer completes service at t.

b> If next customer is present a new service time is generated (s^*).

c> $t^* = \text{clock} + s^*$ is calculated.

d> Next service completion is scheduled at

t^*.

e> Additionally a service completion event will be scheduled at arrival time, when there is an idle server.

f> Service time is an activity.

g> Beginning service is a conditional event, the condition is customer is present and server is idle.

h> Service completion is a primary event.

iii> ALTERNATE GENERATION OF RUN TIMES AND DOWN TIMES

a> At time $t=0$, first run time is generated and end of runtime event will be scheduled.

b> Whenever end of run-time (eor) occurs, a downtime will be generated, and a end-of downtime (eod) will be scheduled.

c> At the eod event, a run-time is generated and eor event is scheduled.

d> Runtimes and downtimes are activities.

e> eor and eod are primary events.

~~iv>~~

5. The cumulative distributive function (cdf) is denoted by $F(x)$, where

$$F(x) = P(X <= x)$$

(i) if X is discrete, then $F(x) = \sum_{\substack{\text{all} \\ x_i \le x}} p(x_i)$

(ii) if X is continous, then $F(x) = \int_{-\infty}^{x} f(t) \cdot dt$

PROPERTIES:

a) F is non-decreasing function. If $a < b$, then $F(a) \leq F(b)$.

b) $\lim_{x \to \infty} F(x) = 1$

c) $\lim_{x \to -\infty} F(x) = 0$

All the probability question about X can be answered in terms of cdf.

eg:

$$P(a < X \leq b) = F(b) - F(a), \ \forall \ a < b$$

Eg:

An inspection device has cdf:

$$F(x) = \frac{1}{2} \int_0^x e^{-t/2} \, dt = 1 - e^{-x/2}$$

The probability that the device lasts for less than 2 years:

$$P(0 \leq X \leq 2) = F(2) - F(0) = F(2) = 1 - e^{-1} = 0.632$$

The probability that it last between 2 to 3 years is

$$P(2 \leq X \leq 3) = F(3) - F(2) = (1 - e^{3/2}) - (1 - e)$$
$$= 0.145$$

——— x ——— x ——— x ———