

## Single Server Queue (Problem):

Q1. A small grocery store has one checkout counter. Customers arrive at the checkout counter at random from 1 to 8 minute apart. Each possible value of inter-arrival time has the same probability of occurrence. The service times vary from 1 to 6 minutes with the probability shown in the table below. The problem is to analyze the system by simulating the arrival and service of 6 customers.

Service time (min)	Probability
1	0.10
2	0.20
3	0.30
4	0.25
5	0.10
6	0.05

Sequence of random number:

Random digit for arrival	913	727	15	948	309	922
Random digit for service time	84	10	74	53	17	79

Assume that first customer arrives at time 0.

- i/ Avg waiting time for a customer.
- ii/ The probability that a customer has to wait in a queue.
- iii/ Fraction of idle time of the server.
- iv/ The avg service time.
- v/ Avg time between arrival
- vi/ Avg waiting time for those who wait.
- vii/ Avg time customer spend in the system.

Ans: Distribution of Arrival Time

Time betn arrival (min)	Probability (1/8)	Cumulative Probability	Random digit assignment.
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	876-000

Distribution of Service Time:

Service time	Probability	C.P	R.D.A
1	0.10	0.10	01-10
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	85-95
6	0.05	1.00	96-00

Time between arrival determination:

Customer	Random Digit	Time between arrival
1	-	-
2	913	8
3	727	6
4	15	1
5	948	8
6	309	3

Service Time:

Customer	R.D	Service Time.
1	84	4
2	10	1
3	74	4
4	53	3
5	17	2
6	79	4

## Simulation Table for Queing Problem :

Customer	intra Arrival time	Arrival time	Service time	Service begin time	Wait (service begin - Arrival)	Service end	time spend in system	idle time. (service begin - service end)
1	—	0	4	0	0	4	4	0
2	8	8	1	8	0	9	1	4 (8-4)
3	6	14	4	14	0	18	4	5 (14-9)
4	1	15	3	18	18-15=3	18+3=21	6	0
5	8	23	2	23	0	25	2 (23-21)	2-(23-25)
6	3	26	4	26	0	30	4	1
			18		3		21	17.2

## Calculations:

1/ Avg waiting time :  $\frac{\text{total time customer waits in que}}{\text{total no of customer}} = \frac{3}{6} = 0.5 \text{m}$

2/ Probability :  $\frac{1}{6} (\text{total no of customer}) = 1/6$

3/ Probability of idle time server =  $\frac{12}{30} = 40\%$   
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 at this time service ends

4/ Avg service time :  $\frac{18}{6} = 3 \text{min}$

5/ Avg time betn arrival :  $\frac{26}{6-1} = 5.2 \text{min}$

6/ Avg waiting time :  $\frac{3}{1} = 3$

7/ Avg time customer spend in a system =  $\frac{21}{6} = 3.5 \text{m}$

## Able and Baken Problem (Simulation Table)

Customer	IAT	Arrival time	Able			Baken			Callen delay	Time in System. (Callendelay + service time)
			time service begin	Service time	time service ends (begin + service time)	time service begin	Service time	time service ends (serv begin + serv time)		
1	—	0	0	5	5 (0+5)	—	—	—	0	0+5=5
2	2	2	—	—	—	2	3	5 (2+3)	0	0+3=3
3	4	6	6	3	9 (6+3)	—	—	—	0	0+3=3
4	4	10	10	5	15 (10+5)	—	—	—	0	0+5=5
5	2	12	—	—	—	12	6	18 (12+6)	0	0+6=6
6	2	14	15	3	18 (15+3)	—	—	—	1	1+3=4