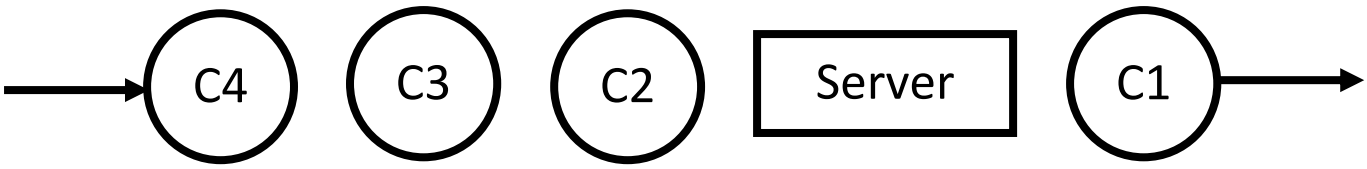
Simulation of Single Server Queue Example



In a single server queueing system the time of the arrival and departure of the customers are given below. Simulation clock starts at 0 & ends at 10.5

Arrival times	0.4, 1.2, 2.2, 3.8, 4.0, 9.0, 9.8, 10.2
Departure times	2.4, 3.1, 4.4, 4.9, 8.6, 9.6, 10.0, 10.5

Questions	
1.	Average Interval (Inter Arrival) Time
2.	Average Waiting Time of Those Who Wait
3.	Average number of Customer in Queue or, Probability of Customer in Queue
4.	Average Delay in Queue or, Average Waiting Time
5.	Average Service Time
6.	Average Time Spend in the Server
7.	Probability of Idle Server
8.	Utilization of the Server
9.	Show the graph of number of customers in the system
10.	Show the graph of B(t) vs t, where B(t) indicates server busy at time t.

Simulation Table

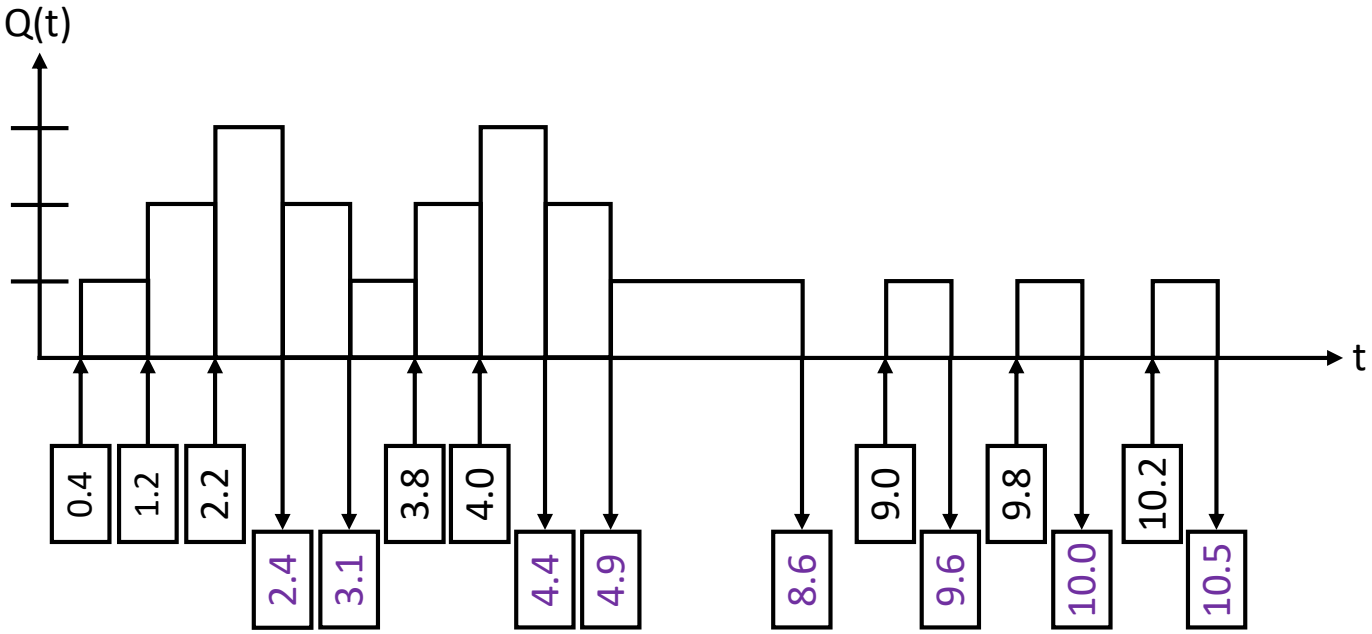
Arrival times	0.4, 1.2, 2.2, 3.8, 4.0, 9.0, 9.8, 10.2
Departure times	2.4, 3.1, 4.4, 4.9, 8.6, 9.6, 10.0, 10.5

Customer No	Arrival Times	Inter Arrival Time	Service Time Begin	Departure Time	Service Time	Delay	Idle Server	Total Spend Time in System
1	0.4	-	0.4	2.4	2	0	0.4	2
2	1.2	0.8	2.4	3.1	0.7	1.2	0	1.9
3	2.2	1	3.1	4.4	1.3	0.9	0	2.2
4	3.8	1.6	4.4	4.9	0.5	0.6	0	1.1
5	4.0	0.2	4.9	8.6	3.7	0.9	0	4.6
6	9.0	5	9	9.6	0.6	0	0.4	0.6
7	9.8	0.8	9.8	10.0	0.2	0	0.2	0.2
8	10.2	0.4	10.2	10.5	0.3	0	0.2	0.3
8		**9.8**		**10.5**	**9.3**	**3.6**	**1.2**	12.9
Total Customer		Total Inter Arrival Time		Server End Time	Total Service Time	Total Delay in Queue	Total Idle Time	Total Spend Time in System by All Customer

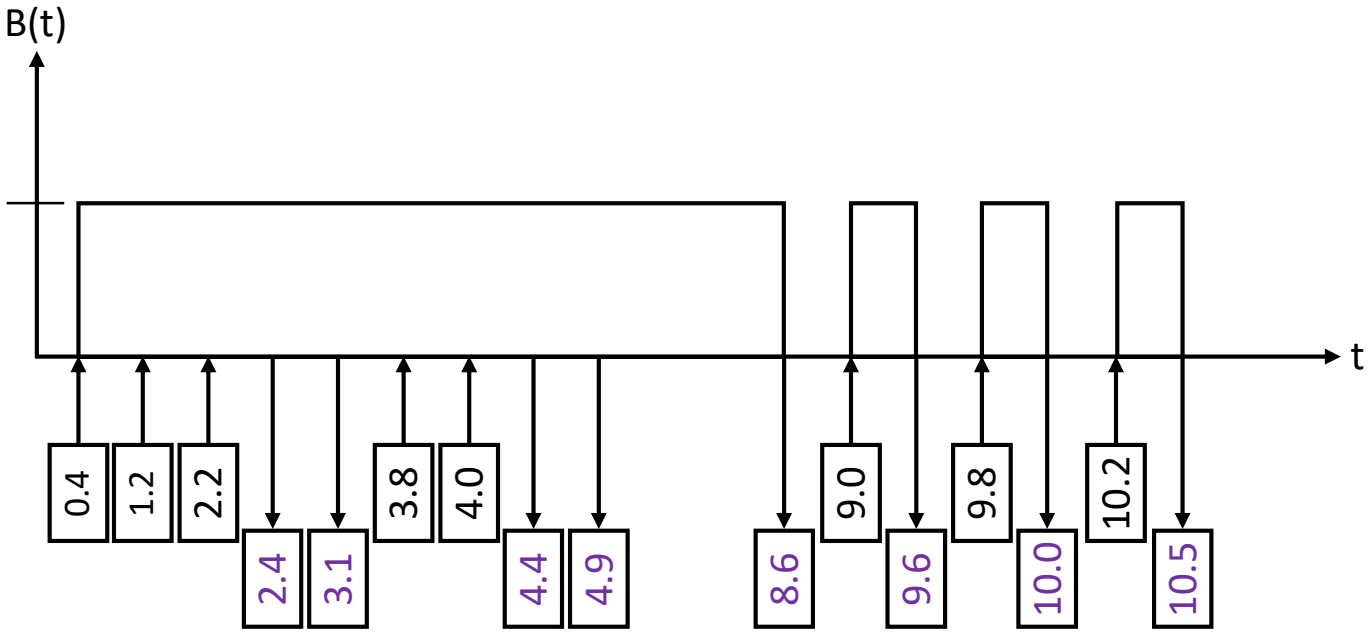
Performance Measure:

Arrival times	0.4, 1.2, 2.2, 3.8, 4.0, 9.0, 9.8, 10.2
Departure times	2.4, 3.1, 4.4, 4.9, 8.6, 9.6, 10.0, 10.5

Number of customers in the system



Show the graph of B(t) vs t, where B(t) indicates server busy at time t.



Average Interval (Inter Arrival) Time or, Average Time between Arrival

$$Average\ Interval\ (Inter\ Arrival)Time = \frac{Total\ Interval\ Time}{Total\ Customer\ -\ 1} = \frac{9.8}{8-1} = \frac{9.8}{7} = 1.4$$

$$Average\ Time\ between\ Arrival = \frac{Total\ Time\ between\ Arrival}{Number\ of\ Arrival\ -\ 1} = \frac{9.8}{8-1} = \frac{9.8}{7} = 1.4$$

Average Waiting Time of Those Who Wait

$$Average\ Waiting\ Time\ of\ Those\ Who\ Wait\ = \frac{Total\ Waiting\ Time}{\begin{matrix}Total\ Customer\\ who\ wait\end{matrix}} = \frac{3.6}{4} = 0.9$$

Average number of Customer in Queue or, Probability of Customer in Queue

$$Average\ number\ of\ Customer\ in\ Queue = \frac{Total\ Customer\ in\ Queue}{Number\ of\ Customer} = \frac{4}{8} = 0.5$$

$$Probability\ of\ Customer\ in\ Queue = \frac{Total\ Customer\ Wait\ in\ Queue}{Total\ Customer} = \frac{4}{8} = 0.5$$

Average Waiting Time or, Average Delay in Queue

$$Average\ Waiting\ Time\ = \frac{Total\ Waiting\ Time}{Total\ Customer} = \frac{3.6}{8} = 0.45$$

$$Average\ Delay\ in\ Queue\ = \frac{Total\ Delay}{Total\ Customer} = \frac{3.6}{8} = 0.45$$

Average Service Time

$$Average\ Service\ Time\ = \frac{Total\ Service\ Time}{Total\ Customer} = \frac{9.3}{8} = 1.16$$

Average Time Spend in Server

$$Average\ Time\ Spend\ in\ Server = Average\ Waiting\ Time + Average\ Service\ Time$$
$$= 0.45 + 1.16 = 1.61$$

$$Average\ Time\ Spend\ in\ Server = \frac{Total\ Spend\ Time\ in\ System\ by\ All\ Customer}{Total\ Customer} = \frac{12.9}{8} = 1.61$$

Probability of Idle Server

$$Probability\ of\ Idle\ Server = \frac{Total\ Idle\ Time}{Total\ Runtime} = \frac{1.2}{10.5} = 0.11$$

Utilization of the Server

$$Utilization\ of\ the\ Server = \frac{End\ Time\ -\ Idle\ Time}{End\ Time} = \frac{10.5 - 1.2}{10.5} = \frac{9.3}{10.5} = 0.89$$