## Exercise 4:

Consider a multiplexer that collects traffic formed by messages arriving according to exponentially distributed interarrival time. The multiplexer is formed by a buffer and a transmission line. Make the following approximation: the transmission time of a message is exponentially distributed with E[X] = 10 ms. From measurements of state on the buffer, we know that the idle buffer probability is $P_0 = 0.8$. We are required to find the mean message delay.

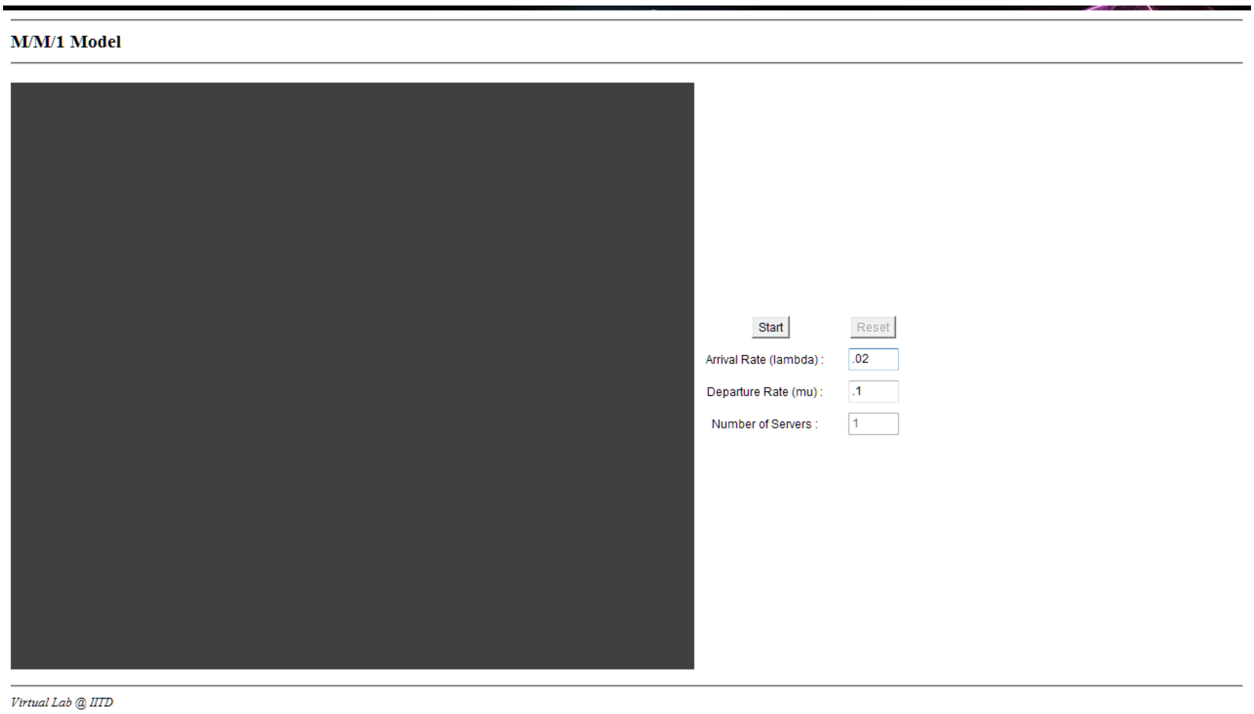
## Solution:

The device can be modelled as a M/M/1 FIFO queue. The arrival is a Poisson process with arrival rate $\lambda$ [which have to determine], the service is exponentially distributed with mean rate $\mu = 1/E[X] = 1/10ms = 0.1\ ms^{-1}$. The net input traffic is therefore $\rho = \lambda/\mu = 10\lambda$ ms. Since the empty queue probability is $P_0 = 0.8$, we have $\rho = 1 - 0.8 = 0.2$, giving us $\lambda = 0.2/10$ ms $= 0.02\ ms^{-1}$. Therefore, the mean number of messages is $N = \rho/(1- \rho) = 0.25$ messages. The delay of the system, as described by Little's Theorem, is now calculated as $T = N/\lambda = 12.5ms$.

## Simulation:

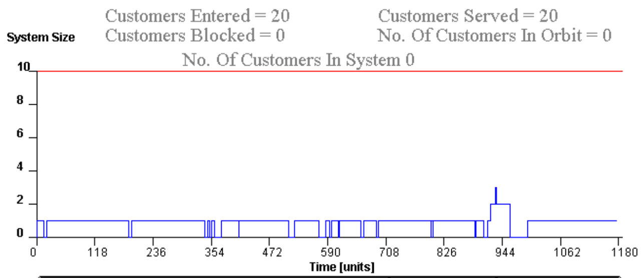
For a simulation of the multiplexer as modelled, perform the following steps:

→ Open the page where the simulation is to be performed.
→ Next feed the data as shown. Put lambda ($\lambda$) = 0.02 and mu ($\mu$) = 0.1



→ Click Start. The applet will now generate a sample path for the queue.

**M/M/1 Model**




| Performance Measures | Run Time (till t=1187) | Steady State (Theoretical) |
|---|---|---|
| Mean No. of Customers in the System | 0.921 | 0.249 |
| Mean No. of Customers in Queue | 0.035 | 0.049 |
| Mean Waiting Time In Queue | 2.078 | 2.499 |
| Mean Sojurn Time In System | 54.685 | 12.5 |
| Utilisation | 0.886 | 0.199 |
| Throughput | 0.016 | 0.02 |
| Blocking Probability | 0.0 | 0.0 |

Pause Reset

Arrival Rate (lambda) : .02

Departure Rate (mu) : .1

Number of Servers : 1

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→ We see that the steady state data obtained from the applet matches beautifully with the theoretically calculated data.