# Queuing Models (2)

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## Today's lecture

- More examples on queuing systems

# Single Server Queue

- Table 7.6 on page 160 summarizes the formulas for a single server queues



# Example (1)

If an M/M/1 queue has arrivals at a rate of two per minute and serves at a rate of four per minute, how many customers are found in the system on average? How many customers are found in service on average?

# Example (1)

Solution:

= / = *Ts = 2* 0.25= 0.5

Average number in system = q

= /(1- )=1

Average number in service = q – w

= = 0.5



# Example (2)

What is the utilization of an M/M/1 queue that has four customers waiting on average?

# Example (2)

Solution:

$w = \rho^2/(1-\rho) = 4$

$\rho^2 + 4\rho - 4 = 0$

$\rho = 0.236$



# Example (3)

Messages arrive at random to be sent across a communication link with a data rate of 9600 bps. The link is 70% utilized, and the average message length is 1000 octets. Determine the average waiting time for constant-length messages and for exponentially distributed length messages?

# Example (3)

Solution:

Ts= 0.833 sec;  = 0.7

Constant-length messages:

Tw =  Ts/ (2 - 2  ) =0.972 sec

Exponentially-distributed:

Tw =  Ts/ (1 - 1  ) =1.944 sec



# Example (4)

Consider a single queue with a constant service time of four sec and a Poisson input with mean rate of 0.20 items per second.

a. Find the mean and standard deviation of queue size?

b. Find the mean and standard deviation of queuing time?

# Example (4)

Solution:

= / = *Ts = 0.2 *4 = 0.8

a. q= 2.4

$_{q}$ = 2.4

b. Tq = 12

$_{Tq}$ = 9.24