

Date: Spring
Duration: 15 min.

- There is only one correct answer for each multiple choice question.
- Each correct answer adds 1 point.
- Each incorrect answer has a penalty of $\frac{1}{3}$ points.
- No score is awarded for unanswered questions, neither positive nor negative.
- Mark out your answers with an "X".
- No score is awarded if you mark more than one answer.

Write your personal data clearly.

Last name:	
First name:	
Group:	

Permutation: A

NIA:

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	A	B	C	D
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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1.- What is the time that a data packet has to wait in the queue in a M/M/1 buffer? Note that the queueing time is different from the total sojourn time.

- (a) $\frac{1-\rho}{(\rho+1)\lambda}$.
- (b) $\frac{\mu}{\rho(1+\lambda)}$.
- (c) $\mu\rho^2$
- (d) $\frac{\rho^2}{\lambda(1-\rho)}$

2.- Given a buffer that can accommodate k packets and receives a Poisson traffic load of $A = \frac{\lambda}{\mu}$ erlangs, what is the average number of packets in the buffer? (This number includes the packet that is currently being transmitted).

- (a) $N = \frac{1-A}{(A+k)\lambda}$.
- (b) $N = \lambda k = \sum_{i=A}^{\infty} k$.
- (c) $N = p_0 \sum_{i=0}^k A^i$.
- (d) $N = \frac{A(1-A)}{1-A^{k+1}} \frac{\partial}{\partial A} \frac{1-A^{k+1}}{1-A}$.

3.- What is the average number of packets in a M/M/1 buffer?

- (a) 42
- (b) $\frac{\lambda}{2}$.
- (c) $p_0 \sum_{i=0}^{\infty} i\rho^i$.
- (d) $\lim_{N \rightarrow \infty} \lambda^\rho$.

4.- Consider two Poisson traffic sources that generate 0.8 packets/second each. To transmit this packets we have two different options, X and Y. Option X is to have two different transmitters (one for each flow) each one with a capacity equal to 1 packet/second and an exponentially distributed service time. The second option (option Y) is to merge the two flows in a single buffer and have a single transmitter of capacity 2 packets/second and exponentially distributed service time.

- (a) Option X offers more throughput than option Y.
- (b) Option X and option Y offer the same average delay.
- (c) Option Y offers twice as much throughput as option X.
- (d) Option Y offers a lower average delay.

5.- Which is the probability of finding an M/M/1 buffer empty?

- (a) $\frac{1}{\rho}$
- (b) $\frac{-1}{\rho^2}$.
- (c) $1 - \rho$
- (d) $\frac{1}{1-\rho}$.

6.- Which of the following is the balance equation that we use to solve a model for a buffer where the arrivals follow a Poisson process with parameter λ and the service time is exponential and the rate is μ . p_n is the probability of having n packets in the system.

- (a) $p_n = \rho p_{n+1}$ for $n = 0$.
- (b) $p_n - p_{n+1} = \frac{\lambda}{\mu}$ for $n \geq 0$.
- (c) $p_{n+1}\lambda = p_n\mu$ for $n \geq 0$.
- (d) $\lambda p_n = \mu p_{n+1}$ for $n \geq 0$.

7.- What is the normalization equation that we use in the process of modelling an M/M/1 system?

- (a) $\sum_i \lambda = \sum_i \mu$.
- (b) $\sum_{i=0}^K p_i = \infty$.
- (c) $\lambda p_i = \sum_{i=\rho}^{\infty}$.
- (d) $\sum_{i=0}^{\infty} p_i = 1$.