Simulation **Solution** **University of the Ryukyus**
3-rd and 4-th Year Undergraduate **Faculty of Engineering**
Mid-Term Examination **Department of Information Eng.**
2011-12-2 time: 90 minutes (score: each 10) **Prof. Mohammad Reza Asharif**

1- What is a simulation?

A : In a simulation, we use computer to imitate or simulate the operations of various kinds of real-world system by using its numerical model.

2- What kind of problems are with simulation?

A :
1 - complexity of writing computer programs.
2 - Large amount of computer time.
3 - Not considering of all aspects of real model

3- Classify simulation models into three different dimensions.

A :
1 - Static vs. dynamic simulation models.
2 - Deterministic vs. stochastic simulation models.
3 - Continuous vs. discrete simulation models.

4- Name two approaches for the simulation clock advancing.
A3:
1 - Next-event time advance.
2 - Fixed-increment time advance.

5- What is the Monte Carlo simulation?

A : A simulation methodology which employs random numbers, U(0,1), for solving certain stochastic or deterministic problems.

6- What are the three measures of the system performance in a single server queuing system?

A :
1 - The average delay in queue .
2 - The time-average number of customer in queue .
3 - The proportion of time the server is busy .

7- In which simulation model, a) time is considered? b) random numbers are used?

A:
a) Dynamic models.

b) Stochastic model

8-Find the value of the following integral by using the Monte-Carlo method (use 6 points).

$$I = \int_0^{2\pi} e^{(\cos x)} dx$$

a) Generate U(0,1)by computer or any means (if you cannot use the following RNG):
U=0.711 0.520 0.144 0.929 0.291 0.468

b) Use the relation: X=(2 π)U to map from U(0,1) into X(0, 2 π), then compute cos(xi)

c) Then use $g(x_i)= e^{(\cos xi)}$ to find $g(x_i)$ and fill the following table:

Table 1

i	***1***	***2***	***3***	***4***	***5***	***6***
cos(x_i)	**-0.24**	**-0.99**	**0.617**	**0.902**	**-0.254**	**-0.980**
g(x_i)	**0.786**	**0.370**	**1.853**	**2.464**	**0.775**	**0.375**

Using Monte-Carlo with 6 points: I=6.935

$I=(b-a)(\Sigma_{i=1}^{6} g(xi))/6$

$I=2\pi$ (6. 623)/6 = 6. 935

9-In the following single server queuing MM1 system, find:

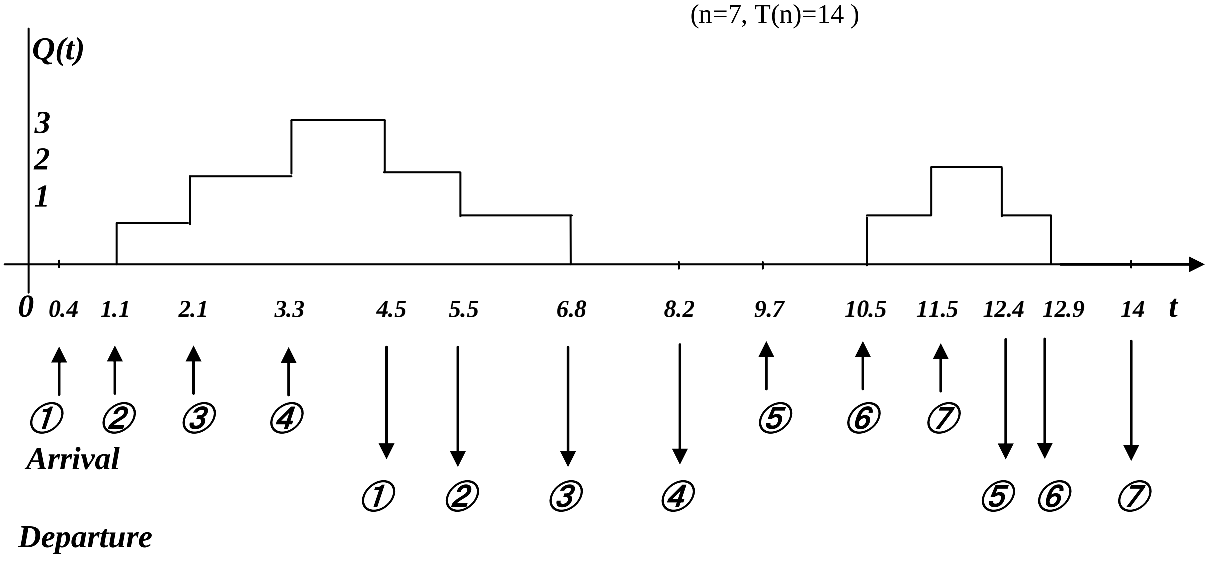
a) Average delay in queue (d(n): ADQ).

b) Average number of customers in the queue (q(n): ANCQ).

c) Efficiency of utilization of the server (u(n): %).

(↑ i means i^{th} arrival *and* ↓ i means i^{th} departure)

(n=7, T(n)=14)



a)

D1=0, D2=4.5-1.1=3.4, D3=5.5.-2.1=3.4, D4=6.8-3.3=3.5, D5=0, D6= 12.4-10.5=1.9, D7=12.9-11.5=1.4
d(n)= Σi=1 to n Di/n=(0+3.4+3.4+3.5+0+1.9+1.4)/7=13.6/7=1.94 ADQ (time)

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b)

T0=1.1+(10.5-6.8)+(14-12.9)=1.1+3.7+1.1=5.9
T1=(2.1-1.1)+(6.8-5.5)+(11.5-10.5)+(12.9-12.4)=1+1.3+1+0.5=3.8
T2=(3.3-2.1)+(5.5-4.5)+(12.4-11.5)=1.2+1+0.9=3.1
T3=(4.5-3.3)=1.2
q(n)= Σi=0 to ∞ i Ti/T(n)= (0x5.9+1x3.8+2x3.1+3x1.2)/14=(3.8+6.2+3.6)/14=
q(n) =13.6/14=0.97 ANCQ (men)

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c) u(n)= Σt=0 to 14 B(t)

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u(n)=[(8.2-0.4)+(14-9.7)]/14=(7.8+4.3)/14=12.1/14=0.86=86% server utility (busy)%
