

TECHNICAL UNIVERSITY OF KENYA

FACULTY OF APPLIED SCIENCES AND TECHNOLOGY

SCHOOL OF COMPUTING & INFORMATION TECHNOLOGY

END OF SEMESTER MAY 2017 EXAMINATION SERIES

FIRST SEMESTER EXAMINATIONS 2016/2017

THIRD YEAR EXAMINATIONS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY

**ECSI 3106 : SIMULATION AND MODELLING**

TIME: 2 Hours  **MAY 2017**

**Instructions to candidates:**

This paper consists of FIVE Questions.

Answer Question ONE [30 Marks] and any other TWO Questions [20 Marks Each].

Mobile phones and any written materials are prohibited in the examination room.

Programmable calculators are prohibited

Write your college number on the answer sheet.

This paper consists of 4 printed pages

**Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.**

@May 2017 The Technical University of Kenya

**QUESTION ONE[30 MARKS] (COMPULSORY)**

1. Explain the terms listed below.
2. System **(1mark)**
3. Performance **(2marks)**
4. Computer simulation **(2marks)**
5. i. What is a model, what is the goal of a model, and why do we build models? **(3marks)**

ii. Differentiate between a permutation and a combination **(2marks)**

c) Consider an unfair six-sided die where the probability of rolling a “1” is three times the probability of rolling any other value. All other values have the same probability of occurring. Let *X* be the random variable that takes on values 1 through 6 for our unfair die.

1. Plot the pmf and CDF of *X*. **(3marks)**
2. Determine the mean of *X*. **(3marks)**

d) For an M/M/1 queue we know that the mean number of customers in the system (*L*) is equal to the utilization divided by one minus the utilization. Using basic laws and relationships, derive thefollowing:

i. Mean wait in the system (*W*) **(1marks)**

ii. The mean number of customers in the queuing area (*Lq*) **(2marks)**

iii. The mean wait in the queuing area (*Wq*) as a function of arrival rate and service rate.

**(3marks)**

e)i. Consider a single server queue with Poisson arrivals (rate λ) and a uniformly distributed service time (with minimum value *a* seconds and maximum value *b* seconds). Solve for the mean number of customers in the system (*L*). You do not need to simplify your expression for *L*.

**(2marks)**

ii. Consider the following single-server queuing system from time = 0 to time = 10 sec. Arrivals and service times are:

* Customer #1 arrives at t = 1 second and requires 2 seconds of service time
* Customer #2 arrives at t = 2 second and requires 2 seconds of service time
* Customer #3 arrives at t = 5 seconds and requires 2 seconds of service time
* Customer #4 arrives at t = 8 seconds and requires 2 seconds of service time

Solve for system throughput (*X*), total busy time (*B*), mean service time (*Ts*), utilization (*U*), mean system time (delay in system) (*W*), and mean number in the system (*L*). Show your work to receive full credit. **(6marks)**

**QUESTION TWO[20 MARKS]**

1. Write a Monte Carlo simulation program to model a biased coin as follows. When flipped if the coin show tails it has a 50% chance of tails or heads on the next flip. However, if the coin shows heads then it has 75% chance of showing heads again on the next flip. The Monte Carlo simulation should determine the probability of a head showing. You may assume that you have access to a function rand\_val() that returns uniform(0.0, 1.0). **(10marks)**

b) i. Discuss **three** mostly used categories of tools for simulation and modeling, giving an example of each **(6marks)**

ii. Give an approximately 100 to 150 word overview or description of what CSIM is. You will be graded for completeness. **(4marks)**

**QUESTION THREE [20 MARKS]**

1. Below are some sample means taken from independent replications of a simulation model.

**10 12 15 15 15 17**

1. What is the 95% confidence interval (CI)? **(3marks)**
2. What is the accuracy of the CI? **(3marks)**

b) Discuss the advantages and disadvantages of independent replications and batch means method for run length control. **(4marks)**

c) i. Sketch the steps in a simulation study. **(6marks)**

ii. Describe the difference between model verification and validation. **(4marks)**

**QUESTION FOUR [20 MARKS]**

1. i. Generate **three** random numbers using Mid Square Random Number Generator. Assume a three digit seed value as 123. **(4marks)**

ii. Write a computer program in C++ for generating random number by mid-square method as given above. (**6marks)**

b) TheFollowing random numbers have been generated by Congruential method.Perform Auto Correlation test totest their randomness. **(10marks)**

**49 95 82 19 41 31 12 53 62 40 87 83 26 01 91 55 38 75 90 35 71 57 27 85**

**52 08 35 57 88 38 77 86 29 18 09 96 58 22 08 93 85 45 79 68 20 11 78 93**

**21 13 06 32 63 79 54 67 35 18 81 40 62 13 76 74 76 45 29 36 80 78 95 25 52**

**QUESTION FIVE [20 MARKS]**

1. i. Generate a random variable with uniform distribution *f* (*x*) given by,

*f*(*x*) =

**(6marks)**

ii. Discuss any **three** methods for testing randomness of numbers **(4marks)**

1. i. Compute the value of π with the help of Monte Carlo Simulation method. **(6marks)**

ii. Explain the role that animation can play in a simulation and modeling study **(4marks)**