HARARE INSTITUTE OF TECHNOLOGY

SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

Bachelor of Technology Honors Computer Science

ICS 411: SIMULATION AND MODELING

SUPPLEMENTARY EXAMINATION

Time: 3 Hours **Date: July/August 2018**

Total Marks: 100

Instructions to Candidates

- This question paper contains a total of **FIVE** questions.
- Each question carries **25 marks**
- Answer **any FOUR** questions
- Mark value to each sub parts of question are shown in right hand side
- Illustrate your answer, where appropriate with large clearly labeled diagrams
- Start a new question on a fresh page

Requirements

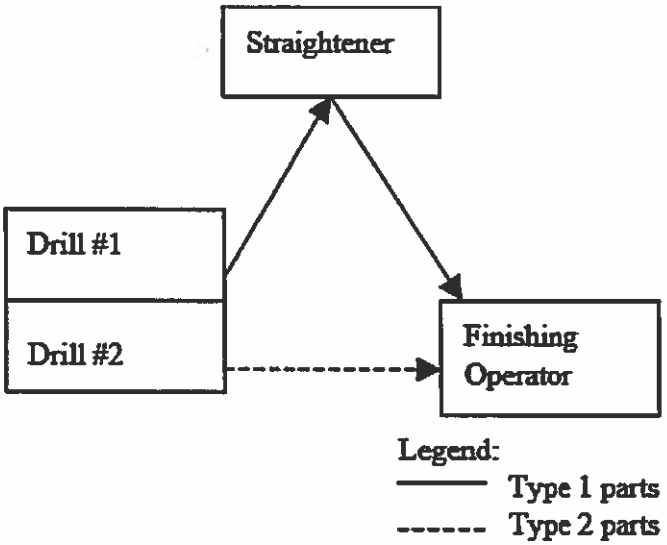
- Answer book

Question 3

a. Briefly explain why we need random numbers in Simulation experiments [5]

b. A recent survey indicated that 82% of single women aged 25years old will be married in their lifetime .Using the binomial distribution, find the probability that two or three women in a sample of twenty will never be married. [5]

c. A machine shop contains two drills, one straightener, and one finishing operator. Figure below shows a schematic of the machine shop. Two types of parts enter the machine shop.



Type 1 parts require drilling, straightening, and finishing in sequence. Type 2 parts require only drilling and finishing. The frequency of arrival and the time to be routed to the drilling area are deterministic for both types of parts.

i. Using the problem presented above show how you can perform simulation analysis? [15]

Question 1

a. Briefly explain the following terms, in the context of modeling and simulation:

   i. Validation [2]

   ii. Credibility [2]

b. State and Explain any **FIVE** techniques used for the verification of simulation models. [5]

c. A system has three possible states, 0, 1 and 2. Every hour it makes a transition to a different state, which is determined by a coin flip. For example, from state 0, it makes a transition to state 1 or state 2 with probabilities 0.5 and 0.5.

   i. Find the transition probability matrix. [4]

   ii. Find the three-step transition probability matrix. [5]

   iii. Find the steady-state distribution of the Markov chain [7]

Question 2

a. Suppose you want to write a simulation model for an Airport using a general-purpose language like C or C++.

   i. Name the entities, attributes, activities, events, and state variables of your system. [7]

b. Briefly explain any **FOUR** characteristics of a Queuing Systems? [8]

c. A fast food service kiosk employs one cashier at its counter. 40 customers arrive on average every 25 minutes. The cashier can serve 20 customers every 10 minutes.

   Assuming poison distribution for arrival and exponential distribution for service rate find:

   i. Average number of customers in queue. [2]

   ii. Average time a customer spends in the system. [3]

   iii. Average time a customer waits before being served. [2]

   iv. Average number of customers in the system. [3]

Question 4

a. Consider a computer system with two processors and one infinite queue. Tasks arrive to the processors according to a Poisson process with a rate λ=20 tasks/sec and each server has a processing speed of $C = 2\ Mbits/sec$ .The service time is exponentially distributed with a mean $\frac{1}{\mu}$ = 50ms.

i. What is the service rate of each processor expressed in tasks/sec? **[3]**

ii. Compute the average task size (L) in Kbits? **[3]**

iii. Determine the queue model of the computer system and compute the expected qu eue length of the system? **[4]**

iv. If an M/M/1 queue model was used for the computer system with an arrival rate λ =20 tasks/sec and one processor with a service rate. $\mu = 40\ tasks/sec$. Decide if the M/M/1 queue model will provide faster response time or not as compared to the previous queue model of the computer system? **[5]**

b. The average time that an employee works at a call center, before leaving the company, is being studied. Suppose that you have been given the results as a Confidence Interval. You have been asked to explain those results to your CEO.

i. Explain what a confidence interval means (make up numbers as necessary). **[5]**

ii. After you present the results, the CEO is not satisfied, saying that the results are not precise enough. She wants the width of the confidence interval to be cut in half. What would you do to achieve the CEO's required level of precision? **[5]**

Question 5

a. Can a simulation model be verified but not valid and vice-versa? Investigate your answer with an example for each. **[4]**

b. Discuss **FIVE** techniques for increasing model validity and credibility. **[5]**

c. List **FIVE** major Pitfalls in simulation modeling **[4]**

d. A genetics engineer was attempting to cross a tiger and a cheetah. She predicted a phenotypic outcome of the traits she was observing to be in the following ratio 4 stripes only: 3 spots only: 9 both stripes and spots. When the cross was performed and she counted the individuals she found 50 with stripes only, 41 with spots only and 85 with both.

   i. According to the Chi-square test, did she get the predicted outcome? **[12]**

----------END OF QUESTION PAPER----------