NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

SMA5274

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED MATHEMATICS

SIMULATION MODELLING

DEC 2002

Time : 3 hours

Candidates should attempt **ALL** questions from Section A and **ANY THREE** questions from Section B.

SECTION A

A1. Verification techniques in simulation include:

(a) structured walk-through,

(b) diagnostic simulation runs,

(c) comparison to a well understood problem,

(d) trace analysis

Discuss how you would use each of these methods, and how they ensure that your model correctly represents the system you are trying to simulate. [8]

A2. Discuss the methods that can be used when simulating a non-terminating system in steady-state, to ensure that the initial bias is eliminated and the data satisfies the assumption of independence. Which method do you consider to be the most effective and why? [12]

A3. Draw the flow diagram for the execution of a three phase simulation model. State the differences between a **B** and **C** activity. [5]

SECTION B

B4. A reservoir receives rainwater during the rainy season (October through to February) and supplies water during the whole year. If there are more than 1000 units in the reservoir, there is an overflow that destroys the nearby crops. When quantity at the beginning of the month surpasses S units, the water flow is let into a river before the 1000 unit mark is reached to avoid an overflow. The water is let out until the level is reduced to s unts. The reservoir manager wants to find the best values of S and s to maximise profits.

Write a project proposal for the simulation of this situation. [25]

B5. (a) Consider the simplest form of *craps*. In this game, a pair of dice is rolled. If on the first throw a 7 or 11 is rolled, a win is right away. If instead, a 2,3 or 12 is rolled, we lose right away. Any other total gives the player a second chance. In this part of the game, the player continues rolling the dice until he gets a 7 or the total of his first throw. If he gets a 7, he loses. If the player rolls the same total as his first throw, he wins. Assuming the dice is fair, develop an experiment to determine the percentage of the time the player wins. [12]

(b) A job shop manager wishes to develop a simulation model in order to help schedule jobs through the shop. He has evaluated the completion times for all the different types of jobs. For one particular job, the times to completion can be represented by the following triangular distribution:

$$f(x) = \begin{cases} \frac{x}{8} - \frac{1}{4} & 2 \leq x \leq 4 \\ \frac{10}{24} - \frac{x}{24} & 4 \leq x \leq 10 \end{cases}$$

Develop a process generator for the distribution using the inverse transformation method and the acceptance-rejection method. [7,6]

B6. A crash repair garage in Bulawayo has a single telephone line. If a call is received when the line is busy the caller is a message informing them that they are in a telephone queue, and smoothing music is played down the telephone until the call can be answered. During weekdays the gaps between succisive calls can be approximately described by an exponential distribution of the form:

$$f(t) = 0.2e^{-0.2t}, \quad \text{where } t \text{ is time in minutes}$$

(a) What is the mean gap between successive calls? [1]

(b) What is the mean number of calls received in one hour? [2]

(c) What is the median time gap between succesive calls? [3]

(d) Calculate the probabilities of gap between calls given the following information:

Gap between successive calls (minutes)	Observed Frequency
0 - 2	80
2 - 4	54
4 - 6	39
6 - 10	41
10 - 20	30
20 - 30	5
30 - 40	1

[6]

(e) Carry out an appropriate statistical test to check if the observed frequencies appear to come from the given distribution. [8]

(f) Records provided by the elephone company show that the durations of the telephone conservations can be described by the probablity distribution given below:

Length of Conservation (mins)	Probability
0 - 2	0.32
2 - 4	0.38
6 - 10	0.20
10 - 15	0.10

Show how you would use random number mappings to simulate the time for the telephone coversation. [5]

B7. Mr Ozias Ncube's Hamburger Joint, ONHJ, speciliases in soyabean burgers. However, soya-burgers are not the only commodity sold. Customers may also buy cokes, fish-burgers, and other fast foods. Customers arrive according to the following interarrival rate distribution over the lunch period from 11:00 AM to 1:00 PM.

Time Between Arrivals(minutes)	Probability
3	0.30
5	0.20
6	0.15
8	0.20
10	0.15

People who want burgers for lunch usually arrive in groups. The following distribution of arrivals has been observed over a period of past history:

Number of People	Probability
1	0.40
2	0.30
3	0.20
4	0.10

Each individual customer orders between none and two burgers according to the following distribution:

Burgers per person	Probability
0	0.20
1	0.65
2	0.15

Due to flunctuations in burger-eating per person, the average stay per person is a random variable given by the following distribution:

Length of stay	Probability
10	0.10
15	0.40
20	0.30
25	0.20

If a group enters ONHJ, the time in the system for the group is determined by the longest length of stay for an individual in that group.

Using random number tables, simulate behaviour of ONHJ for a period of 6 hours. Determine answers to the following questions:

(a) How many burgers would have to be to made on average on an hourly basis?

(b) What is the expected stay in the dining area per group of people?

[25]

END OF QUESTION PAPER