NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

COMPUTER SCIENCE DEPARTMENT

DECEMBER EXAMINATIONS 2001

SUBJECT: SIMULATION AND MODELLING
CODE: SCS 6106

INSTRUCTIONS TO CANDIDATE
THIS PAPER CONSISTS OF SIX (6) QUESTIONS.
ALL QUESTIONS CARRY EQUAL MARKS
You may use scientific calculators
Answer Any FOUR Questions

3 HOURS

QUESTION ONE

Data have been collected on service times at a drive-in bank window at the Chinoyi Street Zimbank. This data are summarised into intervals as follows.

Interval (seconds)	Frequency
15-30	10
30-45	20
45-60	25
60-90	35
90-120	30
120-180	20
180-300	10

Setup a table of intervals and slopes for generating service times by table lookup method and generate three values of service times using four digit random numbers. [25]

QUESTION TWO

A fighter aircraft flies directly towards a sighted Bomber to catch up and destroy it. The bomber continues to fly in a specified curve, so the fighter has to change its direction to keep pointed towards the target (the bomber). It is difficult to solve analytically since the bomber does not travel in a straight line.
Assumptions

1) Both the bomber and the fighter are in the same horizontal plane.

2) The speed of the fighter is constant say 20km/sec.
3) The path of the bomber is known
4) At a fixed time interval Δt (every minute) the fighter changes its direction to point towards the bomber.
5) If the distance between the fighter & bomber is 10km, it can destroy the bomber, within 12mins, if not pursuit is over.

Initial condition

YF=50 XF=0

YB=0 XB=80

Bomber Path.

Time t	0	1	2	3	4	5	6	7	8	9	10	11	12
XB(t)	80	90	99	108	116	125	133	141	151	160	169	179	180
YB(t)	0	-2	-5	-9	-15	-18	-23	-29	-28	-25	-21	-20	-17

Fighter strategy

Look at target at instant t and align the velocity vector with line of sight and fly for one minute and again look at target and so on.

Distance

$$D(t) = \sqrt{(YB(t) - YF(t))^2 + (XB(t) - XF(t))^2}$$

θ from fighter to bomber

$$\sin\theta = \frac{YB(t) - YF(t)}{D(t)}$$

$$\cos\theta = \frac{XB(t) - XF(t)}{D(t)}$$

$$XF(t+1) = XF(t) + VF\cos\theta$$

$$YF(t+1) = YF(t) + VF\sin\theta$$

Develop a C\C++ simulation program to show the path of the fighter and bomber. Showing either destruction of bomber within 12 minutes or escape of bomber after 12 minutes. Include a program flow chart in for the solution of the problem. [25]

QUESTION THREE

Demand for widgets follows the probability distribution shown:

Daily demand	0	1	2	3	4
Probability	0.33	0.25	0.20	0.12	0.1

Stock is examined every 7 days (the plant is in operation every day) and if the stock level has reached 6 units , or less, an order for 10 widgets is placed. The lead time (days until delivery) is probabilistic and follows the following distribution:

Lead time (days)	1	2	3
Probability	0.3	0.5	0.2

When the simulation begins, it is beginning of the week, 12 widgets are on hand, and no orders have been backordered. Simulate 4 weeks of operation of this system. Perform and analysis of the system based on the results of the simulation. [25]

QUESTION FOUR

(a) With the aid of block diagrams, explain model building, verification and validation. [7]

(b) What is the importance of "design of simulation experiments"? [6]

(c) How would you determine the length of static stochastic simulation runs? [12]

QUESTION FIVE

(a) Computer simulation and modeling is amongst various approaches to decision making, briefly discuss the following approaches in decision making. Compare each approach with simulation and modelling. [15]

i. Analytical methods
ii. Intuitive
iii. Experimental

(b) A soft service store employs one cashier at its counter. 17 customers arrive on an average every 10 minutes. The cashier can service 10 customers in 5 minutes. Assuming poison distribution for arrival and exponential distribution for service rate, find:

(i) average number of customers in the system
(ii) average number of customers in queue *(average queue length)*
(iii) average time a customer spends in the system
(iv) average time a customer waits before being served [10]

QUESTION SIX

(a) What are the desirable properties of random numbers? How would you ensure that a given series of numbers is random? Explain any two tests you have specified [10]

(b) A sequence of 40 numbers is given below:

0.41	0.68	0.89	0.94	0.74	0.91	0.55	0.62	0.36	0.27
0.19	0.72	0.75	0.08	0.54	0.02	0.01	0.36	0.16	0.28
0.18	0.01	0.95	0.69	0.18	0.47	0.23	0.32	0.82	0.53
0.31	0.42	0.73	0.04	0.83	0.45	0.13	0.57	0.63	0.29

Determine whether the hypothesis of indepence can be rejected where $Z_{\alpha/2} = 1.96$

(i) Based on runs up and runs down [5]

(c) When is simulation the appropriate tool [5]

(d) Give three advantages and two disadvantages of simulation modelling. [5]

END OF QUESTION PAPER

GOOD LUCK!