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UNIVERSITY EXAMINATIONS 2023/2024

SECOND YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE AND BACHELOR OF SCIENCE IN STATISTICS

SMS 3270: STATISTICAL PROGRAMMING I

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) State and briefly explain three properties to consider when generating pseudo random numbers (6 Marks)

b) i. Write down appropriate command in R to simulate 1000 variates from an exponential distribution with $\lambda = 3$ and store in an object named B, (1 Mark)

ii. Write the command in R to compute their sample mean and standard deviation (2 Marks)

c) Explain how monte-carlo method can be used to approximate the area of irregular shape. (4 Marks)

d) Considering a student who guesses on a multiple choice test question which has five options; the student may guess correctly with probability 0.3 and incorrectly with probability 0.7 Write an appropriate R code using a seed value of 2000 that will help to know how well such a student would do on a multiple choice test consisting of 20 questions. (4 Marks)

e) Explain the use of %%and % / % in R and demonstrate their application through examples (4 Marks)

f) Write down appropriate command in R to use in monte Carlo integration based on 50000 uniform pseudorandom numbers to estimate (4 Marks)

$$I = \int_1^4 x^2 dx$$

ii. Integrate the above equation and calculate the theoretical value (2 Marks)

g) For a normal random variable X with mean 5 and standard deviation 2, write an R code that will,

i. compute the probability that X is less than 3 (I Mark)

ii. compute the probability X is greater than 4.5 (1 Mark)

iii. Compute the probability X is equal to 2 (1 Mark)

QUESTION TWO (20 MARKS)

a) A forest nature reserve has 13 bird-viewing platforms scattered throughout a large block of land. The naturalists claim that at any point in time, there is a 75 percent chance of seeing birds at each platform. Write appropriate r codes that will calculate the probability;

i. you see birds at all sites? Compute also theoretical value (3 Marks)

ii. you see birds at more than 9 platforms? Compute also the theoretical value (3 Marks)

iii. of seeing birds at between 8 and 11 platforms (inclusive)? (3 Marks)

b) Write an appropriate r code that can approximate the integral $\int_2^5 \sin(x)^{dx}$ and the compute the theoretical values (8 Marks)

c) Write 3 properties of a Bernoulli distribution (3 Marks)

QUESTION THREE (20 MARKS)

a) Suppose the proportion defective is 0.15 for a manufacturing operation. Write r code that will

i. Simulate the number of defectives for each hour of a 24-hour period, assuming 25 units are produced each hour. (2 Marks)

ii. Check if the number of defectives ever exceeds 5 (1 Mark)

b) Define simulation and highlight 5 advantages of simulating data (6 Marks)

c) Highlight the steps involved in solving the following integrals by monte-carlo (4 Marks)

i. $\int_{0}^{1} x \quad dx$ (4 Marks)

ii. $\int_{1}^{5} \frac{x^4}{3} \, dx$ (4 Marks)

d) Highlight steps involved in monte carlo simulation. (5 Marks)

QUESTION FOUR (20 MARKS)

a) Discuss the congruential method for generating random numbers. (6 Marks)

b) State three characteristics of a high-quality Monte Carlo simulation. (3 Marks)

c) Briefly explain the following terms as used in programming; (3 Marks)

i. Random seed

ii. Simulation

iii. Pseudo random numbers

d) A bank has a single teller who is facing a queue of 10 customers. The time for each customer to be served is exponentially distributed with per minute. Write the R command to simulate the "service times" for the 10 customers and then the total of the "service times" (3 Marks)

e) Consider an example of blemishes on 1 foot square sheets of metal coming from a production line. Suppose the number of blemishes found is thought to follow a Poisson distribution i.e. $X \sim pois$ (1.22). Write an appropriate R code that does the following;

i. finds the probability of seeing no blemishes (1 Mark)

ii. finds the probability of seeing exactly 4 blemishes (1 Mark)

iii. probability of seeing more than five blemishes (1 Mark)

iv. probability of seeing less than three blemishes (1 Mark)

v. probability of seeing only one blemish (1 Mark)

QUESTION FIVE (20 MARKS)

a) highlight 5 advantages of simulating data. (5 Marks)

b) generate a sequence of 6 integer random number with $a = 19, m = 100, \times_0 = 63 \; and \; c = 1$ (9 Marks)

c) given the commands below

```
>x<-c(11,12,13)
>y<-c(14,15,16)
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What will be the expected output of the following? (2 Marks)

i. x+y (2 Marks)

ii. y*x (2 Marks)

iii. 2+x (2 Marks)