



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya

Tel: +254(0) 799 529 958, +254(0) 799 529 959, + 254 (0) 712 524 293,

Website: [info@must.ac.ke](mailto:info@must.ac.ke) Email: [info@must.ac.ke](mailto:info@must.ac.ke)

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## University Examinations 2022/2023

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

### SMS 3270: STATISTICAL PROGRAMMING I

DATE: APRIL 2023

TIME: 2 HOURS

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INSTRUCTIONS: Answer question *one* and any other *two* questions

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#### QUESTION ONE (30 MARKS)

- a) Briefly explain the following terms as used in programming (6 marks)
- Simulation
  - Random seed
  - Pseudo random numbers
- b) You roll a die with success defined as getting a 4. If you roll the die independently eight times, write an R code to show the probability of observing
- Exactly five successes (1 mark)
  - Three or fewer successes (1 mark)
- c) Write down appropriate command in R to generate 20 random numbers for Y such that  $y \sim Niid(15,4)$  (2 marks)
- d) Explain how to plot a line curve in R for a given set of data (4 marks)
- e) State three characteristics of a high-quality Monte Carlo simulation (3 marks)
- f) Explain any three properties of random number generators (3 marks)
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- g) Write down appropriate command in R to simulate  $n=1000$  variates from an exponential distribution with rate 3, and also the command in R to compute their sample mean and standard deviation (3 marks)
- h) Write down appropriate command in R to use in Monte Carlo integration based on 50000 uniform pseudorandom numbers to estimate (5 marks)
- $$I = 1 \int^4 x^2 dx$$
- ii. integrate the above equation and give the actual output (2 marks)

### QUESTION TWO (20 MARKS)

- a) Given the commands below
- ```
>x<-c(1,2,3)
>y<-c(4,5,6)
```
- What will be the outcome of the following?
- i.  $x + y$  (2 marks)
- ii.  $y * x$  (2 marks)
- iii.  $2 + x$  (2 marks)
- iv.  $2 * y$  (2 marks)
- b) Explain steps in R to generate 1000 normally distributed observations with mean  $\mu = 36$  and standard deviation = 2 (3 marks)
- c) When tossing a fair coin 15 times, write R code that;
- i. Finds the probability of seeing no heads (1 mark)
- ii. Finds the probability of seeing exactly 3 heads (1 mark)
- iii. Probability of seeing more than five heads (1 mark)
- d) Generate five uniform pseudorandom numbers on the intervals  $[0,1]$  and 10 uniform such numbers on the interval  $[-3,-1]$  (2 marks)
- e) Considering a student who guesses on a multiple choice test question which has five options; the student may guess correctly with probability 0.2 and incorrectly with

probability 0.8. write an appropriate R code that will help to know how well such a student would do on a multiple choice test consisting of 20 questions (4 marks)

### QUESTION THREE (20 MARKS)

- a) The data below shows the number of swarms of locusts observed between the months of January and February 2020

| Country          | Meru | Embu | Tharaka Nithi | Isiolo | Kajiado |
|------------------|------|------|---------------|--------|---------|
| Number of swarms | 90   | 50   | 42            | 180    | 120     |

By writing commands in R;

- i. That will plot a well labelled pie chart for the data above (8 marks)

b) Suppose that items on a manufacturing line each have a probability 0.05 of being faulty. Write commands in R to find the probability that a thousand randomly selected items will have less than 15 failures over 24 hour period. (4 marks)

c) Explain the following script in R (5 marks)

```
>z<-rnorm (10000)
>set.seed(50)
>xbar<-mean(x)
>S<-sd(x)
>x<-rpois(n,1a)
```

d) Write appropriate r code that will compute the probability of getting four heads in six tosses of a fair coin. Further compute the actual probability associated with this distribution (3 marks)

### QUESTION FOUR (20 MARKS)

- a) Highlight steps involved in Monte Carlo simulation (5 marks)
- b) Explain how Monte- Carlo method can be used to approximate the area of irregular shape (4 marks)

- c) Explain the use of %% and % /% in R (4 marks)
- d) State and explain instances where Monte Carlo simulations is a great methodology (7 marks)

**QUESTION FIVE (20 MARKS)**

- a) Indicate any four properties of a Poisson distribution (4 marks)
- b) 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  $x \sim \text{pois}(3.22)$ . write an appropriate R code that does the following
- i. Finds the probability of seeing no blemishes (1 marks)
  - ii. Finds the probability of seeing exactly 4 blemishes (1 mark)
  - iii. Probability of seeing more than five blemishes (1 mark)
- c) 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 rate 3 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)
- d) Highlight 5 advantages of carrying out the simulation (5 marks)
- e) Explain how Monte Carlo simulation works (5 marks)