

KATHMANDU UNIVERSITY  
End Semester Examination  
January, 2025

Marks Scored:

Level : B.Sc.

Year : IV

Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : MATH 403

Semester : I

F. M. : 10

Date 13 FEB 2025

SECTION "A"

[10Q.  $\times$  0.5 = 5 marks]

Fill in the blank space(s) by writing the most appropriate word(s) or symbol(s).

1. The R-function `rchisq(100, 12)` gives \_\_\_\_\_.
2. \_\_\_\_\_ is defined as the probability, under the assumption of null hypothesis, of obtaining a result equal to or more extreme than what was actually observed.
3. The random numbers generated by giving different forms of instruction to computing devices using mathematical algorithms are called \_\_\_\_\_.
4. The simulation method in which random numbers of some probability distribution developed from past observation are used is called \_\_\_\_\_.
5. The R-function used to simulate tossing of two coins 10 times is `sample(c("H", "T"), _____, _____)`.
6. In regression model  $TestScore = 23.15 + 0.51 IQ + 0.48 StudyHours$ , the coefficient 0.51 of 'IQ' parameter signifies that \_\_\_\_\_.
7. The general equation used to fit parabola, i.e., 2<sup>nd</sup> degree polynomial model with dependent variable, Y, and an independent variable, X is  $y =$  \_\_\_\_\_.
8. In R-function '`t.test()`' the value of parameter 'paired' is set to 'TRUE' when \_\_\_\_\_.
9. The four components of time series are: trend, seasonal variation, cyclical variation and \_\_\_\_\_.
10. A series of averages calculated over sequential segments of points of a time series are called \_\_\_\_\_.

SECTION "B"  
[10 Q. × 0.5 = 5 marks]

Fill in the blank space(s), **DO NOT TICK**, by selecting the most appropriate answers from among the given ones.

11. To create probability density plot of a normal distribution, \_\_\_\_\_ function is used in parameter 'y' of 'plot()' function.  
[ rnorm()                  pnorm()                  dnorm()                  qnorm() ]
12. The first random number generated by multiplicative linear congruential generation method with  $X_0 = 73, a = 13$  and  $m = 100$  is \_\_\_\_\_.  
[ 0.49                  0.37                  0.81                  0.73 ]
13. In R, `70%%13` is evaluated as \_\_\_\_\_.  
[ 5.38                  910                  5                  57 ]
14. The output of function `"rep(c("a", "b"), times=2, each=2)"` is \_\_\_\_\_.  
[ "a" "a" "b" "b" "a" "a" "b" "b"                  "a" "b" "a" "b" "a" "b" "a" "b"  
"a" "a" "a" "a" "b" "b" "b" "b"                  "b" "b" "a" "a" "b" "b" "a" "a" ]
15. In 'inverse transformation method', the inverse of \_\_\_\_\_ function is used to generate random numbers.  
[ probability density                  probability mass  
cumulative distribution                  empirical distribution ]
16. The R-expression for the algebraic expression  $x^4 \cdot e^{-x}$  is \_\_\_\_\_.  
[ (x\*4) exp(-x)                  x^4) exp^(-x)                  x^4) \*exp^(-x)                  x^4) \*exp(-4) ]
17. The sum of probabilities in a row of a transition probability matrix is \_\_\_\_\_.  
[ 0                  0.5                  1                  -1 ]
18. The non-parametric test used to detect significant difference in means of more than 2 populations is \_\_\_\_\_.  
[ Wilcoxon's signed rank test                  Sign test  
Mann-Whitney U-test                  Kruskal-Wallis H-test ]
19. In \_\_\_\_\_ method of forecasting, all future values are considered to be equal to the last observed value.  
[ average                  naive                  seasonal naive                  rift ]
20. In time series analysis, \_\_\_\_\_ is a technique used to capture important patterns in the data by leaving out noise or rapidly changing values.  
[ trend                  moving average                  auto-regression                  smoothing ]

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3 FEB 2025

SECTION "C"  
[2Q × 8 = 16 marks]

1. What are pseudo-random numbers? Discuss the importance of uniform distribution in generation of pseudo-random numbers. Derive analytically that the mean and variance of  $X \sim U(a, b)$  distribution are given by: [1+1+3+3]

$$E(X) = \frac{a+b}{2}; V(X) = \frac{1}{12}(b-a)^2$$

2.

- a. Given following time series data on weekly demand:

Week	1	2	3	4	5	6	7	8	9
Demand	820	775	680	655	750	802	798	689	775

Obtain exponential smoothing forecasts for weeks 2 to 10, taking smoothing constant  $\alpha = 0.10$ . Also draw a plot of actual and forecast values on the same graph. [4]

- b. Write a difference between average method and naive method of forecasting. Give following data on sales volume in different quarters of year 2024:

Quarter	I	II	III	IV
Sales ('000)	2	5	6	5

Use drift method to obtain forecast of sales in the first and in the second quarter of 2025. [1+3]

SECTION "D"  
[8Q × 3 = 24 marks]

3. In 2007, a university research was published investigating the crash risk of alcohol impaired driving. Data from 2,871 crashes were used to measure the association of a person's blood alcohol level (BAC) with the risk of being in an event. The table below shows results from the study. Here, the *relative risk* is a measure of how many times more likely a person is to crash in comparison to a person who has not been drinking alcohol.

BAC (x)	0	0.01	0.03	0.05	0.07	0.09
Relative Risk (y)	1	1.03	1.06	1.38	2.09	3.54

Fit exponential curve  $y = a.b^x$  to these data.

4. The probability distribution of daily demand of an item is given below:

Daily Demand	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.50	0.12	0.02

Carry simulation of daily demands for 4 days by using random numbers 25, 39, 65 and 76.

P.T.O.

5. Write R-script to use Monte-Carlo method with 1000 repetitions to evaluate

$$\int_1^2 \int_0^1 \frac{1}{(2x + 3y)^2} dx dy$$

6. A person either uses his car or takes a bus or a train to work each day. The transition probability matrix of the Markov chain with three states car (1), bus (2), train (3) is

$$\begin{array}{c} 1 \quad 2 \quad 3 \\ \begin{array}{l} 1 \begin{bmatrix} 0.1 & 0.5 & 0.4 \end{bmatrix} \\ 2 \begin{bmatrix} 0.6 & 0.2 & 0.2 \end{bmatrix} \\ 3 \begin{bmatrix} 0.3 & 0.4 & 0.3 \end{bmatrix} \end{array} \end{array}$$

If the initial probability of these three states is given by vector (0.7 0.2 0.1), find probability that two days later he will be using train, i.e., find  $P(X_2 = 3)$ .

7. Given 10 random numbers: 0.8218, 0.1023, 0.8350, 0.2159, 0.0247, 0.3239, 0.6292, 0.8887, 0.0237, 0.5077, generate random numbers of  $Exp(1)$  distribution, i.e., exponential distribution with parameter  $\lambda = 1$ , by inverse transformation method.
8. What do you mean by (i) trend (ii) seasonal variation (iii) random variation in time series data?
9. Suppose IQ test is given to eleven randomly selected pairs consisting of one brother and one sister from the same family. It is required to test the hypothesis that this sample was drawn from a population in which median IQ of a brother and sister do not differ against the alternative that the sister would score higher than brother. IQ scores are summarized below-

Sister's Score	129	111	117	120	116	101	107	125	105	123	113
Brother's Score	115	108	123	104	110	98	106	119	95	130	101

Write R-script to carry above mentioned test by applying sign test for paired observations.

10. Data on weight, cholesterol level and blood pressure of 10 randomly selected persons are stored as three vectors as given below-

```
wt = c(65, 87, 79, 52, 89, 68, 93, 112, 76, 55) //weight
cl = c(5, 6, 5, 7, 4, 8, 7, 6, 5, 6) // cholesterol level
bp = c(110, 135, 145, 120, 135, 115, 145, 125, 100, 125) //blood pressure
```

Write R-script to carry linear regression of blood pressure on weight and cholesterol level and to display equation in following form:

$$bp = a + b_1 \times wt + b_2 \times cl$$

where 'a' is intercept and 'b<sub>1</sub>' and 'b<sub>2</sub>' are slope coefficients of regression plane. If the value of  $R^2$  of this model is obtained to be 0.5472, interpret the value.