15423

BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – M.Sc.(MATH)-2023
Course Name – Applied Statistics
Course Code - MSCME402C
(Semester IV)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) The principle of optimisation takes into account the factor(s) of ____. Select the correct option.

a) Efficiency b) Cost
c) Both efficiency and cost d) None of these

(ii) _____ is measured by expenditure incurred in terms of money or man-hours. Select the correct option.

a) Efficiency b) Cost
c) Both efficiency and cost d) None of these

(iii) Select the option that represents a small-scale survey conducted previous to the final survey.

a) Pilot survey b) Survey One
c) Census d) None of these

(iv) You obtained a significant test statistic when comparing three treatments in a one-way ANOVA. In words, select the alternative hypothesis.

a) All three treatments have different effects on the mean response.
b) Exactly two of the three treatments have the same effect on the mean response.
c) At least two treatments are different from each other in terms of their effect on the mean response.
d) None of these

(v) ANOVA tests use _____. Select the correct option.

a) t-distribution b) F-distribution

c) Chi-square d) none of these

(vi) Choose the main advantage of using a Completely Randomized Design (CRD).

a) CRD allows for controlling confounding variables through randomization.
b) CRD does not require replication of treatments.
c) CRD is easier to implement in designs with few treatment groups.
d) CRD minimizes the need for statistical analysis.

(vii) Choose the scenario in which a Completely Randomized Design (CRD) would be most appropriate.

a) When the researcher wants to minimize the variability between different blocks of data.
b) When there are large numbers of experimental units and no blocking is required.
c) When the research involves multiple factors that interact with each other.
d) When there is a need to compare treatments across different strata of data.

(viii) Write the purpose of creating blocks in Randomized Block Design (RBD).

a) To ensure that each treatment has the same number of experimental units.
b) To group similar experimental units together to reduce variability within the treatment comparisons.
c) To randomly assign treatments without any consideration of experimental unit characteristics.
d) To separate treatments by their factorial structure and design.

(ix) Write the condition that must be met for a design to be classified as Randomized Block Design (RBD).

a) Experimental units must be assigned treatments randomly without any regard for grouping.
b) Each treatment must be tested in multiple blocks, and random assignment must occur within each block.
c) The experiment must involve factorial treatments with no randomization.
d) There must be no replication within blocks or between treatment groups.

(x) An economic time series generally consists of _____. Choose the correct option.

a) Only seasonal variations
b) Trend, seasonal variations, cyclical fluctuations, and random noise
c) Just cyclical fluctuations
d) Random fluctuations only

(xi) Choose the option that describes the overall time series in the additive model of time series analysis.

a) Trend + Seasonal + Cyclical + Random
b) Trend × Seasonal × Cyclical × Random
c) Trend - Seasonal - Cyclical – Random
d) Trend × (Seasonal + Cyclical + Random)

(xii) Choose the assumption in a Moving Average (MA) model in time series analysis.

a) The value at time t is a linear function of past values and past errors
b) The error term is independent of the observed values
c) The value at time t is the sum of a constant and past errors
d) The data points have a random walk behaviour

(xiii) A transition probability matrix P is said to be doubly stochastic if_____. Select the correct option.

a) the column sums all equal to 1 b) the row sums all equal to 1

c) the column sums all less than 1 d) the row sums all less than 1

(xiv) The steady-state probability vector π of a discrete Markov chain with transition probability matrix P satisfies the matrix equation of _____. Select the correct option.

a) $P\pi = 0$ b) $(2 - P)\pi = 0$

c) $P\,\pi = \pi$ d) $P^t\pi = 0$

(xv) In a matrix of transition probability, the probability values should add up to one in each _____. Select the correct option.

a) Row b) Column

c) Diagonal d) All of these

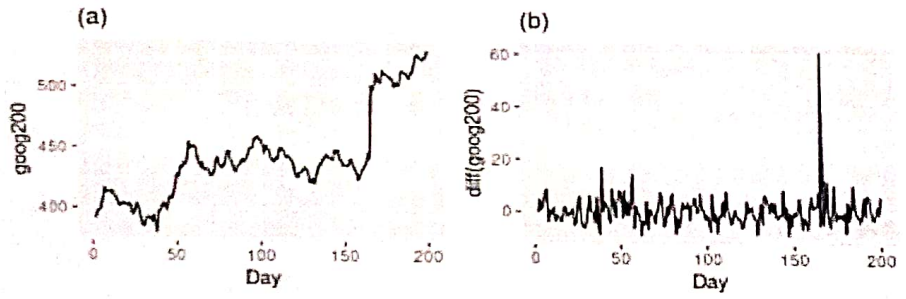
Group-B

(Short Answer Type Questions) 3 x 5=15

2. Tabulate the one-way ANOVA table at 5% level of significance to test if null hypothesis is correct. The following data is given: (3)
Total sum of squares TSS= 112.27
Treatment sum of squares SST=55.55
n=4, k=6.

3. Explain mathematically weakly stationary time series. (3)

4. Conclude which of the following time series is stationary and which is non-stationary. (3)



5. The transition probability matrix of a Markov Chain with 3 states 1, 2, 3 is given as (3)

$$P = \begin{pmatrix} 0.6 & 0.2 & 0.2 \\ 0.4 & 0 & 0.6 \\ 0 & 0.8 & 0.2 \end{pmatrix}$$

Illustrate the state transition diagram.

6. In a 2^k factorial design, there are 2 factors x_A, x_B with 2 levels $High = 1, Low = -1$. Express the combinations as well as the outcome of the experiments in the form of tables. (3)

OR

Express the layout of a completely randomized design where p treatments are given and i^{th} treatment is replicated n_i times. (3)

Group-C
(Long Answer Type Questions) 5 x 6=30

7. Evaluate the Root Mean Square Error for the following time series data: (5)

Actual	5	7	9	6	8
Predicted	4	6	8	5	7

8. Consider the following time series data: (5)

Week	1	2	3	4	5	6
Sales (Y)	50	60	80	100	130	160

Recommend the number of times the data should be differenced to make this series stationary.

9. Let $\{X_n\}, n = 1,2,3 \ldots$ be a Markov chain with state space 1,2,3,4 and initial probability distribution $(\frac{1}{4},\frac{1}{4},\frac{1}{4},\frac{1}{4})$. The one-step TPM is $\begin{pmatrix} 0 & 1 & 0 & 0 \\ 0.3 & 0 & 0.7 & 0 \\ 0 & 0.3 & 0 & 0.7 \\ 0 & 0 & 1 & 0 \end{pmatrix}$. (5)

Enumerate $P(X_3 = 4, X_2 = 2, X_1 = 3, X_0 = 2)$.

10. Show that the MSE of the ratio estimator is $\left(\frac{1}{n} - \frac{1}{N}\right)\bar{Y}^2(C_X^2 + C_Y^2 - 2\rho C_X C_Y)$. (5)

11. Explain error metrics of time series. (5)

12. A researcher is testing three different fertilizers (A, B, and C) on four types of soil. The researcher is concerned that the different soil types could affect the results. To minimize variability from the soil, the researcher decides to randomly assign the fertilizers to plots of land, but each soil type will have all fertilizers applied. Propose the best experimental design to be used in this scenario. (5)

OR

A company is testing the impact of three production methods (Method 1, Method 2, Method 3) on the output quality of a product. However, the company also wants to account for variations in machinery across different shifts, and the shifts are hard to control. The company plans to apply each production method to the same machinery but across different shifts. Propose the best experimental design to be used in this scenario. (5)

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