



[Question of Term Final Examination]

School: SET

Year: 4th Term: I

Course Code: 0542 20 Stat 4101

Total Marks: 60

Khulna University

Statistics Discipline

Examination Year: 2026

Course Title: Multivariate Analysis-I

Time: 3.0 Hours

Program: B.Sc. (Hons)

Session: 2024-2025

Credit: 3.0

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. a) Discuss some points for the relevance of multivariate analysis. [L1,; CLO:2,4] 02
b) Let X be a multivariate data matrix with p variables and n observations. How can the mean vector, variance, covariance matrix, and correlation matrix be computed from this data matrix? [L3,4; CLO:3] 04
c) Explain geometric interpretation of correlation between two variables. How does it analogous to inner product of two vectors. [L4,5; CLO:1] 04
2. a) Define positive definite matrix, positive semi definite matrix, Eigen value and eigen vectors. [L1,2; CLO:1,2] 04
b) Define the spectral decomposition of a positive definite matrix. Hence, explain how it can be applied to obtain the inverse of the matrix. [L4,5; CLO:2,3] 04
c) State at least one matrix inequality with importance in multivariate analysis. [L5; CLO:1,2] 02
3. a) Define the concept of statistical distance and Mahalanobis distance. Compare Mahalanobis distance with ordinary Euclidean distance. [L1,2; CLO:1,2] 04
b) Discuss the properties that the matrix A must satisfy so that $X'AX$ can be interpreted as a statistical distance. Explain your reasoning. [L5,6; CLO:4] 03
c) State the distribution of the Mahalanobis distance. Explain how you would test whether the Mahalanobis distance of an observation is significantly different from zero. [L5; CLO:4] 03
4. a) Define multivariate normal distribution. Derive pdf of multivariate normal distribution as an extension of univariate normal distribution. [L4,5; CLO:2,3] 04
b) Consider $X \sim N_3(\mu, \Sigma)$ with $\Sigma = \begin{bmatrix} 4 & 1 & 0 \\ 1 & 3 & 0 \\ 0 & 0 & 2 \end{bmatrix}$ are X_1 and X_2 independent? What about (X_1, X_2) and X_3 ? [L4; CLO:2,3] 03
c) How can the assumption of normality be evaluated? Describe any one method in detail. [L3; CLO:2] 03

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions

5. a) Develop a procedure for testing the multivariate mean vector. In what way this procedure analogous to the univariate t-test for a population mean? [L1,3; CLO:2,3] 05
- b) Define a simultaneous confidence interval. Compare and contrast the simultaneous confidence interval and one at a time interval. [L1,5; CLO:4] 05
6. a) Define Wishart's distribution. Mention some properties of Wishart's distribution. [L1,5; CLO:2,3] 04
- b) Give a short description about Inverse-Wishart Conjugate Prior. [L4,5; CLO:2,4] 03
- c) Develop the one-way MANOVA model decomposing its sources of variation into various parts of it. [L6; CLO:7] 03
7. a) Define principal component analysis (PCA). [L1,5; CLO:3] 02
- b) Do all principal components together retain the total information contained in the original variables? Justify your answer. [L2,4; CLO:2,4] 04
- c) Let $X_1, X_2, \dots, X_p$ random variable having covarianve matrix- 04

$$\Sigma = \begin{bmatrix} \sigma_{11} & 0 & \cdots & 0 \\ 0 & \sigma_{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{pp} \end{bmatrix}.$$

Find the pricipal components and interpret. [L3; CLO:6]

8. a) Calculate the correlation coefficients between the original variables and the principal components. Then, interpret the results. [L2,3; CLO:3,7] 04
- b) Prove that the variance of i^{th} principle component is equal to the corresponding i^{th} eigen value of the covariance matrix. [L5; CLO:7] 04
- c) Explain the relationship between singular value decomposition (SVD) and principle component analysis. [L2; CLO:7] 02

Good Luck



[Question of Term Final Examination]

Khulna University

School: SET

Statistics Discipline

Program: B.Sc. (Hons)

Year: 4th Term: I

Examination Year: 2026

Session: 2024-2025

Course Code: 0542 20 Stat 4103

Course Title: Biostatistics

Total Marks: 60

Time: 3.0 Hours

Credit: 3.0

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. a) Define Biostatistics and explain its importance in health sciences. [L1; CLO:1] 03
- b) Establish the interrelationship of the probability density function and hazard function. 03
[L4; CLO:1,2]
- c) The survival data of 40 patients with myeloma are as follows: 04

Survival time (months)	0-10	10-20	20-30	30-40	40-50	50+
No. of patients surviving	40	28	18	9	5	2
No. of patients dying	12	10	9	4	3	2

Compute estimated survivorship function, density function, hazard function, and cumulative hazard function. [L2,6; CLO:2]

2. a) Under usual notations, show that $f(t) = h(t) \exp[-\int_0^t h(x) dx]$. [L1; CLO:3] 03
- b) Illustrate the following terms with roughly sketched- [L2; CLO:2,4] 03
i) IFR ii) DFR iii) CFR.
- c) State the different reasons for the occurrence of right censoring. Suppose 100 transistors are placed on test simultaneously, and the experiment is terminated when 50 transistors fail. Identify the type of right censoring involved. [L1,3; CLO:3] 04
3. a) Define mean residual lifetime. Under usual notations, show that 05
$$s(t) = \frac{m(0)}{m(t)} \exp \left[-\int_0^t \frac{du}{m(u)} \right].$$
 [L1,2; CLO:2]
- b) Let T follows a two-parameters Weibull distribution with parameters α and β . Show that the pdf of $y = \log_e T$ is an extreme value distribution. Obtain the mean and variance of y. Express α and β in terms of the mean and variance. [L1,2; CLO:3] 05
4. a) Briefly discuss the different types of failure rates in a lifetime. [L5; CLO:2,6] 04
- b) Suppose the lifetime T follows two parameters Weibull distribution with pdf: 04

$$f(t) = abt^{b-1}e^{-at^b}; t > 0, a, b > 0. \quad [L3; CLO:2]$$

Find the hazard function and discuss the suitability of this distribution as lifetime model.

- c) Give an example of type I and type II censoring. [L1; CLO:1,2] 02

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions

5. a) Explain the likelihood function? Construct the likelihood function for type-II censoring. [L2,4; CLO:1,4] 05
b) Identify the type of censoring and state a plausible reason in each case- 05
i) A cancer study follows patients for 10 years. Some patients are still alive at the end;
ii) A fatigue test stops when 15 components fail, even though others are still functioning;
iii) A patient already has a disease at the time of enrollment;
iv) A subject is tested every 3 months and is found infected between two visits;
v) A device is checked periodically, and failure is detected between inspections. [L1,3; CLO:4]
6. a) Define truncation and extreme value distribution? Determine the confidence intervals for survival probabilities? [L5; CLO:3,4] 04
b) Suppose a lifetime variable T follows exponential distribution with mean θ . Obtain maximum likelihood estimate of θ under type-II censoring. Construct the $100(1 - \alpha)\%$ confidence interval for θ . [L2; CLO:4] 06
7. a) Define proportional hazard (PH) model? Is the exponential regression model belong to PH model? Justify your answer. [L1,2; CLO:7] 04
b) How can you Compare two life distributions using Cox PH model? [L2; CLO:7] 03
c) Ten units were tested at high stress test for up to 250 hours. Six failures occurred on 37, 73, 132, 195, 222 and 248 hours. Four units were taken off test without failing at the following run times: 50, 100, 200 and 250 hours. Compute the Hazard and cumulative hazard values. [L1; CLO:7] 03
8. a) How can you assess the distribution of one-parameter exponential distribution with mean θ . Also estimate its parameters. [L1,6; CLO:7] 05
b) An analysis is conducted to investigate differences in all-cause mortality between men and women participating in the Framingham Heart Study adjusting for age. A total of 5,180 participants aged 45 years and older are followed until time of death or up to 10 years and among them 402 deaths were observed. The descriptive statistics are given as follows: 05

	Died	Alive
Age (Mean $\pm$ SD) (years)	65.6 $\pm$ 8.7	56.1 $\pm$ 7.5
Male, n (%)	221 (55.0)	2145 (45.0)

Now, Cox proportional hazards regression model is estimated and their estimated results along with p-values are given as follows:

Factor	Co-eff	P-Value	HR (95% CI)
Age, years	0.117	0.0001	1.124 (1.111-1.138)
Male Sex	0.404	0.0002	1.497 (1.215-1.845)
Systolic Blood Pressure	0.016	0.0001	1.017 (1.012-1.021)
Current Smoker	0.768	0.0001	2.155 (1.758-2.643)
Total Serum Cholesterol	-0.002	0.0963	0.998 (0.995-2.643)
Diabetes	-0.024	0.1585	0.816 (0.615-1.083)

Write a short report based on the above findings. [L1; CLO:6]

Good Luck



School: SET

Year: 4th Term: I

Course Code: 0542 20 Stat 4105

Total Marks: 60

Khulna University

Statistics Discipline

Examination Year: 2026

Course Title: Econometrics

Time: 3.0 Hours

Program: B.Sc. (Hons)

Session: 2024-2025

Credit: 3.0

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. a) Define econometrics. Discuss the goals and scope of econometrics from a statistical perspective. 05
[L1; CLO:1]
b) Discuss the scope of econometrics in business and public policy. [L3; CLO:1] 05
2. a) Define mean lag and median lag. Find mean lag and median lag for Koyck model. [L3; CLO:1] 05
b) Describe the different steps for Koyck transformation with its basic features. [L1; CLO:1] 05
3. a) Explain mathematically the partial adjustment mechanism. [L2; CLO:2] 03
b) For the given model 07
$$Y_{1t} = \beta_{10} + \beta_{12}Y_{2t} + \gamma_{11}X_{1t} + u_{1t}$$
$$Y_{2t} = \beta_{20} + \beta_{21}Y_{1t} + \gamma_{22}X_{2t} + u_{2t}$$
 - i. Find the reduced form.
 - ii. Are the structural equations identified? Check applying both order and rank condition. [L5; CLO:2]
4. a) Explain why OLS method can't be directly applied to estimate Koyck model. [L4; CLO:2] 02
b) Prove that OLS estimators become inconsistent in simultaneous equation systems. Why does this happen? [L5; CLO:3] 05
c) The biasedness of an OLS estimate obtained from a simultaneous equation can't be removed. 03
Justify the statement. [L4; CLO:3]

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions

5. a) Define with example: i) marginal productivity ii) total productivity iii) average productivity 04
iv) production function [L1; CLO:5]
- b) Define demand and demand function. Show that demand functions are homogeneous of degree 06
zero. [L1,2; CLO:5]
6. a) Let $Q_{DA} = \frac{2Y + P_B}{15P_A + 5}$ with usual notation, where $P_A = 3, P_B = 20, Y = 90$ 07
i. Find cross elasticity, income elasticity and demand elasticity
ii. Determine if products A and B are substitutes or compliments. [L5; CLO:4]
- b) Explain the meaning of price flexibility in economics with an example. [L2; CLO:5] 03
7. a) Show that if the maximum point exists, MP and AP are equal at that point. [L4; CLO:4] 03
b) Discuss the problem of Scultz's method and how to overcome that problem? [L2; CLO:5] 03
c) Derive the ordinary demand function in case of n commodities. [L4; CLO:5] 04
8. a) Prove that cobb-douglas production function is a special case of CES production function. 05
[L5; CLO:4]
- b) Considering a nonlinear regression model discuss how you estimate the parameters by Newton 05
Raphson method. [L6; CLO:3]

Good Luck



School: SET

Year: 4th Term: I

Course Code: 0542 20 Stat 4111

Total Marks: 60

Khulna University

Statistics Discipline

Examination Year: 2026

Course Title: Industrial Statistics and Quality Control

Time: 3.0 Hours

Program: B.Sc. (Hons)

Session: 2024-2025

Credit: 3.0

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. a) Define and discuss quality and quality improvement. [L2; CLO1] 03
 b) Explain the historical development of quality control. [L2; CLO1] 03
 c) Describe the role of statistical methods in quality improvement. [L2; CLO1] 04
2. a) Define MBQNA. [L2; CLO2] 03
 b) Discuss why it is important to establish control on R chart first when using $\bar{x}$ and R chart to bring a process into statistical control. [L3; CLO3] 03
 c) A company manufacturing oil seals wants to establish $\bar{x}$ and R control charts on the process. 04
 There are 20 preliminary samples of 4 shaft diameters in the internal diameter of the seal. The summary data are as follow: $\sum_{i=1}^{20} \bar{x}_i = 10.275$, $\sum_{i=1}^{20} R_i = 1.012$. Find the control limits that should be used on the $\bar{x}$ and R chart. Assume that the 20 samples plot in the control charts. Estimate the process mean and standard deviation. [L1; CLO2]
3. a) Define OC curve. Find the operating characteristic (OC) curve for the Mean chart. [L3; CLO2] 03-04
 b) The following data gives the weight (gm) of an automobile part. Five samples of four items each were taken at random, with an interval of one hour. Draw the control chart for mean and range, and find out the production process. [L4; CLO3] 06

Sample No.	1	2	3	4	5
Observation	10	11	10	11	12
	12	12	10	11	12
	11	13	9	10	11
	12	13	12	14	12

4. a) Illustrate the construction procedure for σ chart (SD given and not given). [L3; CLO3] 06
 b) A drilling machine bores holes with a mean diameter of 0.5230 cm and a standard deviation of 0.0032 cm. calculate the 2-sigma and 3-sigma upper and lower control limits for means of samples 4, and prepare a control chart. [L5; CLO3] 04

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions

5. a) Briefly discuss the construction procedure of p and C -chart. [L2; CLO4] 06
b) The number of defects found by the inspection of quality control process of 13 LED TV sets of 100 each are 6, 9, 4, 5, 4, 4, 6, 7, 5, 8, 10, 5, 11. Comment about the production process about statistical control. [L5; CLO4] 04

6. a) Define defectives and defects with examples. Also, explain how you can construct a control chart for fraction defective. [L2; CLO4] 05

- b) Samples of 100 tubes are drawn randomly from the output of a process that produces several thousand units daily. Sample items are inspected for quality, and defective tubes are rejected. 05

The results of 14 samples are shown below: [L5; CLO4]

Sample No.	No. of defective Tubes	Sample No.	No. of defective Tubes
1	8	8	10
2	10	9	13
3	13	10	18
4	9	11	15
5	8	12	12
6	10	13	14
7	14	14	9

Prepare a control chart for the fraction defective and make comment about the process.

7. a) Define Average Sample Number (ASN) and Lot Tolerance Percent Defectives (LTPD) of the sampling inspection plan. Draw a hypothetical shape of a typical OC curve. [L3; CLO6] 05

- b) Define Average Outgoing Quality (AOQ). Find the AOQ of the double sampling plan. [L3; CLO6] 05

8. a) Explain the concept of acceptance sampling. [L1; CLO4] 03

- b) Illustrate the following sampling plans: 04

- Sequential sampling plan;
- Skip-lot sampling plan. [L5; CLO5]

- c) Write down the advantages and disadvantages of acceptance sampling plan. [L4; CLO5] 03

Good Luck



[Question of Term Final Examination]

Khulna University

Statistics Discipline

Program: B.Sc. (Hons)

School: SET

Year: 4th Term: I

Examination Year: 2026

Session: 2024-2025

Course Code: 0542 20 Stat 4113

Course Title: Analysis of Repeated Measurement

Total Marks: 60

Time: 3.0 Hours

Credit: 3.0

Instructions (if any):

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. a) Write short notes on pairwise comparison and summary-statistic approach in repeated measures analysis. [L1; CLO:1] 03
- b) State three situations in which repeated measurement analysis should be used. [L2; CLO:1] 03
- c) Distinguish between single sample t -test and repeated sample t -test. [L3; CLO:1] 04
2. a) Describe the test procedure of the t -test for repeated measurements. [L2; CLO:2] 05
- b) Explain the importance of correct specification of the covariance structure in repeated measures analysis. [L2; CLO:2] 05
3. a) Discuss the main sources of correlation in repeated measurement analysis. [L2; CLO:3] 05
- b) The ventilation volumes of four subjects were measured under four different inspired dry air temperatures. 05

Subject	Temperature (0°)			
	-10	25	37	50
1	74.5	81.5	83.6	68.6
2	75.5	84.6	70.6	87.3
3	68.9	71.6	55.9	61.9
4	57.0	61.3	54.1	59.2

Is ventilation volume affected by temperature for subject 3? [L3; CLO:2]

4. a) Explain why repeated measures ANOVA is considered a special case of linear mixed models. [L5; CLO:4,5] 03
- b) Construct the ANOVA table for one-sample repeated measures. [L5; CLO:3,5] 04
- c) A clinical study investigates the effect of a treatment on a physiological response. Patients are randomly assigned to either a Treatment group or a Control group. Each subject is measured at three time points: baseline, 2 weeks, and 6 weeks. Explain how the ANOVA F -tests for each effect are constructed using mean squares. [L2; CLO:5] 03

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. a) Write the general form of the linear mixed model and describe the components of the model $(X, \beta, Z, \gamma, \epsilon)$. [L2; CLO:4] 03
b) Explain how residual analysis can help assess the validity of assumptions in a linear mixed model. [L4; CLO:4] 04
c) State the three main components of a Generalized Linear Model (GLM). [L2; CLO:5] 03
6. a) Analyze the differences between Maximum Likelihood Estimation and Quasiliikelihood estimation in GLMs. [L4; CLO:5] 05
b) Show that Gamma distribution belongs to an exponential-family. [L3; CLO:5] 05
7. a) Explain the difference between GEE1 and GEE2 approaches. [L2; CLO:5,6] 03
b) Describe the steps of Wald test statistic used in GEE for hypothesis testing. [L4; CLO:5,6] 04
c) Discuss the role of the working correlation matrix $R(\alpha)$ in GEE. [L2; CLO:3,5] 03
8. a) Demonstrate how hot deck imputation can be used to replace missing observations in a repeated measurement dataset. [L3; CLO:6] 03
b) Analyze how missing data can affect the results of repeated measurement analysis. [L4; CLO:6] 03
c) A dataset contains 5% missing values completely at random. Which missing data treatment method would you choose and why? [L3; CLO:6] 04

Good Luck