



Khulna University

School: SET

Discipline: Statistics

Program: B.Sc. (Hon's)

Year: 3rd

Term: II

Examination Year: 2026

Session: 2024-2025

Course Code: 0314 20 Stat 3201

Course Title: Statistical Inference-III

Total Marks: 60

Time: 03 Hours

Credit: 03

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section-A

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

1. a) Define the following terms:
 - i) Regular Distribution, ii) Fisher's information, iii) Minimum variance linear unbiased estimator. [L1; CLO1] 03
- b) Distinguish between efficient and more efficient estimators. [L4; CLO1] 02
- c) Let X be a random variable taken from beta $(\theta, 1)$. Identify fisher's information for this Distribution. [L3; CLO1] 03
- d) List down the properties of Fishers information. [L1; CLO1] 02
2. a) Mention different conditions for holding Best Asymptotically Normal (BAN) estimator. [L1; CLO3] 02
- b) If the statistic be such that $\frac{\delta}{\delta\theta} \log L$ can be expressed in form of $\frac{\delta}{\delta\theta} \log L = A(\theta)(t - \theta)$. Then prove that, t is a MVB unbiased estimator of θ with variance $\frac{1}{A(\theta)}$. [L5; CLO1] 04
- c) Suppose, $x_1, x_2, \dots, x_n$ are drawn from $pois(\lambda)$. Identify the MVB for achievable by unbiased estimator of $\tau(\lambda) = \lambda$. Also find its variance. [L3; CLO1] 04
3. a) State and prove Rao-Blackwell theorem for finding uniformly minimum variance unbiased estimator (UMVUE). [L5; CLO2] 05
- b) List down the advantage and disadvantage of Rao-Blackwell theorem. [L1; CLO2] 03
- c) Does minimum variance unbiased estimator always exist? Justify your opinion. [L2; CLO1] 02
4. a) Define location parameter and scale parameter with an example. [L1; L2; CLO2] 02
- b) Define Pitman estimator for scale. Show that the pitman estimator for scale is a function of sufficient statistics. [L3; L4; CLO2] 05
- c) Let $X_1, X_2, \dots, X_n$ be a random sample of size n from exponential distribution mean θ . Find Pitman estimator for the parameter θ . [L4; L5; CLO2] 03

[Question of Term-II Final Examination, 2026]



Section-B

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

5. a) What is exponential family of distribution? Check following distributions belong to exponential family of distribution or not? 07
(i) $N(\theta, 1)$; (ii) Exponential (θ); (iii) Binomial (n, θ). [L1; L3; L4; CLO2]
- b) How does minimal sufficient statistics differ from complete sufficient statistics and ancillary statistics? [L1; L3; CLO2] 03
6. a) State and Prove Lehmann-Scheffe theorem. [L1; L2; CLO2] 04
- b) Let $X_1, X_2, \dots, X_n$ be a random sample of size n from uniform distribution $U(0, \theta)$. Find the MVUE of θ . [L3; L4; CLO2] 03
- c) Let X_1, X_2 , and X_3 be a random sample from $(x, \theta) = \theta e^{-\theta x}; x > 0$. Find the UMVUE of $e^{-\theta}$. [L4; L5; CLO1] 03
7. a) Define the concept of average sample number (ASN) function. [L1; CLO6] 02
- b) Develop the operating characteristics (OC) function of SPRT. [L6; CLO6] 05
- c) Prove that every exponential family possesses a sufficient statistic. [L5; CLO5] 03
8. a) Discuss the underlying concept of sequential probability ratio test (SPRT). [L6; CLO6] 01
- b) Distinguish between SPRT and classical test. [L4; CLO6] 03
- c) Let, X be a normal variable with mean μ and variance σ^2 ; for testing $H_0: \mu = \mu_0$ against $H_1: \mu = \mu_1$ construct SPRT and OC function. [L6; CLO6] 06

The End



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Course Code: 0314 20 Stat 3203

Course Title: Nonparametric Tests

Total Marks: 60

Time: 03 Hours

Credit: 03

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section-A

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

1. a) State the meaning of the term "distribution-free test." Also mention the main characteristics of Nonparametric tests. [L1; CLO1] 04
- b) Why are non-parametric methods called assumption-free methods? Explain. [L2; CLO1] 03
- c) Explain how you would decide whether to use a parametric or non-parametric method for a given dataset. [L3; CLO3] 03

2. a) Explain the concept of randomness in Run Test. A sequence of machine outputs is
G D D G G G D D G D G G D D G. 05
- Test randomness using Run Test at 5% significance level. [L4; CLO2]
- b) The appearance transit times for 11 patients with significantly occluded right coronary arteries are as follows:

Patients' No	1	2	3	4	5	6	7	8	9	10	11
Transit time (Sec)	1.80	3.30	5.65	2.25	2.50	3.50	2.75	3.25	3.10	2.70	3.00

05

Can we conclude that at 5% level of significance, the median appearance transit time in the population from which the sample was drawn is 3.50 seconds? [L5; CLO3]

3. a) Define Rank Sum Test and state its assumptions. [L1; CLO3] 03
- b) A researcher wants to examine the relationship between students' IQ scores and their Academic Performance scores. The data for 10 students are given below:

Student	A	B	C	D	E	F	G	H	I	J
IQ (X)	110	125	115	130	120	118	125	112	108	130
Performance (Y)	75	85	80	90	88	84	86	78	72	92

05

Test whether there is a significant rank correlation at the 5% level of significance. [L5; CLO3]

- c) Differentiate between paired t-test and Wilcoxon signed rank test. [L4; CLO3] 02
4. a) Design a complete non-parametric analysis framework for comparing teaching methods in education research. [L6; CLO4] 04
- b) A sample of 12 observations has median claim value 50. Test whether the population median differs from 50 using the Sign Test. [L3; CLO2] 04
- c) State the purpose of Kolmogorov-Smirnov Two Sample Test. [L2; CLO2] 02

[Question of Term-II Final Examination, 2026]



Section-B

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

5. a) Discuss the procedure of McNemar Test in 2×2 contingency analysis. [L2; CLO2] 03
 b) Explain the difference between F test and Kruskal Wallis ANOVA test. [L4; CLO5] 04
 c) Find out the Asymptotic Relative Efficiency (ARE) of the Sign test. [L3; CLO6] 03
6. a) In a locality 100 persons were randomly selected and asked about their educational achievements. The results are given as follows; [L3; CLO5]

	Education		
Sex	Primary	Secondary	College
Male	10	15	25
Female	25	10	15

04

Can you say that education depends on sex?

- b) The total annual precipitation is recorded each year for examining upto 19 years, and certain city is recorded to see if there is any trend in the amount of precipitation. The amounts of precipitation in centimeters were:
 114.9, 116.4, 106.1, 92.1, 115.2, 132.7, 89.8, 145.2, 89.8, 148.1, 104.3, 85.6, 116.2, 96.3, 106.0, 91.6, 126.6, 92.0 and 101.3. Test the hypothesis at 5% level of significance to detect the presence of a trend in the annual precipitation. [L4; CLO5]. 06
7. a) Monthly sales figures are: 12, 15, 18, 20, 22, 25, 28, 30. Use Cox-Stuart Test to determine whether an increasing trend exists. [L3; CLO5] 05
 b) Suppose that $K = 3$ treatment, (A, B and C) result in the following observations. 05
 Method A: 72, 75, 78, 80
 Method B: 68, 70, 74, 76
 Method C: 82, 85, 88, 90
 Use Kruskal Wallis test to determine if the treatments are same. [L5; CLO4]
8. a) Describe the general principle of cross-validation in model selection. [L1; CLO4] 03
 b) Distinguish between additive model and generalized additive model. [L2; CLO4] 04
 c) Explain why kernel smoothing is suitable for low-dimensional data visualization. [L2; CLO6] 03

The End



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Year: 3rd

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Session: 2024-2025

Course Code: 0542 20 Stat-3205

Course Title: Sampling Technique-II

Total Marks: 60

Time: 03 Hours

Credit: 03

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section-A

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

1. a) Define Probability Proportional to Size (PPS) sampling with an example. How does it differ from Simple Random Sampling? [L1; CLO1] 04
- b) Describe the steps of cumulative total methods for the sample selection in PPSWR sampling? [L1; CLO2] 03
- c) A village has 10 holdings consisting of 50, 30, 45, 25, 40, 26, 24, 35, 28, and 27 fields. Select a sample of four holdings using Lahiri's method of PPSWR. [L2, L6; CLO2] 03
2. a) Define inclusion probability. The population is $S = \{2, 4, 7, 10\}$ with population of size $N=4$. A sample of size 3 is drawn without replacement using simple random sampling. Compute the first order and 2nd order inclusion probability. [L1; CLO3] 05
- b) Define Horvitz-Thompson Estimator. In PPS sampling, WOR, show that $\hat{Y}_{HT}$ is an unbiased estimator of the population mean ($\bar{Y}$) with its variance is given by: $V(\hat{Y}_{HT}) = \frac{1}{N^2} \left[\sum_{i=1}^N \frac{(1-\pi_i)y_i^2}{\pi_i} + \sum_{i=1}^N \sum_{j \neq i}^N \frac{(\pi_{ij}-\pi_i.\pi_j)y_i y_j}{\pi_i \pi_j} \right]$. [L1; CLO3] 05
3. a) Define PPS Systematic Sampling. How does it differ from systematic sampling? [L1, L2; CLO2] 03
- b) Under usual notations, show that the estimator $\hat{Y} = \sum_{i=1}^n NM_i \frac{\bar{y}_i}{n}$ is an unbiased estimator of population total (Y) with its variance is given by: [L1, L4; CLO3] 04

$$V(\hat{Y}) = N^2(1 - f_1) \frac{s_b^2}{n} + \sum_{i=1}^n (1 - f_{2i}) \frac{NM_i^2 s_w^2}{nM^2 m_i}$$

- c) Suppose you want to select a sample of $n = 3$ villages using PPS systematic sampling from a list of $N = 6$ villages. The population sizes of the villages are as follows: 100, 300, 200, 400, 150, 250. [L3, L4; CLO2] 03
4. a) Define multi-stage sampling. Mention the differences between PSU and SSU? Define intra-cluster correlation coefficient. [L1, L2; CLO3] 05
- b) For unequal clusters without replacement, show that the simple arithmetic mean of the cluster means $\bar{\bar{y}} = \frac{\sum_{i=1}^n \bar{y}_i}{n}$ is a biased estimator of the population mean ($\bar{Y}$). Find the $Bias(\bar{\bar{y}})$ and the sampling variance, $v(\bar{\bar{y}})$. [L5; CLO3] 05



Section-B

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

5. a) Define auxiliary variable with an example? What does it play in sampling? [L3; CLO4] 03
b) Define double sampling ratio estimator. How does it differ from ratio estimator? [L3, L4; CLO5] 03
c) Find the relative bias of ratio estimator under double sampling. [L4, L5; CLO4] 04
6. a) Briefly describe the concept of double sampling with example. Write the uses of double sampling. Differentiate two phase sampling and two stage sampling. [L1, L2; CLO4] 06
b) Describe the concept of double sampling for stratification. Find the unbiased estimator of population mean ($\bar{Y}$) and proof it's unbiasedness. [L2, L3; CLO4] 04
7. a) Distinguish between sampling and non-sampling error. Mention the procedures for removing non-sampling error. [L2; CLO7] 03
b) Define response and non-response errors in surveys and mention how to control non-response errors. [L2; CLO7] 03
c) Define bias and response bias. Discuss the Hansen-Hurwitz technique of dealing with the problem of non-response bias. [L3; CLO7] 04
8. a) Explain the different sources of non-sampling errors. [L1, L6; CLO7] 04
b) What is network sampling? Explain main concept and mention one situation where its used. [L1; CLO6] 03
c) Define census with a real example in the context of Bangladesh. How does it differ from survey? [L1, L6; CLO7] 03

The End

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Term: II

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Session: 2024-2025

Course Code: 0542 20 Stat 3207

Course Title: Stochastic Process

Total Marks: 60

Time: 03 Hours

Credit: 02

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use a separate sheet for each section.

Section-A

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

- Define state and parameter in the context of a stochastic process. Explain the different natures of stochastic processes with suitable examples. [L1; CLO1,2] 04
 - Compare between a set of variables and a family of variables. [L2; CLO2] 03
 - What is the difference between a deterministic process and a stochastic process? Give suitable examples. [L4, L51; CLO1,4] 03
- What is a probability generating function (pgf). Why is it useful in probability theory? [L1, L2; CLO1,3] 04
 - A biased coin has probability of head $P(H) = 0.7$ and tail $P(T) = 0.3$. The coin is tossed twice independently. Let X be the number of heads. Find the probability generating function of X . [L3, L4; CLO3,6] 04
 - Why is convolution important in stochastic processes? [L1; CLO6] 02
- Suppose we have a renewal process whose mean value function is given by $m(t) = 2t; t \geq 0$
 - What is the probability that at least 1 renewal occurs by time 10.
 - What is the distribution of number of renewals by time 10. [L5; CLO5]
 - Show that the average renewal rate by time t converges with probability 1 to $\frac{1}{\mu}$ as $t \rightarrow \infty$. [L3, L4; CLO8,9] 05
 - What is a recurrent event, and how does it differ from a renewal process? [L2; CLO7,9] 02
- State the conditions under which a Markov chain is ergodic. [L1; CLO3] 02
 - Let a Markov chain consists of the state 0, 1, 2, 3 having the transition probability matrix $P = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 1/2 & 1/2 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$
 - Show that the transition graph of matrix P and check irreducibility of the chain.
 - Show that the chain is periodic and find the period. [L5; CLO5]
 - Distinguish between time-homogeneous and time-heterogeneous Markov chain with a suitable example. [L1, L5; CLO3,4] 03

Section-B

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

5. a) Write down the postulates of a birth–death process considering the immigration effect. 03
[L2, L3; CLO2,3]
- b) Under what conditions does this birth process reduce to a Poisson process? Explain 02
briefly. [L1; CLO2]
- c) Derive the differential equation for the general birth and death process. [L4, L5; 05
CLO3,5]
6. a) Derive the Chapman–Kolmogorov forward equation for a simple birth and death 05
process. [L4, L5; CLO2,3]
- b) State the relationship between birth rate λ_i , death rate μ_i , and the transition probabilities 02
over a small-time interval Δt . [L3, L4; CLO2,5]
- c) Define queueing theory with a suitable example and write down its key properties. [L1; 03
CLO5]
7. a) Write down the properties of M/M/1 model. [L2, L5; CLO5,6] 04
- b) Derive the distribution of the waiting time and show that the expected waiting time in 06
the queue is $W_q = \frac{\lambda}{\mu(\mu-\lambda)}$. [L2, L4; CLO5,6]
8. a) Define restricted and unrestricted random walk. [L1; CLO8] 02
- b) Derive the probability of ruin $P_0(k)$ for a gambler starting with capital k , considering 06
both fair and biased games. [L4, L5; CLO6,9]
- c) Why gamblers ruin is called a random walk? [L2; CLO9] 02

The End



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Course Code: 0542 20 3209

Course Title: Research Methodology

Total Marks: 60

Time: 03 Hours

Credit: 03

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use separate sheet for each section.

Section-A

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

- a) What are the factors that motivate one to undertake research? Explain. [L2; CLO1] 04
 - b) "Research is much concerned with fact finding, analysis and evaluation." Do you agree with this Statement? Give reasons in support of your answer. [L2; CLO1] 03
 - c) Explain baseline study and its uses in project evaluation. [L1; CLO3] 03
- a) Describe the precautions that a researcher must follow while conducting research. [L4; CLO2] 03
 - b) Illustrate the guidelines for researcher to safeguard ethical issues in designing research? [L2; CLO2] 04
 - c) How does a research problem differ from a non-research problem? [L4; CLO2] 03
- a) Discuss the major stages of the research process. [L1; CLO2] 03
 - b) Why research design is needed in research? [L2; CLO2] 03
 - c) Identify which research design (observational study, an experiment, a simulation, or a survey) is best in each of the following situations and explain your answer: 04
 - i. Whether or not a certain coupon attached to the outside of a catalogue makes recipients more likely to order products from a mail-order company.
 - ii. The effect of a severe earthquake would have on the mountain areas.
 - iii. Whether or not smoking has an effect on coronary heart disease.
 - iv. Determining the average household income of homes in Dhaka City. [L3; CLO3]
- a) Distinguish between research methods and research methodology. [L2; CLO3] 04
 - b) Explain the criteria used for evaluating a good proposal. [L4; CLO3] 03
 - c) A well-structured research proposal is the backbone of successful research." — Justify this statement. [L5; CLO5] 03



Section-B

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

- | | | | |
|----|----|---|----|
| 5. | a) | What characteristics should a good questionnaire have? [L2; CLO4] | 03 |
| | b) | Why is probability sampling considered more reliable than non-probability sampling? [L1; CLO3] | 03 |
| | c) | A researcher wants to ensure equal representation of male and female respondents. Which sampling method is appropriate? Justify your answer. [L5; CLO3] | 04 |
| 6. | a) | Why is pretesting considered essential before final field survey? [L1; CLO3] | 02 |
| | b) | State the reasons why sampling is used in the context of research studies. [L5; CLO4] | 03 |
| | c) | Illustrate the difference between probability and non-probability sampling. [L4; CLO5] | 05 |
| 7. | a) | State the causes of sampling and non-sampling errors. [L5; CLO5] | 04 |
| | b) | Differentiate between primary and secondary data. [L4; CLO5] | 03 |
| | c) | What are the usual sources of statistical data in Bangladesh. [L4; CLO5] | 03 |
| 8. | a) | Briefly discuss your understanding on research report or thesis indicating its need and importance in research work [L5; CLO5] | 05 |
| | b) | Why is literature review considered the foundation of quality research? [L1; CLO5] | 02 |
| | c) | Compare narrative literature review and systematic literature review. [L2; CLO5] | 03 |

The End

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Year: 3rd

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Session: 2024-2025

Course Code: 0542 20 Stat 3211

Course Title: Epidemiology

Total Marks: 60

Time: 03 Hours

Credit: 03

Instructions:

- The figures in the margin indicate full marks. The questions are of equal value.
- Use a separate sheet for each section.

Section-A

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

- Define a cohort study. Also, classify the different types of study designs used in epidemiology. [L2; CLO1] 03
 - State and explain the three core functions of public health in epidemiology. [L1; CLO1] 03
 - Suppose a new disease has recently broken out in your native village. As an epidemiologist, discuss the initiatives you would take according to the concepts learned in this course. [L5; CLO2] 04
- What do you mean by case reports and case series? [L1; CLO3, 4] 03
 - Mention the most common advantages and disadvantages of ecological study. [L2; CLO3, 4] 03
 - Environmental scientists suspect that residents living near a brickfield experience a higher rate of asthma attacks than residents in other parts of the town. Hospital records are reviewed for the previous two years. Among residents near the brickfield, 300 asthma attacks occurred during 5000 person-years of residence, whereas 180 asthma attacks occurred during 12,000 person-years among residents living elsewhere. From these data, estimate all the following:
 - the relative risk (rate ratio) for asthma attacks associated with residence near the brickfield.
 - the excess rate attributable to exposure to brickfield pollution.
 - the attributable proportion among exposed residents.Was this a cross-sectional, case-control, cohort, or retrospective cohort study? [L5, L6; CLO4, 5] 04
- Demonstrate about randomized controlled trials (RCTs)? Mention the strengths and weaknesses of RCTs. [L2, L3; CLO4, 5] 04
 - Explain how Phase III trials help determine whether a new treatment is safer and more effective than currently available treatments. [L2, L5; CLO6] 03
 - Compare the approximate number of participants involved in Phase I, Phase II, and Phase III clinical trials. [L2, L5; CLO5, 6] 03
- Discuss blinding? Elaborate on different types of blinding. Write down the names of the levels of evidence. [L1, L6; CLO3, 4] 04
 - Define a causal variable. Write down the Hill's criteria (1897-1991) for causality. [L1; CLO3, 5] 03
 - What is adjusting? What happens if you adjust for an intermediate variable? [L1; CLO2, 3] 03

Section-B

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

5. a) What is the measure of disease frequency? Discuss the fundamental measures of disease frequency. [L1, L6; CLO1, 3] 04
- b) A university health center monitors 6,000 students for 3 years. During this period, 54 students were newly diagnosed with migraine. Assume that the average duration of migraine is 5 years. 06
 - i) What is the annual incidence of migraine among the students? 02

Show the relationship between incidence and prevalence. [L2, L4; CLO3, 4] 05
6. a) Why odds ratio is called the cross-product ratio? [L1; CLO3] 02
- b) Show that the odds ratio is invariant over prospective and retrospective study. [L2; CLO3] 05
- c) When is the odds ratio a good estimate of relative risk? [L1; CLO4] 03
7. a) Define attributable risk. Establish the relationship between attributable risk and relative risk. [L3, L4; CLO3, 4] 05
- b) The preventive advantages of eating fish have been reported in numerous studies. A recent cohort study reported that not eating fish increased the risk of stroke. The table below shows the results of this study: 05

Eating Fish ↓	Cases of stroke	Non-cases of stroke
Never	82	1549
Almost daily	23	779

Calculate attributable risk (AR), percent attributable risk (AR%), Population attributable risk (PAR) and Population attributable risk percent (PAR%). Also, interpret the results.

[L2, L6; CLO4, 5]

8. a) What is screening? Mention the Wilson and Jungner classic screening criteria. [L1, L2; CLO4, 6] 03
- b) What is the ROC curve? If $0.5 < AUC < 1$, then comment on your classifier. [L2, L3; CLO6] 02
- c) Suppose we are trying to create a model that can predict whether a person has that disease or not. So, the confusion matrix for this is given as: 05

	Actual: No	Actual: Yes
Predicted: No	60	8
Predicted: Yes	10	22

- i) Identify the true positive, true negative, false positive, and false negative.
- ii) Calculate classification accuracy, Misclassification rate, precision, recall, and F-measure. [L3, L6; CLO5, 6]

The End