OBE
Curriculum
For

B.Sc. (Hon's) in Statistics

Department of Statistics
Faculty of Science
Comilla University
Cumilla-3506, Bangladesh

Academic Session: 2025-2026, 2026-2027, and 2027-2028

OBE Curriculum for Bachelor of Science

(Statistics Program)

Academic Session: 2025-2026, 2026-2027, and 2027-2028

Faculty of Science

Department of Statistics
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Department of Statistics
Chairman and Faculty Members

	**Dr. Dulal Chandra Nandi** Professor and Chairman PhD., B. Sc.(Hons), M. Sc. (CU) d.c.nandi@cou.ac.bd, +01711232465 **Research Interest:** Time series, Econometrics, Biostatistics, Epidemiology and Population Studies, Machine learning.

	**Dr. J. M. Adeeb Salman Chowdhury** Associate Professor B. Sc(Hons), M. Sc. (CU), IBS, RU adeeb_cu@yahoo.com,chy.cou@gmail.com Mobile- 01719415961 Research Interest: Climate Change and Climate Smart Agriculture, Drought Prediction, Environmental Statistics, Adaptation Modeling for Climate Disaster Risk, Machine Learning, Time Series Econometrics, Demography, Population Science, Stochastic Process.
	**Nahida Afroz** Associate Professor B. Sc.(Hons), M. Sc. (JU) nahidafrz@yahoo.com 01731508496 **Research Interest:** Econometrics, Bio-statistics, Public Health and Categorical data analysis.

	**Humayun Kiser** Associate Professor B. Sc.(Hons), M. Sc. (JU) humayunkiser@gmail.com, 01913440215 Research Interest: Data Science, Machine Learning, Bayesian Analysis, Multivariate Analysis, Mixed Model, Statistical modeling in the areas of Environmental, Health, and Medicine.
	**Md. Sohel Rana** Associate Professor B. Sc.(Hons), M. Sc. (JU) Sohel.573@gmail.com 01913440181 Research Interest: It is my natural alacrity to know and examine different social, political, economic, and educational issues up to roots and I feel different statistical tools are available and significant to do so. I especially like to embark on the following fields: Statistical Modeling (Specially SEM) in the areas of health and population study, Principal Component Analysis, Factor Analysis, Cluster Analysis, Latent Class Analysis, Decomposition Analysis, Multi-state Transition modeling, Application of Bayesian Approach, Data manipulation and management, Survey design and questionnaire development, Actuarial Mathematics.
	**Md. Farhad Hossain** Associate Professor MPhil, B. Sc. (Hons), M. S. (JU) farhad390ju@gmail.com +01724053226, 01914005163 **Research Interest:** My research interests are Machine learning, Fuzzy logic, Neural Network, Bayesian Inference, Data Mining, Simulation, Bio-statistics, Categorical data analysis, Time Series Analysis and Stochastic process. I am also interested to research on Big data analysis.

	**Priyanka Paul** Assistant Professor B. Sc. (Hons), M. Sc. (CU) Priyanka.paulbd@gmail.com 01934460695 Research Interest: Econometrics, Time series analysis, survival analysis, Multivariate Analysis and Robust Regression.
	**AfrinaAkter Mishu** Assistant Professor B. Sc. (Hons), M. Sc. (DU) afreenmishu@yahoo.com 01955448534 Research Interest: Meta-analysis, Biostatistics, Regression analysis, Demographic and health survey.
	**Foyez Ahmmed** Assistant Professor B.Sc. (Hons), M.Sc. (DU) Email: foyez.ahmmed@cou.ac.bd Contact No: +8801818307701 Research Interest: Foyez Ahmmed is an aspiring researcher with a keen interest in Biostatistics, biomarker, ROC curve, and longitudinal data analysis. His research endeavors are focused on exploring the application of statistical techniques to solve complex problems related to disease diagnosis, progression, and treatment. Through his research, he aims to develop novel methodologies for the analysis of longitudinal data, including the development and evaluation of biomarkers using ROC curve analysis. With his passion for statistics and its applications in biomedicine, FoyezAhmmed is poised to make significant contributions to the field of biostatistics.
	**Muhammad Mahabub Rahaman Manik** Assistant Professor B.Sc. (Hons), M.Sc. (CoU) Email:mahabub.rahaman@cou.ac.bd Contact No: +8801679582424 Research Interest: My research interests lie in the intersection of biostatistics and machine learning, specifically in the development of novel statistical and computational methods to address challenges in analyzing large-scale biological and medical data. I am particularly interested

	in using machine learning models such as random forests, deep neural networks, and Gaussian processes for predictive modeling, feature selection, and causal inference. Additionally, I am interested in developing new Bayesian methods for handling missing data and accounting for measurement error in complex biomedical studies.
	**KulsumAkterShapna** Assistant Professor B.Sc. (Hon's), M.Sc(COU) Shapna@cou.ac.bd Cell: +8801835938213 **Research Interest:** Econometrics, Time series analysis, Biostatistics, Demographic and health survey, Machine learning.
	**Dr. Ummay Ayesha** Assistant Professor PhD., B.Sc. (Hons), M.Sc. (DU) ayeshastat@cou.ac.bd Cell: +8801881653722 **Research Interest** Public Health, Machine learning, Population Studies, Time Series Analysis, Biostatistics and Epidemiology with a broader focus on Global Health and community-based interventions.
	**Md. Safayet Hossain** Lecturer B.Sc. (Hon's), M. Sc(COU) safayet@cou.ac.bd Cell: +8801703984217 **Research Interest:** Global Health, Occupational Health, Health Economics, Biostatistics, Machine Learning, and Time Series Econometrics.
	**Meshkat Ebnay Mozahid** Lecturer B.Sc. (Hons), M.Sc. (CU) meshkat@cou.ac.bd Cell: +8801601447715 **Research Interest** Public Health, Epidemiology, Population Studies, Time Series Analysis, and Econometrics.

Department of Statistics

List of Chairmen

SI. NO.	Name	From	To
1.	Md. Mijanur Rahman (Acting)	24.11.2010	31.12.2013
2.	Dulal Chandra Nandi (Acting)	01.01.2014	02.01.2017
3.	J.M. Adeeb Salman Chowdhury (Acting)	03.01.2017	24.06.2018
4.	Dr. Dulal Chandra Nandi	25.06.2018	24.06.2021
5.	NahidaAfroz	25.06.2021	30.11.2021
6.	Humayum Kiser	01.12.2021	03.09.2022
7.	Dr. Dulal Chandra Nandi	04.09.2022	---

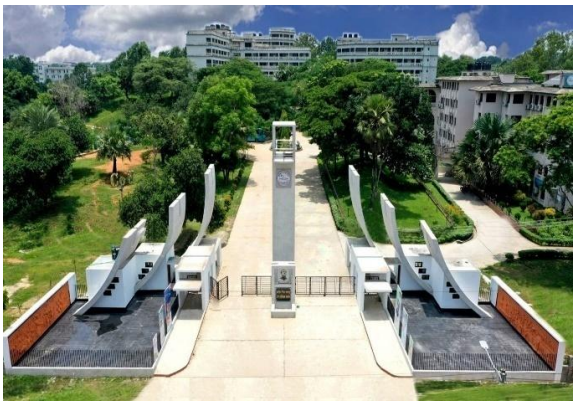
Comilla University

Bachelor of Science Degree in Statistics

Curriculum: Sustaining OBE Compliance

Part A: Introduction

Comilla University at a Glance



Comilla University is a public university located in Kotbari, Comilla, Bangladesh. It was established in 2006, and it is the 26th public university in Bangladesh. The university was founded with the goal of providing higher education opportunities to students all over the Bangladesh. The university has a beautiful and spacious campus covering an area of 250 acres. It is situated in a serene environment, surrounded by lush green trees, and is an ideal place for learning. The campus is equipped with all the necessary facilities and infrastructure required for students to excel in their academic pursuits.Comilla University offers undergraduate and graduate programs in various fields, including Arts, Science, Business Administration, Social Science, Engineering and Law. The university has a distinguished faculty, many of whom have earned their Ph.D. degrees from renowned universities around the world. The faculty members are committed to providing quality education to their students and have a strong focus on research. The university has a modern library with a vast collection of books, journals, and research papers.Thelibrary is a valuable resource for students and researchers who can access the latest information in their respective fields. The university also has well-equipped laboratories and computer facilities that cater to the needs of students and researchers. Apart from academic programs, Comilla University offers various extracurricular activities for students to engage in. The university has several clubs and organizations, including cultural, sports, and debate clubs. These clubs help students develop their leadership skills, socialize with their peers, and explore their talents outside the classroom. Comilla University has a vibrant and diverse student community, with students from different regions of Bangladesh and other countries. The university provides a welcoming and inclusive environment for all students, regardless of their background or beliefs.

Vision of the University

Comilla University is committed to produce graduates who are distinctively capable to advance growth and welfare through innovative solutions.

Mission of the University

To meet its vision, Comilla University sets its missions to –

1. To educate a wide variety of students through effective teaching-learning to achieve academic excellence
2. To create an ambience for creative and innovative academic exercise through high quality research.
3. To undertake actions regarding collaboration which entails opportunities for long-term interaction with academia and industry for producing competent graduate at workplace
4. To develop human potential to its fullest extent so that intellectually capable and socially responsible leaders can emerge in a range of profession. (Draft Final)

Graduate Attributes:

Comilla University is committed to lead through providing effective teaching, research and culturally enriched educational experience that will transform the lives of its students. Aspiration of the university is to produce graduate through developing knowledge, skill and attitudes to equip them to promote growth and welfare of the rapidly changing world.

In addition, to their subject specific expertise (Mastery of Subject Knowledge) the university graduates will have the following attributes:

- Critical thinking, creativity and innovation
- Communication-Language Proficiency and &Digital Literacy
- Professionalism and Ethical
- Entrepreneurial and Leadership
- Community Engagement and Social Responsibility-Cross cultural Communication
- Lifelong learning

Department of Statistics at a Glance

The Department of Statistics at Comilla University is one of the most reputable departments of the university. It was established in 2010 with the aim of providing quality education in statistics and producing skilled statisticians who can contribute to the development of the country.

The department offers undergraduate and graduate programs in statistics. The undergraduate program is a four-year Bachelor of Science degree, while the graduate program is a one-year Master of Science degree. Both programs are designed to provide students with a solid foundation in statistical theory and its practical applications. The faculty members of the Department of Statistics are qualified and experienced in their respective fields. They have earned their degrees from prestigious universities in Bangladesh and abroad.

The department have two modern laboratories equipped with the latest statistical software and tools, where students can apply their theoretical knowledge to real-world problems. The laboratory is also used for research activities and collaborations with other departments and institutions.

The department has a strong focus on research are involved in various activities. The department also organizes seminars, workshops, and conferences to promote research and provide opportunities for students and faculty members to present their research findings. A part from academic

activities, the department also provides extracurricular activities for students. Statistics. The Department of Statistics has been the winner of the inter-university female badminton championship four times and has also emerged victorious in the football championship. The department has a statistics club, which organizes various activities such as quizzes, debates, and sports events.

These activities help students develop their leadership skills, enhance their social skills, and foster a sense of community within the department.

Vision of the Department of Statistics:
The vision of the program is to face the challenges and utilize the advantages of statistics under global aspect through building up knowledge and IT based aimed at achieving academic excellence.

Mission of the Department of Statistics:
The Department of Statistics missions are:

i) To produce graduates who have a sound knowledge of the major areas of statistical methodology, founded on rigorous theoretical principles which equip the graduate to acquire further knowledge and skills for the benefit of the country through own study.
ii) To promote the use and knowledge of Statistics in all fields of Agriculture, Industry, Engineering, Environment, Banking, Social sciences and in which Statistics can contribute to a better understanding of scientific and social phenomena and enhance the quality of decisions and conclusions made on the strength of the statistical approach.
iii) To contribute to the body of fundamental statistical science through research.

Description of the B.Sc. (Hons) in Statistics

The duration of the Bachelor Degree Program in Statistics shall be four academic years divided into eight semesters. Each academic year is divided into two semesters to be called as 1st semester and 2nd semester. An academic semester is comprised of six months. For achieving Degree of Bachelor of Science in Statistics with honor's, a student requires to earn a total of 153 credit points successfully with a minimum CGPA of 2.25; and complete the program within six academic years from her/his 1st admission to the program. A student who secures a CGPA below 2.25 but not less than 2.00 will be eligible for a Bachelor of Science Degree in Statistics.

Vision of B.Sc. (Hons) in Statistics

The vision of the statistics is to excel in the statistical learning through continuous research, innovation and industry-oriented curriculum leading to responsible data science professionals.

Mission of B.Sc. (Hons) in Statistics

M1:	To inculcate teaching and learning process promoting state-of-the-art IT industry practices in statistical science to address global challenges;
M2:	To integrate academics, research and entrepreneurship skills to address present and future challenges of the society and industry;
M3:	To develop professionalism with strong foundations adapting to changing technology.

Program Educational Objectives (PEO'S)

PEO1:	Students will have successful academic and research career.
PEO2:	Students will have employment in public and private sectors and resolve economic, social, health and environmental issues.
PEO3:	Students will have to solve artificial intelligence problems, machine learning algorithm and develop different model.

Mapping of PEOs and Mission of B.Sc. (Hons) in Statistics

PEOs / **Missions**	PEO1	PEO2	PEO3
M1	3	3	2
M2	2	3	3
M3	3	2	1

Program Learning Outcomes (PLO'S)

At the end of the program, students will be able to

PLO1	explain the key statistical, mathematical, computer programming & economics concepts to have a strong knowledge base in statistical domain.;
PLO2	use the concepts of data science and analytics with an emphasis on the applications in health, agriculture and environment;
PLO3	deploy a rich portfolio of advanced statistical techniques using contemporary software tools for the purpose of solving real-life problems by doing projects;
PLO4	apply mathematical foundations, simulation, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in statistical computations;
PLO5	model real-world phenomena into statistical model formulations and develop the statistical models a subsequently interpret the solutions back to the real-world as applicable recommendations;
PLO6	critically read, critique, and evaluate the merit of scientific & technical documents that concern application of statistical science;
PLO7	analyze and explain data from various disciplines. Represent and interpret the results to respective stakeholders, and
PLO8	understanding and commitment to address professional, ethical, legal, security, social issues and responsibilities including a respect for diversity.

Mapping between PEOs and PLOs of Statistics program

PLOs / PEOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
PEO1	3	3	2	1	2	2	1	2
PEO2	2	3	3	2	2	2	1	1
PEO3	2	2	3	2	2	3	2	2

1: Low 2: Significance 3: High

Graduates Profile:

Scholars: Our graduates are expected to have a broad knowledge-basedand disciplinary expertise.

Problem Solvers: With an adequate knowledge of disciplinary expertise and problem domain our graduates will be in a position to formalize any problem and solve that in a methodical way.

Innovators: We want our graduates to be focused on future-proof solution. They will be critical thinkers, creative designers and efficient makers. They are capable of developing unique and sustainable solutions to the real-world problems.

Leaders: Graduates of our department will take personal responsibility and seek opportunities to work with others to advance thinking and achievement in all spheres of their lives. They are confident, inclusive, inspiring and influential.

Global Citizens: Our graduates are locally produced but globally in demand. They are aware of global issues and act with integrity, sensitivity and fluency across cultures and perspectives, and are committed to the betterment of the society as a whole.

Part B

Structure of the Curriculum

Year & Semester	BNQF Code	Course Code	Course Title	Credit No	Marks		
					CA	SFE	Total
First Year First Semester	0542-111	Stat-111	Introductory Statistics	3	40	60	100
	0542-112	Stat-112	Elementary Probability	3	40	60	100
	0542-113	Stat-113	Linear Algebra	3	40	60	100
	0541-114	Stat-114	Calculus	3	40	60	100
	0311-115	Stat-115	Microeconomics	3	40	60	100
	0542-116	Stat-116	Data Analysis-I Lab (Stat-111 and Stat-116)	2			50
			Total	**17**			**550**
First Year Second Semester	0542-121	Stat-121	Bivariate Analysis	3	40	60	100
	0542-122	Stat-122	Probability Distribution	3	40	60	100
	0541-123	Stat-123	Algebra and Analytical Geometry	3	40	60	100
	0311-124	Stat-124	Macroeconomics	3	40	60	100
	0613-125	Stat-125	Programming with C (Lab)	3	40	60	100
			Viva-voce	1.5			50
			Total	**16.5**			**550**
Second Year First Semester	0542-211	Stat-211	Sampling Distribution	3	40	60	100
	0542-212	Stat-212	Sampling Technique-I	3	40	60	100
	0541-213	Stat-213	Numerical Analysis	2	20	30	50
	0542-214	Stat-214	Statistical Quality Control and Index Number	3	40	60	100
	0541-215	Stat-215	Advanced Calculus and Differential Equations	3	40	60	100
	0542-216	Stat-216	Data Analysis- II Lab (Stat-212 and Stat-213)	3			100
			Total	**17**			**550**
Second Year	0542-221	Stat-221	Statistical Inference-I	3	40	60	100

Second Semester	0542-222	Stat-222	Regression Analysis	3	40	60	100
	0541-223	Stat-223	Real Analysis	3	40	60	100
	0542-224	Stat-224	Introductory Demography	3	40	60	100
	0542-225	Stat-225	SPSS, STATA and SAS (Lab)	3			100
	0542-226	Stat-226	Data Analysis-III Lab (Stat-221, Stat-222 and Stat-224)	2			50
			Viva-voce	1.5			50
				18.5			**600**
Third Year First Semester	0542-311	Stat-311	Stochastic Process	3	40	60	100
	0542-312	Stat-312	Design of Experiment-I	3	40	60	100
	0542-313	Stat-313	Time Series Analysis and Forecasting	3	40	60	100
	0311-314	Stat-314	Econometrics-I	3	40	60	100
	0714-315	Stat-315	R and Python (Lab)	3	40	60	100
	0542-316	Stat-316	Data Analysis- IV Lab (Stat-311 and Stat-312)	2			50
	0542-317	Stat-317	Data Analysis- V Lab (Stat-313 and Stat-314)	2			50
				19			**600**
Third Year Second Semester	0542-321	Stat-321	Statistical Inference-II	3	40	60	100
	0542-322	Stat-322	Order Statistics and Non-Parametric Methods	3	40	60	100
	0541-323	Stat-323	Linear Programming and Operation Research	3	40	60	100
	0542-324	Stat-324	Environmental Statistics	2	20	30	50
	0388-325	Stat-325	Research Methodology	3	40	60	100
	0542-326	Stat-326	Data Analysis- VI Lab (Stat-321, Stat-322 and Stat-323)	3			100
			Viva-voce	1.5			50
	Total			**18.5**			**600**

Fourth Year First Semester	0542-411	Stat-411	Multivariate Analysis	3	40	60	100
	0542-412	Stat-412	Sampling Techniques-II	3	40	60	100
	0314-413	Stat-413	Mathematical Demography	3	40	60	100
	0714-414	Stat-414	Statistical Simulation and Modeling	2	20	30	50
	0912-415	Stat-415	Epidemiology	2	20	30	50
	0542-416	Stat-416	Actuarial Statistics	2	20	30	50
	0542-417	Stat-417	Data Analysis-VII Lab (Stat-411 and Stat-414)	3			100
	0542-418	Stat-418	Data Analysis-VIII Lab (Stat-412 and Stat-413)	3			100
	Total			**21**			**650**
Fourth Year Second Semester	0542-421	Stat-421	Design of Experiment-II	3	40	60	100
	0542-422	Stat-422	Biostatistics	3	40	60	100
	0311-423	Stat-423	Econometrics-II	2	20	30	50
	0714-424	Stat-424	Data Mining	3	40	60	100
	0288-425	Stat-425	Generalized Linear Model	3	40	60	100
	0542-425	Stat-426	Data Analysis- IX Lab (Stat-421 and Stat-422)	2			50
	0542-426	Stat-427	Data Analysis-X Lab (Stat-423 and Stat-424)	2			50
	0542-428	Stat-428	Research Project	3			100
			Viva-voce	1.5			100
	Total			**22.5**			**700**
	Grand Total			**150**			**4800**

Mapping between Courses with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
Stat-111	3	2	1	2	1			
Stat-112	2	2	2	1		2		
Stat-113	1	1	3	2				
Stat-114	1			2	1			
Stat-115	2	2					2	
Stat-116	3	2	2	2			2	
Stat-121	2	2	1	2	1	1	1	
Stat-122	1	1	2	2		2		
Stat-123	1			2		1	1	
Stat-124	1		1				2	
Stat-125	2	2	1	2	2		2	
Stat-211	2			2		1	1	
Stat-212	2		2	2	2		2	
Stat-213		2		2			1	
Stat-214	1	2		3	2		1	
Stat-215	2			2				
Stat-216	2	1	1	2	2	1		
Stat-221	1		1				2	
Stat-222	2		2	1	2		2	
Stat-223	1			2			2	
Stat-224	2	2	1	1	2	1	2	1
Stat-225	1	1	2	2	2		2	
Stat-226	3	1	2	2	2		2	
Stat-311	1	2	1	2			1	
Stat-312	2	2	2	3	2		2	
Stat-313	1	2	3			2		1
Stat-314	2		2	2	2		3	
Stat-315	2	2		3	3	2	3	
Stat-316	2		2	2		2	2	
Stat-317		2		2	2		2	
Stat-321	1	2			2	2		
Stat-322			2		2		1	
Stat-323	1	2		2			2	
Stat-324	2		1		1		1	
Stat-325	2	2	2	2		2		3
Stat-326	2	2		1	2		2	
Stat-411	2	2			3		2	
Stat-412	1			2	2			
Stat-413		2		2	2			
Stat-414		2	2	3	2		2	
Stat-415	1			2			2	
Stat-416	2	1		2	1			
Stat-417	2		1	2	2		2	
Stat-418	2		1	2			2	
Stat-421	2	2					2	
Stat-422	2	3		2			1	2
Stat-423	2	2		2	3		2	
Stat-424	1			3	2		3	
Stat-425	1	1		2	2		1	
Stat-426	1	1		2	2		1	
Stat-427	2	2		2			2	3
Stat-428	34	2	2	2		1	2	3

PART C

Detailed Curriculum

1st Year 1st Semester

Course Code:0542-111 (Stat-111) Course Title: Introductory Statistics
Marks: 100 Credits: 03 Number of Class: 42

Rationale:
The course is designed to make the beginners oriented with the basic statistics tools to be used in courses at advanced level.

Objectives:
The objectives of this course are to:

- Orient students with the history and scope of statistics.
- Help them to know types of data and how to collect data.
- Make the students to organize the data by graphical and in tabular form.
- Develop basic skills about measures of locations.
- Make the students to compare different data set and measures of dispersion.
- Develop skills to analyze moments and shape of characteristics of distribution.

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	Gather basic knowledge regarding concepts used in statistics and the theories developed through using these concepts;
CLO2	Gather knowledge about different types of data and the collection of data;
CLO3	Demonstrate basic knowledge about measure of locations;
CLO4	Analyze the variability of the data;
CLO5	Analyze the moments and shape characteristics of distribution.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO
CLO1	3	2		2	1	2		
CLO2	2		1	1				
CLO3	1	2	2					
CLO4	2	2		1		1	1	
CLO5	1	2	1		1	2		

Course Content, Teaching and Assessment Strategy:

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	**History and Scope:** History, Definition, Nature, Scope and Classification of Statistics, Characteristics of Statistics, Functions of Statistics, Limitation, Uses and Abuses of Statistics.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	**Key words concepts and Data Collection:** Population, Sample, Variables, constant, sampling and Attributes, Types of Variables, Scales of Measurement: Nominal, Ordinal, Interval and Ratio; Data, Necessity of data collection, Sources of data, Methods of Collecting Data, Primary and Secondary Data,Questionnaire and its construction.			5
CLO2	**Organization of Data:** Classification and Tabulation of Data, Frequency Distribution, Graphical Presentation of Data, Stem and Leaf Display, Dot Plot, Time Series Plot.			4
CLO3	**Descriptive Statistics:** **Measures of central Tendency**: Mean, Median, Mode, Geometric Mean, Harmonic Mean, Quintiles with their Graphical Presentation, Application of Different Measures of Central Tendency, Partition values or Quantiles, Other Measures of Center.			10
CLO4	**Measures of Dispersion:** Absolute Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Variance and Standard Deviation. Relative Measures of Dispersion: Coefficient of Range, Coefficient of Quartile deviation,			10

	Coefficient of Mean Deviation and Coefficient of Variation. Chebyshev's Rule, Standardized variable and Z-Scores, Application of Different Measures of Dispersion.			
CLO5 CLO1	**Moments and Shape Characteristics of Distribution:** Moments, Sheppard's Corrections for Grouping Error, Skewness and Kurtosis,Box Plots Construction and their Uses, Five Number Summary.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Classroom Discussion and Problem-solving activities	Practice by doing exercise, Summative (Midterm)
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)

Text Book

1. Allan G. Bulman, (2013): *Elementary Statistics: A Step-by-Step Approach*, 9thEdition. McGraw Hill Inc

Reference Books

1. Lind, A. D., Marchal, W. and Wathen, S. (2020): *Statistical Techniques in Business and Economics*, 18thEdition, McGraw Hill Inc.
2. Islam, M. N (2017): *An Introduction to Statistics and Probability*, 3rd edition, Mullick& Brothers.

Course Code: 0542-112 (Stat-112) Course Title: Elementary Probability
Marks:100 Credits: 03Number of Class: 42

Rationale:

Statistical methods are largely dependent on the theory of probability. Before knowing statistical decision procedures, one must have to know about the theory of probability. The concept of probability is applied to all scientific investigation and everyday life.

Objectives

The objectives of this course are to:

- Familiarize him/herself with different approaches to probability theory
- Gather knowledge about Venn diagram to represents the results of set operations.
- Understand the basic principles of probability including the laws for unions, intersections, and complementation, Bayes theorem and use these principles in problem solving situations.
- Understand discrete, continuous and joint random variables and compute the mean variance and covariance of a random variables
- Gather knowledge about probability density, distribution function and joint density function of the random variables
- Understand limit theorems, such as central limit theorems.
- Know different generating function, like as- Moment Generating Function, Characteristics function etc.

Course Learning Outcomes:

At the end of the course students should be able to:

CLO1	Demonstrate Venn diagram to represents the results of set operations
CLO2	Interpret probabilities and conditional probabilities in appropriate ways.
CLO3	Compute the probability of an event using conditional probability, independence and Bayes theorem.
CLO4	Compute the probabilities of events, expectations and the covariance's and correlations between any two random variables from the given joint pf/pdf of several random variable
CLO5	Recognize the importance of the central limit theorem and understand when it is appropriate to use normal approximations for the distribution of a statistic.
CLO6	Examine the generating function (e.g.mgf, cf) from a distribution.

Mapping between PLOs and CLOs of Statistics program

PLOs \ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	3	3	3	3	
CLO2	3	1				1		
CLO3	2	2	3		2	2	2	
CLO4	1			1	2	2	2	
CLO5	3	2	3	3				
CLO6	2	1	2	3	2	2	3	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	**Set Theory:** Set, point of a set, describing set- List method and Roster method, finite set, infinite set, universal set, empty set and subsets. Set operations.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	10
CLO2	**Basic Concepts of Probability**: Approaches to defining Probability: Subjective and Objective Probabilities, Classical, Empirical, Geometric and Axiomatic, Experiment, Outcomes, Equally likely outcomes, Mutually exclusive outcomes, Favorable outcomes, Exhaustive outcomes, Random experiment, Sample space and events, Event space, Union and Intersection of Events, Different Types of Events, Odds and Odds Ratio, Function, Set Function, Probability Functions, Theorems on Probability, Probability Space, Total Probability, Tree Diagrams and Compound Probability, Conditional Probability, Bayes' Theorem and its application.			4
CLO3	**Random Variable:** Concepts of Random Variable, Discrete and Continuous Variables, Functions of Random Variables. Probability Mass Function, Probability Density Function, Distribution Function and their Properties.			8
CLO4	**Expectation:** Meaning of Expectation, Mean, Variance, Moments, Expectation of Sums and Products Random Variables,			5

	Chebyshev's Inequality, Markov Inequality, Central Limit Theorem.			
CLO5	**Generating Function:** Moment Generating Function, Factorial Function, Characteristic Function, and Probability Generating Function, Cumulant Generating Function and Their Properties, Inversion Theorem.			7
CLO6	**Joint and Conditional Distribution:** Joint Distribution Functions, Marginal Distribution and Conditional Distributions, Independence of Random Variables, Conditional Mean and Conditional Variance, Covariance and Correlation Coefficient, Cauchy-Schwarz Inequality			8

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and presentation
CLO2	DIY activities	Assignment and Presentation
CLO3	Discussion and slide show	Practice by doing exercise, Summative (Midterm)
CLO4	Lecturing and group discussion	Summative Measure (Final Exam.)
CLO5	Problem solving activities	Summative Measure (Final Exam.)
CLO6	Lecturing and brainstorming	Summative Measure (Final Exam.)

Text Book

1. Ross, S. (2023): *A First Course in Probability*, 10thEdition, Pearson Education Inc.

Supplementary

1. Feller, W. (1985): *Introduction to Probability Theory and Its Applications*, Vol.1, 3rd edition, John Wiley & Sons, New York.
2. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill.

Course Code:0542-113(Stat-113) Course Title: Linear Algebra
Marks:100 Credits: 03 Number of Class: 42

Rationale:

The course is designed as an essential part of the curriculum of majors such as: Computer science, Engineering, Economics, Physics, and Mathematics. It is blending computational and conceptual aspects of mathematics.

Objectives:

The objectives of this course are to:

- Make Understand the key ideas in linear algebra.
- Upgrade and develop the analytical thinking skills and their ability to communicate technical arguments clearly.
- Clarify the material on vector spaces and related topics.
- Motivate to the geometry of problems in two and three dimensions.
- Give understanding about algorithms of linear algebra, which also central to the theory of scientific computing and numerical analysis.
- Introduce more advanced work in this area including applications to geometry, data fitting and differential equations.

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Gather knowledge about Angle and orthogonality in inner product spaces and Decompose using Gram-Schmidt Process.
CLO2	Study diagonalization problem with some applications
CLO3	Compute inverse matrices and determinants using row reduction.
CLO4	Acquainted about vector space as a unifying concept for understanding properties of vectors, Polynomials, and matrices.
CLO5	Compute eigen values and eigenvectors.
CLO6	Solve problems from a variety of areas inside and outside Mathematics using system of linear equations.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		2	2	1	2	2	
CLO2	2		1	2	1			
CLO3	3		2	1	1			
CLO4	2	1		1	1	1	2	
CLO5	2		2	2	1	2		
CLO6	2		1	2	1			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Introduction to System of Linear Equations, Gaussian Elimination, Matrix and Matrix operations, Inverse: Algebraic properties of Matrices, Elementary matrices and a method for finding A-1, more on Linear systems and invertible Matrices, Diagonal, Triangular and Symmetric Matrices. Rank of a matrix.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	10
CLO2	**Determinant:** Meaning and Properties of Determinant, Determinant by Cofactor Expansion, Minors, Cofactors, Ad joint, Combinatorial Approach to Determinant, Evaluating Determinant by Row Reduction, Properties of Determinants: Cramer's Rule.Sarrus diagram for determinents.			4
CLO3	Vector in 2-space, 3-space and n-space, Norm, Dot Product and Distance in R^n, Orthogonality, the Geometry of Linear System, Cross Product. Real Vector spaces, Subspaces, Linear independence and dependence, Coordinates and basis, Dimension, Change of Basis, Row space, Column space, Null space. Rank Nullity and Matrix spaces, Matrix transformation from R^n to R^m. Cauchy -Schwartz inequality and Minkowski's inequality.			8
CLO4	**Eigenvalues and Eigenvectors:** Definition of Eigenvalues and Eigenvectors,Diagonalization,Orthogonal Diagonalization.Caley Hamilton theorem, Minimal polynomial of a matrix.			5
CLO5	Inner Products, Angle and Orthogonality in Inner Product Spaces, Gram-Schmidt Process QR-Decomposition, Best Approximation: Least Square, Normal, orthogonal and unitary operators, spectral theorem.			7
CLO6	**Characteristic Value Problem and Quadratic Form:**Characteristic Value Problem, Similarity, Characteristic Roots and Vectors of Matrix, Theorems of			8

	Characteristic Roots and Vectors, Orthogonal Matrices, Orthogonal Diagonalization, Quadratic Forms, Index & signature of quadratic form,Jordan canonical form, Hermitian, Unitary and Normal Matrices.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom discussion	Interactive Question-Answer
CLO2	Math games	Assignment and Presentation
CLO3	Classroom Discussion and Problem-solving activities	Practice by doing exercise, Summative (Midterm)
CLO4	Discussion and Slide Show	Practice by doing exercise, Summative (Midterm)
CLO5	Problem-solving activities	Summative Measure (Final Exam.)
CLO6	Lecture and Reflective Discussion	Summative Measure (Final Exam.)

Text Book

1. Anton, H. and Rorres, C. (2014): *Elementary Linear Algebra*, 9th edition, John Wiley and Sons, New York.

Reference Books

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1. Aitken, A.C. (1982): *Determinant and Matrices*, Oliver and Boyd, London.
2. Hadley, G. (1993): *Linear Algebra*, 6th rep., Naroda, New Delhi.
3. Narayan, S. (1985): *A Textbook of Matrices*, 8th edition, Sultan Chand and Co., New Delhi.

Course Code:0541-114(Stat-114) Course Title: Calculus
Marks:100 Credits: 03 Number of Class: 42

Rationale:

The main task of this course is to make student understand about basic knowledge of calculus as well as practical implementation of calculus. Another vision is to make student understand the link or relationship between statistics and calculus.

Objectives:

The objectives of this course are to:

- Understand the major problems of differential and integral calculus.
- Understand the importance of linear functions in mathematics.

- Understand and recognize other important classes of functions (such as trig and rational functions), and be able to use calculus fluidly with these functions.
- Solve important practical problems in an optimal way.

Learning Outcomes:
After completing this course, a student will able to-

CLO1	Gather knowledge about insight about function and different types of function;
CLO2	Acquire knowledge about finite and infinite limits of the function;
CLO3	use limits to determine vertical and horizontal asymptotes of the graph of a function;
CLO4	Find the derivative of elementary algebraic functions and trigonometric functions using the definition of derivative, implicit differentiation and differentiation formulas;
CLO5	Find linear approximations and differentials of functions and use them to solve application problems;
CLO6	Learn to use derivatives for graphing algebraic and trigonometric functions and to solve optimization problems;
CLO7	Evaluate intervals of increase and decrease and local extreme values of elementary algebraic functions and trigonometric functions.

Mapping between PLOs and CLOs of Statistics Program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2	2		2		2		
CLO2	2	2				1		
CLO3	1	1				1		
CLO4		1		1				
CLO5	2	1		1		2		1
CLO6	3			1		2		
CLO7	2			2		1		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	**Functions:** Function and Relation, Domain, Range, Inverse Function and Graphs of Functions Like exponential, Logarithmic, Sine, Tangent etc., Limits, Existence and Finding of Limits, Sandwich	Interactive Class, Open Discussion, Participatory	Assign ments, Class	6

	Theorem, Limit Involving Infinity, Intermediate Value Theorem, Continuity, and Indeterminate Form.			
CLO2 CLO3	**Ordinary Differentiation:** Differentiability, Differentiation, Successive Differentiation and Leibnitz Theorem, Derivatives, Application of the Derivative, Extreme Value Theorem.			7
CLO3 CLO4	**Expansions of Functions:** Rolle's Theorem, Mean Value Theorem, Residue Theorem, First Derivative Test, Concavity Test, Second Derivative Test, Taylor's and McLaurin's Formulae, Maxima and Minima Functions of One Variable, two or more variables.			10
CLO5	**Partial Differentiation**: Euler's Theorem, Tangents and Normal Asymptotes, L-Hospitals Rule, Guide Line for Sketching Graph.			9
CLO6 CLO7	**Indefinite and Definite Integrals**: Method of Substitution, Integration by Parts, Special Trigonometric Functions and Rational Fractions. Fundamental Theorem of Definite Integrals, General Properties, Evaluations of Definite Integrals and Reduction Formulae, Ideas of Double Integral and Triple Integral, Finding the Area of Region, Finding the Value of a Solid Revolution, Riemann Theorem/Sum, Derivation of Inverse Function, Integration by Parts.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom discussion	Interactive Question-Answer
CLO2	Math games	Assignment and Presentation
CLO3	Classroom Discussion and Problem-solving activities	Practice by doing exercise, Summative (Midterm)
CLO4	Discussion and Slide Show	Practice by doing exercise, Summative (Midterm)

CLO5	Problem-solving activities	Summative Measure (Final Exam.)
CLO6	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO7	Lecturing	Summative Measure (Final Exam.)

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry*, Wiley, New York.

Reference Books

1 Ayres, F. and Mendelson, E. (1992): *Calculus*, McGraw-Hill, 3rd edition, New York.
2 Bacon, H.M. (1942): *Differential and Integral Calculus*, 2nd edition, McGraw-Hill, New York.

Course Code:0311-115(Stat-115) Course Title: Microeconomics
Marks:100 Credits: 03Number of Class: 42

Rationale:
Microeconomics focuses on the process used by economic agents to maximize satisfaction (or profits) they receive from participating in economic activities.

Objectives:
The objectives of this course are to:

- Introduce students to the basic concepts, terminology, methodology and theory used by economists to describe the workings of market-based economies
- Perform supply and demand analysis to analyze the impact of economic events on markets and relate how supply and demand interact to determine market equilibrium.
- Discuss price elasticity of demand and supply and how it can be applied.
- Give the names and summarize the main characteristics of the four basic market models and list the conditions required for purely competitive markets
- Distinguish between the short run and the long run-in pure competition and explain the long run equilibrium position for a competitive firm
- Explain how a pure monopoly sets its profit-maximizing output and price.
- Explain why monopolistic competitors earn only a normal profit in the long run

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:

CLO1	Explain the determinants of demand and supply;
CLO2	Explain the price elasticity of demand and price elasticity of supply, and compute both using the midpoint method;
CLO3	Graphically illustrate market equilibrium, surplus and shortage;

CLO4	Differentiate between marginal utility and total utility and explain how consumers maximize total utility within a given income using the Utility Maximizing Rule;
CLO5	Describe the various types of markets and compare their efficiency;
CLO6	Distinguish between perfect competition and imperfect competition and be able to explain the welfare loss in non-competitive markets.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	1	1	2	2		
CLO2	2							
CLO3	1		1		2			
CLO4			2	2	3	3		
CLO5	3	3	2	3		2		
CLO6	2	3	2	2		2		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	**Scope and Methods of Economics:** Meaning of Economics. Scarcity, Choice, Tradeoff and Efficiency, Production Possibility Frontier, Major Economic Problems.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	**Demand, Supply and Price:** Determinants of Demand and Supply, Laws of Demand and Supply, Movements along and Shift of Demand and Supply Curves, Equilibrium Price and Quantity, Concept of Elasticity of Demand and Supply			5
CLO3	**Utility and Preferences:**Concept of Utility, Cardinal and Ordinal Utility, Law of Diminishing Marginal Utility, Principle of Equi-Marginal Utility per Unit of Money Spent, Paradox of Thrift.			10
CLO4	**Cost-Output Relationship:** Concept of Short-run and Long-run,			10

	Average, Marginal and Total Product, Relationship between AP and MP, Law of Diminishing Marginal Returns, Variable Cost, Fixed Cost and Total Cost, Returns to Scale, Relationship between AC and MC.			
CLO5	**Indifference Curve:** Indifference Curve and its Characteristics, Budget Line, Substitution Effect, Income Effect and Price Effect.			4
CLO6	**Perfect Competition Market:** Features of Perfect Competition Market, Marginal Analysis of a Firm, Short-run and Long-run Supply Curve of a Firm, Profit Outcomes in the Short-run and Long-run, Breakeven and Shutdown Point, Efficiency of Competition. **Imperfect Competition Market:** Features of Monopoly, Monopolistic Competition, and Oligopoly, Price Settings Strategies of Monopoly, Price Discrimination and its Types, Monopoly's Output and Price, Dead Weight Loss.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Classroom Discussion	Midterm
CLO4	Discussion and Slide Show	Oral Presentation
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO6	Term Papers	Summative Measure (Final Exam.)

Text Book

1. Parkin, M (2023): *Microeconomics*, 6th edition, Pearson Education Inc., Australia.

Reference Books

1. Mankiw, N. G. (2010): *Principles of Microeconomics*, 9thedition, Worth Publication.

2. Samuelson, P. A. and Nordhaus, W. D. (2009): *Economics*, 19th edition, McGraw-Hill, New York.

Course Code: 0542-116(Stat-116) Course Title: Data Analysis-I Lab
Marks: 50 Credits: 02 Number of Class: 28

Group A (Introductory Statistics): 35 Marks

Rationale:
This course aims to provide insight into basic statistical concepts with emphasis on practical applications by using EXCEL.

Objectives:
The objectives of this course are to:

- Know the steps of construction of frequency distribution with equal and unequal class
- Organize and summarize data and represent graphically the important information contained in a data set.
- Compute numerical quantities that measure the central tendency and dispersion of a set of data.
- Improve abilities to analyze moments and shape of characteristics of distribution

Learning Outcomes:
After studying all materials and resources presented in the course, the student will be able to-

CLO1	Construct frequency distribution for equal and unequal class
CLO2	Use appropriate graph for a particular data set and then interpret the graph
CLO3	Find different measures of central tendency and dispersion of a set of data and they will also be able to interpret the results in a proper way
CLO4	Construct tables and graphs that display measures of central tendency
CLO5	Determine the shape characteristics of a distribution and interpret the result

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2		1				
CLO2	1	1	2					

CLO3	2	1						
CLO4	2		2	1	1		1	
CLO5	1	2	1	2	1			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Construction of Tables and Frequency Distributions with Equal and Unequal Class Intervals, Graphical Representation of data;	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination.	4
				4
				4
CLO3	Calculation of Statistical Averages, Median, Mode, Quartiles and related location measures.			6
CLO3 ClO2	Calculation of Various Measures of Dispersion- Range, Inter-quartile Range, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Standard Error, Coefficient of Variation etc.;			6
CLO5	Determine Moments, Skewness and Kurtosis and interpret the results with graphically also.			4

Mapping of CLOs with Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lab performance	Brain Storming
CLO2	Hands-on activities	Test on Report
CLO3	Problem-solving activities	Summative Measure (Final Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)

Text Book

1. Allan G. Bluman, (2013): *Elementary Statistics: A Step By Step Approach*, 9th Edition. Mcgraw Hill Inc
2. Stuart, A. and Ord, J. K. (1994): *Kendall's Advanced Theory of Statistics*, *Vol 1*: *Distribution Theory*, 6th edition, A Hodder Arnold Publication.

Group-B(Linear Algebra): 15 Marks

Rationale:
This course provides grounding on vectors, matrices, and solving systems of linear equations that is fundamental for future mathematics courses and a many practical applications by using EXCEL

Objectives
The objectives of this course are to:

- Work with matrices and determine if a given square matrix is invertible.
- solve systems of linear equations, compute determinants and know their properties.

Identify Eigen values and eigenvectors of a matrix.

Course Learning Outcomes:
Students that successfully complete this course will be able to-

CLO1	Carry out matrix operations, including inverses and determinant
CLO2	Solve systems of linear equations by using Gaussian elimination to reduce the augmented matrix to row echelon form or to reduced row echelon form
CLO3	Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix
CLO4	Compute the inner product of two vectors

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	1	1	2	2		
CLO2	2	1	2	1				
CLO3	3	3						
CLO4	2	3		2	3	3		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Matrix and Matrix operations, Inverse: Algebraic properties of Matrices, Diagonal, Triangular and Symmetric Matrices. Elementary matrices and a method for finding A-1	Interactive Class, Open Discussion, Participatory Q/A Session, Online	Assignments, Class Tests, Presentation, Attendance and Final Examination.	10
CLO2	System of Linear Equations, Gaussian Elimination, more on Linear systems and invertible Matrices,			7

CLO3	Vector Space, Eigenvalues and Eigenvectors;			6
CLO4	Inner Products, Angle and Orthogonality in Inner Product Spaces,			5

Mapping CLOs with Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Hands-on activities	Summative Measure (Final Exam.)
CLO2	Hands-on activities	Summative Measure (Final Exam.)
CLO3	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)

Text Book

Anton, H. and Rorres, C. (2005): *Elementary Linear Algebra*, 9th edition, John Wiley and Sons, New York.

1st Year 2nd Semester

Course Code: 0542-121(Stat-121)
Course Title: Bivariate Analysis Marks:100 Credits: 03 Number of Class:42

Rationale:

Introductory Bivariate Statistics is a basic tool of analysis, and one must be familiar with statistical concepts to understand analytical efforts. This Course is designed to provide a solid grounding in statistics.

Objectives

The objectives of this course are to-

- Foster the learner's theoretic and practical understanding of bivariate data and construction of bivariate table.
- Give the beginner a clear sense of how to measure the strength and direction of a relationship between two variables by collecting measurements and using appropriate statistical analysis.
- Make evaluate and interpret the outcomes of correlation matrix, i.e. correlation coefficients, strength, direction and significance level.
- explain the concept of regression model and able to interpret the effect of variables regression coefficients (β, Beta), coefficient of determination ($\mathcal{R}^2$),
- Provide the foundation of analysis of attributes, Measures of association and construction of contingency table.

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	Recognize the significance of bivariate data and analyze scatter plots to look into and discuss relationships between two numbers.
CLO2	Investigate and interpret the sample correlation coefficient (r) to determine the strength and direction of the linear relationship between predictor and response variables.
CLO3	Figure out the concept of regression analysis and can build up regression models.
CLO4	Predict and estimate the regression analysis with appropriate variables and validate the models.
CLO5	Comprehend the categorical data and different analysis techniques of attributes.
CLO6	Abolish different contingency table for different types of categorical data.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	1		1	2		
CLO2	2	2	1		1			
CLO3	3		1		1			
CLO4	2	2		1		1		
CLO5	2	2	1		1	2		
CLO6	3	2	1		1			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Summarizing Bivariate Data**: Concept of Bivariate Data, Scatter diagram, Construction of Bivariate Table.	Interactive Class, Open Discussion, Participatory Q/A Session, Online	Assignments, Class Tests, Presentation, Attendance and Final	5
CLO2	**Simple Linear Correlation:** Simple Correlation, Rank Correlation, Spearman Rank Correlation, Kendall's Tau, Intra-class Correlation, Correlation Ratio, Serial			10

	and bi-serial Correlation, Partial and Multiple Correlation, Spurious Correlation and Non-sense Correlation.			
CLO3	**Simple Linear Regression:** Simple Linear Regression Model, Model Assumptions, Method of Least Square, Properties of the Least Square Estimators and Prediction.			10
CLO4	**Fitted Regression Model**: Fitted Regression Model, Coefficient of Determination, Lack of Fit and Pure Error,			6
CLO5	**Analysis of Attributes:** Basic Ideas, Classification, Order of Classes and Class Frequencies, Ultimate Class Frequencies, Positive Attributes, Consistency, Incomplete Data, Association of Attributes, Independence, Complete Association and Disassociation, Measures of Association, Coefficient of Association, Coefficient of Colligation and Partial Association.			6
CLO6	**Contingency Table**: Analysis of *r x c* Contingency Table, Analysis of 2x2 Contingency Table.			5

Mapping of CLOs with Teaching-Learning Strategy&Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Quiz
CLO2	Expository sharing and Math games	Assignment and Presentation
CLO3	Classroom Discussion and Problem-solving activities	Practice by doing exercise, Summative (Midterm)
CLO4	Discussion and Slide Show	Practice by doing exercise, Summative (Midterm)
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO6	Lecturing	Summative Measure (Final Exam.)

Text Book

1. Montgomery, D.C. and Peek, E, (1992): *An Introduction to Regression Analysis*, 2nd edition, John Wiley and Sons, New York.

Reference Books

1. Lind, A. D., Marchal, W. and Wathen, S. (2014): *Statistical Techniques in Business and Economics*, 16th Edition, McGraw Hill Inc.

2. Stuart, A. and Ord, J. K. (1994): *Kendall's Advanced Theory of Statistics*, *Vol 1*: *Distribution Theory*, 6th edition, A Hodder Arnold Publication.

3. Gupta, S.P. and Kapoor, V. K. (2009): *Fundamentals of Mathematical Statistics,* 11th edition, Sultan Chand &Son.

Course Code: 0542-122(Stat-122) Course Title: Probability Distribution
Marks:100 Credits: 03 Number of Class: 42

Rationale: This course offers Statistics Majors with the basics of Probability Distributions (both discrete and continuous). And obviously by understanding the essential dimension of probability distribution as a course, disseminating knowledge of it and fostering students to prepare them as dexterous resources in the arena of scientific research.

Objectives:
The objectives of this course are to:

- Provide students with essential tools in probability theory to comprehend the theory of statistics and their applications.
- Introduce the properties of univariate discrete and continuous probability distributions
- Compute probabilities for various discrete and continuous probability distributions.
- Explain the properties of bi-variate continuous probability distribution such as-bivariate normal distribution

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	Define the main tools to describe a random variable, such as the probability density function, the cumulative distribution function
CLO2	Describe and compare the most widely used discrete probability distributions such as Bernoulli, Binomial, Poisson, Uniform, Multinomial, Truncated Binomial and Poisson
CLO3	Explain the most widely used continuous probability distributions such as Uniform, Normal, Exponential, Gamma, Beta, Log Normal, Pareto, Laplace Double Exponential, Cauchy, Weibull, Gumbel and recognize them in applications.
CLO4	Adroit to use probability generating function, moment generating function, cumulant generating function and characteristic function, derive them in simple cases, and use them to evaluate moments in case of univariate discrete and continuous probability distributions.
CLO5	Explain the concepts of bivariate distribution, and how to apply them.

Mapping between PLOs and CLOs of Statistics program:

PLOs								

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1	2	2	
CLO2	2	3	1	1				
CLO3	3	2	2					
CLO4	2	2		1		1	2	
CLO5	2	2	2		1	2		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Introduction:** Random Variables, Concept of Probability Distribution, Distribution Function, Mass Function, Density Function, Cumulative Distribution Function, Application of Probability Distribution.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance, and Final Examination.	5
CLO2 CLO4	**Univariate Discrete Distribution:** Bernoulli, Binomial, Poisson, Hyper Geometric, Geometric, Negative Binomial, Uniform or Rectangular, Multinomial, Truncated Binomial and Poisson.			15
CLO3 CLO4	**Univariate Continuous Distribution**: Uniform, Normal, Exponential, Gamma, Beta, Log Normal, Pareto, Laplace Double Exponential, Cauchy, Weibull, Gumbel and other Exponential Family of Distributions, Triangular.			15
CLO5	**Bivariate Distributions:** Definition of Joint Distribution, Joint Probability Mass Function, Joint Probability Density Function, Bivariate Probability Distribution, Bivariate Normal Distribution and its Properties.			5

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Reflective Discussion	Quiz and Assignment,
CLO2	Lecture and Discussion	Assignment, Quiz and Summative Exam

CLO3	Lecture and Group Discussion	Mid-Semester and Summative Exam
CLO4	Discussion and Slide Show	Mid-Semester and Summative Exam
CLO5	Lecture and Discussion	Summative Exam

Text Book

1. Allan G. Bulman, (2013): *Elementary Statistics: A Step by Step Approach*, 9thEdition. McGraw Hill Inc

Reference Books

2. Lind, A. D., Marchal, W. and Wathen, S. (2014): *Statistical Techniques in Business and Economics*, 16th Edition, Mcgraw Hill Inc.
3. Yule, G.U. and Kendall, M.G. (1999): *An Introduction to the Theory of Statistics*, Universal Book Stall, New Delhi.
4. Islam, M. N (2004): *An Introduction to Statistics and Probability*, 3rd edition, Mullick & Brothers.

Course Code: 0541-123(Stat-123)
Course Title: Algebra and Analytical Geometry
Marks:100 Credits: 03Number of Class: 42

Rationale:

The purpose of this course is to develop the ability to use the basic methods of algebra and analytical geometry.

Objectives

The objectives of this course are to:

- Use algebra as a tool for representing and solving a variety of practical problems.
- Use tables and graphs to interpret algebraic expressions, equations, and inequalities and to analyze behaviors of functions.
- Know the properties of real and complex numbers and why they are applicable
- Know the algebraic operations on complex numbers
- Explain what inequalities represent and how they are used
- Explain what it means for a sequence to have a limit (converge) or diverge.

Learning Outcomes:

At the end of this, students should be able to-

CLO1	Define the terms "relation" and "function" and describe each of these mathematical concepts in a given context;
CLO2	Solve equations and inequalities, both algebraically and graphically;
CLO3	Perform basic algebraic manipulation and understand the geometric interpretation of complex numbers;
CLO4	Prove and apply the inequality of the means; the triangle inequality; the Cauchy-Schwarz inequality; Weierstrass' inequalities;

CLO5	Accurately identify the equations, properties and graphs of the parabola, circle and ellipse.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	1			1	1			
CLO2	2						1	
CLO3	2	2		1	2			
CLO4	1		2		1	1		
CLO5	2	2	2	1	1	1		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Basic Concepts of Algebra:** Concepts of Equation, Relations and Functions. Binary relation, Operation on Algebraic Expressions, Equivalence Relation, Properties of Real Number and Complex Number, and Definition of Group and Field.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	**Inequality**: Order properties of real number, Arithmetic mean, Geometric mean, Weierstras's Inequality, Cauchy-Schwarz Inequality.			5
CLO2	**Theory of Equations:** Binomial and Polynomial Equations, the Remainder Theorem in Algebra, Multiple Roots, Relation between Roots and Coefficients, Descartes's Rule of Signs, Symmetric Function of the Roots, Sum of the Powers of the Roots, Transformation of Equations, Limit of the Roots, Removal of any Terms of the Equations, Reciprocal Equation, Solutions of Cubic and Bi-Quadratic Equations. **Series**: Basic concepts of series, Techniques of summing up series, Test			4

	of Convergence and Divergence of series.			
CLO3	Basic Concepts about the Formation and History of Geometry, Cartesian and Polar Co-ordinates, Parameters, Changes of Axes Standard Equation in Different Co-ordinate Systems and their Parametric Representation.			10
CLO4	**Straight-line**: Slope, Derivation of the Equation of Straight-line, Angle between Two Straight-line, Condition for Perpendicularity Parallelism Related Problems.			10
CLO5	**Pair of straight-lines**: Concepts of Pair of Straight-line with Homogeneous form, General Equation of Second Degree, Reduction of Pair of Straight-line. **Coins**: Ellipse, Parabola, Hyperbola, Circle & System of circle.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Problem-solving activities	Practice by doing exercise, Midterm
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry*, Wiley, New York.

Reference Book

1. Ayres, F. (2009): Theory and Problems of Modern Algebra, Schaum's Outline Series, 4th edition, McGraw-Hill Book Company.
2. Shahidullah, M. and Bhattacharjee, P. K. (2021): *Text Book on Algebra and Trigonometry*, Latest edition.

Course Code:0311-124(Stat-124) Course Title: Macroeconomics
Marks:100 Credits: 03Number of Class: 42

Rationale:
The aim of this course is to equip students with the foundation skills essential for understanding the macroeconomic environment within which all entities operate.This course is a foundation course that will prepare students to be successful in upper division finance, marketing, business administration, economics, government, and social courses.

Objectives:
The objectives of this course are to:

- Provide an overview of macroeconomic issues: the determination of output, rates of growth, unemployment and inflation.
- Know the meaning and components of the National Income Accounts, especially GDP.
- Understand the meaning of the business cycle and its phases.
- Manipulate the basic Aggregate Supply, Aggregate Demand model of the macro economy.
- Know how fiscal policy operates, its tools, and its advantages and drawbacks
- Know how monetary policy operates, its tools, and its advantages and drawbacks.

Learning Outcomes:
Upon successful completion of the course, students will be able to:

CLO1	Gather knowledge aboutthe behavior of the economy as a whole with major macroeconomic problems;
CLO2	Realize the meaning of unemployment and inflation data and how that data is collected and computed;
CLO3	Calculate GDP, GNP and other major economic measurement;
CLO4	Define aggregate demand and supply for a good in a competitive market and explain how the aggregate demand and supply together determine equilibrium price;
CLO5	Distinguish the role of money and monetary policy and how to allocate budget;
CLO6	Differentiate the inflation and its impact on economy along with economic growth and cycles.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	1	2	2	2	1		

CLO2	3	2		3	2	2		
CLO3	1	2		3	2	2		
CLO4	2		1		1	1		
CLO5	2	2	2	1	1	1		
CLO6	1	2	3		2	2	1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Overall Economic Situation:** Major Macroeconomic Problems – (Inflation, unemployment and low growth rate). Macroeconomic policy & goals. National Output Concepts. Measurement of National output, rates of growth, unemployment and inflation.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	**Aggregate Demand and Aggregate Supply Model:** Determinants of Aggregate Demand – Consumption, Savings and Investment – Aggregate Supply – short run and long run. Determination of income in the very short run. Concept of Multiplier.			5
CLO3	**Money and Monetary Institutions:** Types and Functions of money. Constituents of money supply. Role of Central Bank and Commercial Bank. Multiple expansion of deposits – Control of money supply. Demand for money – Quantity Theory of Money.			4
CLO4	**Role of Government and Fiscal Policy:** Objectives of government – Objectives and instruments of fiscal policy. Budget – Deficit Budget and Surplus – Financing the deficit, Sources of Revenue, Direct and Indirect taxes, Government purchases and transfer payment.			10
CLO5	**Working of Monetary and Fiscal Policy:** Monetary and Fiscal Policy in a closed economy. Open economy – Basis for trade Theory of Comparative Advantage – Perfect mobility of			10

	capital – Determination of interest rate – Exchange rate determination. Monetary and Fiscal Policy in an open economy. Multipliers in the short run and in the long run.			
CLO6	**Inflation:** Causes of Inflation, Cost Push and Demand-Pull Inflation, Stagflation, Demand and Supply Side Factors of Inflation, Phenomenon of Phillips Curve. **Economic Growth and Cycles:** Nature of business cycles. Sources of growth. Benefits and costs of growth. Theories of growth.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Student Group Discussion	Midterm
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO6	Lecture and Reflective Discussion	Summative Measure (Final Exam.)

Text Book

1. M. Parkin (2021): *Macroeconomics*, 6th Edition, Addison Wesley.

Reference Books

1. J.E.Stiglitz (2013): *Principles of Macroeconomics*, 3rd Edition, Norton & Company, Inc.
2. P.A. Samuelson and W.D. Nordhaus (2010): *Economics*, 19th Edition.

Course Code: 0613-125(Stat-125) Course Title: Programming With C
Marks:100 Credits: 03 Number of Class: 42
(LAB)

Rationale:
This Course intends to develop programming skills in the students, using a popular structured programming language `*C*'.

Objectives:
The objectives of this course are to:

- Familiarize the students with basic concepts of computer programming and developer tools.
- Present the syntax and semantics of the "C" language as well as data types offered by the language
- Allow the students to write their own programs using standard language infrastructure regardless of the hardware or software platform

Solve following problem by using C language

- Determine correlation coefficients, strength, direction and significance level and then interpret the results in an appropriate way.
- Estimate the regression coefficients from the practical data and then fit a linear model to a bivariate data set via software
- Evaluate coefficient of determination ($\mathcal{R}^2$), ANOVA table, F- test and T- test.

Explore the basic ideas of analysis of attributes, Measures of association and construction of contingency table.

Learning Outcomes:

After completing this course, a student will able to-

CLO1	Gain insight programming language
CLO2	General discuss flow chart of C-programming
CLO3	Solve different statistical and mathematical problems using C-Programming

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			1				
CLO2	3		1			2		
CLO3	1	3	3		1		2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Programming**: Basic Meaning, Algorithms, Flow Charting, list of Different Programming Languages, FORTRAN, C, C++, Mat lab, etc.	Interactive Class, Open Discussi	Assignments, Class Tests,	**6**

CLO2 CLO3	**Programming in C**: Introduction, Importance of C, Sample C Programs, Basic Structure of C Programs, Programming Style, Compilation and Execution of C Program. Sequential Structure. Character Set, Data Types, Classes of Data, Arithmetic Operations, Expressions, Assignment Statements, Input and Output. Selective Structure. Relational Operations, Logical Operations, Conditional Statements. Repetitive Structure. Functions, Arrays, Pointers, Structure.			**15**
CLO2 CLO3	Applications of C program for Statistical Computation. Different problem in bivariate statistics can be solved by using C.			**18**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book

1. Byron S. Gottfried, (2018). Theory and Problems of Programming with C. 4th Ed.

Reference Book

1. Rajaraman, V. (2014): *Fundamentals of Computers*, Prentice –Wall. 6th Edition.

Viva-Voce **Marks:50** **Credits: 1.5**

2nd Year 1st Semester

Course Code: 0542-211(Stat-211) Course Title: Sampling Distribution
Marks:100 Credits: 03 Number of Class: 42

Rationale:
The role of the course sampling distribution in statistical inference is astronomically relevant and essential. The concept of variants transformation and distribution of sample mean, sample variance, and sample covariance is utmost required to decision making in any field of statistical data analysis.

Objectives:
The objectives of this course are to:

- To present the general theory of statistical distributions.
- To present the standard distributions found in statistical practice.
- To present the relationships among distributions found in statistical practice.
- To provide a good grounding in the general theory of statistical distributions.

Learning Outcomes:

Having successfully completed this course/module student will be able to

CLO1	Derive both central and non-central chi-square, t and F distributions from normal distribution;
CLO2	Calculate moments and moment generating function;
CLO3	Recall definitions of probability function, density function, cumulative distribution function and moment generating function, and their inter-relationships;
CLO4	Gather knowledge in details variate transformation and Laplace transformation.
CLO5	Apply moment generating function to determine distribution function and moments.
CLO6	Recall well known distributions such as Bernoulli, binomial, Poisson, geometric, uniform, exponential, normal, Cauchy, gamma and beta distributions and determine the relationship of those distributions with the central and non-central chi-square, t and F distributions;
CLO7	Construct the distribution of sample mean, sample variance, sample covariance and use these concepts in statistical inference.

Mapping between Program Learning Outcome (PLO) and Course Learning Outcome (CLO):

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	2	2		2	1	
CLO2	3	3	2					
CLO3	3	3	2			1		
CLO4	3	3	1				1	
CLO5	3	3	1	2				
CLO6	3	3	2	2		1		
CLO7	3	3	2	2			1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Random Variable, Its Distribution and Properties, Functions of Random Variable; Sum, Product, and Ratio. Theory of Large Samples, Convergence of Random Variable, Modes of Convergence, Law of Large Number (Strong Law and Weak Law), Central Limit Theorem.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2 CLO3	Concept of Probability andSampling Distribution.Different methods of sampling distribution, methods of obtaining sampling distribution. Variate Transformations: Square Root, Log, Sin Inverse, Fisher's Z Transformation, Laplace Transformation,Hyperbolic inverse, tan inverse			7
CLO3 CLO4	Exact Sampling Distribution Related to Normal Population.			10
CLO5	Distribution of Sample Mean, Sample Variance, Sample Covariance.Distribution of Sample Correlation and Regression Coefficients.			10

CLO6 CLO7	Central and Non-Central Distribution of *t*, Chi square (χ^2), *F*, Cochran's Theorem, Fisher's *Z* and their Applications.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Student Group Discussion	Midterm
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO6	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO7	Lecture and Reflective Discussion	Summative Measure (Final Exam.)

Text Book

1. Hogg, R. V. and Craig, A. T. (2002): *Introduction to Mathematical Statistics*, 5th edition, Pearson Education, Asia.

Reference Books

2. Arnold, B. C., Balakrishnan, N. and Nagaraja, H. N (2008): *A First Course in Order Statistics*, SIAM.
3. Rohatgi, V. K. and Saleh, A. K. Md. (2000): *An Introduction to Probability and Statistics*, Second edition, Wiley-Interscience.
4. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill, New York.

Course Code: 0542-212(Stat-212) Course Title: Sampling Techniques-I
Marks:100 Credits: 03 Number of Class: 42

Rationale:

This subject provides a broad introduction to census, sample survey and different probability and non- probability sampling. The subject is basically concerned with the appropriate sampling techniques to draw sample from population.

Objectives:

The objectives of this course are to:

- know about the basic concept of census and sample survey
- Understand the difference between probability and non- probability sampling.

- Choose the most appropriate sampling method according to the respective population
- Know the estimation procedure of certain parameters, and quantify the uncertainty in these estimates with a margin of error.

Learning Outcomes:

After this course a student will able to-

CLO1	Distinguish design-based statistics (sampling methodology) from model-based statistics (usual methodology).
CLO2	Design studies using common probability sampling designs.
CLO3	Choose an appropriate sample design based on the data and resources that are available.
CLO4	Summarize data collected from a probability survey and understand methods to determine the accuracy of the estimators.
CLO5	Recognize the various approaches taken in gathering survey data.
CLO6	Create a plan for sampling, gather data, then compile it all into a report.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	1	3	2	2	2
CLO2	3	3	3		3	3	2	
CLO3	3	2	3		3			1
CLO4	3	3	1	2	2	3		2
CLO5	3	3	1	2	3	2		3
CLO6	3	3		2	3		1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	**Introduction:** Detailed Study of Census, Post Enumeration Check, Concept and Scope of Sampling, Census versus Sample Survey, Uses of Sample Survey, Principles of Sample Survey, Principal Steps in Sample Survey, Preparation of Questionnaire, Schedules, Instruction etc., Survey Enumeration, Pilot Survey, Requirement of a Good Sampling Design.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation,	5

CLO3 CLO4	**Non-Random Sampling:** Purposive/Judgment Sampling, Quota sampling, Convenience Sampling and Snowball Sampling its Merits, Demerits and their Applications.			10
CLO5	**Probability Sampling:** Procedure of Drawing a Probability Sample. Simple Random Sampling with and without Replacement, Stratified Random Sampling with different Allocation, Systematic Sampling, Cluster Sampling with Equal Probabilities. Estimation of Mean, Proportion, Ratio. Estimated Variance and Confidence Intervals, Sample Size Determination for Estimating Mean and Proportion.			10
CLO6	**Use of Auxiliary Information:** Ratio, Difference, Regression and Product Methods of Estimation. Estimation of Population Total, Mean, Variance and Proportion. **Non-Sampling Errors:** Sampling and Non-sampling errors, Bias, Accuracy and Precision, Sources and Remedies.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and presentation
CLO2	Class projects	Assignment and Presentation
CLO3	Discussion and slide show	Practice by doing exercise, Summative (Midterm)
CLO4	Lecturing and group discussion	Summative Measure (Final Exam.)
CLO5	Problem solving activities	Summative Measure (Final Exam.)
CLO6	Chalkboard instruction	Summative Measure (Final Exam.)

Text Book

1. Cochran, W.G. (2007): *Sampling Techniques*, 3rdedition, Wiley Eastern, New Delhi.

Reference Books

1. Murthy, M.N. (1977): *Sampling Methods*, 2nd edition, Statistical Publishing Society, Calcutta.

2. Islam, M.N.: *An Introduction of Sampling Methods: Theory and Applications*.

Course Code:0541-213(Stat-213) Course Title: Numerical Analysis
Marks: 50 Credits: 02 Number of Class: 28

Rationale:
Numerical analysis is the study of algorithms that use numerical approximation for the problems of mathematical analysis. This course implements advanced numerical methods and apply them to a variety of problems in science and engineering.

Objectives:
The objectives of this course are to-

- Give an introduction to commonly used numerical methods.
- Enable students to use numerical techniques to tackle problems in Statistics that are not analytically soluble.
- Demonstrate techniques for the solution of linear simultaneous equations.
- Explain and demonstrate the use of techniques for polynomial interpolation, spline fitting and soothing of data.
- Explain and demonstrate techniques for numerical integration.

Learning Outcomes:
After successful completion of this course Students will be able to-

CLO1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
CLO2	Apply numerical methods to obtain approximate solutions to mathematical problems.
CLO3	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
CLO4	Analyze and evaluate the accuracy of common numerical method

Mapping between PLOs and CLOs of Statistics program

PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8

CLOs								
CLO1	3		2	3		1		
CLO2	2		2	3			1	
CLO3	2		2	3			2	
CLO4	2	2	2	2		2	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Finite Differences:** Factorial Notation, Shifting Operator, Difference Operator, Differential Operator and their Relationship, Difference Table.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**3**
CLO1 CLO2 CLO3 CLO4	**Interpolation with Equal and Unequal Intervals:** Concepts of Interpolation, Newton's Interpolation Formula, Relationship Between Simple Difference and Divided Difference. Newton's General Interpolation Formula, Lagrange's Formula, Inverse Interpolation, Method of Successive Approximations or Iteration and Reversion of Series. **Central Difference Interpolation Formula:** Gauss Formula, Stirling's Formula and Bessel's Formula. **Numerical Differentiation and Integration:** General Quadrature Formula, Simpson's Rule, Weddle's Rule, Trapezoidal rule, Euler Maclaurin's Formula and their Applications.			**10**
CLO2 CLO4	**Solution of Algebraic and Transcendental Equations:** Bisection Method, Method of			**7**

	False Position, Newton-Raphson Method, Method of Iteration.			
CLO1 CLO2 CLO3 CLO4	**Extrapolation:** Concept of Extrapolation, Different Methods of Extrapolation			**6**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Problem-solving activities.	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Scarborough, J. B. (1966): *Numerical Mathematical Analysis*, 6th edition, Johns Hopkins Press, Baltimor.

Reference Book

1. A.R. Vasishtha& A.K. Vasishtha(2020): *Numerical Analysis*, Krishna Prakashan Media.
2. Averil M. Law (2010): *Simulation Modeling and Analysis,4th Edition,* Tata McGraw-Hill Education Private Limited, New Delhi

Course Code: 0542-214(Stat-214) Course Title: Statistical Quality Control and Index Number

Marks: 100 Credits: 03 Number of Class: 42

Rationale:

The course is designed to give a solid basis on applications of statistics tools used in industrial and economic indices.

Objectives:

The objectives of this course are to:

- Make Comprehensive the techniques and concepts of Statistical Quality Control and the meaning of the term index number.
- Train to Construct the appropriate Quality Control charts / Forecasting and critically discuss the role of such charts / models in monitoring a process.
- Involve them to Assess the ability of a process to meet customer expectations.

Get accustomed to the use of some widely used index numbers

CLO1	Comprehend the requirements for effective quality systems in modern manufacturing
CLO2	Construct and interpret different control charts for the system of process control in industrial sector.
CLO3	Obtain various sampling inspection plans and describe quality systems used in modern manufacturing system.
CLO4	Assume knowledge about industrial sectors and statistics used in industrial analysis.
CLO5	Perceive the basic idea of index number, its applications, and limitations.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2		2	2	2	
CLO2	3		1			2	2	
CLO3		2	2	1	2	2		
CLO4	1			1	2		2	
CLO5	2	2	2		2		2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Statistical Quality Control**: History, Definition, Meaning of Statistical Quality Control (SQC), Process Control and Product Control, Causes of Variation in Quality Product, Basic Principles of Quality Control,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	Control Chart Techniques, Various Attribute and Variable Control Charts, Interpretation, and uses of different control charts.Various graphical tools of Quality control. One sample and two sample hypothesis.			8
CLO3	Acceptance Sampling and Sampling Inspection by Attributes and Variables, Sampling versus Screening, Sampling Plans - Single, Double, Multiple, Continuous Sampling Plans and their Relative Advantages and Disadvantages.			8

	Concept of OC, ASN, AOQ, AOQL, AQL and other characteristics of Sampling Plans, Sequential Sampling Plan, OC and ASN of Sequential Sampling. Total Quality Management (TQM).			
CLO4	**Industrial Statistics**: Sources of Industrial Statistics, Labor Statistics, Working Time, Indicator of Output Statistics, Statistics of Fixed Investment, Expenditure and Production Cost, Identification of Quality Level, Productivity of Labor Quality Control Measures.			6
CLO5	**Index Number**: Meaning of Index Number, Problems Involved in Constructing Index Number, Construction of Index Number in Different Methods, Criteria of a Good Index Number, Uses of Index Number and Limitations of Index Number.			8
CLO5	Unit Test, Time Reversal Test, Factor Reversal Test, Circular Test, Cost of Living Index Number, Economic Adviser's Wholesale Price Index Number, Consumer Price Index Number, Base Shifting, Splicing and Deflating of Index Number, Index of Industrial Production. Value Index Number.			7

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Presentation
CLO3	Classroom Discussion and Problem-solving activities	Practice by doing exercise, Summative (Midterm)
CLO4	Discussion and Slide Show	Assignment
CLO5	Lecturing	Summative Measure (Final Exam.)

Text Book

1. Montogomery, D.C. (2002): *Introduction to Statistical Quality Control*, 4th edition, John Wiley and Sons, New York.

Reference Books

1. Gupta, S.C. and Kapoor, V.K.: *Fundamental of Applied Statistics*
2. Banks, J.: *Principles of Quality Control*, John Wiley and Sons, New York.

Course Code:0541-215(Stat-215) Course Title: Advanced Calculus and Differential Equations

Marks:100 Credits: 03 Number of Class: 42

Rationale: This course builds on students' previous experiences with functions of several variables and their developing and understanding of calculus and differential calculus.

Objectives:

The objectives of this course are to:

- Know the problem about limit, continuity and differentiability of function of several variables.
- Use Taylor's series, Lagrange's method of undetermined multipliers.
- Know Jacobeans transformation and their applications.
- Know multiple integrations, Dirichlet's integral and its extension.
- Know Laplace transformation and change of the order of integration.
- Identify initial value and Boundary value problem in differential equations.
- Know about homogeneous equations.
- Operate simultaneous differential equations

Learning Outcomes:

On completion of this course the student should be able to—

CLO1	Solve the problem about limit, continuity and differentiability of function of several variables.
CLO2	Demonstrate Taylor's series, Lagrange's method of undetermined multipliers.
CLO3	Learn multiple integrations, Dirichlet's integral and its extension.
CLO4	Operate Laplace transformation and change of the order of integration. And identify initial value and Boundary value problem in differential equations.
CLO5	Evaluate about homogeneous equations
CLO6	Operate simultaneous differential equations

Mapping between PLOs and CLOs of Statistics program:

PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8

CLOs								
CLO1	3	2	2		2		2	
CLO2	1	2		1	2		1	
CLO3	3	1	2		2			
CLO4	2	2	2	1	2	2	2	
CLO5	2		2	1	2			
CLO6	1			3		2		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Advanced Calculus:** Function of Several Variables, Limit, Continuity, Differentiability of Function of Several Variables, Taylor's Series, Lagranges Method of Undetermined Multipliers, Jacobian of Transformation, and their Applications in Statistics.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	Double, Triple and Multiple Integrations, Change of Variables, Dirichlet's Integral, and its Extension. Beta and Gamma Functions and their properties. Incomplete Beta and Gamma Functions.			8
CLO3	Fourier Series and Fourier Integrals, Transformations of Integrals, Existence of Laplace Transformation, Properties of Laplace Transformation, Inverse Laplace Transformation, their Application, Change of the Order of Integration.			8
CLO4	**Differential Equations:** Definition, Classification, Origin and Application. Initial-value and Boundary-value Problems. Ordinary Differential Equations of First Order and Degree, Separation of Variables.			6
CLO5	Exact Equations. Separable Equations, Homogeneous Equations, and non-Homogenous Equations, Linear Equations, Bernoulli Equations, Linear Equation with Constant Coefficients, Simple Cases of Differential Equations of			8

	First Order and of Degree Higher than One,			
CLO6	Partial Differential Equations of First and Second Order, Ordinary Simultaneous Differential Equations. Equation Reducible to Homogenous Forms and Homogenous Linear Equations.			7

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Hands-on activities	Interactive Question-Answer
CLO2	Hands-on activities	Quiz and Assignment
CLO3	Classroom Discussion and Problem-solving activities	Summative Measure (Midterm Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)
CLO5	Lecture and Discussion	Summative Measure (Final Exam.)
CLO6	Lecture and Discussion	Summative Measure (Final Exam.)

Text Book

1. Anton, H (2006): *Calculus with Analytic Geometry*, Wiley, New York.
2. Ross, S.L. (1989): *Differential Equations*, 4th Ed., Wiley, N.Y.

Reference Books

1. Ayres, F. (1997): *Differential Equations*, McGraw-Hill, NY.
2. Ayres, F. and Meldelson, E. (1992): *Calculus*, McGraw-Hill, 3rd edition, New York.

Course Code: 0542-216(Stat-216) Course Title: Data Analysis- II
Marks:100 Credits: 03 Number of Class: 42

Group A (Sampling Techniques-I):40 Marks

Rationale:
This course is design to choose appropriate sampling methods for drawing sample from population and find the relative efficiency of different sampling scheme.

Objectives:
The objectives of this course are to:

- Select a suitable sampling design, given available information and resources.
- Draw sample from population by using appropriate sampling techniques such as, Simple Random Sampling, Stratified Sampling, Systematic and Cluster Sampling

- Summarize data collected from a probability survey and understand methods to determine the accuracy of the estimators.

Learning Outcomes:
After successful completion of this course students will be able to-

CLO1	Select appropriate sampling techniques to draw sample from population
CLO2	Determine relative efficiency of different sampling scheme and estimates the parameter and find the variance of estimates,

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	1		1		2	2	2
CLO2	3		1		3	3	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Drawing Samples by Simple Random Sampling, Stratified Sampling, Systematic and Cluster Sampling.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination	8
CLO2	Estimation of Parameters in Each Case. Estimation of Variance of Estimates, Estimates of Parameter, Determination of Precision of Estimates, Relative Efficiency of Different Sampling Scheme. Ratio, Difference, Regression and Product Methods of Estimation, Estimation for Population Total, Mean, Variance and Proportion.			15

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Group discussion	Lab Assessment
CLO2	Lecturing and Problem-solving activities.	Viva-Voce, Lab Performance

Text Book

1. Cochran, W.G. (2007): *Sampling Techniques*, 3rd edition, Wiley Eastern, New Delhi.

Group B (Numerical Analysis): 30 Marks

Rationale:
Aim of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems on the computer.

Objectives:
The objectives of this course are to:

- Provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration
- Improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.
- Puts the practical basis of the random numbers generators from different distribution and analyze the simulated data

Learning Outcomes:
After successful completion of this course students will be able to-

CLO1	Apply numerical methods to obtain approximate solutions to mathematical problems.
CLO2	Numerically approximate functions with polynomials
CLO3	Apply appropriate techniques for numerical differentiation and integration

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2		1		2	1		
CLO2	1	1		1	2			
CLO3	1			1	2		1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Newton's Forward and Backward Interpolation Formula, Newton's General Interpolation Formula, Lagrange's Interpolation Formula, Central Difference Interpolation Formula, Inverse	Interactive Class, Open Discussion, Participator	Assignments, Class Tests, Presentatio	**15**

	Interpolation Formula, Numerical Integration (Simpson's Rule, Weddle's Rule, Trapezoidal Rule, Euler Maclaurence Formula.			
CLO1 CLO2	Solution of Equation by Graphical Method, Bisection Method, Method of False Position, Newton Raphson Method, Method of Iteration.			**15**
CLO3	Generating random variable from different distributions. Analyzing of simulating data.			**9**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion, Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO2	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book:

Scarborough, J. B. (1966): *Numerical Mathematical Analysis*, 6th edition, Johns Hopkins Press, Baltimore.

Group C: (Statistical quality control and Index Number) : Marks 30

Rationale:
Statistical Quality Control provides a comprehensive coverage of statistical approaches and methods for industrial quality management. On the other hand, second module (index number) provides an understanding of the modern theory and practice of index numbers as a means of making price and quantity comparisons.

Objectives:
The objectives of this course are to:

- Construct control charts and develop sampling plans
- Explain process capability
- Familiar students with index numbers methods and to provide practical solutions to general aggregation problems
- Understand the competing merits of different approaches to index number problems and methods for dealing with quality change and new goods

Learning Outcomes:
After studying all materials and resources presented in the course, the student will be able to-

CLO1	Construct control charts for variables and attributes.
CLO2	Estimate the process of acceptance sampling and Construct and interpret the operating characteristic (OC) curves.
CLO3	Calculate the index numbers and be able to provide practical solutions to general aggregation problems.
CLO4	Determine the cost-of-living index number to understand the change in purchasing power of a group/class of people.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	1	2	1	2	3		
CLO2	2		2		2		2	
CLO3	2	2	2		2		1	
CLO4	2		2	2	2	3	3	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Construction of Different Control Charts and OC Curve, Drawing of ASN, AOQ, AOQL, AQL, Simple, Double and Multiple Sample Scheme,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination.	4
				4
				4
CLO3 CLO4	Price Index, quantity index, value index, Industrial index number and cost of living index number.			6

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Hands-on activities	Summative Measure (Final Exam.)
CLO2	Hands-on activities	Summative Measure (Final Exam.)

CLO3	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)

Text Book

1. Montogomery, D.C. (2002): *Introduction to Statistical Quality Control*, 4th edition, John Wiley and Sons, New York.
2. Gupta, S.C. and Kapoor, V.K.: *Fundamental of Applied Statistics*.

2nd Year 2nd Semester

Course Code: 0542-221(Stat-221) Course Title: Statistical Inference-I
Marks:100 Credits: 03 Number of Class: 42

Rationale:

This course is designed to introduce the students with fundamental concepts and techniques of statistical inference including estimation and test of hypotheses to be used in courses at advanced level.

Objectives:

The objectives of this course are to:

- Initiate students with the basic theory behind the development and assessment of statistical analysis techniques in the areas of point and interval estimation as well as hypothesis testing.
- Help the students to develop a deeper understanding of the basis underlying modern statistical inference.
- Able students to draw statistical inference from point estimates of estimated parameters and interpret these estimates.
- Acquaint/Equip students with a statistical tool kit which will enable them to apply their knowledge and skills to real world tasks.

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Estimate unknown parameters of a given probability distribution using different methods of estimation.
CLO2	Explain in detail and demonstrate approaches to include a measure of accuracy for estimation procedures and our confidence in them by examining the area of interval estimation.
CLO3	Organize the theoretical underpinnings of tests for both simple and composite hypotheses conceptually.
CLO4	Recognize the general trends in statistical inference and apply this knowledge to make well-informed decisions when performing data analysis.

Mapping between PLOs and CLOs of Statistics program

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Point Estimation:** Principle of Point Estimation, Methods of Finding Estimators: Maximum Likelihood Estimation, Method of Moments, Method of Minimumχ^2, Method of Least Squares, Method of Minimum Distance. Properties of Estimators: Closeness, Unbiasedness, Consistency, Fisher's Consistency, Sufficiency, Efficiency, Minimal sufficient statistics, Complete statistics. Pitman Closer and Closest Estimator, Mean Squared Error, Loss Function, Risk Function. Minimax Estimator, Admissible Estimator, Correction for Bias, Consistent Asymptotically Normal (CAN) Estimators, Best Asymptotically Normal (BAN) Estimators, MVUE, Cramer-Rao Lower Bound, Completeness, Rao-Blackwell Theorem, Lehman-Scheffe Theorem.	**Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical**	**Assignments, Class Tests, Presentation, Attendance and Final Examination.**	**15**
CLO2	**Interval Estimation:** Concept of Confidence Interval, Method of Finding Confidence Intervals: Pivotal Quantity Method and Statistical Method, Confidence Interval for Mean, Variance. Simultaneous confidence region for the mean and variance, confidence interval for difference in means.			**5**
CLO3	**Test of Hypothesis:** Simple hypothesis, Composite Hypothesis, Critical region, Best Critical Region, Two-sided BCR, Steps of Hypothesis Testing, *p*-value, Power of test, Power Function. Test of Mean, Variance, Proportion, Correlation, Regression Coefficients, Test of Homogeneity in Parallel Samples.			**10**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy

CLO1	Classroom Discussion and interactive learning	Quiz, Mid Term, and Summative assessment
CLO2	Problem-solving activities and Collaborative learning spaces	Mid Term, Assignment, Presentation and Summative assessment
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Summative assessment
CLO4	Lecture, Group discussion and Slide Show	Summative assessment

Text Book

1. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill, New York.

Reference Books

1. Hogg, R.V. and Craig, A. T (2009)*: Introduction to Mathematical Statistics,* 6th edition, Pearson Education, Singapore.
2. Kendall, M.G. and Stuart, A. (2004): *Advanced Theory of Statistics*, 14th edition, Edward Arnold, New York.
3. Cassela, G. and Berger, R. L. (2001): Statistical Inference, Wadsworth Publishing Company, California.

Course Code:0542-222(Stat-222) Course Title: Regression Analysis
Marks:100 Credits: 03 Number of Class: 42

Rationale:
This course investigates the purposes, methods, applications of regression and its generalizations.

Objectives:
The objectives of this course are to:

- Develop a deeper understanding of the linear regression model and its limitations
- Acquaint students with Least Square methods and concept of linear regression, and its applications.
- Specify assumptions, formulate and estimate appropriate models, interpret the results and test their statistical significance.
- Understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model.
- Know how to diagnose and apply corrections to some problems in regression.

Learning Outcomes:

At the end of this, students should be able to

CLO1	Establish presumptions, create and estimate suitable models, analyze the outcomes, and determine the statistical significance of the findings.
CLO2	Recognize and address some of the issues with the linear model that arise when working with real data.
CLO3	Possess the ability to comprehend a dummy variable's meaning and relevance.
CLO4	Construct non-linear and polynomial regression models.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3			1	2	1	
CLO2	1		1	1		1		
CLO3	2			1			1	
CLO4		1				2	3	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Introduction:** Meaning, Dependent and Independent Variables, Distinction Between Correlation and Regression, Uses and Importance of Regression Analysis, Regression Model, Population Regression Line, Sample Regression Line, Types of Regression Analysis.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**6**
CLO1 CLO2	**Multiple Linear Regression:** Multiple Regression Model, Regression Model in Matrix Notation, Model Assumptions, Estimation of Model Parameters by Ordinary Least Square (OLS) Method, Properties of OLS Estimators, Goodness of Fit: R^2, CP			**11**

	AIC, BIC, SIC and Model Selection Criteria. Inference about Regression Parameters, Confidence Interval, Prediction and Prediction Interval.			
CLO1	**Validity of Assumptions and Examination of Residuals:** Overall Plot, Time Sequence Plot, Plot Against Regression Equation, Plot against Predictor Variables, Other Residual Plots, Statistics for Examination of Residuals, Correlations among Residuals, Outliers.			**6**
CLO1 CLO2	**Selection of Best Regression Equation:** All Possible Regression, Best Set of Regression, Backward Elimination Procedure, Stepwise Regression Procedure.			**6**
CLO1 CLO3	**Dummy Variables:** Meaning nature of dummy variables, regression on different combination of quantitative and qualitative variables, comparing two regressions by dummy variables, comparison with chow test.			**6**
CLO1 CLO4	**Polynomial and Non-linear Regression:** Difference Between Linear and Non-linear Regression , Polynomial Regression Models, Orthogonal Polynomials, Different Types of Non-Linear Regression and their Estimation Process.			**6**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Problem-solving activities.	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Montgomery, D. C., Peck, E. and Vining, G.G. (2003): *An Introduction to Linear Regression Analysis*, 3rd edition, Wiley, New York.

Reference Books

1. Draper, N.R. and Smith, H. (1998): Applied Regression Analysis, 3rd edition, John Wiley and Sons, New York.
2. Gujarati, D. (2003): *Basic Econometrics*, 4th edition, McGraw-Hill, New York.

Course Code:0541-223(Stat-223) Course Title: Real Analysis
Marks:100 Credits: 03Number of Class: 42

Rationale:

To expose the students to the basics of real analysis and complex variables for their subsequent course work. It is the part of the essential foundation for advanced study in many areas of pure and applied mathematics.

Objectives:

The objectives of this course are to:

- Define the real numbers, least upper bounds, and the triangle inequality.
- Define the limit of a function at a value, a limit of a sequence, and the Cauchy criterion
- Describe continuity of a function and uniform continuity of a function
- Recognize alternating, convergent, conditionally and absolutely convergent series. prove various theorems about the derivatives of functions and emphasize the proofs' development
- Prove the Rolle's theorem, extreme value theorem, and the Mean Value theorem and emphasize the proofs' development
- Define Riemann integrable and Riemann sums and prove various theorems about Riemann sums and Riemann integrals and emphasize the proofs' development.

Learning Outcomes:

By the end of the course, students should be able to

CLO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis and comprehend rigorous arguments developing the theory underpinning real analysis;
CLO2	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration;
CLO3	Determine several representations of complex number and calculate the limit of a sequence and a complex function;

CLO4	Compute fundamental functions of one complex variable and calculate the complex integral along the path;
CLO5	Find out complex derivative and a formal derivative and apply Cauchy theorem and Cauchy formula.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2					
CLO2		2					2	
CLO3	2			1			2	
CLO4	2						2	
CLO5	2	2			2			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Series:** Function and Real Valued Function. Open set, Dense Set, Countability, Compact, Connected sets, Monotonic Class of Sets and Additive Class of Sets. Convergence Principle, Convergence and Absolute Convergence of Series.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	Comparison Test, Ratio Test, Root test and Integral Test. Rearrangement of Absolute Convergent Series, Cauchy's Convergence, Multiplication of Absolutely Convergent Series.			5
CLO3	**Real Functions:** Continuity, Uniform Continuity, Properties of Continuous Functions, the Exponential, Logarithmic, Trigonometric Functions, Rolle's Theorem,			4
CLO3	Mean Value Theorems, Cauchy's Mean Value Theorem, Taylor's Theorem with Lagrange's and Cauchy's form of the Remainder.			10

CLO4	**Riemann Integral:** The Existence of the Riemann Integral of a Continuous Function, Simple Properties, First and Second Mean Value Theorem;			10
CLO5	Convergence and Absolutely Convergence of Improper and Infinite integrals, Sequences and Series of Functions, Uniform convergence, Comparison Test, Term by Term Integration and Differentiation.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Problem-solving activities.	Assignment and Presentation
CLO3	Lecture and Reflective Discussion	Summative Measure (Midterm Exam.)
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO5	Lecture and Discussion	Summative Measure (Final Exam.)

Text Book

1. Rudin, W (1976): *Real Analysis, Academic Press*, New York.

Reference Books

1. Apostol, T. (1992): *Mathematical Analysis*, McGraw Hill, New York.
2. Binmore, G.H. (1965): *Foundation of Analysis*, Books I & II, C.U.P., London
3. Burkill, J.C. (1962): *A First Course in Mathematical Analysis*, C.U.P., London

Course Code: 0542-224(Stat-224) Course Title: Introductory Demography
Marks:100 Credits: 03 Number of Class: 42

Rationale:

Demography or population studies tackle questions surrounding the structure and dynamics of populations. It is concerned with life events of individuals: birth, marriage, migration and death. Introductory demography is designed to make the students oriented with the concept of vital statistics and to be used in courses at advanced level.

Objectives:

The objectives of this course are to:

- Acquaint students with the basic tools of vital statistics.
- Help them conceptualize basic demographic measures.
- Develop skills to analyze fertility and reproduction, mortality and graduation.
- Construct life table and analyze different types of life table.
- Make the students to understand about marriage and Nuptiality.

- Gather knowledge about migration and urbanization.

Learning Outcomes: After completing this course students will able to

CLO1	Gather basic knowledge regarding concepts of vital statistics and their uses and interpolation;
CLO2	Find out the sources of demographic data and method of data collections;
CLO3	Demonstrate rates, ratio, and population growth and population projection;
CLO4	Analyze fertility and reproduction of population;
CLO5	Construct life table and interpret the life table.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	1	2	1	2	2	
CLO2	2		1	1				
CLO3	3	2	2	3		2	1	
CLO4	2	2		1		1	2	
CLO5		2	2		2	2		1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	**Introduction:** Concepts of Vital Statistics and their Uses and Interpretation, Census, Vital Registration, Sample Survey, Meaning of Demography, Nature and Scope of Demography. Sources of Demographic Data, Methods of Data Collection, Concepts of De Facto and De Jure Census.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2 CLO3	**Demographic Measures:** Rates of Vital Events, Concept of Population Change, Population Growth, Measurement of Population Growth, World Population Growth, Population Projection.			6
CLO4 CLO3	**Marriage and Nuptiality:** Concept of Marriage and Nuptiality, Family Formations, Composition and Dissolution; Estimation of Mean and Median age at			10

	Marriage, Estimation of Singulate Mean age at Marriage. **Migration and Urbanization:** Concepts of Migration, Types and Measures of Migration, Consequences, Determinant's and Trends of Migration, Logistic Curve, Fitting the Curve by Different Methods, Urbanization and Measures of Urbanization			
CLO3	**Mortality and Graduation:** Concepts of Mortality and Morbidity, Measures of Mortality, Trends of Mortality, Differentials, Mortality, Direct and Indirect Standardization of Morbidity Rates, Graduation of Population Data, Graduation of Mortality Rates, Make ham's Graduation formula.			8
CLO4	**Fertility and Reproduction:** Concept of Fertility, Reproduction, Causes of Low and High Fertility, Measurements of Fertility and Reproduction, Fertility, Trends and Differentials, Standardization and Decomposition of Fertility Rate.			8
CLO5	**Life Table:** Concept of Life Table, Types of Life Table, Functions of a Life Table and Relationship Between Life Table Columns, Construction of a Life Table, Application of Life Tables, Forces of Mortality.			7

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Student Activity	Quiz and Assignment,
CLO2	Lecture and Discussion	Assignment and presentation
CLO3	Group Discussion	Mid-Semester Summative Exam
CLO4	Discussion and Slide Show	Summative (Final Exam.)
CLO5	Learning Contracts	Summative (Final Exam.)

Text Book

1. Shryock, H. S., J. S. Siegel and Associates (2004): *The Methods and Materials of Demography*; Latest edition, Academic Press, N.Y.

Reference Books

1.Barclay, J. (2007): *Techniques of Population Analysis*, Wiley, New York.

2. Biswas, S. (1988): *Stochastic Process in Demography and Applications*, Wiley Eastern, New Delhi.

Course Code:0542- 225(Stat-225) Course Title: SPSS, STATA and SAS
Marks:100 Credits: 03 Number of Class: 42
(LAB)

Group A (SPSS); Marks 35

Rationale

This course introduces students to SPSS (Statistical Package for the Social Sciences) — one of the most widely used software for data analysis in the social sciences, business, and applied research. Students will learn how to enter, manipulate, and analyze data using SPSS commands, syntax, and its graphical user interface. Emphasis is placed on developing both conceptual and practical understanding of data management and statistical procedures.

Course Objectives

- Understand the basic concepts, interface, and commands of SPSS.
- Learn data entry, variable definition, transformation, and file management using SPSS syntax.
- Perform descriptive and inferential statistical analysis using SPSS.
- Develop competence in interpreting SPSS output for decision-making and research.

Course Learning Outcomes (CLOs)

After completing this course, students will be able to:

CLOs	Course Learning Outcome	Cognitive Domain (Bloom's Taxonomy)
CLO1	Apply SPSS software to define variables, enter data, and execute commands for data manipulation and transformation.	Apply
CLO2	Demonstrate understanding of SPSS syntax, command structure, and data file operations.	Understand
CLO3	Perform descriptive and inferential statistical analyses (t-test, correlation, regression, ANOVA, chi-square) using SPSS.	Analyze

Mapping Between CLOs and Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1			1
CLO2		2	3			2	2	1
CLO3	2	2	2	1	2	3	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	Introduction to SPSS, Meaning and Features, Concepts of Commands and Syntax Diagram, Running Commands in Interactive and Batch Modes, Sub-commands, Keywords, Values and String Values in Command Specifications, Command Order and Operation Commands.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	6
CLO2	Data Definition and Manipulation Commands, File Management in SPSS, Reading and Writing Data, Exporting and Importing Files, Merging and Combining Datasets, Updating and Transforming Data.			8
CLO3	Statistical Analysis Commands and Procedures: Descriptive Statistics, Correlation, Regression, T-test, ANOVA, Chi-square, Non-parametric Tests, Graphical Representation, Interpretation of Output.			10

Mapping of CLOs with Teaching–Learning and Assessment Strategies

CLOs	Teaching–Learning Strategy	Assessment Strategy
CLO1	Interactive Lecture, Demonstration, Practical Exercises	Assignment, Quiz
CLO2	Collaborative Problem Solving, Hands-on Lab Work	Viva Voce, Class Test
CLO3	Case Study, Data Analysis Projects, Reflective Discussion	Lab Performance, Final Examination

Learning Resources

Textbook:

1. Nie, N.H., Bent, D.H., & Hull, C.H. (2011). *SPSS: Statistical Package for the Social Sciences*. McGraw-Hill.
2. Field, A. (2017). *Discovering Statistics Using IBM SPSS Statistics* (5th Ed.). SAGE Publications.

Additional Resources:

- IBM SPSS Documentation and Tutorials
- Online datasets for practice

Group B (STATA); Marks 35

Rationale

This course introduces STATA, a powerful statistical software used for data management, statistical analysis, and graphical representation. Students will gain hands-on experience in importing, cleaning, transforming, and analyzing data using STATA's command interface and menus. The course also covers matrix operations and solving statistical problems through programming commands, preparing students for advanced analytical and research tasks.

Objectives

- Understand the STATA interface, environment, and core commands.
- Learn how to import, clean, and manage datasets efficiently using STATA.
- Apply STATA commands for descriptive, inferential, and matrix-based statistical operations.
- Develop the ability to automate statistical analysis using STATA syntax and do-files.

Course Learning Outcomes (CLOs)

CLO Code	Course Learning Outcome	Cognitive Domain (Bloom's Taxonomy)
CLO1	Demonstrate understanding of STATA interface, windows, and data management tools for importing, exporting, and cleaning data.	Understand
CLO2	Apply STATA commands for variable manipulation, data transformation, and management of datasets.	Apply
CLO3	Perform statistical and matrix operations (vector algebra, probability distributions, equation solving) using STATA.	Analyze

Mapping Between CLOs and Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1			1
CLO2		2	3			2	2	1
CLO3	2	2	2	1	2	3	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	Overview of STATA; Concept of different windows (Command, Results, Variables, Review, Do-file Editor); Importing and exporting data; Converting data formats using Stat Transfer; Data entry, cleaning, and storage.	Interactive Class, Open Discussion, Participatory Q/A Session,	Assignments, Class Tests, Presentation, Attendance and Final	6

CLO2	Data management: imputing, editing, creating, and changing variables; Saving, reusing, and reorganizing data; Data merging, appending, reshaping, and transformation; Use of basic STATA commands and automation with do-files.			8
CLO3	Probability distributions in STATA; Vector and matrix operations (transpose, addition, subtraction, multiplication, inversion); Solving simultaneous equations; Application to statistical models and data analysis.			10

Mapping of CLOs with Teaching–Learning and Assessment Strategies

CLOs	Teaching–Learning Strategy	Assessment Strategy
CLO1	Interactive Lecture, Demonstration, Hands-on Lab Work	Assignment, Quiz
CLO2	Problem-Solving Practice, Collaborative Learning	Viva Voce, Class Test
CLO3	Case Study, Analytical Project Work, Reflective Discussion	Lab Performance, Final Exam

Textbooks:

1. Kohler, U., & Kreuter, F. (2012). *Data Analysis Using Stata* (3rd Ed.). Stata Press.
2. A cock, A. C. (2018). *A Gentle Introduction to Stata* (6th Ed.). Stata Corp LP.

Group C (SAS); Marks 30

Rationale:

This course introduce two statistical package SPSS and STATA for data analysis and programming language SAS is also introduce for reading and writing data from program.

Objectives:

The primary objective of the course is to

- Learn basic data analysis with SAS.
- Learn how to enter data, define variables, and perform variable manipulation and transformation as well as analyze the data using SAS.
- Perform Statistical Analysis Using SAS

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Apply SAS software in the following sections areas: Manipulate variables, transform data for analysis, Recode and compute variables, Describe data

CLO2	Recognize the fundamentals of selecting and executing simple statistical tests.
CLO3	Solve different statistical problems such as, Correlation, Regression, T-test,ANOVA, Chi-square, and Non-parametric alternatives using strata.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1			1
CLO2		2	3			2	2	1
CLO3	2	2	2	1	2	3	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Overview, List Directed and Column Input, Pointers and Formats, Reading Structured and Unstructured Data Format List. Reading and Writing Raw and System Files, Reading and Writing Data from Program and ASCII Data from External File, File Options, Writing Data to External File, Creating and Reading Permanent SAS Data Set, Working with Large Data Sets Problems.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	7
CLO2	Reading Data from Different Formatted Data Files, Converting Different Database Formatted Files to SAS System Files. Data Set Sub-setting, Concatenating, Merging and Updating Sub-setting, Combining Different Data from Multiple Files, Table Look Up, and Updating Master File form Update File.			8

CLO3	Use of Array for Missing Values to Create New Variables, Transformation of Data Set, Temporary Arrays, Multidimensional Arrays. Use Sas Syntax for graphical representation, interlocutory statistics and bivariate statistics.			9

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and interactive learning	Lab Assessment
CLO2	Problem-solving activities and Collaborative learning spaces	Viva-Voce
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Lab Performance (Summative Examination)

Text Book

1. Delwiche, L. D. and S. J. Slaughter (2003): The Little SAS Book: SAS Institute Inc., Cary, NC, USA

Course Code: 0542-226 (Stat-226) **Course Title: Data Analysis- III**

Marks: 50 **Credits: 02** **Number of Class: 28**

Group A (Regression Analysis): Marks 25

Rationale

This course focuses on building a greater understanding, theoretical underpinning, and tools for applying the linear regression model and its generalizations.

Objectives

The objectives of this course are to:

- Estimate the regression parameter by using appropriate methods and fit a regression line.
- Use different model selection criteria to choose appropriate model.
- Test the significance of regression coefficients and then find confidence interval for these coefficients.
- Detect outliers by using appropriate methods.

Learning Outcomes:

After successful completion of this course students will be able to-

CLO1	Fit a regression line after estimating parameter and then interpret the results perfectly
CLO2	Predict future value by using the fitted model
CLO3	Choose appropriate model by using different model selection criteria.
CLO4	Determine significant regression coefficient and find the confidence interval for this coefficient.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	3		3	2	3	
CLO2	3	2	3		3	2	3	
CLO3	3	2	3		3	2	3	
CLO4	3	2	3		3	2	3	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Estimate the Regression Model, Construction of Fitted Line, Calculation of Coefficient of Determination, Correlation Coefficient, Different Model Selection Criteria.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	25
CLO4	Test of Significance of Regression Coefficients, Confidence Interval for Regression Coefficients, and Detection of Outliers by Different Methods.			14

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion, Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO2	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO4	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text book

1. Montgomery, D. C., Peck, E. and Vining, G.G. (2003): *An Introduction to Linear Regression Analysis*, 3rd edition, Wiley, New York.

Group B (Statistical Inference-I): 15 Marks

Rationale

The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in statistical research.

Objectives

The objectives of this course are to:

- Estimate the point and interval for parameter.
- Estimate the point and interval by any parametric method.

- Test the hypothesis concerning distribution.

Learning Outcomes:

After successful completion of this course students will be able to-

CLO1	Estimate different point estimators such as (MVUE,BAN,CAN etc)Statistics.
CLO2	Find out the interval estimation by any method.
CLO3	Test the different testing approach.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	-	-	2	1	-
CLO2	2	3	-	2	-	-	2	-
CLO3	3	1	2	-	-	-	-	-

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Point Estimation:** Properties of Estimators: Closeness, Unbiasedness, Consistency, Fisher's Consistency, Sufficiency, Efficiency, Pitman Closer and Closest Estimator, Mean Squared Error, Loss Function, Risk Function. Minimax Estimator, Admissible Estimator, Correction for Bias, Consistent Asymptotically Normal (CAN) Estimators, Best Asymptotically Normal (BAN) Estimators, MVUE, Cramer-Rao Lower Bound, Completeness, Rao-Blackwell Theorem, Lehman-Scheffe Theorem.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	7
CLO2	**Interval Estimation:** Concept of Confidence Interval, Method of Finding Confidence Intervals: Pivotal Quantity Method and Statistical Method, Confidence Interval for Mean, Variance.			8
CLO3	**Test of Hypothesis:** Simple hypothesis, Composite Hypothesis, Critical region, Best Critical Region, Two-sided BCR, Steps of Hypothesis Testing, *p*-value, Test of Mean, Variance, Proportion, Correlation, Regression Coefficients, Test of Homogeneity in Parallel Samples.			9

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Classroom Discussion and interactive learning	Quiz, Mid Term, and Summative assessment
CLO1	Problem-solving activities and Collaborative learning spaces	Mid Term, Assignment, Presentation and Summative assessment
CLO2	Lecture, Current events quizzes, and Reflective Discussion	Summative assessment
CLO3	Lecture, Group discussion and Slide Show	Summative assessment

Text book

Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): Introduction to the Theory of Statistics, 3rd edition, McGraw-Hill, New York.

Group C (Introductory Demography): 10 Marks

Rationale:

To introduce students to the core demographic methods and to provide practical experience using such methods.

Objectives:

The objectives of this course are to:

- Present Demographic Data by Graphs and Charts
- Know the computation procedure of different rates and ratios (such as, Growth Rates, TFR, GRR, NRR, ASFR etc.) of demographic data
- Construct life table and analyze different types of life table.
- Project population by using appropriate methods

Learning Outcomes:

CLO1	Identify principal sources of demographic data and assess their strengths and weaknesses
CLO2	Calculate different rates and ratios and then interpret the results in a perfect way
CLO3	Identify the components of population change, including the effects of changing birth, death and migration rates.
CLO4	Construct and interpret different life tables.

Mapping between PLOs and CLOs of Statistics program:

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2		1	5			
CLO2		2	3		2			2
CLO3				2			2	1
CLO4	3	1	1		1			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Presentation of Population and Demographic Data by Graphs and	Interactive	Lab Perform	14

	Charts, Computations of Population Change and Growth Rates, Analysis of Marital Status Distribution, Marriage and Divorce Rates, Computation of Different Measures of Fertility and Reproduction from Vital Registration and Census Data (such as CWR, CBR, ASFR, ASMFR, TFR, GFR, GRR, NRR and PPR),			
CLO3 CLO4	Computation of Different Measures of Mortality CDR, ASMR, IMR, Neonatal, Prenatal Death Rates, Standardization of Birth, Death, Marriage and Divorce Rates, Construction of Complete and Abridged Life Tables by different Methods, Computation of Migration Rates, Estimates of Migration by Survival Methods, Population Estimates and Projection using Mathematical Methods			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Lecturing and Classroom Discussion	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Lecturing and Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO4	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book

1. Barclay, J.: *Techniques of Population Analysis*, Wiley, New York.
2. Shryock, H. S., J. S. Siegel and Associates (2004): *The Methods and Materials of Demography*; Latest edition, Academic Press, N.Y.

Viva-Voce **Marks:50** **Credits: 1.5**

Course Code: 0542-311(Stat-311) Course Title: Stochastic Process
Marks:100 Credits: 03 Number of Class: 42

Rationale:
The course is designed to equip students with theoretical knowledge and practical skills, which are necessary for the analysis of stochastic dynamic systems in economics, engineering and other fields.

Objectives:

The objectives of this course are to:

- Develop and analyze probability models that capture the salient features of the system under study.
- Identify appropriate stochastic process model(s) for a given research or applied problem.
- Predict the short- and long-term effects that this randomness will have on the systems under consideration.
- Present Markov chain models, martingale theory, and some basic presentation of Brownian motion, as well as diffusion and jump processes.
- Discuss the convergence stability analysis of (discrete generation) Markov chains. The course will also be illustrated with a variety of applications.

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	State the defining properties of various stochastic process models.
CLO2	Sample on a computer any type of continuous or discrete time stochastic process.
CLO3	Identify appropriate stochastic process model(s) for a given research or applied problem.
CLO4	Provide logical and coherent proofs of important theoretic results.
CLO5	Solve Random Walk and Ruin Problem.
CLO6	Apply the theory to model real phenomena and answer some questions in applied sciences.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8

CLO1	2	2	2	1	-	-	-	1
CLO2	3	2	2	1	2	-	-	-
CLO3	3	3	-		2	-	1	-
CLO4	2	3	2	2	3	3	1	-
CLO5	3	3	2	-	-	2	2	-
CLO6	3	3	2	2	-	2	2	-

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Stochastic Process:** Concept, definition, state space, parameter space, classification of stochastic process. **Markov Chain:** Concept, definition, conditional probability, transition probability function, one and n-step transition probability, Higher transition probabilities, classification of states and chains, properties of communication of states, Chapman Kolmogorov equations, first entrance decomposition formula.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2	**Counting Process:** Counting process, Poisson process, stationary and independent increment, arrival and waiting time distribution, conditional distribution of inter-arrival time, compound poison process.			5
CLO3	**Random Walk and Ruin Problem:** The classical ruin problem, probability of ruin, effect of change of state, expected duration of the game, expected game. **Markov Process:** Pure birth process, pure death process, birth and death Processes.			4
CLO4	**Renewal Theory**: Renewal event, recurrent event, delayed recurrent event, Renewal Process, Distribution of N(t), Limit Theorems and its application, Renewal reward process, Regenerative Process, Cyclic Renewal, alternative renewal process, branching process.			10

CLO5	**Random Walk and Ruin Problem:** The classical ruin problem, probability of ruin, effect of change of state, expected duration of the game, expected game.			10
CLO6	**Queuing theory:** Concept of queue, characteristics of queuing system, steady state probabilities, exponential queuing models, tandem or sequential system, M/G/I system, Erlang's loss system, M/M/K queue system, distribution of queuing and waiting time.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and interactive learning	Quiz and Assignment,
CLO2	Problem-solving activities and Collaborative learning spaces	Assignment, Quiz and Summative assessment
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Mid-Semester and Summative assessment
CLO4	Lecture, Group discussion and Slide Show	Mid-Semester and Summative assessment
CLO5	Lecture and Student Activity	Summative assessment
CLO6	Lecture and discussion	Summative assessment and Assignment

Text Book

1. Ross, S. M.: *Introduction to Probability Models*, 9th edition, Academic Press.
2. Bhat, U.N. (1981): *Elements of Applied Stochastic Processes*, 2nd Edition, Wiley, New York.

Reference Books:

1. Mehedi, J, (1994): *Stochastic Process*, 2nd Ed, Wiley Eastern Ltd, New Delhi.
2. Barlett, M.S: *An Introduction To Stochastic Process*,5th Ed.
3. Cox, D.R. and Miller, H.D: *Theory of Stochastic Process, Vol. I and II,* Wiley Easter, New Delhi.

Course Code: 0542-312(Stat-312) Course Title: Design of Experiment-I
Marks:100 Credits: 03 Number of Class: 42

Rationale:
This course is designed to introduce the students with basic concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models.

Objectives:
The objectives of this course are to:

- Discuss why we do experiments and identify the steps to follow when conducting an experiment
- Understand the importance of statistical design of experiments and benefits in different field.
- Teach the students how to verify the hypothesis in an efficient way.
- Explore the method of analysis of variance and show how it is structurally linked to particular types of design.
- Introduce the logic, application, and interpretation of analysis of variance (ANOVA) models.
- Give idea about missing value & learn how to deal with different designs if there exists any missing value in the data.

Course Learning Outcomes: At the end of this course students will be able to

CLO1	Define key terms associated with Design of Experiments, explain how to conduct a well-designed statistical experiment and describe the basic principles behind design of experiment.
CLO2	Compare the different types of formal experimental designs (e.g. completely randomized, randomized block, Latin square designs).and explain the advantages and disadvantages of each. Construct the design matrix for simple experiments and estimate their parameters.
CLO3	Perform an analysis of variance (ANOVA) on standard experimental designs and distinguish between different designs and recognize their efficiency.
CLO4	Handle various designs when there are data missing values.
CLO5	Construct the random effects and mixed effects model.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			2	1	1	1	
CLO2	2	1		2	1			

CLO3	2		1			1		
CLO4	2				1			
CLO5	2				1	1		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Basic Concept:** Some Basic Definitions, Basic Principles of Experimental Design, Requirements of a Good Experiment, Analysis of Variance, Linear Statistical Model, Parametric Function, Contrasts, Analysis of Variance on One-Way Classification, Two-way Classification with one Observation Per Cell, Two-way (cross) Classification With Multiple but Equal Number of Observations Per Cell, Three-way Classification With single Observation Per Cell, Three-way (cross) Classification With Multiple but Equal Number of Observations Per Cell. Steps Involved in an Experiment, General Rules for degrees of freedom and Expected Mean Squares.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	10
CLO2 CLO3	**Basic Design:** Introduction, Completely Randomized Design, Randomized Block Design, Latin Square Design, Orthogonal Latin Squares, Non-orthogonal Two-way Classifications.			12
CLO4	**Orthogonally of Design and Missing Values:** Introduction, Missing Data in Randomized Block Design, Missing Data in Latin Square Design.			8
CLO5	**Variance Component Analysis**: Method of Variance Component Analysis, Variance Component Analysis in One Way, Two Way and Three-Way Classified Data.			8

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Student Activity	Quiz and Assignment,
CLO2	Lecture and Discussion	Assignment, Quiz and Summative Exam
CLO3	Lecture and Group Discussion	Mid-Semester and Summative Exam
CLO4	Discussion and Slide Show	Mid-Semester and Summative Exam
CLO5	Lecture and Discussion	Summative Exam

Text Book

1. Montgomery D. C. (2019): *Design and Analysis of Experiments*, 10th edition, Wiley, USA.

Reference Books

1. Das, M. N. and N. C. Giri (2019): *Design and Analysis of Experiments*, 3rd Edition, Wiley Eastern, India.
2. Bhuiyan, M. R.: *Experimental Design*, 2nd Edition (2007), Mullick& Brothers.
3. Cochran, W.G. and Cox, G.M. (2000): *Experimental Design*, 2nd Edition, Wiley, New York.

Course Code: 0542-313(Stat-313) Course Title: Time Series Analysis and Forecasting

Marks: 100 Credits: 03 Number of Class: 42

Rationale:

This course introduces a variety of statistical models for time series and covers the main methods for analyzing these models. This also highlights the usefulness of theoretical time series techniques for understanding data patterns and explores dynamic causal linkages.

Objectives:

The objectives of this course are to:

- Define and explain terminology used to describe time series, including trend, seasonal effects, cyclical effects, outlier and white noise
- Identify, estimate and conduct inferences in time series models
- Investigate historical development.
- Forecast future development,
- Test an economic theory.

- Give an introduction in the statistical modeling and prediction of economic and financial time series.

Learning Outcomes:

CLO1	Recognize the fundamental concepts of forecasting and time series analysis.
CLO2	Utilize time series analysis to keep up with applied economics literature.
CLO4	Apply the most popular methods to practical forecasting issues
CLO5	Utilize time series analysis to simulate financial volatility and conduct empirical tests of economic theory.
CLO6	Modeling non-stationary time series variables that evolve simultaneously over time.
CLO7	Estimate the theoretical properties of estimators and test statistics involving time series models.

Mapping between PLOs and CLOs of Statistics program:

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2	1	1	3	2		2	2
CLO2	2	2		2				
CLO3	1		3		3		2	
CLO4	1			2		2	2	
CLO5			2		2			
CLO6	1	2				1	1	
CLO7	3	3		1			1	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO6	**Introduction:** Meaning and objectives of Time series, the different component of time series, measurement of secular trend, seasonal, cyclical and irregular component, elimination of the seasonal, cyclical and irregular components, simple time series models, stationary models,	Interactive Class, Open Discussion, Participatory Q/A Session	Assignments, Class Tests, Presentation, Attendance and Final	4

CLO6 CLO7	**Stationary Processes:** Basic properties, linear processes, ARMA processes, properties of sample mean and autocorrelation function, forecasting stationary time series, world Decomposition problems.			6
CLO4	**ARMA Models:** ARMA (p,q) process, ACF and PACF of ARMA (p, q) process, Preliminary estimation, maximum likelihood estimation, diagnostic checking, forecasting order selection, problems.			6
CLO2 CLO7	**Spectral Analysis**: Spectral Densities, periodogram, time invariant linear filters, spectral density of ARMA process problems. **Non-Stationary and Seasonal time Series Models**: ARIMA models for non-Stationary time Series, identification techniques, unit roots in time series models, forecasting ARIMA models, seasonal ARIMA(SARIMA) models, regression with ARMA errors.			8
CLO4 CLO5 CLO7	**Multivariate Time Series:** Second order properties, mean and covariance function, multivariate ARAMA (MARMA) models, best linear predictors, modeling and forecasting with MAR or VAR Process. VAR Models, unit root models error correction model, cointegration analysis.			10
CLO1 CLO6 CLO7	**State-space Models**: State-space representation, basic structural mode, state-space representation of ARIMA models, Kalman recursions, estimation for state-space models, state-space models with missing observations, EM algorithm, generalized state-space models.			8

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term

CLO2	Classroom Discussion	Class Test, Mid Term, Quiz
CLO3	Classroom Discussion	Mid Term, Assignment, Quiz
CLO4	Lecture and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO5	Lecture and Re-view Discussion	Summative Measure (Final Exam.)
CLO6	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO7	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Brockwell,P. J. and Davis, R. A. (2002): *Introduction to Time Series and Forecasting*; Springer New York.

Reference Books

1. Box, G., Jenkins, G. M. and Reinsel, G. (2008): *Time Series Analysis: Forecasting and Control*, 3rd edition, Wiley, New York.
2. Gujrati,D. (2003): *Basic Econometrics* 4th Ed, McGraw-Hill, New York.
3. Montogomery, D.C, Johnston, L. A., Gardiner, J. S.:*Forecasting and Time Series Analysis* ,2nd Ed.

Course Code: 0311-314(Stat-314) Course Title: Econometrics-I
Marks:100 Credits: 03 Number of Class: 42

Rationale:
This course provides the methodology and statistical techniques to test empirically the validity of economic hypotheses and to construct models to explain the evolution of the economic environment.

Objectives:
The objectives of this course are to:

- Introduce regression analysis to students so that they are able to understand its applications in different fields in economics.
- Know the nature, scope and sources of econometric data.
- Know the assumption of classical linear regression model
- Understand the econometric modeling and model selection.

Learning Outcomes

After the end of the course, students will be able to:

CLO1	Specify assumptions, formulate and estimate appropriate models, interpret the results and test their statistical significance.
CLO2	Compare and validate different kinds of econometric model.
CLO3	Apply the econometrics techniques learnt during the course and present their results.

CLO4	Evaluate the structural equation models with different types of econometric and time series data.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3			3	3	3	1
CLO2	3		1		3			
CLO3	3		3	3	2	3	2	1
CLO4	3	2	2	1		2		1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Concept:** Meaning, economics and econometrics, types of Econometrics, nature, scope and sources of econometric data. **Multicollinearity:** Concept of multicollinearity, estimation in presence of multicollinearity, theoretical and different consequences of multicollinearity, Consequences of Micro numerosity, detection of multicollinearity, remedial measures of multicollinearity, Ridge Regression.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	4
CLO2	**Heteroscedasticity:** Meaning of heteroscedasticity, Ordinary Least Square(OLS) and Generalized Least Square (GLS) estimation in presence of heteroscedasticity, consequences of using ordinary least squares in presence of heteroscedasticity, detection of heteroscedasticity by both informal and formal methods, Graphical method, Park, Glejser, Spearman's rank correlation, Goldfield-Quandt, and Breusch-Pagan-Godfrey test of heteroscedasticity, Whites general			6

	heteroscedasticity test, remedial measures of heteroscedasticity.			
CLO3	**Autocorrelation:** Concept of autocorrelation, Specification bias, Cobweb phenomenon, Ordinary Least Squares estimators and best linear unbiased estimators, estimation in presence of autocorrelation, consequences of using ordinary least squares in presence of autocorrelation, detection of autocorrelation by graphical methods, run test, Durbin-Watson D-test, H-test asymptotic autocorrelation, remedial measures of autocorrelation for both known and unknown p, Ceohrance-Orcutt Iterative, Durbin's two step and EGLS methods of estimating p, OLS versus FGLS and HAC,concept of autoregressive conditional heteroscedasticity (ARCH) model, generalized ARCH (GARCH) model.			6
CLO4	**Econometric Modeling and Model Selection:** Average economic regression, methodology and specification errors, types of specification error,Detecting the presence of unnecessary variables, nature, consequences and remedies of specification errors, test of specification error, errors of measurement in dependent and explanatory variables, Monte-Carlo experiment of specification error, Different model selection criteria, Recursive Least squares: Chow prediction failure test.			8

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Quiz and presentation
CLO2	DIY activities	Assignment and Presentation
CLO3	Discussion and slide show	Practice by doing exercise, Summative (Midterm)
CLO4	Audio Visual Lecturing	Summative Measure (Final Exam.)

Text Book

1. Gujrati, D. (2019): *Basic Econometrics 6th*edition, McGraw-Hill, New York.

Reference Books

2. Greene, W.H. (2017): *Econometric Analysis*,8th Ed, Pearson Education
3. Desai, M. (1976): *Applied Econometrics*, Oxford Publication.
4. Kleim& Miller: An Introduction to Econometrics.

Course Code: 0714-315(Stat-315) Course Title: R and Python

Marks:100 Credits: 03 Number of Class: 42

(LAB)

R

Rationale:

R is statistical data analysis software. Sometimes it is very difficult to find the exact tools to analyze data in GUI based software, in that case both R is very handy, though in both software we can make our own function, tools, adds-in.

Objectives:

The objectives of this course are to:

- Understand the basic environment and operations of R.
- Apply R to solve statistical problems such as estimation, regression, and hypothesis testing.
- Develop basic programming skills using R and Python.
- Use R for practical data analysis and model interpretation.

Learning Outcomes:

After completing this course, a student will able to

CLO1	Acquire knowledge about the basic environment of R.
CLO2	Solve different statistical problem (Estimation, Regression, ANOVA, Hypothesis Testing) using R.
CLO3	Discover how to use packages and data series in the R environment.
CLO4	Estimate Regression, Hypothesis Testing, ANOVA, and Sampling) with R.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8

CLO1	3	3			3	3	3	1
CLO2	3	1	2				3	1
CLO3		3		2		1		
CLO4		3					1	2

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	**R:** Downloading and installing R, Simple R session with some basic commands, case-sensitivity, recall and correction of previous commands, assignments and expressions, simple manipulations of numbers, getting help on R, making list and data frames, attaching and detaching data frames. Executing commands from a file, diverting output to a file. Obtaining densities, cumulative probabilities, quartiles and random samples from different probability distributions. Conditional execution with if statement, repetitive execution with for, repeat and while statements. Writing R functions, Arguments and defaults, Assignments within functions, Returning multiple objects as output. Reading data from file, importing data from files created by other software.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	6
CLO2 CLO3	**Programming Basics and Strings:** Introduction, How Programming Is Different from Using a Computer Programming, The First Steps, and Starting code Editor, Using code Editor's Python Shell.			8
CLO3, CLO2	**Numbers and Operators:** Different Kinds of Numbers, Numbers in Python, Creating an Imaginary Number, Number Formats, Formatting Numbers as Octal and Hexadecimal.			10

	Variables: Names for Values, Referring to Data – Using Names for Data, Assigning Values to Names, Copying Data, Manipulating, Slicing, Retrieving data set.			
				8
CLO4, CLO2	**Applications of R in Statistics:** Basic statistical techniques, graphs, correlation and regression, estimation of parameters of multiple regression model, inference in multiple regression, partial correlation, multiple correlation and related tests, model selection, fitting polynomial regression, examination of residuals, outliers, influential points.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Lab Assessment
CLO2	DIY activities	Viva-Voce
CLO3	Lab Experiment	Lab Performance
CLO4	Lab Experiment	Lab Performance and final assessment

Text Book

1. Chambers, J.M. (2007): Software for data Analysis: Programming with R. Springer.

Python

Rationale

This course introduces students to Python programming — one of the most widely used languages for data analysis, scientific computing, and automation. Students will learn the fundamentals of Python syntax, data types, and programming structures. The course emphasizes developing a foundational understanding of programming logic, variable manipulation, and computational problem-solving skills essential for data science and statistical analysis.

Objectives

The objectives of this course are to:

- Install and configure Python and its integrated development environments (IDEs).
- Understand Python syntax, variables, and operators.
- Write and execute Python programs for data manipulation and basic computation.

- Develop programming logic and problem-solving skills relevant to data analysis.

Course Learning Outcomes (CLOs)

CLOs	Course Learning Outcome	Cognitive Domain (Bloom's Taxonomy)
CLO1	Install, configure, and use Python environments such as IPython and Jupyter Notebook for programming.	Understand
CLO2	Demonstrate programming skills in handling numbers, operators, and variables in Python.	Apply
CLO3	Write Python code to manipulate strings, slice datasets, and perform computational operations.	Analyze

Mapping Between CLOs and Program Learning Outcomes (PLOs)

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1			1
CLO2		2	3			2	2	1
CLO3	2	2	2	1	2	3	2	

Course Content, Teaching and Assessment Strategy

CLOs	**Course Content**	**Teaching Strategy**	**Assessment Strategy**	**No. of Lectures**
CLO1	Downloading and Installing Python; Introduction to Python, IPython (3.7.0), and Jupyter Notebook; Installing Python using PIP command; Working with code editors and Python shell.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	Programming Basics and Strings: Understanding code structure, writing first Python program, working with strings, string functions, and concatenation.			6
CLO3	Numbers and Operators: Number types, creating and manipulating numbers, using arithmetic and logical operators, number formatting (octal, hexadecimal); Variables: naming conventions, data referencing, slicing, assigning, copying, and manipulating variables.			9

Mapping of CLOs with Teaching–Learning and Assessment Strategies

CLOs	**Teaching–Learning Strategy**	**Assessment Strategy**
CLO1	Lecture demonstration, Hands-on practice	Quiz, Assignment
CLO2	Collaborative programming sessions, Code debugging practice	Class Test, Viva Voce

CLO3	Guided lab work, Mini coding projects, Reflective practice	Lab Performance, Final Exam

Textbooks:

1. Lutz, M. (2013). *Learning Python* (5th Ed.). O'Reilly Media.
2. Downey, A. (2015). *Think Python: How to Think Like a Computer Scientist* (2nd Ed.). Green Tea Press.

Additional Resources:

- Python official documentation: https://docs.python.org
- Tutorials on W3Schools and Geeks for Geeks.

Course Code: 0542-316(Stat-316) Course Title: Data Analysis- IV
Marks:50 Credits: 02 Number of Class: 28

Group A (Stochastic Process): 20 Marks

Rationale:

This course introduces the idea of a stochastic process, and to show how simple probability and matrix theory can be used to build this notion into a beautiful and useful piece of applied mathematic

Objectives:

The objectives of the course are to:

- Generate Markov chain, Transition probability matrix with real world phenomena.
- Develop Homogeneous and non-homogeneous Poisson process.
- Analyze of Queuing Theory and application of the theory to real-world problem.
- Test of Markov chain.
-

Learning Outcomes:

After successful completion of this course students will be able to-

CLO1	Gather knowledge of notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains.
CLO2	Estimate the long-time behavior including transience, recurrence, and equilibrium.
CLO3	Apply these ideas to answer basic questions in several applied situations including genetics, branching processes and random walks.
CLO 4	Embed queuing theory to real-world problem.

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Markov Chain, Transition Probability, Transition Probability Matrix, Probability Distribution. Limiting Distribution, Transition Graph, Chapman-Kolmogorov Equation, Classification of States and Chains,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination.	14
CLO3 CLO4	First Entrance Decomposition Formula, First Passage Time Distribution, Determination of Higher Transition Probabilities, Properties of Reducible and Irreducible Chains, Statistical Inference for Markov Chains, Homogeneous and No-homogenous Poisson Process, Markov Process, Renewal Theory and Different Queuing Systems.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Problem-solving activities.	Report and Summative Exam
CLO2	Lecture and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO3	Classroom Discussion and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO4	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book

1. Ross, S. M.: *Introduction to Probability Models*, 9th edition, Academic Press.
2. Bhat, U.N. (1981): *Elements of Applied Stochastic Processes*, 2nd Edition, Wiley, New York.

Group B (Design of Experiment-I): 30 Marks

Rationale:

This course is design to impart students a general view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.

Objectives:

The objectives of this course are to:

- Understand the issues and principles of Design of Experiments.
- Identify situations where one-way/two-way/three-way (fixed effects, mixed effects and random effects models) ANOVA is and is not appropriate.
- State the modeling assumptions underlying ANOVA and also state the null and alternative hypotheses for the ANOVA test.

Learning Outcomes:

After successful completion of this course students will be able to-

CLO1	Estimate one-way/two-way/three-way (fixed effects, mixed effects and random effects models) ANOVA.
CLO2	Test the appropriate hypothesis for the CRD, RBD, and LSD.
CLO3	Estimate missing cells in RBD and LSD.

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3		3	2		
CLO2	3	1		2	1		2	
CLO3	2	2	3	2		2	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Analysis of variance in one way, two way and three-way classification with equal number of observations per cell with fixed effects, mixed effects and random effects models, variance component analysis in one way, two way and three-way classified data, Introduction to CRD,	Interactive Class, Open Discussion, Participatory Q/A Session, Online	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**20**

	RBD and LSD; Missing data in RBD and LSD.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Problem-solving activities.	Report and Summative Exam
CLO2	Lecture and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO3	Classroom Discussion and Problem-solving activities.	Lab Performance, Report, Summative Exam

Text Book

1. Montgomery D. C. (2019): *Design and Analysis of Experiments*, 10th edition, Wiley, USA.

Course Code: 0542-317(Stat-317) Course Title: Data Analysis- V
Marks:50 Credits: 02 Number of Class: 28

Group A (Time Series Analysis and Forecasting): 20 Marks

Rationale:

This course will provide an introduction to time series models in common use and their use for predicting future observations and/or estimating unobservable components like trend, seasonal, cyclical and irregular effects.

Objectives:

The objectives of this course are to:

- Understand and be able to apply the concepts and methods underlying the analysis of univariate time series, and the context for interpretation of results
- Decompose a time series into trend, seasonal, cyclical and irregular components
- Use various time series model such as moving average (MA), weighted MA, exponential smoothing, AR, ARMA, ARIMA, SARIMA etc for forecasting univariate time series data
- Use multivariate time-series models such as vector auto regression (VAR) to analyze time series data

Learning Outcomes:

CLO1	Decompose a time series into trend, seasonal and irregular component
CLO2	Identify statistical models and techniques that are appropriate for a particular type of time series data
CLO3	Estimate and conduct inferences with time series models

Mapping between PLOs and CLOs of Statistics program

	PLO1	PLO2	PLO3	PLO4	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			2				2	
CLO2	3			1				2	
CLO3	1			1	2				

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Measurement of secular trend, seasonal, cyclical and irregular components, time series plot,	Interactive Class, Discussion, Open Participatory Q/A Online Session	Lab Performance, Lab Writing, Report Attendance and Final Examination	8
CLO2 CLO3	estimation and forecasting by moving average (MA), weighted MA, exponential smoothing, AR, ARMA, ARIMA, SARIMA etc.,			7

CLO3	correlogram analysis, spectral decomposition, VAR model, co integration analysis			9

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Lecturing and Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book:

1. Brockwell,P. J. and Davis, R. A. (2002): *Introduction to Time Series and Forecasting*; Springer New York.
2. Gujrati,D. (latest ed): *Basic Econometrics* 4th Ed, McGraw-Hill, New York.

Group B (Econometrics-I): 30 Marks

Rationale

This course is to introduce an appropriate alternative to ordinary least squares, when assumptions underlying the classical linear regression model are violated.

Objectives

The course objectives are

- To estimate a model in the presence of multicollinearity, heteroscedasticity and autocorrelation
- To test whether multicollinearity, heteroscedasticity and autocorrelation are arises in model.
- To use various remedial measures of multicollinearity, heteroscedasticity and autocorrelation
- To use Durbin H-test, Granger causality test for detecting autocorrelation

Learning Outcomes:

After successful completion of this course students will be able to-

CLO1	Detect multicollinearity, heteroscedasticity and autocorrelation in a model
CLO2	Estimate a model in the presence of multicollinearity, heteroscedasticity and autocorrelation
CLO3	Use various remedial measures of multicollinearity, heteroscedasticity and autocorrelation

Mapping between PLOs and CLOs of Statistics program

	PLO1	PLO2	PLO3	PLO4	PLO4	PLO5	PLO6	PLO7	PLO8

CLO1	3	3	2	1	-	-	2	-	-
CLO2	3	3	2	-	3	-	2	-	2
CLO3	2	2	1	2	-	2	1	-	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Estimation of models in presence of multicollinearity, heteroscedasticity, autocorrelation, tests.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination	5
CLO2 CLO3	Remedial measures of multicollinearity, heteroscedasticity, autocorrelation.			3
CLO3	Different procedures of model specification error, regression with dummy variables, probability models, estimation of different dynamic econometric models, detecting autocorrelation in autoregressive model by Durbin H-test, Granger causality test.			6

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture	Lab Assessment
CLO2	Lecturing and Problem-solving activities.	Viva-Voce
CLO3	Lab Experiment	Lab Performance

Text Book

1. Gujrati,D. (2019): *Basic Econometrics 6th* edition, McGraw-Hill, New York.

Course Code: 0542-321(Stat-321) Course Title: Statistical Inference-II
Marks:100 Credits: 03 Number of Class: 42

Rationale:
This course is designed to provide a strong mathematical and conceptual foundation in the methods of statistical inference. In the course theoretical foundations of the methods will be treated, their statistical properties will be studied and practical aspects for data analysis will be discussed.

Objectives:
The objectives of this course are to:

- Acquire knowledge and insight in concepts of advanced statistical inference.
- Help students to draw better statistical inferences from empirical research.
- Teach students to construct and interpret confidence interval estimates of the parameters of different parametric models.
- Teach students to examine whether the null hypothesis is true using equivalence testing and Bayesian statistics.
- Acquaint/Equip students with a statistical tool kit which will enable them to apply their knowledge and skills to real life situations.
- model by examining the area of hypothesis testing.

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	Acquire the knowledge of definitions, the theoretical properties and the proofs that were given for the studied methodologies.
CLO2	Apply the general concepts and methodology to particular situations (e.g. investigate a new general concept for a particular estimator).
CLO3	Apply the methods and techniques in R and can understand and interpret the output to draw the correct conclusions.
CLO4	Test the quality of estimators.
CLO5	Conduct appropriate methods of inference to tackle real problems.
CLO6	Implement various statistical inferential approaches.
CLO7	Evaluate the plausibility of pre-specified ideas about the parameters of the model by examining the area of hypothesis testing.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	-	-	2	1	-
CLO2	2	3	-	2	-	-	2	-
CLO3	3	1	2	-	-	-	-	-
CLO4	3	3	2	2	1	-	-	-
CLO5	3	2	2	-	-	2	1	-
CLO6	2	3	-	2	-	-	2	-

CLO7	3	1	2	-	-	-	-	-

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Point Estimation:** Minimum Variance Bound, Minimum Variance Unbiased Estimators, Uniformly Minimum Variance Unbiased Estimators, Ancillary Statistics, Minimal Sufficient Statistics, Minimax Estimator, Admissible Estimator, Selection of Conjugate Prior, Bhattacharyya Inequality, MRE Estimator, Shrinkage Estimator, James-Stein Estimator.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical Assignments, Class Tests, Presentation, Attendance and Final Examination.		3
CLO2	**Interval Estimation:** Confidence Intervals for Parameters of Binomial, Poisson, Normal Distribution and Exponential Distribution, Large Sample Confidence Interval, Neyman Classical Confidence Intervals.			5
CLO3	**Hypothesis Test:** Neyman-Pearson Lemma, most powerful test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased Test, Locally Uniformly Most Powerful Unbiased Test, Optimal Tests in Different Situations, Randomized Tests, Consistent Tests, Unbiased Tests, Similar Region. Likelihood Ratio Test, Distribution of LR Statistic, Asymptotic distribution of LR Statistic, LR test in linear model, Generalized Likelihood Ratio Tests, Monotone Likelihood Ratio Test, LM Test and Wald Test.			4
CLO4	**Bayesian Approach** **Point Estimation:** Concept of Bayesian Methods, Bayesian Approach to Estimation Theory, Prior and Posterior			10

	Distribution, Bayes Risk, Bayes Estimation, Posterior Bayes Estimator		
CLO5	**Interval Estimation:** Bayesian Interval Estimation, Credibility Interval. Large sample approximation.		10
CLO6	**Hypothesis Testing:** Bayesian Test of Hypothesis, Test of hypothesis concerning normal and exponential distribution in predictive approach. Bayesian treatment of linear model. Bayesian approach to contingency tables.		6
CLO7	Sequential Analysis, SPRT, Efficiency of SPRT, Fundamental Identity of Sequential Analysis, OC and ASN Function.		4

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and interactive learning	Quiz and Assignment,
CLO2	Problem-solving activities and Collaborative learning spaces	Assignment, Quiz and Summative assessment
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Mid-Semester and Summative assessment
CLO4	Lecture, Group discussion and Slide Show	Mid-Semester and Summative assessment
CLO5	Lecture and Student Activity	Summative assessment
CLO6	Lecture and discussion	Summative assessment and Assignment
CLO7	Lecture and DIY activities	Summative assessment

Text Book

1. Lindley, D.V (1965): *Introduction to Probability and Statistics*, Part-II.C.U.P, London.
2. Kendall, M. and Stuart, A. (1979): *The Advanced Theory of Statistics*, Volume 2, 4th edition, Macmillan Publishing Inc., New York.

Reference Books

2. Hogg, R.V. and Craig, A. T (2009)*: Introduction to Mathematical Statistics,* 6th edition, Pearson Education, Singapore.

3. Rao, C. R. (1984): *Linear Statistical Inference and its Applications*, 2nd edition, Wiley, New York.
4. Rohatgi, V. K. (1993): *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern.

Course Code:0542-322(Stat-322) Course Title: Order Statistics and Non-Parametric Methods
Marks:100 Credits: 03Number of Class: 42

Rationale:
The aim of the course is to enable the student to work with order statistics, which is important in regard to the study of extreme value theory and advanced statistics. The course also aims at providing the basics of hypothesis testing with emphasis on some commonly encountered hypothesis tests in statistical data analysis.

Objectives:
Objective of this course are to-

- Get familiar with distribution theory for order statistics.
- Give the competence to handle model building and/or model calculations
- Give skills to perform statistical analyses
- Give theoretical knowledge about and practical experience with the application of methods and models in statistics
- Give knowledge about the difference between parametric and nonparametric tests of hypothesis
- Get familiarize with some important and widely used non-parametric test
- Introduce the Criteria for choosing an appropriate non-parametric test

Course Learning Outcomes: At the end of this course students will be able to

CLO1	Identify problems that can be solved using order statistics and describe the theoretical properties of order statistics.
CLO2	Perform elementary probability calculations on order statistics and can use order statistics for parameter estimation.
CLO3	Compare and contrast parametric and nonparametric tests of hypothesis and identify multiple applications where parametric or nonparametric approaches are appropriate.
CLO4	Estimatethe moments, point and interval estimation of distribution function and density function.
CLO5	Analysis appropriate hypothesis testing procedure based on type of outcome variable and number of samples in practical situations and formulate, test, and interpret various hypothesis tests for location, scale, independence problems and rank-based methods.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2		2	1	1	1
CLO2	3				2	1		2
CLO3	2		1		1	1	2	
CLO4	2	2	1	1	1	1		1
CLO5	2	2	1	1	1	1	1	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	**Order Statistics:** Definition and distribution function of order statistics for both discrete and continuous case, asymptotic distribution, sample cumulative distribution function, joint distribution of n order statistics, marginal distribution of order statistics, conditional distributions of order statistics, distribution of median and range, exact moments of order statistics, large-sample approximations to mean and variance of r^{th} order statistics, simple estimation of parameters based on order statistics, best linear unbiased estimation based on order statistics, estimation based on selected statistics.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance, and Final Examination.	15
CLO4	**Non-parametric Estimation:** Estimation of moments, point and interval estimation of distribution function and density function with examples, point and interval estimation of percentiles, confidence interval for distribution function.			8
CLO3 CLO5	**Non-parametric Test** Difference between parametric and non-parametric tests, concepts of distribution free test, distribution theory of runs, test based on total number of runs, test based on length of			12

	longest run, runs up and down, and randomness test based on ranks, distribution theory of Kolmogorov-Smirnov (K-S) one sample test statistic and test based on K-S test, comparison of Chi-Square test and Kolmogorov-Smirnov Test for goodness of fit, definition, correlation between variate values and ranks, treatment of ties in rank tests, and Kruskal-Wallis one-way Anova test. **One-Sample and paired-Sample Techniques:** Sign test, Wilcoxon signed-rank test and their distributional properties. **General Two Sample Problem:** Wald-Wolfowitz runs test, Kolmogorov-Smirnov two-sample test, median test and Mann-Whitney U test and their distribution under null hypothesis, confidence interval procedures, and linear rank statistics.			
CLO5	**Linear Rank Test for Location and Scale Problem:** Wilcoxon rank-sum test, and Mood test.			3

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Student Activity	Quiz and Assignment,
CLO2	Lecture and Discussion	Assignment, Quiz and Summative Exam
CLO3	Lecture and Group Discussion	Mid-Semester and Summative Exam
CLO4	Discussion and Slide Show	Mid-Semester and Summative Exam
CLO5	Lecture and Discussion	Summative Exam

Text Book

1. Arnold B.C., Balakrishnan, N. and Nagaraja, H.N.: *First Course in Order Statistics,* Wilely New York.

Reference Books

1. Gibbons, J.D. and Chakraborti, S Gibbons, (1992): *Nonparametric Statistical Inference, Marcel Dekker,* Inc, USA.
2. Conover, W.J.:*Practical Non parametric Statistics,* Willey, New York.

Course Code: 0541-323(Stat-323) Course Title: Linear Programming and Operation Research

Marks:100 Credits: 03 Number of Class: 42

Rationale:

Linear programming (LP) and Operation Research is the fundamental modelling technique in optimal decision-making. The course will discuss theoretical aspects of linear programming, such as polyhedral theory, duality theory, optimality conditions, convexity, degeneracy, and convergence theory. This course will cover the simplex method in detail, emphasizing both mathematical foundations as well as computational considerations for effective computer implementations.

Objectives:

The objectives of this course are to:

- Introduce the fundamental concepts of Operations Research and Linear Programming (LP), with a focus on real-life applications in business, industry, and management.
- Develop the ability to formulate practical problems into LP models for optimization in areas such as resource allocation, production planning, and scheduling.
- Explore the mathematical properties of LP problems, including feasibility, convexity**,** duality, and optimality, with practical interpretation.
- Provide a comprehensive understanding of the simplex method, both from a theoretical perspective and through its implementation in solving real-world problems**.**
- Apply LP techniques to special cases such as transportation and assignment problems, with hands-on problem-solving.
- Introduce the basics of game theory and its practical use in strategic and competitive environments.
- Encourage the use of software tools (such as Excel Solver, MATLAB, or Python) to model and solve LP problems efficiently.

Learning Outcomes:

CLO1	Formulate real-world optimization problems as linear programming (LP) models by identifying decision variables, objective functions, parameters, and constraints across various domains such as finance, supply chain, and healthcare.
CLO2	Apply the Simplex method and related techniques to solve LP problems and interpret the solutions in practical decision-making contexts.
CLO3	Model and solve special LP problems like transportation and assignment problems using both analytical and software-based approaches.
CLO4	Make optimal decisions for resource allocation involving capital, manpower, materials, equipment, and energy under defined constraints.

CLO5	Develop a deeper theoretical understanding of operations research and extend it to include foundational concepts of game theory and modern computational tools.

Mapping between PLOs and CLOs of Statistics program:

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2		1	5			
CLO2		2	3		2			2
CLO3				2			2	1
CLO4	3	1	1		1			
CLO5	1							

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO5	Definition, scope and limitations of operational research, problem formulation and modeling in operational research, classification of operational research and important characteristics of operational research techniques.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	12
CLO2 CLO3 CLO4	Introduction, formulation of linear programming problem, hyper-plane, hyper-sphere, open set, closed set, convex set, convex polyhedron, convex and concave functions, basic solution, basic feasible solution, non-degenerate and degenerate basic solution, theorem related to solution, properties of solution to linear programming problem, graphical solution, generating extreme point solution, simplex methods, revised simplex method, Dual Simplex Method, Two-phase Method, Big-M method, introduction to transportation problem, setting up of transportation problem with its solutions, concept of non-linear programming.			17
CLO3 CLO5	Two-person zero sum" game and non-zero-sum games, pure, mixed and optimal strategy games, solution of game by graphical methods, simplex method, approximate solution of game by brown's algorithm.			13

Mapping of CLOs with Teaching–Learning & Assessment Strategy

CLOs	Teaching–Learning Strategy	Assessment Strategy
CLO1	Interactive Lectures, Open Discussion, Problem-Based Learning, Real-Life Case Studies	Assignments, Class Tests, Presentations, Final Exam
CLO2	Step-by-Step Algorithm Instruction (Simplex, Dual Simplex, etc.), In-Class Problem Solving	Problem Sheets, Quizzes, Summative Exam
CLO3	Case Studies on Transportation & Assignment Models, Software-based Tutorials (Excel Solver/Python)	Lab Reports, Software Performance, Final Exam
CLO4	Optimization Scenario Simulations, Group Exercises on Resource Allocation	Group Projects, Practical Assignments, Final Exam
CLO5	Conceptual Lectures on Game Theory, Software Implementation, Interactive Simulations	Project Reports, Presentations, Summative Exam

Textbooks:

1. Taha, H. A. (2017). *Operations Research: An Introduction* (10th Edition). Pearson.
2. Gass, S. I., & Assad, A. A. (2010). *An Annotated Timeline of Operations Research: An Informal History*. Springer.

Reference Books:

1. Hillier, F. S., & Lieberman, G. J. (2021). *Introduction to Operations Research* (11th Edition). McGraw-Hill Education.
2. Winston, W. L. (2020). *Operations Research: Applications and Algorithms* (5th Edition). Cengage Learning.
3. Bertsimas, D., &Tsitsiklis, J. N. (1997). *Introduction to Linear Optimization*. Athena Scientific.

Course Code: 0542-324(Stat-324) Course Title: Environmental Statistics
Marks: 50 Credits: 02 Number of Class: 28

Rationale:

This course is designed to introduce students to the basic statistical methods necessary to conduct and understand statistical analyses of environmental issues and problems.

Objectives:

The objectives of this course are to:

- Apply statistical methods to important problems in environmental sciences, with a focus on understanding and quantifying change in environmental sciences or problems of this nature.
- Provide intensive ideas of applying different statistical tools in the field of environmental sectors
- Teach the essential theory like deterministic and stochastic process, sampling techniques, dilution theory and statistical rollback alongside the practical components to analyze real environmental data.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

CLO1	Make sense of the statistical terms that appear in scientific papers and the media of environmental sectors.
CLO2	Summarize environmental data using graphs, tables, and numerical summaries
CLO3	Choose appropriate statistical methods to answer research questions
CLO4	Use statistical software to apply these methods, and interpret the output.

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1		3			3		3	2
CLO2	2		3		1		3	
CLO3		1			3	3	1	
CLO4	1		3	3	1		3	3

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO3 CLO4	**Introduction:** Concept of environmental statistics, uses and importance of environmental statistics. **Environmental Pollution:** Pollution and its importance, why does pollution happen? Pollutant sources, detail study of air and water pollution, global climate change and global warming. **Stochastic process in Environment:** Applications of Bernoulli. Poisson and normal processes to environmental problems.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**13**
CLO2 CLO3 CLO4	**Environmental sampling:** Network Sampling, composite sampling, ranked-set-sampling, Finite population sampling, Inaccessible and sensitive data, sampling in the wild. **Detectability of Sampling:** Basic Concept of Detectability, constant			**8**

	detectability over region, estimating detectability, effect of estimated detectability, detectability with simple random sampling.			
CLO2 CLO3 CLO4	**Diffusion and Dispersion of Pollutants:** Wedge Machine, Particle Frame machine, Plume model. **Dilution of Pollutants:** Deterministic dilution, stochastic dilution. Theory of successive random dilution (SRD), application of SRD to Environmental phenomena: Air quality, indoor air quality, water quality, concentrations of pollutants in soils, plants and animals. Concentration in food and human tissue.			**10**
CLO2 CLO3	**Statistical Theory of Rollback:** Predicting concentrations after source control, correlation, previous rollback concepts, environmental transport models in air and water.			**4**
CLO2 CLO3	**Spatial Methods for Environmental process:** Spatial Point Process Models and methods, General Spatial Process, More about Spatial Models, and Spatial Sampling and Spatial Design, Spatial Temporal models and methods.			**4**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Problem-solving activities.	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO4	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Barnett, V. and Turkman, K.F (1993): *Statistics for the Environment,* John Wiley and Sons, Chichester.

Reference Books

1. Bryan, F. J.: *Statistics for Environment Science and Management,* 1st Ed. CRC Press.
2. Wayner.R. Ott,(2002): *Environmental Statistics and Data analysis,* Lewis Publishers, England.

Course Code: 0388-325(Stat-325) Course Title: Research Methodology
Marks:100 Credits: 03 Number of Class: 42

Rationale:
The course research methodology is designed to make the students objective identification, collection, analysis, dissemination and use of information for the purpose of improving decision making related to the identification and solution of problems and opportunities in different sectors.

Objectives:
The objectives of this course are to:

- Know the basic concepts of research.
- Know the types of research.
- Write a research proposal.
- Know the uses of research data.
- Operate the analysis of data.
- Know the evaluation of research.

Prepare the report and present the report.

Learning Outcomes:
At the end of this course students will able to

CLO1	Explain the basic terms and types of research, methods and methodology of research.
CLO2	Apply each step of research process for conducting research
CLO3	Apply the methods of data collection, data coding, data representation using statistical software.
CLO4	Analyze and interpret data using statistical techniques in SPSS for solving research problems;
CLO5	Analyze the research data and presentation of research;
CLO6	Complete a dissertation with writing and evaluate report.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO
CLO1	1	2			1	2	2	2
CLO2		2	1	1		1		
CLO3			2	1			1	
CLO4	2	1		3		1	2	
CLO5	2		2		1	2		1
CLO6			1	2				2

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Introductions:** Definitions, Method and Methodology, Goals and Area of Research, Classification of Research, Research Process, Role of Research in Decision Making, Ethics in Research.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2 CLO1	**Formulation of Research Design:** Definition of Research Design, Classification of research Design and their Relations, The Research Cycle, Problems with the research Process, Structure of Research.			4
CLO2 CLO1	**Exploratory Research Design (Qualitative Research):** Rationale for using qualitative research, Classification of qualitative research procedure, Focus Group Discussion (FGD), Depth Interviews, Projective Techniques. **Causal Research Design:** Concept of causality, Conditions for causality, Definitions of symbols, Extraneous variables, and Classification of experimental design. **Sampling:** External Validity, Sampling Terminology, Statistical Terms in Sampling, Probability Sampling, Nonprobability Sampling, and Sample Size determination.			5
CLO3	**Measurement and Scaling:** Construct Validity, Measurement Validity Types, Idea of Construct, Validity, Convergent & Discriminant Validity, Threats to Construct Validity, The Nomo logical Network, The Multitrait-Multimethod Matrix, Pattern Matching for Construct Validity, General Issues in Scaling, Thurston Scaling, Likert Scaling, Guttmann Scaling, Write to research proposal. **Reliability and Validity:** True Score Theory, Measurement Error, Theory of			8

	Reliability, Types of Reliability, Reliability & Validity, Levels of Measurement.			
CLO4 CLO5	**Exploratory Research Design (Secondary Data):** Advantage and uses of secondary data, Disadvantages of secondary data, Evaluating of secondary data, Classification of secondary data. **Survey Research:** Types of Surveys, Selecting the Survey Method, Constructing the Survey, Types of Questions, Question Content, Response Format, Question Wording, Question Placement, Interviews, Plus & Minus of Survey Methods.			10
CLO5	**Questionnaire and Form Design:** Questionnaire and Observation Forms, Questionnaire Design Process, Type of Interviewing Method, Individual Question Content, Form and Layout, Pretesting, and Computer and Internet Questionnaire Construction. **Data Analysis:** Types of Analytical Procedures, Univariate, Bivariate and Multivariate Analysis, SWOT Analysis, Data Mining.			6
CLO6	**Report Preparation and presentation:** Importance of the Report and Presentation, The Report Preparation and Presentation Process, Report Preparation, Report Format, Report Writing, Research Follow-Up. **Evaluation Research:** Introduction to Evaluation, The Planning-Evaluation Cycle, An Evaluation Culture. Writing an Evaluation Report, Terms of Reference, Plan for Dissemination of Evaluation Report, Monitoring and Evaluation of Training Programs.			6

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Textbook assignment	Interactive Question-Answer
CLO2	Team-building exercise	Survey
CLO3	Classroom Discussion	Summative (Midterm)
CLO4	Field trips	Assignment and Presentation

CLO5	Lecture and Reflective Discussion	Summative Measure (Final Exam.)
CLO6	Individual projects	Summative Measure (Final Exam.)

Text Book

1. Malhotra, N. K. (2022): *Marketing Research,*6th Ed, Pearson Education, Singapore.

Reference Books

1. Kothari. R. (2019): Research *Methodology -. Methods and Techniques.* 2nd Edition, New Age Publications, India.
2. Islam, M. N.: An *introduction to Research Methods.* Book world Zikmund, W. G. (2009): *Business Research Methods*, 7th edition, South-Western Pub.

Course Code:0542-326(Stat-326) Course Title: Data Analysis- VI (Lab)
Marks:100 Credits: 03
Number of Class: 42

Group A (Statistical Inference-II): 30 Marks
Rationale:
The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in statistical research.

Objectives:
The objectives of the course are to:

- Estimate the point and interval for parameter.
- Estimate the parameters by Bayesian approach.
- Test the hypothesis concerning and exponential distribution.

Develop LR test, GLR test, MLR test.
Learning Outcomes:

After completing this course, a student will able to-

CLO1	Estimate the Bayes' Statistics
CLO2	Find out the point and interval estimation.
CLO3	Test the different testing approach such as (LR, GLR, and MLR test).

Mapping with CLOs and PLOs

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	2	3	2	2	
CLO2	3	3	3	2	3	2	2	

CLO3	3	3	2	2	2	2	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Most powerful test, Uniformly Most Powerful Test, Uniformly Most Powerful Unbiased Test, Locally Uniformly Most Powerful Unbiased Test, Optimal Tests in Different Situations, Randomized Tests, Consistent Tests, Unbiased Tests, Similar Region, Likelihood Ratio Test,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**20**
CLO2 CLO3	Generalized Likelihood Ratio Tests, Monotone Likelihood Ratio Test, Test of homogeneity in Parallel Samples., LM Test and Wald Test, SPRT, OC and ASN Function, Bayesian Test of Hypothesis.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Problem-solving activities.	Lab Performance, Report, Summative assessment
CLO3	Panel discussions and Problem-solving activities.	Lab Performance, Report, Summative assessment

Text Book

1. Mood, A. M. and Graybill, F. A. and Boes, D.C. (1974): *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill, New York.
2. Cassela, G. and Berger, R. L. (2001): *Statistical Inference*, Wadsworth Publishing Company, California

Group B (Order Statistics and Non-parametric Methods): 35 Marks

Rationale:

This course aims at introducing order statistics and the "modern" nonparametric techniques in statistical analysis and the use of these techniques in a variety of disciplines

Objectives:
The objective of this course are to-

- Learn the formal definition of order statistics.
- Determine the moments of the r^{th} order statistic from the practical data.
- Derive the probability density function of the r^{th} order statistic.
- Derive a method for finding the $(100p)^{th}$ percentile and confidence interval of the sample.
- Acquaint with the basic ideas, applicability, and methods of nonparametric data analysis

Learning Outcomes:
After completion this course students are able to:

CLO1	Find the moments and probability density function of rth order statistics from the sample also can calculate percentile and confidence interval for distribution function.
CLO2	Perform and interpret the Mann Whitney U Test, median test, Sign test, Wilcoxon Signed Rank Test, Kruskal Wallis, binomial and quantile test
CLO3	Identify the appropriate nonparametric hypothesis testing procedure based on type of outcome variable and number of samples.

Mapping with CLOs and PLOs

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	2	3	2	2	
CLO2	3	3	3	2	3	2	2	
CLO3	3	3	2	2	2	2	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Estimation of moments, point and interval estimation of distribution function and density function, point and interval estimation of percentiles, confidence interval for distribution function.	Interactive Class, Open Discussion, Participatory Q/A Session, Online	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**20**
CLO2 CLO3	Randomness test based on ranks, Kolmogorov-Smirnov (K-S) test, Chi-			

	Square test, Sign test, Wilcoxon signed-rank test, binomial and quantile test, Kolmogorov-Smirnov two-sample test, median test and Mann-Whitney U test, Wilcoxon rank-sum test, test for different location and scale problems.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Problem-solving activities.	Report and Summative Exam
CLO2	Lecture and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO3	Classroom Discussion and Problem-solving activities.	Lab Performance, Report, Summative Exam

Text Book

1. Arnold B.C., Balakrishnan, N. and Nagaraja, H.N.: *First Course in Order Statistics,* Wilely New York.

Group C (Linear Programming and Operation Research): 35 Marks

Rationale:

This course aims at familiarizing the students with quantitative tools and techniques, which are frequently applied to business decision-making & to provide a formal quantitative approach to problem solving and an intuition about situations where such an approach is appropriate.

Objectives:

The objectives of this course are-

1. To introduce the students how to use variables for formulating complex mathematical models
2. To provide the students with opportunity of using various software package for solving linear programming models
3. To introduce the students to the use of basic methodology for the solution of linear programs
4. To use concepts from game theory to construct model for competitive real-world phenomena

Learning Outcomes:

At the end of this course students will able to:

CLO1	Identify and develop operational research models from the verbal description of the real system.

CLO2	Understand the mathematical tools that are needed to solve optimization problems.
CLO3	Use mathematical software to solve the proposed models.
CLO4	select an optimum solution with profit maximization
CLO5	Model competitive real-world phenomena using concepts from game theory
CLO6	propose the best strategy using decision making methods under uncertainty and game theory
CLO7	Possess a set of intermediate level game-theoretic skillistics which can be applied in real world contexts

Mapping between PLOs and CLOs of Statistics program

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			1	2			
CLO2	3	2	1		3			1
CLO3			3					
CLO4	2			2	3			
CLO5			3		3	2		
CLO6	1		3		3	2		2
CLO7	1		3		3	3		1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Solution of linear programming problems by graphical method, geometric, simplex methods, revised simplex method, Dual Simplex Method, Two-phase Method, Big-M method, problems on transportation problem,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final	14
CLO4 CLO5 CLO6 CLO7	Solution of "Two-person zero sum" game and non-zero-sum games, pure, mixed and optimal strategy games, solution of game by graphical methods, simplex method,			10

	approximate solution of game by Brown's algorithm.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Classroom Discussion	Lab Performance
CLO3	Classroom Discussion and Problem-solving activities.	Lab Performance, Report
CLO4	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO5	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO6	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO7	Discussion and Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book

1. Taha, H.A.: *Operation Research an Introduction*, Prentice-Hall New Delhi.
2. Gass, S.I (2010: *Linear Programming Methods and Applications*, 4th edition, Dover Publications/McGraw-Hill, New York.

Viva-Voce	**Marks:50**	**Credits: 1.5**

4th Year 1st Semester

Course Code: 0542-411(Stat-411) Course Title: Multivariate Analysis
Marks:100 Credits: 03 Number of Classes: 42

Rationale:
The purpose of the course is to introduce modern methods of multivariate analysis, their application on real-life data, and proper interpretation of the obtained results. In the process, students also learn how to use the latest software tools for multivariate analysis.

Objectives:

The main aim of the course is to

- Understand and explain what multivariate statistical analysis is and when its application is appropriate and derive various statistics for random vectors via matrix algebra.
- Graphically display multivariate data.
- Demonstrate thorough familiarity with multivariate distributions, and in particular multivariate normal and Wishart distributions.
- Demonstrate knowledge in drawing inferences about mean vectors and comparison of several multivariate means.
- Develop and analyze multivariate regression models.
- Condense information contained in a large number of variables into a smaller set of factors using principle component and factor analysis.
- Search for distinguishable groups of objects using various classification techniques.
- Implement all of the above using standard statistical packages (e.g., R, SPSS, STATA).
- Reproduce the results obtained in statistical packages (e.g., R, SPSS, STATA) using spreadsheets (e.g., Excel)

Course Learning Outcomes: At the end of this course students will be able to

CLO1	Summarize and interpret multivariate data.
CLO2	Perform exploratory analysis of multivariate data, such as plot multivariate data, calculating descriptive statistics, testing for multivariate normality;
CLO3	Conduct statistical inference about multivariate means including hypothesis testing, confidence ellipsoid calculation and different types of confidence intervals estimation;
CLO4	Undertake statistical analyses using appropriate multivariate techniques, which include principal component, factor analysis, discrimination, and classification Canonical Correlation.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1	1	1	1
CLO2	2	2	2	2	1	1	2	
CLO3	2	2	2	1	1	1	2	1
CLO4	2	2	1	1	1	1	1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Introduction:** Concept of multivariate data, examples from real life and uses of multivariate analysis.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance, and Final Examination.	3
CLO2	**Multivariate Normal Distribution:** Meaning, derivation and properties of normal distribution, multivariate determining probability density contour, maximum likelihood estimator of mean vector and variance covariance matrix. Evaluating normality of univariate and multivariate normal distribution and normal distribution by P-P and Q-Q plot, steps in detecting outliers and cleaning data, transformation to near normality by square root, logit, Fisher's and box-cox transformation. Mahalnobis D^2.			10
	Comparison of Several Multivariate Means: Paired comparisons and repeated measures design, comparing mean vectors from two populations, comparing several multivariate populations means (MANOVA), simultaneous confidence interval for treatment effects, two-way multivariate analysis of variance, profile analysis. **Multivariate Linear Regression Model:** classical linear regression model, least square estimation, inference about the regression model, model checking, multivariate multiple regression			

CLO3	**Multivariate Sampling Distributions:** Hoteling's T^2 and its properties, Wishart distribution and its properties.			5
CLO4	**Principal Components:** Introduction to the principal components analysis. ML estimator of the principal components and their variances. Sampling properties of the Sample principal components. Statistical inference. **Factor Analysis:** Definition and purpose of factor analysis, the mathematical model for factor structure. ML estimators for random orthogonal factors. Estimation for fixed factors. Testing the goodness of Fit of the factor model. Factor interpretation and transformation. **Discriminant Analysis:** Meaning and goals of Discriminations and Classification, Fisher's linear discriminate function, Classification into one of two and into one of more than two multivariate populations. Quadratic discriminators. Test of a discriminate function. **Canonical Correlation and Canonical Variables**: Concepts of Canonical Variables and Canonical Correlation, Estimation of Canonical Correlation and Varieties, Large sample Statistical Inference of Canonical Correlation.			20

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture and Group Discussion	Quiz and Assignment,
CLO2	Lecture and Student Activity	Assignment, Quiz and Summative Exam
CLO3	Lecture and Group Discussion	Mid-Semester and Summative Exam
CLO4	Lecture and Discussion	Mid-Semester and Summative Exam

Text Book

1. Johnson, R.A. &Wichern, D.W. (2007): *Applied Multivariate Statistical Analysis,* Prentice –Hall Inc.

2. Anderson, T. W. (1984), *Introduction to Multivariate Analysis,* 2nd edition, 1984, John Wiley, New York.

Reference Books

1. Kendell. M.G.: *Multivariate Analysis,* New York,
2. Kshiragar, A.M: *Multivariate Analysis, Marcell DekkarInc.*New York.

Course Code: 0542-412(Stat-412) Course Title: Sampling Technique-II
Marks:100 Credits: 03 Number of Classes: 42

Rationale:
The main reason of this course is to provide an overview of different sampling scheme and their estimation methods. Also, to design and execute a survey with proper sampling technique.

Objectives:
The main objective of this course is to:

- Demonstrate knowledge and understanding of the basic methods of cluster sampling of equal and unequal size clusters and varying probability.
- Exhibit different sampling scheme, their practical implications and compare their relative efficiencies.
- Explain Multistage and Multiphase sampling scheme and their applications in practical situations.
- Depict the importance of repetitive surveys in two or more than two occasions.
- Enlighten about sampling and non-sampling error in surveys and how to handle these errors in practice.

Course Learning Outcomes:
At the end of this course students will be able to

CLO1	Comprehend survey using single stage cluster sampling of unequal size and varying probability.
CLO2	Perceive different sampling scheme, their practical implications and compare their relative efficiencies.
CLO3	Supervise two stage or multistage cluster sampling and obtains estimator with great precision.
CLO4	Design double sampling or multiphase sampling procedures (stratified sampling, ratio estimator, regression and different estimator)
CLO5	Administer Repetitive surveys in two or more than two occasions.
CLO6	Figure out the meaning sampling and non-sampling error, characteristics of non-response error and remedial measures of non-response error.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO
CLO1	3	2	3			1	2	
CLO2	3		2			1	2	
CLO3	3		1	2		1		
CLO4		2	3		2		1	
CLO5	3	2		1		1		
CLO6	3	2	3			1	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Single stage Cluster sampling with equal and unequal cluster sizes, Equal and unequal Probability Sampling with and without replacement, Relative Efficiency,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	Different sampling schemes, Horvitz-Thompson estimator, probability proportional to size sampling Brewers, Durbin, Raj, Murthy, Rao and Cochran's methods, comparisons of their efficiencies.			8
CLO3	Sub-sampling or two stage sampling with units of Equal and Unequal sizes. Three stage and Multistage sampling. Optimum sampling and sub-sampling fractions, Determination of optimum cluster size, Relative Accuracy's.			8
CLO4	Double sampling or two-phasesampling, double sampling for Stratification, Ratio, Difference, and Regression estimation, Optimum allocation, Multiphase sampling.			8
CLO5	Repetitive surveys or successive surveys, objectives of repetitive surveys, Sampling on two occasions, Sampling on more than two occasions, optimum allocations.			8

CLO6	Error in sample survey, sources and prevention of error, characteristics of non-response, measuring non-response, dealing with non-response, perspectives on non-response, estimation in presence of unit non-response, methods of reducing non-response and response errors.			5

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Interactive Question-Answer
CLO2	Expository sharing	Assignment and Presentation
CLO3	Classroom Discussion	Practice by doing exercise, Summative (Midterm)
CLO4	Reflective Discussion	Practice by doing exercise, Summative (Midterm)
CLO5	Lecturing	Summative Measure (Final Exam.)
CLO6	Slide Show	Summative Measure (Final Exam.)

Text Book

1. Cochran, W. G. (1977): *Sampling Techniques*, 3rd edition, Wiley, New York.

Reference Books

1. Raj, D. and Chandhok, P. (1998): *Sample Survey Theory*, Narosa Publishing House, New Delhi.
2. Islam, M.N.: *An Introduction of Sampling Methods: Theory and Applications*.
3. Murthy, M.N. (1977): *Sampling Methods*, 2nd edition, Statistical Publishing Society, Calcutta.

Course Code: 0314-413(Stat-413) Course Title: Mathematical Demography

Marks: 100 Credits: 03 Number of Classes: 42

Rationale:

Mathematical demography focuses on population phenomena and their relations with other population phenomena. This also reviews some of the latest developments in the large body of mathematical theory concerned with the growth processes of populations.

Objectives:

The objectives of this course are-

- Compute and interpret key demographic indicators such as birth, death, fertility rates, and life expectancy.
- Analyze population structure using age-sex composition and construct population pyramids.
- Evaluate and adjust demographic data using the Dual Record System and Chandra Sekhar-Deming method.
- Perform population projections and assess future demographic trends.
- Construct and interpret single and multiple decrement life tables.
- Explain micro-demographic concepts and estimate population change using Lexis diagrams and stable population models.

Learning Outcomes:

By the end of the course students should be able to-

CLO1	Construct and interpret life tables and estimate key measures such as life expectancy and mortality rates.
CLO2	Analyze and compute stable population models, including key indicators and dynamics of population growth and structure.
CLO3	Perform basic operations on matrices and vectors, and apply matrix algebra techniques to solve population projection problems.
CLO4	Evaluate and address specific challenges in population projections, including small-area, household, and multistate projections.
CLO5	Demonstrate problem-solving skills by using spreadsheets and open-access demographic software to perform a variety of demographic analyses and projections.

Mapping between PLOs and CLOs of Statistics program

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2						3	
CLO2	2	2					1	
CLO3	2			2	1			1
CLO4	1		2		2			
CLO5	1		3					

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Age-Sex Composition and Structure, Statistics on Age, Age Heaping Evaluation of Age and Sex Data, Myer's Index, Whipple's Index, United Nation Index, Causes of Errors in Age Data and their Detection, Population Pyramid, Cohort and Lexis Diagram.	Interactive Class, Open Discussion, Participatory Q/A Session	Assignments, Class Tests, Presentation, Attendance and Final	8

CLO2 CLO3	Dual Record System, Chandra Sekhar-Deming Formula, Evaluation and Adjustment of Demographic Data. Fertility Models (Coale-Trussell, Gompertz Relational), Proximate Determinants of Fertility.			8
CLO1	Life Table Functions, Properties and Interrelationships, Sampling Distribution of Life Table Functions, Estimation of Survival Probability, Multiple Decrement Life Table, Increment-Decrement Life Tables, Model Life Tables.			8
CLO3 CLO4	Lotka and Dublin's Model, Intrinsic Age Distribution, Lotka's Integral Equation and its Complex Roots, Relationship Between the Mean Length of Generation and age of Childbearing, Graduation of the Net Marternity Function-Lokta, Wicksell and Hadwiger, Interrelationship of Demographic Variables in Stable Population, Quasi Stable Population, Comparison of the age Distribution of a Stable Population with that of Quasi Stable Population.			8
CLO5	Fecundity, Fecundability and Sterility, Effective Fecundability, Residual Fecundability Estimation of Measures of Fecundability Pearl Index, Effectiveness and Efficiency of FP Method. Population Projection: Population Projection in Matrix Notation (Lasli Matrix)			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Lecturing and Problem-solving activities.	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO4	Lecturing and Problem-solving activities.	Summative Measure (Final Exam.)
CLO5	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Rogers, A (1966): *Introduction to Multiregional Mathematical Demography.* Wiley Interscience, NW

Reference Books

1. Bogue, D.J. (1969): *Principles of Demography,* Wiles & Sons. NW
2. Biswas, S. (1988): *Stochastic Processes to demography & Application,* Wiley Eastern Ltd. Delhi.
3. Shyrock, H.S. & Siegel J.S. (1973): *The Methods and Materials of Demography. Vol 1 & 2:* Bureau of Census, Washington.

Course Code: 0714-414(Stat-414) Course Title: Statistical Simulation and Modeling
Marks: 50 Credits: 02 Number of Classes: 28

Rationale:
Statistical analysis of real-world systems and models will typically require computer intensive methods. The course starts with a study of modern Monte Carlo methods, including Markov chain Monte Carlo, and variance reduction methods.

Objectives:
The objectives of this course are to:

- Making students familiar with the most important elements of the Monte Carlo method
- Explain and demonstrate techniques for the generation of random numbers with normal, Poisson and other distributions.
- Define basic concepts in modeling and simulation
- Demonstrate the use of random number sets for simulation of data with a random error and for Monte-Carlo methods for integration and simulations.

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Model and simulate basic statistical problems
CLO2	Generate random numbers from different distributions
CLO3	Collect, analyze and present numerical data in general and simulation results in particular.
CLO4	Classify various simulation models and give practical examples for each category
CLO5	Construct a model for a given set of data and motivate its validity

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	2	2	1	2	-	-

CLO2	2	2	-	2	-	-	2	-
CLO3	2	2	2	-	-	1	-	-
CLO4	3	3	-	2	1	-	-	-
CLO5	2	2	2	-	2	2	1	-

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Overview:** Meaning, Simulation Process, Verification, Validation, Synchronous and Asynchronous Discrete Event Simulation, Continuous Event Simulation, Hybrid Event Simulation, Monte Carlo: Hit or Miss Monte Carlo Method, Sample- Mean Monte Carlo Method.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	**Generating Discrete Random Variables:** The Inverse Transform method, Generating Poisson Random variable, Generating Binomial Random variables, The Acceptance-Rejection Technique, The Composition Approach, and Generating Random vectors. **Generating Continuous Random Variables:** The Inverse Transform Algorithm, The Rejection Method, The Polar Method for Generating Normal Random Variables, and Generating a Poisson Process.			10
CLO3	**Discrete Event Simulation Approach:** Simulation via Discrete Events, A Single-Server Queuing System, A Queueing System with Two Servers in Series, A Queueing System with Two Parallel Servers, An Inventory Model. **Variance Reduction Technique:** Stratified Sampling, Conditional Monte Carlo, Jackknifing, Antithetic Variates.			8
CLO4	**Generating Uniform Random Variable**: Classes of Generators – Random Devices, Tables, Midsquare Method, Fibonacci			14

	and Additive Congruential Generators, Linear Congruential Generators, Linear Recursion Mod 2 Generator, Combinations of Generators, Choosing Good Generator Based on Theoretical Considerations, Serial Correlation, Cycle of Length, Spectral Test. **Generating Non-Uniform Random Variables:** Alias Method, Inverse Transformation Method, Acceptance-Rejection Method, Polar Method, Method of Generating Random Numbers from Normal, Exponential, Gamma, Beta, Cauchy, Binomial, Poisson, Geometric, Negative Binomial Distributions t, F and χ^2.			
CLO5	**Markov Chain Monte Carlo Methods:** Markov Chain, The Hasting-Metropolis Algorithm, The Gibbs Sampler.			5

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and interactive learning	Quiz and Assignment,
CLO2	Problem-solving activities and Collaborative learning spaces	Assignment, Quiz and Summative assessment
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Mid-Semester and Summative assessment
CLO4	Lecture, Group discussion and Slide Show	Mid-Semester and Summative assessment
CLO5	Lecture and Student Activity	Summative assessment

Text Book

1. Bartley, P., Fox, B. L. and Schrage, L. E. (1987): *A Guide to Simulation*, 2nd Edition, Springer-Verlag, New York.

Reference Books

1. Averil M. Law (2010): *Simulation Modeling and Analysis,4th Edition,* Tata McGraw-Hill Education Private Limited, New Delhi
2. Rubinstein, R. Y. and Kroese, D. P. (2007): *Simulation and the Monte Carlo Method,* 2nd Edition, John Wiley and Sons, New York.

Course Code: 0912-415(Stat-415) Course Title: Epidemiology
Marks: 50 Credits: 02 Number of Class: 28

Rationale:

Epidemiology will accustom the students with the origin and causes of diseases in a community. It is the scientific method of investigation problem-solving used by disease detectives. This course will offer powerful tools to quantify the degree to which risk factors and humanitarian interventions affect population health in a crisis

Objectives:

- Get accustomed with epidemiologic terminology, outcome measures, and study designs;
- Combine appropriate epidemiological concepts and statistical methods.
- Distinguish the roles and relationships between epidemiology and biostatistics in the prevention of disease and the improvement of health
- Compute basic descriptive statistics and explore data analytic methods.

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Gather knowledge criteria commonly used to evaluate causal relationships
CLO2	Critique the study design and quantitative methods used in published literature and appropriately interpret the findings
CLO3	Calculate commonly used health measures, such as relative risk, attributable risk, and odds ratio; select appropriate methods for estimating such measures
CLO4	Interpret descriptive and inferential statistics resulting from data analysis and draw relevant conclusions
CLO5	Apply the concepts of confounding and bias to describe variables
CLO6	Identify key sources of epidemiologic data and know appropriate methods of analyzing these data
CLO7	Formulate and apply epidemiologic methodology to identify a specific public health problem, develop a hypothesis, and design a study to investigate the issue

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			2			1	
CLO2	2		1		1	3		
CLO3		3					3	
CLO4		2		2	2	3		
CLO5	3	2						1
CLO6	2	2					1	
CLO7	1	2	3		2		3	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Introduction:** Definition and scope of epidemiology, uses of epidemiology, Descriptive Epidemiology, Concept of cause, establishing cause of disease. Natural History and Health Status of Disease, Achievements in Epidemiology.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2	**Types of Epidemiologic Studies:** Cross Sectional, cohort, case control, retrospective and prospective, clinical trials, community intervention and cluster randomized trials			7
CLO3 CLO4	**Measures of Disease Frequency:** Incidence and prevalence rates, relation between incidence and prevalence, case fatality rate, risk ratio, rate ratio, risk difference, rate difference, mortality measures, standardized mortality ratio.			8
CLO3 CLO4	**Measures of association**: Relative risk, attributable risk, odds ratio, risk difference, comparison of proportion different sample.			5
CLO6	**Epidemiology and Prevention:** Scope of prevention, levels of prevention: primordial, primary, secondary and tertiary.			5
CLO6 CLO7	**Screening:** Sensitivity, specificity, negative and positive predictive values. Positive and negative Likelihood ratio, Determinants of Predictive Value, Receiver Operator Characteristic (ROC) Curve, Diagnostic Accuracy.			5
CLO5	**Confounding and Interaction**: Confounding, interactions, methods for assessment of effect modification; Strategies to allow/adjust for confounding in design and analysis.			5

Mapping of Course Learning Outcomes (CLOs) with Teaching–Learning & Assessment Strategy

CLOs	Teaching–Learning Strategy	Assessment Strategy

CLO1	Interactive Lectures, Open Discussion, Online Resources, Practical Application	Assignments, Class Tests, Presentations, Final Exam
CLO2	Case Study Discussions, Literature Review, Study Design Analysis	Report Writing, Class Test, Summative Assessment
CLO3	Problem-Solving Sessions, Application of Epidemiologic Formulas	Numerical Problem Sheets, Quizzes, Final Exam
CLO4	Data Analysis Workshops, Statistical Software Demonstrations	Practical Report, Class Test, Final Exam
CLO5	Conceptual Discussions on Bias and Confounding, Case-based Learning	Assignments, Class Participation, Final Exam
CLO6	Interactive Lectures, Data Source Exploration, Practical Tasks	Quizzes, Assignments, Final Exam
CLO7	Project-Based Learning, Hypothesis Development Sessions, Study Design Activities	Project Report, Presentation, Final Exam

Text Book

1. Kenneth, J. and Rothman, S. G. (2008): *Modern Epidemiology,* 3rd Ed, Lippincott Williams and Wilkins, USA.

Reference Books

1. Kleinbaum, .G, Kupper L. L and Morgenstern (1982): *Epidemiologic Research.*
2. Mark Woodward: *Epidemiology, Study design and data analysis.*

Course Code: 0542-416 (Stat-416) Course Title: Actuarial Statistics
Marks: 50 Credits: 02 Number of Classes: 28

Rationale:
This course will focus not only on quantitative aspects but also on management aspect. The program intends to train personnel to work in Insurance firms, Pension departments of various organizations, Banks and other Financial Institutions in the national and international arena.

Objectives:
The main objectives of this course are to

- Provide an understanding of the fundamental concepts of financial mathematics, and how these concepts are applied in calculating present and accumulated values for various streams of cash flows.
- Introduce financial instruments, such as derivatives, the concept of no-arbitrage.
- Provide a solid grounding in the subject of life contingencies for single life, and in the subject of the analysis of life assurance and life annuities, including pension contracts.

- Provide an introduction to mathematical methods for managing the risk in life insurance.
- Develop skills of calculating the premium for a certain life insurance contract, including allowance for expenses and profits.

Course Learning Outcomes:

At the end of this course students will be able to

CLO1	Recognize and compute various interest rates, as well as the present and future values of a cash flow.
CLO2	Derive formulae for all kinds of annuities.
CLO3	Given an annuity with level payments, immediate (or due) , payable monthly, (or payable continuously), and any three of present value, future value, interest rate, payment, and term of annuity, calculate the remaining two items.
CLO4	Given an annuity with non-level payments, immediate (or due) , payable monthly, (or payable continuously), the pattern of payment amounts, and any three of present value, future value, interest rate, payment, and term of annuity, calculate the remaining two items.
CLO5	Given an annuity with non-level payments, immediate (or due) , payable monthly, (or payable continuously), the pattern of payment amounts, and any three of present value, future value, interest rate, payment, and term of annuity, calculate the remaining two items.
CLO6	Calculate the outstanding balance at any point in time.
CLO7	Calculate a schedule of repayments under a loan and identify the interest and capital components in a given payment.
CLO8	Calculate the present value of payments from a fixed interest security, bounds for the present value of a redeemable fixed interest security.
CLO9	Given the price, calculate the running yield and redemption yield from a fixed interest security.
CLO10	Explain and analyze the factors that affect mortality, simple life assurance and life annuity contracts
CLO11	Concept (and the mathematical assumptions) of the future life time random variables in continuous and discrete time
CLO12	Define and calculate the different types of the survival probabilities in theoretical and numerical examples

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3						1	

CLO2	1				2			
CLO3	3							
CLO4	3		2				1	
CLO5	3					1		
CLO6	2			1				
CLO7	3						2	
CLO8	1		1					
CLO9	1							
CLO10	2					1		
CLO11				1				
CLO12								1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	The meaning of actuarial science, its relationship with life insurance, role of insurance in the economy, important uses of actuarial statistics specially in context of Bangladesh, role of an actuary.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	3
CLO2 To CLO7	Theory of rates of interest and discount including theoretical continuous case of forces of interest and discount, annuities and sinking funds including continuous case, practical and theoretical applications primarily to mortgages and bonds, Book value, Bond Amortization schedule, yield rates.			13
CLO8 CLO9	Economics of insurance, utility theory, application of probability to problems of life and death, determination of single premium for insurances and annuities in both discrete and continuous case, perpuities, unknown time and unknown rate of interest.			7
CLO10 CLO11	Theory and practice of pension plan funding, assumptions, basic actuarial functions, population theory applied to private pensions.			7
CLO12	Survival distributions, life table, life insurance, life annuities, net premium, premium series, multiple life			7

	functions, multiple decrement models, valuation theory for pension plans, expense function and dividends. Models for individual claims, approximations for the distributions of sum of claims.			

Mapping of CLOs with Teaching–Learning & Assessment Strategy

CLOs	Teaching–Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion, Open Discussion, Online Resources, and Participatory Q&A Sessions	Assignments, Class Tests, Presentation, Final Exam
CLO2	Lectures, Problem-solving Activities, Numerical Examples	Class Tests, Report, Summative Exam
CLO3	Problem-solving Activities, Practical Examples	Class Tests, Report, Summative Exam
CLO4	Lectures, Numerical Problem-solving, Practical Case Study Discussions	Class Tests, Report, Summative Exam
CLO5	Problem-solving with Annuities, Case-based Learning	Assignments, Report, Final Exam
CLO6	Interactive Problem-solving on Loans and Balance Calculations	Quizzes, Report, Final Exam
CLO7	Lectures, Amortization Schedules, Loan Repayment Activities	Class Tests, Report, Final Exam
CLO8	Interactive Lecture, Problem-solving with Fixed Securities	Assignments, Class Tests, Final Exam
CLO9	Calculation-based Learning, Financial Instrument Analysis	Class Tests, Report, Summative Exam
CLO10	Lecture, Demographic and Insurance Data Analysis, Case Studies	Assignments, Report, Final Exam
CLO11	Theoretical Lectures on Life Time Random Variables, Simulation	Class Tests, Report, Summative Exam
CLO12	Lectures on Life Tables, Decrement Models, Numerical Examples	Assignments, Report, Final Exam

Text Book

1. Parmenter: *Theory of Interest and Life contingencies with pension Application.*

Reference Books

1. Bowers, N.L., Gerber, H.V., Hickman, J.C., Jones, D.A. and Nesbitt, C. J.: *Actuarial Mathematics.*
2. Uddin, Mohammad Sohrab: *An Introduction to Actuarial and Financial Mathematics.*

Course Code: 0542-417 (Stat-417) Course Title: Data Analysis- VII
Marks:100 Credits: 03 Number of Class: 42

Group A (Multivariate Analysis): 50 Marks

Rationale:

This course focuses on the standard methods of multivariate statistical analysis. Many essential data analysis techniques, such as principal component analysis and discriminant analysis.

Objectives:

The objectives of this course are to-

- Understand the main features of multivariate data.
- Use exploratory and confirmatory multivariate statistical methods properly.

Carry out multivariate statistical techniques and methods efficiently and effectively.

Learning Outcomes:

After completion this course students are able to:

CLO1	Analyze multivariate data and the dependence structure of variates to extract the useful information from a massive dataset;
CLO2	Apply suitable tools for exploratory data analysis, dimension reduction, and classification to formulate and solve real-life problems;
CLO3	Implement the multivariate analysis techniques with statistical software such as Rand SPSS in a manner that the methodology adopted is motivated by appropriate statistical theory.

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	2	3	2	2	
CLO2	3	3	3	2	3	2	2	
CLO3	3	2	3	2	3	2	2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Assessing multivariate normality, Box-Cox Transformation, Test for a mean vector, Test for equality of Mean vectors, problems related on	Interactive Class, Open Discussi	Assignments, Class Tests, Presents	**20**

	discrimination analysis, Principal component analysis, Factor Analysis.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and Problem-solving activities.	Report and Summative Exam
CLO2	Lecture and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Exam

Text Book:

1. Johnson, R.A. &Wichern,D.W. (2007): *Applied Multivariate Statistical Analysis,* Prentice –Hall Inc.

Group B (Statistical Simulation and Modeling): 50 Marks

Rationale:

Rationale of this course is to generate random number from different discrete and continuous distribution by using different Monte-Carlo Methods.

Objectives:

The objectives of this course are to:

- Use different Monte-Carlo Methods and computer program to generate random numbers from various distributions.
- Practice different parametric, non-parametric tests and graphical methods for testing Uniform Random Numbers.

Learning Outcomes:

After successful completion of this course students will be able to

CLO1	Generate random number from Uniform, Binomial, Poisson, Normal, Exponential, and Gamma Distribution by Different Monte-Carlo Methods
CLO2	Test random number variates and apply them to develop simulation models

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2	3	2	1	2	3	3	
CLO2	2	2	2		2	3	1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Generating Random Number from Uniform, Binomial, Poisson, Normal, Exponential, and Gamma and Weibull Distribution by Different Monte-Carlo Methods and Using Standard Software's and Computer Program; Testing Uniform Random Numbers using Chi-Square Test, Kolmogorov-Smirnov Test and Graphical Methods, Assess Different Statistical Properties of Generated Data, Integration by Monte-Carlo Simulation.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**20**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance and summative assessment
CLO2	Panel discussions and Problem-solving activities.	Lab Performance, Report, Summative assessment

Text Book

1. Bartley, P., Fox, B. L. and Schrage, L. E. (1987): *A Guide to Simulation*, 2nd Edition, Springer-Verlag, New York.

Course Code: 0542-418 (Stat-418) Course Title: Statistical Data Analysis- VIII
Marks: 100 Credits: 03 Number of Classes: 42

Group A: (Sampling Technique-II): 50 Marks

Rationale:

The course is design to inspect the practical approach of the design of a sample and estimation method about real life phenomena.

Objectives:

The objectives of the course are to:

- Understand and apply cluster sampling methods with equal and unequal probabilities.
- Design and implement double sampling and repetitive survey techniques using suitable software.
- Identify and analyze non-response errors and apply appropriate remedial measures using software tools.
- Perform estimation procedures accounting for non-response errors through statistical software applications.

Learning Outcomes:

After studying all materials and resources presented in the course, the student will be able to-

CLO1	Understand and design cluster sampling with equal and unequal probability techniques.
CLO2	Design double sampling procedures (stratified sampling, ratio estimator, regression estimator, product, PPS) and repetitive surveys (twophase sampling) using appropriate software.
CLO3	Find out the non-response error, characteristics of non-response error also remedial measures of non-response error by using different software.
CLO4	Perform estimation procedure in the presence of non-response error using appropriate software.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	2	1	2	3	3	
CLO2	2	3	2		2	3	3	
CLO3	2	3	2		2	3	3	
CLO4	2	3	2	2	2	3	3	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Drawing probability sample, sample with and without replacement and variance of estimators for cluster sampling,	Interactive Class, Open Discussion, Participatory Q/A Session, Online	LabPerformance, LabReportWriting, Attendance and Final	4
				4
				4
CLO2	Double sampling, two stage sampling, Allocation of sample sizes for optimum cost and variance function for different sampling procedures.			6
CLO3	Characteristics of non-response, measuring non-response, dealing with non-response, perspectives on non-response			
CLO4	Estimation in presence of unit non-response, methods of reducing non-response and response errors.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Hands-on activities	Summative Measure (Final Exam.)
CLO2	Hands-on activities	Summative Measure (Final Exam.)
CLO3	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)

Text Book

1. Cochran, W. G. (1977): *Sampling Techniques*, 3rd edition, Wiley, New York.
2. Raj, D. and Chandhok, P. (1998): *Sample Survey Theory*, Narosa Publishing House, New Delhi.

Reference Books

1. Islam, M.N.: *An Introduction of Sampling Methods: Theory and Applications*.
2. Murthy, M.N. (1977): *Sampling Methods*, 2nd edition, Statistical Publishing Society, Calcutta.
3. Sing, D: *Theory of Analysis of Sample Survey Design,* New Age Publisher.

Thompson, S. K(2002), *Sampling,* John Wiley, New York.

Group B (Mathematical Demography): 50 Marks

Rationale:

This course introduces the basic techniques of demographic analysis. Students will become familiar with the sources of data available for demographic research. Population composition and change measures will be presented. Life table, standardization and population projection techniques will also be explored.

Objectives:

The objectives of this course are to

- Identify appropriate sources of data, perform basic demographic analyses using various techniques and ensure their comparability across populations.
- Produce population projections and interpret the information gathered by the different demographic methods.

Learning outcomes:

After completion of this course, the student will be able to

CLO1	Perform basic demographic analyses using various techniques.
CLO2	Project the population by using different demographic methods.
CLO3	Construct life table and migration rate using different methods.

Mapping between PLOs and CLOs of Statistics program

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			3				
CLO2	1	3	2				3	
CLO3	1			3				2

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Estimation of Completeness of Birth and Death Registration. Calculation of Whipples's Index, Myer's Index. Smoothing of Age Data. Estimation of Intrinsic Birth Rate, Death Rate, Growth Rate and Stable Age Distribution,	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	LabPerformance, LabReportWriting, Attendance and Final	14
CLO1 CLO2 CLO3	Construction Multiple Decrement Life Table. Estimation of Fertility Schedule Using Coale-Trussel Fertility Model and			10

	Gompertz Relational Model. Estimation of Fertility Using P/F Ratio Method. Estimating Child Mortality from Information on Children Ever Barn and Children Surviving. Estimation of Adult Mortality Using Orphan hood Data, Widowhood Data and from information on the distribution of Deaths by Age. Population Projection. Fitting of Logistic Curves by Different Technique.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Lecturing and Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book

1. Rogers, A (1966):*Introduction to Multiregional Mathematical Demography.* Wiley Interscience, NW

4th Year 2nd Semester

Course Code: 0542-421 (Stat-421) Course Title: Design of Experiment-II
Marks:100 Credits: 03 Number of Classes: 42

Rationale:
This course is designed to make the students oriented with most applied experimental designs to be used in different field at advanced level.

Objectives:
Objectives of this course are to-

- Give students a sound understanding of different experimental design, both theoretical and practical.
- Able students to learn the experimental designs most widely used in practice.
- Help students to choose an appropriate experimental design based on the study objectives.
- Teach students how to construct and implement the design selected.
- Help students to analyze the data collected based on the design used and its underlying assumptions.
- Able students to interpret the results of the experiment and report the conclusions.

Learning Outcomes:

By the end of this course students will be able to:

CLO1	Describe the concepts of experimental design, determine the design used in a particular practical situation, and identify the factors relevant to the situation.
CLO2	Choose appropriate experimental design techniques in context of the problem.
CLO3	Identify, analyze and report on a selection of advanced experimental designs.
CLO4	Interpret the results and computer output from all of the above designs and present clear, orderly and informative statistical summaries and technical reports.
CLO5	Perform formal statistical analysis of data from a variety of disciplines
CLO6	Build and apply experimental designs for the real-world problems.

Mapping between PLOs and CLOs of Statistics program:

	PLO1	PLO2	PLO3	PLO4	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	2	2						2	

CLO2	3	2			1				
CLO3	1`							2	2
CLO4	1	1		2				2	2
CLO5	3		3		3				

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Factorial experiment up to p^n series, asymmetrical factorial experiments, confounding, partial confounding, total confounding, balanced confounding, fractional replications, multiple comparison test, split-plot design.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	10
CLO3	Balanced incomplete block and partially balanced incomplete block design with their construction.			10
CLO4 CLO5	Covariance Analysis, Covariance Analysis with One and Two Concomitant Variable, Analysis of Covariance in One-Way and Two-Way Classified Data.			12
CLO3	Nested Design, Analysis of Two Stage Nested Design, Analysis of Three Stage Nested Design.			10

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Lecturing and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO4	Lecturing and Problem-solving activities.	Summative Measure (Final Exam.)
CLO5	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO6	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Montgomery D. C. (2005): *Design and Analysis of Experiments*, 6th edition, Wiley, USA.

Reference Books

1. Cochran, W.G. and Cox, G.M. (2000): *Experimental Design*, 2nd Edition, Wiley, New York.
2. Das, M. N. and N. C. Giri (1986): *Design and Analysis of Experiments*, 2nd Edition, Wiley Eastern, India.

Course Code: 0542-422(Stat-422) Course Title: Biostatistics
Marks:100 Credits: 03 Number of Classes: 42

Rationale:

Biostatisticians will be trained in the skilled application of statistical methods to the solution of problems encountered in public health and medicine. Students with the statistical background, undertaking this course will further enhance their understanding of health issues and the application of statistics.

Objectives:

- Know the basic concepts of Biostatistics
- Get a clear idea about survival data and related lifetime distribution
- Learn to get information from incomplete data or censoring mechanism
- Compare the efficiency of different survival curves.
- Develop statistical models, specified for health-related data
- Learn to analyse and interpret real life survival data using statistical software's.

Learning Outcomes:

After completion of this course students will be able to

CLO1	Apply basic statistical concepts commonly used in Health and Medical Sciences;
CLO2	Apply descriptive techniques commonly used to summarize public health data;
CLO3	Interpret results of statistical analyses found in public health studies;
CLO4	Build statistical model over real health data;
CLO5	Estimate and compare efficiency of models;
CLO6	Apply statistical software to analyze health –related data.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		2		2			1
CLO2	3	2	1	1	1	3	2	1
CLO3	2	1		1			2	1
CLO4	3	1		2	2		3	2

CLO5	3	2		1	1		2	3
CLO6	2	1	1		3	2		

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Lifetime Distributions:** Survival Data, Probability density function, hazard function, survival function and their interrelationship, mean residual life function and median lifetime, some important lifetime distributions;	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	5
CLO2 CLO3	**Incomplete data analysis:** Types of censoring. Construction of likelihood function with censored data. Estimation of life parameters and their sampling variances from Exponential, Weibull, and extreme value distributions using type I and type II censored data;			7
CLO3 CLO4	**Non-parametric Methods:** Estimation of hazard and survival functions, actuarial and product-limit methods, standard errors, median survival time, tests, confidence intervals;			10
CLO5	**Parametric Survival Distributions:** Likelihood function of failure time data for different censoring mechanisms with exponential, two parameter exponential, Weibull, lognormal, normal and gamma distributions, inference procedures (Estimation and tests for small and large samples).			8
CLO6	**Comparison of Survival Curves:** Comparison of Two Groups, Log-rank (Mantel-Haenszel) Test; Hazard ratios, confidence interval for hazard ratios, stratified log rank test, median survival, non-proportional hazards, other tests for comparing two groups, comparison of more than two groups. **Logistic Regression Model:** Introduction to logistic regression, important special cases of logistic regression model, computing the odds			12

	ratio in logistic regression, maximum likelihood estimation statistical inferences, modeling strategy for assessing interaction and confounding, analysis of matched data, logistic regression for care control data, polytomous logistic regression model. **Proportional hazard model:** Basic Parametric regression model (Exponential and Weibull regression model)			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Lecturing and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO4	Lecturing and Problem-solving activities.	Summative Measure (Final Exam.)
CLO5	Discussion and Slide Show	Summative Measure (Final Exam.)
CLO6	Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Kleinbaum, D.G, (1996): *Survival Analysis,*Springer,New York.

Reference Books

1. Cox, D.R and Oakes, D,(1988): *Analysis of Survival data,* Chapman and hall
2. Daniel W.W: *Bio-statistics: A Foundation for Analysis in the Health Science,* 7th Ed. John Wiley and Sons, New York.

Course Code:0311-423 (Stat-423) Course Title: Econometrics-II
Marks: 50 Credits: 02 Number of Classes: 28

Rationale:
This course relates more advanced topics in econometrics. Students are expected to have knowledge in Regression Analysis and Econometrics. The emphasis is on understanding the models and the related theories. Through the course, we will apply the theories developed to real-world data and interpret the estimation results in many different respects

Objectives:

- Use various advanced econometric models (Probability model, Dynamic Econometric Model, Structural Equation Model, Non-Linear Model), estimation methods and related econometric theories.
- Apply the above theories to empirical data or be able to develop new econometric theory.

Learning Outcomes:
On successful completion of this course, students will be able to:

CLO1	Explain the mathematical basis of the linear Probability model, logit, probit and Tobit models.
CLO2	Apply distributed Lag model, Autoregressive model and Structural Equation Model.
CLO3	Explain the role of Non-Linear model and input output analysis.
CLO4	Apply GMM, GLS, and GEE methods to analyze non-spherical disturbances, panel data, and dynamic models.

Mapping between PLOs and CLOs of Statistics program:

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2	3		3		3	
CLO2	3		2	1			1	1
CLO3	3	2	1		3		3	2
CLO4	3	2		1	1			

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Qualitative Response Variables:** MoDetail study of linear probability model, logistic (logit), orderedlogit, generalized ordered logit, probit and tobit models.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**8**
CLO2	**Dynamic Econometric Model:** Auto regression, distributed lagged variables, lag model, meaning of dynamic distribution lag and autoregressive models' role and reasons for lags in econometric model. Method of estimation of lag by Adhocmollud, Koyck and Almon method of estimating distributed lag			**12**

	model, median lag of different models, method of instrumental variable, detecting autocorrelation in autoregressive model by Durbin H-test, Granger causality test.			
CLO3	**Non-Linear Model:** Non-linear model and principles of non-linear least squares estimation, numerical method of estimating least squares, properties of non-linear regression, Cobb-Douglas and CES production functions, estimation of Cobb-Douglas production function parameters. Input-output analysis internal efficiency inter-industry relation, application of social accounting matrix in planning and development.			**10**
CLO4	Non-spherical Disturbances, Generalized Regression and GMM Estimation and Generalized Estimating Equation (GEE), Consequences for LSE, GLS, MLE and GMM Estimation, Testing Hypothesis in GMM Framework Models with Discrete Dependent Variable, Models for Panel Data for Fixed Random Effects, Autocorrelation and Dynamic Model.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Class Test, Mid Term, Quiz
CLO2	Problem-solving activities.	Mid Term, Assignment, Presentation and Summative Measure (Final Exam.)
CLO3	Lecture and Reflective Discussion and Slide Show	Summative Measure (Final Exam.)
CLO4	Lecture and Reflective Discussion and Slide Show	Summative Measure (Final Exam.)

Text Book

1. Gujrati. (2011): *Basic Econometrics* 5th edition, McGraw-Hill, New York.

Reference Books

1. Greene, W.H. (2023): Econometric Analysis, 8th Ed, Pearson Education

2. Kleim & Miller: An Introduction to Econometrics
3. Johnston, J. (1977): *Econometric Methods*, 4th edition, McGraw-Hill, New York.

Course Code: 0714-424 (Stat-424) Course Title: Data Mining and Machine Learning
Marks:100 Credits: 03Number of Classes: 42

Rationale:
Data mining is an interdisciplinary field which brings together techniques of machine learning, database, information retrieval, mathematics and statistics. These techniques are used to find useful patterns in large datasets. It provides the methods for such knowledge discovery in data bases are required owing to the size and complexity of data collection in administration, business and science.

Objectives:
- Provide the student with a working knowledge of select topics from data mining and machine learning.
- Particular focus will be on the fundamental statistical properties and analysis of a select few popular techniques for learning, classification and prediction.
- Implement algorithms and running code to solve computationally intensive statistical problems.
- Development of solid theoretical (theorems follows by proofs) analysis of classification error in the simplest machine learning settings.

Learning Outcomes:
On successful completion of this course, students will be able to:

CLO1	Acquire knowledge about the fundamentals of machine learning and basics of data mining, which is essential for anyone contemplating a career as a professional statistician or data analyst in industries reliant upon such expertise.
CLO2	Develop a working knowledge of the statistical and theoretical underpinnings of the topics covered.
CLO3	Apply Statistical association rules.
CLO4	Introduce Database/OLTP Systems, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Data Warehousing and Machine Learning.
CLO5	Percieve Statistical Perspective on Data Mining, Decision Trees, And Genetic Algorithms.
CLO6	Develop appropriate neural network algorithm.
CLO7	Implement classification and clustering technique in real world phenomena.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	1		3	3	3			3
CLO2	3	2	2	2	2			1
CLO3	3	3			3	3	3	3
CLO4	3	3	1					
CLO5	3	3				2		1
CLO6	2		3	3		3	3	
CLO7	2	1	3	3		3	3	1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	**Overview:** Concept of data mining and its advantages and disadvantages. Basic Data Mining Tasks: Classification, Regression, Time Series Analysis, Prediction, Clustering, Summarization, Association Rules, and Sequence Discovery. Data Mining Versus Knowledge Discovery. Data Mining Versus Data extraction. Development of Data Mining, Data Mining Issues and Metrics, Social Implications of Data Mining.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**4**
CLO2	**Related Concepts:** Database/OLTP Systems, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Data Warehousing, Machine Learning, Pattern Matching.			**4**
CLO3	**Data Mining Techniques**: Statistical Perspective on Data Mining, Point Estimation, Models based on Summarization, Bayes Theorem, Hypothesis Testing, Regression and Correlation, Similarity Measures, Decision Trees, Genetic Algorithms.			**6**

CLO4	**Neural Network**: Background, Learning, Basic Neuron Model, Perception, Multiplayer Perception, Recurrent Network, Hopfield Network, Boltzanann Machine Network, Kohonen Self Organizing network, Background, Description, Determining the Winning Neuron, Learning Algorithm.			**8**
CLO5	**Classification**: Issues in Classification, Statistical-Based Algorithms: Regression, Bayesian Classification. Distance-Based Algorithm: Simple Approach, K Nearest Neighbors. Neural Network-Based Algorithms: Propagation, NN Supervised Learning, Radial Basis Function Networks, Perceptions. Rule-Based Algorithms: Generating Rules form a DT, Generating Rules for a Neural Net.			**6**
CLO6	**Clustering:** Similarity and Distance Measures, Outliers, Hierarchical Algorithms, Partitional Algorithms: Minimum Spanning Tree, Squared Error Clustering Algorithm, K-Means Clustering, Clustering with Genetic Algorithm and Neural Networks. Clustering Large Databases, Clustering with Categorical Attributes, Comparison.			**8**
CLO7	**Association Rules**: Meaning of Association, Basic Algorithms, Apriori Algorithm, Sampling Algorithm, Partitioning, Parallel and Distributed Algorithms, Data Parallelism, Task Parallelism, Advanced Association Rule Techniques, Quantitative Association Rules, Correlation Rules, Measuring the Quality of Rules. **Web Mining:** Concept of Web mining, techniques.			**6**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Interactive Lecturing	Assessment Strategy
CLO1	Classroom Discussion	Class Test
CLO2	DIY activities	Mid Term
CLO3	Brainstorming	Quiz
CLO4	Lecturing	Assignment
CLO5	Problem-solving activities.	Problem Solving
CLO6	Multimedia based Lecturing	Mid Term, Presentation and Summative Measure (Final Exam.)
CLO7	Lecture and Reflective Discussion and Slide Show, Group Discussion	Summative Measure (Final Exam.)

Text Book

1. Dunham, M. H. (2003): *Data Mining: Introductory and Advanced Topics*, Pearson Education,
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction" Authors: Trevor Hastie, Robert Tibshirani, and Jerome Friedman

Reference Books

1. Ibrahim, A.M. (2004): *Fuzzy Logic for Embedded Systems Applications*, Elsevier Science, USA.
2. Larose, D.T. (2006): *Data Mining Methods and Models*, Wiley-Interscience, India.

Course Code: 0542-425 (Stat-425) Course Title: Generalized Linear Model

Marks: 100 Credits: 03 Number of Class: 42

Rationale

The course is designed to provide students with a comprehensive understanding of statistical modeling techniques for quantitative and qualitative data commonly encountered in research. It introduces the Generalized Linear Model (GLM) as a unifying framework that encompasses classical linear regression, logistic regression, and Poisson regression, among others. The course aims to develop the theoretical foundation and practical skills necessary for fitting, interpreting, and assessing these models in real-world applications.

Objectives

- Introduce students to the theoretical framework of statistical models used for analyzing different types of data.
- Familiarize students with the exponential family of distributions and their role in defining GLMs.
- Develop an understanding of the general linear model for quantitative responses, including multiple regression, ANOVA, and ANCOVA.
- Introduce binomial regression models for binary data, including logistic and probit models.
- Teach modeling techniques for count data, such as Poisson and negative binomial regression.
- Enable students to apply estimation, inference, and goodness-of-fit techniques within the GLM framework.

Course Learning Outcomes (CLOs)

At the end of this course, students will be able to:

CLO Code	Learning Outcome
CLO1	Explain the exponential family of distributions and their role in defining the GLM framework.
CLO2	Describe and apply estimation methods such as maximum likelihood and least squares for fitting GLMs.
CLO3	Analyze quantitative data using the general linear model, including multiple regression, ANOVA, and ANCOVA.
CLO4	Fit and interpret logistic and probit regression models for binary and categorical response data.
CLO5	Apply Poisson and negative binomial regression models for analyzing count data and assess their goodness of fit.

Mapping between PLOs and CLOs of the Statistics Program

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	2		1	2	1		
CLO2	2	2	1	1		1		
CLO3	2	3	2	1	1	2		
CLO4	2	3	2	2	1	1	1	
CLO5	2	3	2	2	1	2	1	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lectures
CLO1	**Generalized Linear Models (GLMs) Structure:** Two components of generalized linear models, Random component - Exponential dispersion models (EDMs), EDMs in dispersion model form, Systematic component, Total deviance.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	6
CLO2	**GLMs Estimation:** Likelihood, Estimating parameters, Residual deviance, Best estimator, Using R to fit GLMs.			8
CLO3	**GLMs Inference:** Inference for coefficients, Large sample asymptotics, Goodness-of-fit tests, Small dispersion asymptotics, Comparing Wald, Score and likelihood ratio tests, Choosing between non-nested GLMs.			10
CLO4	**GLMs Diagnostics:** Assumptions of GLMs, Residuals for GLMs, Leverages in GLMs, When to use which type of residual, Checking the model assumptions, Outliers and influential observations, Quasi-likelihood and extended quasi-likelihood, Using R for diagnostic analysis of GLMs.			10
CLO5	**Models for Proportions (Binomial GLMs):** Modelling proportions, Link functions, Tolerance distributions and the probit link, Odds, Odds ratios and the logit link, Binary variable, Logistic regression model, Goodness of fit statistics, Residuals, Median effective dose, Complementary log-log link in assay analysis, Using R to fit GLMs to proportion data.			8

Mapping of Course Learning Outcomes (CLOs) with Teaching–Learning & Assessment Strategy

CLOs	Teaching–Learning Strategy	Assessment Strategy
CLO1	Interactive lecture and Q/A discussion	Assignment and short quizzes
CLO2	Expository teaching and problem-solving sessions	Midterm test and practice exercises
CLO3	Discussion and data-based analysis	Midterm exam and practical tasks
CLO4	Case studies and applied modeling sessions	Project report and final exam
CLO5	Lectures and reflective discussions	Summative final exam

Textbook

1. **Dobson, A.J. & Barnett, A.G. (2008).** *An Introduction to Generalized Linear Models* (3rd ed.). Chapman & Hall.

Reference Books

1. **McCullagh, P. & Nelder, J.A. (1989).** *Generalized Linear Models* (2nd ed.). CRC Press.
2. **Agresti, A. (2007).** *An Introduction to Categorical Data Analysis* (2nd ed.). Wiley.
3. **Hardin, J.W. & Hilbe, J.M. (2018).** *Generalized Linear Models and Extensions* (4th ed.). Stata Press.

Course Code:0542 – 426 (Stat-426) Course Title: Data Analysis- IX
Marks:50 Credits: 02Number of Classes: 28

Group A (Design of Experiment-II): 25 Marks

Rationale:
This course deals with the concepts and techniques used in the design and analysis of experiments. The concepts and different models of an experimental design will be studied, leading to their statistical analysis based on linear models

Objectives:
The main objectives of this course are to-

- impart students a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications

Learning Outcomes:

CLO1	Construct frequency distribution for equal and unequal class;
CLO2	Apply appropriate graph for a particular data set and then interpret the graph;
CLO3	Find different measures of central tendency and dispersion of a set of data and they will also be able to interpret the results in a proper way;
CLO4	Construct tables and graphs that display measures of central tendency
CLO5	Determine the shape characteristics of a distribution and interpret the result.

Mapping between PLOs and CLOs of Statistics program:

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	1		3		1			1
CLO2	2				1			
CLO3	3	1					2	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2	Additivity test of model in case of two-way classification, analysis of LSD with and with missing observation, problems on factorial experiment,	Interactive Class, Open Discussion, Participatory Q/A Session, Online	Lab Performance, Lab Report Writing, Attendance and Final	6
				6
				6
CLO3	confounding, split plot, balanced incomplete block design, covariance analysis.			6

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion	Lab Performance
CLO2	Lecturing and Classroom Discussion	Lab Performance, Report
CLO3	Lecturing and Problem-solving activities.	Lab Performance, Report, Summative Measure (Final Exam.)

Text Book:

1. Montgomery D. C. (2005): *Design and Analysis of Experiments*, 6th edition, Wiley, USA.

Group B (Biostatistics): 25 Marks

Rationale:
This **course** is designed to teach the basic principles of biostatistics. It can be the first course in biostatistics for those students who will use the knowledge in future statistical and health related measurements.

Objectives:
The objectives of this course are to-

- Learn the probability density function, survival function and hazard function
- Gather knowledge about Non-parametric estimation of survival probabilities and their Standard errors from ungrouped and grouped data,
- Construction of survival curves and their confidence belts,

fit appropriate parametric model to observed data and testing goodness of fit of fitted models

Learning Outcomes:
After studying all materials and resources presented in the course, the student will be able to-

CLO1	Estimate probability density function, survival function and hazard function
CLO2	Graphically represents probability density function, survival function and hazard function, non-parametric.
CLO3	Determine a Kaplan-Meier estimate of the survival function that describes the "survival experience" of a cohort of subjects.
CLO4	Construct Logistic regression model to estimate the relative probabilities for required data.

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	2	1	2	3	3	
CLO2	2	3	2		2	3	3	
CLO3	2	3	2		2	3	3	
CLO4	2	3	2	2	2	3	3	

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.

CLO1	Estimation of probability density function, survival function and hazard function, non-parametric Estimation of survival probabilities and their Standard errors from ungrouped and grouped data.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Lab Performance, Lab Report Writing, Attendance and Final Examination.	4
				4
				4
CLO2	Construction of survival curves and their confidence belts, Graduation of life data (Censored and uncensored) by plotting procedures.			6
CLO3	Fitting of appropriate parametric model (one parameter exponential, two parameter exponential and Weibull) to observed data and testing goodness of fit of fitted models.			
CLO4	Construction of confidence limits for life parameters for the fitted models, problems related on logistic regression.			

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Hands-on activities	Summative Measure (Final Exam.)
CLO2	Hands-on activities	Summative Measure (Final Exam.)
CLO3	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)
CLO4	Classroom Discussion and Problem-solving activities	Summative Measure (Final Exam.)

Text book:

1. Kleinbaum, D.G, (1996): *Survival Analysis,*Springer,New York.
2. Lawless, J.F,(2003): *Statistical Models and Methodsfor Lifetime data,* 2nd Ed, Wiley, New York

Course Code:0542 – 427 (Stat-427) Course Title: Statistical Data Analysis- X

Marks:50 Credits: 02 Number of Class: 26-28

Group A(Econometrics-II): 25 Marks

Rationale:

This course relates more advanced topics in econometrics. Students are expected to have knowledge in Regression Analysis and Econometrics with real world data

Objectives:

The course objectives are to apply the advance econometric theory to apply the real-world phenomena.

Learning Outcomes:

After completion this course students are able to:

CLO1	Apply distributed Lag model, Autoregressive model and Structural Equation Model
CLO2	Explain the role of Non-Linear model
CLO3	Estimate input-output analysis well

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		1	2		1	3	
CLO2	3			1	3	1		1
CLO3	3	3		1	1			1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1 CLO2 CLO3	Construct Probability Model, Dynamic Econometric Model, Non-linear model and principles of non-linear least squares estimation, numerical method of estimating least squares, properties of non-linear regression, Cobb-Douglas and CES production functions, estimation of Cobb-Douglas production function parameters.	Interactive Class, Open Discussion, Participatory Q/A Session, Online resources and Practical	Assignments, Class Tests, Presentation, Attendance and Final Examination.	**20**

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and Problem-solving activities.	Lab Performance and Summative Exam

CLO2	Lecturing and Problem-solving activities.	Lab Performance, Report, Summative Exam
CLO3	Problem-solving activities.	Lab Performance, Report, Summative Exam

Text Book

1. Gujrati,D. (2011): *Basic Econometrics* 5th edition, McGraw-Hill, New York.
2. Greene, W.H. (2023): Econometric Analysis, 8th Ed, Pearson Education

Group-B (Data Mining and Machine Learning): 25 Marks

Rationale:
The course is designed to finding hidden information from real world phenomena.
Objectives:
The main objective of the course is to:

- Determine the minimum distance decision boundary.
- Perform different classification techniques.
- Determine the partition set of data.

Learning Outcomes:
After completion of the course, students are able to:

CLO1	Apply different classification techniques
CLO2	Employ Cluster in real life data
CLO3	Develop association rule based on transactional data

Mapping between PLOs and CLOs of Statistics program

PLOs / CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		1	2		1	3	
CLO2	3			1	3	1		1
CLO3	3	3		1	1			1

Course Content, Teaching and Assessment Strategy

CLOs	Course Content	Teaching Strategy	Assessment Strategy	No. of Lec.
CLO1	Performing K-NN Classification Using Euclidean and Statistical Matrix, Application of Different Rules of Data Mining, Classification by Regression Tree, Decision Tree, Bayesian Approach, Neural Network.	Interactive Class, Open Discussion, Participatory	Assignments, Class Tests, Presentation, Attendance and Final	7

CLO2	Determination of Partition of Set of Data by Sum of Squares of Errors, Clustering Criteria, Hierarchical Clustering by Nearest Neighbor, Further Neighbor, K-Means Method or Algorithm, Determination of Minimum Distance Decision Boundary,			8
CLO3	AprioriAlgorithm, Sampling Algorithm, Partitioning, Parallel and Distributed Algorithms			9

Mapping of Course Learning Outcomes (CLOs) with the Teaching – Learning &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Classroom Discussion and interactive learning	Lab Assessment
CLO2	Problem-solving activities and Collaborative learning spaces	Lab report Writing and Viva-Voce
CLO3	Lecture, Current events quizzes, and Reflective Discussion	Lab Performance (Summative Examination)

Text Book

1. Dunham, M. H. (2003): *Data Mining: Introductory and Advanced Topics*, Pearson Education,

Course Code: 0542- 428 (Stat-428) Course title: Research Project
Marks:100 Credits: 03

Rationale

Statistics project reports allow students to communicate research findings, support hypotheses, and validate research methodology and conclusions. This course helps students develop the ability to evaluate data, present results clearly, and draw meaningful conclusions, enhancing their statistical reasoning and practical research skills.

Objectives

- Describe the data sources accurately.
- Ensure precision in data analysis.
- Draw accurate conclusions and discussions.
- Present findings clearly and coherently.
- Demonstrate the significance and relevance of the study.

Learning Outcomes

By the end of the course, students will be able to:

CLO No.	Course Learning Outcome (CLO)
CLO1	Write a research proposal for the project.

CLO2	Identify a research gap in the chosen field.
CLO3	Collect and organize relevant data for analysis.
CLO4	Perform accurate statistical analysis of the data.
CLO5	Discuss results, draw conclusions, and provide recommendations.

Mapping Course Learning Outcomes (CLOs) with PLOs

(CLOs)	Fundamental Skill	Social Skill	Thinking Skill		Personal Skill	
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
CLO 1	3	3	3	3	2	2
CLO 2	2	2	3	3	1	1
CLO 3	1	2	1	1	3	2
CLO 4	1	1	1	1	2	2
CLO 5	2	2	2	2	3	3

Course Contents

Each project student will be assigned to a principal supervisor by the department. The project students will determine the topic of the project in consultation with their supervisor and co-supervisors.

Mapping Course Learning Outcomes (COs) with the Teaching-Learning& Assessment Strategy

COs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO 1	Lectures and books that CLO over thesis topic	Semester-end examination
CLO 2		Semester-end examination
CLO 3		Semester-end examination
CLO 4		Semester-end examination
CLO 5		Semester-end examination

Viva-Voce **Marks: 50** **Credits: 1.5**

PART D

Examination Rules and Regulations for Bachelor's Degree

(Semester System)

Effective from the session 2011-12

As passed by the 26th Meeting of the Academic Council and approved by the 33th meeting of the Syndicate.

1.*THE RELEVANT ACTS*

১। ২৮ মে ২০০৬ খ্রিঃ, ১৪ জৈষ্ঠ্য ১৪১৩ বঙ্গাব্দ, তারিখশিক্ষামন্ত্রণালয়েরপ্রজ্ঞাপনেকুমিলাবিশ্ববিদ্যালয় ১৭ নং আইনেরধারা ১-এর উপধারা (২) দ্বারাপ্রতিষ্ঠিত হয়। উক্ত আইনের ক্রমিক ৪১ ও ৪২ মোতাবেককুমিলাবিশ্ববিদ্যালয়েরপরীক্ষাব্যবস্থা নিম্নরূপহইবেঃ

***অনুচ্ছেদ-৪১:*<u>পরীক্ষা</u>**

(১) ভাইস-চ্যান্সেলরেরনিয়ন্ত্রণাধীনেপরীক্ষানিয়ন্ত্রকপরীক্ষাপরিচালনার জন্য যাবতীয়ব্যবস্থা গ্রহণকরিবেন।

(২) একাডেমিককাউন্সিলপরীক্ষাকমিটিসমূহনিয়োগকরিবেএবংউহাদেরগঠন, ক্ষমতা ও কার্যাবলীবিশ্ববিদ্যালয়বিধিদ্বারানির্ধারিতহইবে।

(৩) কোনপরীক্ষারব্যাপারে কোনপরীক্ষক কোনকারণে দায়িত্ব পালনেঅসমর্থ/অপারগহইলেপরীক্ষাকমিটিরসুপারিশেরপরিপ্রেক্ষিতে ভাইস-চ্যান্সেলরেরঅনুমোদন ক্রমে তাঁহার স্থলে অন্য একজনপরীক্ষককেনিয়োগ দেওয়াযাইবে।

***অনুচ্ছেদ-৪২:*<u>পরীক্ষাপদ্ধতি</u>**

(১) বিশ্ববিদ্যালয়ে সেমিস্টার ও নির্ধারিতসংখ্যক কোর্স একক (credit-hours) পদ্ধতিতেপরীক্ষাগ্রহণকরাহইবে।

(২) সম্পূর্ণ পাঠ্যসূচিকয়েকটি সেমিস্টারেবিভাজিতহইবেএবংডিগ্রী, স্নাতকোত্তরবাডিপ্লোমাবিশেষের জন্য নির্ধারিতসংখ্যক কোর্স একক (credit-hours) প্রাপ্তিরভিত্তিতেডিগ্রীলাভেরসর্বোচ্চসময়নির্ধারিত থাকিবেএবংপ্রত্যেকপাঠক্রমেরসফলসমাপ্তিএবংউহারপরীক্ষাগ্রহণের পর পরীক্ষার্থীকে গ্রেড বা নম্বরপ্রদানকরাহইবে।

(৩) শিক্ষারমাধ্যমহিসাবেঅবশ্যইবাংলাভাসারসহিতইংরেজিভাষাব্যবহারকরিতেহইবে।

(৪) সকল সেমিস্টারপরীক্ষারপ্রাপ্ত গ্রেড বা নম্বরের যোগফলেরভিত্তিতেপরীক্ষার্থীকেডিগ্রীপ্রদানকরাহইবে।

(৫)বিশ্ববিদ্যালয়ের কোনবিভাগেপ্রদত্তপ্রতিটি কোর্স, যাহাবিশ্ববিদ্যালয়ের কোনডিগ্রীপ্রদানের জন্য নির্ধারিতপাঠক্রমের অংশ বিশেষ, উহা পরীক্ষণের জন্য নিযুক্ত পরীক্ষকগণেরএকজনঅবশ্যইবিশ্ববিদ্যালয়েরবহিরাগতহইবেন।

নোটঃ-(র) বহিরাগতপরীক্ষকনিয়োগেরবিষয়েকুমিল্লাবিশ্ববিদ্যালয়েরআইনেপরিবর্তনের সুপারিশকরাহয়েছে।২০১৩সনের সংশোধিতআইনে উক্ত পরিবর্তনঅনুমোদিতহয়নি।

Examination Rules and Regulations for Bachelor's Degree

1. PREAMBLE (প্রস্ড়াবনা)

This rule is named "Examination Rules and Regulations for Bachelor's Degree" of Comilla University. This rule is applicable for Four/Five Years' 'Bachelor Degree Programme' divided into eight/ten Semesters. ***(Amended in 35th Academic Council). The***Programmes will be operated under semester system and will be guided and assessed according to the credit point system. Departments under the Faculty of Arts, Business Studies, Sciences, and Social Sciences, and other faculty/faculties as may be approved and/or opened by the University have the autonomy to develop guidelines and conduct all types of academic activities within the department either guided by or not in contradiction with this rule. Unless otherwise described, in this rule, a Semester means academic curriculum and activities conducted for a period of 6 (six) months.

2. PROGRAMME AND DEGREE

a. All Bachelor degree programmes are the composite programmes following semester system of teaching-learning, examination and evaluation.

b. All sorts of Bachelor degrees shall be treated as terminal degree.

c. The names of the degrees of different faculties shall be as follows :

Faculty	Degree Awarded	
Faculty of Science	Bachelor of Science (Honours)	BSc (Hons.) in....
Faculty of Social Sciences	Bachelor of Social Science (Honours)	BSS (Hons.) in...
Facultyof Arts & Humanities	Bachelor of Arts (Honours)	BA (Hons) in.....
Faculty of Business Studies	Bachelor of Business Administration	BBA(Hons) in...
Faculty of Engineering	Bachelor of Science (Engineering)	B.Sc. (Engg.) in..

3. MEDIUM OF INSTRUCTION

The medium of instruction of the programme of different academic faculties shall be English and /or Bangla. The Academic Committee of the concerned department shall have the right to decide the medium of instruction.

4. DURATION OF THE ACADEMIC PROGRAMME

The duration of the Bachelor degree programmes shall be f*our*/f*ive* academic years divided into eight/ten semesters. ***(Amended in 35th Academic Council).*** Each academic year is divided into two semesters to be called as 1st semester and 2nd semester.

An academic semester comprised of six months is distributed as follows:

(Amended in 67th Academic Council &82th Syndicate)

(i) Class Teaching (actual class) = 14 weeks

(ii) Preparation time for semester-final examination = 1 weeks

(iii) Semester-final examination = 3 weeks

Total = 18 weeks

Final examination may be scheduled during holidays. Within one week after the semester final examination classes of the next semester will resume.

a) Definition of credit hour:

- One credit hour refers to one lecture hour per-week for thirteen weeks.

b) Gap between examinations of two courses

- Full unit - not more than 3 days' gap between two courses. (If Weekly or National holidays do not make it longer)
- Half unit - not more than 2 days' gap between two courses. (If Weekly or National holidays do not make it longer)

5. EXAMINATION ENTRY REQUIREMENTS

A student will be allowed to take part in Semester Final Examination if s/he fulfills the following conditions:

a. If the student has registered for the concerned semester in due time.

b. If s/he has the required percentage of attendance in each course lecture.

c. If the student has paid all dues (registration fees/tuition fees/other charges) applicable to university administration/residential hall administration/discipline administration.

d. If the student has not been instructed by the Disciplinary Board / Examination Disciplinary Committee to refrain from taking part in the examination.

6. EXAMINATION PROCEDURES

a. Formation of the Examination Committee: The departmental Academic Committee will form Examination Committee for each academic year consisting of two semesters of the programmed. The Examination Committee shall comprise of 4 (four) members: one chairman, two internal members and an external member appointed from any other reputed university not below the rank of Associate Professor. One cannot be the member of the Examination Committee if any of her/his relative[1] is a student / examinee of the concerned year. In special cases, external member might be an Assistant Professor with the approval of the Academic Council/Vice-Chancellor. In case of any vacancy, absence or inability of a member to perform his duty of any examination work shall not be invalidated. Chairman of the 4th year (7th and 8th Semester) Examination Committee will be a senior teacher of the department. However, if available, Chairman of any Examination Committee must not be below the rank of Assistant Professor. It is advised to form the Examination Committee at the beginning of the academic year.

b. Functions of the Examination committee:

i. The relevant Examination Committee shall nominate the question setters and examiners for each theoretical course and report the nomination to the Controller of Examinations, who shall issue appointment letters subject to the approval of the Vice Chancellor.

ii. The Examination Committee shall arrange moderation and printing of question papers, conduct the practical /oral (viva-voce) examination, and prepare the results. If needed the Examination Committee may invite the course teacher for moderation of the particular course if the course content is not very familiar to the member of the moderation board. The Examination Committee of the concerned Department shall be responsible to conduct examination. However, In Examination Committee such cases,

[1] Relative means son and daughter, spouse, siblings, first cousin, nephew, niece, spouse of siblings and spouse of first cousin, brother-in-law, sister-in-law, son-in-law, daughter-in-law, first uncle, and first aunt.

even the Examination Committee can request the Controller of Examinations to appoint a guest moderator, if necessary redundant Examination Committee.

b. Examination schedule: Departmental Academic Committee shall make the semester plan for the course teachers and concerned students to follow. The plan will include the tentative dates of mid-term examinations, class suspension and final examinations.

Before each semester, the Examination Committee in consultation with the chairman of the department, shall prepare the semester final examination schedule and send it to the Controller of Examinations through the Dean of the faculty for necessary arrangements. Accordingly, the Controller of Examinations will make necessary arrangements to conduct the examination.

c. Setting Question-paper, Moderation, Evaluating and Scrutinizing Answer-script and Preparation of Marks sheet:

i. There shall be two question setters / examiners (1st and 2nd) for each course of the semester-final examination. The course teacher will normally act as the 1st examiner for each course. The Examination Committee shall select the second examiner from the 'Panel of Examiners' as approved by the Vice Chancellor. If more than one teacher conducts a course, the Examination Committee would select any one or both jointly as 1st examiner who shall act as question setter and script evaluator, as well and remuneration will be distributed accordingly.

ii. The question setters will submit signed manuscripts of questions in sealed envelopes directly to the chairman of the Examination Committee personally or through insured-postal mail. The Examination Committee shall have the right to take any decision regarding the moderation of the question that is not received from external and/or internal in time.

iii. The course teacher will display before-final marks in the notice board for the students before the commencement of the semester final preparatory leave. Thecourse teachers will submit three sets of marks of before-final assessments (class participation and continuous assessment) of the courses in sealed envelopes: two sets directly to the chairman of the Examination Committee and one set to the controller of examinations. Final examination answer scripts cannot be received by the examiner before the submission of before-final assessment marks.

iv. The question setters, the answer-script examiners, the scrutineers and the tabulators will have to consider all the documents and information related to the examination results very confidential. After receiving these documents, the chairman of the Examination Committee will keep them secured.

v. If the concerned person(s) makes any change or correction in the manuscript of question-paper, marks on the marks-sheet or grades written in the grade-sheet, s/he must sign there. In case of correction of marks, the wrong one has to be struck through and the correct one has to be written beside it. Overwriting or use of whitener or correctly should be avoided.

vi. Questions asking for political views or affiliation or religious belief or comments hurting the belief of the examinee should be avoided.

vii. For each theory course, maximum one-third of the total number of questions to be answered can be given as options (additional questions).

viii. The question-setter must put his/her name and signature with date in each page of the manuscript.

ix. If any question-setter or answer-script examiner is unable to accept his/her appointment, he must inform the Controller of Examinations immediately after receiving the appointment. If any answer-script examiner is unable to examine answer-scripts for any valid reason he must send scripts back to the controller of examinations without delay.

x. On receiving the packet of answer-script the examiner will compare the number of answer-script/s and other information written on the top-sheet given inside the packet. If any discrepancy is found, that shall be notified in writing to the controller of examinations within three days after receiving the answer-scripts, otherwise it will be taken as granted that everything mentioned in the top-sheet was found alright. If mistakenly, the script of another course or section is supplied, the examiner concerned should instantly return that to the Controller of Examinations.

xi. The examiners will evaluate every answer within the script and will write the marks in the prescribed marks-sheet. If any student answers more number of questions than asked for, the examiner will not evaluate the last redundant answer(s).

xii. In evaluation of answer-scripts, if the examiner finds enough reason to believe that unfair means has been adopted by the examinee, s/he should instantly send confidential report to the chairman of the Examination Committee on the matter mentioning the basis.

xiii. If the examinee or anybody on behalf of the examinee tries to influence the examiner in evaluating answer-scripts, the examiner will instantly notify that to the chairman of the Examination Committee. This will be treated as serious offence and all grades in the concerned course will be suspended. Until the Examination Disciplinary Committee takes Examination Disciplinary Committee decision in this regard.

xiv. The course teachers, question setters, examiners, moderators, scrutinizers, tabulators, relevant persons and the other concerned will submit remuneration bill to the chairman of the Examination Committee. The chairman of the Examination Committee will forward the bills to the Controller of Examinations. Postal charge and other relevant expenses should be included with the bill attaching necessary voucher(s).

xv. Within 3 to 6 weeks of publication of the results in each semester the chairman of the Examination Committee will handover answer-scripts of the mid-term examinations to the controller of examinations. The Controller of examination will preserve all answer-scripts of each student for two more years after publication of the result.

d. Conduct of Examinations: All semester-final examinations shall be conducted by the Department with the assistance of the office of the Controller of Examinations. The Examination Committee/ the Controller of Examinations shall be responsible for safe

custody of manuscripts, question papers and answer scripts along with the supporting papers of that examination. The Chairman of the Examination Committee will make the appointment of the invigilators and supporting staff to conduct the examination. The Examination Committee, however, shall conduct semester-final examinations under the following principles:

i) The Chairman of the examination Committee/member shall act as the Chief Invigilator. The course teacher will be invigilator. ***(Amended in 36th Academic Council ঃ agenda-15).***

ii) Excluding the Chief Invigilator, there shall be one invigilator for every 20 examinees in each course of semester-final examinations. In case of valid grounds, the Chairman of the Examination Committee may appoint one extra invigilator.

iii) In case of a candidate suffering from contagious or infectious diseases (e.g.chicken pox etc.) duly certified by the university medical officer, s/he will be provided with a sick bed in the medical center or at a convenient place within the campus (other than the hall of residence) as decided by the chairman of the Examination Committee. In such cases, the candidate should inform the Chairman of the Examination Committee well ahead of examination date so that the Controller of Examinations or the chairman of the Examination Committee may have enough time to arrange sick bed and appoint separate invigilator (if necessary). The Vice-Chancellor, the Dean of the concerned faculty, The Chairman of the department may visit the Examination Hall as and when he feels necessary.

iv) ***Duration of the Final Examination:*** The final examination for every one or two credit point theoretical course shall be of 2-hour duration and the courses having more than two credit point theoretical course shall be of 3-hour duration. Duration of the practical examination shall be four to six hours as decided by the concerned Department.

v) ***Penalty for adoption of unfair means:*** Astudent who has adopted unfair means in any examination, assignments, term papers, reports, research monograph etc. might be expelled from that semester or any other punishment might be imposed on him/her by the Examination Disciplinary Committee. Each such case has to be reported to the Examination Disciplinary Committee by the chief invigilator through the chairman of the Examination Committee. The Instruction to the examinee on cover leaf of the answer script must be followed by the examinee. Violation of these instructions and/ or any clause under Section-4 of the "Rules and Regulation Regarding Examination Offences and Disciplinary Actions" (Annex-2) will be treated as serious offence and punishable.

e. Distribution of the answer scripts: The course teacher who is the 1st examiner and the chief invigilator of his course final examination, shall receive the answer scripts from the examination hall at the end of the examination with acknowledgement from the person assigned by the Controller of Examinations along with necessary supporting documents (question, top sheet, instructions, blank mark sheets, envelops, etc). On receipt of examined answer scripts from the 1st examiner, the Controller of Examinations shall count the answer scripts and send them by insured mail to the 2nd examiner in a new packet (s) with the top sheets and the supporting documents for evaluation. The answers scripts must be posted through registered mail or in person over to the 2nd examiner with his/her

acknowledgement of receive. Both 1st and 2nd examiners shall return the answer scripts within the specified date, along with three sets of hand written marks sheets signed with name and date separately - two sets to the chairman of the relevant Examination Committee and one set to the Controller of Examinations. The Controller of Examinations shall follow the 'five answer-scripts a day' policy in specification of the date of submission. For external examiners extra ten (10) days may be given on postal reason. For delaying the submission of the answers scripts a penalty[2] will be charged for each delayed day. The Controller of Examinations shall keep all dispatch records properly.

f. Third Examination: The arithmetic mean of the marks given by two examiners (1st and 2nd) shall be taken as final marks. If the marks given by 1st and 2nd examiners to a candidate differ by more than 20%, the respective answer script(s) will be evaluated by a third examiner.~~IN SUCH CASES, THE ARITHMETIC MEAN OF THE CLOSER TWO MARKS SHALL BE TAKEN AS FINAL.~~ The third examiner shall be appointed by the respective Examination Committee from the approved panel of examiners other than any member of the concerned Examination Committee, or any examiner of that particular course.

Amended in 31st Academic Council: In such cases, the arithmetic mean of the closer two marks shall be taken. If the three marks are equally apart, arithmetic mean of the higher two will be counted.

g. Submission of Marks Sheets: All examiners including course teachers involved in before-final assessment, viva-voce, etc., shall prepare three (3) copies of marks sheets and submit two (2) copies to the Chairman of the respective Examination Committee and one (1) copy to the Controller of Examinations.

i. Tabulation: The Examination Committee concerned shall arrange tabulation works. under the following principles:

i. The tabulation works shall not begin until marks of all courses are received.
ii. Sealed marks sheets shall be opened in front of the Examination Committee.
iii. Any marks sheet without original signature, name and designation of the examiner cannot be considered for tabulation. In such cases the concerned examiner must be requested to submit an acceptable marks sheet immediately.
iv. Confidentiality must be maintained in tabulation.
v. A three-step procedure in tabulation must be followed. In the first step, before-final examination marks, internal examiner's marks and the external's marks must be inputted in the prescribed format to identify the answer scripts required for third examination. The second step is to input third examiner's marks to get the tabulation marks sheet complete. Final step is the insertion of marks in the final tabulation sheet.
vi. Total marks (before final marks and final marks) for each course shall be compiled in round figures.(৫০মার্কস এর ক্ষেত্রেপ্রথমে রাউন্ডকরেতারপরশতকরায়নিতেহবে। উদাহরন ৩৫.২ কে ৩৫(৭০), ৩৫.৫ কে ৩৬(৭২) (৩১এসি এজেন্ডা-১৯)

[2] It will be mentioned in the letter of instructions to the examiner as issued by the Controller of Examinations.

vii. **A fraction of total marks 0.5 or above shall be rounded up to the next higher integer (marks), and a fraction of less than 0.5 shall be rounded to the preceding integer.**

viii. Grade Point Average (GPA) / Cumulative Grade Point Average (CGPA) will be calculated up to the second decimal points. If the third decimal point is 0.5 or above it shall be rounded up to following second decimal points.

ix. The final CGPA will be calculated based on the Grade Points (GP) of all the courses.

j. Preservation of the Examination Documents: The Chairman of the Examination Committee, after finalizing the results, shall hand over all relevant documents (all marks sheets, Tabulation sheets and Examination statements along with the resolutions of the Examination Committee) to the Controller of Examinations. The Controller of Examinations should send one copy of the published results to the Chairman of the concerned department to be preserved in the department office. The copies of all the examination documents belonging to the Examination Committee will be handed over to the chairman of the department to preserve for a certain period.

7. EVALUATION SYSTEM

a. Theoretical Course: Each theoretical course offered should be composed of either 50 or 100 marks (each 50 marks course consisting of 2 credit point). The proportion of the total marks of a particular course shall be distributed as follows:

Continuous Assessment /Before-Final Assessment	40%
Semester-Final Examination	60%
	Total = 100%

b. Continuous Assessment: Marks allocated for before-final assessment shall be distributed as follows:

i. ***Internal Evolution:***

a) Mid-Semester examination (At least Two mid- semester exams.)	20%
b) Class Test and/or Quiz and/or In-course and/or Sudden test and/or tutorial and/or Assignment and/or Term paper preparation & presentation/ Case study and/or practical and/or Field work [3]	15%
- Class Attendance	5%
	Total = 40%

ii ***Class Attendance:*** The marks allocated for class attendance shall be given as following proportions:

Attendance	Marks
90% and above	100%
85% to less than 90%	90%

[3] Concerned department and/or course teacher will decide the allocation of this mark in different activities.

Attendance	Marks
80% to less than 85%	80%
75% to less than 80%	70%
70% to less than 75%	60%
65% to less than 70%	50%
60% to less than 65%	40%
Less than 60%	00%

iii. ***Before-final Assessment Report:***

- At the end of the course, the course teacher shall calculate the total marks of the continuous assessment (including class attendance) and prepare a marks sheet. **The answer scripts of the mid-term examinations should be shown to the students as it is valuable for their learning process.** The before-final assessment marks have to be submitted to the Controller of the Examinations before the suspension of class for the semester final examinations.
- The course teacher shall also submit the class attendance marks along with the register/documents to the Chairman of the Department. The chairman will take into consideration the attendance mark while forwarding the examination entry forms to the Controller of the Examinations.

c. Class-Attendance Requirements to Appear in the Semester Final Examination:

i. If class attendance of any student at any course is below 60%, but in the range of 40% to 59%, s/he will be allowed to attend the examination only with the recommendation of the course teacher and approval of the chairman of the department. In such cases the student will have to pay a fine as fixed by the authority/department.

ii. A student with class attendance of less than 40% in any course will be debarred from appearing in the Final Examination.

d. Letter Grade and Grade point: Total marks obtained in each course, oral (viva-voce) examination and practical courses shall be converted into LG (Letter Grade) and GP (Grade point) as follows:

Numerical Grade	Letter Grade		Grade point	Interpretation
80% and above	A+	(A Plus)	4.00	Outstanding
75% to less than 80%	A	(A regular)	3.75	Excellent
70% to less than 75%	A-	(A minus)	3.50	Very Good
65% to less than 70%	B+	(B Plus)	3.25	Good
60% to less than 65%	B	(B regular)	3.00	Satisfactory
55% to less than 60%	B-	(B minus)	2.75	Below Satisfactory
50% to less than 55%	C+	(C Plus)	2.50	Average
45% to less than 50%	C	(C regular)	2.25	Pass
40% to less than 45%	D	.....	2.00	Poor
Less than 40%	F	.....	0.00	Fail

* In the Transcript/Grade sheet, only the Letter Grade and the Corresponding Grade points, and final CGPA (in the 8th Semester), not the numerical marks, will be shown.

8. PREPARATION AND PUBLICATION OF RESULT

a. The following information shall be shown in the tabulation sheets:

i. The Semester-final result will include before-final assessment marks, semester-final marks, total marks and Letter Grade (LG) in each course (including Viva-voce/ internship/practical/project/field work/monograph, etc.) and secured Grade Point Average (GPA)/ Cumulative Grade Point Average (CGPA) and Earned Credit Point (ECP);

ii. The Final Result sheet will include (after completion of the program) continuous assessment marks, semester-final marks, total marks, LG and GP in each course, including viva-voce/internship/practical project/field work/monograph etc. marks with corresponding LG, GP, total points secured, CGPA, ECP and the Interpretation of the result;

iii. Keeping record in tabulation sheet: The "F" removal marks shall be written in the tabulation sheet of the concerned year by the present Examination Committee; and must be signed by members of the Examination Committee.

iv. Manifestation in semester-final Result Sheet: The Semester-final result sheets, which shall be published for the students, shall show only the LG, GP in each course, GPA and CGPA, not the numerical marks.

[The ECP, GPA and CGPA shall be calculated using the formula as shown in Annex-5 of this rule and regulation. The elaborations of the abbreviations are: LG = Letter Grade; GP = Grade point; GPA = Grade point Average; CGPA = Cumulative Grade Point Average; ECP = Earned Credit Point]

b. The internal members (other than the chairman of the Examination Committee and external member) of the Examination Committee shall ordinarily act as tabulators. **If necessary, the Controller of Examinations on recommendation of the relevant Examination Committee would appoint tabulators other than the members of the Examination Committee.** The tabulators shall prepare the final result sheets and the chairman of the Examination Committee shall send them to the Controller of Examinations for publication duly signed by tabulators, the chairman and the internal members of the Committee will also send the proceedings of the meeting of the Examination Committee. An 'Examination Statement' shall be prepared by the Chairman of the Examinations Committee which shall include;

I. Number of courses with Course code, Course Title, Full marks, and Credit points;

II. The name of the Mid-Term examiners with the number of examinees of each examination;

III. The name of the question setters of each course;

IV. The name of the 1st, 2nd& 3rd (if any) examiners/evaluators in each course/ examiner of the practical course with the number of scripts, (monograph/fieldwork report/project report/internship report etc.)

V. The name of the question moderators with signature sheet;

VI. The name of the participating members in the oral examinations and their signature sheet with the number of examinees; and

VII. The name of the tabulators with the number of examinees. Other related documents to be attached with the tabulated result sheets are:

- list of evaluators of monograph/fieldwork report/project report/internship report/etc.
- resolution of the with recommendation for publication of the results; and
- other relevant/necessary papers.

c. The Controller of Examinations shall publish the results of each semester-final and the final result of the program, subject to the approval of the academic council and then shall send a copy of the tabulation sheets to the Chairman of the concerned Department duly signed by him with date. The Controller of Examinations shall also provide the transcript/grade sheet showing course-wise LG and the corresponding GP (the numerical marks shall not be shown), the CGPA, LG and the interpretation of the CGPA of the candidates for the Bachelor degree. Final Grade must be spelled out clearly in the certificate/transcript.

[Example: C + = 'C' (C plus); A- = 'A-' (A minus); B = 'B' (B regular)].

d. The result of the semester-final examinations shall be published within 08 (eight) weeks from the date of the last examination. The final result of the programme shall be published within 10 weeks from the date of the last examination including practical /monograph /fieldwork/project/viva-voce, etc. ***(Amended in 35th Academic Council).***

e. Result sheets of each examination as prepared by the Controller of Examinations shall be compared and signed by the chairman of the Examination Committee or his/her nominee who must be a member of the Examination Committee.

9. REGISTERING COMPLAINTS ABOUT MARKING, GRADING AND RELATED ISSUES:

No complain shall be accepted on final marking, grading and related issues. Correction on before-final assessment can be made by the concerned course teacher if s/he finds justifiable ground to correct and that must be done before submission of before-final assessment marks to the Controller of Examinations.

10. PROMOTION[4]

a. Keeping consistence with the spirit of the semester system, semester-wise promotion will be declared.

b. For promotion from one semester to the next semester, a student is required to earn minimum 50% of the total credit in the respective semester on condition that s/he has passed the viva-voce. Remaining Credit hour has to earn within next available batches. *

The failed student shall be allowed to appear in the examination only in the failure course/s and no need to appear the course/s that already passed except improvement.

উপরোক্ত ধারারব্যাখ্যাহিসাবেনিম্নোক্ত পাদটিকা সংযুক্ত হবে-

In calculating 50% of the total credit number of courses will be counted to avoid fractions. For example, 50% of 15 credit courses will be counted 09 credits; rather than 7.5 credits (If there are five courses 03 credit each)

কোন সেমিস্টারে ৫০% ক্রেডিটআওয়ারগননায় ৫০% কোর্স এর পুর্ণ সংখ্যাবিবেচিতহবে। উদাহরণহিসাবেযদি কোন সেমিস্টারেপ্রতিটি ৩ ক্রেডিটবিশিস্ট ৫টি কোর্স থাকেতবে এ নিয়মঅনুযায়ী ৫টি কোর্সেরঅর্ধেকপূর্ণ সংখ্যাহিসাবে ৩টি কোর্স

[4] For the session 2006-07 to 2010-11 the promotion rule is different and is attached in Annex-1 .

হবে। ৩টি কোর্সের ক্রেডিটআওয়ারহবে ৩×৩=৯ ক্রেডিটহবে। অর্থাৎ এ সেমিস্টারেপ্রমোশন পেতেহলে কোনছাত্রকে ৯ ক্রেডিটপাশকরতেহবে। অনুরুপভাবে কোন সেমিস্টারে ৩ ক্রেডিটের ৪টি কোর্স থাকলেএকজনছাত্রকেপ্রমোশনের জন্য ১২ ক্রেডিটের ৫০% অর্থাৎ ৬ ক্রেডিটবা ২টি কোর্স পাশকরতেহবে।) ***(Amended in 35th Academic Council).***

C.If anybody is absent from the viva-voce on any valid ground a viva-voce may be arranged for him/her on condition that s/he will bear all expenses of the viva. In such case s/he has to apply to chairman of the department within 15 days after the viva-voce exam.

11. DEGREE REQUIREMENTS

a. For Bachelor (Honours) degree/BBA degree, a student requires to:

i. Earn required number of total credit points successfully;

ii. Earn a minimum CGPA of 2.25; and

iii. Complete the program within six academic years from her/his 1st admission to the program.

b. Award of (Pass) Degree:

i. A student who fails to secure a minimum CGPA of 2.25 after completing eighth semester final examination but succeeds in securing a CGPA between 2.00 and 2.25 will be eligible for a Pass Degree.

ii. A student who fails to remove 'F' in any two courses but secure a minimum CGPA of 2.00 after completing eight semester final examination will be eligible for a pass degree. ***(Amended in 33th Academic Council).***পরীক্ষাবিধির উপরোক্ত ধারাটি ২০১১-২০১২ শিক্ষাবর্ষ হতেকার্যকরহবে। ইতিপূর্বে যাদেরফলাফলপ্রকাশিতহয়েছেতারাও উপরোক্ত বিধিরআওতায়পড়বে।

iii. The student with a Pass Degree shall not be eligible for admission into Master's Program. **(Amended in 35th Academic Council)**

12. IMPROVEMENT/F-REMOVAL OF GRADES

i. **F-REMOVAL:** A student having earned 'F' grade in any course in any semester shall be required to remove the 'F' grade. Removal of 'F' grade in any course is permitted only for two (2) times excluding the regular examination which has to be done with subsequent available batches ***(Amended in 35th Academic Council).***

ii. **IMPROVEMENT**: A student having earned letter grade **'B-' (GP- 2.75)** or below in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch[5]. S/he can avail this opportunity only once for a course. In such case the best GPA from the improvement or the regular examination of the concern subject shall be calculated for tabulation. ***(Amended in 35th Academic Council).***পরীক্ষাবিধিরউপরোক্ত ধারাটি ২০১১-২০১২ শিক্ষাবর্ষ হতেকার্যকরহবে। ইতিপূর্বে যাদেরফলাফলপ্রকাশিতহয়েছেতারাও উপরোক্ত বিধিরআওতায়পড়বে।

iii. No improvement shall be allowed in 7th& 8th semester.

iv. For appearing in the improvement examination, a student shall have to pay fees for the course prescribed for the purpose.

[5]If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

v. A student willing to improve grade should apply to the controller of examination through the chairman of the department within 01 (one) week after the publication of the results of the semester.

vi. No improvement shall be allowed in continuous assessment (mid-term/class-test/assignment/ fieldwork/ monograph/ project/ practical/case-study/term-paper/quiz test/etc.).

vii. The concerned (current) examination committee to that semester will take necessary actions to arrange the improvement examinations, tabulation and posting of marks.

viii. **SPECIAL SEMESTER EXAM:** Students who did not get the opportunity of removing 'F' in any course as per rule 12 (i) shall be allowed to sit for a special semester examination. This will be allowed only for the courses in 7th and 8th semester. In special cases this opportunity would be allowed for courses in semester 5th and 6th. In such cases student have to apply to the Chairman of the department within one week after publication of the 8th semester result. The Chairman of the department shall take necessary administrative measures for arranging the special semester examinations by the respective 4th year examinations committee. All the expenses relating to this examination shall be borne by the candidate(s). ***(Amended in 35th Academic Council).***

* If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

13. RE-ADMISSION

a. A student failing to earn the requisite credit points for promotion (clause 10) from one semester to the next may seek readmission with the following batch.

b. For readmission a student shall have to apply within one month after the announcement of the result of the concerned semester.

c. Readmitted student shall be allowed to appear in the examination only in the fail course/s and no need to appear the course/s that already passed except improvement. * সকলশিক্ষাবর্ষের জন্য বিধিটিপ্রযোজ্য। (৩৫তম বিশেষএকাডেমিককাউন্সিল)

d. সকলবিশ্ববিদ্যালয়েঅনুসৃতএকাডেমিকর ুলস্অনুসারেএকজনছাত্র-ছাত্রীস্নাতক (সম্মান) সম্পন্নকরার জন্য সর্বোচ্চছয় (০৬) ক্রম শিক্ষাবর্ষ সময়পাবে। একটিবর্ষে সর্বোচ্চএকবারএবংসম্পূর্ণ প্রোগ্রামেঅনধিক দুইবারপুনঃভর্তিরসুযোগপাবে। (পুনঃভর্তি সংক্রান্ড় অন্যান্য শর্ত পূরণসাপেক্ষে)

(Amended in 24th Academic Council).

14. DROP OUT

a. If a student re-admitted twice in any semester fails to earn minimum required credits [6] for promotion shall be dropped out from the programme.

b. If a student fails to earn required total credit points within six academic years since admissions, s/he will be dropped-out from the program and will no more be allowed to continue his/her studentship with other program.

15. CREDIT TRANSFER

No Credit transfer from any other program /University /Institutions to the Comilla University is allowed.

[6] For the session 2006-07 to 2010-11 'the minimum required CGPA in each class year'.

16. ACADEMIC ADMINISTRATION

a. Academic Calendar: The Academic Calendar showing dates of beginning and closing of classes, commencement of examinations and probable dates for publication of the results shall be published by the respective Departmental Academic Committee before commencement of each Semester. The copy shall be sent to the Dean of the faculty, Controller of Examinations and the respective University authority.

b. Academic and co-academic activities: Within the framework of these rules and regulations, and the rules of the University, the departmental academic committee may adopt policies for strengthening the academic and co-academic activities of the department.

17. FINAL RESULTS, DEGREE AND CERTIFICATE

a. 8th semester result preparation and published separately without CGPA. Internship result declared separately with the cumulative result. At the end of 4th year 2nd semester (Semester 8), the results of successful regular students of that semester and that of overall final results for graduation shall be published separately. The overall final results covering all semester results of regular successful students will be declared based on CGPA. ***(Amended in 35th Academic Council).***

b. The final results of the repeater or irregular students after 4th year 2nd semester will be published on clearance of the courses with F grade(s) and fulfillment of necessary course-credit requirement.

c. The transcript shall show the course code number, course title, credits, grade and grade point of individual courses, and GPA of each semester along with the final CGPA. ***(Amended in 35th Academic Council).***

d. The course number, course title, credits and grade obtained by the student in optional course(s), if any, will be shown in the transcript. ***(Amended in 35th Academic Council).***

e. The controller of examinations may issue the provisional certificate to a successful candidate on demand after submitting clearance certificates of all the fees and dues of the University. The original certificate of the degree shall normally be issued during the Convocation of the University.

18. DEAN'S MERIT LIST AND AWARD

Students who have earned CGPA of 4.0 shall be included in the Dean's Merit list. Students securing a CGPA of at least 3.90 shall be included in the Dean's Honor list of the year. In addition, each department can create Honor society to recognize the academic achievements of students securing a minimum CGPA of 3.95.

Academic awards may be given for superior performance based on overall final results. A student with record of "F" removal/ Improvement results will not be considered for any merit award.

19. AMENDMENT OF THE EXAMINATION RULES AND REGULATIONS

In order to make any addition, alteration, change or modification in these rules and regulations, it must be placed to the 'Departmental Academic Committee'. The Chairman of the concerned Department will forward it through the Dean to the 'Academic Council' and subsequently to the Syndicate for approval.

Annex-1: This examination rule is effective from the session 2006-07 to session 2010-11 with replacement of the Rule-10 and Rule-12 as follows:

10. PROMOTION

a) Promotion will be declared on academic year basis.

b) For promotion from one class year to next class year, a student is required to earn minimum CGPA of 2.00 in each class year. **(২৮ তমএকাডেমিককাউন্সিলসংযোজন on condition that s/he has passed the Viva-voce.)**

c) If anybody is absent from the viva-voce on any valid ground a viva-voce may be arranged for him/her on condition that s/he will bear all expenses of the viva. In such case s/he has to apply to chairman of the department within 15 days after the viva-voce exam.

12. IMPROVEMENT/F-REMOVAL OF GRADES

i. **F-REMOVAL:**A student having earned 'F' grade in any course in any semester shall be required to remove the 'F' grade. Removal of 'F' grade in any course is permitted only for two (2) times excluding the regular examination. This has to be done within his academic tenure.

ii. **IMPROVEMENT**:A student having earned letter grade **'B-' (GP- 2.75)** or below in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch[7]. S/he can avail this opportunity only once for a course. In such case the best GPA from the improvement or the regular examination of the concern subject shall be calculated for tabulation.

iii. No improvement shall be allowed in 8^{th} semester**.**

iv. For appearing in the improvement examination, a student shall have to pay fees for the course prescribed for the purpose.

v. A student willing to improve grade should apply to the controller of examination through the chairman of the department within 01 (one) week after the publication of the results of the semester.

vi. No improvement shall be allowed in continuous assessment (mid-term/class-test/assignment/ fieldwork/ monograph/ project/ practical/case-study/term-paper/quiz test/etc.).

vii. The concerned (current) examination committee to that semester will take necessary actions to arrange the improvement examinations, tabulation and posting of marks.

viii. **SPECIAL SEMESTER EXAM:**Students who did not get the opportunity of removing 'F' in any course as per rule 12 (i) shall beallowed to sit for a special semester examination. This will be allowed only for the courses in 7^{th} and 8^{th} semester. In special cases this opportunity would be allowed for courses in semester 5^{th} and 6^{th}. In such cases student have to apply to the Chairman of the department within one week after publication of the 8^{th} semester result. The Chairman of the department shall take

[7]If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

necessary administrative measures for arranging the special semester examinations by the respective 4th year examinations committee. All the expenses relating to this examination shall be borne by the candidate(s). ***(Amended in 35th Academic Council).***

Annex-2: Rules regarding Examination Offences and Disciplinary Action

Formation of Examination Disciplinary Committee:

1. Disciplinary action against candidates involved in Examination offences shall be taken by the Syndicate on recommendation of the Examination Discipline Committee as constituted below:

(i)	The Vice-Chancellor	Chairman
(ii)	The Deans of the Faculties	Members
(iii)	Two provosts to be nominated by the Vice-Chancellor	Members
(iv)	Three teachers of the University to be nominated by the Vice-Chancellor	Members
(v)	Two Chairman be nominated by Vice-Chancellor	Members
(vi)	Proctor	Members
(vii)	The Controller of Examinations	Members- Secretary

2. Members other than Vice-Chancellor members shall hold office for a period of one year after formation of the committee.
3. Five members shall form the quorum
4. The following shall be considered Examination offences:
   (a) Communication or attempt to communicate with any other candidate in the Examination Hall.
   (b) Writing in the Examination Hall anything incriminating on the question paper or admit card, table, desk, bench, etc.
   (c) Possession of incriminating notes, books, map, chart, slip, chit or any other documents, in the examination hall.
   (d) Creating or inciting to create any nuisance or disturbance in the Examination Hall.
   (e) Copying or attempt to copy from incriminating documents or from another's script, or from any writing on the person or wearing apparel while appearing at the Examination.
   (f) Taking the script out of the Examination Hall.
   (g) Changing the script or inserting unauthorized sheets in the script.
   (h) Approaching or influencing the Invigilator, Examiners, or members of the Examination Committee, Tabulators to gain undue favor or advantage in connection with Examination.
   (i) Using abusive language or holding out threat to the invigilator or any other person engaged on Examination duty inside or outside the Examination Hall.
   (J) Assault or attempt to assault or use criminal force against Chief Invigilator or the Invigilator or any other person engaged on Examination duty inside or outside the Examination Hall.

5. In making its recommendation, the Examination Discipline Committee shall follow the following rules.

(a) Candidates found guilty of offence or offences falling under Section 4 (a), (b) and (c) shall be penalized with the cancellation of the Examination at which they commit offence or offences.

(b) Candidates found guilty of offence falling under Section 4(d) shall in addition to cancellation of the Examination at which the offence is committed, be debarred from appearing at the subsequent Examination.

(c) Candidates found guilty of offences falling under Section 4(e), (f), (g) and (h) shall be debarred depending on the gravity of the offence from appearing at course(s) or from that semester Examination in addition to the cancellation of the course Examination at which the offence is committed. ***(Amended in 35th Academic Council).***

(d) Candidates found guilty of offence falling under Section 4 (i) and (j) shall, in addition to the cancellation of the Examination at which the offence is committed, be debarred from appearing at the subsequent Examinations of the one or two semesters depending on the gravity of the offence.

6. Any other offence not covered by the above rules shall be dealt with by the Syndicate on the recommendation of the Examination Discipline Committee as it deems fit.

7. Candidates committing offences except those falling under Section 4 (a), (b), (c), (d), (e) and (i) shall not be allowed to continue to appear in that paper, and their scripts shall not be sent for evaluation but shall be sent separately to the Controller of Examinations in sealed cover.

8. The Invigilator shall submit separate report for each case, regarding the nature of the offence and the circumstances in which it is alleged to have been committed, with all supporting documents underlining the coped portion in the script as well as in the incriminating documents in the case of actual copying.

9. The Chief Invigilator of the Examination Center shall forward the report of the Invigilators and relevant documents with his expressed opinion along with the script. These reports and documents will be preserved by the Controller of Examinations for a period of at least six months from the date of the publication of the penalty list.

10. The following procedure shall be adopted in dealing with cases of candidates involved in Examination offences:

(i) On receipt of reports from the Chief Invigilator of the Examination Center, the Controller of Examinations shall call for explanation from the candidate concerned asking him why disciplinary action shall not be taken against him for the alleged committed of examination offence. Such show-cause notice must be sent by registered post to his permanent address as recorded in the Examination Entry Form registration form. The candidate must be given ten days time from the date of issue of show-cause notice to submit his explanation. If no explanation is received within the prescribed time limit, the Examination Disciplinary Committee may take necessary disciplinary action.

(ii) The controller of Examinations will then place all relevant documents of the case together with the explanation of the candidate to the Examination Discipline Committee for consideration. The proceedings of the Discipline Committee shall be forwarded to the registrar for reporting it before the Syndicate.

11. Provided that in any emergency, notwithstanding the provisions of the Rules and Regulations on the subject, the Vice-Chancellor may in exercise of the powers vested in him in terms of clause (j) of Section 11 [of the Comilla University Act, 2006; take any disciplinary action considered necessary in the circumstances and report the same to the Syndicate for information.

Annex-3: Rules for Laboratory Courses

The laboratory courses will be offered to students as per provision of the department duly endorsed by the Committee of Courses, Faculty and the Academic Council.

Credit specification:

Different credits will be assigned to laboratory courses as mentioned in the syllabus of the department on the basis of importance. Two laboratory hours per week for the duration of 13 weeks will be considered as one (1) credit.

For each laboratory course in the syllabus, the department will assign preferably two teachers to conduct laboratory classes.

Laboratory Examination:

Marks assigned to each laboratory course will be 100. Students will be evaluated in two phases. The marks distribution will be as follows:

Continuous Assessment:	40%	
Lab Attendance:	10%	
Lab Performance:	20%	(on all experiments)
Lab Report Writing:	10%	
Final Assessment:	60%	
Evaluation on Experiments:	50%	(25% on each experiment)
Viva-voce:	10%	

Detail distribution of Marks for the evaluation on experiment will be decided by the Examination Committee and the course teachers.

Duration of Semester-end Examination:

The duration of semester-end examination for each laboratory course will be of maximum 6 hours. The corresponding Examination Committee will decide the duration of the semester-end examination for each laboratory course of the semester.

Conduction of Examinations:

In order to conduct the final examination, the Examination Committee in consultation with the teachers associated with the laboratory course will set the laboratory examination procedure.

To conduct the semester-end laboratory examination, minimum 02 (two) internal examiners and an external examiner will be appointed. If external examiner is unable to attend, the examination will not be invalidated.

Selection of External Examiners:

External examiners will be selected from within the university or from other public university of the country as decided by the corresponding Examination Committee.

*** Note:**Rules for Project / Internship procedure shall be decided by the Academic Committee of the department. With recommendation from the Dean this has to be approved by the Academic Council to let it be effect.

Annex-4 :সাময়িকসনদপত্র/মূলসনদপত্র/মার্ক সার্টিফিকেটইত্যাদিরনির্ধারিত ফি সমূহ :

১।	সাময়িকসনদপত্র	৩০০/-
২।	সাময়িকসনদপত্র (জরুরি)	৮০০/-
৩।	মূলসনদপত্র	৫০০/-
৪।	মূলসনদপত্র (জরুরি)	৮০০/-
৫।	ট্রান্সক্রিপ্ট (ক) সেমিস্টারমার্কস/ট্রান্সক্রিপ্ট (সাময়িক) (খ) সেমিস্টারমার্কস/ট্রান্সক্রিপ্ট (খ) অনার্সসহবিভিন্নপরীক্ষা (জরুরি)	 ২০০/- ২০০/- ৮০০/-
৬।	ট্রান্সক্রিপ্ট	৫০০/-
৭।	ডুপ্লিকেটসাময়িকসনদপত্র	৫০০/-
৮।	ডুপ্লিকেটমূলসনদপত্র	৬০০/-
৯।	ট্রিপ্লিকেট সনদ	১০০০/-
১০।	বিভিন্নপরীক্ষারফলপ্রকাশেরতারিখেরপ্রমানপত্র	২০০/-
১১।	**পরীক্ষানিয়ন্ত্রকঅফিস কর্তৃক ইস্যুকৃত সাময়িক/মূলসনদপত্র/মার্কস সার্টিফিকেট/ট্রান্সক্রিপ্টযাচাই (প্রতিটি দলিলের জন্য)**	**২০০/-**
১২।	নামসংশোধন	২০০/-
১৩।	দেশের বাইরেহতেআগত সনদ যাচাই বাবদ ফি	৬০০/-
১৪।	সেমিস্টারপরীক্ষারআবেদন ফরম	১০০/-
১৫।	অন্যান্য সনদ/প্রত্যয়নপত্র	২০০/-

* (জরুরি) শব্দের অর্থ তিনকর্মদিবস।

* মাষ্টার্স ও ইএমবিএ এর জন্য উপরোক্ত হারে ফি সমূহপ্রযোজ্য। ***(Amended in 36th Academic Council).***

Annex-5: Computation of Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

The GPA and CGPA will be computed in following formula:

$$GPA = \frac{\Sigma (\text{Credit} \times \text{Grade Points Secured})}{\text{Total Credits Offered in the Semester}^{8}}$$

$$CGPA = \frac{\Sigma (\text{Credit} \times \text{Grade Points Secured})}{\text{Total Credits Offered in the Year}^{8}}$$

[8] For Session 2006-07 to 2010-11 'Total Credits offered in the Year'.

Total Number of Credits offered in the whole program

Comilla University
Department of Statistics
Curriculum of B. Sc. (Hons.)
Academic Session: 2025-2026,2026-2027 and 2027-2028

Departmental Courses			
Course Code	**Course Title**	**Credit No**	
Stat-111	Introductory Statistics	3	1st Year 1st Semester
Stat-112	Elementary Probability	3	
Stat-121	Introductory Bivariate Statistics	3	1st Year 2nd Semester
Stat-122	Probability Distribution	3	
Stat-211	Sampling Distribution	3	2nd Year 1st Semester
Stat-212	Sampling Technique-I	3	
Stat-214	Statistical Quality Control and Index Number	3	
Stat-221	Statistical Inference-I	3	2nd Year 2nd Semester
Stat-222	Regression Analysis	3	
Stat-311	Stochastic Process	3	3rd Year 1st Semester
Stat-312	Design of Experiment-I	3	
Stat-313	Introductory Demography	3	
Stat-314	Time Series Analysis and Forecasting	3	
Stat-321	Statistical Inference-II	3	3rd Year 2nd Semester
Stat-322	Order Statistics and Non-Parametric Methods	3	
Stat-324	Environmental Statistics	2	
Stat-325	Research Methodology	3	
Stat-411	Multivariate Analysis	3	4th Year 1st Semester
Stat-412	Sampling Techniques-II	3	
Stat-416	Actuarial Statistics	2	
Stat-421	Design of Experiment-II	3	4th Year 2nd Semester
Stat-422	Biostatistics	3	
	Total Credit	**64**	
Statistics Lab Courses			
Stat-116	Data Analysis-I (Lab)	2	

Stat-125	Programming with C (Lab)	3	1st Year 1st Semester
Stat-216	Data Analysis- II (Lab)	3	2ndYear 1st Semester
Stat-224	SPSS, STATA and SAS (Lab)	3	2ndYear 2nd Semester
Stat-225	Data Analysis-III (Lab)	2	
Stat-316	R and Python (Lab)	3	3rd Year 1st Semester
Stat-317	Data Analysis- IV (Lab)	2	
Stat-318	Data Analysis- V (Lab)	2	
Stat-326	Data Analysis- VI (Lab)	3	3rd Year 2nd Semester
Stat-417	Data Analysis-VII (Lab)	3	4th Year 1st Semester
Stat-418	Data Analysis-VIII (Lab)	3	
Stat-426	Data Analysis- IX (Lab)	2	4th Year 2ndSemester
Stat-427	Data Analysis-X (Lab)	2	
	Total Credit	**33**	
GED (Interdisciplinary Courses)			
Stat-113	Linear Algebra	3	1st Year 1st Semester
Stat-114	Calculus	3	
Stat-115	Microeconomics	3	
Stat-123	Algebra and Analytical Geometry	3	1st Year 2ndSemester
Stat-124	Macroeconomics	3	
Stat-213	Numerical Analysis	2	2nd Year 1st Semester
Stat-215	Advanced Calculus and Differential Equations	3	
Stat-223	Real Analysis	3	2nd Year 2nd Semester
Stat-315	Econometrics-I	3	3rd Year 1st Semester
Stat-323	Linear Programming and Operation Research	3	3rd Year 2nd Semester
Stat-413	Mathematical Demography	3	4th Year 1st Semester
Stat-414	Statistical Simulation	2	
Stat-415	Epidemiology	2	
Stat-423	Econometrics-II	2	4th Year 2nd Semester
Stat-424	Data Mining	3	
Stat-425	Generalized Linear Model	3	
	Total Credit	**44**	
Viva-Voce			

	Viva-Voce	1.5	1st Year
	Viva-Voce	1.5	2nd Year
	Viva-Voce	1.5	3rd Year
	Viva-Voce	1.5	4th Year
	Total Credit	**06**	
Project Report			
Stat-428	Research Project	3	4th Year 2nd Semester
	Total Credit	**03**	

Comilla University
Department of Statistics
Statistics Alumni Association
Convener Committee

SL.	Name	Designation
01	Gobinda Karmakar	Convener
02	Kulsum Akter Shapna	Member
03	Ummol Khayer Sumi	Member
04	Taj Uddin	Member
05	Md. Borhan Uddin	Member
06	Md. Iqbal Hossain	Member
07	Md. Safayet Hossain	Member Secretary

Co-curricular and Extra Curricular activities in Statistics department.

The department permitted an association named as Parisankhan Somite. This is an association for all current students (B. Sc. and M. Sc.) of the department. Its office is situated at the department of Statistics, Comilla University. The Statistical Association completed different Co-curricular and extra-curricular activities in favor of department and current students, which are-

a) Attending different statistical seminar and conference
b) Sports program(Indoor and outdoor games)
c) Cultural and Heritage program
d) Arrangement of study tour
e) Arrangement of tour
f) Debating

g) Participating different national day program

Comilla University

Department of Statistics Scenario

Office Room

Statistics Lab-1

Statistics Lab-02

Seminar Library

Corridor (3rd floor)

Corridor (2nd floor)