OBE Curriculum

For

Bachelor of Science (Hons.) in Statistics

Sessions: 2022-2023 and 2023-2024

Department of Statistics
Faculty of science and Engineering
University of Barishal, Kornokathi, Barishal-8254

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University of Barishal
Department of Statistics
Established: 10 OCTOBER, 2018

Chairman

Sr. No.	Name	Tenure
1.	Md. Saif Uddin Rashed	10.10.2018 – 03.12.2020 (In charge)
2.	Md. Saif Uddin Rashed	04.12.2020 - Present

Faculty Members

	Md. Saif Uddin Rashed B.Sc. (Hons.), M.S.(JU) **Assistant Professor & Chairman** **Email: md.saifuddinrashed@gmail.com. msurashed@bu.ac.bd** **Area of Interest:** Time Series Analysis, Multivariate Analysis, Biostatistics, Data Mining and Machine Learning.
	Momenul Haque Mondol *(Study Leave)* B.S. (Hons.), M.S. (DU) **Assistant Professor** **Email: mmondol@isrt.ac.bd** **Area of Interest:** Longitudinal Data Analysis, Small Sample Estimation, Model validation, Clinical trial, Spatial Data Analysis.
	Ahsanul Haque B.S. (Hons.), M.S. (IU) **Lecturer** **Email: ahaque@bu.ac.bd** **Area of Interest:** Time Series Analysis, Econometrics Analysis, Survival Analysis and Experimental Design.
	Md. Ayub Ali B.S. (Hons.), M.S. (RU) **Lecturer** **Email: ayubkhanstat@gmail.com; maali@bu.ac.bd** **Area of Interest:** Advanced Sample Survey, Big Data Analysis, Public Health and Epidemiology, Robust Regression, Data Mining and Machine Learning Algorithms.

Office Staff

	Md. Mehedi Hasan (Rasel) Computer Operator Department of Statistics University of Barishal
	Lokman Hossain Office Assistant Department of Statistics University of Barishal

Curriculum

of the
Department of Statistics
University of Barishal

Profile of the Department

The University of Barishal has launched a new department in 2018 named as "Department of Statistics". The academic activities of the department were launched on 10th October, 2018 with three faculty members: Md. Saif Uddin Rashed (Chairman), Farhana Akter Bina (Lecturer), and Momenul Haque Mondol (Lecturer) along with 30 students.

The department is offering four (4) years' Bachelor of Science (B.S.) Honours Degree Program in Statistics. The Program will be operated annually and intends to include all kinds of theoretical and practical/ applied aspects of modern age particularly with computer intensiveness. The courses are designed so that after successful completion, the graduates from this Program will be highly sought in a wide variety of field like data analysts, researchers in government and non-government agencies, biostatisticians in hospitals and medical research facilities, actuaries and financial analysts with insurance firms, pension administrators, survey methodologists, instructors, researchers and trainers at different institutions and firms.

- **Faculty Name:** Faculty of science and Engineering& Engineering.
- **Degree Awarded:** Bachelor of Science (Honours).
- **Degree to be written on the Certificate:** B.S. (Hons.) in Statistics.

1. VISION OF THE UNIVERSITY

Vision Statement

MISSION OF THE UNIVERSITY

Mission Statement

2. VISION OF THE DEPARTMENT

Improvement of expertise in Statistics and disseminate its uses for achieving Sustainable Development Goals in Bangladesh.

MISSION OF THE DEPARTMENT

M1	Provide high quality education in statistical theory and applications conducting leading-edge research with a regular updating curriculum for the requirements of contemporary job markets.
M2	Organizing training, research collaboration, workshop, seminar and conference to maintain a vigorous program of independent statistical research for developing new statistical methods in a diversified research area.
M3	To promote the use and knowledge of Statistics in all disciplines and enhance the quality of decisions and conclusions made on the strength of the statistical approach.
M4	To prepare students for professional careers in data collection, management and analysis in Local and Global contrast.

3. Program Education Objectives

PEO1	Graduates will apply knowledge of statistical science to solve health, agricultural, environmental and contemporary problems;
PEO2	Deliver professional services with updated technologies in statistical science and data analyzed based career;
PEO3	Graduates will demonstrate lifelong learning in the field of computing by up-gradation of knowledge, skills and abilities;
PEO4	To bring to their careers the self-assurance, integrity, and technical strengths thatdrive innovation, and collaboration skills;
PEO5	Develop leadership skills and incorporate ethics, team work with effective communication and time management in the profession.

4. PEO to Mission Statement Mapping

MISSION STATEMENTS	PEO1	PEO2	PEO3	PEO4	PEO5
M1	✓		✓		✓
M2		✓			✓
M3				✓	✓
M4	✓		✓	✓	

5. Program Learning Outcome (PLO) with Graduate Attributes

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	Model real-world phenomena into statistical model formulations and develop the statistical models asubsequently interpret the solutions back to the real-world as applicable recommendations.
PLO5	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.
PLO6	Analyze big data and employ Big data Technology.
PLO7	Capable of Conducting research independently.
PLO8	Appreciate human behavior, culture, interaction and organization through studies in the humanities and social sciences. A knowledge of the impact of computing solutions in a local and global context.
PLO9	Apply written and oral communication in both technical and nontechnical environments; an ability tocommunicate with a range of audience; and an ability to identify and use appropriate available technical literature.
PLO10	Devise a way on the road to future career.

6. Mapping of PLOs to PEOs

PEO/PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO8	PLO9	PLO10
PEO 1	✓		✓	✓						
PEO 2	✓	✓		✓	✓					
PEO 3		✓						✓	✓	
PEO 4			✓					✓	✓	
PEO 5		✓						✓	✓	

7. Scheme of the Program

General Policies, Rules and Regulations

- **Admission:**

As per university rules, students from different disciplines are eligible to be admitted into the program. After the announcement of admission test date, intending students should apply through the prescribed application form. A rigorous written test is conducted for the applicants. A combined score is developed based on marks in the written test, S.S.C. and H.S.C examinations. Selections are made based on the combined score. It should be noted that Bachelor of Science is a terminal degree.

- **Program Duration and Course Distribution:**

The duration of B. S. (Hons.) program is four years effective from session 2022-2023. A total of 160 credit hours have to be completed by the students in 31 taught courses, 12 Lab courses, 04 viva-voce examinations and 01 project report. Students have to appear in all examinations at the end of each class year. In addition, students have to undergo a project at the end of fourth year. The project carries 4 credit hours including the viva-voce.

The B. S. (Hons.) program shall be evaluated on the basis of 4000 total marks. Out of which 3100 marks shall be for 31 teaching course units, 600 marks for Statistics Lab, 200 marks for viva-voce examination, and 100 marks for a project report program. The 4-year B. S. (Hons.) program has to be completed by maximum of six years from the date of original entry.

Year	Total No. of Courses	Total Credit Hours
First Year	10	34
Second Year	13	44
Third Year	12	40
Fourth Year	13	42
Total	**48**	**160**

Parts	Total Marks	Total Credit Hours
Theoretical	3100	124
Statistical Lab	600	24
Project Report	100	04
Viva-Voce	200	08
Total	**4000**	**160**

****Note: 1 Credit = at least 14 Class hours**

- **Medium of Instruction:**

The medium of instruction of the program of different academic faculties shall be in English.

The Academic Committee of the concerned department shall have the right to decide the medium of instruction.

- **Teaching- Learning Strategy:**

Teaching learning strategies can include a range of whole class, group and individual activities to accommodate different abilities, skills, learning rates and styles that allow every student to participate and to achieve success. The following teaching method used by the course teacher: Lecturing, demonstrating, collaborating, classroom discussions, debriefing, recitation oral question answer session, case study, presentation each chapter in the course by the student, problem based learning and solving, group work, field visit, individual work, assignment, multimedia projector used for lecture and example cooperative learning, debate on current issues.

- **Assessment Strategy:**

The assessment of students in a particular course will be based on the marks obtained in the (i) class works in the form of class attendance, in-course examinations and presentation/ assignments, and (ii) course-end examinations. The course-end examinations shall be held at the end of the first year, second year, third year and fourth year, respectively. The proportion of the total marks of a particular course shall be distributed as follows:

Internal Assessment/ Before-Final Assessment:	40%
Final Examination:	60%
Total	100%

i. Evaluation:

The marks allocation for theoretical and computing courses will be as follows:

Theoretical Marks Allocation		
Attendance	:	05%
Assignment and/ or Term Paper	:	10%
Mid-Term/ In-course Examinations	:	20%
Tutorial/ Class Test/ Quiz Test/ Class Performance	:	05%
Final Examination	:	60%
Total	:	100%

Practical Marks Allocation		
Lab Attendance	:	10%
Lab Performance	:	20%
Lab Report Writing	:	10%
Final Examination	:	60%
Total	**:**	**100%**

There will be two in-course examinations for each of the theoretical and computing courses.

The courses including 4 credits and 3 credits will be evaluated by 100 marks and 2 credits will be evaluated by 50 marks.

The students will have to submit a report carrying 100 marks at the end of the fourth year. The topic of the report shall be approved by the Chairperson of the Department on the

recommendation of the research supervisor, which shall be submitted on or before the day as fixed by the fourth year examination committee. At the end of all course examinations in each academic year students shall have to face a viva-voce that carries 50 marks.

ii. Class Attendance:

The marks allocated for class attendance shall be given as following proportions:

Attendance Range (in percentage)	Marks
90% and above	5.0
85% to less than 90%	4.5
80% to less than 85%	4.0
75% to less than 80%	3.5
70% to less than 75%	3.0
65% to less than 70%	2.5
60% to less than 65%	2.0
Less than 60%	0.0

iii. Final Examination:

Final examination will cover the entire course syllabus. The exam will be all-inclusive at a location and time determined by the university. The final examination is for evaluation purposes only, and the examination scripts will not be returned to the students for review after it is marked. Creativity will not be suppressed. Writing in your own words is definitely welcomed as long as the provided information is scientifically correct, grammatically sound, and to the point. No extra marks will be given for what was not asked in the question paper.

iv. Duration of the Final Examination:

The final examination for every one or two credit hour theoretical courses shall be of 2-hour duration and the course having 3 and 4 credit hour theoretical courses shall be of 3 hours.

v. Grading System:

Grading policy of the total 100 marks on the above evaluation process is given below:

Marks Range	Letter Grade		Grade Point
80+	A+	(A plus)	4.00
75-79	A	(A regular)	3.75
70-74	A-	(A minus)	3.50
65-69	B+	(B plus)	3.25
60-64	B	(B regular)	3.00
55-59	B-	(B minus)	2.75
50-54	C+	(C plus)	2.50
45-49	C	(C regular)	2.25
40-44	D	……..	2.00
Below 40	F	……..	0.00

* In the Transcript/Grade sheet, only the Letter Grade and the Corresponding Grade Points, and final CGPA (in the fourth year), not the numerical marks, will be shown.

- **Policy of Evaluation System:**
  - Two examiners (First and Second) will evaluate the scripts of final examination.
  - The arithmetic mean of the marks given by the two examiners (first and second) shall be taken as final marks.
  - If the Marks given by first and second 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. If the

differences between the three are equal the average of the higher two marks will be counted.

- Total marks (internal assessment and final marks) for each course shall be rounded up to the next integer in case of fractions.
- Grade Point Average (GPA)/Cumulative Grade Point Average (CGPA) will be calculated up to the second decimal points in the final examination.
- The final CGPA will be calculated based on the Earned Grade Points (EGP) of all the courses.

- **Examination Entry Requirements:**

A. A student will be allowed to take part in the Final Examination if s/he fulfills the following conditions:

i. If the student has registered for the concerned year in due time;
ii. If the student has the required percentage of attendance;
iii. If the student has paid all dues (registration fees/tuition fees/development fees/other charges) applicable to the university administration/discipline administration/department;
iv. If the student has not been instructed by the Disciplinary Board/Examination Disciplinary Committee to refrain from taking part in the examination.

B. To be a valid examination candidate, a student needs to be collegiate by earning at least 75% attendance on an average. A student having the attendance percentage in the range of 60% to less than 75% will be regarded as non-collegiate and will be allowed to sit for the final examination on condition of paying a fine of Tk. 750. A student having the attendance below 60% will be regarded as dis-collegiate and shall not be allowed to sit for the final examination. However, students having at least 50% attendance shall be allowed to seat for the examination on payment of a fine of Tk. 2,500. In this case the compulsion of attendance shall be relaxed up to 5% (maximum) for female students.

- **Promotion:**

Keeping consistence of the spirit of the year system, year-wise promotion will be declared. For promotion from one year to the next the minimum GPA shall be 2.00. In addition, a student is also required to earn minimum 50% of the total credit points in the respective year and the pass marks in the viva-voce for promotion from one year to next.

- **Degree requirements:**

A. For B.S. (Hons.) 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:

A student who fails to secure a minimum CGPA of 2.25 after completing fourth year final examination but succeeds in securing a CGPA of 2.00 and above but below 2.25 will be eligible for a pass degree.

- **Credit Transfer:**

No credit transfer from any other programs or institutions is allowed for the B.S.(Hons.) degree.

- **Improvement of Grades (Supplementary):**

  A. A student securing a grade lower than B will be allowed to improve the grade only once with the next available batch. If the student fails to improve the grade the previous grade will remain valid. Not more than three courses of a particular year shall be allowed for improvement.
  B. The improvement examination of the student shall be taken on the syllabus of his/ her academic session.
  C. No improvement shall be possible for the courses of fourth year.
  D. Students willing to improve the grade in a course should apply to the Chairman of the Department at least 8 weeks before the start of the final examination.

- **Removal of 'F' (Fail) Grade:**

The removal of 'F' grade in any course shall be allowed and only for two times.

- **Re-Admission:**
  A. A student failing to get the requisite credit points for promotion to the next year may seek re-admission with the next available batch.
  B. A student shall have to apply for re-admission within seven working days after the announcement of result of the concerned year.

- **Drop Out:**
  A. If a student re-admitted twice and fails to earn minimum required credits for promotion shall be dropped-out from the program.
  B. If a student fails to earn required total credit points within six academic years since the admission to the first year, s/he will be dropped-out form the program and will no longer be allowed to continue his /her studentship in the program.

- **Penalty for adoption of unfair means:**

The instruction to the examinee on cover leaf of the answer script must be followed by the examinee. A student who has adopted unfair means in any examinations, assignments, term papers, reports, research monograph etc. might be expelled from that year 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.

- **Final Results, Degree and Certificate:**
  A. At the end of the fourth year, the results of successful regular students of that year and overall final results for graduation shall be published separately. The overall final results covering all years' results of regular successful students will be declared in order of merit based on CGPA.
  B. The final results of those who have failed in any course will be published on clearance of the courses with 'F' grade(s) and fulfillment of necessary course-credit requirement.
  C. 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 in/after the Convocation of the University.

- **Computation of Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA):** The GPA and CGPA will be computed in following formula:

$$GPA = \frac{\sum(\text{Credit} \times \text{Grade Points Secured})}{\text{Total Credits Offered in the Year}}$$

$$CGPA = \frac{\sum(\text{Credit} \times \text{Grade Points Secured})}{\text{Total Number of Credits offered in the whole programme}}$$

Example:

First Year

Courses	No. of Credits	Grade Awarded	Total Grade Points	Grade points Secured
	Col.1	**Col.2**	**Col.3**	**Col.4 = (Col.1× Col. 3)**
STA 0542 101	4	A-	3.50	14
STA 0542 102	4	A+	4.00	16
STA 0542 103	4	A	3.75	15
MAT 0541 104	4	B	3.00	12
MAT 0541 105	4	A	3.75	15
CSE 0612 106	4	A+	4.00	16
SSS 0222 107	4	A+	4.00	16
STA 0542 108	2	A+	4.00	8
CSE 0612 109	2	B+	3.25	6.5
STA 0542 110	2	B+	3.25	6.5
Total	**34**			**125**
GPA = Total Grade Points Secured ÷ Total Number of Credits= 125 ÷ 34 = 3.68				

Second Year

Courses	No. of Credits	Grade Awarded	Total Grade Points	Grade points Secured
	Col.1	**Col.2**	**Col.3**	**Col.4 = (Col.1× Col. 3)**
STA 0542 201	4	A	3.75	15
STA 0542 202	4	A+	4.00	16
STA 0542 203	4	A	3.75	15
STA 0542 204	4	B	3.00	12
SSS 0314 205	4	A	3.75	15
MAT 0541 206	4	A+	4.00	16
STA 0542 207	4	A+	4.00	16
CSE 0612 208	4	A+	4.00	16
ECO 0311 209	4	A	3.75	15
STA 0542 210	2	A	3.75	7.5
STA 0542 211	2	A+	4.00	8
CSE 0612 212	2	A+	4.00	8
STA 0542 213	2	A+	4.00	8
Total	**44**			**167.5**
GPA = Total Grade Points Secured ÷ Total Number of Credits = 167.5 ÷ 44 = 3.81				

Cumulative Data:

Total Credit= 34+44 = 78

Total Grade Points Secured= 125+167.5 = 292.5

Cumulative Grade Point Average (CGPA) = 292.5 ÷ 78 = 3.75

Project Assessment Methods
Every student will have to submit research report to the department through assigned teachers. The reports will be examined by the assigned teachers against 50% marks, by another examiner against 50% marks. The continuous assessment of reports for examination by the supervisor will carry 20%. The oral presentation of reports for examinations by the examination committee will carry another 30% marks. Results will be processed by the examination committee.

Viva-Voce Assessment Methods
Viva-Voce will be on 100%.

General Education (GED) Courses		
Course Type	Course Title	Credits
Theory	1. Basic Algebra	4
	2. History of the Emergence of Independent Bangladesh	4
	3. Linear Algebra	4
	4. Calculus and Differential Equations	4
	5. MS Excel and Computer Programming with C/C++	4
	6. Demography	4
	7. Mathematical Methods and Numerical Analysis	4
	8. Programming with R & Python and Simulation	4
	9. Principles of Economics	4
	10. Econometrics	4
	11. Public Health and Epidemiology	4
Lab	Programming (C/C++) Lab	2
	MS Excel and Programming with C/C++ Lab	2
	Econometric Lab	2
	Machine learning Lab	2
Total		**52**

Curriculum of B.S. (Hons.) in Statistics
Sessions: 2022-2023 and 2023-2024

The year wise distribution of courses, credits and detailed curriculum for the B.S. (Hons.) program are as follows:

Courses for the First Year

Course Code	Course Title	Course Category	Credit
STA 0542 101	Basic Statistics	Core	4
STA 0542 102	Elementary Probability	Core	4
STA 0542 103	Probability Distributions	Core	4
MAT 0541 104	Linear Algebra	General Education	4
MAT 0541 105	Calculus and Differential Equations	General Education	4
CSE 0612 106	MS Excel and Computer Programming with C/C++	General Education	4
SSS 0222 107	History of the Emergence of Independent Bangladesh	General Education	4
STA 0542 108	Statistical Computing-I	Core	2
CSE 0612 109	MS Excel and Programming with C/C++ Lab	General Education	2
STA 0542 110	Viva-Voce	Core	2
Total			**34**
	Courses for the Second Year	**Course Category**	
Course Code	**Course Title**		**Credit**
STA 0542 201	Statistical Inference	Core	4
STA 0542 202	Sampling Distributions	Core	4
STA 0542 203	Regression Analysis	Core	4
STA 0542 204	Sampling Technique-I	Core	4
SSS 0314 205	Demography	General Education	4
MAT 0541 206	Mathematical Methods and Numerical Analysis	General Education	4
STA 0542 207	Actuarial Statistics	Core	4
CSE 0612 208	Programming with R & Python and Simulation	General Education	4
ECO 0311 209	Principles of Economics	General Education	4
STA 0542 210	Statistical Computing-II	Core	2
STA 0542 211	Statistical Computing-III	Core	2
CSE 0612 212	Programming (Python & R) Lab	General Education	2
STA 0542 213	Viva-Voce	Core	2
Total			**44**

Courses for the Third Year

Course Code	Course Title	Course Category	Credit
STA 0542 301	Non-parametric Methods and Order Statistics	Core	4
STA 0542 302	Sampling Technique-II	Core	4
STA 0542 303	Design and Analysis of Experiments	Core	4
STA 0542 304	Stochastic Processes	Core	4
STA 0542 305	Time Series Analysis and Forecasting	Core	4
STA 0542 306	Industrial Statistics and Operational Research	Core	4
STA 0542 307	Research Methodology and Social Statistics	Core	4
STA 0542 308	Data Mining	Core	4
STA 0542 309	Statistical Computing-IV	Core	2
STA 0542 310	Statistical Computing-V	Core	2
STA 0542 311	Statistical Computing-VI	Core	2
STA 0542 312	Viva-Voce	Core	2
Total			**40**

Courses for the Fourth Year

Course Code	Course Title	Course Category	Credit
STA 0542 401	Classical and Bayesian Inference	Core	4
BIO 0512 402	Public Health and Epidemiology	General Education	4
STA 0542 403	Multivariate Analysis	Core	4
STA 0542 404	Categorical Data Analysis	Core	4
ECO 0311 405	Econometrics	General Education	4
STA 0542 406	Biostatistics and Bioinformatics	Core	4
STA 0542 407	Machine Learning	Core	4
STA 0542 408	Statistical Computing-VII	Core	2
STA 0542 409	Statistical Computing-VIII	Core	2
STA 0542 410	Statistical Computing-IX	Core	2
STA 0542 411	Statistical Computing- X	Core	2
STA 0542 412	Project Report	Core	4
STA 0542 413	Viva-Voce	Core	2
Total			**42**

Courses for the First Year

Course Code	Course Title	Course Category	Credit
STA 0542 101	Basic Statistics	Core	4
STA 0542 102	Elementary Probability	Core	4
STA 0542 103	Probability Distributions	Core	4
MAT 0541 104	Linear Algebra	General Education	4
MAT 0541 105	Calculus and Differential Equations	General Education	4
CSE 0612 106	MS Excel and Computer Programming with C/C++	General Education	4
SSS 0222 107	History of the Emergence of Independent Bangladesh	General Education	4
STA 0542 108	Statistical Computing-I	Core	2
CSE 0612 109	MS Excel and Programming with C/C++ Lab	General Education	2
STA 0542 110	Viva-Voce	Core	2
Total			**34**

Course Title: Basic Statistics **Course No:** STA 0542 101

Contact Hours per Week: 04 **Credit:** 04

Rationales: Statistics is the art of using data to make numerical conjectures about problems. This is an introductory course in Statistics designed to provide students with the basic concepts of Statistics, data processing, exploratory data analysis, basic statistical tools and techniques of analyzing data and statistical computing.

Objectives: The objectives of this course are to understand data, nature of data, demonstrate their understanding of descriptive statistics by practical application of quantitative reasoning and data visualization.

After completion of this course, students will be able to
CLO1: Organize and summarize a data set to gather knowledge regarding data.
CLO2: Apply appropriate statistical tools and techniques in real life problem.
CLO3: Present, evaluate, adjust and finally interpretation of the data.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓						✓	
CLO2		✓		✓				✓	✓	
CLO3			✓		✓			✓		

Topic	Course Content	Hours	CLO
Introduction	Background of Statistics, functions of Statistics, classification of Statistics, scope and limitations, relation with other disciplines, abuse of Statistics.	**05**	**CLO1**
Concepts of Statistics	Population, sample, parameter, statistic, types of variable, scales of measurement, attribute.	**04**	**CLO1**
Sources of Statistical Data	Data, types of data, data sources, data collection tools and techniques, etc.	**04**	**CLO1 CLO2**

Organization and Presentation of Data	Classification and tabulation, construction of frequency distribution, graphical presentation of data, different types of graphs and charts with their relative merits and demerits.	**05**	**CLO2**
Measures of Central Tendency	Concepts of central tendency, different measures of central tendency, applications and properties of different measures of central tendency, quantiles with their graphical representation and properties.	**06**	**CLO2**
Measures of Dispersion	Concepts of dispersion, different measures of dispersion, application and properties of different measures of dispersion, relation between standard deviation and other measures, interpretation of data with these measures.	**06**	**CLO2 CLO3**
Exploratory Data Analysis	Stem-and-leaf plot, extremes and median, hinges and 5-number summaries, schematic plots, box-and-whiskers plots, tri-mean, trimmed mean, outliers.	**06**	**CLO3**
Shape Characteristics of Distribution	Moments, Sheppard's correction for grouping error, skewness, kurtosis and their measures.	**06**	**CLO2 CLO3**
Simple Correlation and Regression	Bivariate data, scatter diagram, simple correlation, correlation ratio, rank correlation, simple linear regression analysis.	**06**	**CLO2 CLO3**
Time Series Analysis	Basic concept of time series data and its components.	**06**	**CLO2**
Books Recommended	**Text Books:** **1.** Bluman, A. (2014). *Elementary Statistics: A step by step approach 9e*. McGraw Hill. **2.** Islam M. N. *An Introduction to Statistics and Probability*, Book World, 4th Edition, Dhaka (2012). **3.** Roy M. K., Paul J. C. and Roy D. C., *Business Statistics*, Volume-1 (2017). **Reference Books:** **1.** Weiss N. *Introductory Statistics*, 7th *edition*. Addison Wesley (2007). **2.** Mason R. D. And Lind D. A., *Statistical Techniques in Business and Economics, 15th Edition*, Irwin McGraw-Hill, (2011).		
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.		

Course Title: Elementary Probability **Course No:** STA 0542 102

Contact Hours per Week: 04 **Credit:** 04

Rationales: A very basic course about probability. Many statistical theories are developed based on probability theory. So it is very important to know about probability. The aim of the course is to get acquainted students with the basic principles of probability theory.

Objectives: The objectives of this course are to provide detail knowledge about probability so that student can apply the knowledge in different statistical problems.

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

CLO1: Demonstrate basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables;

CLO2: Derive the probability density function of transformations of random variables and use these techniques to generate data from various distributions;

CLO3: Calculate probabilities, and derive the marginal and conditional distributions of Bivariate random variables;

CLO4: Solve real-world problems with probability models;

CLO5: Apply appropriate inequality for solving problems related to probability;

CLO6: Calculate conditional expectation and conditional variance;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√			√			
CLO2	√			√			√			
CLO3	√	√		√	√	√	√			
CLO4	√	√		√	√	√	√			√
CLO5	√									√
CLO6	√									

Topic	Course Content	Hours	CLO
Set Theory	Fundamentals of set, set operations, laws of set.	**04**	**CLO1**
Methods of Counting	Principles of counting, review of permutations and combinations, Pascal's triangle, binomial coefficient and theorem.	**05**	**CLO1 CLO2**
Basic Concept of Probability	Experiment, random experiment, sample space, sample point, events, event space, union and intersection of events, different types of events, Multiplicative law, laws of probability, some elementary theorems of probability, scope of probability, probability and possibility, definition of probability, different approaches of defining probability.	**05**	**CLO1**
Conditional Probability, Bayes Theorem, Independence	Conditional probability, independence, geometric probability, tree diagrams and compound probability, theorem of total probabilities, Bayes theorem and its uses.	**06**	**CLO6**
Random Variable	Concept of random variable, types of random variable, probability mass function, probability density function, distribution function, joint, marginal and conditional probability function, functions of random variable and properties of functions of random variable and its distribution, independence of random variables.	**08**	**CLO3**
Mathematical Expectation	Meaning of expectation and conditional expectation, mean, expectation of a function of a random variable, variance, conditional mean and conditional variance, moments, covariance and correlation coefficient, expectation of sums and products of random variables, Chebyshev's inequality.	**08**	**CLO4**

Generating Function	Moment generating function, characteristic function, probability generating function, cumulant generating function and their properties, inversion theorem, convolution.	**06**	**CLO5**

Books Recommended	**Text Books:** **1.** Ross S. M. *A First Course in Probability*, 8th *edition*. Prentice-Hall (2020). **Reference Books:** **2.** Rohatgi and Saleh. *An introduction to Probability and Statistics*, 3rd edition, John & Wiley (2015). **3.** Roy, M. K. & Roy, D. C. *Fundamentals of Probability and Probability Distributions* (2019). **4.** Hogg and Tanis, *Probability and Statistical inference*, 6th edition, Prentice Hall, N.Y, (2001).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Probability Distributions **Course No:** STA 0542 103
Contact Hours per Week: 04 **Credit:** 04

Rationales: In this course students will know about probability distribution. Success of statistics totally depends on perfectly identification of the distribution of the data. The analysis and interpretation are different for different distributions. Frequency distribution and graphical representation only gives preliminary ideas but to know exact distribution we must learn this course.

Objectives: At the end of the course, students able to learn the various univariate distributions, truncated distributions and bivariate normal distribution; to learn applications of these probability distributions; to develop real life problem-solving skills.

After completion of this course, students will be able to

CLO1: Understand various basic concepts of probability distributions.
CLO2: Apply the distributions in real word situation.
CLO3: Evaluate the properties of the probability distributions.
CLO4: Create the distributional forms for given data.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓									
CLO2		✓	✓	✓	✓			✓		
CLO3				✓						
CLO4							✓			✓

Topic	Course Content	Hours	CLO

Basic Concept	Probability space, probability calculus, measure theoretical approach to probability, concept of family of exponential distributions.	**04**	**CLO1**
Univariate Discrete Distributions	Rectangular, binomial, hyper-geometric, geometric, negative binomial, multinomial, logarithmic, beta-binomial, generalized negative binomial, negative hyper-geometric distribution, power series distribution, Edgeworth Series, Gram Charlie's series.	**09**	**CLO1 CLO2 CLO3 CLO4**
Univariate Continuous Distributions	Uniform, normal, beta, exponential, gamma, half normal, log normal, Cauchy, Weibull, inverted gamma, inverse Gaussian, Laplace, Gumbell, Maxwell, Erlang, Pareto and other exponential family of distribution, Rayleigh and Rician distribution.	**08**	**CLO1 CLO2 CLO3 CLO4**
Special Distributions	Pearsonian type curves, contagious, truncated and mixture distribution of normal, Poisson and binomial.	**04**	**CLO3**
Bivariate Distributions	Concept of bivariate probability distributions, bivariate normal distribution, marginal and conditional distribution of bivariate normal distribution, moment and cumulant generating functions of bivariate normal distribution.	**09**	**CLO2 CLO3 CLO4**

Books Recommended	**Text Books:** 1. Stuart, A., & Ord, K. (2010). *Kendall's advanced theory of statistics, distribution theory* (Vol. 1). John Wiley & Sons. 2. Roy, M.K., Fundamentals of Probability and Probability Distributions. **Reference Books:** 1. Mood, A. M, Graybill, F. A. and Boes, D. C., Introduction to Theory of Statistics, McGraw Hill; 3rd edition (1974). 2. Hogg, R. V., McKean J. and Craig, A. T., Introduction to Mathematical Statistics, Pearson; 7th edition (2012).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Linear Algebra **Course No:** MAT 0541 104
Credit: 04 **Contact Hours per Week:** 04

Rationales: Linear algebra is an essential cornerstone of mathematics. Its powerful tools are applied in virtually every area of pure and applied mathematics. A strong foundation in linear algebra is essential for success in every mathematical endeavor. The algorithm of linear algebra is also important to the theory of scientific and solving numerical analysis.

Objectives: The objectives of this course are to determine the rank, to understand the matrix representation of a linear operator, to obtain the eigenvalue and eigenvectors of the matrix, to apply the Gram-Schmidt orthogonalization process.

After completion of this course, students will be able to

CLO1: Compute dimension, rank, nullity and linear transformations.

CLO2: Explain the basic concepts of vector spaces and determinations.

CLO3: Describe the properties of eigenvalues and eigenvectors.

CLO4: Use computer software for solving linear algebra problems

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓						✓	
CLO2		✓		✓				✓	✓	
CLO3	✓		✓		✓			✓		
CLO4										

Topic	Course Content	Hours	CLO
Vector	Definition of a vector, different types of vectors, geometrical interpretation, length and angle between two vectors, operation with vectors.	**05**	**CLO2**
Vector Set	Vector set linearly dependent and independent set of vectors, sweep out method, orthogonal set, normalization, Gram-Schmidt orthogonalization process, subset and superset of vectors, related theorems. Spanning set of vectors, vector spaces and subspaces, their geometric interpretation, rank and basis of vector spaces, orthogonal and orthonormal basis, related theorems.	**06**	**CLO3**
Matrices	Different types of matrices, definitions with example, matrix operations, properties of such operations, rank and elementary transformation of matrices, diagonal reduction of a matrix, related theorems of ranks, trace of a matrix, its properties with proofs. Inverse of a matrix, different methods of finding inverse of a matrix, properties of such inverse with proofs.	**06**	**CLO1**
Determinants	Matrix and vector, square matrix and determinants, ideas of minors and cofactors, product of determinants, properties of determinants, different types of determinants, solution of equations with the help of determinants, evaluation of $n \times n$ determinants.	**05**	**CLO1 CLO2**
Generalized Inverse (g-Inverse)	Definition, methods of finding g-inverse, properties of g-inverses, existence, uniqueness other properties, kinds of g-inverse, their properties, methods of finding unique g-inverse, Cayley-Hemilton's theorem and its application, application of g-inverses in the solution of system of equations.	**05**	**CLO3 CLO4**
System of Linear Equations	Introduction, types of linear equations: homogenous system, non-homogenous system, consistent and inconsistent unique solution, different methods of solutions of each equations: Gaussian elimination, Cramer's rule, sweep - out method, uses matrix inverse, related theorems on system of linear equations.	**05**	**CLO1**
Kronecker Sum and Product of Matrices	Operational conformability of matrices and vectors, definitions of Kronecker sum and product of matrices and vectors of different order orders, their examples, properties of Kronecker products with proofs, their uses.	**05**	**CLO4**
Quadratic Forms	Definition with examples, classifications of quadratic forms, rank, index and signature, latent roots and latent vector of matrices, canonical form of a quadratic form, related theorems of eigen values, eigen vectors and quadratic forms.	**05**	**CLO4**

Books Recommended	**<u>Text Books:</u>**

	1. Anton H. 2010. *Elementary Linear Algebra*, 10th Edition, Wiley 2. Lipschutz S., Lipson M. 2012. *S Haum's Outline of Linear Algebra*, 5th Edition, McGraw-Hill Education. 3. Rahman, A. 2006. College Linear Algebra. Nahar Book Depot & Publications. Bangladesh **Reference Books:** Nicholson W. K., Linear Algebra with Applications, 7th Edition.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Calculus and Differential Equations **Course No:** MAT 0541 105
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to apply techniques and theories of advance calculus.

Objectives: The objectives of this course are to interpret the vector valued functions and their graphs, limit and continuity of the functions and to introduce the notion of differentiation and integration of the vector valued functions.

After completion of this course, students will be able to
CLO1: Understand the major problems of differential and integral calculus.
CLO2: Know the problem about limit, continuity and differentiability of function of several variables and the importance of linear functions in mathematics.
CLO3: Identify initial value and Boundary value problem in differential equations and evaluate homogeneous and simultaneous differential equations.
CLO4: Apply double and triple integrals.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓		✓	✓					✓
CLO2	✓	✓								✓
CLO3			✓		✓				✓	

Topic	Course Content	Hours	CLO
	Calculus		
Functions	Definition, types of functions, domain and range of functions, graph of functions, limit and continuity of functions.	**07**	**CLO1**
The Derivative and Applications	Differentiability, derivative of a function, geometric interpretation of the derivative, formula of differentiation, the chain rule, implicit differentiation, derivatives from parametric equations, higher order derivatives, Leibnitz's theorem, analysis of functions (increase, decrease, concavity, relative extrema, absolute extrema), applications of extrema problems, Rolle'stheorem, mean value theorem.	**07**	**CLO1 CLO2**
Functions of Several Variables	Definition, limit and continuity, differentiability, partial derivatives, the chain rule, total differentials, extrema, Jacobian of transformation, applications in statistics.	**06**	**CLO2**
Integral Calculus	The anti-derivatives (indefinite integral), elementary integration formulas, integration by substitution, integration by parts, the definite integral, fundamental theorem of calculus, properties of definite integrals, evaluation of definite	**07**	**CLO1 CLO4**

	integrals, reduction formulas.		
Applications of Definite Integral	Area between two curves, volumes by slicing, disks, washers and cylindrical shells, arc lengths, evaluation of double and triple integrals (only for Cartesian coordinates).	**07**	**CLO2 CLO4**
	Differential Equations		
Introduction	Definition of differential equation, Classification of differential equations, Order and degree of differential equation, Classification of ordinary differential equations (ODE), Formulation of ODE, Nature of solutions of ODE, Initial value problems, Boundary value problems, Basic existence and uniqueness theorem (Statement and illustration only).	**08**	**CLO4**
Solution of First Order ODEs	Separable equations, Reducible to separable equations, Exact equations, Linear equations, Bernoulli equations, Homogeneous equations, Special integrating factors and transformation.	**08**	**CLO3 CLO4**
Applications of First Order ODEs	Orthogonal and oblique trajectories, Exponential growth and decay, Newton's law of cooling, Mixtures of solutions, Series circuit, Logistic growth.	**06**	**CLO3 CLO4**
Solution of Linear Higher Order ODEs	Basic theory of linear differential equations, Reduction of order, Homogeneous linear ODEs with constant coefficients, Non-homogeneous ODEs, Method of undetermined coefficients, Variation of parameters, The Cauchy-Euler ODEs.	**04**	**CLO3 CLO4**
Books Recommended	**Text Books:** **1**. Anton, H. & Herr A.: *Calculus with Analytic Geometry*, Wiley, John & Sons, Incorporated (1995) **2**. Ross, S. L. Differential Equations, 3rd Edition, John Wiley & Sons, New York.		
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.		

Course Title: MS Excel and Programming With C/C++ **Course No:** CSE 0612 106
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to enhance fundamental concept of computer, its application in statistics and to develop programming skills in the students using a popular structured programming language C/ C++/ Java.
Objectives: This course covers introductory ideas about MS excel and how to connect C/C++ programming with statistics through flowchart and programming code execution using compilation, link and run. To understand how to analyses descriptive statistics and data analysis using C/C++ programming.

After completion of this course, students will be able to
CLO1: Provide basic knowledge about different task oriented software and Understand the basic concepts, syntax and the process of problem-solving using C/C++ programming language.
CLO2: Ability to write programs in C/C++ by using basic control structures (conditional statements, loops, switches, branching, functions, etc.
CLO3: Implement C/C++ programs for simple applications of real-life problems and statistical computation.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓		✓							
CLO2		✓		✓	✓	✓				
CLO3					✓		✓			✓

Topic	Course Content	Hours	CLO
Microsoft Excel	Overview of excel environment, starting excel, creating charts and graphs customizing, data analysis, editing workbooks, file management, formatting, formula and function management.	**12**	
Fundamental of C/C++	Component of C program, declare variable and assign values, function, C keywords, program control statements: if, if-else, while loop, do while loop, for loop, nested loop, nested if, break, continue, return, goto, exit, switch, incremental, decrement, printf), relation and logical operators, input Characters, Data types, variable and expressions, arrays and strings, pointers, function prototypes, main (), console I/U and file I/U.	**16**	**CLO1 CLO2**
Applications of C/C++ programming in data analysis	Frequency distributions, data summary, e.g. mean, median, maximum, minimum, matrix operations, calculation of different rates, fitting simple linear regression line, sorting a vector.	**20**	**CLO3**

Books Recommended	**Text Books:** **1.** Dietel, P. and Deitel, H., *C: How to Program*, Prentice Hall; 7th edition (2012). **2.** Balagurusamy, E. (2016). Programming In Ansi C. **Reference Books:** **1.** Nicholson W. K., Linear Algebra with Applications, 7th Edition.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: History of the Emergence of Independent Bangladesh **Course No:** SSS 0222 107
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is a moral and fundamental effort to provide students with a true and complete history of Bangladesh, its culture and economy. To understand the present and plan for the future advancement of a country, it is the prerequisite to know its culture, heritage and the history very well. The valiant struggles for language, nationality, unity and independence will always encourage the students to be patriot as well as more optimistic.
Objectives: This course will enrich the learners with proper understanding about the opportunities available to grow as a developing nation along with the challenges we might need to face.

Course Learning Outcome: After completion of this course students will be able to
CLO1: exhibit a clear understanding on the history, cultural and heritage of our country with concrete data and knowledge.
CLO2: explore and evaluate the factors that changed the political dynamics across the subcontinent and contributed to the rise of nationalism.
CLO3: analyze the role of Bangabandhu Sheikh Mujibur Rahman, Awami League and the Mujibnagar government in the liberation war.
CLO4: assess the currentsocio-economic scenario of Bangladesh in relation to the discriminations and oppression faced until independence.
CLO5: evaluate the role of national and international community during and after our liberation war as well as the challenges faced to build a new nation.

CLO6: communicate and convey knowledge regarding the history, culture, society and economy of our country in the most effective way to promote equality and tolerance.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				√			√			
CLO2				√			√			
CLO3	√	√			√	√				
CLO4		√		√	√	√	√			
CLO5	√									
CLO6	√									

Topic	Course Content	Hours	CLO
Introduction to Bangladesh	Geographical Features; Ancient Janapadas; Ethnic Composition; Indigenous Communities; Religious Process in Bengal; General Overview of the Economy, Culture, and Heritage.	**10**	**CLO1 CLO2 CLO3**
History of Bengal up to the Partition of India	From Pre-Historic Period to the Guptas; Sasanka; The Palas and the Senasi; The Conquest of Bakhtiyar; The Independent Bengal Sultanate (1338-1538); The Growth of the Nawabs and the Battle of Palashi; Initial Resistances to the British Rule; The Partition of Bengal in 1905 and the Subsequent Nationalist Movements; Politics in Bengal 1937–47; The Lahore Resolution 1940; United Bengal Scheme; Partition of India in 1947	**8**	**CLO1 CLO2 CLO3 CLO7**
Growth of Opposition, Language Movements & Attempts to Build a Democratic Government	Pakistan's Early Years; State Formation, Bureaucratic Influence, and Economic, Social, and Cultural Discrimination; Foundation of the Awami League 1949; Language Movement of 1948 and 1952; Election of 1954 and the United Front; Constitution of 1956.	**8**	**CLO4**
Declaration of Military Rule, The Growth of Bengali Nationalism & Quest for Autonomy	Military Rule in 1958 and Notable Measures of Ayub Khan; The Constitution of 1962; Six Point Programme of the Awami League; Agartala Conspiracy Case; 11 Points Movement; Mass Upsurge of 1969 and Yayah Khan's Rise to Power; the Election of 1970.	**8**	**CLO4 CLO5**
Liberation War of 1971	The 7thMarch Address of Bangabandhu; Non-cooperation Movement; Quest for a Constitutional Solution and Operation Search Light; Declaration of Independence and the Mujibnagar Government; Sporadic and Organized Resistance (MuktiFauj, MuktiBahini, and Guerilla Warfare); Genocide by the Pakistan Army and their Local Collaborates (Peace Committee, Al-Badr, Al-Shams, RazakarBahini, and Pro-Pakistani Political Parties); The Role of Muslim World & Super Powers.	**8**	**CLO4 CLO6**

The Regime of Bangabandhu (1972-1975)	Bangabandhu's Homecoming; State Formation; Constitution of 1972 and Subsequent Amendments; Economic Reconstruction; Global Recognition of Bangladesh and the Efforts of Bangabandhu; The Killing of Bangabandhu and the Ideological Transition.	**10**	**CLO1 CLO2 CLO3 CLO7**

Books Recommended	**Text Books:** **1.** Sirajul Islam, History of Bangladesh, an Introductory Reader. **2.** Sirajul Islam (Editor), History of Bangladesh 1704-1971, Asiatic Society of Bangladesh.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.
Assessment Strategy	Final exam, class test, quiz, assignment, presentation.

Course Title: Statistical computing-1 **Course No:** STA 0542 108
Contact Hours per Week: 02 **Credit:** 02

Rationales: Apply acquired knowledge to explore data.

Objectives: Provide knowledge on exploratory data analysis and Make students understand bivariate data analysis

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Construct frequency distribution and present results graphically;
CLO2: Compute and interpret measures of central tendency, location, dispersion, and shape characteristics;
CLO3: Quantify association of attributes;

Mapping CLOs to PLOs

CLO/PLO	PL1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√		√		√			√	√	
CLO2	√		√		√			√	√	
CLO3	√		√	√				√	√	

Topic	Course Content	Hours	CLO
Lab	Condensation and tabulation of data, frequency distribution, graphical representation of data, measures of central tendency, dispersion, skewness and kurtosis, measures of association, correlation and regression.	**28**	**1,2,3**

Books Recommended	**Text Books:** 1. Rahman M. S., (2020), Statistics and Probability: An Introductory Analysis, Kazi Prokashoni, Dhaka **Reference Books:** 1. Weiss N. A., (2016), Introductory Statistics, 10th Edition, Pearson
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: MS Excel and Programming with C/C++ Lab **Course No:** CSE 0612 109
Contact Hours per Week: 02 **Credit:** 02

Rationales: This course is designed to write documents in Microsoft word and present a topic using power point presentation. Computation of various matrix operation and measures of central tendency, measure of dispersion, moments, skewness, kurtosis from both ungrouped and group data using MS Excel.

Objectives: This course introduces diverse application of MS Office in statistical field.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Perform various matrix operations using Microsoft Excel.
CLO2: Analyze data using Microsoft Excel.
CLO3: Apply programing language and solve the problem using C programming language.
CLO4: Implement C programs for simple applications of real-life problems and statistical computation.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1									√	
CLO2										√
CLO3					√					
CLO4			√		√					

Topic	Course Content	Hours	CLO
Lab	Matrix operation and Different kind of Probability distributions using MS Excel. Programming C/C++: introduction and basic structure of C/C++ programs. Sequential Structure: data types, arithmetic operations, expressions, assignment statements, input and output. Selective Structure: relational operators, logical operators, conditional Statements, repetitive structure, functions, arrays, application of programming in C/C++ for statistical computation.	**28**	**CLO1** **CLO2** **CLO3** **CLO4**

Books Recommended	**Text Books:** **1.** Norton, P., *Introduction to Computers*, 6th edition, McGraw-Hill, (2008). **2.** Frye D. *Step by Step MS Excel*. **Reference Books:** **1.** Sinha P. K. *Computer Fundamentals*. **2.** Anita Goel. Computer Fundamentals.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Viva-Voce **Course No:** STA 0542 110
Contact Hours per Week: **Credit:** 02

Rationale of the course: Assessing students' comprehensive knowledge on basic concepts of the courses learned in the current semester.

Objectives: Help students to gain confidence in their own ability to present and explain the basic concepts of the courses. Provide the knowledge of oral communication and presentation skills that are essential for later professional career

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Develop verbal communication and presentation skills;

CLO2: Communicate their learning effectively and appropriately to formal audiences;
CLO3: Explain key concepts of the courses, interpret key terms, and justify their arguments logically to non-statisticians;
CLO4: Prepare for professional oral examinations which is useful to enhance employment interview skills;
CLO5: Demonstrate their ability to participate in academic discussion.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√			√			√	√	√
CLO2	√	√			√			√	√	√
CLO3	√	√			√			√	√	√
CLO4	√	√			√			√	√	√
CLO5	√	√			√			√	√	√

Topic	Course Content	Hours	CLO
Viva-Voce	Comprehensive contents of all the underlying courses of the semester.	**NA**	**NA**

Books Recommended	**Main Text** • Textbooks referred for all the underlying courses of the semester. **Reference Books** • Reference books referred for all the underlying courses of the semester.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Courses for the Second Year

Course Code	Course Title		Credit
STA 0542 201	Statistical Inference	Core	4
STA 0542 202	Sampling Distributions	Core	4
STA 0542 203	Regression Analysis	Core	4
STA 0542 204	Sampling Technique-I	Core	4
STA 0314 205	Demography	General Education	4
MAT 0541 206	Mathematical Methods and Numerical Analysis	General Education	4
STA 0542 207	Actuarial Statistics	Core	4
CSE 0612 208	Programming with R & Python and Simulation	General Education	4
ECO 0311 209	Principles of Economics	General Education	4
STA 0542 210	Statistical Computing-III	Core	2
STA 0542 211	Statistical Computing-IV	Core	2
CSE 0612 212	Programming (Python & R) Lab	General Education	2
STA 0542 213	Viva-Voce	Core	2
Total			**44**

Course Title: Statistical Inference **Course No:** STA 0542 201
Contact Hours per Week: 04 **Credit:** 04

Rationales: The course gives theoretical base knowledge of statistical estimation methods. Student will be able to gather vast concepts and algorithms of estimation methods with their properties and uses.

Objectives: At the end of the course, students will be able to learn how to estimate a good estimator with application as well as check the properties of a good point estimator. Students will be also able to know different methods of interval estimation, confidence intervals and confidence limits.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Use the appropriate classical methods in any estimation problems.
CLO2: Apply estimation methods to real life applications.
CLO3: Detect the best estimator of a parameter.
CLO4: Understand important theorems in classical inference theory.
CLO5: Draw valid conclusions about hypotheses from the results of different statistical tests.
CLO6: Differentiate between parametric and non-parametric tests of hypotheses and employ the appropriate technique on a given data set

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√			√			
CLO2	√			√			√			
CLO3	√	√		√	√	√	√			
CLO4	√	√		√	√	√	√			√
CLO5				√		√				
CLO6		√		√		√				

Topic	Course Content	Hours	CLO

	Theory of Estimation		
Concept of Statistical Inference	Estimation, problem of estimation, types of estimation, estimator and estimate.	**04**	**CLO1**
Methods of Finding Estimators	Method of moments, method of maximum likelihood, method of minimum distance, method of minimum chi-square, method of least squares etc. MSE	**07**	**CLO1 CLO2 CLO3**
Consistency	Definition, best asymptotically normal, consistent asymptotically normal, pitman-closer, pitman-closest, invariance.	**07**	**CLO4**
Sufficiency	Sufficiency, Rao-Blackwell theorem, families of distributions, group family, exponential family etc., minimal sufficiency and complete sufficiency and advanced theorems on these topics. Ancillary statistic and its relation with complete sufficient statistic and UMVUE. Lehmann-Schefe theorem for UMVUE, Lehmann-Schefe theorem for minimal sufficiency,	**08**	**CLO4**
Interval Estimation	Introduction, confidence interval and confidence limit, confidence belt and confidence bound, confidence coefficient, confidence interval for mean, variance, difference of mean, ratio of variance, correlation coefficient, regression coefficient etc. methods of finding confidence intervals: pivotal quantity method, statistical method; large sample confidence intervals; Bayesian interval estimation; methods of evaluating interval estimators: size and coverage probability.	**08**	**CLO4**
Preliminaries of Tests	Hypothesis, simple and composite hypotheses, null and alternative hypotheses, concept of test of significance, procedures of a test, errors in testing hypothesis, level of significance, power of test, power function, one tailed and two-tailed tests, *P-value*, tests based on usual normal.	**10**	**CLO5**
Test of Hypothesis:	Testing the significance of single mean, single variance, single proportion, difference of two means and proportions, ratio of two variances and their confidence intervals. tests and confidence intervals concerning simple correlation coefficient and regression coefficient for single and double sample. paired *t*-test. Testing the homogeneity of several population mean, variance and proportions. Statement about p-values for these tests. Association of attributes, association & disassociation, measure of association, attribute, contingency tables, test of independence in an $r \times c$ contingency table. Fisher's exact test for a 2×2 contingency table. Test of goodness of fit.	8	**CLO5 CLO6**

Books Recommended	**Text Books:** **1.** Mood, Graybill and Boes, *Introduction to the Theory of Statistics*, 3rd Ed., McGraw-Hill. **2.** Kendall & Stuart, *The Advanced Theory of Statistics*, Vol. I & II. **Reference Books:**

	3. Rao, C. R., *Linear Statistical Inference and Its Applications*, Wiley. 4. Hogg, R.V. and Craig, A.T., *Introduction to Mathematical Statistics*, Mcmillan-Collierm, N.Y. 5. Cassela C. and Burger R. *Statistical Inference*, 3rd edition. 6. Cox, D. R. & Hinkley, U., *The Theory of Statistics*, Methuem, London. 7. Lehmann, *Theory of Point Estimation*. 8. Gupta S. C. & Kapoor V. K., *Fundamentals of Mathematical Statistics.*
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Sampling Distributions **Course No:** STA 0542 202
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to afford basic concept and the application of various sampling distributions.
Objectives: At the end of this course, students will be able to apply different methods of transformation of random variables. Depict the role of sampling distributions in inferential statistics.

After completion of this course, students will be able to
CLO1: Understand Different methods of transformation in various distributions.
CLO2: Estimate the sampling distribution of mean, variance, correlation and regression coefficients.
CLO3: Establish the interrelationship in ***t***, ***F*** and χ^2 distributions.
CLO4: Understand the theory of large samples

Mapping of PLOs to CLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓		✓		✓					✓
CLO2		✓		✓	✓	✓	✓			✓
CLO3	✓			✓						
CLO4		✓		✓						✓

Topic	Course Content	Hours	CLO
Methods of Finding Sampling Distribution	Concept related to Sampling distribution, Methods of finding sampling distributions	**06**	**CLO2**
Distributions of Functions of Random Variables	Method of distribution functions, method of transformations, method of moment generating functions, distribution of sum, difference, product and quotient of random variables, central limit theorem with real life applications, probability integral transform,	**10**	**CLO1 CLO2**
Exact Sampling Distributions	Distribution of sample mean and variance and their independence for normal population, application of χ^2, t and F distributions in Statistics. Sampling distribution of correlation and regression coefficients, standard errors	**08**	**CLO2 CLO3**

	of statistics with their large sample approximations, Fisher's Z-transformation, transformation of variables including square root, log, sin-inverse etc.		
Non-central Distributions	Brief discussion on non-central Chi-square, non-central t and F distributions.	**08**	**CLO2 CLO3**
Law of Large Number	Theory of large samples, convergence of random variable, modes of convergence, law of large number (strong law and weak law), central limit theorem, inversion theorem, Chebyshev's inequality with real life problems.	**10**	**CLO4**

Books Recommended	**Text Books:** **1**. Hogg R.V., McKean J. & Craig A. T, *Introduction to Mathematical Statistics*, Pearson; 7th Edition (2012). **2**. Cassela C. and Burger R. *Statistical Inference*, 3rd edition. **Reference Books:** **1.** Gupta, S. C. and Kapoor, V. K., *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons (2014).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Regression Analysis **Course No:** STA 0542 203
Contact Hours per Week: 04 **Credit:** 04

Rationales: The course provides an overview of the most common techniques used to quantify regression analysis and to establish relationship and model building techniques.

Objectives: The objectives of this course are to **a**pply and fit appropriate regression model according to the nature of data, critically analyzing results obtained from fitted regression model and use statistical software's and programming language for building a statistical model.

After completion of this course, students will be able to
CLO1: Understand all the features of regression analysis.
CLO2: Formulate, analyze and forecaster the bivariate/multiple data.
CLO3: Interpret the results of the fitted model.
CLO4: Understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model;
CLO5: Know how to diagnose and apply corrections to some problems in regression.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓						✓	
CLO2		✓		✓				✓	✓	
CLO3			✓		✓			✓		
CLO4		✓			✓			✓		
CLO5		✓	✓		✓			✓	✓	

Topic	Course Content	Hours	CLO
Introduction	Measures of association for quantitative data: correlation and inference concerning correlation; regression and model building, motivating examples, uses of regression.	**05**	**CLO1**
Simple Linear Regression	Simple linear regression model, hypothesis testing on the slope and intercept, interval estimation, prediction of new observations, coefficient of determination, regression through the origin, estimation by maximum likelihood, case where the regressor x is random. Matrix representation of simple linear regression model, inference and prediction.	**06**	**CLO1**
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*, *AIC*, *BIC*, *SIC* and model selection criteria, inference about regression parameters, confidence interval, prediction and prediction interval.	**08**	**CLO1 CLO2**
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.	**08**	**CLO2**
Influential Observation	Influential observations, High leverage points and outliers, Deletion of observations, Measures of influential observations, Cook's distance, DFFITS, DFBETA, MDFIT, Outlier diagnostics, Measures of high leverage points.	**07**	**CLO3**
Robust regression	Group deletion, Masking and swamping, Breakdown point and Robust estimators, Least median of squares technique, Reweighted least squares residuals, Detection of multiple outliers.	**09**	**CLO2**
Selection of Best Regression Equation	All possible regression, best set of regression, backward elimination procedure, stepwise regression procedure, ridge regression, predictor sum of squares, principal component regression, latent root regression, stage- wise regression procedure,.	**08**	**CLO2 CL05**
Polynomial and Non-linear Regression	Polynomial regression models, orthogonal polynomials, different types of non-linear regression and their estimation process.	**08**	**CLO4**

Books Recommended	**<u>Text Books:</u>** **1.** Montgomery, D. C. Peck, E., Vining G. G. Introduction to Linear Regression Analysis, Wiley, N.Y, Fifth Edition (2012). **2.** Draper, N. R, and Smith, H., *Applied Linear Regression*, Wiley-Interscience; Third edition (1998). **<u>Reference Books:</u>**

	1. Ryan, T. P., *Modern Regression Methods*, Wiley-Interscience; 2nd Edition (2008). 2. Gujarati, D. N. (2012). Basic econometrics. Tata McGraw-Hill Education
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Sampling Techniques-I **Course No:** STA 0542 204
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course mainly deals with appropriate statistical sampling techniques, census, survey design and method of data collection.

Objectives:

- To familiarize students with the concepts of sampling, sampling techniques, census, survey design and methods of data collection,
- Help students conceptualize different sampling techniques such as simple random sampling, stratified random sampling, systematic sampling, cluster sampling,
- To facilitate necessary knowledge to compare the efficiency among different sampling techniques,
- Help students properly apply knowledge to select appropriate sampling technique for collecting data according to the requirement of problems to be analyzed.

Course Learning Outcomes: After completion of this course, students will be able to
CLO1 - Prepare layouts of different sampling techniques;
CLO2 - Apply methods and analytical tools for collecting data;
CLO3 - Collaborate in a project for collecting primary data;
CLO4 - Assess the quality of collected data;
CLO5 - Produce necessary estimates of parameters;
CLO6 - Calculate efficiency of the estimates;
CLO7 - Construct confidence intervals of the estimates;
CLO8 - Compare efficiency of alternative sampling designs.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√				√	√		√
CLO2	√	√	√				√	√		√
CLO3	√	√	√				√	√		√
CLO4	√	√	√				√	√		√
CLO5	√	√	√				√	√		√
CLO6	√	√	√				√	√		√
CLO7	√	√	√				√	√		√
CLO8	√	√	√				√	√		√

Topic	Course Content	Hours	CLO
Introduction	Role of sampling theory, requirements of a good sample design, units, population, sampling units, sampling frame and related problems, uses of sample survey, random or probability sampling and non-random or purposive sampling, bias, precision and accuracy of estimates,	**08**	**CLO1 CLO2 CLO3 CLO4**

	different types of errors associated with sampling and complete enumeration.		
Simple Random Sampling	Advantages and disadvantages, drawing of samples, with and without replacement sampling - estimates, standard errors and confidence intervals, simple random sampling for proportion and ratio estimate, standard error and confidence interval, determination of sample size for specified precision.	**08**	**CLO4 CLO5 CLO6 CLO7**
Systematic Sampling	Definition, use, limitation, estimates, bias, standard error and efficiency, comparison with simple random sampling, systematic sampling for populations with linear trend, methods for dealing with population with linear trend or periodic variation.	**06**	**CLO4 CLO5 CLO6 CLO7**
Stratified Random Sampling	Reasons for stratification, formulation and number of strata, stratified random sampling estimates, standard error and confidence interval, allocation of samples to strata, equal allocation, proportional allocation, Neyman allocation and optimum allocation, stratified sampling for proportions, post stratification and quota sampling.	**10**	**CLO4 CLO5 CLO6 CLO7**
Cluster Sampling	Definition, reasons, formation of clusters, size of clusters, simple cluster sampling with equal and unequal sized clusters estimates, bias, standard error and efficiency, comparison with simple random sampling and systematic sampling, determination of optimum cluster size. Stratified cluster sampling: advantages, estimates, bias, standard error and efficiency, comparison with simple random sampling, systematic sampling and usual stratified random sampling.	**10**	**CLO4 CLO5 CLO6 CLO7**
Use of Supplementary Information on Ratio estimation and Regression estimation	Ratio estimation with examples, estimated bias, mean squared error, approximate variance; conditions for unbiased ratio estimation; unbiased ratio-type estimates; necessity and limitation of ratio estimates; ratio estimates in stratified random sampling; comparison of the combined and separate estimates; difference estimation. Regression estimation with examples, assumptions, properties and limitations; bias and approximate variance; estimate of the variance; regression estimates a stratified sampling combined and separate estimates; comparative merits and demerits of ratio and regression estimates. Product estimation and its mean variance.	**10**	**CLO4 CLO5 CLO6 CLO7**

Books Recommended	**<u>Text Books:</u>** **1**. Singh, D. & Chaudhury, F. S., *Theory and Analysis of Sample Survey Design*, John Wiley & Sons Inc. (1987). **2.** Cochran, W. G., *Sampling Techniques.* John Wiley & Sons; 3rd Edition (1977). **3.** Mukhopadhyay P., *Theory and Methods of Survey Sampling*, PHI Learning; 2nd Edition (2008).

	Reference Books: **1**. Lohr, S. L. (2005), *Sampling: Design and Analysis*, Duxbury Press; 2nd Edition (2009). **2.** Islam, M. N. (2008), *An Introduction to Sampling Methods*, Book World.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Demography **Course No:** SSS 0314 205
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to estimate the rate of population growth, fertility, mortality, marriage, migration, etc. The entire thing is related to population growth are discussed in Demography. The development plan in a nation are strongly depend on perfectly knows the population in a certain time period.

Objectives: The purposes of this course are to, identify appropriate sources of data; perform basic demographic analyses using various techniques and ensure their comparability across populations; interpret the information gathered by the different demographic methods.

After completion of this course, students will be able to
CLO1: Identify access and interpret socio-demographic and economic data.
CLO2: Analyze the demographic characteristics of a given population.
CLO3: Present the socio-demographic trends and current composition of the Bangladeshi population. .

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓		✓				✓		
CLO2		✓		✓				✓		✓
CLO3			✓		✓	✓		✓	✓	

Topic	Course Content	Hours	CLO
Basic Concept of Demography	Definition, nature and scope of demography, role and importance of demography and population studies, vital events, demographic characteristics in Bangladesh, relationship between demography and other disciplines.	**04**	**CLO1**
Sources of Demographic Data	Methods of demographic data collection, dual record system, census, vital registration system, sample surveys, registers and other sources especially in Bangladesh, advantages and disadvantages of these methods, concept of de-facto and de-jure population, assessment of quality of demographic data.	**05**	**CLO1 CLO2**
Errors in Demographic Data	Types of errors in demographic data, age heaping, age misstatement, under enumeration, over count etc., post enumeration check, application and adjustment of different methods in detecting errors/ digital preferences, estimation method of under count and over count.	**05**	**CLO2**

Fertility and Reproduction	Rates, ratios and proportions, sex ratio, child-women ratio, dependency ratio, detail study of fertility, fecundity and reproduction, various measures of fertility and reproduction, important determinants of fertility, estimation of mean age at child bearing.	**06**	**CLO3**
Mortality	Detail study of mortality, various measures of mortality, important determinants of mortality and morbidity, infant mortality rate and its components, trends of mortality and its differentials.	**04**	**CLO3**
Nuptiality	Marriage, types of marriage, concept of marriage and nuptiality, family formation, composition and dissolution, age at marriage and its effect on fertility, celibacy, widowhood, divorce and separation, their effect on fertility and population growth, estimation of mean and median age at marriage, estimation of singulate mean age at marriage.	**06**	**CLO2 CLO3**
Concepts of Standardization	Concepts of standardization in demographic measurements, different methods of standardization with their merits and demerits.	**04**	**CLO3**
Migration	Concept, types and measures of migration, determinants and trends of migration, migration with respect to Bangladesh.	**03**	**CLO1 CLO3**
Life Table	Concept, structure and calculation, construction of complete life table (life table by single year of age) and abridge life table, multiple decrement life tables, actuarial life tables, working life table, different life table functions and interrelationships among them, use of life tables etc.	**05**	**CLO3**

Books Recommended	**Text Books:** **1.** Islam M. N. *An Introduction to Demographic Techniques*, Mullick & Brothers,1st Edition (2015). **2.** Swanson D. A. Siegel, J. S.,*The Methods and Materials of Demography*, Emerald Group Publishing; 2nd Edition (2004). **Reference Books:** **1**. Misra. B. D., *An Introduction to the Study of Population*, South Asia, New Delhi (2004). **2**. Bogue, D., *Principles of Demography*, John Wiley & Sons Inc. (1969). **3.** Barcley, G.W.: *Techniques of Population Analysis*, John Wiley & Sons Inc. (1958). **4.** Kpedekpo, G. M. K., *Essentials of Demographic Analysis for Africa*, Heinemann International Literature & Textbooks (1982).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Mathematical Methods and Numerical Analysis **Course No:** MAT 0541 206
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course presents mathematical and elements of scientific computing approach for solving mathematical problems that arises mainly in science and engineering applications.
Objectives: The course wants to develop an understanding of the core idea and concepts of numerical methods.

After completion of this course, students will be able to
CLO1: Apply the interpolation and inverse interpolation formulas in different fields
CLO2: Solve simultaneous equations using Newton-Raphson method;
CLO3: Formulate mathematical problems of series; differentiate and integrate of Fourier series.
CLO4: Gain the concept of using Laplace transformation, Inverse Laplace transformation and its properties.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓				✓			✓
CLO2			✓	✓	✓	✓				
CLO3			✓	✓		✓				✓
CLO4			✓			✓			✓	

Topic	Course Content	Hours	CLO
Solution of Equation in One Variable	Bisection algorithm, Method of false position, fixed point iteration, Newton-Raphson method, Error Analysis for iterative method, Accelerating limit of convergence.	**12**	**CLO1 CLO2**
Interpolation and Polynomial Approximation	Taylor polynomials, Interpolation and Lagrange polynomial, Iterated interpolation, Extrapolation.	**06**	**CLO1**
Differentiation and Integration	Numerical differentiation, Richardson's extrapolation, Elements of Numerical Integration, Adaptive quadrature method, Romberg's integration, Gaussian quadrature.	**12**	**CLO2 CLO3**
Fourier Series	Periodic function; Fourier series process of determining the Fourier coefficients; Dirichlet conditions; odd and even functions; half range Fourier sine or cosine series; Parseval's identity; differentiation and integration of Fourier series.	**12**	**CLO2 CLO3**
Laplace Transform	Introduction; definition of integral transformation; definition of Laplace transform; Laplace transform of some elementary functions; sufficient conditions for the existence of Laplace transform; some important properties of Laplace transform; initial and final value theorem; Laplace transforms of some special functions.	**12**	**CLO3 CLO4**
Inverse Laplace Transform	Definition of inverse Laplace transform; Lerch's theorem; some important properties of the inverse Laplace transform; partial function decompositions; definition of the convolution; convolution theorem; Heaviside's expansion formula; evaluation of integrals;	**12**	**CLO3 CLO4**

	application of Laplace transform; Taylor's and Laurent series.		

Books Recommended	**<u>Text Books</u>** **1.** Burden, R. L. and Faires, J. D. (2010), *Numerical Analysis*, Brooks Cole; 8th Edition (2004). **2.** Scarborough W. & Scarborough J. B., *Numerical Mathematical Analysis*, The Johns Hopkins University Press; 6th Edition (1966). **<u>References:</u>** 1. Mallick, S. A. and Uddin, M. A. (2007), *Numerical Mathematics*. 2. Noble B, Numerical Methods, Vol. I and II. 3. Numerical analysis with R
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Actuarial Statistics **Course Code:** STA 0542 207
Contact Hours per Week: 04 **Credit:** 04

Rationales: The course provides basics in mathematical and statistical techniques which can be used in calculating in respect of payments depending on life contingencies.

Objectives: The objectives of the course are to understand risk management as well as to develop stochastic models applied to finance, insurance and pension.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Define various forms of assurance, annuity, and pension contracts.
CLO2: Obtain expressions for the mean and variance of the present value of benefits under each contract.
CLO3: Evaluate net premiums, net premium reserves, gross premiums and gross premium reserves of simple insurance contracts.
CLO4: Analyzing expected cash flows that are contingent upon multiple decrement events.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√					√			
CLO2		√	√	√					√	√
CLO3	√		√			√				
CLO4		√			√			√		√

Topic	Course Content	Hours	CLO
The Meaning of Actuarial Science	Role of insurance in the economy, the role of an actuary, its relationship with life insurance, and important uses of actuarial statistics especially in the context of Bangladesh.	**06**	**CLO1 CLO2**
Fundamentals of Theory of Interest	Definition of simple interest and compound interest and their comparisons; accumulated value factors and present value factors, effective and nominal rates of interest and their interrelationship, effective and nominal rates of discount, the relation between interest and discount, present and accumulated values of immediate annuity and annuity	**12**	**CLO2 CLO3**

	due, the present value of deferred annuities and variable annuities, analysis of annuities payable at a different frequency than interest is convertible, perpetuity, capital redemption policies, amortization schedules and sinking funds, and Bonds, including the determination of outstanding principal, the split of payments into principal and interest, and the determination of required periodic payments.		
Actuarial Mathematics	Discrete life annuity and its applications, present values of different life annuities, life assurance, present values of various life assurances in terms of commutation functions, related problems, net premiums, net premiums for various life assurances, premiums payable m times a year, determination of premiums for pension benefits, related problems, office premiums, relation between the office and net premiums, the equation of payments, basic concepts of valuation and distribution of surplus.	**12**	**CLO2 CLO3 CLO4**
Construction of Actuarial Tables	Introduction to the mortality table, principles of construction of mortality table, fundamental assumptions underlying exposure formulas and the implications of these assumptions, techniques of calculating exposures from individual records including considerations involving the selection of studies. Survival distributions, life tables, life insurance, life annuities, net premium, premium series, multiple life functions, multiple decrement models, valuation theory for pension plans, expense function and dividends.	**12**	**CLO1 CLO2 CLO4**

Books Recommended	**<u>Text Books:</u>** **1.** Michael M. Parmenter, *Theory of Interest and Life Contingencies with Pension Applications: A Problem-Solving Approach* **2.** Kellison, S.. *The Theory of Interest*, McGraw-Hill/Irwin; 3rd Edition (2008). **3.** Sohrab Uddin, An introduction Actuarial and Financial Mathematics. **<u>Reference Books:</u>** **1.** Ayres, F., Theory and Problems of *Mathematics of Finance*, Schaum (1963). **2.** Garret S., *An Introduction to Actuarial and Financial Mathematical Methods,* Academic Press; 1st Edition (2015).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with the real-life problem, presentation.

Course Title: Programming with R & Python and Simulation **Course No:** CSE 0612 208
Contact Hours per Week: 04 **Credit:** 04

Rationales: *R* is free software that is capable of handling mathematical and statistical manipulations. It has its own programming language as well as built in functions to perform any specialized task. Students intend to learn the basics of *R* software in this course. This course is designed to provide basic concepts of computer programming with *R* programming language for statistical data.

Objectives: To be able to learn and apply the basics of *R*, like creating objects, writing functions, reading/creating data frames, reading external data sets, basic programming (looping and if-conditioning), creating plots, and also, perform exploratory data analysis.

Course Learning Outcome: At the end of the course the students will be able to
CLO1: Understand basic concepts, syntax and the process of problem-solving using *R* and *Python* programming language.
CLO2: Construct multiple plots and calculate probability from different distributions using *R* and *Python* programming language.
CLO3: Solve linear algebra problems such as simultaneous equations, matrix operations using *R* and *Python* programming language.
CLO4: Compute simple and complex calculus problems such as differentiation, integration using *R* and *Python* programming language.
CLO5: Write programs in *R* and *Python* using basic control structures (conditional statements, loops, switches, etc.) and solve real life problems related to big data analytics.
CLO6: Perform statistical data analysis and build carrier as a data scientist.
CLO7: Demonstrate the use of random number sets for simulation of data with a random error and for Monte-Carlo methods for integration and simulation.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√		√			√				
CLO2				√						
CLO3				√	√					
CLO4					√	√				
CLO4		√					√			
CLO6	√	√	√	√		√	√	√		√
CLO7			√	√		√		√		√

Topic	Course Content	Hours	CLO
Introduction to R	*R* basics, code editors for *R*, running *R* programs, *R* language essentials – Expressions, objects, functions, arguments, vectors, functions that create vectors, matrices and arrays, factors, lists, data frames, indexing, grouped data, finding help.	**6**	**CLO1**
Control Structures	Conditional executions, comparison operators, logical operators, if and if else statements, loops, for, while and apply loop family, improving speed performance of loops.	**4**	**CLO5**
Functions	Syntax to define and call functions, Syntax rules for functions, Control utilities for functions: return,	**4**	**CLO5**

	warning and stop, function examples, calling C function from *R*.		
Mathematical Functions	Matrix operations, solution of system of linear equation, differentiation, integration, optimizing functions etc.	**6**	**CLO3 CLO4**
Basic Plotting	Graphical display of data and probability distributions.	**2**	**CLO2**
Applications of R for Data Analysis	Perform different exploratory data analysis: descriptive statistics, probability and probability distributions, correlation, regression, sampling, random number generation using different distributions etc.	**6**	**CLO6**
Downloading and Installing Python	Introduction to Python, IPython (3.7.0) and IPython Notebook, installing Python using PIP command.	**8**	**CLO1**
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.	**10**	**CLO5**
Numbers and Operators	Different Kinds of numbers, numbers in python, creating an imaginary number, number formats, formatting numbers as octal and hexadecimal.	**12**	**CLO3 CLO4**
Variables	Names for values, referring to data – using names for data, assigning values to names, copying data, manipulating, slicing, retrieving data set.	**8**	**CLO3 CLO4**
Packages of Python	Pandas, numpy, and scipy.	**6**	
Applications of R and Python 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.	**8**	**CLO3 CLO4**
Simulation	Concepts of simulation and its uses in statistics; random number generations: congruential generators, seeding; random variate generations: inversion method (direct method), rejection method (indirect method); simulating discrete random variables; simulating normal random variables: rejection with exponential envelope, Box-Muller algorithm; Monte-Carlo integration: hit-and-miss method, improved Monte-Carlo integration; variance reduction: antithetic sampling, importance sampling, control variates.	**10**	**CLO7**

Books Recommended	**Text Books:** 1. Peng RD (2015). R Programming for Data Science. Leanpub. 2. Peng RD (2015). Exploratory Data Analysis with R. Leanpub. 3. Kabacoff RI (2010). R in Action. Manning.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem.
Assessment Strategy	Final exam, continuous assessment, quiz, assignment.

Course Title: Principles of Economics **Course No:** ECO 0311 209
Credit: 04 **Contact Hours per Week:** 04

Rationales: Principles of Economics is premeditated to facilitate student to understand the basic conceptions and applications of preliminary stage of economics. This course concerns to make decision at individual and national level. Learning this course¸ student will be capable to understand the socio-economic activities in an economic way.

Objectives: The objectives of this course are to analyze economic system that will provide answer the questions of what to produce, how to produce and for whom to produce, to analyze the human behavior and their choices, to evaluate the production cost and production process, to acquire an in-depth knowledge regarding the factors of production and the role of government in promoting greater efficiency and equity in the economy.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Understand the concepts of micro economics and macroeconomics.
CLO2: Explain the general distribution and allocation theory.
CLO3: Explore the human behavior that affects the determinants of supply and demand.
CLO4: Identify the production cost and production process.
CLO5: Predict the market structure in relation with scarce resources, and unlimited want.
CLO6: Understand the macroeconomic policy, money and banking system and relationship between unemployment and inflation rate.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√			√			
CLO2										
CLO3	√	√		√	√					
CLO4		√		√	√	√	√			√
CLO5	√									√

Topic	Course Content	Hours	CLO
	Micro-Economics		
Introduction	Definition and scope of Economics, basic concepts and tools used in Economics, Economics problems-scarcity and resources.	**04**	**CLO1**
Demand, Supply and Market	Concept of demand, supply and equilibrium, determinants of demand and supply, shifting of demand and supply curves, application of demand and supply, elasticity of demand and supply.	**04**	**CLO2**
Theory of Consumer Behavior	Concepts of utility, paradox of value, law of diminishing marginal utility, indifference curve, budget constraint, consumer's equilibrium.	**04**	**CLO3**
Theory of Firm	Production function, law of diminishing return, stages of production, law of variable proportion, short run and long run production and costs. division of labor; returns to scale; law; Isoquants; Cobb-Douglas and CES production function; theory of cost; fixed and	**05**	**CLO3**

	variable cost; total and marginal costs.		
Market	Taxonomy of markets, characteristics of different types of markets	**06**	**CLO4**
	Macro-Economics		
Introduction to Macroeconomics	Definition, macro-economic performance, measuring national product and national income-GNP, NNP, NI, personal disposable income, national and real GNP, circular flow of income, value added tax.	**04**	**CLO5**
Money and Banking	Definition and functions of money, different kinds of money, commercial bank and the money stocks, functions of central bank, money supply.	**05**	**CLO5**
Introduction to Inflation and Unemployment	Inflation and consumer price index, Concept of globalization and free trade. Types and costs of inflation and unemployment.	**05**	**CLO5**
Distribution of Personal Income	Pareto's law, Lorenz curve, concentration ratio, the lognormal distribution, stochastic model of income distribution.	**05**	**CLO6**

Books Recommended	**Text Books:** **1.** Mankiw, N. Gregory *Principles of Microeconomics*, 4th Edition, Thomson Southwestern Printed, (2007). **2.** Parkin, M. *Microeconomics*, Latest edition, Pearson Education Inc. **References Books:** **1.** Roger A. Arnold. *Economics*, 8th edition, Thomson South-Western Printed, (2008). **3.** Samuelson, P. A. and Nordhaus, W. D. *Economics*, 18th Edition¸ Tata McGraw Hill Publishing Company ltd., (2005).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing-II **Course No:** STA 0542 210
Contact Hours per Week: 02 **Credit:** 02

Rationales: Apply acquired knowledge on methods of estimation and tests of hypotheses.

Objectives: At the end of the course, students will be able to learn the methods of point estimations well as adopt the techniques of interval estimation. Students will be also able to develop ability to perform hypothesis testing using real data.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Generate random sample from different distributions.
CLO2: Apply point estimation methods to estimate the parameters using the sample from different distributions.
CLO3: Construct interval estimation of the parameters using the sample from different distributions.
CLO4: Apply different hypothesis testing methods on data.
CLO5: Fitting different types of regression models using real data.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√		√							√
CLO2		√		√	√					√
CLO3		√	√	√	√					√
CLO4			√		√			√		√
CLO5		√		√	√				√	√

Topic	Course Content	Hours	CLO
Statistical Inference Lab	Drawing sample from univariate and bivariate normal distributions. Point estimation of parameters of univariate distributions by method of moments, method of maximum likelihood and method of least squares. Construction of confidence intervals for parameters of normal distribution, construction of large sample confidence interval for parameters of the distribution. Tests for proportions, means, two means, several means and variances. Test for independence and association in contingency table, exact test in a 2 x 2 contingency table. Test of hypothesis of parameters of Binomial and Normal distribution.	**28**	**CLO1 CLO2 CLO3 CLO4**
Regression Analysis Lab	OLS estimators, correlation ratio, hypothesis testing, regression through the origin, scaling and units of measures. Estimation of parameters and standard error, separation of effects, multiple and partial correlation. Analyses of residuals by graphs, lack of fit.	**20**	**CLO5**

Books Recommended	**<u>Text Books:</u>** **1.** Mood, Graybill and Boes, *Introduction to the Theory of Statistics*, 3rd Ed., McGraw-Hill. **2.** Gupta S. C. & Kapoor V. K., *Fundamentals of Mathematical Statistics.* **3**. Draper, N. R, and Smith, H., *Applied Linear Regression*, Wiley-Interscience; Third edition (1998).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing-III **Course No:** STA 0542 211
Contact Hours per Week: 02 **Credit:** 02

Rationales: This course is designed to acquire basic concepts of inferential statistics for data

analysis.

Objectives: At the end of this course, students will be able to provide robust information on sample distribution, analysis and interpretation of data and results in various fields of research.

After completion of this course, students will be able to

CLO1: Perform analysis and interpret results in different fields of study;

CLO2: Identify the shape of sampling distribution to interpret the nature of statistical data.

CLO3: Conduct statistical tests of hypotheses for different sample and interpret parameters.

CLO4: Apply various demographic measures into real life data

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓		✓		✓	✓				
CLO2		✓		✓	✓	✓				✓
CLO3			✓	✓			✓			
CLO4		✓		✓			✓			✓

Topic	Course Content	Hours	CLO
Sampling distribution Lab	Small and large sample tests for proportion, mean, variance, correlation coefficient, regression coefficient, test for independence in contingency table.	**20**	**CL01 CL02 CL03**
Demography Lab	Calculation of various rates, ratios, proportions for demographic data, calculation of various measures of population growth, construction of life tables, calculation of standardized death rate and ratios, fitting of growth curves. Other topics as covered in the theory part.	**20**	**CL04**

Books Recommended	**Text Books:** **1.** Hogg R.V., McKean J. & Craig A. T, *Introduction to Mathematical Statistics*, Pearson; 7th Edition (2012). **2.** Islam M. N. *An Introduction to Demographic Techniques*, Mullick & Brothers,1st Edition (2015).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Programming (Python & R) Lab **Course No:** CSE 0612

Contact Hours per Week: 02 212 **Credit:** 02

Rationales: *R* is free software that is capable of handling mathematical and statistical manipulations. It has its own programming language as well as built in functions to perform any specialized task. Students intend to learn the basics of *R* software in this course. This course is designed to provide basic concepts of computer programming with *R* programming language for statistical data.

Objectives: To be able to learn and apply the basics of *R*, like creating objects, writing functions, reading/creating data frames, reading external data sets, basic programming (looping and if-conditioning), creating plots, and also, perform exploratory data analysis.

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

CLO1: Understand basic concepts, syntax and the process of problem-solving using *R* and *Python* programming language.
CLO2: Write programs in *R* and *Python* using basic control structures (conditional statements, loops, switches, etc.) and solve real life problems related to big data analytics.
CLO3: Perform statistical data analysis and build carrier as a data scientist.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√		√			√				
CLO2				√						
CLO3				√	√					

Topic	Course Content	Hours	CLO
Problem Solving through R and Python	Solving different statistical problems by R and python (measures of central tendency, measures of dispersion, correlation and regression), graphical presentation of statistical data by R, analysis of data by R, writing and running syntax in R and python to solve different statistical problems.	**20**	**CLO1 CLO2**

Books Recommended	**Text Books:** 1. Kabacoff RI (2010). *R in Action*. Manning.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem.
Assessment Strategy	Final exam, continuous assessment, quiz, assignment.

Course Title: Viva-Voce **Course No:** STA 0542 213
Contact Hours per Week: NA **Credit:** 02

Rationale of the course: Assessing students' comprehensive knowledge on basic concepts of the courses learned in the current semester.

Objectives: Help students to gain confidence in their own ability to present and explain the basic concepts of the courses. Provide the knowledge of oral communication and presentation skills that are essential for later professional career

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Develop verbal communication and presentation skills;
CLO2: Communicate their learning effectively and appropriately to formal audiences;
CLO3: Explain key concepts of the courses, interpret key terms, and justify their arguments logically to non-statisticians;
CLO4: Prepare for professional oral examinations which is useful to enhance employment interview skills;
CLO5: Demonstrate their ability to participate in academic discussion.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√			√			√	√	√

CLO2	√	√			√			√	√	√
CLO3	√	√			√			√	√	√
CLO4	√	√			√			√	√	√
CLO5	√	√			√			√	√	√

Topic	Course Content	Hours	CLO
Viva-Voce	Comprehensive contents of all the underlying courses of the semester.		

Books Recommended	**Main Text** • Textbooks referred for all the underlying courses of the semester. **Reference Books** • Reference books referred for all the underlying courses of the semester.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Courses for the Third Year

Course Code	Course Title	Course Category	Credit
STA 0542 301	Non-parametric Methods and Order Statistics	Core	4
STA 0542 302	Sampling Technique-II	Core	4
STA 0542 303	Design and Analysis of Experiments	Core	4
STA 0542 304	Stochastic Processes	Core	4
STA 0542 305	Time Series Analysis and Forecasting	Core	4
STA 0542 306	Industrial Statistics and Operational Research	Core	4
STA 0542 307	Research Methodology and Social Statistics	Core	4
STA 0542 308	Data Mining	Core	4
STA 0542 309	Statistical Computing-IV	Core	2
STA 0542 310	Statistical Computing-V	Core	2
STA 0542 311	Statistical Computing-VI	Core	2
STA 0542 312	Viva-Voce	Core	2
Total			**40**

Course Title: Non-parametric Methods and Order Statistics **Course Code:** STA 0542 301
Contact Hours per Week: 04 **Credit: 04**

Rationales: This course covers order statistics and nonparametric testing procedures and learning about the different aspects of such procedures.

Objectives: The objectives of the course are-know about the basic concepts of nonparametric statistical inference using order statistics and applying the nonparametric test for analyzing real data.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Understand the concepts and uses of order statistics.
CLO2: Applying the non-parametric test when suitable.
CLO3: Use the statistical software to draw inferences using nonparametric tests.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√					√			
CLO2		√		√		√				√
CLO3	√	√		√		√			√	

Topic	Course Content	Hours	CLO
Order Statistics	Concepts of order statistics and their applications, the joint distribution of order statistics, the marginal distribution of order statistics, conditional distributions of order statistics, distributions of maximum, minimum, range, median, and other quantiles, order statistics for discrete and continuous parent distributions, exact moments of order statistics; large-sample approximations to mean and variance of rth order statistics, the asymptotic distribution of order statistics.	**18**	**CLO1 CLO3**
Non-Parametric Tests	Overview of non-parametric tests, distinction with parametric tests, concept of distribution-free test.	**03**	**CLO1**

Test Based on Runs	Distribution theory of runs, test based on the total number of runs, test based on length of longest run, runs up and down, randomness test based on Runs.	**03**	**CLO2 CLO3**
Test of Goodness of Fit	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, test for goodness of fit, Lillifors test for normality.	**03**	**CLO2**
One-Sample and Paired-Sample Techniques	Sign Test, Wilcoxon signed ranks test and their distributional properties, power and confidence interval procedure, binomial and quantile test.	**03**	**CLO2 CLO3**
General Two-Sample Problem	Wald –Wolfowitz runs test, Kolmogorov-Smirnov two sample test, median test, Mann-Whitney U Test and their distribution under the null hypothesis, confidence interval properties.	**03**	**CLO2 CLO3**
Linear Rank Test for Location and Scale	Definition, Distributional Properties of Linear Rank Statistics. Wilcoxon rank-sum test, Terry-Hoeffding test, Vander Waerden test and their distributions under null hypothesis. Mood test, Freund-Ansari-Bradley-David-Barton test, Seigel-Tukey test, Klotz-Normal Score test, Sukhatme test and their distributions under null hypothesis, moments under null hypothesis.	**10**	**CLO2 CLO3**
Test of Equality of K Independent Samples	Extension of median test, Kruskal-Wallis one way ANOVA test, distributional properties of each test, test against ordered alternatives, comparisons with control.	**03**	**CLO2 CLO3**

Books Recommended	**<u>Text Books:</u>** 1. Gibbons, J. D. and Chakraborty, S. (1992), *Nonparametric Statistical Inference*, Chapman and Hall/CRC; 5th Edition (2010). 2. Balakrishnan, N. and Cohen, A. C., *Order Statistics and Inference Estimation Method*, Academic Press (1986). **<u>Reference Books:</u>** 1. David, H. A., *Order Statistics*, Wiley-Interscience; 3rd Edition (2003).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Sampling Techniques - II **Course No:** STA 0542 302
Contact Hours per Week: 04 **Credit:** 04

Rationales: Acquiring knowledge to design and implement complex sample surveys.

Objectives:

- Acquaint students with the concepts and solid knowledge of how to use auxiliary information about the population to estimate unknown population parameters of interest in ratio and regression estimation, multistage sampling, double sampling, and sampling on two or more occasions,
- Make students understand sampling and non-sampling errors and consequences of such errors,

Course Learning Outcomes: Apply appropriate sampling techniques in real world problems.
CLO1: Design survey using different sampling strategies, calculating estimate and assessing precision of estimators.
CLO2: Carry out estimation and precision estimation on data from some standard sampling designs for two stage sampling.
CLO3: Distinguish between sampling with unequal probability;
CLO4: Describe and discriminate cluster sampling, multistage sampling, double sampling, and sampling on two or more occasions
CLO5: Differentiate between sampling and non-sampling errors;
CLO6: Produce appropriate estimation of population means, and totals along with their standard errors under various sampling techniques;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√			√		√			√
CLO2	√	√			√		√			√
CLO3	√	√			√		√			√
CLO4	√	√			√		√			√
CLO5	√	√			√		√			√
CLO6	√	√			√		√			√
CLO5	√	√			√		√			√

Topic	Course Content	Hours	CLO
Sampling Strategy	Sampling with unequal probability with and without replacement different selection methods: PPS selection, Brewer's, Durbin's, Samford's, PPS systematic, Horvitz Thomson, Des-Raj's, Murthy's and Rao-Hartley-Cochran methods of selection; detailed study on the related formulae, estimates, variances, estimates of variances for these methods,	**08**	**CLO1 CLO2**
Two-Stage Sampling	Two-stage sampling with equal and unequal sized clusters-estimates and standard errors; estimation for proportions; stratified two-stage sampling.	**05**	**CLO4**
Multistage Sampling	The concept of three stage and multistage sampling and self-weighting estimates; assumptions for self-weighting estimates; sampling schemes resulting in self-weighting estimates.	**08**	**CLO4**
Multiphase Sampling	Concept of two-phase or double sampling; ratio, difference and regression estimators for double sampling and respective standard errors; double sampling for stratification; repeated sampling; sampling from the same population on two occasion, more than two occasions; Interpenetrating subsampling, Concept of base line survey and panel survey	**08**	**CLO1 CLO2**
Sampling and Non-Sampling Errors	Sources and types of non-sampling error, non-sampling bias, non-response error, control of non-response, techniques for adjustments of non-response, Politz-Simon's technique, and response bias and response variance. Role of design and model in sampling: design unbiasedness, model	**07**	**CLO5 CLO6**

	unbiasedness.		
Large Scale Sample Survey	Population census, Economic census, BDHS and other census conducted by BBS.		

Books Recommended	**Text Books:** 1. Singh, D., & Chaudhary, F. S. (1986). Theory and analysis of sample survey designs. 2. Raj, D. (1968). Sampling theory. **Reference Books:** 1. Cochran, W. G., *Sampling Techniques.* John Wiley & Sons; 3rd edition (1977). 2. Lohr, S. L. (2005), *Sampling: Design and Analysis*, Duxbury Press; 2nd edition(2009). 3. Kish, L., *Survey Sampling*, Wiley-Interscience; Revised edition (1995).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Design and Analysis of Experiments **Course No:** STA 0542 303
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course covers the area on analysis of variance, different design of experiments.

Objectives: The objectives of the course are-understand the issues and principles of design of experiments learn formulation and applications of experimental design develop significantly higher ability to design and data collection procedures with maximum precisions.

After completion of this course, students will be able to
CLO1: Explain methods of ANOVA;
CLO2: Compare variations between groups;
CLO3: Discriminate the within group and between group variability;
CLO4: Prepare design and analyze data from single factor experiments;

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√	√	√		√	√		√
CLO2	√		√	√	√		√	√		√
CLO3	√		√	√	√		√	√		√
CLO4	√	√	√	√	√		√	√		√

Topic	Course Content	Hours	CLO
Preliminaries	Definitions and fundamentals of analysis of variance, different types of models, analysis of variance of one-way classification with equal and unequal observations per cell, two-way classification and three-way classification with equal number of per cell. Analysis of variance with fixed effects, mixed effects and random	**10**	**CLO1**

	effects model.		
Basic Concepts of Design of Experiment	Concept of design and design of experiment, difference between design of experiment and design of sample survey, requirements of a good experiments, principles of design of experiments, important steps to conduct design of experiments, contrast, orthogonal contrasts, mutually orthogonal contrasts, efficiency of a design, relative efficiency of designs.	**08**	**CLO1 CLO2**
Detailed Study of Basic Design	Completely randomized design (CRD), randomized block design (RBD), latin square design (LSD), and replicated latin square design, cross-over design.	**08**	**CLO2 CLO3**
Multiple Comparison	Introduction, Tukey's W-test, Newman-Keuls several range test, Duncan Multiple Range Test, Dennett's test, Fisher's least significance difference test.	**08**	**CLO2 CLO3**
Missing Plot Techniques	Orthogonality and non-orthogonality problems, effects of missing values in basic designs, methods of estimation for missing values, and their standard error, adjustment in analysis procedures.	**08**	**CLO3**
Factorial Experiments	Comparative study of factorial and non-factorial experiments, construction and analysis of 2^2, 2^3 and 2^4 factorial experiments. Construction and analysis of 3^2 and 3^3 factorial experiments. Construction and analysis of 2×3, 2×4 3×4 of factorial experiments. Definition, necessity of confounding, types of confounding, total, partial and balanced confounding.	**10**	**CLO4**
Analysis of Covariance	Analysis of covariance in one way classification with a single covariance, Analysis of covariance in RBD and LSD with single covariate.	**05**	**CLO2**

Books Recommended	**<u>Text Books:</u>** 1. Montgomery, D.C., *Design and Analysis of Experiments*, Wiley; 8th Edition (2012). 2. M. R. Bhuiyan, *Fundamentals of Experimental Design*, 2nd Edition (2007). 3. Das, M. N. and Giri, N. C., *Design and Analysis of Experiments*, John Wiley & Sons Inc.; 2nd edition (1987). **<u>Reference Books:</u>** 1. Cochran W. G. & Cox G. M., *Experimental Design*, Wiley; 2nd Edition (1992). 2. KC Bhuiyan 3. Kempthorne O., Hinkelman K., *Design and Analysis of Experiments*, Wiley-Interscience; Volume 2nd Edition (2005).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Stochastic Processes **Course No:** STA 0542 304
Contact Hours per Week: 04 **Credit:** 04

Rationales: The purpose of this course is to embellish students with theoretical knowledge to show how simple probability and matrix theory can be used to build this notion into a beautiful and useful piece of applied mathematics, which are necessary for the analysis of stochastic dynamical systems in economics, engineering and other fields.

Objectives: The objectives of this course to study of the basic concepts of the theory of stochastic processes, analysis of queuing theory and its application of the theory to real-world problem.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Elucidate the power of stochastic processes and their range of applications;
CLO2: Demonstrate essential stochastic modeling tool including Markov chains and queuing theory;
CLO3: Formulate and solve problems which involve setting up stochastic models.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓				✓					
CLO2	✓		✓	✓						
CLO3	✓				✓	✓				✓

Topic	Course Content	Hours	CLO
Stochastic Processes	Stochastic process, different types of stochastic process, discrete time Markov chains, continuous time Markov chains, transition matrix, higher transition probabilities, Chapman-Kolmogorov equation, recurrent events, transient states, classification of states, ergodic properties, evaluation of P^n, random walk model, gambler's ruin problem.	**07**	**CLO1**
Markov Chains	Introduction, transition probability matrices of a Markov chain, first step analysis, some special Markov chains, regular transition probability matrices, the classification of states, basic limit theorem of Markov chain, reducible Markov chains.	**07**	**CLO1 CLO2**
Counting Process	Counting process, Poisson process, birth process death process, birth death process.	**07**	**CLO1 CLO2**
Poisson Process	The Poisson distribution, counting and Poisson process, the law of rare events, distribution associated with Poisson process, spatial Poisson process, compound and marked Poisson processes.	**07**	**CLO3**
Continuous Time Markov Chains	Pure birth processes, pure death processes, birth and death processes, limiting behavior of birth and death processes, birth and death process with absorbing states, finite state continuous time Markov Chains, renewal theory and its applications: introduction, distribution of $N(t)$, limit theorems and their applications, renewal reward process regenerative process, semi- Markov process.	**07**	**CLO3**
Queuing and Branching	Concepts, components of queuing process, queuing model, single server queues, multiple server queues, equilibrium theory, limiting properties of queues, related mathematical	**07**	**CLO3**

Process	problems. Details study of branching process.		

Books Recommended	**Text Books:** **1.** Ross, S. M., *Stochastic Process*, Wiley; 2nd Edition (February 8, 1995). **2.** Medhi, J. (1994). *Stochastic processes*. New Age International. **3.** Karlin, S. & Taylor, H. M., *A first Course in Stochastic Processes*, Academic Press; 2nd Edition (1975). **Reference Books:** **1.** Shah M. A. & Khalek M. A., *Stochastic Processes*, Ekush Printers Ltd. (2022). **2.** Bhat, B, R., *Modern Probability Theory*, New Age International, (2007).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Time Series Analysis and Forecasting **Course No:** STA 0542 305
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course covers various statistical models for time series data and methods for analyzing these models.
Objectives: The objectives of this course are to become familiar with concepts and techniques of correlogram, ARIMA models and forecast for future occurrences of time series data.

After completion of this course, students will be able to

CLO1: Understand the concepts of time series and their application to health, climate, finance and other areas.
CLO2: Apply statistical methods to analyze time series data using computer software and programming.
CLO3: Interpret the outcomes of analyses.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓							
CLO2		✓		✓		✓				
CLO3			✓		✓					

Topic	Course Content	Hours	CLO
Introduction	**Review:** Meaning, characteristics, objective and terminologies of time series analysis, different components of time series data, additive and multiplicative models of time series, measurement of secular trend, seasonal, cyclical and irregular components by different methods, test of randomness of a time series data, effect of moving average on cyclical and irregular components.	**12**	**CLO1**
Probability Models For Time	Stochastic process, stationary process, random walk model, mixed model, etc.	**08**	**CLO1**

Series			
Smoothing of Time Series	Exponential smoothing for a constant process and linear trend process, choice of smoothing constant, smoothing models for seasonal data, autoregressive moving average (ARMA) process, auto-covariance function (ACVF), auto-correlation function (ACF) from AR (1), AR (2), MA (1), MA (2), ARMA (1,1) models, correlogram analysis.	**10**	**CLO1 CLO2**
Forecasting	Stationary time series-best linear predictor, mean squared predictor error and predictor operator, forecasting ARMA And ARIMA models.	**06**	**CLO2**
Forecasting Techniques	ARAR algorithm, Holt-Winters algorithm, Holt-Winters Seasonal algorithm, choosing a forecasting algorithm, problems.	**06**	**CLO2**
Multivariate Time Series	Second-Order Properties, mean and covariance function, multivariate *ARMA (MARMA)* models, best linear predictors, modeling and forecasting with *MAR* or *VAR* process, *VAR* models, unit root models, error-correction model, cointegration analysis.	**10**	**CL03**

Books Recommended	**Text Books:** **1.** Montgomery, D. C., Johnston, L. A., Gardiner, J. S., *An Introduction to Time Series Analysis and Forecasting*, Wiley; 1st Edition (2008). **2.** Box G. E.P., Jenkins G. M., Reinsel G. C., *Time Series Analysis: Forecasting and Control*, Wiley; 4th Edition (2008). **Reference Books:** **1.** Makridakis, S. G., Wheelwright, S. C. and Hyndman R. J., *Forecasting: Methods and Applications*, Wiley; 3rd Edition (1997) **2.** Cryer, J. D., Chan, K. S., *Time Series Analysis: With Applications in R, Springer, 2nd Edition (2018).*
	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Industrial Statistics and Operational Research **Course No:** STA 0542 306
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course emphasizes the application of quality control tools for solving industrial problems.

Objectives: The objectives of the course are- to familiar with official statistics, to solve quality-related problems using different methods of statistical quality control.

After completion of this course, students will be able to
CLO1: Apply different statistical quality control techniques in industry;
CLO2: Plan acceptance sampling;
CLO3: Perform sequential sampling procedure;
CLO4: Identify and use statistical tools to analyze educational and psychological data;
CLO5 : Illustrate the key aspects of official statistics in Bangladesh;

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√		√	√	√		√			√
CLO2	√		√	√	√		√			√
CLO3	√		√	√	√		√			√
CLO4	√		√	√	√		√			√
CLO5	√		√	√	√		√			√

Topic	Course Content	Hours	CLO
Introduction	Basic concepts and principles of industrial statistics and its purposes, industrial quality control, total quality control, statistical quality control, chance and assignable causes of variation, statistical process control.	**06**	**CLO1**
Control Chart	Concept of control chart, statistical basis of the control chart, basic principles, choice of control limits, sample size and sampling frequency, rational subgroups, analysis of patterns on control charts, sensitizing rules for control charts, necessary steps for constructing control charts, types of control charts (control charts with standard given and control charts with no standard given), control charts for attributes, concepts of nonconformity, nonconforming unit, defect, defective unit, P-Chart, D-Chart, C-Chart, U-Chart, basic concepts of control charts for variables, statistical basis and interpretation of R And S charts.	**12**	**CLO1**
Sampling Plan	Basic Concepts of acceptance sampling, OC curve and its uses, types of OC curves, properties of OC Curves, single sampling plan, basic concepts of single sampling plan for attributes, construction of type A and type B OC curves under single sampling plan for attributes, specific points on the OC curve (AQL, LTPD), rectifying inspection, AOQ, AOQL, ATI, ASN, designing a single sampling plan, double sampling plan: basic concepts of double sampling plan, OC Curve, ASN, AOQ, ATI, designing a double sampling plan, introduction to multiple sampling plan and sequential sampling analysis, acceptance sampling plan by variables, basic concepts of acceptance sampling plan, types of sampling plans, designing a variable sampling plan with a specified OC Curve, CUSUM procedure, concept of sequential probability ratio test.	**12**	**CLO1 CLO2 CLO3**
Operational Research	Nature and impact of OR approach; phases of OR; concept of linear programming problem (LPP); construction of LPP; solution of LPP: graphical and the simplex method; revised simplex method; big-M method, two phase method; concept of convergence, degeneracy and cycling; duality: dual primal relationship and formulation of dual problems; sensitivity analysis: introduction to sensitivity analysis; game theory: finite and infinite games; zero sum games; two person zero sum games; pay of matrix; maximum and minimum criterion of optimal solution of a game; dominance property; algebraic method for the solution of a game; equivalence of rectangular game matrix	**20**	**CLO3**

	and linear programming; application in real life situation using MATLAB/Octave software.		

Books Recommended	**Text Books:** 1. Montgomery, D. C., *Introduction to Statistical Quality Control*. Wiley; 6th Edition (2008) 2. Duncan, A. J., *Quality Control and Industrial Statistics*, Irwin; 5th Edition (1986). 3. Gupta, S. C. and Kapoor, V. K., Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.(2014).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Research Methodology and Social Statistics **Course No:** STA 0542 307
Contact Hours per Week: 04 **Credit:** 04

Rationales: The aim of this course is to figure out the in depth knowledge on research methodology so that a researcher can do his/her research with satisfying all steps.

Objectives: The objectives of this course are to understand all the features of a complete research; learn how to plan and conduct a survey research, able to write a study proposal and research report, learn how to monitor and evaluate development programs.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Know how to write title, introduction, materials and methods, results, discussion, conclusion and recommendation of a complete research
CLO2: Write a research proposal and research report.
CLO3: Appreciate the components of scholarly writing, monitoring and evaluate its quality.
CLO4: Understand the principles of social statistics; and methods of measurements of national income;
CLO5: Give the students concept of Psychometrics, poverty and its issues

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	✓				✓	√	✓		✓
CLO2		✓			✓	✓	√		✓	✓

Topic	Course Content	Hours	CLO
Fundamentals of Research	Meaning of research, concepts of methods and methodologies, selection of topic, research process, components of research process, and categories of research: descriptive, exploratory and explanatory, conceptualization, operationalization, formulation of research problems and proposal, review of literature, objectives of the study,	**07**	**CLO1**
Research Design	Types of design, case studies, trend and panel studies, experimental design, non-experimental design, cross-sectional and quasi-experimental design etc., sampling design and sample size determination.	**07**	**CLO1**

Data Collection Methods and Techniques	Questionnaire construction, primary and secondary sources of data, different methods to collect data: mail-questionnaire, personal interview, telephone interview, principles of interviewing.	**07**	**CLO1**
Qualitative Data Collection	Observations, key informants interview, in-depth interview, focus group discussion (FGD), rapid appraisal technique (RAT), Delphi technique.	**07**	**CLO1**
Data Analysis and Interpretation	Data processing and analysis, descriptive statistics, testing hypothesis, concepts of multivariate analysis.	**07**	**CLO1 CLO2**
Reliability and Validity	Concepts of reliability and validity. Threats to reliability and validity, Measurements of reliability and validity.		
Proposal Development and Report Writing	Content and organizations of the report, heading and subheadings, techniques of writing conclusion, summary, recommendations, footnotes, references, appendix, etc. examining some local and international reports.	**07**	**CLO1 CLO2**
Concept of Monitoring and Evaluation (M & E)	Objectives, usefulness and scope of M & E; views of different schools on M & E; performance monitoring versus performance evaluation. Monitoring and evaluation plan and data sources: Indicators for monitoring and evaluation; identification of indicators and characteristics of ideal indicators.	**08**	**CLO3**
National Income	Concepts and methods of measurement; theoretical distribution of income and wealth: Pareto and Lognormal distribution of income ; Concept, meaning, measurement of positive and normative measures of inequality; Lorenz curve; Gini coefficient; Atkinson's index, Theil's index, Herfindahl index, Human development index etc; desirable properties of a measures of inequality.	**10**	**CLO4**
Poverty	Concept, definition, and issues of poverty; approach for drawing poverty line income; measurement of different poverty indices; Foster, Greer and Thorlock's general class of poverty measure	**05**	**CLO4 CLO5**
Introduction to Psychometrics and Anthropology	Measurement in psychology and education; intelligent and achievement tests; test scores; equivalence of scores; Z-score and T-score; intelligent quotient. Definition, nature and importance of anthropology; role and functions of family, social inequality: inequality by sex, age, rank, caste, race, class, power, rule and social connections.	**06**	**CLO5**

Books Recommended	**<u>Text Books:</u>** 1. Islam, M. N. (2011), *An introduction to Research Methods*, Book World. 2. Neuman, W. L. (2000), *Social Research Methods: Qualitative and Quantitative Approaches*, Pearson; 7th Edition (2009). **3.** Kothari, C. R., *Research Methodology*, New Age International, (2004).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Data mining **Course No:** CSE 0612 308
Contact Hours per Week: 04 **Credit:** 04

Rationales: Data mining is an interdisciplinary field which brings together different techniques, database, information retrieval, mathematics and statistics.

Objectives:

Provide an overview of concepts and techniques in knowledge discovery and data mining; Describe data mining algorithms and applicability of data mining; Implement algorithms and running code to solve computationally intensive statistical problems and suggest appropriate solutions to data mining problems.

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

CLO1: Understand the fundamentals of data mining, and develop a working knowledge of the statistical and theoretical underpinnings of the topics covered;

CLO2: Understand the statistical association rules and database/OLTP systems, fuzzy sets and fuzzy logic, information retrieval, decision support systems, data warehousing;

CLO3: Know the statistical perspective on data mining, decision trees, neural network algorithm and genetic algorithms;

CLO4: Implement classification and clustering technique in real world phenomena.

CLO5: Familiarize the students with basic learning algorithms and techniques and their applications;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√						
CLO2		√								
CLO3				√		√				
CLO4	√				√					
CLO5			√							

Topic	Course Content	Hours	CLO
Overview	Meaning of data mining and knowledge discovery, basics, data mining tasks, classification, regression, time series analysis, prediction, clustering, summarization, association, rules, sequence discovery, development of data mining, data mining issues and mining metrics, social implications of data mining.	**07**	**CLO1 CLO2**
Related Concepts of Data Mining: Fuzzy Sets	Introduction, classical set, set operation, Boolean logic, basic concepts of fuzzy sets, other representations of fuzzy sets, determination of membership functions, fuzzy sets properties, operations on fuzzy sets, logic operations, algebraic operations on fuzzy sets.	**05**	**CLO3**
Fuzzy Relation	Classical relations, classical reasoning, fundamentals of fuzzy relations, operations on binary fuzzy relations, types	**08**	**CLO3**

	of fuzzy relations, fuzzy reasoning, concluding remarks, bibliography, web resources. Database/OLTP systems, logic, information retrieval, decision support systems, dimensional modeling, multidimensional schemas, indexing, data warehousing, OLAP, web search engines, statistics, pattern matching.		
Data Mining Techniques	Statistical perspective on data mining: point estimation, models based on summarization, application of Bayes theorem, hypothesis testing, regression and correlation, similarity measures, decision tree, genetic algorithms.	**06**	**CLO2 CLO3**
Classification and Clustering	**Classification:** Issues in classification, statistical-based algorithms, regression, Bayesian classification, distance-based algorithms, K-Nearest neighbors, decision tree-based algorithms, ID3, C4.5, C5.0, CART, neural network-based algorithms, propagation, NN, supervised learning, radial basis function network, perceptrons, rule-based algorithms, generating rules from DT, generating rules from neural net. **Clustering:** Similarity and distance measures, outliers, hierarchical algorithms, agglomerative algorithms, divisive clustering, partitional algorithms, minimum spanning tree, squared error clustering algorithm, k-means clustering, nearest neighbor algorithm, PAM Algorithm, Bond Energy algorithm, clustering with genetic algorithms, clustering with neural networks, clustering large databases, and clustering with categorical attributes.	**06**	**CLO3**
Association Rules	Meaning of association, large item sets, basic algorithms, apriori algorithm, sampling algorithm, partitioning, parallel and distributed algorithms, data parallelism, task parallelism, advanced association rule/technique, quantitative association rules, correlation rules, and measuring quality of rules.	**05**	**CLO4**
Web Mining and Text Mining	Web content mining, crawlers, harvest system, virtual web view, personalization, web structure mining, page rank, clever, web usage mining, preprocessing, data structures, pattern discovery, and pattern analysis.	**06**	**CLO3**

Books Recommended	**<u>Text Books:</u>** 1. Dunham, M. H. (2003). *Data Mining: Introductory and Advanced Topics*, 1st Edition, Pearson. 2. James, G., Witten, D., Hastie, T., and Tibshirani, R. (2014). *An Introduction to Statistical Learning*, Springer, 2013. 3. Ibrahim, A. M. (2004). *Fuzzy Logic for Embedded Systems Applications*, Elsevier Science, USA.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical computing-IV **Course No:** STA 0542 309
Contact Hours per Week: 02 **Credit:** 02

Rationales: The course covers solving the problems on advanced design of experiments.

Objectives: Students will be able to conduct confounded factorial design of experiments, analyze asymmetric factorial designs, and perform analysis of covariance and incomplete block design of experiment. Practical application of Data mining.

After completion of this course, students will be able to
CLO1: Analyze missing values in RBD and LSD;
CLO2: Apply the confounded factorial experiment and advanced experimental designs;
CLO3: Analyze asymmetrical experiments;
CLO4: Analyze data on experiments with incomplete blocks;
CLO5: Application of Data mining techniques.

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓		✓						✓
CLO2		✓			✓	✓	✓	✓		✓
CLO3			✓	✓						
CLO4		✓			✓	✓	✓			✓
CLO5		✓	✓					✓		

Topic	Course Content	Hours	CLO
Design of Experiment LAB	One-way classification with equal and unequal observations, Two-way and three-way classification with equal number of observations per cell, Experimental error and interpretation of data, Analysis of variance with fixed effect, random effect and mixed effect models, Model adequacy checking. Tukey's W-test, Newman-Keuls several range test, Duncan multiple range test, Bonferroni test. Estimation and analysis of completely randomized design, randomized block design and Latin square design. Dealing with missing data in experimental design. Missing value; Main effect and interaction effect in factorial experiment, Total, partial and simultaneous confounding, ANCOVA.	**14**	**CLO2 CLO3**
Data Mining LAB	Solving numerical problems related to the course Data mining.	**14**	**CLO5**

Books Recommended

Text Books:

1. Montgomery, D.C., *Design and Analysis of Experiments*, Wiley; 8th Edition (2012).
2. M. R. Bhuiyan (2007), *Fundamentals of Experimental Design*, 2nd Edition.
3. Dunham, M. H. (2003). *Data Mining: Introductory and Advanced Topics*, 1st Edition, Pearson.

Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing-V **Course No:** STA 0542 310
Contact Hours per Week: 02 **Credit: 02**

Rationales: Apply acquired knowledge for solving the problems of time series data.

Objectives: Help the students to identify different types of time series data and using appropriate model in real life situation.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Apply different probability models for time series data.
CLO2: Know how to do smoothing of time series.
CLO3: Able to forecast based on time series data.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√				√				√
CLO2			√	√	√	√				√
CLO3			√	√	√	√				√

Topic	Course Content	Hours	CLO
Lab	Solving numerical problems related to the course Time Series Analysis.	**28**	**CLO1 CLO2 CLO3**

Books Recommended	**Text Books:** 1. Montgomery, D. C., Johnston, L. A., Gardiner, J. S., *An Introduction to Time Series Analysis and Forecasting*, Wiley; 1st Edition (2008). 2. Box G. E.P., Jenkins G. M., Reinsel G. C., *Time Series Analysis: Forecasting and Control*, Wiley; 4th Edition (2008).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing-VI **Course No:** STA 0542 312
Contact Hours per Week: 02 **Credit:** 02

Rationales: Apply acquired knowledge to draw sample from population using different sampling techniques and collect data.
Objectives:
- Help students develop ability to draw sample using different sampling techniques such as simple random sampling, stratified random sampling, systematic sampling, cluster sampling;
- Make students capable to measure the efficiencies of different sampling techniques and compare them.

.
Course Learning Outcomes: After completion of this course, students will be able to
CLO1: Determine appropriate methods and analytical tools for collecting data;
CLO2: Draw sample from population through different sampling techniques;
CLO3: Collect primary data from different sources for various purposes;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√				√	√		
CLO2		√						√		√
CLO3	√		√				√			√

Topic	Course Content	Hours	CLO
Lab	Simple random sampling, stratified random sampling, systematic sampling, and cluster sampling designs, Advanced sampling techniques (PPS), Non-sampling error,	**28**	**CLO1 CLO2 CLO3**

Books Recommended	**Text Books:** **1.** Singh, R., & Mangat, N. S. (2013). *Elements of survey sampling* (Vol. 15). Springer Science & Business Media. **Reference Books:** 1. Islam, M. N. (2008), *An Introduction to Sampling Methods*, Book World.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Viva-Voce **Course No:** STA 0542 312
Contact Hours per Week: NA **Credit:** 02

Rationale of the course: Assessing students' comprehensive knowledge on basic concepts of the courses learned in the current semester.

Objectives: Help students to gain confidence in their own ability to present and explain the basic concepts of the courses. Provide the knowledge of oral communication and presentation skills that are essential for later professional career

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Develop verbal communication and presentation skills;
CLO2: Communicate their learning effectively and appropriately to formal audiences;
CLO3: Explain key concepts of the courses, interpret key terms, and justify their arguments logically to non-statisticians;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		√			√				√	√
CLO2	√							√		√
CLO3	√	√			√			√	√	

Topic	Course Content	Hours	CLO
Viva-Voce	Comprehensive contents of all the underlying courses of the semester.		

Books Recommended	**Main Text** • Textbooks referred for all the underlying courses of the semester. **Reference Books** • Reference books referred for all the underlying courses of the semester.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Courses for the Fourth Year

Course Code	Course Title	Course Category	Credit
STA 0542 401	Classical and Bayesian Inference	Core	4
BIO 0512 402	Public Health and Epidemiology	General Education	4
STA 0542 403	Multivariate Analysis	Core	4
STA 0542 404	Categorical Data Analysis	Core	4
ECO 0311 405	Econometrics	General Education	4
STA 0542 406	Biostatistics and Bioinformatics	Core	4
STA 0542 407	Machine Learning	Core	4
STA 0542 408	Statistical Computing-VII	Core	2
STA 0542 409	Statistical Computing-VIII	Core	2
STA 0542 410	Statistical Computing-IX	Core	2
STA 0542 411	Statistical Computing- X	Core	2
STA 0542 412	Project Report	Core	4
STA 0542 413	Viva-Voce	Core	2
Total			**42**

Course Title: Classical and Bayesian Inference **Course No:** STA 0542 401
Contact Hours per Week: 04 **Credit:** 04

Rationales: The course is covers theoretical base of Decision theory and Bayesian inference.
Objectives: The objectives of the course are- to develop and assess statistical analysis in the areas of risk function, loss function as well as Bayesian inference.

After completion of this course, students will be able to
CLO1: Understand different areas of Classical estimation theory
CLO2: Understand important theorems in Bayesian inference
CLO3: Understand different areas of Hypothesis theory

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓			✓		✓			
CLO2		✓	✓	✓	✓		✓			✓
CLO3	✓		✓	✓		✓				✓

Topic	Course Content	Hours	CLO
Classical Estimation	Median and modal unbiased estimator, simultaneous estimation of several parameters, vectors of parameters, ellipsoid of concentration, Wilk's generalized variance, Chapman-Robinsons-Keiffer lower bound, generalized Rao-Cramer lower bound, Bhattacharya's system of lower bound, efficiency, asymptotic efficiency, best CUAN estimator, optimum properties of ML estimation, general set up in estimation, location, invariance, Pitman estimator for location and scale.	**15**	**CLO1**
Resampling Techniques	Different types of resampling technique: Jackknife and Bootstrapping techniques.		
Bayesian Estimation	Loss Function, risk function, admissible estimator, minimax estimator, Bayes factor, conjugate prior, non-informative prior,	**15**	**CLO2**

	Jeffrey's non informative prior, maximum entropy priors, squared error loss function, linex loss function, Bilinear loss function, modified linex loss, entropy loss, intrinsic loss, balanced loss, capture-recapture problem, linear bayes estimator, equivariance, principle of equivariance, minimum risk equivariant estimator (MRE), location scale families, some methods of estimation in large samples, confidence belt, theory of confidence sets, shortest set of confidence intervals, relationship between confidence estimation and hypothesis testing, unbiased confidence intervals, Fiducial interval, Bayesian interval, Fishers-Behreu problem.		
Test of Hypothesis	Most powerful test, uniformly most powerful test, uniformly most powerful unbiased test, locally uniformly most powerful test, locally uniformly most powerful unbiased test, optimal tests in different situations, randomized tests, consistent tests, unbiased tests, similar region. Prior and posterior odds, Bayes factor for simple vs. simple hypothesis, Bayes factor for composite vs. composite hypothesis. Sequential analysis, SPRT, efficiency of SPRT, fundamental identity of sequential analysis, O.C. functions of sequential plan, ASN function. Bayesian test of hypothesis, test of influential variables in predictive approach, Bayesian approach to contingency tables, concepts of decision theory.	**25**	**CLO1** **CLO2** **CLO3**

Books Recommended	**<u>Text Books:</u>** **1.** Kendall & Stuart, *The Advanced Theory of Statistics*, Vol. II. **2.** Cassela C. and Burger R. *Statistical Inference*, 3rd edition. **3.** Gelman, A., Carlin, J. B., Stern, H. S., & Rubin, D. B. (1995). *Bayesian data analysis*. Chapman and Hall/CRC. **4.** Bolstad W. M., *Introduction to Bayesian Statistics*, Wiley-Interscience; 2nd Edition (2007). **5.** Press S. J., *Bayesian Statistics: Principles, Models and Applications*, Wiley; 1st Edition (1989).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Public Health and Epidemiology **Course No:** BIO 0512 402
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course covers the basic principles and methods of epidemiology, with an emphasis on critical thinking, analytic skills, and application to clinical practice and research. Topics include outcome measures such as incidence, prevalence, bias, confounding, screening, matching, quantitative study designs, and sources of data, analysis of exposure-disease relationship and causal inference. This course will provide the knowledge to evaluate and assess clinical research and data analyses and give them scientific and methodological background information.

Objectives: The objectives of the course are to identify the determinants of disease and and provide a means of assessing the magnitude of public health problems and the success of interventions designed to control them, introduce the basic principles and methods of epidemiology and demonstrate their broad applicability to public health.

Course Learning Outcome: After completing this course the students will be able to:
CLO1: Understand the different public health studies and epidemiological designs.
CLO2: Become familiar with public health and epidemiologic terminology, outcome measures, and study designs;
CLO3: Application of epidemiologic methods in the studies of both infectious and chronic diseases and current public health issues.
CLO4: Work in public health and pharmaceutical sectors.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1							√	√		
CLO2			√	√			√			
CLO3				√				√	√	
CLO4		√								√

Topic	Course Content	Hours	CLO
Introduction	Some examples of health study; Selection of health problem for research; Framing different type of study design: prospective study, retrospective study, longitudinal study, experimental study, observational study, intervention study, single blind study, double blind study; Selection of study population and cases for the study; causal variables, confounder variables; Ethical issue related to health study.	**8**	**CLO1**
Measuring Death and Diseases	Sources of health statistics. Meaning and Concept. Biological variations. Health indicators classification. Morbidity concepts and measures. Illness, diseases and their classifications. Multiple causation of diseases The conquest and resurgence of infectious diseases. The biomedical basis of chronic diseases. Measuring diseases frequency and errors in measurement. Mortality. Nutrition in Bangladesh; special emphasis on infant and child nutrition.	**8**	**CLO2**
Epidemiologic Concepts	Definition and scope of epidemiology, key issues in epidemiology; health and disease, sources of data on	**6**	**CLO1**

	community health, vital statistics and morbidity data, descriptive epidemiology: person, place, time, analytic epidemiology, causality.		
Types of Epidemiologic Research	Experimental (laboratory, clinical trial, and community intervention), quasi experimental (clinical/laboratory, program/policy), observational studies: design options in observational studies – methods of observations, typology of observational study designs (cohort, case-control, and cross-sectional studies).	**4**	**CLO1**
Measures of Disease Frequency	Incidence and prevalence, basic measures of incidence and prevalence, estimation of risk and rate, mortality measures, age, period and cohort effects.	**4**	**CLO2 CLO3**
Measures of Association	Ratio measures and difference measures (relative risk, odds ratio; risk difference etc.), comparison of proportions from different samples, standard error of estimators, test of hypotheses.	**4**	**CLO2 CLO3**
Measures of Potential Impact	Etiologic fractions, prevented fractions.	**4**	**CLO2 CLO3**
Diagnostic Testing:	Positive and negative predictive values, false positive and false negative, sensitivity and specificity. Sample size determination in epidemiologic studies.	**4**	**CLO2 CLO4**
Validity Considerations	Validity and precision, internal and external validity, direction of bias, sources of bias, selection bias, measurement or information bias, misclassification, effects of misclassification error, control of misclassification error.	**4**	**CLO3**
Stratified Analysis	Test for overall association, Mantel-Haenszel estimators and test, confounding, criteria and test for confounding (single factor confounding).	**4**	**CLO2 CLO3**
Matching	Definition of matching, types of matching schemes, advantages and disadvantages of category matching, *r*-to-1 matching, comparison of *m* matched samples, Mcnemar test.	**4**	**CLO3**
Interaction Effect Modification and Synergism:	Combining evidence from four-fold tables, construction and interpretation based on various chi-square tests.	**4**	**CLO2 CLO3**

Books Recommended	**Text Books:** 1. Schneider, Mary Jane (2006): *Introduction to Public Health*, Gaithersburg, Maryland. 2. Nicholas P. J., *Statistics for Epidemiology*, Chapman and Hall/CRC; 1st Edition (2003). **3.** Kleinbaum D. G., Kupper L. L., Morgenstern H., *Epidemiologic Research: Principles and Quantitative Methods*, Wiley; 1st Edition (1982).
Teaching Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.
Assessment	Final exam, class test, quiz, assignment, presentation.

Strategy	

Course Title: Multivariate Analysis **Course No:** STA 0542 403
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course introduces students to several useful multivariate techniques, and making strong use of illustrative examples.

Objectives: The objectives of this course are to identify the need for multivariate statistical techniques, recognize the appropriate multivariate method for a problem and interpret results and make statistical inference.

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

CLO1: Perform exploratory analysis of multivariate data, such as plot multivariate data, calculating descriptive statistics, testing for multivariate normality**;**

CLO2: Conduct statistical inference about multivariate means including hypothesis testing, confidence ellipsoid calculation and different types of confidence intervals estimation;

CLO3: Undertake statistical analyses using appropriate multivariate techniques, which include Principal Component, Factor Analysis, Discriminant and Clustering Analysis.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√			√			
CLO2	√			√			√			
CLO3	√	√		√	√	√	√			
CLO4	√	√		√	√	√	√			√

Topic	Course Content	Hours	CLO
Introduction	Ideas of multivariate data, applications of multivariate techniques; data display and pictorial representations; distance.	**06**	**CLO1**
Random vectors and random sampling	Some basic of matrix and vector algebra; positive definite matrices; a square-root matrix; random vectors and matrices; mean vectors and covariance matrices; matrix inequalities and maximization; the geometry of the sample; random sample and expected values of sample means and covariance matrix; generalized variance; sample mean, covariance, and correlation as matrix operations; sample values of linear combinations of variables.	**10**	**CLO1**
Multivariate Distributions	Multinomial distribution with properties, multivariate normal distribution (MND) with properties and estimation of parameters, brief study of Wishart distribution, Hotelling T^2 Distribution, Mahalanobis D^2, generalized variance and distribution of quadratic forms.	**08**	**CLO1 CLO2**
Inference about a Mean Vector	Introduction, the plausibility of μ_0 as a value for a normal population mean, likelihood ratio tests, confidence regions and simultaneous comparisons of component means, large sample inferences about a population mean vector, inferences about mean vectors when some observations are missing.	**08**	**CLO2**

Comparisons of Several Multivariate Means	Introduction, paired comparison and a repeated measures design, comparing mean vectors from two populations, comparing several multivariate population means (one-way MANOVA), simultaneous confidence intervals for treatments effects, two-way multivariate analysis of variance, profile analysis, repeated measures designs and growth curves.	**10**	**CLO2**
Principal Component Analysis	Introduction to the principal components analysis, ML estimator of the principal components and their variances, sampling properties of the sample principal components, statistical inference.	**5**	**CLO3**
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 information and transformation.	**5**	**CLO3**
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.	**5**	**CLO3**
Discrimination and Classification Analysis	Meaning and goals of discriminations and classification, Fisher's linear discriminant function, classification into one of two and into one of more than two multivariate populations, quadratic discriminators, test of a discriminant function.	**5**	**CLO3**
Cluster Analysis	Meaning and objectives of clustering, different similarity measures, Euclidean distance, statistical distance, Minkowski, Canberra, hierarchical clustering method, non-hierarchical method.	**5**	**CLO3**

Books Recommended	**Text Books:** **1.** Johnson R. A and Wichern D. W (1999). *Applied Multivariate Statistical Analysis*, 4th *Edition*. Prentice-Hall. **2.** Anderson, T.W., (1984), Introduction of Multivariate Statistical Analysis, 2nd Ed., John Wiley. Morrison, D.P., (1976), *Multivariate Statistical Methods*, 4th Edition McGraw-Hill. **Reference Books:** **1.** Srivastava MS (2002). Methods of Multivariate Statistics. Wiley. **2.** Bhuiyan, K.C., (2006), Multivariate Analysis and Its Applications. New Central Book Agency. **3.** Kleinbaum, D. G., Kupper and Muller, K. E., (1998), *Applied Regression Analysis and Other Multivariate Methods*, 3rd Ed., Duxbury Press, Pacific Grove.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Categorical Data Analysis **Course No:** STA 0542 404
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to introduce basic concepts and common statistical models and analyses for categorical data; to provide enough theory, examples of applications in a variety of disciplines and practice using categorical techniques and computer software.

Objectives:

1. Introduce and explore categorical data analysis with basic asymptotic tools.
2. Introduce contingency tables and inference for two way contingency tables.
3. Regression models for categorical and generalized linear models for count models. Gather the concept on models for multinomial responses and matched pairs.
4. Analyze clustered categorical data and making decision.

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

CLO1: Familiar with a variety of methods for analyzing categorical or count data along with its applications and statistical inferences;

CLO2: Describe and analyze contingency tables with test of independence;

CLO3: Analyze the generalized linear models and its likelihood using exponential family of distributions;

CLO4: Apply logistic regression models in several settings including cohort and case-control studies;

CLO5: Analyze models for multinomial responses and matched pairs;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√					√				
CLO2		√			√					
CLO3				√						
CLO4					√					
CLO5			√				√			√

Topic	Course Content	Hours	CLO
Introduction-Distributions and Inference for Categorical Data	Categorical response data, distributions for categorical data, statistical inference for categorical data, statistical inference for binomial and multinomial parameters, Bayesian inference for binomial and multinomial parameters.	**07**	**CLO1**
Contingency Tables and Inference for Two-Way Contingency Tables	Probability structure for contingency tables, comparing two proportions, conditional association in stratified 2×2 tables, measuring association in $i \times j$ tables, confidence interval for association parameters, testing independence in two-way contingency tables, following up chi-square tests, two-way tables with ordered classifications, small-sample tests of independence, Bayesian inference for two-way contingency tables, extensions for multiway tables and non-tabulated responses.	**05**	**CLO1 CLO2**
Logistic Regression-Building and Applying	Interpreting parameters in logistic regression, inference for logistic regression, logistic models with categorical predictors, multiple logistic regression, fitting logistic regression models, strategies in model selection, logistic	**06**	**CLO4**

	regression diagnostics, summarizing the predictive power of a model, Mental-Haenszel and related methods for multiple 2×2 tables, detecting and dealing with infinite estimates, sample size and power consideration.		
Generalized Linear Model	Basic concept of exponential family of distributions along with its derivation, mean and variance. Generalized linear models, generalized linear models for binary data, generalized linear models for counts, moments and likelihood for generalized linear models, inference and model checking for generalized linear models, fitting generalized linear models, quasi-likelihood and generalized linear models.	**08**	**CLO3**
Models for Multinomial Responses	Nominal responses: baseline-category logit models, ordinal responses: cumulative logit models, ordinal responses: cumulative link models, alternative models for ordinal responses, testing conditional independence. In $i \times j \times k$ tables, discrete-choice multinomial logit models, Bayesian modeling of multinomial responses. Ordinal and nominal regression models using different distributions	**05**	**CLO5**
Poisson Regression	Poisson regression and modelling, testing parameters.	**05**	**CLO5**

Books Recommended	**<u>Text Books:</u>** **1.** Agresti, A. (2012).*Categorical Data Analysis*, 3rd Edition, John Wiley and Sons, New York. **2.** Dobson, A. J., & Barnett, A. G. (2018). *An introduction to generalized linear models*. CRC press. **3.** Powers, D. A. and Xie, Yu. (2008).*Statistical Methods for Categorical Data Analysis*, 2nd Edition, Emerald Group Publishing Ltd., London.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Econometrics **Course No:** ECO 0311 405
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course covers a range of econometric methods required to conduct empirical economic research and understand applied econometric results.

Objectives: The objectives of this course are to introduce students to the basic principles of econometric analysis to gain theoretical understanding of the methods needed for econometric research including their underlying assumptions, advantages and limitations, to understand how to use different econometric to OLS in real-world economic problems and interpret findings.

Course Learning Outcomes: At the end of the course, students will be able to –
CLO1: Describe the steps of econometrics;
CLO2: Estimate the parameters of econometric models and interpret the results of the models.

CLO3: Understand econometric problems such as Multicollinearity, autocorrelation, heteroscedasticity , etc;
CLO4: Identify errors in variables and solve issues related to such errors;
CLO5: Create and study dummy variables and use it in data analysis;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√									
CLO2	√	√								
CLO3				√						
CLO4					√					
CLO5			√				√			√

Topic	Course Content	Hours	CLO
Preliminaries	Meaning, Methodology of Econometrics, Types of Econometrics, Scope and Role of Econometrics, Difference between Mathematical Economics and Economic Statistics, Meaning of Population Regression Function (PRF) and Sample Regression Function (SRF), Different Functional Form of PRF and Transformation of PRF to Linear Form. Nonlinear regression models; Cob-Douglas production function, Chaw test.	**07**	**CLO1 CLO2**
Model Misspecification	Basic Concepts and Consequences, Omitted Variables, Irrelevant Variables and Measurement Errors.	**05**	**CLO4**
Generalized Least Squares (GLS)	Spherical and Non-spherical Disturbances, Sources of Non-spherical Disturbances and Problems Associated with These, OLS Estimators under Non-Spherical Disturbances and Their Properties, The Generalized Least-Squares Estimator.	**08**	**CLO2**
Multicollinearity	Nature of Multicollinearity, Estimation in the Presence of Multicollinearity, Practical Consequences of Multicollinearity, Detection of Multicollinearity, Remedial Measures.	**06**	**CLO3**
Heteroscedasticity	Nature of Heteroscedasticity, Method of Generalized Least Squares, Consequences Using Ordinary Least Squares in the Presence of Heteroscedasticity, Detection of Heteroscedasticity, Remedial Measures.	**05**	**CLO3**
Autocorrelation	Nature of the Problem, OLS Estimation in The Presence of Autocorrelation, The BLUE Estimator in the Presence of Autocorrelation, Consequences of Using OLS in the Presence of Autocorrelation, Detection of Autocorrelation, Remedial Measures, Autoregressive Conditional Heteroscedasticity (ARCH) Model.	**06**	**CLO3**
Indicator/Dummy Variables	Indicator Variables Versus Regression on Allocated Codes, Dummy Variables to Separate Blocks of Data with Different Intercepts, Same Model, Interaction Terms Involving Dummy Variables, Dummy Variables for Segmented Models. Models for Dummy Variables.	**05**	**CLO5**
SEM	Preliminaries of simultaneous equations models and estimation procedures; 1SLS, 2SLS.	**05**	**CLO5**

Books Recommended	**Text Books:** 1. Gujarati, D. N. & Porter D. *Basic Econometrics*, McGraw-Hill Education; 5th Edition (2008). 2. Koutsoyiannis, A. *Theory of Econometrics*, Palgrave Macmillan, 2nd Edition (2001).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Biostatistics and Bioinformatics **Course No:** STA 0542 406
Contact Hours per Week: 04 **Credit:** 04

Rationales: This course is designed to provide basic concepts of handling the incomplete data of health Science and Bioinformatics to enhance understanding of health issues and the application of statistics.

Objectives:

1. Know the basic concepts of Survival analysis and related lifetime distribution.
2. Learn to get information from incomplete data or censoring mechanism and cover the appropriate application, calculation and interpretation of statistical test for incomplete data.
3. Learn to analyze and interpret real life survival data using statistical software's.
4. Have a strong understanding of fundamental concepts of the statistics that underlie bioinformatics.

Course Learning Outcomes: At the end of the course, students will be able to –
CLO1: Conceptualize basic understanding of survival analysis techniques and when they need to be applied.
CLO2: Apply basic statistical concepts commonly used in Health and Medical Sciences along its interpretation.
CLO3: Frame out the importance of bioinformatics.
CLO4: Gather knowledge about Genome, Transcriptome, Proteome, Viruses and immune systems.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√									
CLO2	√	√								
CLO3			√							
CLO4				√						

Topic	Course Content	Hours	CLO
Basic Concepts of Lifetime Distributions	Survival analysis and survival data, probability distribution function, hazard function, survival function, and their interrelationships; mean residual life function and quantile lifetime.	**07**	**CLO1 CLO2**
Important Lifetime Distributions	Exponential, Weibull, extreme value, log-normal, log-logistic, location-scale, log-location-scale, goodness of fit: graphical approaches, survival function, hazard function, mean residual life function, quantile under different lifetime distributions.	**05**	**CLO2**

Estimation and Test	Brief review of maximum likelihood estimation, Newton-Raphson iterative approach, and test (Wald test, Score test, Likelihood Ratio test).	**08**	**CLO2**
Incomplete Data	Censoring, left and right censoring, type I (progressive type I, Generalized type I etc.), type II censoring, progressive type II censoring, random censoring, construction of likelihood functions under different censoring schemes.	**06**	**CLO2**
Parametric Methods	Estimation and tests (for small and large samples) under different censoring schemes for important lifetime distributions, confidence intervals, delta method, estimation, test, and confidence interval for survival function, hazard function.	**05**	**CLO2**
Non-parametric Methods	Empirical survival function, product limit approach for the estimation of survival function, Nelson-Aalen estimate of the survivor function, estimation of hazard functions, product-limit methods, standard errors, median survival time, tests, confidence intervals.	**06**	**CLO2**
Semi Parametric Proportional Models	Proportional hazards model for different distributions; Poisson, Weibull, Exponential and Gamma distribution.	**06**	**CLO2**
Comparison of Survival Curves	Comparison of two groups: log-rank (Mantel-Haenszel) test; other tests comparing two groups, comparison of more than two groups. Survival regression model, Cox's proportional hazards model, partial likelihood function, estimation and interpretation of model parameters.	**05**	**CLO2**
Introduction to Problems and Challenges in Bioinformatics	Introduction, genome, transcriptome, proteome, interference technology, viruses and the immune system.	**05**	**CLO3** **CLO4**
Probabilistic Approaches	Introduction to probability, application of Bayes Theorem, Bayesian networks, Markov networks.	**05**	**CLO2**
Books Recommended	**<u>Text Books:</u>** 1. Lawless, J.F., (2003). *Statistical Models and Methods for Lifetime Data*, 2nd Edition, Wiley, New York. 2. Cox, D. R. and Oakes, D., (1988). *Analysis of Survival Data*, Chapman and Hall, London. 3. Lesk, A., (2014). *Introduction to Bioinformatics*, 4th Edition, Oxford University Press.		
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.		

Course Title: Machine Learning **Course No:** STA 0542 407
Contact Hours per Week: 04 **Credit:** 04

Rationales: Machine learning is also an integral part of many commercial applications and research projects today.

Objectives:

Introduction to machine learning tools, applications and goals of machine learning; Introduction to supervised and unsupervised learning algorithms; Design and analyze machine learning experiments.

Course Learning Outcomes: At the end of the course, students will be able to –
CLO1: Understand the fundamentals of Machine learning, and develop a working knowledge of the statistical and theoretical underpinnings of the topics covered;
CLO2: Implement classification and clustering technique in real world phenomena.
CLO3: Familiarize the students with basic learning algorithms and techniques and their applications;
CLO4: Formulate machine learning problems corresponding to different applications using machine learning in real world data.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√			√						
CLO2		√								
CLO3				√		√				
CLO4	√				√					

Topic	Course Content	Hours	CLO
Introduction to Machine Learning	Machine learning goals and applications, machine learning processes, artificial intelligence and machine learning.	**05**	**CLO1**
Supervised Learning	Introduction, supervised machine learning algorithms, linear methods for classification, linear methods for regression, logistic regression, support vector machines, basis expansions, model selection procedures, k-nearest neighbors, linear models, naïve Bayes classifiers, random forest, decision trees, ensembles of decision trees, neural network (deep learning), uncertainty estimates from classifiers, supervised learning projects.Ensemble Learning Methods: Bagging, Boosting and Stacking	**08**	**CLO2 CLO3**
Unsupervised Learning	Introduction, types of unsupervised learning, preprocessing and scaling, clustering, the EM algorithm, factor analysis, principal component analysis, independent component analysis, association rules, reinforcement learning, unsupervised learning projects.	**07**	**CLO2 CLO3**
Model Evaluation and Improvement	Cross validation, grid search, evaluation metrics and scoring.	**10**	**CLO4**
Real World Machine Learning	Introduction, choosing an algorithm, design and analysis of machine learning experiments, common software for machine learning.	**08**	**CLO4**

Books Recommended	**Text Books:** 1. Alpaydin, E. (2004). *Introduction to Machine Learning*, 2nd Edition. 2. James, G., Witten, D., Hastie, T., and Tibshirani, R. (2014). *An Introduction to Statistical Learning*, Springer, 2013.

Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing- IX **Course No:** STA 0542 408
Contact Hours per Week: 02 **Credit:** 02

Rationales: Apply acquired knowledge of the analysis and interpretation of real-life multivariate data.
Objectives: Facilitate necessary skills to draw multivariate random samples, testing of multivariate means, apply multivariate linear regression model and test for goodness of fit.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Apply multivariate normal distribution;
CLO2: Use multivariate sampling distributions;
CLO3: Analyze multivariate linear models;

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1			√	√		√	√			√
CLO2			√	√		√	√			√
CLO3			√	√		√	√			√

Topic	Course Content	Hours	CLO
Lab	Simulation of multivariate normal variate. Tests of mean vectors by Hotelling's T^2 and Mahalanobish D^2; Tests for covariance and correlation patterns and multivariate normality. Estimation of multivariate linear regression and construction of MANOVA.	**28**	**CLO1 CLO2 CLO3**

Books Recommended	**Text Books:** 1. Johnson R. A and Wichern D. W (1999). *Applied Multivariate Statistical Analysis*, 4th *Edition*. Prentice-Hall. 2. Srivastava MS (2002). Methods of Multivariate Statistics. Wiley. **Reference Books:** 1. Anderson, T.W., (1984), Introduction of Multivariate Statistical Analysis, 2nd Ed., John Wiley. Morrison, D.P., (1976), *Multivariate Statistical Methods*, 4th Edition McGraw-Hill. 2. Bhuiyan, K.C., (2006), Multivariate Analysis and Its Applications. New Central Book Agency.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing- X **Course No:** STA 0542 409
Contact Hours per Week: 02 **Credit:** 02

Rationales: This course introduces methods of modern Bayesian inference, with an emphasis on

practical issues and applications

Objectives: The objectives of the course are- to formulate, analyses and interpret hierarchical models, fitting them using R and to demonstrate how decision making is performed in Bayesian framework.

After comp **Credit:** 01letion of this course, students will be able to

CLO1: A analyze basic statistical models using a Bayesian approach and correctly interpret the results,

CLO2: Use Bayesian models for prediction and decision making

CLO3: Implement more advanced statistical models using modern simulation methods,

Mapping of PLOs to CLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	✓	✓	✓				✓			✓
CLO2		✓		✓	✓	✓				✓
CLO3			✓	✓	✓	✓	✓			✓

Topic	Course Content	Hours	CLO
LAB	posterior probability distribution, Bayes estimator, risk function, loss function, credible interval, credible regions (including HPDRs), decision tree, optimum decision function, independent simulation techniques for posterior sampling, conditional profit table, conditional loss EPPI,EVPI, EOL	**28**	

Books Recommended	**Text Books:** **1.** Bolstad W. M., *Introduction to Bayesian Statistics*, Wiley-Interscience; 2nd Edition (2007). **2.** Press S. J., *Bayesian Statistics: Principles, Models and Applications*, Wiley; 1st Edition (1989). **3.** Chemoff, H. &-Moses, L. E., *Elementary Decision Theory*, Dover Publications (1986).
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing- X **Course No:** STA 0542 410

Contact Hours per Week: 02 **Credit:** 02

Rationales: This course covers a range of econometric methods required to conduct empirical economic research and understand applied econometric results.

Objectives: The objectives of this course are to introduce students to the basic principles of econometric analysis to gain practical understanding of the methods needed for econometric research including their underlying assumptions, advantages and limitations, to understand how to use different econometric to OLS in real-world economic problems and interpret findings.

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

CLO1: Run econometric models.

CLO2: Detect various econometric problems.

CLO3: Fit models after removing econometrics problems.

CLO4: Create and study dummy variables and use it in data analysis.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		√								
CLO2			√							
CLO3				√						
CLO4					√		√			

Topic	Course Content	Hours	CLO
Lab	Detection and tests for heteroscedasticity, Multicollinearity, fitting of model after removing these problems. Tests of autocorrelation and estimation of parameters with autocorrelated disturbances. Fitting of dummy variable regression models, tests of parameters of dummy variable regression model.	**28**	

Books Recommended	**Text Books:** 2. Gujarati, D. N. & Porter D. *Basic Econometrics*, McGraw-Hill Education; 5th Edition (2008). **3.** Koutsoyiannis, A. *Theory of Econometrics*, Palgrave Macmillan, 2nd Edition (2001)
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Statistical Computing- XI **Course No:** STA 0542 411
Contact Hours per Week: 02 **Credit:** 02

Rationales: This course is designed to implement practical applications for categorical data analysis. It covers the basic principles and methods of epidemiology, with an emphasis on critical thinking, analytic skills, and application to clinical practice and research.

Objectives:
Understand categorical Data; Explore the basic asymptotic tools; Analyze contingency tables and inference for two way contingency tables; Estimate and test the categorical data; Apply Regression models for Categorical and Count Models; Get accustomed with epidemiologic terminology, outcome measures, and study designs; Describe and discuss the role and contribution of epidemiology to health;

Course Learning Outcomes: At the end of the course, students will be able to –
CLO1: Learn Statistical inference for categorical data.
CLO2: Describe and analyze contingency tables.
CLO3: Analyze generalized linear models and its likelihood;
CLO4: Analyze public health related models and its parameter.
CLO5: Analyze epidemiology related models and its parameter.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		√								
CLO2			√							
CLO3				√						
CLO4					√		√			

CLO4		√			√	√				

Topic	Course Content	Hours	CLO
Lab-A	Chi-square test, exact test for small samples, association in three-way tables, generalized linear model, GLMs for binary data, GLMs for count data, inference and model checking, fitting generalized linear models, logistic regression-building and applying: interpreting logistic regression, inference for logistic regression, multiple logistic regression, strategies in model selection, model checking, multi-category logit models, logit models for nominal response, model for matched pairs: comparing dependent proportions, measuring agreement, loglinear models, loglinear models for 2-way and 3-way tables, inference for loglinear model.	**16**	**CLO1 CLO2 CLO3**
LAB-B	Public health and epidemiology related data analysis. Dealing the health related data with regression models.		**12**

Books Recommended	**Text Books:** 1. Agresti, A. (2012). *Categorical Data Analysis*, 3rd Edition, John Wiley and Sons, New York. 2. Powers, D. A. and Xie, Yu. (2008). *Statistical Methods for Categorical Data Analysis*, 2nd Edition, Emerald Group Publishing Ltd., London.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.

Course Title: Project Report **Course No:** STA 0542 412
Contact Hours per Week: 04 **Credit:** 04

Rationales: Developing skills on application of the statistical knowledge acquired throughout the undergraduate program.

Objectives: The objectives are to facilitate necessary skills about hands-on experience of conducting a research project

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1 - Design a research project;
CLO2 - Write an appropriate research proposal;
CLO3 - Develop suitable questionnaire for collecting necessary primary data;
CLO4 - Demonstrate ability to design a database and data processing;
CLO5 - Perform necessary data analysis;
CLO6 - Write a research report and give an effective oral presentation.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√		√			√			√
CLO2		√			√					√
CLO3	√	√		√		√				
CLO4			√			√				
CLO5					√	√	√			√
CLO6								√	√	√

Topic	Course Content	Hours	CLO
Project	Students will in consultation with assigned teachers select project topics	**04**	

Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with the real-life problem, presentation.

Course Title: Viva-Voce **Course No:** STA 0542 413
Contact Hours per Week: NA **Credit:** 02

Rationale of the course: Assessing students' comprehensive knowledge on basic concepts of the courses learned in the current semester.

Objectives: Help students to gain confidence in their own ability to present and explain the basic concepts of the courses. Provide the knowledge of oral communication and presentation skills that are essential for later professional career.

Course Learning Outcomes: At the end of the course, students will be able to -
CLO1: Develop verbal communication and presentation skills;
CLO2: Communicate their learning effectively and appropriately to formal audiences;
CLO3: Explain key concepts of the courses, interpret key terms, and justify their arguments logically to non-statisticians;
CLO4: Prepare for professional oral examinations which is useful to enhance employment interview skills;
CLO5: Demonstrate their ability to participate in academic discussion.

Mapping CLOs to PLOs

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√			√			√	√	√
CLO2	√	√			√			√	√	√
CLO3	√	√			√			√	√	√
CLO4	√	√			√			√	√	√
CLO5	√	√			√			√	√	√

Topic	Course Content	Hours	CLO
Viva-Voce	Comprehensive contents of all the underlying courses of the semester.		

Books Recommended	**Main Text** • Textbooks referred for all the underlying courses of the semester. **Reference Books** • Reference books referred for all the underlying courses of the semester.
Teaching-Learning Strategy	Lecture, group discussion, assignment, dealing with real life problem, presentation.