KHULNA UNIVERSITY

Learn, Lead and Live

OBE OUTCOME BASED EDUCATION

2021-22
and onwards

Undergraduate Curriculum

# Statistics Discipline

Science, Engineering and Technology School

OUTCOME-BASED CURRICULUM

# BACHELOR OF SCIENCE (HONOURS) IN STATISTICS

Statistics Discipline
**Khulna University**
August 2022

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OUTCOME BASED EDUCATION

# 01 Title of the Academic Program

Bachelor of Science (Honours) in Statistics

**Program Overview**

| | |
|---|---|
| Degree | Bachelor of Science (Honours) in Statistics |
| Abbreviated form of the Degree | B. Sc. (Hon's) in Statistics |
| Discipline/Program Offering Entity (POE) | Statistics Discipline |
| School | Science, Engineering and Technology School |
| Awarding Institution | Khulna University |
| Location | Khulna, Bangladesh |
| Bangladesh National Qualifications Framework (BNQF) Level | 7 |
| International Standard Classification of Education (ISCED) Code | 0542 |
| Mode of Study | Full Time |
| Language of Study | English |
| Applicable Session | 2021-2022 and onwards |

# 02 Name of the University

Khulna University

# 03 Vision of the University

Creation of global leaders who will contribute to make knowledge-based just society through accelerating inclusive and transformative growth of Bangladesh and the world. The university aims to achieve this vision through scholarly enquiry and contribution to the global knowledge pool.

# 04 Mission of the University

**University Mission & Details**

| | |
|---|---|
| UM1 | Explore human potential to the fullest extent and produce self-motivated, aspiring leaders to work for the betterment of the humankind based on wisdom, freethinking, creativity and unhindered intellectual exercises; |
| UM2 | Ensure a transformative educational experience that enables creative learning, entrepreneurship and inquisitiveness among the students; |
| UM3 | Create an inclusive research environment that enables graduates to make demonstrable economic and social impacts through translating knowledge and innovation into practice driven by moral values and professional ethics. |

UM = University Mission

## 05 Name of the Discipline/Program Offering Entity (POE)

Statistics Discipline

## 06 Vision of the Discipline/POE

Develop the next generation of statistics professionals by achieving excellence in teaching and research to meet the increasing demand for Statistics.

## 07 Mission of the Discipline/POE

**Discipline Mission & Details**

| | |
|---|---|
| M1 | To produce competent graduates who will oversee premium research, instruction, and innovation in the field of statistics and other multidisciplinary areas to satisfy the demands of fast-changing world. |
| M2 | To provide excellent training in data acquisition, processing, and analysis, blending theory with a practice involving interactive learning processes. |
| M3 | To organize workshops, seminars, conferences, and research collaborations for enhancing research and teaching; |
| M4 | To disseminate the knowledge of Statistics to understand scientific and social phenomena better. |

M = Mission of the Discipline/POE

## 08 Objectives of the Discipline/POE

**Discipline Objectives & Details**

| | |
|---|---|
| 01 | To conduct education and research in the field of Statistical modeling, Biostatistics, Epidemiology, Public Health, Bioinformatics, Econometrics, Experimental designs, Engineering, Social aspects etc. through various programs, such as Bachelor's, Masters' and Ph.D. |
| 02 | To contribute the sustainable development and industrial revolution in different sectors utilizing statistical tool and techniques. |
| 03 | To communicate effectively with skills in research collaboration and teamwork. |
| 04 | To provide full support across the university for research and professional development of faculty as well as of students. |

O = Objective of the Discipline/POE

## 09 Name of the Degree

Bachelor of Science (Honours) in Statistics

## 10 Description of the Program

The Bachelor of Science (Honours) program given by the statistics discipline Khulna University is one of Bangladesh's most distinguished undergraduate statistics degrees. Statistics is a branch of Mathematics concerned with collecting, classifying, and interpreting a group of facts according to their relative number and determining specific values that represent the characteristics of the group. In the present world, statistics is an essential subject to us in our daily lives. Its importance and scope dominate the practical spheres of life in the laboratory. Statistics has become inevitable as state affairs as in medical science, in predicting the weather, in the knowledge of the condition of the share markets. Improving a better understanding of statistical resources will require significant contributions from academicians, researchers, scientists, politicians, and people of all stakes. Statistics Discipline initiated academic activities in 2012 to meet these needs to produce quality statistician professionals.

The curriculum is intended to give students an outcome-based education, and the inclusion of diverse general education courses will help them widen their knowledge, analysis and ethics. Statistics is a pioneering discipline of the Science, Engineering, and Technology Science School, offering a four-year Bachelor of Science (Honours) in Statistics. This Discipline provides excellent education and research in physical science and public health, which will help ensure the long-term management of existing resources. It has also focused in the curriculum and courses on probability, sampling, time series, inference, regression, experimental design, multivariate analysis, data mining, and a balanced emphasis on fundamental statistics disciplines. The curriculum is specifically designed to generate proficient statistics professionals who can think critically and lead.

The Discipline has produced a considerable number of high-quality statisticians since its inception. Graduates of this subject have already made a name for themselves in both professional and non-professional work markets. Our graduates are prepared to face the countries and the world's future resource concerns and environmental issues.

## 11 Graduate Attributes

| | Graduate Attributes | Domain |
|---|---|---|
| GA1 | Academic excellence with deep discipline knowledge. | Fundamental |
| GA2 | Creative and confident users of digital knowledge. | Fundamental |
| GA3 | Be global in outlook and effective communicators and collaborators. | Social |
| GA4 | Active citizenship thorough accepting of social and civic responsibilities and rights. | Social |
| GA5 | Creative and critical thinking, problem-solving, and decision-making skill. | Thinking |
| GA6 | Self-learning and research skills. | Thinking |
| GA7 | Professionalism, employability, enterprise. | Personal |
| GA8 | Self-management and development. | Personal |

GA = Graduate Attributes

## 12 Program Educational Objectives (PEOs)

| | Program Educational Objectives | Domain |
|---|---|---|
| PEO1 | To give a solid foundation in statistical theory and applications, allowing to pursue higher degrees and research in the field of statistics. | Fundamental |
| PEO2 | To contribute to the establishment of effective operational and strategic decisions based on statistical theory and methodology in almost every discipline by developing statisticians who can understand not only basic theoretical and applied principles of statistics but also communicate key statistical concepts to non-statisticians in interdisciplinary areas such as economic, health, agriculture, government, business, industry, and telecommunications. | Social |
| PEO3 | To compete in the job market by teaching and research how to use statistical software and data collecting and analysis procedures. | Thinking |
| PEO4 | To develop a strong foundation in best practices for information gathering and distribution. | Thinking |
| PEO5 | To involve in research projects to obtain better training in research, problem-solving, teamwork, and communication, as well as a desire to become contributing members of society through their knowledge and professional abilities. | Personal |

PEO = Program Educational Objective

## 13 Program Learning Outcomes (PLOs)

After successful completion of the degree, the learners will be able to:

| | |
|---|---|
| **A. Fundamental Skills** | |
| PLO1 | Apprehend substantial theoretical and practical knowledge and understanding of fundamental principles and essential theories relevant to statistics and their applications. |
| PLO2 | Enrich knowledge of computer equipment with statistical software to analyze data critically, make judgments and propose solutions to various problems. |
| **B. Thinking Skills** | |
| PLO3 | Comprehend the statistical tools and techniques available in Mathematics, Economics, Computer science, social science, etc. |
| PLO4 | Attain practical knowledge and wide-ranging professional practice in statistics and multidisciplinary areas. |
| **C. Social Skills** | |
| PLO5 | Understand to analyze effectively and make evident high leadership qualities for handling problems on big data. |
| PLO6 | Demonstrate moral values, ethics, professionalism, and patriotism for leadership development. |
| **D. Personal Skills** | |
| PLO7 | Engage in independent learning using scholarly reviews and secondary sources of information. |
| PLO8 | Design and organize research problems and conduct different research projects considering real-life situations to make informed decisions based on rigorous research and critical analysis of relevant information. |

PLO = Program Learning Outcome

## 14 Mapping Mission of the University with PEOs

| PEOs \ Missions | UM1 | UM2 | UM3 |
|---|---|---|---|
| PEO1 | 1 | 2 | 1 |
| PEO2 | 2 | 3 | 3 |
| PEO3 | 3 | 1 | 3 |
| PEO4 | 1 | 1 | 1 |
| PEO5 | 2 | 3 | 3 |

Level of association: 3=High, 2=Medium, 1=Low

## 15 Mapping PLOs with PEOs

| Program Learning Outcomes (PLOs) | | Program Educational Objectives (PEOs) | | | | |
|---|---|---|---|---|---|---|
| | | PEO1 | PEO2 | PEO3 | PEO4 | PEO5 |
| Fundamental Domain | PLO1 | ● | | ● | ● | ● |
| | PLO2 | | ● | | ● | ● |
| Thinking Domain | PLO3 | ● | ● | ● | ● | ● |
| | PLO4 | | ● | | ● | |
| Social Domain | PLO5 | ● | ● | | | ● |
| | PLO6 | | | ● | | ● |
| Personal Domain | PLO7 | | ● | ● | ● | ● |
| | PLO8 | ● | ● | ● | | ● |

# 16 Mapping Courses with PLOs

| Course Code and Course Title | Program Learning Outcomes (PLOs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fundamental Domain | | Thinking Domain | | Social Domain | | Personal Domain | |
| | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 |
| **First Year First Term** | | | | | | | | |
| 0542 20 Stat 1101: Basic Statistics-I | ● | | ● | ● | ● | ● | | ● |
| 0542 20 Stat 1103: Elementary Probability | ● | | ● | ● | | | | ● |
| 0542 20 Stat 1104: Basic Statistics and Probability Lab | ● | | | ● | ● | | ● | ● |
| 0542 20 Stat 1110: Fundamentals of Computer Lab | ● | ● | ● | ● | | | ● | ● |
| 0541 20 Math 1151: Algebra and Geometry | ● | | ● | ● | | | ● | |
| 0541 20 Math 1153: Fundamentals of Calculus | ● | ● | | | | | ● | |
| 0311 20 Econ 1155: Principles of Economics | ● | ● | ● | ● | | ● | | ● |
| 0231 20 Eng 1157: Communicative English | | | | ● | ● | ● | ● | |
| **First Year Second Term** | | | | | | | | |
| 0542 20 Stat 1201: Basic Statistics-II | ● | | ● | ● | | | ● | ● |
| 0542 20 Stat 1203: Discrete Probability Distributions | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 1204: Basic Statistics and Discrete Probability Distributions Lab | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 1220: Viva Voce-I | ● | ● | ● | ● | ● | ● | ● | ● |
| 0541 20 Math 1251: Advanced Calculus | | | ● | ● | | | ● | |
| 0541 20 Math 1253: Matrix Algebra in Statistics | ● | ● | ● | ● | | | | ● |
| 0714 20 CSE 1255: Computer Programming | ● | ● | | ● | ● | | ● | ● |
| 0714 20 CSE 1256: Computer Programming Lab | ● | ● | | ● | | | | ● |
| 0314 20 Soc 1257: Population Studies | ● | | ● | ● | | | | ● |

| Course Code and Course Title | Program Learning Outcomes (PLOs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fundamental Domain | | Thinking Domain | | Social Domain | | Personal Domain | |
| | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 |
| **Second Year First Term** | | | | | | | | |
| 0542 20 Stat 2100: Statistical Package Lab | | ● | ● | | | | ● | ● |
| 0542 20 Stat 2101: Continuous Probability Distributions | ● | | ● | ● | | | ● | ● |
| 0542 20 Stat 2103: Sampling Technique-I | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 2104: Continuous Probability Distributions and Sampling Technique Lab | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 2105: Sampling Distributions | ● | | ● | ● | | | ● | ● |
| 0542 20 Stat 2107: Order Statistics and Non-central Distributions | ● | | ● | ● | | | | ● |
| 0541 20 Math 2151: Differential Equation | ● | | ● | ● | ● | | | ● |
| 0311 20 Econ 2153: Economic Statistics | ● | ● | ● | | ● | ● | ● | ● |
| **Second Year Second Term** | | | | | | | | |
| 0542 20 Stat 2200: Computing in Statistics Lab | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 2201: Statistical Inference-I | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 2203: Regression Analysis-I | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 2204: Statistical Inference and Regression Analysis-I Lab | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 2205: Analysis of Variance | ● | ● | ● | ● | | | | ● |
| 0542 20 Stat 2207: Time Series Analysis | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 2208: Analysis of Variance and Time Series Analysis Lab | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 2220: Viva Voce-II | ● | ● | ● | ● | ● | ● | ● | ● |
| 0541 20 Math 2251: Numerical Analysis | ● | | ● | ● | | | | ● |
| 0541 20 Math 2253: Real Analysis | ● | | ● | ● | | | ● | ● |

| Course Code and Course Title | Program Learning Outcomes (PLOs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fundamental Domain | | Thinking Domain | | Social Domain | | Personal Domain | |
| | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 |
| **Third Year First Term** | | | | | | | | |
| 0542 20 Stat 3101: Statistical Inference-II | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3103: Regression Analysis-II | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3104: Statistical Inference and Regression Analysis-II Lab | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3105: Experimental Design | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3107: Modeling and Simulation | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3108: Experimental Design and Simulation Lab | ● | ● | ● | ● | | | | ● |
| 0542 20 Stat 3109*: Actuarial Statistics | ● | | ● | ● | | | ● | ● |
| 0542 20 Stat 3111*: Statistical Pattern Recognition | ● | | ● | | | | | ● |
| 0541 20 Math 3151: Operation Research | | ● | ● | ● | ● | | | ● |
| 0541 20 Math 3152: Operation Research Lab | ● | ● | | ● | | | | |
| **Third Year Second Term** | | | | | | | | |
| 0542 20 Stat 3200: Fieldwork | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3201: Statistical Inference-III | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3203: Nonparametric Tests | ● | | ● | ● | | ● | | ● |
| 0542 20 Stat 3204: Nonparametric Tests and Inference Lab | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3205: Sampling Technique-II | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3207: Stochastic Process | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3208: Sampling Technique and Stochastic Process Lab | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 3209: Research Methodology | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3211*: Epidemiology | ● | | | ● | | ● | ● | ● |
| 0542 20 Stat 3213*: Decision Theory | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 3220: Viva Voce-III | ● | ● | ● | ● | ● | ● | ● | ● |

| Course Code and Course Title | Program Learning Outcomes (PLOs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fundamental Domain | | Thinking Domain | | Social Domain | | Personal Domain | |
| | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 |
| **Fourth Year First Term** | | | | | | | | |
| 0542 20 Stat 4100: Project Proposal Development | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4101: Multivariate Analysis-I | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4102: Multivariate Analysis-I Lab | ● | ● | ● | ● | | ● | ● | ● |
| 0542 20 Stat 4103: Biostatistics | ● | | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 4105: Econometrics | ● | | | ● | ● | ● | ● | ● |
| 0542 20 Stat 4106: Econometrics and Biostatistics Lab | ● | ● | ● | ● | | | | ● |
| 0542 20 Stat 4107*: Robust Statistics | ● | | ● | | | ● | ● | ● |
| 0542 20 Stat 4109*: Industrial Statistics and Quality Control | ● | | ● | | | | ● | ● |
| 0542 20 Stat 4111*: Analysis of Repeated Measurement | ● | | | ● | | | | ● |
| **Fourth Year Second Term** | | | | | | | | |
| 0542 20 Stat 4200: Project | ● | ● | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4201: Multivariate Analysis-II | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4202: Multivariate Analysis-II Lab | ● | ● | ● | ● | ● | ● | ● | ● |
| 0542 20 Stat 4203: Statistical Data Mining | ● | | ● | ● | | ● | | ● |
| 0542 20 Stat 4204: Statistical Data Mining Lab | ● | ● | ● | ● | | ● | | ● |
| 0542 20 Stat 4205*: Environmental Statistics | ● | | ● | ● | | | | ● |
| 0542 20 Stat 4207*: Statistical Methods for Meta-Analysis | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4209*: Statistical Genetics | ● | | ● | ● | ● | | ● | ● |
| 0542 20 Stat 4211*: Comprehensive | ● | | ● | ● | ● | ● | | ● |
| 0542 20 Stat 4212: Data Analysis Lab | | ● | ● | ● | | | | ● |
| 0542 20 Stat 4120: Viva Voce-IV | ● | | ● | ● | ● | ● | ● | ● |
| 0541 20 Math 4151: Measure Theory | ● | | ● | ● | | | | ● |

Note: The Course code is designated by: (a) a four-digit International Standard Classification of Education (ISCED) code (0542 for Statistics), (b) a two-digit Discipline identity code (20 for Statistics Discipline), (c) a two to four-letters-word identifying the Subject (Stat for Statistics), and (d) a four-digit number referring to the academic year, term and nature of the course (odd number indicates a theoretical course and the even number a sessional, dissertation, and viva voce). For ninth and tenth digits, 01-50 will usually denote departmental courses, while 51-99 will usually denote non-departmental courses. The asterisk (*) indicates optional course.

# 17 Structure of the Curriculum

| | | | |
|---|---|---|---|
| a) | Duration of the Program | 04 Years | 08 Terms |
| b) | Admission Requirements | The applicants having HSC or equivalent degree will be eligible for admission into this program. Other terms and conditions are set or revised periodically by the appropriate authority. | |
| c1) | Graduating Credits / Total Minimum Credit Requirement to Complete the Program | 160 | |
| c2) | Available Credits | 174 | |
| d) | Total Class Weeks in a Term* | 14 | |
| e) | Minimum CGPA Requirements for Graduation | 2.50 | |
| f) | Maximum Academic Years of Completion | 07 Years | |

*Term Duration

| Teaching and Learning | Preparatory Leave | Term Final Examination | Term Break | Total |
|---|---|---|---|---|
| 14 Weeks | 2 Weeks | 4 Weeks | 2 Weeks | 22 Weeks |

g1) Area-wise Credit Distribution

| Area | Course Type | Number of Courses | Credits | Total Credits |
|---|---|---|---|---|
| General Education (GED) Courses** | Theory | 14 | 37.0 | 39.5 |
| | Sessional | 2 | 2.5 | |
| Core/Compulsory Courses | Theory | 26 | 73.0 | 99.5 |
| | Sessional | 22 | 26.5 | |
| Optional/Elective Courses | Theory | 11 | 31.0 | 31.0 |
| | Sessional | 0 | 0 | |
| Capstone Courses | Project | 2 | 4.0 | 4.0 |
| | Total | 77 | 174 | 174 |

**25% of GED core courses from 160 minimum required credits.

g2) Category of Courses

| Area | Course Type | Course Title | Credits |
|---|---|---|---|
| General Education (GED) Courses | Theory | 01. Algebra and Geometry<br>02. Fundamentals of Calculus<br>03. Principles of Economics<br>04. Communicative English<br>05. Advanced Calculus<br>06. Population studies<br>07. Matrix Algebra in Statistics<br>08. Computer Programming<br>09. Differential Equation<br>10. Economic Statistics<br>11. Numerical Analysis<br>12. Real Analysis<br>13. Operation Research<br>14. Measure Theory | 37.0 |

| Area | Course Type | Course Title | Credits |
|---|---|---|---|
| | Sessional | 01. Computer Programming Lab<br>02. Operation Research Lab | 2.5 |
| Core/ Compulsory Courses | Theory | 01. Basic Statistics-I<br>02. Elementary Probability<br>03. Basic Statistics-II<br>04. Discrete Probability Distributions<br>05. Continuous Probability Distributions<br>06. Sampling Technique-I<br>07. Sampling Distributions<br>08. Order Statistics and Non-central Distribution<br>09. Statistical Inference-I<br>10. Regression Analysis-I<br>11. Analysis of Variance<br>12. Time Series Analysis<br>13. Statistical Inference-II<br>14. Regression Analysis-II<br>15. Experimental Design<br>16. Modeling and Simulation<br>17. Econometrics<br>18. Statistical Inference-III<br>19. Nonparametric Tests<br>20. Sampling Technique-II<br>21. Stochastic Process<br>22. Research Methodology<br>23. Multivariate Analysis-I<br>24. Biostatistics<br>25. Multivariate Analysis-II<br>26. Statistical Data Mining | 73 |
| | Sessional | 01. Basic Statistics and Probability Lab<br>02. Fundamentals of Computer Lab<br>03. Basic Statistics and Discrete Probability Distributions Lab<br>04. Statistical Package Lab<br>05. Continuous Probability Distributions and Sampling Technique Lab<br>06. Computing in Statistics Lab<br>07. Statistical Inference and Regression Analysis-I Lab<br>08. Analysis of Variance and Time Series Analysis Lab<br>09. Statistical Inference and Regression Analysis-II Lab<br>10. Experimental Design and Simulation Lab<br>11. Fieldwork<br>12. Nonparametric Tests and Inference Lab<br>13. Sampling Technique and Stochastic Process Lab<br>14. Multivariate Analysis-I Lab<br>15. Econometrics and Biostatistics Lab<br>16. Multivariate Analysis-II Lab<br>17. Statistical Data Mining Lab<br>18. Data Analysis Lab<br>19. Viva Voce-I<br>20. Viva Voce-II<br>21. Viva Voce-III<br>22. Viva Voce-IV | 26.5 |

| Area | Course Type | Course Title | Credits |
|---|---|---|---|
| Optional/ Elective Courses | Theory | 01. Actuarial Statistics<br>02. Statistical Pattern Recognition<br>03. Epidemiology<br>04. Decision Theory<br>05. Robust Statistics<br>06. Industrial Statistics and Quality Control<br>07. Analysis of Repeated Measurement<br>08. Environmental Statistics<br>09. Statistical Methods for Meta-Analysis<br>10. Statistical Genetics<br>11. Comprehensive | 31.0 |
| | Sessional | | 0.0 |
| Capstone Courses | Sessional | 01. Project Proposal Development<br>02. Project | 4.0 |
| | | Total | 174 |

Summary of credit in all Years and Terms

| Year | Term | Theory | | Viva | Sessional | | Total |
|---|---|---|---|---|---|---|---|
| | | Core | Optional | Core | Core | Optional | |
| First | First | 17.0 | 0.0 | 0.0 | 2.5 | 0.0 | 19.5 |
| | Second | 16.0 | 0.0 | 1.0 | 3.0 | 0.0 | 20.0 |
| Second | First | 17.0 | 0.0 | 0.0 | 3.0 | 0.0 | 20.0 |
| | Second | 16.0 | 0.0 | 1.0 | 4.0 | 0.0 | 21.0 |
| Third | First | 14.0 | 4.0 | 0.0 | 3.5 | 0.0 | 21.5 |
| | Second | 13.0 | 6.0 | 1.0 | 3.5 | 0.0 | 23..5 |
| Fourth | First | 9.0 | 9.0 | 0.0 | 4.5 | 0.0 | 22.5 |
| | Second | 8.0 | 12.0 | 1.0 | 5.0 | 0.0 | 26.0 |
| Total | | 110.0 | 31.0 | 4.0 | 29.0 | 0.0 | 174.0 |

# 18 Year/Term-wise Distribution of Courses

| Course Code | Course Title | Course Status | Contact Hours/Week | | Credits | Prerequisites |
|---|---|---|---|---|---|---|
| | | | Theory | Sessional | | |
| **First Year First Term** | | | | | | |
| 0542 20 Stat 1101 | Basic Statistics-I | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 1103 | Elementary Probability | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 1104 | Basic Statistics and Probability Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 1110 | Fundamentals of Computer Lab | Core | - | 1.5 | 1.0 | None |
| 0541 20 Math 1151 | Algebra and Geometry | Core | 3.0 | - | 3.0 | None |
| 0541 20 Math 1153 | Fundamentals of Calculus | Core | 3.0 | - | 3.0 | None |
| 0311 20 Econ 1155 | Principles of Economics | Core | 3.0 | - | 3.0 | None |
| 0231 20 Eng 1157 | Communicative English | Core | 2.0 | - | 2.0 | None |
| Total | Core Courses: 08, Optional Courses: 00,<br>Theory Courses: 06, Sessional Courses: 02 | | 17.0 | 3.75 | 19.5 | None |
| | | | 20.75 | | | |
| **First Year Second Term** | | | | | | |
| 0542 20 Stat 1201 | Basic Statistics-II | Core | 2.0 | - | 2.0 | None |
| 0542 20 Stat 1203 | Discrete Probability Distributions | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 1204 | Basic Statistics and Discrete Probability Distributions Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 1220 | Viva Voce-I | Core | - | 1.5 | 1.0 | None |
| 0541 20 Math 1251 | Advanced Calculus | Core | 3.0 | - | 3.0 | None |
| 0541 20 Math 1253 | Matrix Algebra in Statistics | Core | 3.0 | - | 3.0 | None |
| 0714 20 CSE 1255 | Computer Programming | Core | 2.0 | - | 2.0 | None |
| 0714 20 CSE 1256 | Computer Programming Lab | Core | - | 2.25 | 1.5 | None |
| 0314 20 Soc 1257 | Population Studies | Core | 3.0 | - | 3.0 | None |
| Total | Core Courses: 09, Optional Courses: 00,<br>Theory Courses: 06, Sessional Courses: 03 | | 16.0 | 6.0 | 20.0 | |
| | | | 22.0 | | | |

| Course Code | Course Title | Course Status | Contact Hours/Week | | Credits | Prerequisites |
|---|---|---|---|---|---|---|
| | | | Theory | Sessional | | |
| **Second Year First Term** | | | | | | |
| 0542 20 Stat 2100 | Statistical Package Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 2101 | Continuous Probability Distributions | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2103 | Sampling Technique-I | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2104 | Continuous Probability Distributions and Sampling Technique Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 2105 | Sampling Distributions | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2107 | Order Statistics and Non-central Distribution | Core | 3.0 | - | 3.0 | None |
| 0541 20 Math 2151 | Differential Equation | Core | 3.0 | - | 3.0 | None |
| 0311 20 Econ 2153 | Economic Statistics | Core | 2.0 | - | 2.0 | None |
| Total | Core Courses: 08, Optional Courses: 00,<br>Theory Courses: 06, Sessional Courses: 02 | | 17.0<br>21.5 | 4.5 | 20.0 | |
| **Second Year Second Term** | | | | | | |
| 0542 20 Stat 2200 | Computing in Statistics Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 2201 | Statistical Inference-I | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2203 | Regression Analysis-I | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2204 | Statistical Inference and Regression Analysis-I Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 2205 | Analysis of Variance | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2207 | Time Series Analysis | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 2208 | Analysis of Variance and Time Series Analysis Lab | Core | - | 1.5 | 1.0 | None |
| 0542 20 Stat 2220 | Viva Voce-II | Core | - | 1.5 | 1.0 | None |
| 0541 20 Math 2251 | Numerical Analysis | Core | 2.0 | - | 2.0 | None |
| 0541 20 Math 2253 | Real Analysis | Core | 2.0 | - | 2.0 | None |
| Total | Core Courses: 10, Optional Courses: 00,<br>Theory Courses: 06, Sessional Courses: 04 | | 16.0<br>23.5 | 7.5 | 21.0 | |

| Course Code | Course Title | Course Status | Contact Hours/Week | | Credits | Prerequisites |
|---|---|---|---|---|---|---|
| | | | Theory | Sessional | | |
| **Third Year First Term** | | | | | | |
| 0542 20 Stat 3101 | Statistical Inference-II | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3103 | Regression Analysis-II | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3104 | Statistical Inference and Regression Analysis-II Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 3105 | Experimental Design | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3107 | Modeling and Simulation | Core | 2.0 | - | 2.0 | None |
| 0542 20 Stat 3108 | Experimental Design and Simulation Lab | Core | - | 1.5 | 1.0 | None |
| 0542 20 Stat 3109 | Actuarial Statistics | Optional | 2.0 | - | 2.0 | None |
| 0542 20 Stat 3111 | Statistical Pattern Recognition | Optional | 2.0 | - | 2.0 | None |
| 0541 20 Math 3151 | Operation Research | Core | 3.0 | | 3.0 | None |
| 0541 20 Math 3152 | Operation Research Lab | Core | - | 1.5 | 1.0 | None |
| Total | Core Courses: 08, Optional Courses: 02,<br>Theory Courses: 07, Sessional Courses: 03<br>(at least 01 course should be selected from the optional courses) | | 18.0<br>23.25 | 5.25 | 21.5 | |
| **Third Year Second Term** | | | | | | |
| 0542 20 Stat 3200 | Fieldwork | Core | - | 3.0 | 1.5 | None |
| 0542 20 Stat 3201 | Statistical Inference-III | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3203 | Nonparametric Tests | Core | 2.0 | - | 2.0 | None |
| 0542 20 Stat 3204 | Nonparametric Tests and Inference Lab | Core | - | 1.5 | 1.0 | None |
| 0542 20 Stat 3205 | Sampling Technique-II | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3207 | Stochastic Process | Core | 2.0 | - | 2.0 | None |
| 0542 20 Stat 3208 | Sampling Technique and Stochastic Process Lab | Core | - | 1.5 | 1.0 | None |
| 0542 20 Stat 3209 | Research Methodology | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3211 | Epidemiology | Optional | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3213 | Decision Theory | Optional | 3.0 | - | 3.0 | None |
| 0542 20 Stat 3220 | Viva Voce-III | Core | - | 1.5 | 1.0 | |
| Total | Core Courses: 09, Optional Courses: 02,<br>Theory Courses: 07, Sessional Courses: 04<br>(at least 01 course should be selected from the optional courses) | | 19.0<br>26.5 | 7.5 | 23.5 | |

| Course Code | Course Title | Course Status | Contact Hours/Week | | Credits | Prerequisites |
|---|---|---|---|---|---|---|
| | | | Theory | Sessional | | |
| **Fourth Year First Term** | | | | | | |
| 0542 20 Stat 4100 | Project Proposal Development | Core | - | 4.0 | 2.0 | None |
| 0542 20 Stat 4101 | Multivariate Analysis-I | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 4102 | Multivariate Analysis-I Lab | Core | - | 1.5 | 1.0 | None |
| 0542 20 Stat 4103 | Biostatistics | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 4105 | Econometrics | Core | 3.0 | - | 3.0 | None |
| 0542 20 Stat 4106 | Econometrics and Biostatistics Lab | Core | - | 2.25 | 1.5 | None |
| 0542 20 Stat 4109 | Robust Statistics | Optional | 3.0 | - | 3.0 | None |
| 0542 20 Stat 4111 | Industrial Statistics and Quality Control | Optional | 3.0 | - | 3.0 | None |
| 0542 20 Stat 4113 | Analysis of Repeated Measurements | Optional | 3.0 | | 3.0 | None |
| Total | Core Courses: 06, Optional Courses: 03,<br>Theory Courses: 06, Sessional Courses: 03<br>(at least 02 course should be selected from the optional courses) | | 18.0<br>25.75 | 7.75 | 22.5 | |
| **Fourth Year Second Term** | | | | | | |
| 0542 20 Stat 4200 | Project | Core | - | 4.0 | 2.00 | None |
| 0542 20 Stat 4201 | Multivariate Analysis-II | Core | 3.0 | - | 3.00 | None |
| 0542 20 Stat 4202 | Multivariate Analysis-II Lab | Core | - | 1.5 | 1.00 | None |
| 0542 20 Stat 4203 | Statistical Data Mining | Core | 2.0 | - | 2.00 | None |
| 0542 20 Stat 4204 | Statistical Data Mining Lab | Core | - | 1.5 | 1.00 | None |
| 0542 20 Stat 4205 | Environmental Statistics | Optional | 3.0 | - | 3.00 | None |
| 0542 20 Stat 4207 | Statistical Methods for Meta-Analysis | Optional | 3.0 | - | 3.00 | None |
| 0542 20 Stat 4209 | Statistical Genetics | Optional | 3.0 | - | 3.00 | None |
| 0542 20 Stat 4211 | Comprehensive | Optional | 3.0 | - | 3.00 | None |
| 0542 20 Stat 4212 | Data Analysis Lab | Core | - | 1.5 | 1.00 | None |
| 0542 20 Stat 4220 | Viva Voce-IV | Core | - | 1.5 | 1.00 | None |
| 0541 20 Math 4251 | Measure Theory | Core | 3.0 | - | 3.00 | None |
| Total | Core Courses: 08, Optional Courses: 04,<br>Theory Courses: 07, Sessional Courses: 05<br>(at least 02 course should be selected from the optional courses) | | 20.0<br>30.0 | 10.0 | 26.0 | |

# 19 Course Description

| First Year First Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 1101 | | Year: First | Term: First |
| Course Title | Basic Statistics-I | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental statistical concepts and some of their practical application in Science and Society. | | |
| Course Objectives | • Disseminate the message about the vital roles of statistics in our society.<br>• Present the scopes, applications and current research work both in national and international level.<br>• Motivate in students an intrinsic interest in statistical thinking.<br>• Instill the belief that Statistics is important for scientific research.<br>• Provide a foundation and motivation for exposure to statistical ideas subsequent to the course. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Statistics: Origin, history, definition, scope and classification of statistics, it's relation with other disciplines, misuses and abuses, uses of statistics. | 1 |
| 2 | Sources and Processing of Data: Primary and secondary data, methods and types of collecting data, measurement scales, variables and attributes, array formulation, tabulation, frequency distribution, cross sectional, longitudinal, follow-up and panel data. | 2, 3 |
| 3 | Presentation of Data: Graphical representation of data, details of different types of graphs and charts, concept of explosive data analysis, stem and leaf display, dot plot, time series plot. | 3, 4 |
| 4 | Measures of Central Tendency: Mean, median, mode, geometric mean, harmonic mean and quadratic mean, trimmed mean with their properties, quantiles with their graphical representation and uses, application of measures of central tendency. | 4, 5 |
| | Section B | CLOs |
| 5 | Some other Positional Measures: Quartile, decile, percentile, box-plot, outliers and 5-number summaries. | 1, 2 |
| 6 | Measures of Dispersion: Measures of dispersion, application of different measures of dispersion, range, standard deviation, mean deviation, quartile deviation, coefficient of variation and related mathematical relationship, relative measure of dispersion. | 1, 2 |
| 7 | Moments and Shape Characteristics of Distribution: Moments, skewness and kurtosis. | 2, 3 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO 1 | Decipher the background of statistics and its scopes, and applications. | 1 |
| | CLO 2 | Identify the relevant population, sample, study units (subjects), variables, data and conceptualize observational studies, controlled experiments, cross sectional study. | 1, 3 |
| | CLO 3 | Produce and interpret graphical summaries of data and its proper application. | 1, 5 |
| | CLO 4 | Describe basic characteristics of the data distribution, including shape, center, spread, and outliers. | 3 |
| | CLO 5 | Calculate and interpret numerical summary statistics as well as to have knowledge of important properties of different measurements. | 3, 4, 8 |
| | CLO 6 | Calculate positional value and identify the features (shape, spread, and outliers) that describe a pattern of data and illustrate the impact of skewness and outliers on the various summary statistics. | 5 |
| | CLO 7 | Recognize the properties of the normal curve particularly identify data that follow a normal curve and its deviation from symmetric pattern. | 4, 6 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous Assessment. |
| CLO2 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO3 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO4 | Lecture and Group Discussion | Continuous Assessment and Assignment. |
| CLO5 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO6 | Lecture and Group Discussion | Continuous Assessment, Assignment and Final Examination. |
| CLO7 | Lecture and Presentation | Continuous Assessment and Assignment. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Bluman, G. Allan (2006). A step-by-step Approach, McGraw-Hill Higher Education.<br>Islam, M.N. (2011). An Introduction to Statistics and Probability. Mullick & Brothers, Dhaka.<br>Weiss, N. A., & Weiss, C. A. (2017). Introductory statistics. London: Pearson. |
| Supplementary Readings | Newbold, P., Carlson, W.L. and Thome, B. (2003). Statistics for Business and Economics, Fifth Edition, Prentice-Hall, Inc.<br>Lind, D. A., Marchal, W. G., & Wathen, S. A. (2017). Statistical techniques in business & economics. McGraw-Hill Education.<br>Mostafa, M.G. (2016). Methods of Statistics. Brothers Publications, Dhaka.<br>Anderson, R. L. and Bencroft, T. A. (1977). Statistical Theory in Research, McGraw-Hill, New York.<br>Steel, R. G. D., & Torrie, J. H. (1960). Principles and procedures of statistics. Principles and procedures of statistics. |

| Course Code: 0542 20 Stat 1103 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Elementary Probability | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | The course explores the basic concepts of fundamental concepts of probability and formulation of mathematical concepts on probability with practical applications. | | |
| Course Objectives | • To understand basic set theory, combination and permutation;<br>• To provide an understanding of the basic concepts in probability, conditional probability and independent events.<br>• To understand basic probability theory and statistical analysis;<br>• To focus on the random variable, and mathematical expectation.<br>• To compute moments and expected mean and variance of random variables; | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Elements of set theory: Fundamentals of set, operations with set, laws of set, Venn diagram and tree diagram, review of permutation and combination. | 1 |
| 2 | Probability: Probability and possibility, methods of assigning probabilities: classical, empirical, geometric, relative frequency and axiomatic methods of probability, total probability, marginal and conditional probability, random experiment, sample space, events, event space, different types of events, mutually exclusive, exhaustive, independent events, compound probability, Bayes' theorem and its application. | 1, 2 |
| 3 | Random Variable: Concept of random variable, discrete and continuous random variables, probability mass function, probability density function, distribution function, function of random variable and its distribution, bivariate random variable, joint, marginal and conditional distributions, independence of random variables, odds ratio. | 1, 3, 4 |
| Section B | | CLOs |
| 4 | Expectation: Meaning of expectation, marginal and conditional expectation, mean, variance, conditional mean and conditional variance, moments, covariance and correlation coefficient, expectation of sums and products of random variables, Chebyshev's inequality. | 3, 5, 6 |
| 5 | Generating Function: Moment generating function, characteristic function, probability generating function, and cumulant generating function and their properties, and their applications in well-known functions. | 5, 6 |

| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| | CLO 1 | Identify the role statistics and probability can play in any field problem-solving process. | 1, 4, 8 |
| | CLO 2 | Calculate and interpret probability of any given event. | 1, 3, 4 |
| | CLO 3 | Known the underlying concept of random variable and their usage. | 1, 4, 8 |
| | CLO 4 | Known the meaning of mathematical expectation and use this to find mean, variance, moments, correlation coefficient of random variables. | 1, 3, 4, 8 |
| | CLO 5 | Use Chebyshev's inequality to compute the probability of a random variable. | 1, 8 |
| | CLO 6 | Calculate Moment generating function, characteristic function and probability generating function of a random variable as well as well-known distribution. | 1, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and group discussions. | Quiz. |
| CLO2 | Lecture and class presentations. | Class test, assignment and final examination. |
| CLO3 | Lecture and class presentations. | Class test, quiz and final examination. |
| CLO4 | Lecture and group discussions | Class test, assignment and final examination. |
| CLO5 | Lecture and class presentations. | Assignment. |
| CLO6 | Lecture and group discussions. | Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M.N. (2015). An Introduction to Statistics and Probability, 4th Edition, Book World, Dhaka.<br>Meyer, P. L. (1970). Introductory Probability and Statistical Applications, 2nd Edition, Oxford and IBH, N.Y.<br>Roy, M.K. (2011). Fundamentals of Probability and Probability Distribution, Romax Publications, Dhaka. |
| Supplementary Readings | Mood, A. M., Graybill, F. A. and Boes, D. C. (1973). Introduction to the Theory of Statistics, 3rd Edition, McGraw-Hill, New York.<br>Devore, J. L. (2002). Probability and Statistics for Engineering and the Science, 6th Edition, Duxbury Thompson Learning, USA.<br>Roy, M. K. and Paul J. C. (2012). Business Statistics, 1st Edition, Jahangir Press, Dhaka. |

| Course Code: 0542 20 Stat 1104 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Basic Statistics and Probability Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | Students of this course are expected to have practical knowledge of handling data and calculating fundamental summary statistics and probability. | | |
| Course Objectives | • To analysis data both manually and using software.<br>• To interpret the results of summary statistics and probabilistic terms.<br>• To provide a foundation and motivation for exposure to statistical ideas subsequent to the course. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Different graphs and charts, construction of frequency distribution (qualitative and quantitative data) stable with equal and unequal class intervals, measures of central tendency and quantiles, measures of dispersion, standard error, moments, skewness and kurtosis. | 1, 2 |
| 2 | Venn Diagram and tree diagram; calculation of probability of any event; marginal, joint, and conditional probability, marginal, joint, and conditional density; mathematical expectation and independence check of any event, variable(s). | 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Construct different graphs and charts using real life data. | 1, 4 |
| | CLO2 | Calculate summary statistics of data and describe basic characteristics of the data distribution, including shape, center, spread, and outliers. | 1, 8 |
| | CLO3 | Construct both for discrete and continuous sample space using Venn diagram and tree diagram, and hence calculate probability using different procedures. | 5, 7 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, class presentations, and problem solving | Assignment, continuous assessment and viva voce. |
| CLO2 | Lecture, group discussions, class presentations, and problem solving | Group work and discussion |
| CLO3 | Lecture, group discussions, class presentations, and problem solving | Assignment, continuous assessment and Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M.N. (2015). An Introduction to Statistics and Probability, 4th Edition, Book World, Dhaka.<br>Meyer, P. L. (1970). Introductory Probability and Statistical Applications, 2nd Edition, Oxford and IBH, N.Y.<br>Roy, M.K. (2011). Fundamentals of Probability and Probability Distribution, 4th Edition, Jahangir Press, Dhaka. |
| Supplementary Readings | Mood, A. M., Graybill, F. A. and Boes, D. C. (1973). Introduction to the Theory of Statistics, 3rd Edition, McGraw-Hill, New York.<br>Devore, J. L. (2002). Probability and Statistics for Engineering and the Science, 6th Edition, Duxbury Thompson Learning, USA.<br>Roy, M.K. and Paul J.C. (2012).Business Statistics, 1st Edition, Jahangir Press, Dhaka. |

| Course Code: 0542 20 Stat 1110 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Fundamentals of Computer Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to enhance fundamental concepts of computer learning and its application in statistics. | | |
| Course Objectives | • Analysis data both manually and using software.<br>• Develop fundamental calculation.<br>• Import data and present primary analysis.<br>• Provide basic idea about hardware and software. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Introduction to computer, basic components of a computer, data processing and devices, PC operating system, hardware and software, networking and internet. | 1, 2 |
| 2 | MS-Office (word processing packages, and PowerPoint), Spread sheet analysis packages. | 3, 4 |
| 3 | Solving statistical and mathematical problem using MS Excel. | 3, 4 |
| 4 | Prepare graphs and solve basic statistical problems using real life data. | 1, 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Identify the basic components of computer. | 1, 2, 3 |
| | CLO2 | Acquire knowledge about different operating systems. | 1, 2, 3, 7 |
| | CLO3 | Construct different graphs and curves using real life data. | 1, 2, 4, 8 |
| | CLO4 | Solve mathematical and statistical problems. | 1, 2, 3, 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Assignment and viva-voce. |
| CLO2 | Lecture and Presentation | Continuous assessment and examination. |
| CLO3 | Practical work and presentation | Report assessment, Assignment and viva-voce. |
| CLO4 | Practical tasks, group work and presentation | Report assessment and viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Frye C.D. (2010). Step by Step MS Excel. Microsoft Press, Wasington<br>Norton, P. (2006-2007). Introduction to Computers, 6th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. |
| Supplementary Readings | Capron, H. L. (2000).Tools for an Information Age, 7th edition, Prentice Hall, USA.<br>Gallo, A. M. and Nenno, R. B. (1985). Computers and Society with Basic and Pascal, Prindle, Weber and Schmidt, Boston.<br>Rajaraman, V. (1999). Fundamentals of Computers, Prentice Hall, India. |

| Course Code: 0541 20 Math 1151 | Year: First | Term: First |
|---|---|---|
| Course Title | Algebra and Geometry | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to introduce the basic concept of algebra and geometry due to the level of students. | |
| Course Objectives | • Conceptualize the basic idea of set theory.<br>• Acquire knowledge on the number system.<br>• Know about the concept of series.<br>• Familiar with the basic concept of the theory of equations.<br>• Understand the basic concept of geometry. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Set Theory: Sets and set operations, Cartesian product of two sets, relations, order relation, equivalence relations, injective, bijective and subjective functions, inverse functions. | 1 |
| 2 | Number System: Field and order properties, natural numbers, integers and rational numbers, absolute value and their properties. | 2 |
| 3 | Summation of Algebraic Series: Arithmetic, Geometric series, method of difference, successive differences, use of mathematical induction, indirect method of proof, Contra positive and contradiction, direct proof. | 3 |
| 4 | Theory of Equations: Synthetic division, number of roots of polynomial equations, relations between roots and coefficients, multiplicity of roots, symmetric functions of roots, sum of the powers of the roots, Descartes rule of signs, upper and lower limit of roots, transformation of equations (removal of any terms of the equations), reciprocal equations, solution of cubic and bi quadratic equations. | 4, 5 |
| | Section B | CLOs |
| 5 | Geometry in Two Dimensions: Cartesian and polar co-ordinates, transformation of co-ordinates, translation and rotation of axes, invariants, pair of straight lines, general equation of second degree and reduction to standard form, homogeneous and non-homogeneous identification of conic, circles and system of circles, parabola, ellipse, hyperbola | 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Know the concept of different types of functions with set operations. | 3, 4 |
| | CLO2 | Realize the concept of number system | 3, 4 |
| | CLO3 | Describe different types of algebraic series with simple examples | 3, 4 |
| | CLO4 | Identify the roots of polynomial equations. | 3, 4 |
| | CLO 5 | Solve the cubic and bi quadratic equations using different methods. | 3, 4 |
| | CLO 6 | Know the concept of Cartesian and polar co-ordinates | 3, 4 |
| | CLO 7 | Acquire knowledge on straight line, conic, circles and system of circles, parabola, ellipse, and hyperbola. | 3, 4, 7 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Final Examination |
| CLO2 | Lecture and Presentation | Continuous Assessment and Final Examination |
| CLO3 | Lecture and Presentation | Class test and Final Examination |
| CLO4 | Lecture and Group Discussion | Final Examination |
| CLO5 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination |
| CLO6 | Lecture and Presentation | Continuous Assessment and Final Examination |
| CLO7 | Lecture and Group Discussion | Final Examination |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anton, H. (2006). Calculus with Analytic Geometry, 4th Edition, Wiley, New York.<br>Beardon, A. F. (2005). Algebra and geometry. Cambridge University Press. |
| Supplementary Readings | Agarwal, R. S. (1989). Set Theory and Number system, 4th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.<br>Bernard and Child (1936). Higher Algebra, 1st Edition, S.G Wasani for Macmillan India Ltd, New Delhi.<br>Stewart, J. (2003). Single Variable Calculus, Cergage Learning EMEA Brooke/Cole, California.<br>Bhattacharjee, R. (1998). Two and Three dimensional geometry, 10th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. |

| Course Code: 0541 20 Math 1153 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Fundamentals of Calculus | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | Calculus has a widespread use in statistics and led to the development of new areas of mathematical science including real and complex analysis, topology, and non-Euclidean geometry. | | |
| Course Objectives | Introduce the fundamental ideas of the differential and integral calculus of functions of one variable. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Functions, families of functions, inverse functions, inverse trigonometric functions, exponential and logarithmic function | 1 |
| 2 | Limits and Continuity: The Idea of Limits, Definitions of Limits, Techniques for Computing Limits, Infinite Limits, Limits at Infinity, Continuity, Continuity of trigonometric, exponential and inverse functions. | 2, 4 |
| 3 | Derivatives: Introducing the Derivative, Rules of Differentiation, Product and Quotient, Rule, Derivatives of Trigonometric Functions, Chain Rule, Implicit Differentiation, Derivatives of Logarithmic and Exponential Functions, Derivatives of inverse trigonometric Functions, | 3, 5 |
| 4 | Application of the Derivative: Analysis of function, Maxima and Minima, What Derivatives tell us, Graphing Functions, Linear Approximations, Newton's methods, Rolle's Theorem, The Mean Value Theorem, L Hospital's Rule, and Anti-derivatives. | 3, 6 |
| Section B | | CLOs |
| 5 | Integration: Definite and Indefinite Integral, Fundamental Theorem of Calculus, Working with Integrals, Substitution Rule, Working with Integrals, Substitution Rule. | 7 |
| 6 | Application of Integration: Region between Curves, length of plane curve, area volume, surface of revolution. | 8 |
| 7 | Integration Techniques: Integration by Parts, Trigonometric Integrals, Trigonometric, Partial Fractions, Improper Integrals | 9 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Recognize properties of functions and their inverses. | 3, 4 |
| | CLO2 | Recall and use properties of polynomials, functions, rational functions, exponential, logarithmic, trigonometric and inverse trigonometric functions. | 3, 4 |
| | CLO3 | Know the terms domain, range and sketch graphs using function, its first derivative, and the second derivative. | 3, 4 |
| | CLO4 | Use the algebra of limits, and L Hospital's rule to determine limits of simple expressions. | 1, 3, 4 |
| | CLO 5 | Apply the procedures of including implicit and differentiation accurately, logarithmic differentiation. | 1, 3, 4 |
| | CLO 6 | Obtain the linear approximations of functions and to approximate the values of functions. | 3, 4 |
| | CLO 7 | Perform accurately definite and indefinite integration, using parts, substitution, and inverse substitution and apply the procedures for integrating rational functions. | 1, 3, 4 |
| | CLO8 | Carry out accurately improper integrals and calculate the volumes of solid objects, the length of arcs and the surface area. | 3, 4 |
| | CLO9 | Transform polar-to rectangular and rectangular to-polar conversions. | 3, 4 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz, Continuous Assessment and Final Examination. |
| CLO2 | Lecture and Presentation | Continuous Assessment and Final Examination |
| CLO3 | Lecture and Presentation | Class test and Final Examination |
| CLO4 | Lecture and Group Discussion | Final Examination. |
| CLO5 | Lecture | Continuous Assessment and Final Examination |
| CLO6 | Lecture and Presentation | Continuous Assessment and Group discussion |
| CLO7 | Lecture | Quiz, Continuous Assessment and Final Examination |
| CLO8 | Lecture | Quiz, Continuous Assessment and Final Examination |
| CLO9 | Lecture and Presentation | Continuous Assessment, Group discussion and Final Examination |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anton, H. (2006). Calculus with Analytic Geometry, 4th Edition, Wiley, New York.<br>Swokowski, W. E., Olinick, M. and Peuce, D. (2004). Calculus, 6th Edition, Western University, N.Y.<br>Apostol, (1969), Calculus, Vol. I and II, 2nd Edition, John Wiley and Sons, New York. |
| Supplementary Readings | Ayres, F. and Meldelson, E. (1992). Calculus, 3rd Edition, McGraw-Hill, New York.<br>Ayres, F. (1974). Calculus. (Diff. and Int.), 2nd Edition, McGraw-Hill, New York. |

| Course Code: 0311 20 Econ 1155 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Principles of Economics | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | By conducting this course students will be acquainted with a thorough grounding in the basic principles of economics and an exposure to a range of applications of the theory in real world problems. | | |
| Course Objectives | • To provide a self-contained introduction to economics principles.<br>• To develop in students an understanding of fundamental concepts in micro and macroeconomic analysis.<br>• To equip students with a range of appropriate analytical skills including descriptive and graphical methods for solving real world problems. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Definition, nature and scope of economics; Microeconomics versus macroeconomics; Positive versus normative economics; Economic versus free good; Concept of – scarcity, choice, commodity and wealth; Basic economic activities – production, distribution, exchange, consumption; Economic system and its types – capitalistic, socialistic, mixed. | 1, 2 |
| 2 | Demand and Supply Concept: Concept of demand and supply; Law of demand and supply, Determinants of demand and supply; Demand and supply functions, equations, schedules and curves; Movement along and shift of demand and supply curves; Concept of market equilibrium in equation and graph; Various concepts of elasticity; Price, income, cross and supply elasticity; Determination of EP; Different values of EP; Measurement of ES and its value. | 1, 2, 3 |
| 3 | Theory of Production: Concept of production; Factors of production; Short-run and long-run production functions; Total, average and marginal product; Law of variable proportion; Law of diminishing return; Returns to scale; Stages of production; Iso- quant curve, Iso-cost line; Producers' equilibrium; Change in producers' equilibrium due to change in expenditure; Expansion path; Constrained output maximization and constrained cost minimization. | 3, 4 |
| 4 | Market Structure: Definition; Classification of market; Characteristics of perfectly competitive and monopoly markets; Concept of firm and industry; Concept of normal and super-normal profit; Conditions of profit maximization; Determination of short-run and long-run equilibrium of firm and industry under perfectly competitive and monopoly markets; Perfect competition versus monopoly; Concept of optimum production and optimum plant. | 5, 6, 7 |
| | Section B | CLOs |
| 5 | Introduction: Concepts and measurement of – Gross Domestic Product (GDP), Gross National Product (GNP), Net National Product (NNP), National Income (NI), Personal Income (PI), Disposable Income (DI) and per capita income; Nominal and Real GNP; Growth of GNP; GNP as an indicator of economic welfare; Potential and actual GNP; GNP gap; Calculation of Consumer Price Index (CPI), Business cycle; Stabilization policy; Fiscal policy and monetary policy. | 1, 2, 3 |
| 6 | National Income Accounting: Concept of – final good and intermediate good, injection into the economy and withdrawal from the economy, government expenditure, tax and transfer payment; Methods of measuring national income – product, income, expenditure and value-added approach; Problem of double counting; Problems of national income accounting; Importance of national income accounting; Concept of circular flow of income and expenditure in two, three and four sector economy. | 3, 2, 7 |
| 7 | Inflation: Concept of inflation; Measurement of inflation – CPI, PPI, GNP deflator; Types and causes of inflation – cost-push, demand- pull, mixed, stagflation; Cost of inflation; Remedies for inflation; Inflationary and deflationary gap; Measurement and policies to reduce gaps. | 4, 5, 7 |

| | Section B | CLOs |
|---|---|---|
| 8 | Unemployment: Concept of – full-employment, unemployment and natural rate of unemployment; Measurement of unemployment; Types of unemployment – voluntary, involuntary, cyclical, seasonal, frictional, structural and disguised; Socioeconomic cost of unemployment; Remedies to and policies to tackle unemployment. | 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Know the key ideas that define the economic way of thinking as statistician and policy advisers. | 1, 4 |
| | CLO2 | Demonstrate substantial knowledge on fundamental economic question of allocating scarce resources, principles of demand, supply, market price and quantity determination. | 1, 3, 4, 8 |
| | CLO3 | Grasp the knowledge of how consumers make choices and understand the production theory and firm behavior. | 1, 3 |
| | CLO4 | Distinguish between different types of market structure and identify the profit maximizing behavior of a perfectly competitive firm. | 2, 4, 8 |
| | CLO5 | Develop a solid grasp of detailed functioning of monopoly and oligopoly market. | 1, 3, 4 |
| | CLO6 | Explain the measurement of macroeconomic aggregates and realize the functions of money. | 1, 3, 4 |
| | CLO7 | Develop critical knowledge on the issue of external sector of economy, exchange rate and short-run economic fluctuation. | 3, 4, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Assignment and Final Examination. |
| CLO3 | Lecture and Presentation | Assignment and Final Examination. |
| CLO4 | Lecture and Group Discussion | Continuous Assessment, Viva voce and Final Examination. |
| CLO5 | Lecture and Presentation | Quiz and Continuous Assessment |
| CLO6 | Lecture and Group Discussion | Continuous Assessment, Assignment and Final Examination. |
| CLO7 | Lecture and Group Discussion | Continuous Assessment, Assignment and Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Samuelson, P., & Nordhaus, W. (2009). EBOOK: Economics. McGraw Hill.<br>Lipsey, R.G. and Chrystal, K.A., (1995). An Introduction to Positive Economics, Oxford University Press.<br>Lipsey, R. G., & Harbury, C. (1992). First principles of economics. Oxford University Press, USA. |
| Supplementary Readings | Ahuja, H. L. (2004). Modern Microeconomic Theory and Applications, Sultan Chand and Company Ltd., New Delhi.<br>Parkin, M. (2003). Microeconomics, 6th edition, Pearson Education Inc., Australia.<br>Ahuja, H. L. (2017). Modern Microeconomics. S. Chand Publishing.<br>Branson, W. H. (2005). Macroeconomic theory and policy (first East).<br>Mankiw, N. G. (2020). Principles of economics. Cengage Learning.<br>Dwivedi, D. N. (2016). Microeconomics: Theory and Applications. Vikas Publishing House.<br>Henderson, J. M., & Quandt, R. E. (1971). Microeconomic theory: A mathematical approach.<br>Marshall, A., Ghosh R.N. (2010). Principles of Economics. Atlantic Publishers & Distributors (P) Ltd.<br>Taussig, F. W. (2013). Principles of economics (Vol. 2). Cosimo, Inc. |

| Course Code: 0231 20 Eng 1157 | | Year: First | Term: First |
|---|---|---|---|
| Course Title | Communicative English | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to improve the students' English language skills in reading, writing and grammar. These skills are taught, reviewed and reinforced through | | |
| Course Objectives | • Enhance vocabulary and conversational skills.<br>• Develop understanding of grammar terms and four skills i.e. listening, speaking, writing and reading.<br>• Improve the use of grammar, parts of speech, tenses and punctuation.<br>• Use skillfully the dictionary to grasp the meanings of words.<br>• Participate in class discussions. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Communicative Grammar: Article, verbs and tenses, subject-verb agreement, preposition, conditional sentences, affixes, appropriate prepositions and related grammars. | 1, 2, 3 |
| 2 | Writing Skill: Application (mainly regarding academic affairs and to newspaper editions), paragraph, dialogue writing, synonyms and antonyms, research proposal writing, thesis topic introduction and abstract writing. | 2, 4 |
| | Section B | CLOs |
| 3 | Reading Skill: Reading small passages for specific answers, reading passages, related to the majors taken by the students, reading short stories and related grammars. | 1, 4, 5 |
| 4 | Speaking Skill: Asking questions, inviting, agreeing, disagreeing, drawing attention etc. controlled speaking practice: speaking in classroom on prepared topics and related grammars. | 3, 5 |
| 5 | Listening Skill: Listening to social English, listening to small dialogues, from New Headway by Liz and John Soars, Oxford University Press. | 3, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Know and use basic English grammar correctly, Read with better understanding. | 4, 6, 7 |
| | CLO2 | Write coherent paragraphs. Identify and correct a limited set of grammar errors in written texts. | 7 |
| | CLO3 | Communicate by asking questions and answering them with English, argue with others on different topic using English. | 4, 5, 6, 7 |
| | CLO4 | Read English passages correctly and answer small questions. | 7 |
| | CLO5 | Understand the English language dialogues. | 4, 5, 6 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination. |
| CLO3 | Lecture, group discussion and Presentation | Continuous Assessment, Assignment, and viva-voce. |
| CLO4 | Lecture and Presentation | Continuous Assessment, Final Examination. |
| CLO5 | Lecture and Audio& video presentation | Viva voce and Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Maniruzzaman, D. M. (2002). Basic English language skills. Dhaka: Friends Book Corner.<br>Ahmed, S. (2010). Learning English the easy way.<br>Bailey, S. (2014). Academic writing: A handbook for international students. Routledge. |
| Supplementary Readings | Swan, M. (2005). Practical English usage (Vol. 688). Oxford: Oxford university press.<br>McCarter, S., & Ash, J. (2004). IELTS test builder. Macmillan Education.<br>Murphy, R. (1994). Intermediate English Grammar. Cambridge University Press.<br>Langan, J. (2001). College writing skills with readings (p. 800). New York.<br>Salé, É. (2005). Liz Soars, John Soars, New Headway Advanced. Oxford: Oxford University Press, 2003. |

| First Year Second Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 1201 | | Year: First | Term: Second |
| Course Title | Basic Statistics-II | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide some elementary applied statistical concepts and their practical application in science, engineering and business. | | |
| Course Objectives | • Analyze a collection of data and determine whether there appears to be a relationship between the two variables.<br>• Observe whether two measurement variables co-vary, and quantify the strength of the relationship between the variables, whereas regression expresses the relationship in the form of an equation.<br>• Familiar with dichotomous data and association of attributes.<br>• Calculate index number and its application in business data. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Concept of bivariate data, scatter diagram, construction of bivariate table. | 1 |
| 2 | Regression: simple linear regression, least square principle, assumption and properties, principle of minimum perpendicular method, fit regression line, population regression line, and interpretation of regression parameter. | 1, 2 |
| 3 | Correlation- correlation and meaning of correlation, Karl Pearson coefficient of correlation, calculation of correlation coefficient, probable error of correlation coefficient, relation between correlation and regression coefficient, Rank correlation and different types of rank correlation coefficient, correction ratio and its measure, intra class correlation. | 1, 2 |
| 4 | Multiple and partial correlation: Yule's notation, plane of regression, properties of residuals, properties and coefficient of multiple correlations, coefficient of partial correlation. | 2 |
| | Section B | CLOs |
| 5 | Theory of Attributes: Concept, notation and dichotomy. Classes and Frequencies, order of classes and frequencies, relation between class frequencies, class symbols as operators. Consistency of data and its condition. Independency of Attributes, Association of Attributes, Yule's coefficient of association, coefficient of colligation. | 3 |
| 6 | Index Number: Basic concepts, classification, calculation and problem of index number, different types of measures of index number, mathematical test of index number, cost of living index number. | 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Summarize relationships in bivariate data using graphical, tabular, and numerical methods including scatter plots, two-way tables. | 1, 4, 7 |
| | CLO2 | Identify linearity, non-linearity, and outliers, and describe their impact on a simple linear regression model (ordinary least squares) and on the correlation coefficient. | 1, 4, 7 |
| | CLO3 | Familiar with attributes and identify the order of classes and frequencies of attributes, and check the independency of attributes and consistency of data. | 1, 8 |
| | CLO4 | Construct index number and its practical application in economic data. | 1, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Quiz and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO3 | Lecture, and problem solving | Class test and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M. N. (2011). An Introduction to Statistics and Probability, 4th Edition, Mullick & Brothers, Dhaka.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Ahmed, A. R., Bhuiya, A. A., Reza, Z. A. & Hossain, M. Z. (2009). Methods of Statistics. 3rd Edition, Mymensingh, Bangladesh. |
| Supplementary Readings | Roy, M. K. and Paul J. C. (2012). Business Statistics, 1st Edition, Jahangir Press, Dhaka.<br>Islam, M. N. (2021). An Introduction to Business Statistics. 1st edition, Mullick and Brothers, Dhaka |

| Course Code: 0542 20 Stat 1203 | Year: First | Term: Second |
|---|---|---|
| Course Title | Discrete Probability Distributions | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide the concept, use and application of different discrete probability distributions. | |
| Course Objectives | • Understand the meaning of discrete probability distribution.<br>• Introduce new techniques for carrying out probability calculations and identifying probability distributions.<br>• Formulate and evaluate the problems associated with discrete probability distribution. | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Limit Theorems: Laws of large numbers, convergence in probability and convergence in distribution, almost and sure convergence, inversion theorem. | 1 |
| 2 | Univariate Distribution: Probability space, Probability calculus, Bernoulli, Binomial, Poisson, Rectangular, Geometric, Multinomial probability distribution, Truncated Binomial and Poisson distributions. | 1, 2 |
| Section B | | CLOs |
| 3 | Univariate Distribution: Hyper-geometric and Negative Binomial, Logarithmic, beta binomial | 1, 2 |
| 4 | Univariate Distribution: Family of Hyper-geometric, Generalized Negative Binomial, Power series, Family of Hyper-geometric, Negative Hyper-geometric Distribution distributions | 1, 2 |
| 5 | Truncated Distributions: truncated Binomial and Poisson, Bivariate Binomial and Bivariate Poisson distributions. | 1, 2 |

| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| | CLO1 | Point out the probability space and probability calculus with their uses. | 1, 4, 5, 7, 8 |
| | CLO2 | Use discrete probability distributions in different practical situation as well as find different properties of the distribution. | 1, 3, 5, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous Assessment, and Final Examination. |
| CLO2 | Lecture and Presentation | Class test, Assignment and Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Materials | Ross, S.M. (2002). Introduction to Probability Models, 3rd ed, Academic Press, N.Y.<br>Roy, M.K. (2011). Fundamentals of Probability and Probability Distribution, Dhaka, Bangladesh, |
| Supplementary Materials | Arnold J.C. (1995). Introduction to probability and statistics; Principles and Application for Engineering and Computing Sciences, 3rd Ed.<br>Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw-Hill, New York.<br>Devore, J. L. (2002). Probability and Statistics for Engineering and the Science, 6th edition, Duxbury Thompson Learning.<br>Meyer, P. L. (1970). Introductory Probability and Statistical Applications, 2nd edition, Oxford and IBH, New Delhi.<br>Hogg, R. V. and Craig, A. T. (2007). Introduction to Mathematical Statistics, 6th edition, Pearson Education (Singapore) Pte Ltd.<br>Mosteller, F., Rourke, R. E. and Thomas, G. B. (1970). Probability with Statistical Application, 2nd edition, Addison-Wesley, London.<br>Islam, M.N. (2009). An Introduction to Statistics and Probability, Mullick & Brothers, Dhaka. |

| Course Code: 0542 20 Stat 1204 | | Year: First | Term: Second |
|---|---|---|---|
| Course Title | Basic Statistics and Discrete Probability Distributions Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide practical application of applied statistics methods in real data and fit appropriate discrete distribution of that data. | | |
| Course Objectives | • Analyze a collection of data and determine whether there appears to be a relationship between the two variables and find their correlation and also calculate partial correlation.<br>• Show the relationship between correlation coefficient and regression coefficient for real data.<br>• Fit appropriate discrete distribution and establish relationship to others for any discrete data set. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Simple Regression line, Correlation coefficient and interpretation of the result. | 1 |
| 2 | Rank correlation using different types of methods, Multiple and partial correlation. | 2 |
| 3 | Independency of Attributes, Association of Attributes, Yule's coefficient of association, coefficient of colligation. | 3 |
| 4 | Problem of index number using different types of measures of index number, mathematical test of index number, cost of living index number. | 4 |
| 5 | Discrete probability distribution, nature, and shape of the distribution. | 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Fit simple linear regression line and predict the value of one variable based on the value of an associated variable. | 1, 3, 7 |
| | CLO2 | Calculate and interpret the correlation between two variables. | 3, 5, 8 |
| | CLO3 | Check the independency of attributes. | 3, 5 |
| | CLO4 | Construct index number and its practical application in real life data. | 1, 7, 8 |
| | CLO5 | Fit appropriate distribution and comments on the shape of the distribution. | 1, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Quiz and Continuous Assessment. |
| CLO2 | Lecture and Presentation | Continuous Assessment. |
| CLO3 | Lecture and Presentation | Quiz and Continuous Assessment. |
| CLO4 | Lecture and Presentation | Assignment and Continuous Assessment. |
| CLO5 | Lecture and Presentation | Report Assessment and viva voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M. N. (2011). An Introduction to Statistics and Probability, 4th Edition, Mullick & Brothers, Dhaka.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Ross, S. M. (2002). Introduction to Probability Models, 3rded, Academic Press, N.Y.<br>Roy, M. K. (2011). Fundamentals of Probability and Probability Distribution, |

**Learning Materials**

| | |
|---|---|
| Supplementary Readings | Arnold J.C. (1995). Introduction to probability and statistics; Principles and Application for Engineering and Computing Sciences, 3rd Ed.<br>Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw-Hill, New York.<br>Devore, J. L. (2002). Probability and Statistics for Engineering and the Science, 6th edition, Duxbury Thompson Learning.<br>Meyer, P. L. (1970). Introductory Probability and Statistical Applications, 2nd edition, Oxford and IBH, New Delhi. |

| Course Code: 0542 20 Stat 1220 | Year: First | Term: Second |
|---|---|---|
| Course Title | Viva Voce-I | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | The Viva-voce provides an opportunity to express the knowledge that the student(s) gathered during term education. | |
| Course Objectives | • To acquire knowledge and skills to face the interview panel.<br>• To equip the students with analytical and evaluation abilities to o respond to spontaneous questions by the panel members.<br>• To make the students to face the expert panel and present the knowledge, skills and problems in the most efficient way. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | The course contents are related to all courses taught in first year first term and second term for viva-voce preparation. | 1, 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Should be able to demonstrate the application of the knowledge acquired in the term to solve the problems of the various forms. | 1, 2, 3, 4 |
| | CLO2 | Solve the real life problems and assess the implications of various forms of solutions. | 3, 5, 8 |
| | CLO3 | Should be able to make effective presentation of different topics learnt in front to the experts. | 5, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO2 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO3 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | All the recommended books and materials of the first year, first and second terms. |

| Course Code: 0541 20 Math 1251 | | Year: First | Term: Second |
|---|---|---|---|
| Course Title | Advanced Calculus | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide advanced thinking calculus and its application in Statistics. | | |
| Course Objectives | Introduce the advanced ideas of the differential and integral calculus of functions of one variable. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Power Series and Polar Coordinates: Power Series, polynomial approximation, linear and quadratic approximation, Taylor polynomials, approximation with Taylor polynomials, properties of power series, Taylor series of a function, convergence of Taylor series, limits by Taylor series, differentiating power series, integrating power series, defining polar coordinates, converting between cartesian and polar coordinates, basic curves in polar coordinates. | 1, 2 |
| 2 | Functions of Several Variables: Functions of two variables, domain and range, graphs of functions of two variables, functions of more than two variables, limit of a function of two variables, continuity of functions of two variables. | 3 |
| 3 | Derivatives: Introducing the Derivative, Rules of Differentiation, Product and Quotient, Rule, Derivatives of Trigonometric Functions, Chain Rule, Implicit Differentiation, Derivatives of Logarithmic and Exponential Functions, Derivatives of inverse trigonometric Functions, | 4, 5 |
| 4 | Partial Derivatives: Derivatives with two variables, partial derivatives, higher order partial derivatives, functions of three variables, the chain rule with one independent variable, the chain rule with several independent variables, directional derivatives and the gradient, tangent planes, tangent planes for f(x,y,z)= 0, tangent planes for z = f(x,y), linear approximation. local maximum/minimum values, saddle point. | 4 |
| Section B | | CLOs |
| 5 | Vector-Valued Functions: Lines and curves in space vector-valued functions, lines in space, curves in space, calculus of vector-valued functions, tangent vector, orientation of curves: unit tangent vector, integrals of vector-valued functions, length of curves | 6, 9 |
| 6 | Multiple Integration: Double integrals over rectangular regions, double integrals over general regions, double integrals in polar coordinates, triple integrals in rectangular coordinates, changing the order of integration, triple integrals in cylindrical coordinates, green's theorem, surface integrals, stokes' theorem. | 7, 8 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Know the power series, indicating at which points the series converges absolutely/conditionally and application of power series. | 3, 4 |
| | CLO2 | Construct Taylor and Maclaurin series and use these series for approximation of functions and estimate the error. | 3, 4 |
| | CLO3 | Understand and use the concept of a function of several variables, find its domain. | 3, 4 |
| | CLO4 | Apply partial derivatives for finding equations of tangent planes, normal lines, an for extreme values. | 3, 4 |
| | CLO5 | Calculate the local maximum and minimum value from any function. | 3, 4 |
| | CLO6 | Operate with vector functions, find their derivatives and integrals, and find the length. | 3, 4 |
| | CLO7 | Evaluate double integrals in polar coordinates and triple integrals in cylindrical coordinates. | 3, 4 |
| | CLO8 | Apply multiple integrals for computing areas and volumes. | 3, 4 |
| | CLO9 | Use different theorem in vector calculus. | 3, 4 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Continuous Assessment and Final Examination |
| CLO2 | Lecture and Presentation | Assignment and Final Examination |
| CLO3 | Lecture and Presentation | Assignment and Final Examination |
| CLO4 | Lecture and Group Discussion | Continuous Assessment and Final Examination |
| CLO5 | Lecture and Presentation | Assignment and Final Examination |
| CLO6 | Lecture and Presentation | Class test and Final Examination |
| CLO7 | Lecture and Group Discussion | Continuous Assessment and Final Examination |
| CLO8 | Lecture and Presentation | Assignment and Final Examination |
| CLO9 | Lecture and Presentation | Assignment and Final Examination |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Spiegel, M. R. (1974). Advanced Calculus, Schaum's Outline Series, McGraw-Hill, N.Y<br>Anton, H. (2006). Calculus with Analytic Geometry, 4th Edition, Wiley, New York. |
| Supplementary Readings | Burkill, J.C. (1962). A First Course in Mathematical Analysis, C.U.P., London<br>Courant, H. (1988). Differential and Integral Calculus, Vol. II & III, Blackie.<br>Hardy, G.H. (1983). A First Course in Pure Mathematics. C.U.P..<br>London Rudin, W (1976). Real Analysis, Academic Press, N.Y. |

| Course Code: 0541 20 Math 1253 | | Year: First | Term: Second |
|---|---|---|---|
| Course Title | Matrix Algebra in Statistics | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concepts of linear algebra. | | |
| Course Objectives | • Develop the concepts of vector spaces such as independence, basis, dimensions, orthogonality etc.<br>• Identify the different characteristics of matrices.<br>• Solve linear system of equations and study the properties of a linear transformation.<br>• Perform operations with matrices and find the transpose and inverse of a matrix. | | |

| Course Contents | | CLOs |
|---|---|---|
| | Section A | |
| 1 | Vector and Vector Set: Definition of a vector, different types of vectors, length and angle between two vectors, linearly dependent and independent set of vectors, operation with vectors, orthogonal set, normalization, vector dot and cross product. | 1, 2 |
| 2 | Vector Spaces: Vector spaces and sub-spaces and their geometrical interpretation, rank, basis and dimension of vector spaces and sub-spaces, orthogonal and orthogonal basis. | 1, 2, 3 |
| 3 | Matrix and Matrix Operations: Definition of matrix, matrix operations and their properties, different types of matrices: square, identity, scalar, diagonal, null, symmetric, skew-symmetric, orthogonal, unitary, Hermitian, Skew-hermitian, idempotent, nilpotent and involuntary, random, variance-covariance and correlation, product, partitioned matrices, matrix products as linear combinations, transpose of matrix, trace of matrix. | 1, 2, 4 |
| 4 | Determinants and Rank: Properties of determinants, ideas of minors and co-factors, product of determinants, different types of determinants, solution of equations with the help of determinants, evaluation of n×n determinants, rank and elementary transformations of matrices, related theorems of ranks. | 3, 4, 5 |
| | Section B | CLOs |
| 6 | Inverse Matrix: Adjoint, inverse, generalized inverse of matrix, properties of inverse, matrix inequalities and maximization, canonical and normal form of Matrix. | 5, 7 |
| 7 | Quadratic Forms: Definition, classification, rank, index and signature, latent roots and latent vectors of matrices. | 4, 5 |
| 8 | System of Linear Equation: Introduction to systems of linear equations, Different methods - Elementary row operations, Row-reduced echelon form, Cramer's rule, Homogeneous and Non-homogeneous systems. | 4, 5 |
| 9 | Eigen-values and Eigenvectors: Definition of Eigen values and Eigen vectors, characteristic equation, Cayley-Hamilton theorem and its application. | 5, 6, 7 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Test for independence, vector addition, scalar multiplication, inner products, projections, norms. | 1, 4 |
| | CLO2 | Find the dimension and basis of a vector space, orthogonal vectors, spanning sets, subspaces, and rank. | 1, 4 |
| | CLO3 | Determine the rank, determinant and inverse of matrix. | 1, 3 |
| | CLO4 | Decide whether or not a quadratic form is positive definite and further be able to characterize quadric surfaces. | 2, 4 |
| | CLO5 | Solve systems of linear equations. | 1, 3 |
| | CLO6 | Calculate eigenvalues, eigenvectors and determine if a matrix is diagonalizable, and if it is, diagonalize it. | 2, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO3 | Lecture and Presentation | Assignment and Final Examination. |
| CLO4 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination. |
| CLO5 | Lecture and Presentation | Class test, Assignment and Final Examination. |
| CLO6 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Lipschutz, S., & Lipson, M. L. (2013). Schaum's Outline of Linear Algebra. McGraw-Hill Education.<br>Schott, J. R. (2016). Matrix analysis for statistics. John Wiley & Sons.<br>Basilevsky, A. (2013). Applied matrix algebra in the statistical sciences. Courier Dover Publications. |
| Supplementary Readings | Abadir, K. M., & Magnus, J. R. (2005). Matrix algebra (Vol. 1). Cambridge University Press.<br>Rao, C. R., & Rao, M. B. (1998). Matrix algebra and its applications to statistics and econometrics. World Scientific.<br>Harville, D. A. (1998). Matrix algebra from a statistician's perspective.<br>Gentle, J. E. (2007). Matrix algebra. Springer texts in statistics, Springer, New York, NY. |

| Course Code: 0714 20 CSE 1255 | | Year: First | Term: Second |
|---|---|---|---|
| Course Title | Computer Programming | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide basic concepts of computer and programming language and practices in computer. | | |
| Course Objectives | • Develop the basic concept of C Programming Language.<br>• Execute statistical data in C.<br>• Analyze dynamic allocation in C programming.<br>• Understand graphics function and sequential structure of data in C and operate data arithmetically. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Introduction, Importance of C, sample C programs, basic structure of C programs, programming style, executive of C program. | 1, 2 |
| 2 | Basic Loops and functions in programming: Looping structures with for, while, do-while, structures, union, points, strings, dynamic allocation, static, global, external and register, user defined data types, C functions and user defined functions. | 1, 2, 3, 4 |
| Section B | | CLOs |
| 3 | Basic concepts: Concepts, character and file I/O, basics of simple file I/O, ANSI standard libraries, pre-processor with define, include, macro, if def, uses of graphics functions. | 1, 5 |
| 4 | Sequential and Selective structure: Overview, character set, data types, classes of data, arithmetic operations, expressions, assignment statements, input and output, repetitive structure, application of programming in C for statistical computation and relevant topics based on the program. | 2, 4, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Design the basic structure of C programs. | 1, 2, 4,7 |
| | CLO2 | Understand operating in union, points, strings, dynamic allocation as well as apply arithmetic operations, expressions, assignment statements in C. | 1, 2, 4 |
| | CLO3 | Summarize external and register data types in C. | 2, 5 |
| | CLO4 | Write down C functions and user defined functions. | 1, 2, 4, 7 |
| | CLO5 | Familiar with the basic concepts of file I/O, ANSI standard libraries, arithmetic operation in C, and Sequential and Selective structure in C. | 1 |
| | CLO6 | Apply C for statistical computation and relevant topics. | 1, 2, 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination. |
| CLO3 | Lecture, group discussion and Presentation | Continuous Assessment, viva-voce and Final Examination. |
| CLO4 | Lecture, group discussion and Presentation | Continuous Assessment, Assignment, viva-voce and Final Examination. |
| CLO5 | Lecture | Viva voce and Final Examination. |
| CLO6 | Lecture, group discussion and Presentation | Continuous Assessment, Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Balagurusamy, E. (1994). Programming in ANSI C (Vol. 3, p. 4). Tata McGraw-Hill Education, New Delhi.<br>Ritchie, D. M., Johnson, S. C., Lesk, M. E., & Kernighan, B. W. (1978). The C programming language. Bell Sys. Tech. J, 57(6), 1991-2019. |
| Supplementary Readings | Andersen, L. O. (1994). Program analysis and specialization for the C programming language (Doctoral dissertation, University of Copenhagen).<br>Kernighan, B. W., & Ritchie, D. M. (1988). The C programming language. Pearson Education. |

| Course Code: 0714 20 CSE 1256 | Year: First | Term: Second |
|---|---|---|

| | |
|---|---|
| Course Title | Computer Programming Lab |
| Course Status | Core |
| Credit | 1.5 |
| Prerequisite(s) | None |
| Rationale | This course is designed to provide fundamental concepts of Computer programming Lab. |
| Course Objectives | • Develop basic structure of C programs.<br>• Execute different own created functions in C programming and solve different statistical problems. |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Solution of problems using C programming. | 1, 2 |
| 2 | Students will complete at least 2 projects with proper documentation as assigned by the teacher based on computer programming with C | 1, 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Execute different problems using C programming. | 1, 2, 4 |
| | CLO2 | Develop algorithm of different problem and solve it in C programs | 1, 2, 4 |
| | CLO3 | Perform different programming style in C programming. | 1, 2, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation, problem solving | Report Assessment and viva voce |
| CLO2 | Problem solving and group discussion | Assignment and viva voce |
| CLO3 | Lecture and Presentation, relevant problem solving | Report Assessment and viva voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Balagurusamy, E. (1994). Programming in ANSI C (Vol. 3, p. 4). Tata McGraw-Hill Education, New Delhi.<br>Ritchie, D. M., Johnson, S. C., Lesk, M. E., & Kernighan, B. W. (1978). The C programming language. Bell Sys. Tech. J, 57(6), 1991-2019. |
| Supplementary Readings | Andersen, L. O. (1994). Program analysis and specialization for the C programming language (Doctoral dissertation, University of Copenhagen).<br>Kernighan, B. W., & Ritchie, D. M. (1988). The C programming language. Pearson Education. |

| Course Code: 0314 20 Soc 1257 | | Year: First | Term: Second |
|---|---|---|---|
| Course Title | Population Studies | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to afford deep concepts of demography and carry out different demographic techniques to measure population characteristics. | | |
| Course Objectives | • Acquire the fundamentals of demography.<br>• Discern the consequence of demography and perform demographic research.<br>• Estimate present, past and future conditions of people in a particular region as well as whole country.<br>• Identify population behavior in a particular region as well as whole country.<br>• Differentiate age-sex composition, structure and its impact over the country and know the life durability of a country. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Demography: Definition, nature and scope of demography, uses and importance of demography, vital events, demography and population studies, demographic characteristics in Bangladesh, census and survey– definition, vital registration system in Bangladesh, sources of demographic data, methods of demographic data collection, types of errors in demographic data, detection and reduction of errors. | 1, 2, 4 |
| 2 | Rates and Ratio: Rates, ratios, and proportions, concept of population change, population growth, measurement of population growth, cause and consequences of rapid population growth, population dynamics in Bangladesh. | 2, 3 |
| 3 | Age-sex Composition: Statistics on age, age heaping, causes of errors in age data and their detection, age-sex composition, structure and its impact, population pyramid. | 4, 5, 6 |
| Section B | | CLOs |
| 4 | Demographic Measures: Various measures of fertility, mortality, morbidity, marriage and Nuptiality, migration, important determinants of fertility, mortality and all other measures, estimation of mean age of child bearing, adjusted measure of morbidity, infant mortality rate and its components, GRR, NRR, different methods of standardization, stable and Stationary population. | 3, 5, 6 |
| 5 | Life Table: Life table and its uses, current and cohort life table, construction of life table, types of life table, function of life tables, applications of life tables, force of mortality. | 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Unfold the fundamental concepts of demography. | 1, 4, 8 |
| | CLO2 | Describe various features and explain the requirements of demography. | 1, 3, 8 |
| | CLO3 | Provide knowledge about rapid population growth. | 1, 3 |
| | CLO4 | Identify essential thoughts about demographic measures and their consequences. | 3, 4, 8 |
| | CLO5 | Acquaint with why and when we apply mean age of child bearing. | 1, 2, 4, 6 |
| | CLO6 | Make out the needs of the Life tables, their construction and applications. | 1, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO3 | Lecture and Presentation | Continuous Assessment and Final Examination. |
| CLO4 | Lecture and Group Discussion | Viva voce and Final Examination. |
| CLO5 | Lecture and Presentation | Continuous Assessment, Assignment and Final Examination. |
| CLO6 | Lecture and Group Discussion | Viva voce and Final Examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Shryock, H. S., & Siegel, J. S. (1980). The methods and materials of demography (Vol. 2). Department of Commerce, Bureau of the Census.<br>Swanson, D., & J. S. Siegel (2004). The methods and materials of demography. Elsevier Academic Press. |
| Supplementary Readings | Misra, B. D. (1980). An Introduction to the Study of Population, South Asia, New Delhi.<br>Islam, M.N (2017). Introduction to Demographic Techniques. 1st edition, Mullick and Brothers, Dhaka.<br>Pressat, R. (1988). The Dictionary of Demography, Blackwell, UK.<br>Biswas S. (1994). Stochastic Process in Demography and Applications, Wiley Eastern.<br>Swanson, D., & J. S. Siegel (2004). The methods and materials of demography. Elsevier Academic Press |

| Second Year First Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 2100 | | Year: Second | Term: First |
| Course Title | Statistical Package Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to introduce different statistical packages with processing and analyzing data using these packages. | | |
| Course Objectives | • Introduce different statistical packages.<br>• Process, summarize, analyze data using introduced packages and interpret the results. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Introduction to Statistical Package (e.g., SPSS, STATA, Maple etc.), concepts of commands, syntax diagram, running commands in inter-relative mode, sub-commands, values in command specifications, string values in command specifications, delimiters command order, operation commands, data definition and manipulation commands, file management. | 1, 2 |
| 2 | Commonly used procedure commands for data analysis, data read, write, export, import, merge, combining, updating, computing recoding variables, file handling, file transformation, sub-setting, sort cases, add cases and variables, select cases, weight cases. | 2, 3 |
| 3 | Data Analysis-computing descriptive statistics, correlation, regression, comparing group means, analysis of categorical data, demography, graphical representation etc. | 3, 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Understand the layout and interface of statistical packages. | 2, 3, 7 |
| | CLO2 | Describe and explore datasets, compute, recode and transformation of a variable. | 2, 3, 8 |
| | CLO3 | Produce different graphical display of data with statistical package | 2, 3 |
| | CLO4 | Perform simple statistical analyses in statistical package for continuous and categorical variables (descriptive statistics, correlation, linear regression etc.). | 2, 3, 7, 8 |
| | CLO5 | Apply different statistical analysis of real data with the help of command and programming. | 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Assignment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Report assessment, examination and viva-voce |
| CLO5 | Lecture and Presentation | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Whittier, N., Wildhagen, T., & Gold, H. J. (2019). Statistics for social understanding: With stata and SPSS. Rowman & Littlefield.<br>Norusis, M. J. (2012). A Guide SPSS/PC for Data Analysis, SPSS Inc., USA. |
| Supplementary Readings | Afifi, A.A. and Azen, S.P. (1979). Statistical Analysis: A Computer Oriented Approach, 2nd edition, Academic Press, New York.<br>STATA reference manual.<br>Kremelberg, D. (2010). Practical statistics: A quick and easy guide to IBM® SPSS® Statistics, STATA, and other statistical software. SAGE publications.<br>Nair, N. S., Harichandrakumar, K. T., & Ravishankar, N. (2018). Statistical Packages for Data Analysis. Thesis Writing for Master's and Ph. D. Program, 285-294. |

| Course Code: 0542 20 Stat 2101 | | Year: Second | Term: First |
|---|---|---|---|
| Course Title | Continuous Probability Distributions | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide the concept, use and application of different continuous probability distribution. | | |
| Course Objectives | • Understand the meaning of continuous probability distribution.<br>• Introduce techniques for carrying out probability calculations and identifying probability distributions.<br>• Estimate probabilities associated with continuous probability distributions.<br>• Formulate the applications area of different probability distributions. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Univariate Distribution-I: Uniform, Exponential, Normal, Beta, Gamma, Cauchy, Erlang, Log Normal distributions. | 1, 2 |
| Section B | | CLOs |
| 2 | Univariate Distribution-II: Weibull, Inverse Gaussian, Laplace, Gumbell, Maxwell, Pareto and other Exponential Family, Pearsonian System of Curves, truncated and mixture distribution of Normal, Poisson and Binomial, Bivariate Normal Distribution distributions. | 1, 2 |
| 3 | Bivariate distribution: Introduction to basic Bivariate Beta and Gamma distribution. | 1, 2 |
| 4 | Probability convergence and Limit theorem: Convergence in probability and convergence in distribution, almost and sure convergence, law of large numbers, limit theorems. | 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Know the different continuous distributions. | 1, 3 |
| | CLO2 | Use Continuous probability distribution in different practical situation and as well as find different properties of the distribution. | 1, 4, 7, 8 |
| | CLO3 | Recognize the meaning of different types of convergence and can relate it with real situation. | 1, 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Quiz and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, class presentations, and problem solving | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Hogg, R. V. and Craig, A. T. (2002). Introduction of Mathematical Statistics, 5th edition, Pearson Education, Asia.<br>Roy M. K. and Roy D.C. (2014). Fundamentals of Probability and Probability Distributions, 4th edition, Romex publications, Dhaka. |

**Learning Materials**

| | |
|---|---|
| Supplementary Readings | Devore, J. L. (2002). Probability and Statistics for Engineering and Sciences, 5th edition, Thomson Books/Cole, USA.<br>Evans, M., Hasting, N. and Peacock, B. (2000). Statistical Distributions, 3rd edition, Wiley, New York.<br>Johnson, N., Kotz, S. and Kemp, A. (1994). Univariate Discrete Distributions, 2nd edition, John Wiley and Sons, New York.<br>Kendall, M. & Stuart, A, (1979). The Advanced Theory of Statistics, Vol-2, 4th edition, Macmillan Publication Inc. New York.<br>Meyer, P. L. (1970). Introductory Probability and Statistical Applications, 2nd edition, Oxford and IBH, New Delhi.<br>Mood, A. M., Graybill, F. A. and Boes, D. C. (1974). Introduction to the Theory of Statistics, 3rd edition, Tata McGraw-Hill, New Delhi. |

| Course Code: 0542 20 Stat 2103 | | Year: Second | Term: First |
|---|---|---|---|
| Course Title | Sampling Technique-I | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concepts of sampling and practices involved different techniques in taking sample. | | |
| Course Objectives | • Introduce fundamentals of sampling theory.<br>• Identify population characteristics in a specific region.<br>• Determine sample size and estimate population size in a specific region using different sampling techniques.<br>• Perform research-based work in our country. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Basic concepts of sampling, sampling frame, sample survey versus census, steps in sample survey, selection bias, sampling and non-sampling errors, probability and non-probability samples with classification, requirements of a good sample, framework for probability sampling. | 1, 2 |
| 2 | Simple Random Sampling (SRS): Definition, situations, simple random sampling with and without replacement, drawing a simple random sampling, estimation of population characteristics and their standard errors, confidence intervals, sampling for proportions, determination of sample size. | 1, 2 |
| 3 | Stratified Random Sampling: Introduction and principles of stratification, advantages and disadvantages, estimation of population means, total and their variances, allocation of sample size in different strata, relative precision of stratified random sampling with SRS, concept of post-stratification and deep stratification. | 2, 3 |
| | Section B | CLOs |
| 4 | Systematic Sampling: Definition and basic ideas, advantages and disadvantages, estimating population characteristics, comparison with simple random sample and stratified random sampling, comparison of systematic sampling with simple and stratified random sampling. | 4, 5 |
| 5 | Use of Auxiliary Information: Ratio, difference, regression, and product method of estimation of the population parameter, comparison of the different methods. | 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Perform estimation procedures depend on the sample design. Acquainted with the desirable properties of estimates. | 1, 3, 7 |
| | CLO2 | Provide point estimate to population mean and total able to estimate variance of their corresponding estimates. | 3, 4, 5 |
| | CLO3 | Know how to perform SRS, Stratified sampling, Systematic sampling and Auxiliary information estimates. | 3, 7, 8 |
| | CLO4 | Find sample size needed for estimating population mean and population total. | 1, 3, 7, 8 |
| | CLO5 | Be aware of the truth of ratio, regression, product, combine estimates and check the condition to see whether one can use the ratio, regression and other estimates and learn about the biasedness of the ratio estimate via a small population example. | 1, 4, 6, 7, 8 |
| | CLO6 | Determine the optimal allocation of sample sizes and provide estimates for stratified sample for proportion. | 4, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test, quiz and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Quiz, assignment and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Class test and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Class test, quiz, assignment and final examination. |
| CLO6 | Lecture and Group Discussion | Assignment, viva-voce and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Singh, D., & Chaudhary, F. S. (1986). Theory and analysis of sample survey designs. John Wiley & Sons.<br>Cochran, W. G. (1977). Sampling techniques. John Wiley & Sons.<br>Islam, M. N. (2009). An Introduction to Sampling Methods, Book World, Dhaka. |
| Supplementary Readings | Murthy, M. N. (1977). Sampling Methods, 2nd edition, Statistical Publishing Society, Calcutta.<br>Raj, D. and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House, New Delhi.<br>Tryfos, P. (1996). Sampling Methods for Applied Research, John Wiley and Sons, New York. |

| Course Code: 0542 20 Stat 2104 | Year: Second | Term: First |
|---|---|---|
| Course Title | Continuous Probability Distributions and Sampling Technique Lab | |
| Course Status | Core | |
| Credit | 1.5 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to generate random number, fit continuous probability distributions as well as to draw samples and estimate parameters. | |
| Course Objectives | • Generate data associated with different continuous probability.<br>• Calculate mean, variance, standard deviation, proportion, probability for different distributions and perform inferential statistics.<br>• Draw sample using different sampling techniques. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Continuous probability distribution, nature, and shape of the distribution simulating data. | 1,2 |
| 2 | Drawing samples by simple random sampling, stratified sampling, systematic and Auxiliary sampling, estimation of parameters in each case, estimation of variance of estimates, determination of precision of estimates, relative efficiency of different sampling scheme, ratio, difference, regression estimation, estimation for population total, mean, variance and proportion. | 3,4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Simulate statistical data for different continuous distribution and study the pattern of data. | 1, 3, 4, 7 |
| | CLO2 | Compare and contrast different distributions with comments. | 1, 3 |
| | CLO3 | Determine sample size for different sampling techniques and estimate mean, variance, proportions and construct confidence interval. | 1, 2, 3, 5, 8 |
| | CLO4 | Choose appropriate sampling techniques in practical situation | 1, 3, 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Assignment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Roy M. K. and Roy D.C. (2014). Fundamentals of Probability and Probability Distributions, 4th edition, Romex publications, Dhaka.<br>Cochran, W. G. (2002). Sampling Techniques, 4th edition, Wiley Eastern, New Delhi.<br>Islam, M. N. (2009). An Introduction to Sampling Methods, Book World, Dhaka. |
| Supplementary Readings | Johnson, N., Kotz, S. and Kemp, A. (1994). Univariate Discrete Distributions, 2nd edition, John Wiley and Sons, New York.<br>Kendall, M. & Stuart, A, (1979). The Advanced Theory of Statistics, Vol-2, 4th edition, Macmillan Publication Inc. New York.<br>Murthy, M. N. (1977). Sampling Methods, 2nd edition, Statistical Publishing Society, Calcutta.<br>Raj, D. and Chandhok, P. (1998). Sample Survey Theory, Narosa Publishing House, New Delhi. |

| Course Code: 0542 20 Stat 2105 | Year: Second | Term: First |
|---|---|---|
| Course Title | Sampling Distributions | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide basic concepts of sampling distribution and the application in different field of statistical data analysis. | |
| Course Objectives | • Transfer one variable to another variable by different method of transformation.<br>• Describe sampling distribution in terms of "all possible outcomes" and repeated sampling.<br>• Depict the role of sampling | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Concept of sampling distribution and parent distribution, scope and importance of sampling distribution in statistics. Law of large numbers and Central limit theorem. | 1, 2 |
| 2 | Methods: Different methods of finding sampling distribution: analytical method, inductive method, geometrical method, method of using characteristic function, etc. | 2, 3 |
| 3 | Transformation Techniques: Variate transformations with square root, log, sin inverse, fisher's Z transformation, Fisher-Cochran's theorem, their uses and importance. | 1, 2 |
| 4 | Finding Distributions: distribution of sample mean, sample variance, sample covariance, correlation coefficient, regression coefficient, sampling distribution of CDF, distribution of Pearson's lambda. | 3, 4 |
| | Section B | CLOs |
| 5 | Central distribution: Concept of central distribution, scope and important fields of central distribution in statistical analysis. | 1, 5 |
| 6 | t-distribution: Basic concepts of central t-distribution, finding pdf, mean, variance, characteristics function and importance uses in statistics. | 2, 4 |
| 7 | Chi-square distribution: Basic concepts of chi-square distribution, finding pdf, mean, variance, importance properties and applications in statistics. | 1, 2 |
| 8 | F- distribution: Basic concepts and functional form of F-distribution, establish relationship between other distributions, finding different properties importance properties and applications in statistical tests. | 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Explore the concept of random variable and find its appropriate sampling distribution. | 1, 4 |
| | CLO2 | Apply different methods of transformation of variables in various distributions. | 1, 3 |
| | CLO3 | Estimate the sampling distribution of mean, variance, correlation coefficient and regression coefficient. | 1, 3, 5 |
| | CLO4 | Fit and find the characteristics of central distribution. | 3 |
| | CLO5 | Study the shape of central distribution to interpret the nature of statistical data. | 7 |
| | CLO6 | Establish the interrelationship in different central (t, F and chi-square) distributions. | 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Quiz, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Class test, quiz, assignment and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Continuous assessment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO6 | Lecture, and problem solving | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Hogg, R. and A.T. Craig (2002): Introduction to Mathematical Statistics, 8th ed., Pearson Education Asia.<br>Marx, M. L., & R. J. Larsen (2006). Introduction to mathematical statistics and its applications. Pearson/Prentice Hall.<br>Robinson E (1985). Probability Theory and Applications. Springer Science & Business Media. |
| Supplementary Readings | Forbes, C., M. Evans, N. Hastings, & B. Peacock (2011). Statistical distributions. John Wiley & Sons.<br>Wadsworth G.P. and Bryan J.G. (1960). Introduction to Probability and Random Variables. McGraw-Hill.<br>Arnold B.C., Balakrishnan N. and Nagaraja H.N. (2008). A First Course in Order Statistics. Society for Industrial and Applied Mathematics. |

| Course Code: 0542 20 Stat 2107 | | Year: Second | Term: First |
|---|---|---|---|
| Course Title | Order Statistics and Non-central Distribution | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concepts of order statistics and non-central distribution. | | |
| Course Objectives | • Demonstrate general strategies for problems about order statistics.<br>• Explore the application area of order statistics in real life as well as statistical theory.<br>• Depict the role of non-sampling distributions in inferential statistics. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Basic of Order Statistics: Concept of order statistics, joint and marginal distributions of order statistics, distribution of the order statistics, distribution of rth order statistics, distribution of the sample median and the range, illustrations from uniform and exponential parent distribution with example and application, exact moments of order statistics, large-sample approximations to mean and variance the of rth order. | 1, 3, 7 |
| Section B | | CLOs |
| 2 | Relation and Estimation of Order Statistics: Recurrence relations and identities and results for uniform, exponential, logistic, gamma, Weibull and normal distributions, order statistics in estimation-least squares estimation of location and scale parameters by order statistics, estimation of location and scale parameters for censored data. | 2, 4, 5 |
| 3 | Non-central Distribution: Non-central chi-square, F and t distributions, its relationships and applications, distribution of quadratic forms. | 4, 5, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Introduce order statistics and derive the distribution function of the order statistic | 1, 3 |
| | CLO2 | Find out the point estimation for irregular distribution. | 1, 3 |
| | CLO3 | Construct distribution free confidence interval for quantities and distribution free tolerance interval. | 1, 3 |
| | CLO4 | Derive the form of different non-central distribution and its proper application in real life problems. | 4, 3, 8 |
| | CLO5 | Fit and find the characteristics of non-central distribution. | 1, 3 |
| | CLO6 | Study the shape of non-central distribution to interpret the nature of statistical data. | 1, 3 |
| | CLO7 | Establish the interrelationship in different non-central (t, F and chi square) distribution. | 1, 4 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Continuous assessment, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Class test and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO6 | Lecture, and problem solving | Class test, assignment and final examination. |
| CLO7 | Lecture, group discussions, and problem solving | Class test and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | David, H.A. (1980). Order Statistics, 2nd ed., Wiley, N.Y.<br>Mood, A.M., Graybill, F. A. and Bose, D. C. (1974). Introduction to the Theory of Statistics, 3rd edition, McGraw-Hill, New York.<br>Gibbons, J.D. and Chakraborti, S. (1992). Nonparametric Statistic Inference, Marcel Dekker, Inc., USA. |
| Supplementary Readings | Arnold, B.C., Balakrishnan, N. and Nagaraja, H.N. (2008). First Cour in Order Statistics, John Wiley and Sons, New York.<br>Balakrishnan, N. and Cohen, A.C. (2004). Order Statistics and Inference Estimation Methods, Academy Press Inc., London.<br>Hogg, R. V., Mckean, A.J. and Craig, A.T. (2007). Introduction Mathematical Statistics, 6th Edition, Pearson Education Pte. Ltd. Singapore.<br>Rohatgi V.K. and Saleh, A.K.M.E. (2001). An Introduction to Probability and Statistics, John Wiley and Sons Inc., New York. |

| Course Code: 0541 20 Math 2151 | | Year: Second | Term: First |
|---|---|---|---|
| Course Title | Differential Equation | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | The course differential equation can be describing as the study of equations involving derivatives and the study of anything that changes. This course also designs to be studied qualitatively, determining general properties of solution without concern for exact behavior. | | |
| Course Objectives | • Use analytic techniques to compute solutions to various differential equations.<br>• Apply analytic and qualitative techniques to understand the behavior of solutions to various differential equations.<br>• Understand the mathematical foundations of the technique we study and why they are valid. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Differential equation and their solutions: Definition and Classification, Origin and application of differential equation, solutions of differential equations, initial-value and boundary-value problems, existence of solutions. | 1, 2 |
| 2 | First order equation: standard forms of first order difference equations, exact differential equation and their solutions by different methods. Integrating factor. Separable equations, homogeneous equations, linear equation, Bernoulli equations, special integrating factors and transformation. | 2, 3 |
| 3 | Application of first order equations: Orthogonal and oblique trajectories, different procedure of finding Orthogonal and oblique trajectories. | 1, 2 |
| | Section B | CLOs |
| 4 | Higher order differential equations: Definition and basic existence theorem, reduction of order, Homogeneous: distinct real roots, Homogeneous equations: repeated and conjugate complex roots, non-homogeneous equations, Undetermined coefficients, Variation of parameters, The Cauchy–Euler equation, application. | 1, 5 |
| 5 | System of differential equation: types of linear system, differential operators, operator methods for linear system with constant coefficients and applications, matrix methods for linear system with constant coefficients and applications. | 2, 4 |
| 6 | Laplace Transformation: Definition, existence and general properties of the Laplace transform, inverse transforms and convolution, Laplace transforms solution of linear system. | 1, 2, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Understand basic concept, classification, origin and application of differential equation. | 1, 4 |
| | CLO2 | Find the solution of initial value and boundary value problem. | 1, 3 |
| | CLO3 | Solve first order differential equation by different methods | 1, 3 |
| | CLO4 | Apply first order differential equation in real life problem. | 3, 5 |
| | CLO5 | Extend first order differential equation into higher order differential equation and solve these problems by different methods. | 4 |
| | CLO6 | Use Laplace transformation and inverse transformation and solve the system of equation. | 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO3 | Lecture, and problem solving | Class test and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Continuous assessment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO6 | Lecture, and problem solving | Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Ross, S. L. (2007). Differential equations. John Wiley & Sons.<br>Ayres, F. (1997). Differential Equations, Schaum's Outline Series, McGraw-Hill, NY.<br>Boelkins, M.R.J.L., Goldberg & Potter M.C. (2009). Differential equations with linear algebra. Oxford University Press USA. |
| Supplementary Readings | Zwillinger, D., &Dobrushkin, V. (1998). Handbook of differential equations. Chapman and Hall/CRC.<br>Renardy, M., & Rogers, R. C. (2006). An introduction to partial differential equations (Vol. 13). Springer Science & Business Media.<br>Goodge, S.M. (2000). Differential Equations and Linear Algebra, Prentice Hall, N.J., USA. |

| Course Code: 0311 20 Econ 2153 | Year: Second | Term: First |
|---|---|---|
| Course Title | Economic Statistics | |
| Course Status | Core | |
| Credit | 2.0 | |
| Prerequisite(s) | None | |
| Rationale | Since understanding economic statistics is central for statisticians, economists and policy makers, this course are highly essential in the study of Statistics. It is designed to introduce the main concepts used by statisticians and economists to measure and interpret economic phenomena with relevant data. | |
| Course Objectives | • Develop in students an understanding of basic concepts related to economic statistics.<br>• Equip students with a range of appropriate analytical and statistical skills for interpreting economic statistics. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Basic idea of economic statistics, its application and nature, demand for economic statistics. | 1, 2 |
| 2 | National Income Accounting: Concepts and measurement of Gross Domestic Product (GDP), Gross National Product (GNP), Net National Product (NNP), National Income (NI), Personal Income (PI), Disposable Income (DI), per capita income. Calculation of Consumer Price Index (CPI), inflation, unemployment, balance of payment, balance of trade, exchange rate. | 1, 2 |
| 3 | Analysis of Family Budget: Consumer's survey, limitation of budget surveys, the use of group means, the Engel curve and Engel law, quality variation and household composition, Pigous method for family budget data. | 2, 3 |
| 4 | Input Output Analysis: Basic idea regarding inter-industry relationship; Concept of intermediate and final demand; Mathematical presentation of the model; Input co-efficient matrix; Technology matrix; Solution for appropriate levels of output / final demand and labor requirement; Hawkins-Simon condition and its economic implication | 3, 4 |
| | Section B | CLOs |
| 5 | Development Issues: Measurement and comparability of per capita income as an index of development, Human Development Index (HDI), Measurement of HDI, OECD Better Life Index, Food Security Index. | 3, 5 |
| 6 | Poverty and Inequality: Concept of poverty, poverty line, measurement of poverty, Multidimensional Poverty Index and its measurement, concept of economic inequality, curves of concentration, Lorenz curve, concentration ratio, Gini coefficient, Kuznet's hypothesis. | 3, 4 |
| 7 | Producer of Economic Statistics: International statistical system, OECD statistical system, Bangladesh Bureau of Statistics: National accounts, household income expenditure survey, Demography and health survey, labor force survey, agriculture and fisheries statistics, energy statistics, industry and service statistics, monetary and financial statistics, Assessing the quality of economic statistics. | 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Explain the measurement of macroeconomic aggregates, recent trends in macroeconomic variables and issues. | 1, 2, 3, 7 |
| | CLO2 | Demonstrate the ability to apply fundamental concepts in exploratory data analysis. | 2, 3, 5, 8 |
| | CLO3 | Apply correctly a variety of statistical techniques, both descriptive and inferential way in explaining economic data. | 2, 3, 5 |
| | CLO4 | Analyze and interpret the formulation of different indices related to economics. | 1, 2, 3, 7, 8 |
| | CLO5 | Understand the general procedure of surveying economic data. | 1, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Quiz and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Continuous assessment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Todaro, M. P. and Smith, S. C. (2007). Economic Development, 8th edition, Pearson Education, India.<br>Parkin, M (2003). Microeconomics, 6th edition, Pearson Education Inc., Australia. |
| Supplementary Readings | Mankiw, N. G. (2001). Principles of Microeconomics, Latest edition, Worth Publication.<br>Samuelson, P. A. and Nordhaus, W. D. (2001). Economics, 17th edition, McGraw-Hill, New York.<br>Allen, R. G. D. (1959). Mathematical economics.London: Macmillan. |

| Second Year Second Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 2200 | | Year: Second | Term: Second |
| Course Title | Computing in Statistics Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | The aim of this course is to provide an introduction to statistical software for performing the theoretical and practical analyses in a computer-aided platform. | | |
| Course Objectives | • Introduce different statistical software.<br>• Conduct differential statistics and perform inferential statistics.<br>• Perform database conversion in different formats.<br>• Process, summarize, analyze data using introduced software and interpret the results. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Statistical Software: Introduction to statistical software (e.g., R, MATLAB, Python, etc.), basic operations, list and data frames, grouping, loops and conditional execution, functions, statistical models, fitting distributions, reading from a text file. | 1, 2 |
| 2 | Calculating Probability: Random sampling, probability calculations, discrete and continuous distributions, densities, cumulative distributions, quantiles, random numbers, descriptive statistics and graphics, summary statistics for a single group, graphical display distributions-histograms, and empirical cumulative distributions. | 2, 3 |
| 3 | Drawing Statistical graphs: Q-Q plots, box plots, summary statistics by groups, graphs for grouped data, generating tables, graphics for grouped data, generating tables, graphics for grouped tables, and graphical display for tables (bar plot, dot plot, and pie chart). | 3, 4, 5 |
| 4 | Correlation and regression: Simple and multiple linear regressions residuals, and fitted values, prediction, and confidence bands, basic test: t-test, z-test, chi-square test etc. | 2, 4, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Evaluate data types and their relative parameters. | 1, 2, 3, 7 |
| | CLO2 | Perform statistical analysis with the computer application. | 2, 3, 5, 8 |
| | CLO3 | Deal with large scale database and infer decision from the data and analyses. | 2, 3, 5 |
| | CLO4 | Construct model with dependent and independent variables. | 1, 2, 3, 7, 8 |
| | CLO5 | Create loops, density functions, and statistical models. | 1, 6, 7, 8 |
| | CLO6 | Display statistical graphs, tables, and analyze correlation, regression. | 1, 3, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Continuous assessment, assignment and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Quiz and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO6 | Lecture, and problem solving | Quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Tattar, P. N. (2017). Statistical Application Development with R and Python. Packt Publishing Ltd.<br>Zhang, N. (2020). A Tour of Data Science: Learn R and Python in Parallel. Chapman and Hall/CRC.<br>Agresti, A., & Kateri, M. (2021). Foundations of Statistics for Data Scientists: With R and Python. Chapman and Hall/CRC. |
| Supplementary Readings | Agresti, A., & Kateri, M. (2021). Foundations of Statistics for Data Scientists: With R and Python. Chapman and Hall/CRC.<br>https://www.w3schools.com/ai/default.asp<br>https://www.w3schools.com/python/default.asp<br>Whittier, N., Wildhagen, T., & Gold, H. J. (2019). Statistics for social understanding: With Stata and SPSS. Rowman & Little field. |

| Course Code: 0542 20 Stat 2201 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Statistical Inference-I | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This lesson is designed to afford fundamental concepts of statistical inference and carry out different statistical inference methods to infer sample as well as population phenomena. | |
| Course Objectives | • Introduce to basic idea about statistical inference for concluding different statistical problems.<br>• Estimate large and small intervals for accuracy measurement of statistical tools and make out rudiments of Bayes estimator.<br>• Formulate hypothesis test for different statistic and execute proper inference in practical field. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Concept of inference, parameter space, concept of estimation, estimate and estimator, point and interval estimations and testing of hypothesis, basic concepts of point estimation, principles of point estimation. | 1, 2 |
| 2 | Characteristics of Point Estimators: criteria of good estimator, unbiasedness, consistency, sufficiency-completeness, Factorization theorem on sufficient statistic, invariance property of sufficient estimator, Fisher-Neyman criterion on sufficient estimator and their application, efficiency, problems and examples. | 2, 3 |
| 3 | Method of Point Estimation: Method of maximum likelihood estimation (MLE), method of moments, method of least squares, method of minimum chi-squares, method of minimum variance and their properties and related theorem, problems and examples. | 1, 2 |
| | Section B | CLOs |
| 4 | Test of Significance: Concept and preliminaries, statistical hypothesis-simple and composite hypothesis, test of a statistical hypothesis, null and alternative hypotheses, Type I and Type II error, acceptance and critical region, standard error, test procedures, P-value, level of significance, test of single mean, equality of two mean and equality of several mean, test of significance of variance, equality of two variance and several variances, test of proportions, test for correlation and regression coefficients, association of attribute, test for independence and association of attributes for and contingency tables, Fishers exact test, test for association in three - way contingency tables. | 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Narrate the fundamental concepts of inference. | 4 |
| | CLO2 | Describe various feature of point estimator and its requirements in real life. | 1, 3 |
| | CLO3 | Articulate idea of point estimation, their properties, problems and examples. | 1, 3, 5 |
| | CLO4 | Understand the basic concept of statistical hypothesis | 2 |
| | CLO5 | Carry out the testing procedure of different statistic that's help to know the population characteristics. | 1 |
| | CLO6 | Test the independence and association of attribute. | 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO3 | Lecture, and problem solving | Quiz and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO6 | Lecture, and problem solving | Class test and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall. |
| Supplementary Readings | Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Mood, A. M., F. A. Graybill, and D. C. Boes (1994). Introduction to the theory of statistics. 5th edition, McGraw Hill, N.Y.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY. |

| Course Code: 0542 20 Stat 2203 | | Year: Second | Term: Second |
|---|---|---|---|
| Course Title | Regression Analysis-I | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is oriented to provide basic concept of regression analysis and fit different statistical models to real life data. | | |
| Course Objectives | • Ensure the students to have a concrete understanding of the probability and statistical foundations of Regression Analysis.<br>• Acquaint students with Least Square methods and concept of linear regression, correlation and its applications.<br>• Introduce the linear regression model, and explore its numerical and statistical properties.<br>• Discuss briefly the range of problems that arises in the analysis of real-life data. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Definition, nature and types of regression analysis, model assumptions, population regression line, non-linear model, least square estimator, precision of the estimated regression model, examining regression equation, | 1 |
| 2 | Multiple Regression Models: multiple linear regression, regression model in matrix notation, model assumptions, ordinary least square (OLS) method, estimation of the model parameters, properties of OLS estimators, the "extra sum of squares" principle, properties of errors estimation with restriction, restricted least squares, hypothesis testing in multiple linear regression. | 1, 2 |
| 3 | Model Adequacy Checking: Introduction, residual Analysis, lack of fit of the regression model and pure error. | 1, 3, 4 |
| 4 | Polynomial Regression Models: Introduction, polynomial regression models, polynomial models in one variable, polynomial model in two or more variables, orthogonal polynomials, confidence interval and testing hypothesis. | 2, 3, 4, 5 |
| | Section B | CLOs |
| 5 | Transformations and Weighting to Correct Model Inadequacies: General regression models for k variable, generalized least squares (GLS) and weighted least squares (WLS), | 3, 4 |
| 6 | Variable Selection and Model Building: Introduction, model-building problem, criteria for evaluating subset regression models, uses of regression and model evaluation criteria, computational techniques for variable selection, strategy for variable selection and model building. | 3, 5 |
| 7 | Dummy Independent Variables: Introduction, regression with dummy independent variables, examples of dummy independent variables in regression models. | 4, 5 |
| 8 | Ridge Regression: Ridge regression and latent root regressions, Properties of Ridge regression and latent root regressions, methods of estimation of parameter of ridge regression and latent root regressions. | 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Understand the method and concept of simple and multiple regression. | 1, 3, 4 |
| | CLO2 | Derive and explain the statistical properties of the OLS estimator under the standard classical regression assumptions. | 1, 3, 4, 7 |
| | CLO3 | Investigate the limitation of OLS estimation and apply the advanced technique. | 1, 3, 5, 8 |
| | CLO4 | Diagnose and apply corrections to some problems with the regression model found in real data. | 1, 3, 4, 7, 8 |
| | CLO5 | Identify the significant variables and select the best model. | 1, 3, 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, and class presentations. | Class test, assignment and final examination. |
| CLO2 | Lecture | Assignment and final examination. |
| CLO3 | Lecture, group discussions, and class presentations. | Quiz, assignment and final examination. |
| CLO4 | Lecture. | Assignment and final examination. |
| CLO5 | Lecture, and class presentations. | Class test, Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to linear regression analysis. John Wiley & Sons.<br>Draper, N. R., & Smith, H. (1998). Applied regression analysis (Vol. 326). John Wiley & Sons. |
| Supplementary Readings | Sykes, A. O. (1993). An introduction to regression analysis. The University of Chicago Law School (pp. 1-50). Law and Economics Working Papers.<br>Chatterjee, S., & Hadi, A. S. (2006). Regression analysis by example. John Wiley & Sons.<br>Neter, J., Wasserman, W., & Kutner, M. H. (1990). Applied statistical linear models. Irwin, New York. |

| Course Code: 0542 20 Stat 2204 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Statistical Inference and Regression Analysis-I Lab | |
| Course Status | Core | |
| Credit | 1.5 | |
| Prerequisite(s) | None | |
| Rationale | This lab course helps the students to analysis the inter-correlated socio-economic data and draws a valid inference on different population parameters based on sample observations. | |
| Course Objectives | • Analyze data both manually and using software.<br>• Formulate Hypothesis and find necessary calculation.<br>• Establish the relationship between dependent and independent variables and assess the impact of independent variables on dependent variables. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Unbiasedness, consistency, sufficiency, efficiency related problems, different method of point estimation techniques related problems such as MLE, method of moments, method of least squares, method of minimum chi-squares, method of minimum variance, Calculation of Type I and Type II error, acceptance and critical region, test of mean(s), variance(s), proportion(s), correlation coefficient(s) and regression coefficients. Test for independence and association of attributes for contingency tables. | 1, 2, 3 |
| 2 | Calculation of, regression coefficient, fitting of multiple regression model, separation of effects and tests of hypothesis, fitting of polynomial and analysis of residuals and test for lack of fit, examination of residuals, Dummy variable regression. | 3, 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Find out unbiasedness, consistency, sufficiency, efficiency from data set. | 1, 3, 4 |
| | CLO2 | Calculate MLE, method of moments, method of least squares etc. | 1, 2, 5 |
| | CLO3 | Construct hypothesis for particular parameters and Understand P-value, critical region and other test. | 1, 3, 4, 7 |
| | CLO4 | Determine correlation coefficient, regression coefficient and interpret the result. | 1, 2, 5 |
| | CLO5 | Identify the best model fit and test the significance. | 3, 4 |
| | CLO6 | Use an appropriate software tool for data summary and data analysis. | 1, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Assignment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Assignment and viva-voce |
| CLO5 | Lecture and Presentation | Viva-voce |
| CLO6 | Lecture and Presentation and problem solving | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall.<br>Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to linear regression analysis. John Wiley & Sons.<br>Draper, N. R., & Smith, H. (1998). Applied regression analysis (Vol. 326). John Wiley & Sons. |
| Supplementary Readings | Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Mood, A. M., F. A. Graybill, and D. C. Boes (1994). Introduction to the theory of statistics. 5th edition, McGraw Hill, N.Y.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY.<br>Sykes, A. O. (1993). An introduction to regression analysis. The University of Chicago Law School (pp. 1-50). Law and Economics Working Papers.<br>Chatterjee, S., & Hadi, A. S. (2006). Regression analysis by example. John Wiley & Sons.<br>Neter, J., Wasserman, W., & Kutner, M. H. (1990). Applied statistical linear models. Irwin, New York. |

| Course Code: 0542 20 Stat 2205 | | Year: Second | Term: Second |
|---|---|---|---|
| Course Title | Analysis of Variance | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course provides a gentle introduction to comparing a set of alternatives using the ANOVA technique. | | |
| Course Objectives | • Understand basic concept of experimental designs and ANOVA techniques.<br>• Analyze data from different experiments and make valid inferences.<br>• Extend the analysis of variance by examining ways of making comparisons within a set of means. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Basic concepts: Definition, basic principle of experimental design, requirements of good experiments, non-experimental design and different classifications of ANOVA. | 1 |
| 2 | Linear models: Linear models in one-way, two-way and three-way classification of data. | 2 |
| 3 | Analysis of variance: Analysis of variance in one-way, two-way and three-way classification with equal and unequal number of observations per cell; analysis of variance with fixed effects, mixed effects and random effects model. | 1, 2, 5 |
| Section B | | CLOs |
| 6 | Standard Design: Introduction, analysis of completely randomized design (CRD), Randomized block design (RBD). Latin square design (LSD). | 1, 5 |
| 4 | Orthogonally of Design and Missing Values: Introduction, missing data in RBD and LSD. | 3, 5 |
| 5 | Multiple Comparisons: Concept and procedure of multiple comparison tests, Fishers LSD methods, Duncan's multiple range test, Neyman-Keul's test, Tuckey's test. | 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Introduce the basic concept and purpose of different classifications of ANOVA, experimental designs (CRD, RBD, and LSD) and its analysis procedure. | 1, 2, 3, 4, 8 |
| | CLO2 | Recognize linear models of different classifications of ANOVA and differentiate orthogonal design and non-orthogonal design. | 1, 2, 3, 4 |
| | CLO3 | Find out the data analysis procedure one-way and two-way classification with missing values in RBD and LSD. | 1, 3, 8 |
| | CLO4 | Understand the concept and application of different multiple comparisons test such as LSD, DMRT, Tuckey's test etc. | 1, 2, 3, 4, 8 |
| | CLO5 | Apply this knowledge in real-life problem for different agricultural and non-agricultural field. | 2, 3 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and class presentations. | Class test, assignment and final examination. |
| CLO2 | Lecture and class presentations. | Assignment and final examination. |
| CLO3 | Lecture and class presentations. | Assignment and final examination. |
| CLO4 | Lecture, group discussions, and class presentations. | Class test, assignment and final examination. |
| CLO5 | Lecture, group discussions, and class presentations. | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi.<br>Bhuiyan, M. R. (2011). Fundamentals of Experimental Design, 2nd edition, Mullick & Brothers, Dhaka. |
| Supplementary Readings | Das, M. N. and Giri, N. C. (1997). Design and Analysis of Experiments, 2nd edition, New Age International (P) Ltd., India.<br>Federer, W. T. (1967). Experimental Design: Theory and Application, Oxford and IBH, New Delhi.<br>Gomez, K.A. and A.A. Gomez, (1984). Statistical procedures for agricultural research (2 ed.). John wiley and sons, NewYork,<br>K.C. Bhuiyan, (2006). Experimental Design and Analysis of Variance, Vol.1 & 2, Bangla Academy.<br>Scheffe, H. (1997). Analysis of Variance, Wiley, N.Y.<br>Yates, F. (2001). Design and Analysis of Factorial Experiments, Harpenden, Herts, England. |

| Course Code: 0542 20 Stat 2207 | Year: Second | Term: Second |
|---|---|---|

| | |
|---|---|
| Course Title | Time Series Analysis |
| Course Status | Core |
| Credit | 3.0 |
| Prerequisite(s) | None |
| Rationale | This course is designed to introduce a variety of statistical models for time series and cover the main methods for analyzing these models. |
| Course Objectives | • Appreciate the important features that describe a time series, and perform simple analyses and computations on series.<br>• Understand the definitions of the important stochastic processes used in time series modeling, and the properties of those models.<br>• Appreciate and apply key concepts of estimation and forecasting in a time series context. |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Meaning of time series, objectives and importance of time series analysis, examples of time series from various fields, components of a times series, additive and multiplicative models, First order, second order and p-th order difference equation, and their solution, lag operator. | 1, 2, 3, 4 |
| 2 | Components of time series analysis: Estimation of trend by linear filtering (simple and weighted moving averages) and curve fitting (polynomial, exponential and Gompertz), de-trending, estimation of seasonal component by ratio to moving-average method, ratio to trend method, link relative method, depersonalization, measurement of seasonal, cyclical and trend component, basic of stationary process, weak stationary, autocorrelation function and correlogram, prediogram, co-integration. | 5, 6, 7 |
| | Section B | CLOs |
| 3 | Stationary Process: Expectations, stationary, ergodicity and white noise, Moving-average (MA) process and Autoregressive (AR) process of orders one and two, estimation of the parameters of AR(1) and AR(2) – Yule-Walker equations, ARMA (p, q) process, ACF and PACF of ARMA (p, q) process, properties of sample mean and autocorrelation function of ARMA model, maximum likelihood function of Gaussian AR, MA, ARMA and their estimation. | 2, 3, 4 |
| 4 | Forecasting: Basic concept of forecasting, objective, step and methods of forecasting, basic forecasting tools, exponential smoothing method of forecasting, principle of forecasting, forecasting based on finite and infinite number of observations, forecasting stationary time series, diagnostic checking and forecasting of ARMA model (Wald's decomposition and Box-Jenkins modeling philosophy), ARAR algorithm, Holt-Winters algorithm, choosing a forecasting algorithm. | 3, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Introduce time series data and their applications. | 1, 4, 6, 8 |
| | CLO2 | Find out different variation in time series data. | 1, 3 |
| | CLO3 | Estimate different components of time series analysis by using linear and non-linear approaches. | 1, 3, 5, 7 |
| | CLO4 | Compute and interpret a correlogram, AR(p), MA(q) model, ACF, PACF. | 3, 6, 8 |
| | CLO5 | Identify ergodicity and white noise of time series data. | 1, 3, 5, 7, 8 |
| | CLO6 | Forecast time series data with different techniques. | 4, 5, 7 |
| | CLO7 | Perform diagnostic checking and forecasting of ARMA model. | 1, 3, 5, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and class presentations. | Class test, quiz, assignment and final examination. |
| CLO2 | Lecture and class presentations. | Class test, assignment and final examination. |
| CLO3 | Lecture and class presentations. | Class test, assignment and final examination. |
| CLO4 | Lecture and class presentations. | Class test, quiz, assignment and final examination. |
| CLO5 | Lecture, group discussions, and class presentations. | Assignment, viva-voce and final examination. |
| CLO6 | Lecture, group discussions, and class presentations. | Class test, quiz, assignment and final examination. |
| CLO7 | Lecture, group discussions, and class presentations. | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Hamilton, J. D. (1994). Time Series Analysis, Princeton University Press, New Jersey.<br>Diebold, F. X. (2004). Elements of Forecasting, 3rd edition, Rahul Print O Pack, India.<br>Gujrati, D. (2003). Basic Econometrics 4th Ed, McGraw-Hill, New York. |
| Supplementary Readings | Chatfield C. (1975). The Analysis of Time Series: An Introduction, Sixth Edition. Chapman & Hall/CRC Texts in Statistical Science.<br>Brockwell, P. J. and Davis, R. A. (2002). Introduction to Time Series and Forecasting, Springer, New York.<br>Box, G., Jenkins, G. M. and Reinsel, G. (2008). Time Series Analysis: Forecasting and Control, 3rd edition, Wiley, New York. |

| Course Code: 0542 20 Stat 2208 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Analysis of Variance and Time Series Analysis Lab | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to explore the application of Analysis of Variance and a variety of statistical models for time series in practical life. | |
| Course Objectives | • Analyze data from different experiments and make valid inferences:<br>• Understand the definitions of the important stochastic processes used in time series modeling, and the properties of those models.<br>• Appreciate and apply key concepts of estimation and forecasting in a time series context. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Analyze one way, two way and three-way classified data, Analysis data with respect to completely randomized design (CRD), Randomized block design (RBD). Latin square design (LSD), Analyze data with missing values in RBD and LSD. Fisher's LSD methods, Duncan's multiple range test, Tuckey's test for multiple comparisons test. | 1, 2, 5, 6 |
| 2 | Different methods of finding trends, measurement of secular trend, seasonal variation, cyclical movement and irregular components, simple timer series models, stationary models and the autocorrelation function, estimation and elimination of trend and seasonal components, fitting AR, MA, ARMA models, estimation of parameters, diagnostic checking, forecasting and prediction by different technique. | 1, 2, 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Perform ANOVA and make valid inference for different model. | 1, 4, 5, 6, 8 |
| | CLO2 | Apply the different multiple comparisons test and make a valid inference. | 1, 3, 6, 8, 7 |
| | CLO3 | Know how to Work with additive and multiplicative model of different order. | 1, 2, 3, 5, 8 |
| | CLO4 | Find out different variation in time series data. | 1, 3, 4, 5, 7 |
| | CLO5 | Identify a non-stationary time series data. | 2, 3, 5, 7, 8 |
| | CLO6 | Forecast time series data. | 1, 3, 4, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment/Quiz and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Assignment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Assignment and viva-voce |
| CLO5 | Lecture and Presentation | Report assessment and viva-voce |
| CLO6 | Lecture and Group Discussion | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Hamilton, J. D. (1994). Time Series Analysis, Princeton University Press, New Jersey.<br>Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Bhuiyan, M. R. (2011). Fundamentals of Experimental Design, 2nd edition, Mullick & Brothers, Dhaka. |

| | |
|---|---|
| Supplementary Readings | Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi.<br>Diebold, F. X. (2004). Elements of Forecasting, 3rd edition, Rahul Print O Pack, India.<br>Das, M. N. and Giri, N. C. (1997). Design and Analysis of Experiments, 2nd edition, New Age International (P) Ltd., India.<br>Chatfield C. (1975).The Analysis of Time Series: An Introduction, Sixth Edition. Chapman & Hall/CRC Texts in Statistical Science.<br>Brockwell, P. J. and Davis, R. A. (2002). Introduction to Time Series and Forecasting, Springer, New York.<br>Box, G., Jenkins, G. M. and Reinsel, G. (2008). Time Series Analysis: Forecasting and Control, 3rd edition, Wiley, New York. |

| Course Code: 0542 20 Stat 2220 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Viva Voce-II | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | The Viva-voce provides an opportunity to express the knowledge that the student(s) gathered during term education. | |
| Course Objectives | • To acquire knowledge and skills to face the interview panel.<br>• To equip the students with analytical and evaluation abilities to o respond to spontaneous questions by the panel members.<br>• To make the students to face the expert panel and present the knowledge, skills and problems in the most efficient way. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | The course contents are related to all courses taught in second year first term and second term for viva-voce preparation. | 1, 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Should be able to demonstrate the application of the knowledge acquired in the term to solve the problems of the various forms. | 1, 2, 3, 4 |
| | CLO2 | Solve the real-life problems and assess the implications of various forms of solutions. | 3, 5, 8 |
| | CLO3 | Should be able to make effective presentation of different topics learnt in front to the experts. | 5, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO2 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO3 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | All the recommended books and materials of the second year, first and second terms. |

| Course Code: 0541 20 Math 2251 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Numerical Analysis | |
| Course Status | Core | |
| Credit | 2.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide fundamental concepts of numerical analysis and simulation. | |
| Course Objectives | • Understand the basic numerical techniques with the underlying mathematical notions,<br>• Interpret the reliability of numerical results.<br>• Provide users with practical feedback when designing real world systems and allow the designer to determine the correctness and efficiency of a design before the system is actually constructed. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Solution of Equation in One Variable: Bisection method, method of False Position, Newton-Rapson method, method of iteration, difference of polynomials, | 1, 2 |
| 2 | Interpolation and Extrapolation: Different Operators, Concept of interpolation and Extrapolation, Newton's interpolation formula (forward and backward). | 1, 2, 3 |
| 3 | Central Difference Formula: Gauss formula, Stirling's formula and Bessel's formula, interpolation with unequal intervals, divided difference formula: Newton's general interpolation formula, Lagrange's formula. | 1, 2, 4 |
| | Section B | CLOs |
| 4 | Inverse Interpolation: Lagrange's formula, Newton's divided interpolation formula, successive approximations and reversion of series, different methods of extrapolation, differentiation and Integration: | 4, 7 |
| 5 | Differentiation, Integration and Iterative technique of Matrix: general quadrature formula, Trapezoidal rule Simpson's rule, Weddle's rule. Iterative technique of Matrix algebra: Iterative techniques for solving linear systems, LU-Decomposition, Error estimates and Eigenvectors. | 5, 6 |
| 6 | Numerical solution of Non-linear system: Fixed point for functions of several variables, Newton's method, Taylor method and solution of Non-linear systems. | 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Apply numerical methods to obtain approximate solutions to mathematical problems and derive numerical methods for various mathematical operations and tasks. | 1, 3 |
| | CLO2 | Determine the root(s) of a nonlinear equation using the bisection method, functional iteration and Newton's method. | 3, 4, 8 |
| | CLO3 | Understand Gauss-type integration rules; construct an interpolating polynomial using either the Lagrange or Newton formula, and describe their relative advantages and disadvantages. | 3 |
| | CLO4 | Estimate the error for the interpolating polynomial using the Lagrange form for the error. | 3 |
| | CLO5 | Construct forward difference tables for prescribed data and derive the trapezoidal and Simpson's rules for approximating an integral. | 1, 3, 8 |
| | CLO6 | Apply iterative technique to operate Matrix algebra and solve the linear systems, LU-Decomposition, Error estimates and Eigenvectors. | 4, 8 |
| | CLO7 | Derive numerical solution of Non-linear system: Fixed point for functions of several variables, Newton's method. | 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and class presentations. | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and class presentations. | Class test, assignment and final examination. |
| CLO3 | Lecture and class presentations. | Assignment and final examination. |
| CLO4 | Lecture and class presentations. | Class test, assignment and final examination. |
| CLO5 | Lecture, group discussions, and class presentations. | Quiz, assignment and final examination. |
| CLO6 | Lecture and class presentations. | Viva voce and final examination. |
| CLO7 | Lecture, group discussions, and class presentations. | Class test/ quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Scarborough, J. B. (1966). Numerical Mathematical Analysis, 6th edition, Oxford and IBH, New Delhi.<br>Sastry, S. (1997). Introductory Methods of Numerical Analysis, 2nd edition, Prentice-Hall, New Delhi. |
| Supplementary Readings | Cornte, S. D. and de Boor, C. (1981). Elementary Numerical Analysis: An Algorithmic Approach, 3rd edition, McGraw-Hill, Singapore.<br>Kuo, S. S. (1972). Computer Applications of Numerical Methods, Addision-Wiley, Reading.<br>Mallick, S.A. and Uddin., M.A. (2007). Numerical Mathematics. |

| Course Code: 0541 20 Math 2253 | Year: Second | Term: Second |
|---|---|---|
| Course Title | Real Analysis | |
| Course Status | Core | |
| Credit | 2.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide advanced concepts of mathematics and their applications in different field of statistics. | |
| Course Objectives | • Understand the basic concept of sequence and series.<br>• Acquire knowledge on some real function with associated theorems.<br>• Develop the concept of Riemann integral. | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Sets: Function, Real valued function. Open set. Dense Set. Countability, compact and connected sets. Monotonic class of sets. Additive class of sets. | 1, 3 |
| 2 | Sequences and Series: Introduction. Convergence principle, Convergence and absolute convergence of series. Comparison test. Ratio test. Root test. Integral test. Rearrangement of absolute convergent series. Cauchy's convergence. Multiplication of absolutely convergent series. Abel's Lemma. Dirichlet's test. Abel's test for conditional convergent power series. | 2, 3 |
| Section B | | CLOs |
| 3 | Real Functions: Continuity. Properties of continuous functions. Uniform continuity. The Exponential, Logarithmic and Trigonometric functions. Derivatives. Rolle's theorem. Mean value theorems. Cauchy's mean value theorem. Taylor's theorem with Lagrange's and Cauchy's form of the remainder. | 3 |
| 4 | Riemann Integral: The existence of the Riemann integral of a continuous function. Simple properties. First and second mean value theorem. Convergence and absolutely convergence of improper and infinite integrals. Sequences and series of functions. Uniform convergence. Comparison test. Term by term integration and differentiation. | 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Introduce the concept of set theory. | 1, 3, 4 |
| | CLO2 | Understand and formulate different types of sequence and series with their application. | 1, 3, 4 |
| | CLO3 | Develop the basic concept of real function and its application. | 1, 3, 8 |
| | CLO4 | Understand the concept of Riemann integral with related properties and solve problem. | 1, 3, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, and class presentations. | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and class presentations. | Quiz, assignment and final examination. |
| CLO3 | Lecture, and class presentations. | Assignment and final examination. |
| CLO4 | Lecture, and class presentations. | Viva-voce and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Bali, N. P. (2005). Golden real analysis. Firewall Media.<br>Sohrab, H. H. (2003). Basic real analysis (Vol. 231). New York: Birkhäuser. |
| Supplementary Readings | Royden, H. L., & Fitzpatrick, P. (1988). Real analysis (Vol. 32). New York: Macmillan.<br>Bartle, R. G., & Sherbert, D. R. (2000). Introduction to real analysis (Vol. 2). New York: Wiley. |

| Third Year First Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 3101 | | Year: Third | Term: First |
| Course Title | Statistical Inference-II | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | Statistical Inference-II is designed by some hypothesis testing method that uses statistical evidence from a sample to draw a conclusion about a population. | | |
| Course Objectives | • Gather idea about interval estimation and construct interval estimation by different methods.<br>• Calculate Bayes estimator using different probability distributions.<br>• Find best critical region and generate knowledge of MP and UMP tests. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Bayes Estimator: Loss function, risk function, posterior density, fundamentals of Bayes methods, and its properties and uses. | 1, 2 |
| 2 | Interval Estimation: Concept of central and non-central confidence intervals, Methods of interval estimation, large sample confidence interval, Bayesian interval, Neyman classical confidence intervals, finding confidence intervals pivotal quantity method and statistical method, confidence intervals for parameters of normal, binomial, Poisson and exponential distribution, | 1, 2 |
| | Section B | CLOs |
| 3 | Parametric Tests: Basic concepts of parametric and non-parametric tests, critical region, best critical region, Neyman-Pearson fundamental lemma, most powerful (MP) test, uniformly most powerful (UMP) test, two-sided BCR. | 3, 4 |
| 4 | Likelihood Ratio Test: Introductory discussion about LR test, distribution of LR Statistic, asymptotic distribution of LR statistic, LR test in linear model. | 3, 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Discover vital judgment of central and non-central confidence intervals through different distributions. | 1, 3, 4 |
| | CLO2 | Gather knowledge of Bayesian interval and Neyman classical confidence intervals. | 1, 3, 4 |
| | CLO3 | Understand the basic concept of parametric test. | 1, 3, 5, 8 |
| | CLO4 | Identify different critical regions for parametric test. | 1, 3, 4, 7, 8 |
| | CLO5 | Apply different parametric tests in real life examples. | 1, 3, 4, 5, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Quiz and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Quiz and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference. Upper Saddle River, NJ, USA: Pearson/Prentice Hall. |
| Supplementary Readings | Härdle, W. K., V., Spokoiny, V., Panov, & W. Wang (2014). Testing a Statistical Hypothesis. In Basics of Modern Mathematical Statistics. Springer Berlin Heidelberg.<br>Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E. L. (2000). Testing of Statistical Hypothesis. 4th ed., Wiley, N.Y.<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY.<br>Rao, C. R. (2009). Linear statistical inference and its applications. John Wiley & Sons<br>Wald A. (1947). Sequential Analysis. John Wiley And Sons, Inc., New York. |

| Course Code: 0542 20 Stat 3103 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Regression Analysis-II | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide advanced analysis of interdependency among the econometric data and statistical hypothesis. | | |
| Course Objectives | • Incorporate the violation of classical linear regression assumptions.<br>• Determine confidence intervals for different estimators.<br>• Estimate Bayes estimator for different distributions.<br>• Apply different parametric tests. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Multiple Regression and Linear Estimation: Basic concept, estimation and tests, asymptotic properties of OLS estimators, errors in variable and errors in equations, specification error, instrumental variable and lagged variable in regression analysis. | 1, 2, 5 |
| 2 | Heteroscedasticity: Concept and consequence, detection and testing for heteroscedasticity, estimation with heteroscedestic disturbances. | 1, 2, 3 |
| 3 | Multicollinearity: Concept of exact and near multicollinearity, consequence, estimable functions, effects of multicollinearity, detection and remedial measures of multicollinearity. | 4, 5, 7 |
| 4 | Autocorrelation: Sources and consequences of autocorrelation, tests for auto correlated disturbances, estimation of parameters. | 3, 4, 9 |
| Section B | | CLOs |
| 5 | Dummy Variables: General concepts, use of dummy variables in regression analysis, dummy variable trap, models with dummy dependent variable and their estimation, linear probability model, logit model, probit model, tobit model and logistic model. | 6, 7, 8 |
| 6 | Logistic Regression and Diagnostic: Simple logistic regression, method of maximum likelihood, exact logistic regression, measures of model fit and test for significance of regression parameters, LR test, exact conditional scores tests, exact p-value. Confidence intervals, Exact confidence intervals, Hosmer-Lemeshow goodness of fit test, Pearson and deviance residuals, diagnostics and identification of influential observations, high leverage points and outliers, variable selection. | 7, 8, 9 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Explain the assumptions of the ordinary least squares model. | 1, 4, 8 |
| | CLO2 | Diagnose violations of the assumptions of the OLS model. | 1, 3 |
| | CLO3 | Perform statistical tests to investigate whether the classical assumptions in regression analysis are satisfied. | 3, 5, 7, 8 |
| | CLO4 | Narrate the consequences of autocorrelation, multicollinearity and heteroscedasticity, estimate the regression model under such circumstances, and test them | 3, 5, 7 |
| | CLO5 | Implement Durbin test of autocorrelation and interpret the results | 1, 4, 8 |
| | CLO6 | Specify dummy variables to measure qualitative influences in regression analysis | 1, 5 |
| | CLO7 | Formulate the appropriate models for binary dependent variables stating the suitable situation (logit, probit and tobit). | 2, 3, 5, 7, 8 |
| | CLO8 | Understand the basic idea behind estimating model parameters via the maximum likelihood method | 1, 3, 4, 8 |
| | CLO9 | Interpret outcomes of econometric analyses and draw appropriate conclusions | 1, 3, 5, 7 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Quiz and assignment. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, quiz, assignment and final examination. |
| CLO6 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO7 | Lecture, and problem solving | Class test and assignment. |
| CLO8 | Lecture, group discussions, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO9 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to linear regression analysis. John Wiley & Sons.<br>Ryan, T. P. (2008). Modern regression methods. John Wiley &Sons. |
| Supplementary Readings | Birkes, D. and Dodge, Y. (1993). Alternative methods of Regression, Wiley, N.Y.<br>Chatterjee, S. and B. Price (2006). Regression Analysis by Example, John Wiley & Sons, New York.<br>Dobson A.J. (1990). An Introduction to Generalized Linear Models, Chapman and Hall, N. Y.<br>Draper, N.R. and H. Smith (2006). Applied Regression Analysis, 2d ed., John Wiley & Sons, New York.<br>Gujarathi, D. M. (2022). Gujarati: Basic Econometrics. McGraw-hill.<br>Johnston, J. (1997). Econometric Methods, McGraw-Hill, New York Johnston, J., & DiNardo, J. (1963). Econometric methods.<br>Koutsoyiannis, A. (1973).Theory of econometrics. London: McMillan.<br>Weisberg, S. (2005). Applied linear regression (Vol. 528). John Wiley & Sons. |

| Course Code: 0542 20 Stat 3104 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Statistical Inference and Regression Analysis-II Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide advanced analysis of interdependency among the econometric data and statistical hypothesis. | | |
| Course Objectives | • Incorporate the violation of classical linear regression assumptions.<br>• Determine confidence interval for different estimator.<br>• Estimate Bayes estimator for different distribution.<br>• Apply different parametric test. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Regression Analysis: Fitting of multiple regression model and logistic regression model, separation of effects and tests of hypothesis, examination of residuals, outliers, influence curve analysis, detection and testing for heteroscedasticity, estimation with heteroscedastic disturbances, detection and remedial measures of multicollinearity, tests for auto correlated disturbances, estimation of parameters. | 1, 2, 3 |
| 2 | Statistical Inference: Confidence interval for different probability distribution using different interval estimation, Bayes methods in estimation, Critical region, best critical region, most powerful (MP) test, uniformly most powerful (UMP) test. Likelihood Ratio (LR) Test distribution of LR Statistic, LR test in linear model | 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Identify the OLS problems and apply technique how to solve the problems | 1, 2, 3, 4, 5, 7, 8 |
| | CLO2 | Estimate the parameters of regression model and examine the residuals and its behavior | 1, 2, 3, 4, 5,7, 8 |
| | CLO3 | Solve the problems and apply test for regression coefficients with ANOVA. | 1, 3, 5, 7, 8 |
| | CLO4 | Construct the confidence interval of parameters for different probability distribution. | 1, 2, 3, 4, 5, 7, 8 |
| | CLO5 | Find Critical region, best critical region, most powerful (MP) test, and uniformly most powerful (UMP) test for different probability function. | 1, 2, 3, 4, 5, 7, 8 |
| | CLO6 | Perform LR test for different population. | 1, 3, 4, 5, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, group discussions, and problem solving | Continuous assessment. |
| CLO2 | Lecture, class presentations, and problem solving | Continuous assessment and Viva voce. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, group discussions, class presentations, and problem solving | Assignment and final examination and Viva voce. |
| CLO5 | Lecture, class presentations, and problem solving | Final examination. |
| CLO6 | Lecture, and problem solving | Final examination and viva voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall.<br>Montgomery, D. C., Peck, E. A., & Vining, G. G. (2021). Introduction to linear regression analysis. John Wiley & Sons.<br>Draper, N. R., & Smith, H. (1998). Applied regression analysis (Vol. 326). John Wiley & Sons. |
| Supplementary Readings | Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Mood, A. M., F. A. Graybill, and D. C. Boes (1994). Introduction to the theory of statistics. 5th edition, McGraw Hill, N.Y.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY.<br>Sykes, A. O. (1993). An introduction to regression analysis.<br>Chatterjee, S., &Hadi, A. S. (2006). Regression analysis by example. John Wiley & Sons.<br>Neter, J., Wasserman, W., & Kutner, M. H. (1990). Applied statistical linear models. Irwin, New York. |

| Course Code: 0542 20 Stat 3105 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Experimental Design | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | The course is designed to provide advanced concept of experimental design and link up these with some real-life problem. | | |
| Course Objectives | • Acquire knowledge on factorial experiment as well as confounding concept.<br>• Understand the structure of split-plot design and ANCOVA.<br>• Develop the concept of nesting factors inside another factor.<br>• Apply theoretical knowledge to solve real-life problems. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Factorial Experiments: Basic ideas, $2^k$ factorial experiments, total and partial confounding in factorial experiments. | 1 |
| 2 | Factorial Experiments at 3 Levels and Mixed Factorial Experiment: $3^2$ and $3^3$factorial experiment in RBD, 2×3 and 3×4 factorial experiment. | 1, 2 |
| 3 | Split-plot Design: Analysis of split-plot design, analysis of split-split-plot design. | 1, 2 |
| Section B | | CLOs |
| 5 | Analysis of Covariance: Covariance analysis with one concomitant variable, analysis of covariance in RBD and LSD with a single covariate. | 4, 6 |
| 6 | Variance Component Analysis: Method of variance component analysis, variance component analysis in one-way and two-way classified data. | 5, 7 |
| 7 | Nested Design and Lattice Design: Introduction, two-stage nested design, three-stage nested design. Concept of Lattice design. | 4, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Put forward the basic idea of factorial experiment with application area. | 1, 2, 3, 7 |
| | CLO2 | Narrate advantages of factorial experiment over single factor experiment. | 2, 3, 4, 5, 8 |
| | CLO3 | Differentiate between total and partial confounding in factorial experiments. | 2, 3, 5 |
| | CLO4 | Understand the basic concept of SPD and nested design with layout. | 1, 2, 3, 7, 8 |
| | CLO5 | Evaluate the applications benefits of SPD over other design. | 1, 4, 7, 8 |
| | CLO6 | Perform ANOVA, ANCOVA for different design. | 1, 2, 4, 8 |
| | CLO7 | Describes variance component analysis in one-way, two-way and three-way classified data. | 1, 2 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, quiz and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, quiz and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test and assignment. |
| CLO6 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO7 | Lecture, and problem solving | Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi.<br>Bhuiyan, M.R. (2011). Fundamentals of Experimental Design, 2nd Edition. Mullick Brothers, Dhaka. |
| Supplementary Readings | Das, M. N. and Giri, N. C. (1997). Design and Analysis of Experiments, 2nd edition, New Age International (P) Ltd., India.<br>Federer, W. T. (1967). Experimental Design: Theory and Application, Oxford and IBH, New Delhi.<br>Gomez, K.A. and A.A. Gomez, (1984). Statistical procedures for agricultural research (2 ed.). John wiley and sons, NewYork,<br>Bhuiyan, K.C. (2006). Experimental Design and Analysis of Variance, Vol.1 & 2, Bangla Academy.<br>Scheffe, H. (1997). Analysis of Variance, Wiley, N.Y.<br>Yates, F. (2001). Design and Analysis of Factorial Experiments, Harpenden, Herts, England. |

| Course Code: 0542 20 Stat 3107 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Modeling and Simulation | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to formulate a stochastic model to describe a real phenomenon; it is used to be that one compromised between choosing a model that is realistic replica of the actual situation and choosing one whose mathematical analysis is tractable. | | |
| Course Objectives | • To introduce with the various system simulation and modeling techniques, and highlight their applications.<br>• To introduce modeling, design, simulation, planning, verification and validation in the areas of simulation.<br>• To develop skills among the learners of system simulation.<br>• To make them able to solve real world problems, which cannot be solved by mathematical approaches | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Basic Simulation Modeling: The nature of simulation, systems, models and simulation, discrete event simulation, purposes, advantages and disadvantages of simulation, Steps in a simulation study, simulation application examples-queuing system, inventory system, , Monte Carlo simulation. | 1, 2 |
| 2 | Random number generator: Introduction, linear congruential generator: Mixed and multiplicative generator. Tests for random numbers: Frequency test (Chi-Square test, Kolmogorov-Smirnov test), Runs test, Autocorrelation test, Gap test, Poker test, etc. | 3, 4 |
| | Section B | CLOs |
| 3 | Methods for generating random variates: inverse transformation, composition, convolution, acceptance-rejection, Random samples from probability functions: Uniform, Weibull, Gamma, normal, lognormal, exponential, beta, binomial, Poisson, geometric, negative binomial etc. Monte Carlo Simulation Method. | 2, 3 |
| 4 | Model Verification and Validation: Introduction, Model Verification and Validation, Model Validation Method and verification methods, Techniques in simulation modeldesign, goodness of fit tests for both discrete and continuous data.MCMC methods: Introduction, Markov chain, Hastings-Metropolis Algorithm, Gibbs Sampler, and Simulated Annealing. Applications of cross validation approaches in statistical models. | 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Define systems, models and simulation and their application in real life problem. | 1, 3, 4 |
| | CLO2 | Apply simulation in queuing and inventory systems. | 2, 3, 4, 7 |
| | CLO3 | Generate random numbers by different generators with its validity test. | 1, 3, 5, 8 |
| | CLO4 | Learn different mathematical models and their applications in simulation. | 1, 3, 4, 7, 8 |
| | CLO5 | Introduce MCMC methods in simulation modeling. | 2, 3, 4, 5, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, quiz, assignment, continuous assessment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Ross, S. M. (2013). Simulation. Fifth Edition. Academic press.<br>Law, A. M., Kelton, W. D., & Kelton, W. D. (2007). Simulation modeling and analysis (Vol. 3). New York: Mcgraw-hill. |
| Supplementary Readings | Bartley, P., Fox, B. L. and Schrage, L. E. (1987). A Guide to Simulation, 2nd Edition, Springer-Verlag, New York.<br>Rubinstein, R. Y., & Melamed, B. (1998). Modern simulation and modeling (Vol. 7). New York: Wiley. |

| Course Code: 0542 20 Stat 3108 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Experimental Design and Simulation Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to explore the application of experimental design and simulation modeling related problem in practical life. | | |
| Course Objectives | • Analyze data from different factorial experiments and make valid inferences.<br>• Analyze data from different experimental designs for analysis of covariance and make valid inferences.<br>• Apply stochastic model in practical problem.<br>• Generate random number and fit different probability distribution using simulation modeling. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Experimental Design: Factorial experiments at 2 and 3 levels, mixed factorial experiments, total and partial confounding split plot design, analysis of covariance, solution of the problem from analysis of variance, Variance Component Analysis. | 1, 2 |
| 2 | Simulation: Generate Random number using Mixed and multiplicative generator. Tests for random numbers, generating random variates by different techniques, Generate Random samples from probability functions, generating random using Monte Carlo Simulation Method, Goodness of fit tests for both discrete and continuous data. | 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Perform ANOVA in case of different factorial experiments and make valid inference. | 1, 2, 3, 4 |
| | CLO2 | Perform ANCOVA for different experimental designs and make valid inference. | 1, 2, 3, 4 |
| | CLO3 | Calculate Probability generating function and hence probabilities from different well-known distribution. | 1, 2, 4, 8 |
| | CLO4 | Produce random numbers by different generators with its validity test. | 1, 2, 3, 4 |
| | CLO5 | Generate continuous, discrete random variates form some probability function and random. Numbers using Monte Carlo simulation method. | 1, 2, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce. |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce. |
| CLO3 | Practical work and presentation | Assignment, and report assessment. |
| CLO4 | Practical tasks, group work and presentation | Report assessment and viva-voce. |
| CLO5 | Lecture and Presentation | Continuous assessment and viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi.<br>Ross, S. M. (2013). Simulation. Fifth Edition. Academic press.<br>Law, A. M., Kelton, W. D., & Kelton, W. D. (2007). Simulation modeling and analysis (Vol. 3). New York: Mcgraw-hill. |
| Supplementary Readings | Das, M. N. and Giri, N. C. (1997). Design and Analysis of Experiments, 2nd edition, New Age International (P) Ltd., India.<br>Gomez, K.A. and A.A. Gomez, (1984). Statistical procedures for agricultural research (2 ed.). John wiley and sons, NewYork<br>Federer, W. T. (1967). Experimental Design: Theory and Application, Oxford and IBH, New Delhi.<br>Bhuiyan, M. R. (2011). Fundamentals of Experimental Design, 2nd edition, Mullick & Brothers, Dhaka.<br>Bartley, P., Fox, B. L. and Schrage, L. E. (1987). A Guide to Simulation, 2nd Edition, Springer-Verlag, New York.<br>Rubinstein, R. Y., & Melamed, B. (1998). Modern simulation and modeling (Vol. 7). New York: Wiley |

| Course Code: 0542 20 Stat 3109 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Actuarial Statistics | | |
| Course Status | Optional | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concept of actuarial statistics. | | |
| Course Objectives | • Provide students with the necessary knowledge to work in the general areas of actuarial science, mainly life and health insurance, pension funds, and financial security.<br>• Offer formal academic and professional training to students who wish to join the actuarial profession.<br>• Supply adequate knowledge for students to sit for the early professional examinations organized by international actuarial organizations so that they can successfully join the actuarial profession after graduation. | | |

| Course Contents | | CLOs |
|---|---|---|
| | Section A | |
| 1 | Basics-Meaning of actuarial science, role of insurance in the economy, role of an actuary | 1, 2 |
| 2 | Fundamentals of Theory of Interest-Definition of simple interest, 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, relationship between interest and discount, equations of value and use of the time diagram in solutions of problems in interest, problems involving unknown length of investment and unknown rate of interest. | 2, 3, 4 |
| 3 | Annuities: Annuity, different types of annuities certain, present and accumulated values of immediate annuity and annuity due, present value of deferred annuities and variable annuities, analysis of annuities payable at a different frequency than interest is convertible, perpetuity. | 3, 4 |
| 4 | Capital redemption policies: Capital redemption policies, amortization schedules and sinking funds, split of payments into principal and interest, and the determination of required periodic payments. | 1, 3, 4 |
| | Section B | CLOs |
| 5 | 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 function and related problems. | 3, 4, 5 |
| 6 | Premiums: Net premiums, net premiums for various life assurances, premiums payable m times a year, determination of premiums for pension benefits and related problems, office premiums, relation between office and net premiums, equation of payments, basic concepts of valuation and distribution of surplus. | 2, 3, 4, 5 |
| 7 | 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 selection of studies, various observation periods and various methods of tabulating deaths, techniques of calculating exposures from valuation schedules including the general concept of fiscal year, the use of interim schedules and variations in observations period or method of grouping deaths and practical aspects of construction of actuarial tables | 5, 6 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Know basic actuarial problems. | 1, 4, 7, 8 |
| | CLO2 | Model basic actuarial problems using mathematical, probabilistic and statistical methods | 1, 3, 4, 7, 8 |
| | CLO3 | Apply various analytic and quantitative methods to define and solve problems in insurance, finance, economics, investment, pension, financial risk management | 1, 3, 4, 7, 8 |
| | CLO4 | Identify the nature of insurance, finance and investment risks. | 1, 7, 8 |
| | CLO5 | Solve actuarial problems by applying actuarial mathematics in life contingencies, and the ability to apply the concepts of actuarial science in solving | 1, 3, 4, 8 |
| | CLO6 | Construct Actuarial Tables, of mortality table, techniques of calculating exposures | 1, 3, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO6 | Lecture, class presentations, and problem solving | Class test/ quiz/ assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Kellison, S. G. (2009). The Theory of Interest; 3rd Ed., Richard D. Irwin Inc.<br>Uddin, M. S. (2010). An Introduction to Actuarial and Financial Mathematics. Book World, Dhaka. |
| Supplementary Readings | Ayres, F. Jr., (1963). Theory and Problems of Mathematics of Finance, Schaum's Publishing Co., New York.<br>Bather, R. W. (1998). Mortality Table Construction, Wiley, N.Y.<br>Benjamin, B., Pollard, J. H., & Haycocks, H. W. (1980). The analysis of mortality and other actuarial statistics (Vol. 3). London: Heinemann.<br>Borowiak, D. S., & Shapiro, A. F. (2003). Financial and actuarial statistics: an introduction. CRC Press.<br>Bowers, N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J., (1997). Actuarial Mathematics<br>Kellison, S. G. (2009). Theory of Interest, 3rd Edition, Mcgraw-Hill/Irwin.<br>Promislow SD (2011). Fundamentals of Actuarial Mathematics, 2nd edition. John Wiley & Sons. |

| Course Code: 0542 20 Stat 3111 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Statistical Pattern Recognition | | |
| Course Status | Optional | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to introduce to statistical pattern recognition theory and techniques. | | |
| Course Objectives | • Provide a concise description of many of the most useful of today's pattern processing techniques.<br>• Understanding parametric and nonparametric density estimation. Build knowledge of linear and nonlinear discriminant analysis.<br>• Construct awareness of Tree-based methods, Clustering, Outlier detection etc. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Statistical pattern recognition, Stages in a pattern recognition problem, issues, supervised versus unsupervised, Approaches to statistical pattern recognition. | 1 |
| 2 | Density estimation: parametric (Normal based models, Normal mixture models, Bayesian estimates), nonparametric (Histogram method, k-nearest-neighbor method, Kernel methods). | 2 |
| 3 | Linear Discriminant Analysis: Two-class algorithms, Multiclass algorithms, Logistic discrimination, kernel methods such as Optimization criteria, Radial basis functions, Nonlinear support vector machines. | 2 |
| Section B | | CLOs |
| 4 | Nonlinear discriminant analysis: The multilayer perception, Projection pursuit. | 3 |
| 5 | Tree-based methods: Classification trees, Multivariate adaptive regression sp-lines. | 4 |
| 6 | Performance: Performance assessment, comparing classifier performance, Combining classifiers. | 4 |
| 7 | Clustering: Hierarchical methods, Quick partitions, Sum-of-squares methods. Outlier detection and robust procedures, Structural risk minimization and the Vapnik-Chervonenkis dimension. | 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Understand statistical pattern and approaches of statistical pattern. | 1, 3 |
| | CLO2 | Evaluate density estimation both parametric and nonparametric way. | 1, 3, 8 |
| | CLO3 | Demonstrate nonlinear discriminant analysis. | 1, 3 |
| | CLO4 | Develop tree-based methods; assess performance, clustering, Outlier detection. | 1, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Quiz, assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Webb, A. R. (2003). Statistical pattern recognition. John Wiley & Sons.<br>Fukunaga, K. (2013). Introduction to statistical pattern recognition. Elsevier.<br>Kharin, Y. (1996). Robustness in statistical pattern recognition (Vol. 380). Springer Science & Business Media. |
| Supplementary Readings | Webb, A. (1999). Statistical pattern recognition. Newnes.<br>Chen, C. H., Pau, L. F., & Wang, P. S. P. (1973). Statistical pattern recognition. New Jersey.<br>McLachlan, G. J. (2005). Discriminant analysis and statistical pattern recognition. John Wiley & Sons.<br>Franc, V., &Hlavác, V. (2004). Statistical pattern recognition toolbox for Matlab. Prague, Czech: Center for Machine Perception, Czech Technical University. |

| Course Code: 0541 20 Math 3151 | | Year: Third | Term: First |
|---|---|---|---|
| Course Title | Operation Research | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concepts of Operation Research and practices involved in different applications on complex mathematical problems. | | |
| Course Objectives | • Enlarge the concepts of operation research.<br>• Identify, evaluate, and interpret information and data in support of assignments, projects or research.<br>• Improve proficiency with tools from optimization, probability, statistics and economic analysis. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Nature and Impact: Meaning and Scope of operations Research, Nature and impact of OR approach, Phases of OR. | 1 |
| 2 | Linear Programming: Concept and basic elements of linear programming problem (LPP), Formulation of LPP, Solution of LPP, Graphical method, simplex method, Big-M method, two phase method, and revised simplex method, concept of convergence, Degeneracy and cycling, integer LPP, transportation problem. | 2, 3, 6 |
| | Section B | CLOs |
| 3 | Inventory model: continuous review models, single period models, multi-period models. | 3 |
| 4 | Game Theory: Basic concept of game theory, finite and infinite game theory, two Persons and n persons zero-sum game, pay off matrix, maximum and minimum criterion of optimal solution of a game, dominance property. | 4, 5 |
| 5 | Duality: Dual primal relationship and formulation of dual problems. | 6 |
| 6 | Sensitivity Analysis: Introduction to sensitivity analysis and application, Path Analysis. | 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Discern the meaning and phases of operation research and linear programming problems. | 2, 3, 4 |
| | CLO2 | Formulate and model a linear programming problem from a word problem and solve them graphically as well as using different algorithms. | 2, 3, 4 |
| | CLO3 | Apply tools of operation research in industry and the public sectors contexts in involving uncertainty and scarce or expensive resources. | 2, 4, 8 |
| | CLO4 | Know how game theorists think and apply to analyze real world situations. | 2, 4 |
| | CLO5 | Recognize the strategic issues in a problem and understand how a game theorist might decide on the appropriate tools to analyze it. | 2, 3, 4, 5 |
| | CLO6 | Place a primal linear programming problem into standard form and use the Simplex Method or Revised Simplex Method, etc. to solve it. | 2, 3, 4 |
| | CLO7 | Explain the concept of complementary slackness and its role in solving primal/dual problem pairs with interpret. | 2, 3, 4 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Quiz, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, quiz and final examination. |
| CLO6 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO7 | Lecture, group discussions, and problem solving | Class test, quiz, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Matousek J. and Gartner B. (2007). Understanding and Using Linear Programming, 1st Edition, Springer, NY.<br>Glicksman, A. M. (2001). An introduction to linear programming and the theory of games. Courier Dover Publications. |
| Supplementary Readings | Gass, S.L. (1984). Linear Programming, 5th Edition, McGraw Hill, N.Y. 5. Taha H.A. (2003), Operations Research: An introduction, 7th Edition. Prentice Hall, N.Y.<br>Gupta, D. K. and Man Mohan (2001). Linear Programming and The of Games, 8th Edition, Sultan and Chand, New Delhi.<br>Kall P. and Myer J. (2005). Stochastic Linear Programming, Library of Congress Cataloging- in Publishing Data, Kluwer Academic Publisher, USA.<br>Lewis, C. (2008). Linear Programming: Theory and Applications. Whitman College Mathematics Department.<br>Myerson, R. B. (2013). Game theory. Harvard university press.<br>Schilling, E. G., & D. V. Neubauer (2012). Acceptance sampling in quality control. CRC Press.<br>Spiring, F. (2007). Introduction to Statistical Quality Control. Technometrics.<br>Thie, R. Paul and G. E. Keough (2008). An Introduction to Linear Programming and Game Theory, 3rd ed., John Wiley & Sons, Inc., Hoboken, New Jersey.<br>Vajda, S (1993). Game Theory, Wiley, N.Y. |

| Course Code: 0541 20 Math 3152 | Year: Third | Term: First |
|---|---|---|
| Course Title | Operation Research Lab | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is planned to explore the applications of operation research related problems in practical life such as manufacturing, location planning, defense and facility layout etc. | |
| Course Objectives | • Apply operations research in real life.<br>• Analyze trade-offs between key systems variables.<br>• Develop decision support tools. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Formulate and solve problem linear (LPP), programming graphical method, simplex method, Big-M method, two phase method and revised simplex method, transportation problem. Game theory, finite and infinite game theory, two Persons and n persons zero-sum game, pay off matrix, maximum and minimum criterion of optimal solution of a game, dominance property. Dual problems, sensitivity analysis and application. | 1,2,3,4,5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Formulate complex problems in real life. | 1, 2, 4 |
| | CLO2 | Identify decision variables, control parameters, constraints in problems. | 2, 4 |
| | CLO3 | Optimize cost and profit in an industry. | 1, 2, 4 |
| | CLO4 | Validation and analysis of game in mathematically. | 2, 4 |
| | CLO5 | Interpretation implementation of a result. | 2, 4 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Assignment, continuous assessment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Continuous assessment and viva-voce |
| CLO5 | Lecture and Presentation | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Matousek J. and Gartner B. (2007). Understanding and Using Linear Programming, 1st Edition, Springer, NY.<br>Glicksman, A. M. (2001). An introduction to linear programming and the theory of games. Courier Dover Publications. |
| Supplementary Readings | Gass, S.L. (1984). Linear Programming, 5th Edition, McGraw Hill, N.Y. 5. Taha H.A. (2003), Operations Research: An introduction, 7th Edition. Prentice Hall, N.Y.<br>Gupta, D. K. and Mohan, M. (2001). Linear Programming and The of Games, 8th Edition, Sultan and Chand, New Delhi.<br>Lewis, C. (2008). Linear Programming: Theory and Applications. Whitman College Mathematics Department.<br>Schilling, E. G., & D. V. Neubauer (2012). Acceptance sampling in quality control. CRC Press.<br>Spiring, F. (2007). Introduction to Statistical Quality Control. Technometrics. |

| Third Year Second Term | | | |
|---|---|---|---|
| Course Code: 0542 20 Stat 3200 | | Year: Third | Term: Second |
| Course Title | Fieldwork | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to introduce the specific aims of a formal statement of the objectives and milestones of a research plan in a grant application. | | |
| Course Objectives | • Critically evaluate existing knowledge, including background literature and relevant data.<br>• Reflect an updated knowledge of the fieldwork in statistical perspectives.<br>• Discuss the importance and relevance of the research aims.<br>• Highlight potential policy or practice impacts and importance beyond the confines of the specific research plan. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | The main part of a grant application describing a research proposal, starting its importance and how it will be conducted in statistical perspectives, concepts of research design, concept of decision making, different sampling techniques and its appropriateness, determination of sample size, data collection, questionnaire, report writing and oral presentation of your fieldwork. | 1, 2, 3, 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Provide an overview of the proposed design and conceptual framework. | 1, 2, 7 |
| | CLO2 | Overview of the institutional and production processes and their statistical applications. | 1, 2, 3, 4, 8 |
| | CLO3 | Describe any novel concepts, approaches, tools or techniques of fieldwork. | 2, 3, 5, 8 |
| | CLO4 | Specify methodology explain why the proposed methods are the best to accomplish study goals. | 1, 2, 3, 7, 8 |
| | CLO5 | Gather knowledge about data, collecting primary and secondary data, preliminary concept of fieldwork. | 1, 4, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture, Presentation, and field visit | Continuous assessment, report assessment and viva-voce |
| CLO3 | Practical work and presentation | Report assessment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Continuous assessment and viva-voce |
| CLO5 | Lecture and Presentation | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Kothari, C. R., Garg,G.(2014). Research Methodology: Methods and Techniques. 3rd edition.<br>Islam, M.N. (2015). An Introduction to Research Methods, Mullick and brothers, 3rd edition. Dhaka |
| Supplementary Readings | Zikmaund W. G. (2000). Business Research Methods (6th edition): Harcourt College.<br>Babbie, E. (2004). The Practice of Social Research (10th edition), Thompson, Wads Worth.<br>All the recommended books and materials for the fieldwork. |

| Course Code: 0542 20 Stat 3201 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Statistical Inference-III | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide highly developed notions of statistical inference and apply involved special skills in making decision. | | |
| Course Objectives | • Increase knowledge of sophisticated statistical inferential methods.<br>• Capable of understanding different inferential theorem and their applications.<br>• Realize the utilization of re-sampling techniques in statistical fields.<br>• Acquaint with exponential families and minimal sufficient statistics. | | |

| Course Contents | | CLOs |
|---|---|---|
| | Section A | |
| 1 | Concept of Efficient estimator, more efficient estimator with example, minimum variance unbiased estimators (MVUE), uniformly minimum variance unbiased estimators (UMVUE), Theorem related to MVUE, LMVUE, UMVUE, Cramer-Rao inequality, condition for the equality sign in Cramer-Rao inequality, use of Cramer-Rao inequality in finding UMVUE, asymptotically efficient estimators, consistent asymptotically normal estimators, best asymptotically normal estimators, Rao-Blackwell theorem, application of these theorem, EM algorithm, MVB estimator, Pitman-closer, Pitman-closest, invariance property. | 1, 2, 3 |
| | Section B | CLOs |
| 2 | Lehman-Scheffe theorem, ancillary statistics, Basu theorem and minimal sufficient statistics, exponential families of distribution, complete family of a distribution and their application, median and modal unbiasedness, vector of parameter, ellipsoid of concentration, Wilks generalized variance, Bhattacharya's inequality.<br>Sequential Test- Introduction, Sequential Probability Ratio Test (SPRT), Operating Characteristic (OC), function of SPRT and Average Sample Number (ASN) function. | 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Come across why and when we use efficient estimator, minimum variance unbiased estimators. | 1, 5 |
| | CLO2 | Execute uniformly minimum variance unbiased estimators. | 1 |
| | CLO3 | Compute best asymptotically normal estimators, asymptotically efficient estimators, consistent asymptotically normal estimators. | 1, 3, 5 |
| | CLO4 | Recognize how to apply Pitman-closer, Pitman-closest estimation. | 4 |
| | CLO5 | Explore why exponential families of distribution, complete family of a distribution and their application is so important in statistics. | 4, 5 |
| | CLO6 | Use SPRT techniques, draw OC curve, and calculate ASN function for different distributions. | 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, and assignment. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test and assignment. |
| CLO6 | Lecture, class presentations, and problem solving | Class test, quiz and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall. |
| Supplementary Readings | Härdle, W. K., V., Spokoiny, V., Panov, & W. Wang (2014). Testing a Statistical Hypothesis. In Basics of Modern Mathematical Statistics. Springer Berlin Heidelberg.<br>Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E. L. (2000). Testing of Statistical Hypothesis. 4th ed., Wiley, N.Y.<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY.<br>Rao, C. R. (2009). Linear statistical inference and its applications. John Wiley & Sons<br>Wald A. (1947). Sequential Analysis. John Wiley And Sons, Inc., New York. |

| Course Code: 0542 20 Stat 3203 | Year: Third | Term: Second |
|---|---|---|
| Course Title | Nonparametric Tests | |
| Course Status | Core | |
| Credit | 2.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide fundamental concepts of non-parametric test. | |
| Course Objectives | • Compare and contrast parametric and nonparametric tests.<br>• Perform multiple applications where nonparametric approaches are appropriate.<br>• Act upon and interpret different nonparametric tests for different cases.<br>• Apply appropriate nonparametric hypothesis testing procedure based on type of outcome variable and number of samples. | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Fundamentals of Non-parametric Methods: Fundamentals concepts of non-parametric methods, distinction between parametric and non-parametric methods, assumptions involved in parametric and non-parametric methods | 1, 3 |
| 2 | One and Two Sample Test: Sign test, Run-test, Rank sum test, Randomization test, two-sample test, Kolmogorov-Smirnov one sample test, Wilcoxon matched-pairs signed ranks test, Median test, Mann-Whitney-U test, Kolmogorov - Smirnov two sample test, Paired t-test, Rank correlation test, Chi-square goodness of fit test. | 1, 2, 3, 6 |
| Section B | | CLOs |
| 3 | Advance Test: Introduction about advance test, ARE and robustness of a non-parametric test, McNemar test in 2x2 contingency analysis, Cox and Stuart test for trend, Cramer's contingency coefficient, Cochran test for related observations, ARE of Mann-Whitney test and Sign test, Kruskal-Wallis test and CRS design, square rank test for variances, quantile test, Friedman test. | 2, 5, 6 |
| 4 | Smoothing Technique: Non-parametric regression, Kernel smoother, regression sp-lines, cross validation, additive models and generalized additive model. | 4, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Summarize data using both graphical and numerical methods for use in nonparametric statistical methods. | 1, 3, 4, 8 |
| | CLO2 | Formulate, test and interpret various hypothesis tests for location, scale, and independence problems. | 3, 4, 6, 8 |
| | CLO3 | Characterize, compare, and contrast different nonparametric hypothesis test. | 5, 6 |
| | CLO4 | Use statistical methods, including nonparametric bootstrapping. | 3, 4, 8 |
| | CLO5 | Construct and interpret interval estimators for population medians and other population parameters based on rank-based methods. | 3, 5, 6, 7, 8 |
| | CLO6 | Produce and interpret statistics and graphs, using nonparametric density estimation. | 3, 4, 7, 8 |
| | CLO7 | Apply Non-parametric regression, Kernel smoother, regression sp-lines, cross validation, additive models and generalized additive model. | 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and presentation | Class test and final examination. |
| CLO2 | Lecture, Presentation and group discussion | Quiz, assignment, and final examination. |
| CLO3 | Lecture, Presentation and group work | Assignment and final examination. |
| CLO4 | Lecture and presentation | Class test and final examination. |
| CLO5 | Lecture and Presentation | Class test and final examination. |
| CLO6 | Lecture, Presentation and group discussion | Continuous assessment. |
| CLO7 | Lecture, Presentation and group discussion | Continuous assessment. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Hogg, R. V. and Craig, A. T. (2002). Introduction to Mathematical Statistics, 5thed., Pearson Education, Singapore.<br>Gibbons, J.D. and Chakraborti, S. (1992): Non parametric Statistical Inferences, Marcel Dekkar, N.Y. |
| Supplementary Readings | Kalbfleisch, J. (1981). Probability and Statistical Inference, Vol.2, Springer-Verlag, N.Y.<br>Kendall, M.G. and Stuart, A. (2004). Advanced Theory of Statistics, 14th ed.,Edward Arnold, N.Y.<br>Lehmann, E. L.(2000). Testing of Statistical Hypothesis 4th ed., Wiley, N.Y.<br>Lehmann, E.L. and H.J.M D'Abrera (1981). Non parametric Statistics. McGraw-Hill,N.Y.<br>Mukhopadhaya, N. (2000). Probability and Statistical Inference, Marcel Dekkar, N.Y.<br>Rao, C. R. (1984). Linear Statistical Inference and its Applications, 2nd ed., Wiley,N.Y. |

| Course Code: 0542 20 Stat 3204 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Nonparametric Tests and Inference Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to solve the practical problem for non-parametric tests and draw inference for its validity. | | |
| Course Objectives | • Perform and interpret different non parametric test in real problems.<br>• Apply advanced inference to estimate and check validation of different estimators.<br>• Develop practical knowledge about different inference procedures. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Nonparametric tests: One and two sample non-parametric sign test, run-test, rank sum test, randomization test, Kolmogorov-Smirnov test, Wilcoxon matched-pairs signed ranks test, median test, Mann-Whitney test, rank correlation test, goodness of fit test, McNemar test in 2x2 contingency analysis, Cox and Stuart test for trend, Cramer's contingency coefficient, Cochran test for related observations, Kruskal-Wallis test and CRS design, square rank test for variances, quantile test, Friedman test. | 1, 2 |
| 2 | Statistical Inference: Minimum variance unbiased estimators (MVUE), uniformly minimum variance unbiased estimators (UMVUE), Cramer-Rao inequality, EM algorithm, MVB estimator, efficient estimators, exponential families of distribution, complete family of a distribution and their application, Solve sequential test related problem., calculation of Operating Characteristic (OC), function Average Sample Number (ASN) function | 3, 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Summarize data using both graphical and numerical methods for use in nonparametric statistical methods. | 1, 3, 4, 5 |
| | CLO2 | Formulate and interpret various non-parametric tests for location, scale, and independence problems. | 2, 3, 7, 8 |
| | CLO3 | Execute minimum variance unbiased estimators, uniformly minimum variance unbiased estimators and application of different theorem of estimation. | 1, 3, 4, 5 |
| | CLO4 | Compute best asymptotically normal estimators, asymptotically efficient estimators, consistent asymptotically normal estimators. | 1, 3, 4, 8 |
| | CLO5 | Solve problem using EM algorithm. | 1, 3, 4, 5, 8 |
| | CLO6 | Use SPRT techniques, draw OC curve, and calculate ASN function for different distributions. | 1, 3, 4, 5, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation, problem solving | Assignment and viva voce. |
| CLO2 | Problem solving and group discussion | Report assessment and viva voce. |
| CLO3 | Lecture and Presentation, relevant problem solving | Continuous assessment, report assessment and viva voce. |
| CLO4 | Presentation, problem solving and group discussion | Assignment, report assessment and viva voce. |
| CLO5 | Lecture and Presentation, problem solving | Report Assessment and viva voce. |
| CLO6 | Problem solving and group discussion | Report Assessment and viva voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Casella, G., & Berger, R. L. (2021). Statistical inference. Cengage Learning.<br>Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.<br>Hogg, R. V. and A. T. Craig (2002). Introduction to Mathematical Statistics, 5thed., Pearson Education, Singapore.<br>Gibbons, J.D. and S. Chakraborti (1992). Non parametric Statistical Inferences, Marcel Dekkar, N.Y. |
| Supplementary Readings | Härdle, W. K., V., Spokoiny, V., Panov, & W. Wang (2014). Testing a Statistical Hypothesis. In Basics of Modern Mathematical Statistics. Springer Berlin Heidelberg.<br>Hogg, R. V., & Craig, A. T. (1995). Introduction to mathematical statistics. Englewood Hills, New Jersey.<br>Kendall, M.G. and A. Stuart (2010). Advanced Theory of Statistics, 14th ed., Edward Arnold, N.Y. [Volume 01]<br>Lehmann, E. L. (2000). Testing of Statistical Hypothesis. 4th ed., Wiley, N.Y.<br>Lehmann, E.L. and G. Cassela (1998). Theory of Point estimation, Springer Verlag, NY.<br>Lehmann, E.L. and H.J.M D'Abrera (1981). Non parametric Statistics. McGraw-Hill,N.Y.<br>Mukhopadhaya, N. (2000). Probability and Statistical Inference, Marcel Dekkar, N.Y.<br>Rao, C. R. (1984). Linear Statistical Inference and its Applications, 2nd ed., Wiley,N.Y. |

| Course Code: 0542 20 Stat 3205 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Sampling Technique-II | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide advanced concepts of sampling and practices involved different advanced techniques in taking sample. | | |
| Course Objectives | • Develop knowledge about advanced sampling techniques.<br>• Outline how to make a survey design.<br>• Formulate demographic survey in Bangladesh. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | PPS Sampling: Comparison with sampling with equal probabilities, selection of clusters with equal and unequal probability with and without replacement, determination of sample size, two and three stage-equal and unequal clusters, selection of units with equal and unequal probability with or without replacement, Horvitz-Thompson estimator and its standard error, Rao-Hartley and Cochran methods of selection, PPS systematic selection, estimation and standard errors. | 1, 2, 3 |
| 2 | Cluster and Multi-stage Sampling: Cluster sampling with equal and unequal size, estimation of mean and their variances, determination of sample size, two and three stage-equal and unequal clusters, selection of units with equal and unequal probability with or without replacement, self-weighting estimates. | 1, 2 |
| | Section B | CLOs |
| 3 | Double Sampling and Multiphase Sampling: Double sampling for stratification, ratio, regression and different estimations, repetitive surveys, Sampling on two or more occasions, multiphase sampling. | 4, 5 |
| 4 | Network and Capture-recapture sampling: Concept of Network and Capture-recapture sampling and estimation of the parameters. | 6 |
| 5 | Sampling Errors and Non-sampling Errors: Concept of sampling and non-sampling error. Different methods of estimating non-sampling errors, non-response, interviewer`s bias, interpenetrating subsamples, familiarity with recent sample surveys in Bangladesh. | 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Perform equal and unequal probability sampling. | 1, 2, 3, 7 |
| | CLO2 | Demonstrate cluster sampling and counsel in relation to multi-stage design. | 1, 2, 3, 4 |
| | CLO3 | Compute the Hansen-Hurwitz estimator and its estimated variance when primary units are selected with SRS and PPS sampling and secondary units selected with SRS. | 1, 2, 3, 5, 8 |
| | CLO4 | Clarify how to perform double sampling and convey to use double sampling for auxiliary Information. | 1, 2, 3, 7, 8 |
| | CLO5 | Know multiphase sampling and sampling on two or more occasions. | 1, 4, 7, 8 |
| | CLO6 | Make use of some advance sampling like Network and Capture-recapture sampling. | 1, 3, 4 |
| | CLO7 | Apprehend the different methods of sampling errors, non-sampling errors, non-response. Also interpenetrating sub-sample technique to take care of interviewer effect. | 5, 6, 7 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and presentation | Quiz and final examination. |
| CLO2 | Lecture and group discussion | Assignment and final examination. |
| CLO3 | Lecture and presentation | Quiz and final examination. |
| CLO4 | Lecture, presentation, and group work | Continuous assessment and final examination. |
| CLO5 | Lecture and problem solving | Assignment and final examination. |
| CLO6 | Lecture and Presentation | Class test and final examination. |
| CLO7 | Lecture and group discussion | Final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Cochran, W. G. (2002). Sampling Techniques, 3rd Ed, John Wiley, N.Y.<br>Islam, M.N. (2009). An Introduction to Sampling Methods, Book World, Dhaka. |
| Supplementary Readings | Raj, D. (1998). Sampling Theory, Norosa Publishing House, New Delhi.<br>Sing D. and Choudhary, F.C. (1999). Sampling Designs, 4th Ed., New Delhi. |

| Course Code: 0542 20 Stat 3207 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Stochastic Process | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide fundamental concepts of stochastic process and practices involved in different fields of statistics. | | |
| Course Objectives | • Understand basic concept of generating function, limit theorems and their role in probability theory.<br>• Elucidate the power of stochastic processes and their range of applications.<br>• Formulate and solve problems which involve setting up stochastic models.<br>• Apply appropriate stochastic process model(s) for a given research or applied problem. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Concept of stochastic process, types, specification of stochastic processes, Markov process, stationary process, Gaussian processes, martingales process. | 1, 2, 4 |
| 2 | Generating Functions: Generalities, convolutions, bivariate generating functions, continuity theorem. | 1, 3, 6 |
| 3 | Recurrent Events: Introduction, renewal equation, delayed recurrent events, number of occurrences of a recurrent event, application to the theory of success runs. | 7, 8, 9 |
| 4 | Markov Chains: Definition, classification of states and chains, Transition matrix, higher transition probabilities, ergodic properties, evaluation of Chapman-Kolmogorov equation. Finite Markov chain, transient states, absorption probabilities, application to recurrence times. | 3, 4, 5 |
| Section B | | CLOs |
| 5 | Homogeneous Markov Processes: Poisson process, birth process, death process, simple birth-death process, effect of immigration. | 2, 3, 5 |
| 6 | Queuing Processes: Introduction, limiting properties of queues, the queue M/M/1, the queue M/M/1 with balking, the M/M/1queue with state-dependent service, the queue M/M/1 with additional server for longer queues, The queue M/G/1 and G/M/1. | 5, 6 |
| 7 | Random Walk and Ruin Problem: Classical ruin problem with application, expected duration of the game, generating functions for the duration of the game and for the first- passage times, Browning motion. | 6, 8, 9 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Formulate different generating functions with their applications. | 1, 4, 5, 7, 8 |
| | CLO2 | Identify appropriate stochastic model(s) for a given problem and the role of limit theorems in statistics. | 1, 3, 6, 8 |
| | CLO3 | State the defining properties of various stochastic process models. | 1, 3, 5, 7, 8 |
| | CLO4 | Provide logical and coherent proofs of important theoretic results. | 1, 3, 5, 7, 8 |
| | CLO5 | Apply the theory to model real phenomena and answer some questions in applied sciences. | 3, 6, 8 |
| | CLO6 | Introduce Poisson process, birth process, death process, simple birth death process. | 1, 4 |
| | CLO7 | Formulate and solve different process related problem. | 1, 2, 3, 5, 8 |
| | CLO8 | Describe the random walk and understand about barriers. | 2, 3 |
| | CLO9 | Solve ruin, first passage time and expected duration problems. | 1, 3, 4, 5, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Class test and assignment |
| CLO4 | Lecture, and problem solving | Class test and assignment |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, quiz and final examination. |
| CLO6 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO7 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO8 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO9 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Medhi, J. (1994). Stochastic processes. New Age International.<br>Gikhman, I. I., & Skorokhod, A. V. (2004). The theory of stochastic processes II. Springer Science & Business Media.<br>Gusak, D., Kukush, A., Kulik, A., Mishura, Y., &Pilipenko, A. (2010). Theory of stochastic processes. Problem Books in Math. Springer, New York. |
| Supplementary Readings | Ross, S.M. (2001): Stochastic Processes, Academic Press, N.Y.<br>Ross, S. M., Kelly, J. J., Sullivan, R. J., Perry, W. J., Mercer, D., Davis, R. M., ... & Bristow, V. L. (1996). Stochastic processes (Vol. 2). New York: Wiley.<br>Bailey, N. T. (1991). The elements of stochastic processes with applications to the natural sciences (Vol. 25). John Wiley & Sons.<br>Cox, D. R., & Miller, H. D. (2017). The theory of stochastic processes. Routledge.<br>Bhat, U. N., & Miller, G. K. (2002). Elements of applied stochastic processes (Vol. 3). Hoboken^ eN. JNJ: Wiley-Interscience. |

| Course Code: 0542 20 Stat 3208 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Sampling Technique and Stochastic Process Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to solve the practical problem for advanced sampling techniques and Stochastic process. | | |
| Course Objectives | • Apply advanced sampling technique and estimate sample from geographical region.<br>• Develop practical knowledge about survey in Bangladesh.<br>• Apply stochastic model in practical problem. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Drawing samples by cluster, multi-stage, double sampling, multi-phase and network sampling. Estimation of parameters in each case, estimation of variance of estimates, determination of precision of estimates, relative efficiency of these different sampling scheme, estimation for population total, mean, variance and proportion. | 1, 2, 4 |
| 2 | Generating Functions, Probability estimates of the denumerable Markov chain, determination of higher transition probabilities: two- state Markov chain, three - state Markov chain, statistical inference for Markov chain, Homogeneous Markov Processes and their estimation of the parameter, Random Walk and Ruin Problem. | 3, 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Estimate different characteristics of sample and population for related sampling technique. | 1, 4, 8 |
| | CLO2 | Calculate approximate sampling and non-sampling error in sample survey. | 1, 3, 7 |
| | CLO3 | Calculate Probability generating function and hence probabilities from different well-known distribution. | 1, 3, 5, 8 |
| | CLO4 | Fit the two and higher order Markov chain model in case of practical problem. | 3, 9 |
| | CLO5 | Formulate and solve random work ruin problem. | 1, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO2 | Lecture and Presentation | Continuous assessment and viva-voce |
| CLO3 | Practical work and presentation | Report assessment and viva-voce |
| CLO4 | Practical tasks, group work and presentation | Continuous assessment and viva-voce |
| CLO5 | Lecture and Presentation | Report assessment and viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Medhi, J. (1994). Stochastic processes. New Age International.<br>Islam M.N. (2009), An Introduction to Sampling Methods, Book World, Dhaka.<br>Gusak, D., Kukush, A., Kulik, A., Mishura, Y., &Pilipenko, A. (2010). Theory of stochastic processes. Problem Books in Math. Springer, New York. |
| Supplementary Readings | Cochran W. G. (2002), Sampling Techniques, 3rd Ed, John Wiley, N.Y.<br>Gikhman, I.I., and Skorokhod, A.V. (2004). The Theory of Stochastic Processes, Springer.<br>Raj, D. (1998). Sampling Theory, Norosa Publishing House, New Delhi<br>Sing D. and F.C. Choudhary (1999). Sampling Designs, 4th Ed., New Delhi<br>Islam M.N. (2009). An Introduction to Sampling Methods, Book World, Dhaka. |

| Course Code: 0542 20 Stat 3209 | Year: Third | Term: Second |
|---|---|---|
| Course Title | Research Methodology | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to explore various steps in research, types of methodologies, structure of research, understanding and skills need for conducting research in effective manner. | |
| Course Objectives | • Develop the basic framework of research process, various research designs and techniques.<br>• Identify various sources of information for literature review and data collection.<br>• Appreciate the components of scholarly writing and evaluate its quality.<br>• Introduce the concept of scientific research and the methods of conducting scientific enquiry. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Basic Concepts of Research Methodology: Meaning of research, characteristics, objectives, importance of research, Types of Research, Areas of Research, difference between research project and research program, concepts, meaning and fundamental difference of methods methodology, concepts of theory, proposition, Axiom, hypothesis. | 1, 2 |
| 2 | Research Design: Concepts of research design, types of research design, structured and unstructured research, and exploratory research deign, conclusive research design and action research design. Selection of appropriate research design. | 1, 2 |
| 3 | Research Process: Basic ideas, steps used for solving a research problem, concept of decision making, stages of decision making. | 2, 3 |
| 4 | Research Proposal: Purpose of proposals, research benefits, proposal development, types of research proposal, structuring the research proposal, evaluation of research proposal. | 3 |
| | Section B | CLOs |
| 5 | Sampling Methods: Importance of sampling in social and marketing research, different sampling techniques and its appropriateness, determination of sample size. | 3 |
| 6 | Data Collection: Different types of data, selection of appropriate methods for data collection and their advantages and disadvantages. Questionnaire and its construction, schedule, difference between them. | 3, 4 |
| 7 | Presentation of Data: Stages of data preparation process, preliminary plan of data analysis, questionnaire checking, editing, coding, data cleaning, statistically adjusting the data, selecting a data analysis strategy. | 4 |
| 8 | Report Preparation and Presentation: Importance and function of literature review in research, steps for writing a literature review, report format, report writing, guidelines for tables and graphs, oral presentation, reading the research report, research follow-up. | 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Enumerate the characteristics of research, identify the different types of research, and explain the roles of research in development. | 1, 2, 3, 7 |
| | CLO2 | Plan a research design with questionnaires and schedule and perform the steps of research process and decision-making stage. | 2, 3, 4, 5, 8 |
| | CLO3 | Create and justify a research proposal with appropriate techniques. | 2, 3, 5 |
| | CLO4 | Determine sample size for different sampling technique. | 1, 2, 3, 7, 8 |
| | CLO5 | Organize and conduct research (advanced project) in a more appropriate manner. | 1, 4, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, Assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, Assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Kothari, C. R., Garg,G. (2014). Research Methodology: Methods and Techniques. 3rd edition.<br>Islam, M.N. (2015). An Introduction to Research Methods, Mullick and brothers, 3rd edition. Dhaka |
| Supplementary Readings | Zikmaund W. G. (2000). Business Research Methods (6th edition): Harcourt College.<br>Panneerselvam, R. (2016). Research Methodology. PHL learning Private Ltd. 2nd edition, Delhi, India.<br>Trochim, W. M. K. (2006). Research Methods (2nd edition), Biztantra, New Delhi.<br>Dooley, D. (2001). Social Research Methods (4th edition), Prentice Hall of India.<br>Babbie, E. (2004). The Practice of Social Research, Thompson, Wads Worth. |

| Course Code: 0542 20 Stat 3211 | Year: Third | Term: Second |
|---|---|---|
| Course Title | Epidemiology | |
| Course Status | Optional | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide students with the necessary knowledge and skills to be able to critique, design and conduct and human population-based research and advanced knowledge of epidemiological principles and procedures. | |
| Course Objectives | • Critically appraise and evaluate the design, analysis and interpretation of epidemiological studies;<br>• Describe and discuss the role and contribution of epidemiology to health;<br>• Select, devise and develop appropriate study designs for epidemiological research;<br>• Conduct appropriate statistical analyses of epidemiological data. | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Epidemiologic Concept: Epidemiology, health and disease, sources of health-related data. | 1, 2 |
| 2 | Study Designs: Concept and framing different types of study design: descriptive and analytical study design. Ecological/geographical studies: uses and interpretation of ecological studies, advantages and disadvantages of ecological investigation, ecological fallacy and ecological bias, Case control studies: retrospective, prospective study design. Cohort studies: cross-sectional, retrospective and prospective cohort study design. Intervention studies and RCTs: characteristics, confounding and bias, randomization. Blinding: concept and different types of blinding. Longitudinal study and causal variables. | 3, 4, 5 |
| 3 | Matching: Purpose and effect of matching, matching in case-control studies, matching in Cohort studies | 5, 6 |
| Section B | | CLOs |
| 4 | Measures of disease frequency: definition and calculation of prevalence, incidence, risk, rate, choosing suitable measures, limitations of case and population definitions, and their impact on measures of disease frequency | 1, 3 |
| 5 | Measures of association: definition and calculation of risk ratio, rate ratio, odds ratio, absolute risk and rate differences, choosing suitable measures | 3, 4 |
| 6 | Measures of population impact: definition and calculation of population attributable risk and fraction, assumptions and limitations of these measures<br>Association and Causation: causal paradigms and criteria for causality | 1,4 |
| 7 | Validity and reliability: definitions, generalizability, sensitivity, specificity, positive and negative predictive value of a test and its related topics.<br>Screening: definition, evaluation, and criteria for implementation. | 4,6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Comprehend the basic idea about epidemiology, health and disease and its related topics. | 1 |
| | CLO2 | Frame out different epidemiologic study design. | 1, 3 |
| | CLO3 | Choose an appropriate study design for epidemiologic problem | 3, 4, 5 |
| | CLO4 | Design, conduct, and analysis of epidemiologic studies | 2 |
| | CLO5 | Interpret different types of measure of effect and association of disease. | 1, 7, 8 |
| | CLO6 | Appraise epidemiologic studies, synthesis and integration of epidemiologic research, and causal inference in epidemiologic research | 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test and assignment. |
| CLO6 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Jewell, N. P. (2003). Statistics for epidemiology. Chapman and hall/CRC.<br>Kleinbaum, D. G., Kupper, L. L., & Morgenstern, H. (1991). Epidemiologic research: principles and quantitative methods. John Wiley & Sons. |
| Supplementary Readings | Rothman, K. J., Greenland, S., & Lash, T. L. (2008). Modern epidemiology (Vol. 3). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins.<br>Rothman, K. J. (2012). Epidemiology: an introduction. Oxford university press.<br>Beaglehole, R., Bonita, R., &Kjellström, T. (1993). Basic epidemiology (pp. 133-142). Geneva: World Health Organization. |

| Course Code: 0542 20 Stat 3213 | | Year: Third | Term: Second |
|---|---|---|---|
| Course Title | Decision Theory | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | Decision theory is concerned with the reasoning underlying an agent's choices, whether this is a mundane choice about whether to pursue a demanding political career. | | |
| Course Objectives | • Develop knowledge about decision framework.<br>• Make decision under considering loss and risk as well as certainty and uncertainty.<br>• Analyze opportunity cost functions and terminate decisions based on prior information. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | An Overview of the Decision Framework: Concepts & Preliminaries, Characteristics of Decision problem, General problems of statistics. | 1, 2 |
| 2 | Elements of Decision: Parameter space, Action space, State Space, Consequence, Family of Experiments, Sample Space, Decision Rule, Utility Evaluation. A Case involving decision making under conditions of Certainty and uncertainty, Payoffs and Losses, Payoffs table, Expected Payoff, Decision function, Loss function, Risk function with examples, Opportunity Loss, Expected Opportunity Loss, Maximin, Maximax and Minimax, Regret Strategies, Hurwicz criterion, Laplace Criterion, Expected Monetary value Criterion, Expected Opportunity Loss Criterion. | 3, 4, 5 |
| Section B | | CLOs |
| 4 | Decision Analysis: Introduction, Decision making Problems, Decision making Process, Decision Making Environment, Decisions under Risk, Problems with discrete and continuous loss functions, non-probabilistic criteria and Probabilistic criteria for decision under uncertainty. Terminal Decisions based on prior information, Expected value of Perfect information (EVPI). Decision Trees, Sequential Decisions, and Information Acquisition decisions. | 4, 5, 6 |
| 5 | Sensitivity Analysis: Introduction, Basic Principles in Sensitivity, change in the Co-efficient of the Objectives functions, Change in the RHS of the constraint, Dominance and Admissibility. | 6, 7 |
| 6 | Different areas of statistical decision theory: Estimation, Test of hypotheses, Inference and decision, Terminal decision and posterior decisions, Introduction to Markov Decision Processes: A Framework for Sequential Decision Problems, Sequential Probability analysis, Sequential Probability Ratio Test. | 5, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Demonstrate basic concepts of decision theories. | 1, 4 |
| | CLO2 | Understand general problems of decision and its characteristics as well as different | 3, 5, 7 |
| | CLO3 | Outline of loss function, risk functions, payoffs matrix and conditions of certainty | 1, 4 |
| | CLO4 | Recognize about expected monetary value criterion and opportunity loss criterion. | 3, 6 |
| | CLO5 | Discern about decision making problems, environment and process. | 1, 8 |
| | CLO6 | Comprehend about decision trees, sequential decisions, problems, sequential | 1, 2, 3, 5, 8 |
| | CLO7 | Appreciate importance about sensitivity analysis in decision making and applying | 1, 3, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO2 | Lecture, group discussions, and problem solving | Class test, assignment and final examination. |
| CLO3 | Lecture, and problem solving | Assignment and final examination. |
| CLO4 | Lecture, and problem solving | Assignment and final examination. |
| CLO5 | Lecture, group discussions, class presentations, and problem solving | Class test, quiz, assignment and final examination. |
| CLO6 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |
| CLO7 | Lecture, class presentations, and problem solving | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Pratt, J. W., Raiffa, H., &Schlaifer, R. (1995). Introduction to statistical decision theory. MIT press.<br>Parmigiani, G., & Inoue, L. (2009). Decision theory: Principles and approaches. John Wiley & Sons. |
| Supplementary Readings | Box, G. E. P. and Tiao, G. C. (1973). Bayesian Inference in Statistical Analysis; Addision-Wesley Publishing Co.<br>Hogg, R. V. and Craig, A. T. (2002). Introduction to Mathematical Statistics; 4th edition, Macmillan Publishing Co., Inc.<br>Lehman, E. L.(1959). Testing Statistical Hypotheses; John Wiley and Sons Inc.<br>Barnett, V. (1996). Comparative Statistical Inference; 2nd edition, John Wiley and Sons Inc. |

| Course Code: 0542 20 Stat 3220 | Year: Third | Term: Second |
|---|---|---|
| Course Title | Viva Voce-III | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | The Viva-voce provides an opportunity to express the knowledge that the student(s) gathered during term education. | |
| Course Objectives | • To acquire knowledge and skills to face the interview panel.<br>• To equip the students with analytical and evaluation abilities to o respond to spontaneous questions by the panel members.<br>• To make the students to face the expert panel and present the knowledge, skills and problems in the most efficient way. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | The course contents are related to all courses taught in third year first term and second term for viva-voce preparation. | 1, 2, 3 |

| | | Upon successful completion of the course, the students will be able to: | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Should be able to demonstrate the application of the knowledge acquired in the term to solve the problems of the various forms. | 1, 2, 3, 4 |
| | CLO2 | Solve the real-life problems and assess the implications of various forms of solutions. | 3, 5, 8 |
| | CLO3 | Should be able to make effective presentation of different topics learnt in front to the experts. | 5, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1-3 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | All the recommended books and materials of the third year, first and second terms. |

| Fourth Year First Term | | |
|---|---|---|
| Course Code: 0542 20 Stat 4100 | Year: Fourth | Term: First |

| | |
|---|---|
| Course Title | Project Proposal Development |
| Course Status | Core |
| Credit | 2.0 |
| Prerequisite(s) | None |
| Rationale | The project proposal development/Project-I course provides an opportunity to gather research base knowledge and produce a substantial piece of work. |
| Course Objectives | • Develop student research curiosity and skills in critical and creative thinking, project management, and communication, which will enrich their subsequent academic and employment experiences. |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Topics selection of the project, literature review and methodology of the research project, data collection from primary and/or secondary sources, data cleaning, and processing. | 1, 2, 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Find out the own area of interest and explore in depth. | 1, 2, 3, 7 |
| | CLO2 | Identify own question and think critical way to solve problems. | 2, 3, 4, 5, 8 |
| | CLO3 | Experience the process of producing knowledge. | 2, 3, 5, 8 |
| | CLO4 | Develop and demonstrate analytical, judgmental, presentation and communication skills. | 1, 2, 3, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Discussion about research project with supervisor(s) | Project defense |
| CLO2 | Review of literature, Supervisor contacts, Data collection and processing | Report evaluation and Project defense |
| CLO3 | Review of literature, Supervisor contacts, Data collection and processing | Report evaluation and Project defense |
| CLO4 | Review of literature, Supervisor contacts, Data collection and processing | Report evaluation and Project defense |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Kothari, C. R., Garg,G.(2014): Research Methodology: Methods and Techniques. 3rd edition.<br>Islam, M.N. (2015): An Introduction to Research Methods, Mullick and brothers, 3rd edition. Dhaka. |
| Supplementary Readings | Panneerselvam, R. (2016). Research Methodology. PHL learning Private Ltd. 2nd edition, Delhi, India.<br>Trochim, W. M. K. (2006). Research Methods (2nd edition), Biztantra, New Delhi.<br>Dooley, D. (2001). Social Research Methods (4th edition), Prentice Hall of India.<br>Babbie, E. (2004). The Practice of Social Research (10th edition), Thompson, Wads Worth.<br>Elliot, J.A. (2012). An Introduction to Sustainable Development, 4th Ed, Routledge, Taylor & Francis.<br>Data Gap Analysis of Sustainable Development Goals (SDGs): Bangladesh Perspective, (2017). General Economics Division (GED), Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.<br>BBS and NIPORT, All Demographic Reports. |

| Course Code: 0542 20 Stat 4101 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Multivariate Analysis-I | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to present different concept of multivariate terms, techniques, structure of real-life data and its application to advanced research. | | |
| Course Objectives | • Outline the main features of multivariate data.<br>• Use exploratory and confirmatory multivariate statistical methods properly.<br>• Carry out multivariate statistical techniques and methods efficiently and effectively. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Basics: Preliminaries of multivariate statistics, multivariate observations, difference between multivariate and univariate observations, Distance, random vectors and matrices, mean vectors and covariance matrices, Geometry of the sample mean, random samples and the expected values of the sample mean and covariance matrix. | 1, 6 |
| 2 | Multivariate Normal Distribution: Bivariate normal distribution, Distribution of linear combinations of normally distributed variates, marginal and conditional distributions, maximum likelihood methods for estimating the mean vector and the covariance matrix in multivariate normal distribution. | 2, 3, 5 |
| Section B | | CLOs |
| 3 | Wishart's Distribution: Wishart's distribution and some properties, generalized variance and their proportion, inference about multivariate means, Hotelling 〖T〗^2, multivariate analysis of variance, Mahalanabis D-square. | 4 |
| 4 | Principal Components Analysis (PCA): Introduction to principal components in the population, ML estimator of the principal components and their variances, sampling properties of the sample principal components, singular value decomposition (SVD) and its application to PCA, application of principal component in regression analysis. | 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Explore and summarize multivariate data using graphical and numerical methods and techniques to uncover hidden information and patterns. | 1, 3, 8 |
| | CLO2 | Conceptualize the basic idea of organization, display of multivariate data. | 3, 4, 5, 8 |
| | CLO3 | Explain the covariance structure, partitioning and its distribution. | 3, 5, 8 |
| | CLO4 | Describe properties of multivariate distributions such as multivariate normal. | 1, 2, 3 |
| | CLO5 | Test for multivariate normality of the data. Apply multivariate statistical methods via hypothesis testing, point estimation and confidence interval estimation. | 1, 4, 8 |
| | CLO6 | Distinguish between ANOVA and MANOVA. | 1, 3 |
| | CLO7 | Perform data reduction technique using principal component analysis (PCA). | 1, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and group discussion | Quiz and continuous assessment |
| CLO2 | Lecture, presentation and problem solving | Assignment and final examination. |
| CLO3 | Lecture and Presentation | Continuous assessment and final examination. |
| CLO4 | Lecture, presentation and problem solving | Assignment and final examination. |
| CLO5 | Lecture and Presentation | Quiz and final examination. |
| CLO6 | Lecture and Presentation | Continuous assessment and final examination. |
| CLO7 | Lecture and Presentation | Continuous assessment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 5th ed., Wiley, N.Y.<br>Johnson, R. A., & Wichern, D. W. (1992). Applied multivariate statistical analysis. New Jersey, 405. |
| Supplementary Readings | Dillon, W. R., & Goldstein, M. (1984). Multivariate analysis: Methods and applications. New York (NY): Wiley.<br>Krzanowski, W. J.(1988) Principles of Multivariate Analysis: A User's Perspective.<br>Srivastava, M.S. and Carter, E.M. (1983). An Introduction to Applied Multivariate Statistics, North Holland, Netherlands. Tong, Y.L. (1990). The Multivariate Normal Distributions. Springer-Verlag, N.Y. |

| Course Code: 0542 20 Stat 4102 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Multivariate Analysis-I Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course increases the capability of analyzing high dimensional data. | | |
| Course Objectives | • Carry out multivariate statistical techniques and methods efficiently and effectively.<br>• Generate and partition the covariance structure of multidimensional data. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Details study of multivariate analysis: analysis of statistical distance, geometry of different statistics, multivariate normal distribution, statistical inference, introduction to principal components, ML estimator of the principal components and their variances with its application. | 1, 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Analyze multivariate data and draw valid inference. | 1, 2, 3, 8 |
| | CLO2 | Obtain ML estimate for multivariate techniques. | 1, 2, 3, 4, 6, 8 |
| | CLO3 | Reduce dimension remaining the almost same information. | 2, 3, 6, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, presentation and computer based sessional | Continuous assessment and viva voce. |
| CLO2 | Lecture, presentation and computer based sessional | Continuous Assessment, final examination, viva voce. |
| CLO3 | Lecture, presentation and computer based sessional | Continuous Assessment, final examination, viva voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 5th ed., Wiley, N.Y.<br>Johnson, R. A., & Wichern, D. W. (1992). Applied multivariate statistical analysis. New Jersey, 405. |
| Supplementary Readings | Hyvarinen, A, Karhunen, J. and Oja, E. (2001). Independent Component Analysis, Wiley, New York<br>Dillon W.R. and Goldstien, M. (1984). Multivariate Analysis: Methods andApplications<br>Krzanowski, W. (1990). Principles of Multivariate Analysis A users perspective,Oxford.<br>Srivastava, M.S. and E.M Carter (1983). An Introduction to Applied Multivariate Statistics, North Holland, Netherlands.<br>Tong, Y.L. (1990). The Multivariate Normal Distributions. Springer-Verlag, N.Y. |

| Course Code: 0542 20 Stat 4103 | Year: Fourth | Term: First |
|---|---|---|
| Course Title | Biostatistics | |
| Course Status | Core | |
| Credit | 3.0 | |
| Prerequisite(s) | None | |
| Rationale | This course is designed to provide basic concepts of handling the incomplete data of health Science. | |
| Course Objectives | • Apply basic statistical concepts commonly used in health sciences and clinical research.<br>• Explore why biologists need a background in statistics conducting research.<br>• Cover the appropriate application, calculation and interpretation of statistical tests for incomplete data. | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Overview of biostatistics, development and nature of discipline, current focuses and challenges. | 1, 2 |
| 2 | Basic Quantities: Failure, intensity of failure, lifetime, life time data, residual life, life table, lifetime distribution, survival function, hazard function, interrelationships, mean residual life function, median life time. failure rate, study of IFR, DFR, CFR, | 1, 2, 3 |
| 3 | Location and Scale Families of Distributions: Uniform, Exponential, Weibull, Extreme Value, Log-normal, Gumbel and Laplace distribution, concept of censoring and truncation, types of censoring. | 2, 3, 5 |
| | Section B | CLOs |
| 4 | Nonparametric Methods: Kaplan-Meier estimation, estimation of survival function, hazard function, reduced sample method, product limit method, actuarial method, estimation and standard error. | 2, 3, 4 |
| 5 | Parametric Methods: Likelihood construction for censored and truncated data, estimation of parameters and their sampling variances from Exponential, Weibull, Log-normal and Extreme value distributions using complete and type I and type II censored data, and draw inference about the estimators. | 4, 5 |
| 6 | Proportional Hazards Models: Introduction, Cox proportional hazard (PH) model and hypothesis test, partial likelihood, estimation of model parameters, applications of Cox PH model. | 5, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Describe the roles of biostatistics serves in the discipline of public health. | 1, 5 |
| | CLO2 | Recognize the problems that censoring brings and understand why the more statistical techniques are insufficient with such data. | 3, 7 |
| | CLO3 | Apply descriptive techniques commonly used to summarize public health data and estimate Kaplan-Meier estimator and other survival function. | 1, 8 |
| | CLO4 | Apply descriptive and inferential methodologies according to the type of study design for answering a particular research question | 1, 3, 5 |
| | CLO5 | Interpret results of statistical analyses found in public health studies and Learn the basics of the Cox proportional hazards model. | 1, 4, 6, 7 |
| | CLO6 | Fit parametric regressions models and test for relationships. | 1, 3, 5, 8 |
| | CLO7 | Develop written and oral presentations based on statistical analyses for both public health professionals and educated lay audiences. | 1, 5, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and continuous assessment |
| CLO2 | Lecture and Presentation | Assignment and final examination. |
| CLO3 | Lecture and problem solving | Continuous assessment, assignment and final examination. |
| CLO4 | Lecture and Presentation | Class test and final examination. |
| CLO5 | Lecture and Presentation | Continuous assessment and assignment. |
| CLO6 | Lecture and Presentation | Continuous assessment and assignment. |
| CLO7 | Lecture and Group Discussion | Viva voce and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Lawless, J. F. (2011). Statistical models and methods for lifetime data. John Wiley & Sons.<br>Karim, M. R., & Islam, M. A. (2019). Reliability and survival analysis. Springer Singapore. |
| Supplementary Readings | Cox, D. R., & Oakes, D. (2018). Analysis of survival data. Chapman and Hall/CRC.<br>Kalbfleisch, J. D., & Prentice, R. L. (2011). The statistical analysis of failure time data. John Wiley & Sons.<br>Kleinbaum, D. G., Kupper, L. L., & Morgenstern, H. (1991). Epidemiologic research: principles and quantitative methods. John Wiley & Sons.<br>Elandt-Johnson, R. C., & Johnson, N. L. (1980). Survival models and data analysis (Vol. 110). John Wiley & Sons.<br>Lee, E. T., & Wang, J. (2003). Statistical methods for survival data analysis (Vol. 476). John Wiley & Sons. |

| Course Code: 0542 20 Stat 4105 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Econometrics | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This session is designed to facilitate research techniques in real situation and integrated with economics, social science and life related problems. | | |
| Course Objectives | • Pertain knowledge of mathematics, economics, social science and engineering.<br>• Design a scheme and gratitude the ability to keep in life-long research-oriented works.<br>• Apply time related problems especially simultaneous equation theory in assessing the performance of a structure.<br>• Measure market condition using different production functions and uses nonlinear regression to measure nonlinearity of parameter. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Preliminary Concepts: Origin and scope econometrics, goals of econometrics, division of econometrics, econometrics for policy analysis, simultaneous equation models. | 1, 2 |
| 2 | Dynamic Econometric Models: Auto regressive and distributed lag models, role of time and lag models, reasons for bias, estimation of distributed lag models, Koyck approach, combination of adaptive expectations and partial adjustment models, estimation of autoregressive models, Sargan test, problems and solutions of dynamic econometric models. | 2 |
| 3 | Simultaneous Equation Models: Simultaneous equation bias, inconsistency of OLS estimators, types and rules of identification, estimation in simultaneous estimation methods, method of indirect least square (ILS), two stage least square (2SLS),three stage least squares (3SLS), full information maximum likelihood method, limited information maximum likelihood method. | 2, 3 |
| Section B | | CLOs |
| 4 | Linearity Homogeneous and Production Function: Introduction, the economic model, the statistical model, Cobb- Douglas (CD) production with properties and estimation, constant elasticity of substitution (CES) production function. | 3, 4 |
| 5 | Demand Analysis: Introduction, the origin of demand analysis, the basic model; Schultz's method, the estimation of price flexibility's, single-commodity studies; dynamic demand analysis. The Almost Ideal Demand System (AIDS) model. | 4 |
| 6 | Nonlinear Regression: Intrinsically linear and nonlinear regression, estimating nonlinear regression models such as direct methods, direct optimization, and iterative linearization methods. | 4, 5 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Develop an idea about econometrics and policy analysis. | 1, 7 |
| | CLO2 | Observe different simultaneous equation models and its effect in time related situations. | 4, 8 |
| | CLO3 | Exploit nonlinear regression to gain quick answers to nonlinearity questions. | 5, 8 |
| | CLO4 | Formulate Cobb- Douglas (CD) production and constant elasticity of substitution (CES) production function problems. | 1, 6, 8 |
| | CLO5 | Analyze dynamic demand function; price flexibilities to observe market condition. | 4, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and continuous assessment |
| CLO2 | Lecture and Presentation | Continuous assessment, assignment and final examination. |
| CLO3 | Lecture and Presentation | Assignment and final examination. |
| CLO4 | Lecture and Presentation | Continuous assessment, and final examination. |
| CLO5 | Lecture and Group Discussion | Viva voce and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Gujarati, D. N. (2010). Basic Econometrics; 4rd edition; McGraw-Hill Inc.<br>Draper, N. R., & Smith, H. (1998). Applied regression analysis. John Wiley & Sons. |
| Supplementary Readings | Johnston, J. (1997). Econometric Methods, 4th Ed., McGraw-Hill, N.Y.<br>Koutsoyiannis, A. (1987). Theory of Econometrics; 2nd Edition, Mcmillan Press Ltd.<br>McCullagh and Nelder (1989). Generalized Linear Models, Chapman and Hall. |

| Course Code: 0542 20 Stat 4106 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Econometrics and Biostatistics Lab | | |
| Course Status | Core | | |
| Credit | 1.5 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to implement practical econometric related problems and enhance the capability of analyzing censored data. | | |
| Course Objectives | • Appreciate dynamic econometric models and simultaneous equation models.<br>• Estimate Douglas production function and CES production function in real life situation.<br>• Apply parametric and non-parametric methods to life time data.<br>• Assess the effects of different hazardous factors on failure time. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Problems and solutions of dynamic econometric models, solve identification problems, estimation in simultaneous estimation methods such as method of indirect least square (ILS) and two stage least square (2SLS) and 3 SLS, full information maximum likelihood method, limited information maximum likelihood method, estimation and application of Cobb-Douglas production function and, CES production function and AIDS demand model. | 1, 2 |
| 2 | Non-parametric estimation of survival and hazard functions with standard errors and confidence intervals, fitting of parametric survival distributions under different types of censored data, comparison of two and/or more than two survival curves, check of proportional hazard assumptions, Cox proportional hazard model analysis, fitting of parametric regression models and tests of fit. Solve different problem based on epidemiology/ environmental statistics. | 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Find out dynamic econometric models from huge data set and calculate simultaneous equation models. | 1, 2, 3, 4 |
| | CLO2 | Estimate and apply the C-D production function and CES production function and analyze dynamic demand function and nonlinear regression models. | 1, 2, 3, 4 |
| | CLO3 | Obtain the Kaplan-Meier estimate of survival function with confidence interval and construct likelihood function for censored data and calculate necessary statistic. | 1, 2, 3, 4 |
| | CLO4 | Fit Cox proportional hazard model and measure the impact of factors on this function and use an appropriate software tool for data analysis. | 1, 2, 3, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Assignment and continuous assessment, viva voce. |
| CLO2 | Lecture, and problem solving | Assignment and continuous assessment. |
| CLO3 | Lecture and problem solving | Continuous assessment and viva voce. |
| CLO4 | Lecture and problem solving | Continuous assessment, and viva voce. |

| | |
|---|---|
| Recommended Readings | Gujarati, D. N. (2010). Basic Econometrics; 4rd edition; McGraw-Hill Inc.<br>Draper, N. R., & Smith, H. (1998). Applied regression analysis. John Wiley & Sons.<br>Lawless, J. F. (2011). Statistical models and methods for lifetime data. John Wiley & Sons.<br>Karim, M. R., & Islam, M. A. (2019). Reliability and survival analysis. Springer Singapore. |
| Supplementary Readings | Johnston, J. (1997). Econometric Methods, 4th Ed., McGraw-Hill, N.Y.<br>Koutsoyiannis, A. (1987). Theory of Econometrics; 2nd Edition, Mcmillan Press Ltd.<br>Cox, D. R., & Oakes, D. (2018). Analysis of survival data. Chapman and Hall/CRC.<br>Kalbfleisch, J. D., & Prentice, R. L. (2011). The statistical analysis of failure time data. John Wiley & Sons.<br>Kleinbaum, D. G., Kupper, L. L., & Morgenstern, H. (1991). Epidemiologic research: principles and quantitative methods. John Wiley & Sons.<br>Elandt-Johnson, R. C., & Johnson, N. L. (1980). Survival models and data analysis (Vol. 110). John Wiley & Sons.<br>Lee, E. T., & Wang, J. (2003). Statistical methods for survival data analysis (Vol. 476). John Wiley & Sons. |

| Course Code: 0542 20 Stat 4109 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Robust Statistics | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course offers an introduction to the field of robust statistics, which comprises the study of statistical methods that are more resistant to outlying observations than classical statistics. It introduces the most fundamental estimators in several statistical models. | | |
| Course Objectives | • Develop the concepts and theory of robust statistics.<br>• Compare classical approach with robust approach.<br>• Approximate the asymptotic theory and efficiency of robust statistic.<br>• Explain robustness, statistical computing and fit robust regression with diagnostic. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Basic concepts of robust statistics, aim, properties, applications and limitation, robust vs. classical statistics, outlier and its effect in different estimator, influence of an observation in different estimator, robust in location and scale estimator, three sigma rule and its limitation. | 1, 2 |
| 2 | Location model: Concept, invariant estimator for location, some probability distribution function for location model, M-estimator and development of M-estimator for location model, MLE for location model with examples, score and loss function, Huber M-estimator, distribution of M-estimator. Other's location estimators: α-trimmed mean, α-winsorized mean. Others Robust Estimators and their properties: R-estimators, least trimmed squares estimator (LTS), reweighted least squares estimator (RLS), Resistance properties of M-estimators. | 2, 3 |
| Section B | | CLOs |
| 3 | Scale model: Concept, some probability distribution function for scale model, MLE for scale with example, M-estimator and development of M-estimator for scale model, numerical computation for location and scale model. | 1, 5 |
| 4 | Measuring Robustness: Different concepts of robustness. Measuring robustness: breakdown point and influence function. Robustness vs. Efficiency. | 2, 4 |
| 5 | Robust Regression: Introduction, goal and necessities of robust regression. M-estimates with known scale, Regression M-estimates and its application, M-estimates with preliminary scale. The breakdown point, LMS estimator, LTS estimator and S-estimator of regression model. The reweighted least squares residuals. MM-estimator, Lp norm. Robust test for linear hypothesis. | 1, 2, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Introduce the basic concept of robust statistics. | 1 |
| | CLO2 | Describe and decide when it is, and when it is not, appropriate to use robust methods. | 1, 3 |
| | CLO3 | Measure the strengths and limitations of a range of robust methods. | 6, 7 |
| | CLO4 | Develop idea about different robust estimators and their applications. | 1, 8 |
| | CLO5 | Extract the properties and techniques of robust estimator. | 1, 8 |
| | CLO6 | Estimate robust regression and its diagnostic procedure | 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and Continuous Assessment |
| CLO2 | Lecture and Presentation | Continuous Assessment, Assignment |
| CLO3 | Lecture and Presentation | Assignment |
| CLO4 | Lecture and Group Discussion | Continuous Assessment |
| CLO5 | Lecture and Presentation | Quiz, Continuous Assessment |
| CLO6 | Lecture and Presentation | Quiz, Assignment and Final Examination |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Huber, P. J. (2011). Robust statistics. In International encyclopedia of statistical science (pp. 1248-1251). Springer, Berlin, Heidelberg.<br>Maronna, R. A., Martin, R. D., Yohai, V. J., & Salibián-Barrera, M. (2019). Robust statistics: theory and methods (with R). John Wiley & Sons. |
| Supplementary Readings | Robinson E (1985). Probability Theory and Applications. Springer Science & Business Media<br>Wadsworth GP and Bryan JG (1960). Introduction to Probability and Random Variables. McGraw-Hill.<br>Arnold BC, Balakrishnan N and Nagaraja HN (2008). A First Course in Order Statistics. Society for Industrial and Applied Mathematics.<br>Rousseeuw, P. J., & Hubert, M. (2011). Robust statistics for outlier detection. Wiley interdisciplinary reviews: Data mining and knowledge discovery, 1(1), 73-79.<br>Rousseeuw, P. J. (1991). Tutorial to robust statistics. Journal of chemometrics, 5(1), 1-20.<br>Olive, D. J. (2008). Applied robust statistics. Preprint M-02-006. |

| Course Code: 0542 20 Stat 4111 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Industrial Statistics and Quality Control | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to understand quality of product, its improvement and build knowledge about different sampling plans to access current market conditions as well as supply and demand of product. | | |
| Course Objectives | • Interpret history of quality control and progress.<br>• Develop methodology and philosophy of statistical process control.<br>• Draw different control charts and explore their applications.<br>• Apply control charts to access the market behavior and further implication. | | |

| Course Contents | | CLOs |
|---|---|---|
| | Section A | |
| 1 | Quality Improvement in the Modern Business Environment: Overview and learning objectives, meaning of quality and quality improvement, a brief history of quality control, statistical methods for quality control and improvement, management aspects of quality Improvement. | 1 |
| 2 | Modeling Process Quality: Describing variation, Method and philosophy of statistical process control: chance and assignable causes of quality variation, statistical basis of the control chart, implementing SPC in a quality improvement program, an application of SPC, applications of statistical process control and quality improvement tools in transactional and service businesses. | 1, 2 |
| 3 | Control Charts for Variable: Introduction, control charts for and R, Shewhart control chart for individual measurements, summary of procedures for , R, and s charts, applications of variables control charts. | 2, 3 |
| | Section B | CLOs |
| 4 | Control Charts for Attributes: Introduction, control chart for fraction nonconforming, control charts for nonconformities (defects), choice between attributes and variables control charts, guidelines for implementing control charts. | 3, 4 |
| 5 | Acceptance Sampling: Lot-by-lot acceptance sampling for attributes, acceptance sampling problem, single sampling plans for attributes, double, multiple, sequential Sampling, Dodge–Romig sampling plans, other acceptance sampling techniques: acceptance sampling by variables, designing a variables sampling plan with a specified OC curve. | 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Display a broad idea of different quality improvement methods, improvement and aspects of quality improvement. | 1, 3, 7 |
| | CLO2 | Evaluate quality control charts to improve service businesses. | 1, 3, 8 |
| | CLO3 | Demonstrate conformities and nonconformities with implementing control charts. | 1, 8 |
| | CLO4 | Develop hypotheses based on the different quality control chart results and test them. | 1, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and group discussion | Class test and assignment. |
| CLO2 | Lecture and presentation | Quiz and final examination. |
| CLO3 | Lecture and presentation | Quiz and final examination. |
| CLO4 | Lecture | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Montgomery, D. C. (2020). Introduction to statistical quality control. John Wiley & Sons. |
| Supplementary Readings | Dodge and Roming., (1998). Sampling inspection tables: Single and Double Sampling, 2nd revised edition, Wiley.<br>Islam, M. N. (2021). An Introduction to Business Statistics, 1st edition, Mullick and Brothers, Dhaka.<br>Grant, E.L., (1996). Statistics Quality Control. 6th Edition, Wiley<br>Croxton and Cowden (1969). Practical Business Statistics. 4 thedi, Asia Publishing House.<br>Wessel, Wellet and Simons. (2016). Statistics as applied to Economics and Business, Springer International Publishing<br>Wetherill, G.B. (1977). Sampling Inspection and Q.C. Chapman & Hill.<br>Gupta S.C. and Kapur, V.K. (1994). Applied Statistics. 3rd Reprint Edition. Sultan Chand & Sons. |

| Course Code: 0542 20 Stat 4113 | | Year: Fourth | Term: First |
|---|---|---|---|
| Course Title | Analysis of Repeated Measurements | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course provides general view of repeated measurements and modeling the variables | | |
| Course Objectives | • Provide different sources of correlation.<br>• Construct different models to health science and predict model.<br>• Apply GEE method and analyze missing data. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Introduction of repeated measurement data, examples, objectives of repeated measurement analysis, problems related to one sample and multiple samples, sources of correlation in repeated measurement analysis, exploring repeated, measures data. | 1 |
| 2 | Linear model for repeated measurements: Introduction, notation and distributional assumptions, simple descriptive methods of analysis, modeling the mean, modeling the covariance, estimation and statistical inference. | 1, 2 |
| 3 | Repeated measures ANOVA: The fundamental model; one sample repeated measures ANOVA model, multiple samples repeated measures ANOVA models. | 2, 3 |
| Section B | | CLOs |
| 4 | Linear mixed effects models: Introduction, random effects covariance structure, prediction of random effects, residual analysis and diagnostics. | 4 |
| 5 | Methods based on extension of generalized linear models:Review of univariate generalized linear models, quasi-likelihood, methods of analysis of repeated measurements: marginal models, random effects models, transition models, comparison between these approaches. | 5 |
| 6 | GEE Methods: Methodology, hypothesis tests using Wald statistics, assessing model adequacy; GEE1 and GEE2. | 5, 6 |
| 7 | Statistical analysis with missing data: Missing data, missing data pattern, missing data mechanism, imputation procedures, mean imputation, hot deck imputation. | 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Analyze data of repeated measurement. | 1, 4 |
| | CLO2 | Construct linear model for repeated measurement and modeling mean response variable. | 1, 4, 8 |
| | CLO3 | Handle repeated measures ANOVA model. | 1, 4, 8 |
| | CLO4 | Have a concrete knowledge on random effects covariance structure. | 1, 4 |
| | CLO5 | Compare and assess different GEE approaches. | 1, 4, 8 |
| | CLO6 | Apply GEE method with missing data. | 1, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Class test. |
| CLO2 | Lecture and Presentation | Class test, and assignment. |
| CLO3 | Lecture and Group Discussion | Assignment, final examination. |
| CLO4 | Lecture, problem solving and Presentation | Assignment, and final examination. |
| CLO5 | Lecture and Presentation | Assignment, final examination. |
| CLO6 | Lecture and Presentation | Assignment. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Davis, C. S. (2002). Statistical methods for the analysis of repeated measurements (No. 04; QA278, D38.). New York: Springer.<br>Islam, M. A., & Chowdhury, R. I. (2017). Analysis of repeated measures data (pp. 51-66). Singapore: Springer. |
| Supplementary Readings | Littell, R. C. (1990). Analysis of repeated measures data.<br>Crowder, M. J., & Hand, D. J. (2017). Analysis of repeated measures. Routledge.<br>Gurevitch, J., & Chester, S. T. (1986). Analysis of repeated measures experiments. Ecology, 67(1), 251-255. |

| Fourth Year Second Term | | |
|---|---|---|
| Course Code: 0542 20 Stat 4200 | Year: Fourth | Term: Second |

| | |
|---|---|
| Course Title | Project |
| Course Status | Core |
| Credit | 2.0 |
| Prerequisite(s) | None |
| Rationale | It is designed to draw together all of the knowledge that the student has acquired on the program and will enable them to develop and demonstrate analytical, judgmental and communication skills. |
| Course Objectives | • Develop student research interest, critical skills, creative thinking, project management, and communication, which will improve their consequent academic and service experiences. |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Data analysis and data presentation, interpretation of results, and final report writing. | 1, 2, 3 |

| | | Upon successful completion of the course, the students will be able to: | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Use their communication, information-seeking and intellectual skills. | 1, 2, 3, 7 |
| | CLO2 | Organize and complete research-oriented works. | 2, 3, 4, 5, 8 |
| | CLO3 | Develop and demonstrate analytical, judgmental, presentation and communication skills. | 2, 3, 5, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Supervisor contacts, data analysis, report writing | Report evaluation, Project defense |
| CLO2 | Supervisor contacts, data analysis, report writing | Report evaluation, Project defense |
| CLO3 | Discussion and report writing | Report evaluation, Project defense |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Kothari, C. R., Garg,G.(2014). Research Methodology: Methods and Techniques. 3rd edition.<br>Islam, M.N. (2015). An Introduction to Research Methods, Mullick and brothers, 3rd edition. Dhaka. |
| Supplementary Readings | Babbie, E.(2004). The Practice of Social Research (10th edition), Thompson, Wads Worth.<br>Jennifer A. Elliot, (2012). An Introduction to Sustainable Development, 4th Ed, Routledge, Taylor & Francis.<br>Data Gap Analysis of Sustainable Development Goals (SDGs): Bangladesh Perspective, (2017). General Economics Division (GED), Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.<br>BBS and NIPORT, All Demographic Reports. |

| Course Code: 0542 20 Stat 4201 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Multivariate Analysis-II | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to continue higher Multivariate Analysis and co-integrated with Multivariate Analysis. | | |
| Course Objectives | • Indulgent of initial concepts of factor analysis, factor interpretation and transformation.<br>• Understanding algorithms of linear discriminant function and classification.<br>• Appreciative knowledge about statistical inference of canonical correlation.<br>• Ability to apply clustering methods and understand correspondence analysis.<br>• Develop skill of entropy, mutual information etc. to realize independent component theory. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Factor Analysis: Introduction, the mathematical model for factor structure, ML estimators for random orthogonal factors, estimation for fixed factors, testing the goodness of fit of the factor model, factor interpretation and transformation. | 1, 2 |
| 2 | Discrimination 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, ada-boost for classification. | 2, 3, 4 |
| Section B | | CLOs |
| 3 | Canonical Correlation Analysis: Introduction, canonical correlation and varieties in the population, estimation of canonical correlation and varieties, statistical inference. | 3, 4 |
| 4 | Cluster Analysis: Introduction, similarity measures, hierarchical clustering methods (Single linkage, complete linkage, average linkage, and Ward's methods), non-hierarchical clustering methods (K-means, Fuzzy and model-based clustering), and correspondence analysis. | 4, 5 |
| 5 | Independent Component Analysis: Introduction, information theory (entropy, mutual information, K-L divergence, maximum entropy, negentropy), ICA by maximizing non-gaussianity, ICA by maximum likelihood estimation, ICA by minimizing mutual information, algorithms (Fast ICA, Infomax). | 5, 6, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Display a widespread accepting of factor, testing factor model, factor interpretation and data reduction. | 1, 3, 7 |
| | CLO2 | Evaluate factor model using Eigen value and Eigen vector with respect to their accuracy. | 3, 4 |
| | CLO3 | Demonstrate capacity to perform a self-directed piece of practical work that requires the application of discrimination and classification techniques. | 1, 4 |
| | CLO4 | Understand estimation of canonical correlation and what does it mean. | 3, 5 |
| | CLO5 | Realize different kinds of clustering tools and its implementation in economic sector and artificial world. | 1, 3 |
| | CLO6 | Identify the necessity of information theory and algorithms. | 2, 5, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and class test. |
| CLO2 | Lecture and presentation | Continuous assessment, assignment and final examination. |
| CLO3 | Lecture and presentation | Class test, assignment and final examination. |
| CLO4 | Lecture and presentation | Class test, assignment and final examination. |
| CLO5 | Lecture, group discussion and presentation | Class test, quiz and final examination. |
| CLO6 | Lecture and presentation | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 5th ed., Wiley, N.Y.<br>Johnson, R. A., & Wichern, D. W. (1992). Applied multivariate statistical analysis. New Jersey, 405. |
| Supplementary Readings | Hyvarinen, A, Karhunen, J. and Oja, E. (2001). Independent Component Analysis, Wiley, New York<br>Dillon W.R. and Goldstien, M. (1984). Multivariate Analysis: Methods andApplications<br>Srivastava, M.S. and E.M Carter (1983). An Introduction to Applied Multivariate Statistics, North Holland, Netherlands.<br>Tong, Y.L. (1990). The Multivariate Normal Distributions. Springer-Verlag, N.Y. |

| Course Code: 0542 20 Stat 4202 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Multivariate Analysis-II Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is planned to implement practical multivariate analysis related problem. | | |
| Course Objectives | • Apply factor analysis and cluster analysis and ICAto solve the social problem.<br>• Estimate canonical correlation to represent the relationship of multiple causes and effects of real phenomena. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Discrimination and classification, factor analysis of multivariate data including factor rotation, factor interpretation etc., estimation and interpretation of canonical varieties and canonical correlation, application cluster analysis and ICA, application of computer package programs for multivariate data analysis. | 1, 2, 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Calculate factor from large data set and interpret factor rotation, factor score. | 1, 7 |
| | CLO2 | Apply cluster analysis. | 2, 3 |
| | CLO3 | Solve discrimination and classification problems. | 4, 6, 8 |
| | CLO4 | Construct multiple decrement tables. | 1, 2, 3, 5 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and continuous assessment |
| CLO2 | Lecture and Presentation | Class test and final examination. |
| CLO3 | Lecture and Problem solving | Assignment and final examination. |
| CLO4 | Lecture and Presentation | Continuous assessment and assignment. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Anderson, T.W. (2003). An Introduction to Multivariate Statistical Analysis, 5th ed., Wiley, N.Y.<br>Johnson, R. A., & Wichern, D. W. (1992). Applied multivariate statistical analysis. New Jersey, 405. |
| Supplementary Readings | Hyvarinen, A, Karhunen, J. and Oja, E. (2001). Independent Component Analysis, Wiley, New York<br>Srivastava, M.S. and E.M Carter (1983). An Introduction to Applied Multivariate Statistics, North Holland, Netherlands.<br>Tong, Y.L. (1990). The Multivariate Normal Distributions. Springer-Verlag, N.Y. |

| Course Code: 0542 20 Stat 4203 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Statistical Data Mining | | |
| Course Status | Core | | |
| Credit | 2.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide concepts to develop and apply critical thinking, problem solving and decision making in various perspectives. | | |
| Course Objectives | • Comprehend foundational concepts of data mining.<br>• Build basic terminology of data mining, principles and techniques.<br>• Demonstrate basic data mining algorithms, methods, and tools.<br>• Apply data mining tools to real-world problems and identify its business applications. | | |

| Course Contents | | CLOs |
|---|---|---|
| | Section A | |
| 1 | Introduction: Basic data mining tasks, Data mining versus Knowledge discovery in database, data mining issues, data mining metrics, social implications of data mining, data mining from a database perspective. | 1, 2 |
| 2 | Related concepts: Database/OLTP systems, introduction of fuzzy sets, Boolean logic, other representations of fuzzy sets and fuzzy logic, information retrieval, decision support systems, dimensional modeling, data warehousing, OLAP, web search engines, statistics, machine learning, pattern matching. | 2, 3, 9 |
| 3 | Data mining techniques: A statistical perspective on data mining, point estimation, models based on summarization, Bayes theorem, hypothesis testing, regression and correlation, similarity measures, decision trees, neural network, genetic algorithms. | 3, 4, 5 |
| | Section B | CLOs |
| 4 | Classification: Issues in classification, statistical-based algorithms, regression, Bayesian classification, distance-based algorithms, decision tree-based algorithms, neural network-based algorithms, and Rule-based algorithms. | 6, 7 |
| 5 | Clustering: Similarity and distance measures, outliers, hierarchical algorithms, Partitional algorithms, clustering large database, BIRCH, DBSCAN, Cure algorithms, clustering with categorical attributes. | 5, 8, 9 |
| 6 | Association rules: Introduction, large item sets, basic algorithms, Apriori algorithms, parallel and distributed algorithms, comparing approaches, incremental rules, advanced association rule techniques, measuring the quality rules, web mining. | 5, 6, 8 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Display a comprehensive understanding of different data mining tasks and algorithms in most appropriate for addressing them. | 1, 3 |
| | CLO2 | Extract knowledge using data mining techniques and evaluate models/ algorithms with respect to their accuracy. | 3 |
| | CLO3 | Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques. | 4, 6, 8 |
| | CLO4 | Critique the results of a data mining exercise and conceptualize a data mining Solution to a practical problem. | 1, 3 |
| | CLO5 | Design a data mart or data warehouse for any organization as well as adapt to new Data mining tools. | 3, 4 |
| | CLO6 | Overview of the developing areas - web mining, text mining, and ethical aspects of data mining. | 3, 4, 8 |
| | CLO7 | Formulate a hypothesis based on the analysis of the results obtained and test them. | 1, 6, 8 |
| | CLO8 | Use the heuristic search techniques for AI related problems, natural language processing techniques to computer. | 1, 2, 8 |
| | CLO9 | Use the heuristic search techniques for AI related problems, natural language processing techniques to computer and Sequencing Alignment and Dynamic Programming. | 2, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and class test |
| CLO2 | Lecture and Presentation | Class test, assignment and final examination. |
| CLO3 | Lecture and Group Discussion | Assignment and final examination. |
| CLO4 | Lecture | Class test. |
| CLO5 | Lecture and problem solving | Assignment and final examination. |
| CLO6 | Lecture | Class test and final examination. |
| CLO7 | Lecture and Presentation | Class test assignment and final examination. |
| CLO8 | Lecture | Class test and final examination. |
| CLO9 | Lecture | Class test and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Dunham, M. H. (2006). Data mining: Introductory and advanced topics. Pearson Education India. |
| Supplementary Readings | Ibrahim, A. (2004). Fuzzy logic for embedded systems applications. Newnes.<br>Larose, D. T. (2006). Data mining methods & models. John Wiley & Sons.<br>Friedman, M., & Kandel, A. (1999). Introduction to pattern recognition: statistical, structural, neural and fuzzy logic approaches (Vol. 32). World Scientific Publishing Company.<br>Schalkoff, R. (1992). Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley & Sons. Inc, New York.<br>Bozdogan, H. (Ed.). (2003). Statistical data mining and knowledge discovery. CRC Press.<br>Azzalini, A., & Scarpa, B. (2012). Data analysis and data mining: An introduction. OUP USA. |

| Course Code: 0542 20 Stat 4204 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Statistical Data Mining Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | The course is designed to help the students to understand and gather knowledge in work on database management system with appropriate statistical software. | | |
| Course Objectives | • Develop database management systems.<br>• Discover desirable information from large data sets.<br>• Estimate hidden information and missing value in a data set.<br>• Apply data mining tools to real-world problems and identify its business applications. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Introduction of fuzzy sets, and operation, information retrieval, decision support systems, dimensional modeling, data warehousing, statistics, machine learning, pattern matching. | 1, 2 |
| 2 | A statistical perspective on data mining, point estimation, models based on summarization, Bayes theorem, hypothesis testing, regression and correlation, similarity measures, decision trees, neural network, genetic algorithms. | 2, 3 |
| 3 | Issues in classification, statistical-based algorithms, regression, Bayesian classification, distance-based algorithms, neural network-based algorithms, and Rule-based algorithms. | 3, 4, 5 |
| 4 | Similarity and distance measures, outliers, hierarchical algorithms, Partitional algorithms, clustering large database, BIRCH, DBSCAN, Cure algorithms, clustering with categorical attributes. | 4, 5 |
| 5 | Introduction, large itemset, basic algorithms, Apriori algorithms, parallel and distributed algorithms, comparing approaches, incremental rules, advanced association rule techniques, measuring the quality rules, web mining. | 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Develop database management systems. | 1, 2, 3 |
| | CLO2 | Create new key buttons and delete old buttons from database software. | 2, 3, 8 |
| | CLO3 | Extract hidden information and missing values from a large data set. | 2, 3, |
| | CLO4 | Develop skills to write queries using DMQL. | 1, 2, 3, 8 |
| | CLO5 | Design classification, regression, genetic algorithm with programming. | 1, 6, 8 |
| | CLO6 | Display statistical graphs, tables, and analyze correlation, regression. | 1, 2, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and problem solving | Continuous assessment. |
| CLO2 | Lecture and group discussion | Continuous assessment and viva voce. |
| CLO3 | Lecture and problem solving | Quiz and continuous assessment. |
| CLO4 | Lecture and problem solving | Quiz and continuous assessment. |
| CLO5 | Lecture, group discussion and Presentation | Quiz, continuous assessment and final examination. |
| CLO6 | Lecture and problem solving | Report assessment and viva voce. |

| | |
|---|---|
| Recommended Readings | Dunham, M. H. (2006). Data mining: Introductory and advanced topics. Pearson Education India. |
| Supplementary Readings | Ibrahim, A. (2004). Fuzzy logic for embedded systems applications. Newnes.<br>Larose, D. T. (2006). Data mining methods & models. John Wiley & Sons.<br>Friedman, M., & Kandel, A. (1999). Introduction to pattern recognition: statistical, structural, neural and fuzzy logic approaches (Vol. 32). World Scientific Publishing Company.<br>Schalkoff, R. (1992). Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley & Sons. Inc, New York.<br>Bozdogan, H. (Ed.). (2003). Statistical data mining and knowledge discovery. CRC Press.<br>Azzalini, A., & Scarpa, B. (2012). Data analysis and data mining: An introduction. OUP USA. |

| Course Code: 0542 20 Stat 4205 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Environmental Statistics | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to introduce the basic concept of environmental factors and its monitoring system in the aspect of statistics. | | |
| Course Objectives | • Conceptualize the basic essence and monitoring system of environmental factors.<br>• Acquire knowledge on some economics theory associated with environmental factors. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Environment and Ecology: Factors of environment, pollution and contamination, system theory and ecosystem, its function, classification of environmental systems, concepts of sustainable development. | 1, 2, 4 |
| 2 | Environmental Economics: Theory of environmental externalities, Coase theorem, environmental welfare analysis, trade and environmental policy, resource allocation over time, valuing the environment, cost-benefit analysis, allocation of resources, ecological perspectives on population growth, resources and classification of resources, renewable and non-renewable resources. | 2, 3, 4, 5 |
| Section B | | CLOs |
| 3 | Environmental Monitoring: Detect ability methods for environmental populations, sampling techniques applicable to environmental studies, conventional and adaptive sampling, network sampling, inverse sampling, capture-recapture sampling, ranked set sampling, modification of these methods for various situations, spatial distribution and prediction, spatial point process models and methods. | 3, 5, 6 |
| 4 | Diversity: Measurement of diversity, different diversity indices. | 5, 7 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Describe the environmental system with associated factors. | 1, 8 |
| | CLO2 | Illustrate the ecosystem with its function. | 1, 3, 4 |
| | CLO3 | Identify sustainable ecosystem and its development. | 1, 3, 8 |
| | CLO4 | Recognize economic related environmental factors. | 1, 8 |
| | CLO5 | Depict some methods for identification of environmental population. | 1, 4, 8 |
| | CLO6 | Identify the appropriate environmental sampling technique for collecting data of a real problem. | 1, 3, 4, 8 |
| | CLO7 | Measure diversity with different indices. | 1, 2, 3, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, and presentation | Class test and final examination. |
| CLO2 | Lecture, and Presentation and group discussion | Quiz and assignment |
| CLO3 | Lecture and Presentation | Class test and final examination. |
| CLO4 | Lecture | Class test. |
| CLO5 | Lecture and Presentation | Class test and final examination. |
| CLO6 | Lecture, Presentation and group discussion | Assignment and final examination. |
| CLO7 | Lecture and group discussion | Assignment. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Barnett, V. (2004). Environmental Statistics: Methods and Applications, John Wiley and Sons, New York.<br>Hill, M. K. (2012). Understanding Environmental Pollutions, 3rd Edition, Combridge University Press, London. |
| Supplementary Readings | Thompson, S. K. (2012). Sampling, 3rd Edition, John Wiley and Sons Inc., New York.<br>Wayne, R. Ott. (1995). Environmental Statistics and Data Analysis, Lewis Publishers, England.<br>Barnett, V. and Turkman, K. F. (1993). Statistics for the Environment, John Wiley and Sons, Chichester. |

| Course Code: 0542 20 Stat 4207 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Statistical Methods for Meta-Analysis | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide the basic concept of Mea-Analysis and to synthesize the available evidence for a given question | | |
| Course Objectives | • Establish statistical significance with studies that have conflicting results.<br>• Develop a more correct estimate of effect magnitude.<br>• Provide a more complex analysis of harms, safety data, and benefits.<br>• Examine subgroups with individual numbers that are not statistically significant. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Introduction: Definition and purpose, Types of meta-analyses, Steps to Perform a Meta-Analysis, Criticisms of Meta-Analyses. | 1 |
| 2 | Effect, Size and Precision: Treatment effects and effect sizes, Parameters and estimates, Effect sizes based on means: Introduction, Raw (unstandardized) mean difference D, Standardized mean difference, d and g | 1, 2 |
| 3 | Response ratios effect sizes based on binary data (2×2 tables): Introduction, Risk ratio, Odds ratio, Risk difference, choosing an effect size index, Effect sizes based on correlations: Introduction, Computing r. | 2, 3 |
| 4 | Converting among effect sizes: Introduction, converting from the log odds ratio to d, Converting from d to the log odds ratio, converting from r to d, Converting from d to r. | 3 |
| Section B | | CLOs |
| 5 | Different model and their performance: Overview, Fixed-effect model: Introduction, The true effect size, Impact of sampling error, performing a fixed-effect meta-analysis. Random-effects model: Introduction, The true effect sizes, Impact of sampling error, performing a random-effects meta-analysis, Fixed-effect versus random-effects models: Definition of a summary effect, Estimating the summary effect, Extreme effect size in a large study or a small study, Confidence interval, The null hypothesis, Which model should we use? , Model should not be based on the test for heterogeneity. | 4 |
| 6 | Heterogeneity: overview, identifying and quantifying heterogeneity: Introduction, Isolating the variation in true effects, Computing Q, estimating $\pi^2$ and confidence intervals, the $I^2$ statistic and confidence intervals, comparing the measures of heterogeneity. | 5 |
| 7 | Subgroup analyses: Introduction, Fixed-effect model within subgroups, Computational models, Random effects with separate estimates of $\pi^2$, Random effects with pooled estimate of $\pi^2$, the proportion of variance explained, Mixed-effects model, obtaining an overall effect in the presence of subgroups. | 4, 5 |
| 8 | Meta-regression: Introduction, fixed-effect model, fixed or random effects for unexplained heterogeneity, random-effects model. | 6 |

| | | | |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
| | CLO1 | Describe about meta-analysis, how to perform meta-analysis, what will be the situation and condition. | 1, 3, 8 |
| | CLO2 | Understand the treatment effect and effect size. Find effect size based on mean difference, based on binary data and based on correlation. | 3, 4, 8 |
| | CLO3 | Perform fixed effect model, random effect model and convert different effect sizes in meta-analysis and estimate the summary effect and extreme effect size in large or small study. | 3, 5, 8 |
| | CLO4 | Identify and quantify heterogeneity, compare the measure of heterogeneity. | 1, 3, 7, 8 |
| | CLO5 | Explain the effect of subgroup in fixed effect model, compute random effect with separate estimates of $\pi^2$, compute random effect with pooled effect of $\pi^2$. | 1, 4, 7, 8 |
| | CLO6 | Explain the fixed or random effect model for unexplained heterogeneity. | 3, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture | Quiz and class test |
| CLO2 | Lecture and Presentation | Class test, assignment and final examination. |
| CLO3 | Lecture and problem solving | Assignment and final examination. |
| CLO4 | Lecture and Presentation | Class test and final examination. |
| CLO5 | Lecture and Presentation | Class test and Assignment. |
| CLO6 | Lecture and Group Discussion | Class test and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). Introduction to meta-analysis. John Wiley & Sons.<br>Borenstein, M. (2013). Computing effect sizes for meta-analysis. Wiley-Blackwell. |
| Supplementary Readings | Hedges, L. V., & Olkin, I. (2014). Statistical methods for meta-analysis. Academic press.<br>Lipsey, M. W., & Wilson, D. B. (2001). Practical meta-analysis. SAGE publications, Inc.<br>Wayne, R. Ott. (1995). Environmental Statistics and Data Analysis, Lewis Publishers, England.<br>Barnett, V. and Turkman, K. F. (1993). Statistics for the Environment, John Wiley and Sons, Chichester. |

| Course Code: 0542 20 Stat 4209 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Statistical Genetics | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to perform statistical analysis of biological science. | | |
| Course Objectives | • Comprehend the basic concept of genetics;<br>• Apply different statistical models and methods to analyze the genetic data;<br>• Introduce different genetic data analysis software:<br>• Explore the future research area. | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Basic Genetics: Introduction, Genes, Chromosomes and quantitative trait loci (QTL), Meiosis and Mitosis, Mendel's Laws, Linkage, Genetic distance and Recombination, Quantitative genetics, Molecular Genetics, Genotyping and Genotyping technology. | 1 |
| 2 | Basic Statistics of Genetics: Populations and Models, Samples, Descriptive Statistics, Likelihood Estimation and Hypothesis Testing. | 1 |
| 3 | Linkage Analysis and Map Construction: Introduction, Experimental Design, Mendelian Segregation, Segregation Patterns in a Full-Sib Family, Two-Point Analysis, Three-Point Analysis, Multilocus Likelihood and Locus Ordering, Estimation with Many Loci, Mixture Likelihoods and Order Probabilities, Map Functions and Algorithms and Software for Map Construction. | 2, 3 |
| | Section B | CLOs |
| 4 | Marker Analysis of Phenotypes: Introduction, QTL Regression Model, Analysis at the Marker, Moving Away from the Marker, Power Calculation, Marker Interaction Analysis, Whole-Genome Marker Analysis. | 4 |
| 5 | The Structure of QTL Mapping: Introduction, The Mixture Model, Population Genetic Structure of the Mixture Model, Quantitative Genetic Structure of the Mixture Model, Experimental Setting of the Mixture Model, Estimation in the Mixture Model, Computational Algorithms for the Mixture Model. | 4, 5 |
| 6 | Interval Mapping Approaches for QTL Analysis: Introduction, Linear regression and maximum likelihood approaches for QTL analysis with backcross and inter-cross (F2) populations, Composite Interval Mapping, Multiple Interval Mapping, Threshold and Precision Analysis. | 4, 5, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Learn about the basic concept of genetics and apply the basic statistics of genetic data. | 1, 3 |
| | CLO2 | Demonstrate the linkage analysis and map construction procedure. | 3, 7 |
| | CLO3 | Evaluate, from simple datasets, evidence for linkage disequilibrium and disease associations using basic association tests. | 3, 5, 8 |
| | CLO4 | Apply the QTL Regression Model for marker analysis. | 1, 8 |
| | CLO5 | Identify the population genetic structure of mixture model and learn computational algorithms for mixture model. | 1, 4, 8 |
| | CLO6 | Apply linear regression and MLE approaches for QTL analysis. | 1, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, and class presentations. | Class test and assignment. |
| CLO2 | Lecture, and class presentations. | Class test and assignment. |
| CLO3 | Lecture, group discussions, and class presentations. | Class test, assignment and final examination. |
| CLO4 | Lecture, and class presentations. | Class test. |
| CLO5 | Lecture, group discussions, and class presentations. | Class test, quiz and final examination. |
| CLO6 | Lecture, and class presentations. | Class test, assignment and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.<br>Wu, R., C. Ma & G. Casella (2007). Statistical genetics of quantitative traits: Linkage, maps and QTL. Springer. |
| Supplementary Readings | Barnes, M. R. (Ed.). (2007). Bioinformatics for geneticists: a bioinformatics primer for the analysis of genetic data. John Wiley & Sons.<br>Johnson, A. D. (2008). Bioinformatics for geneticists: a bioinformatics primer for the analysis of genetic data.<br>Mathur, S. K. (2009). Statistical Bioinformatics: with R. Academic Press.<br>Stuart M. Brown (2015). Next-Generation DNA Sequencing Informatics, Second Edition, Cold Spring Harbor Laboratory Press. |

| Course Code: 0542 20 Stat 4211 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Comprehensive | | |
| Course Status | Optional | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to recall the statistical tools most commonly used in other multidisciplinary area of research and job preparation. | | |
| Course Objectives | • Comprehend the knowledge of descriptive statistics;<br>• Understanding about probability and sampling distributions;<br>• Learn techniques of statistical inference and basic sampling methods;<br>• Gain different tools used for demographic and agricultural research: | | |

| | Course Contents | CLOs |
|---|---|---|
| | Section A | |
| 1 | Basic Statistics-Statistics, sources & processing of data, presentation of data, measures of central tendency, measures of dispersion, moments and shape characteristics of distribution, simple correlation and regression. | 1 |
| 2 | Probability distribution and Sampling distribution- Basic concepts of probability, random variable, expectation, generating function. Basic probability distributions. $\chi 2$, F and t distributions (central) and their uses in statistics. | 1, 2 |
| 3 | Sampling Technique-Basic concepts of sampling, idea about simple random sampling, stratified random sampling, systematic sampling, cluster sampling, sampling and non-sampling errors, determination of sample size, design effect. | 3 |
| | Section B | CLOs |
| 4 | Statistical Inference-Concept of inference, estimation and hypothesis testing, fundamentals concepts of parametric and non-parametric tests. | 3, 4 |
| 5 | Regression Analysis-Uses and importance of multiple regression analysis, least square estimators and their properties, precision of the estimated regression model, idea about dummy independent variables and stepwise regression. | 3 |
| 6 | Experimental design- Analysis of variance, linear models, standard design with single factor experiments, estimation of missing values, different transformations. | 4 |
| 7 | Basic demographic measures: Concept of population projection, Life table. | 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Understand the basic concepts of descriptive statistics need for all subject areas. | 1, 3, 5, 8 |
| | CLO2 | Realize the practical concept of field survey techniques. | 1, 4, 5, 8 |
| | CLO3 | Describe different types of regression model and inferential techniques of Statistics. | 1, 3, 8 |
| | CLO4 | Crack the statistical tools of demographic and agricultural research. | 1, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and Presentation | Class test, quiz, final examination. |
| CLO2 | Lecture and Problem solving | Class test and assignment. |
| CLO3 | Lecture and Presentation | Class test. |
| CLO4 | Lecture and Presentation | Class test, final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M. N. (2011). An Introduction to Statistics and Probability, 4th Edition, Mullick & Brothers, Dhaka.<br>Lohr, S. L. (2021). Sampling: design and analysis. Chapman and Hall/CRC.<br>Islam, M. N. (2009), An Introduction to Sampling Methods. Book World, Dhaka.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall.<br>Montgomery, D. C. and Peek, E. (1992). An Introduction to Regression Analysis, 2nd Edition, John Wiley and Sons, New York.<br>Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Shryock, H. S. (1976). The Methods and Materials of Demography, Academic Press, New York. |
| Supplementary Readings | Draper, N. R. and Smith, H. (1998). Applied Regression Analysis, 3rd Edition, John Wiley and Sons, New York.<br>Chatterjee, S. and Price, B. (1977). Regression Analysis by Examples 2nd Ed., Wiley Series, NY.<br>Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi.<br>Islam, M. N. (2021). An Introduction to Business Statistics, 1st edition, Mullick and Brothers, Nilkhet, Dhaka. |

| Course Code: 0542 20 Stat 4212 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Data Analysis Lab | | |
| Course Status | Core | | |
| Credit | 1.0 | | |
| Prerequisite(s) | None | | |
| Rationale | The course is designed to help the students to apply statistics in environmental problem / Genomic analysis / perform meta-analysis. / Comprehensive problem. | | |
| Course Objectives | • Develop database management systems.<br>• Discover desirable information from environmental / genomic data/meta-analysis/comprehensive problem.<br>• Estimate different statistical estimator in a data set. | | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | Solving theory related problem of any two courses from Environmental Statistics / Meta-Analysis/ Statistical Genetics/Comprehensive problem. | 1, 2, 3, 4 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Apply statistical tools in environmental data. | 2, 3, 8 |
| | CLO2 | Solve real life problems with Meta-analysis. | 2, 3, 8 |
| | CLO3 | Use statistics in biological science. | 2, 3, 8 |
| | CLO4 | Apply tools related to comprehensive statistics. | 2, 3, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture and presentation | Quiz, continuous assessment, viva-voce |
| CLO2 | Lecture and problem solving | Continuous assessment, viva-voce |
| CLO3 | Lecture and problem solving | Continuous assessment, viva-voce |
| CLO4 | Lecture and problem solving | Continuous assessment, viva-voce |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Islam, M. N. (2011). An Introduction to Statistics and Probability, 4th Edition, Mullick & Brothers, Dhaka.<br>Lohr, S. L. (2021). Sampling: design and analysis. Chapman and Hall/CRC.<br>Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2010). Probability and statistical inference (pp. 387-389). Upper Saddle River, NJ, USA: Pearson/Prentice Hall.<br>Montgomery, D. C. and Peek, E. (1992). An Introduction to Regression Analysis, 2nd Edition, John Wiley and Sons, New York.<br>Montgomery, D. C. (2003). Design and Analysis of Experiments, 5th edition, Wiley, USA.<br>Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.<br>Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). Introduction to meta-analysis. John Wiley & Sons.<br>Barnett, V. (2004). Environmental Statistics: Methods and Applications, John Wiley and Sons, New York. |
| Supplementary Readings | Wu, R., C. Ma & G. Casella (2007). Statistical genetics of quantitative traits: Linkage, maps and QTL. Springer.<br>Draper, N. R. and Smith, H. (1998). Applied Regression Analysis, 3rd Edition, John Wiley and Sons, New York.<br>Borenstein, M. (2013). Computing effect sizes for meta-analysis. Wiley-Blackwell.<br>Islam, M. N. (2021). An Introduction to Business Statistics, 1st Edition, Mullick and Brothers, Nilkhet, Dhaka.<br>Chatterjee, S. and Price, B. (1977). Regression Analysis by Examples 2nd Edition, Wiley Series, NY.<br>Cochran, W. G. and Cox, G. M. (2000). Experimental Design, 2nd edition, John Wiley and Sons, New Delhi. |

| Course Code: 0542 20 Stat 4220 | Year: Fourth | Term: Second |
|---|---|---|
| Course Title | Viva Voce-IV | |
| Course Status | Core | |
| Credit | 1.0 | |
| Prerequisite(s) | None | |
| Rationale | The Viva-voce provides an opportunity to express the knowledge that the student(s) gathered during term education. | |
| Course Objectives | • To acquire knowledge and skills to face the interview panel.<br>• To equip the students with analytical and evaluation abilities to o respond to spontaneous questions by the panel members.<br>• To make the students to face the expert panel and present the knowledge, skills and problems in the most efficient way. | |

| | Course Contents/Tasks | CLOs |
|---|---|---|
| 1 | The course contents are related to all courses taught in fourth year first term and second term for viva-voce preparation. | 1, 2, 3 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Should be able to demonstrate the application of the knowledge acquired in the term to solve the problems of the various forms. | 1, 2, 3, 4 |
| | CLO2 | Solve the real-life problems and assess the implications of various forms of solutions. | 3, 5, 8 |
| | CLO3 | Should be able to make effective presentation of different topics learnt in front to the experts. | 5, 6, 7, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO2 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |
| CLO3 | Lecture, tutorials, group discussions and class presentations. | Evaluation of respective term committee members on the basis of viva-voce. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | All the recommended books and materials of the fourth year, first and second terms. |

| Course Code: 0541 20 Math 4251 | | Year: Fourth | Term: Second |
|---|---|---|---|
| Course Title | Measure Theory | | |
| Course Status | Core | | |
| Credit | 3.0 | | |
| Prerequisite(s) | None | | |
| Rationale | This course is designed to provide advanced concepts of probability based on measure theory and their applications in different field of statistics. | | |
| Course Objectives | • Clarify the basic concept of set theory, different types of algebra and measure with their limitations.<br>• Introduce random variable and distribution of a random variable based on measure theory.<br>• Apply modern theorem of advanced probability to solve the real problem. | | |

| Course Contents | | CLOs |
|---|---|---|
| Section A | | |
| 1 | Sets and Classes of Events: Algebra of sets, relations, open and closed set on, the events and classes of events. | 1 |
| 2 | Measure: σ-Algebra, measurable set, the concept of measurability, Lebesgue measure on the real line, elementary properties of measures, Borell set. | 1, 2 |
| 3 | Random Variables and Function: Random variable, limit of random variables, function, inverse function, measurable function, simple function, Borell function, characteristic function, random variable as measurable functions. | 3, 6 |
| Section B | | CLOs |
| 4 | Integral of Measurable Function: Lebesgue integral of simple functions, Integrable functions, Sequences of integrable functions, the general and Riemann-Stieltje's integral. | 2, 4, 5 |
| 5 | Probability Measure: Definition of probability, some simple properties, Discrete probability space, General probability space, Induced probability space, Extension of probability, Probability measure, Lebesgue-Stieltje's measure, Signed measure, Borel-Cantelli lemmas, Zero-one Law, Kolmogorov's Zero-one law. | 2, 5, 6 |
| 6 | Distribution Functions and Expectations: Distribution function of a random variable and a random vector, decomposition of D. F's, correspondence theorem, and definition of expectation, properties of expectation, moments and inequalities. | 3, 6 |

| | Upon successful completion of the course, the students will be able to: | | Mapping with PLOs |
|---|---|---|---|
| Course Learning Outcomes (CLOs) | CLO1 | Gather the knowledge about the basic concept of algebra with set theory and differentiate with σ Algebra. | 1, 3 |
| | CLO2 | Describe different types of measure with their applications. | 1, 3, 4 |
| | CLO3 | Formulate and solve the problem of measure theory. | 1, 3, 4, 8 |
| | CLO4 | Describe Lebesgue integral of simple function and differentiate with Riemann integral. | 1, 3 |
| | CLO5 | Analyze some modern theorem of probability theory. | 1, 3, 4, 8 |
| | CLO6 | Compute expectation and moment of a random variable based on measure theory. | 1, 3, 4, 8 |

Mapping CLOs with the Teaching-Learning and Assessment Strategy

| CLOs | Teaching-Learning Strategy | Assessment Strategy |
|---|---|---|
| CLO1 | Lecture, presentation | Quiz and final examination. |
| CLO2 | Lecture, Presentation and group discussion | Class test, assignment, viva-voce and final examination. |
| CLO3 | Lecture, Presentation and group work | Class test, assignment and final examination. |
| CLO4 | Lecture and presentation | Class test. |
| CLO5 | Lecture and Presentation | Class test. |
| CLO6 | Lecture, Presentation and group discussion | Class test and final examination. |

**Learning Materials**

| | |
|---|---|
| Recommended Readings | Athreya, K. B., &Lahiri, S. N. (2006). Measure theory and probability theory (Vol. 19). New York: Springer.<br>Bhat, B. R. (2007). Modern probability theory. New Age International. |
| Supplementary Readings | Billingsley, P. (2008). Probability and measure. John Wiley & Sons.<br>Halmos, P. R. (2013). Measure theory (Vol. 18). Springer.<br>Bogachev, V. I., &Ruas, M. A. S. (2007). Measure theory (Vol. 1). Berlin: springer.<br>Cohn, D. L. (2013). Measure theory (Vol. 1). New York: Birkhäuser.<br>Tao, T. (2011). An introduction to measure theory (Vol. 126, p. 206). Providence: American Mathematical Society.<br>Kallenberg, O. (2002). Foundations of modern probability. springer |

# 20 Grading and Evaluation

### 20.1 Grading Scale

a) Letter Grades and corresponding Grade Points will be awarded following provisions shown below:

| Numerical Grade | Letter Grade | Grade Point |
|---|---|---|
| 80% or above | A+ (A plus) | 4.00 |
| 75 to less than 80% | A (A regular) | 3.75 |
| 70 to less than 75% | A- (A minus) | 3.50 |
| 65 to less than 70% | B+ (B plus) | 3.25 |
| 60 to less than 65% | B (B regular) | 3.00 |
| 55 to less than 60% | B- (B minus) | 2.75 |
| 50 to less than 55% | C+ (C plus) | 2.50 |
| 45 to less than 50% | C (regular) | 2.25 |
| 40 to less than 45% | D | 2.00 |
| Less than 40% | F | 00 |
| Incomplete | I | |
| Withdrawn | W | |
| Continuation (for the project, thesis design, etc. course) | X | |

20.1.1 Evaluation of Theory Courses

a) All theory courses will be evaluated out of 100 marks, the distribution of which is given below:

| Sl. No. | Items | Marks |
|---|---|---|
| 1 | Attendance and Class Participation | 10 |
| 2 | Continuous Assessments | 30 |
| 3 | Term Final Examination | 60 |
| | Total | 100 |

b) The basis for awarding marks for class attendance and participation will be as follows:

| Attendance & Participation | Marks |
|---|---|
| 90% or above | 10 |
| 85 to below 90% | 9 |
| 80 to below 85% | 8 |
| 75 to below 80% | 7 |
| 70 to below 75% | 6 |
| 65 to below 70% | 5 |
| 60 to below 65% | 4 |
| Below 60% | 0 |

c) The continuous assessments of the theory courses may be conducted in the form of class tests, assignments, homework, presentation, quiz, viva voce, etc. The course teacher(s) will evaluate every continuous assessment and share the result with the students within 2(two) weeks of conducting that continuous assessment.

d) The duration of a class test may be 20-45 minutes, and it will preferably be given during class hours.

e) If a student does not attend the class test for reasons satisfactory enough to the course teacher, the course teacher may allow the student one more chance for such assessment during the term; however, it must be held before the term final examinations. A student who has been absent for a short period, up to a maximum of three weeks due to illness, should approach the course teacher(s) or Coordinator(s) for make-up of quizzes/class tests or assignments, etc.,

immediately on returning to the classes. Such request should be supported by a medical certificate endorsed by the Chief Medical Officer of the University. The medical certificate issued by a registered medical practitioner (with the registration number shown explicitly on the certificate) and endorsed by the Chief Medical Officer of the University will also be acceptable only when the student has valid reasons for his/her absence from the University.

f) The number of Continuous Assessments (CAs) in each course will be as follows:

| No. of credit(s) | Total no. of CA required | CAs to be consideredfor grading |
|---|---|---|
| 3 – 4 | 4 (2 in each section) | Section best assessments shall be averaged for grading |
| 1.5 – 2 | 3 (at least one in each section) | |

g) If two teachers teach a course, both the teachers will conduct continuous assessments individually.

h) Answer scripts of the continuous assessment may be shown to the students to identify their strengths and weaknesses, but those would not be returned to them. The concerned teacher would submit the evaluated continuous assessment answer scripts and attendance register to the Head of the Discipline/Program Offering Entity (POE). The final score of attendance and class participation (out of 10) and continuous assessment (out of 30) should be displayed on the Discipline's notice board/ Discipline website/ Course web page before starting the term final examination.

i) The course teachers must submit the continuous assessment mark sheets to the Chair of the Examination Committee before the starting of the term final examination.

j) The Term Final Examination will carry 60 marks. There will be two separate answer scripts for Section A and Section B in the Term Final Examination.

k) When a student repeats a course in which he/she previously obtained an F grade, he/she will be given just an immediate lower grade that he/she obtained in the repeated course. However, in case he/she obtains a D grade, that will be maintained, and this grade will be shown in the transcript. If a student has to repeat a course due to punishment on him/her, the grade obtained will be maintained. If a student obtains a grade other than an F in a course, he/she will not be allowed to repeat the course for grade improvement.

l) If a student obtains an 'F' grade in any Core course in any term, this 'F' grade will not be counted for Grade Point Average (GPA) but will be shown on the grade sheet, and in such case, he/she will have to retake the course for grade improvement.

m) While registering for a retake/re-retake theoretical course, a student must be given an option to decide whether s/he intends to sit for continuous assessment of the course. If s/he opts to sit for continuous assessments, his/her fresh mark will be counted to prepare the result. However, the class attendance and participation marks will be taken from the previous record.

n) A student has to register for the backlog/retake/re-retake core courses first followed by the fresh courses offered by the Discipline for the term s/he is going to enrol subject to the compliance with: (i) completion of prerequisite courses (if any) and (ii) maximum registration limit of 25 credits per term. However, s/he may not choose to register the optional backlog/retake/re-retake courses first.

o) In addition, a student may be allowed to register for advance course(s) in a term subject to: (i) his/her all backlog/retake/re-retake and offered core courses are either clear or registered, (ii) his/her current terms' offered all core courses are registered, (iii) completion of corresponding prerequisite courses (if any), (iv) compliance with a maximum registration limit of 25 credits per term, and (v) the desired advance courses are offered by the Discipline/POE in the current term. However, such advance course registration option will not be applicable for capstone courses like Thesis/Project/ Internship/ Research study/ Monograph/ Portfolio, and so on.

p) A Special Term may be offered for the final year students who have retake/re-retake course(s). In this case, the maximum credit limit for a student will be 15 credits. This will be a Non-Taught Term. The Examination of Special Term will start 4 (four) weeks after publishing 4th-year 2nd Term results and will continue not more than 2 (two) weeks. The continuous assessment marks (40%) will be carried over from previously registered theory course(s), and Special Term Final Examination will carry the remaining (60%) marks. Final Year Term Thesis/Dissertation/Design or Core Sessional(s) supervisor(s)/course teacher(s) in consultation with the Head may allow the student(s) to re-submit the Thesis/

Dissertation Design or Core Sessional(s) within the Special Term schedule. However, it must be within the allowed limits of the Special Term credits.

20.1.2 Evaluation of Sessional Courses

a) All sessional courses will be evaluated out of 100 marks, the distribution of which is given below:

| Sl. No. | Items | Marks |
|---|---|---|
| 1 | Attendance/Class Participation/Contact with teachers | 10 |
| 2 | Sessional Evaluation/Internal criticism/Observation | 60 |
| 3 | Viva Voce/ Final Jury | 30 |
| | Total | 100 |

b) Sessional evaluation would be done through a laboratory test, class test, quiz, assignment, assigned project, report, oral test, performance/behaviour of the students, etc. The course teacher(s) will complete every sessional evaluation and share the result with the students within 2(two) weeks of conducting that item. Attendance and sessional evaluation mark sheets (out of 10+60=70) will be displayed on the Discipline's notice board/Discipline website/Course web page before starting the term final examination.

c) Viva Voce of each sessional course will usually be conducted by the course teacher(s). The senior most among the course teachers (if any) will be the Chair of the viva board. However, such viva voce/final assessment of a sessional course can also be done through jury board in applicable cases. The jury board will be headed by the Head of the Discipline or any other senior teacher of the Discipline/POE not below the rank of Assistant Professor. The Chairman of the viva/jury board may appoint other teacher(s) as a board member if necessary. A student must attend a sessional evaluation and viva voce. In case of absence in any component, he/she will get an F grade in that course.

d) The course teachers must submit the continuous assessment mark sheets to the Chair of the Examination Committee before the starting of the term final examination.

e) A student may register sessional courses as retake/re-retake (if applicable) on the Discipline Head's written approval. For retake/re-retake sessional courses, no previous records/marks will be counted.

20.1.3 Evaluation of Capstone Courses

a) The distribution of marks for a Capstone (Thesis/ Monograph/ project paper/ etc.) course will be as follows:

| Sl. No. | Description | Marks |
|---|---|---|
| 1 | Contact/Discussion/Communication with the Supervisor | 10 |
| 2 | Evaluation | 60 |
| 3 | Oral presentation and/or Viva voce | 30 |
| | Total | 100 |

b) There will be two examiners (including the Supervisor) to examine the Thesis. Each examiner will evaluate the Thesis separately, and the average marks will be considered for grading. However, if the marks given by the First and Second Examiners vary 20% or more, a Third Examiner to be appointed by the concerned Examination Committee from the outside the University will evaluate the Thesis Monograph/Project paper. Among these numbers, the average of the closest two numbers will be considered for grading. However, if the marks given by the Third Examiner happen to stand at the middle of the marks given by the first two Examiners, the average of the three marks will be considered for grading.

c) For the thesis/dissertation/final project/other projects like the thesis of the final year students, there will be a presentation and defense session before the defense board. If deemed necessary to the concerned defense board, these sessions might be arranged online. A three-member defense board will evaluate the presentation and defense session. The Supervisor of the thesis/ project/ internship/ research study/ monograph/ portfolio courses will normally be the Chairman of the board while the second examiner and one member nominated by the Head of the Discipline/POE will be the members of the defense board. Every member of the defense board will evaluate individually and the final marks will be calculated by averaging all the marks given by the three members. The defense board members will be remunerated individually as per the approved rate of the university. For Jury board or in other special circumstances, the Head of the Discipline/POE might include additional member(s) in the board for justifiable reasons.

d) A Discipline might allow some students to register for an Internship program/ Project paper/ Monograph/ Research study according to the course curriculum of the respective Discipline. Such an internship program/ Project paper/Research study course might be considered as the substitute of Thesis for those students. The evaluation and related activities of such Internship program/ Project paper/ Research study courses will be similar to Thesis. Usually, a Thesis will carry double weight in terms of credit compared to other alternatives like Project/ Internship/ Research study/ Monograph/ Portfolio and so on.

e) A Discipline might allow splitting the thesis/similar course into more than one term. 'X' grade may be assigned for continuing the same course in multiple terms to assign a complete grade in the last term. Alternatively, multiple courses under thesis/similar course might be assessed by providing complete grades at the end of each term. The curriculum of the concerned Discipline/Entity will clarify all such issues.

20.1.4 Evaluation of Viva Voce

a) There might be a grand viva voce in each term. A student will not usually be allowed to register for more than one course of this type bearing 01 (one) credit in a term. The concerned Examination Committee of that Term will conduct the viva and assess the students. The distribution of marks for viva voce will be as follows:

| Description | Marks |
|---|---|
| Viva voce | 100 |

### 20.2 Grades

Grade related issues are reported in section 20.1.

### 20.3 Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

a) Grade Point Average (GPA) is the weighted average of Grade Points obtained in all the courses passed/completed by a student. For example, if a student has passed/completed five courses in a term having credits of C1, C2, C3, C4, and C5 and his/her points in these courses are G1, G2, G3, G4, and G5, respectively, then,

$GPA = \sum CiGi/\sum Ci$

b) A Numerical Example: Suppose a student has completed five courses in a term and obtained the following grades:

| Course | Credit | Grade | Grade Point |
|---|---|---|---|
| A | 3 | A+ | 4.00 |
| B | 3 | C+ | 3.00 |
| C | 3 | A | 3.75 |
| D | 2 | B | 3.25 |
| E | 1 | B+ | 3.50 |

Then his/her GPA for the term will be computed as follows:
GPA= 3(4.0) + 3(3.0) + 3(3.75) + 2(3.25) + 1(3.5) /(3 + 3 + 3 + 2 + 1) = 3.52

c) A student's performance will be evaluated in terms of three indices- Term Grade Point Average (TGPA), Yearly Grade Point Average (YGPA), and Cumulative Grade Point Average (CGPA). The TGPA is computed by dividing the total points earned in a Term by the number of credits taken in the Term. The YGPA is computed by dividing the total grade points earned in two Terms in a year by dividing the number of credits taken in that year. The CGPA is computed by dividing the total grade points accumulated till date by the total completed credits. Thus a student who has earned 275 grad points in attempting 100 credits of courses would have an overall CGPA of 2.75.

### 20.4 Course Withdrawal

a) 'W' is the corresponding grade for withdrawn of a course, as mentioned in section 20.1.

b) If any student cannot complete the Term Final Examination due to severe illness or serious accident, he/she may apply to the Dean through the Head of the concerned Discipline for total withdrawal from the Term within eight working days after the Term Final Examination. However, he/she may choose not to withdraw from any sessional course if the grade obtained in such a course is C or better. A medical certificate endorsed by the Chief Medical Officer of the University must support the application. The Dean of the concerned School will decide on such an application and inform the Academic Council. If a student is allowed to withdraw from a Term, he/she will have to register as fresh from the Term he/she has withdrawn. However, he/she may be allowed to register for backlog courses, if offered.

### 20.5 Incomplete (I) Courses

'I' is the corresponding grade for an incomplete course, as mentioned in section 20.1.

### 20.6 Retake

Retake related issues are reported in sections 20.1.1 and 20.1.2.

### 20.7 Grade Improvement

Grade improvement related issues are reported in section 20.1.1.

### 20.8 Dropout/Cancellation of Studentship

a) A first-year first term student's admission will stand cancelled if he/she fails to complete course registration by ten working days from the beginning of the classes.

b) A first-year first term student's admission will stand cancelled if he/she fails to attend at least 50 percent of classes during ten working days from the beginning of the classes. However, in case of severe illness/accident this provision may be relaxed subject to submission of a medical certificate issued by a registered medical practitioner (with the registration number shown explicitly on the certificate) and endorsed by the Chief Medical Officer of the University.

c) A student's studentship will stand cancelled if he/she fails to comply with registration of minimum credit requirements under article 12.2 of the latest (July 2022) 'Ordinance for Undergraduate Program' of Khulna University. According to that article, a student must register for at least 15 credits per term and may be allowed to register for up to a maximum of 25 credits if recommended by his/her Discipline Head. The Discipline/POE might offer less than, greater than or equal to 25 credits per term as per the approved curriculum. The student will enjoy the option of choosing backlog, re-take, re-retake, advance courses (subject to compliance with applicable requirements/restrictions, as reported in other articles of the Ordinance) in addition to fresh courses to comply with the restriction of maximum 25 credits per term. If any student fails to register, in any way, for minimum credits (15 credits), his/her studentship at the University will stand cancelled. This minimum 15-credit registration limit may be relaxed if: (i) the student requires less than 15-credit to complete his/her graduation, or (ii) the sum of applicable (for the student) credits offered by the Discipline is less than 15-credit in the corresponding term for any valid reason.

d) A student's studentship will stand cancelled if he/she fails to earn minimum credits under article 12.5.2 of the latest (July 2022) 'Ordinance for Undergraduate Program' of Khulna University. According to that article, when a student is going to register for his/her courses in the 3rd year 2nd term, his/her earned credits up to 2nd year 2nd term must be at least 36. Otherwise, his/her studentship at the University will stand cancelled.

| Approval Records | |
|---|---|
| Approving Authority | Date of Approval |
| Curriculum Committee of the Discipline | August 28, 2022 |
| Executive Committee of the School | September 11, 2022 |
| BOAS (if applicable) | |
| Academic Council | October 12, 2022 |
| Syndicate (if applicable) | October 20, 2022 |

Appendix 01: Summary of Major Changes in the OBE Format Curriculum

Program : Bachelor of Science (Honours) in Statistics
Discipline : Statistics Discipline
School : Science, Engineering and Technology School

| Sl. No. | Criteria | Existing Curriculum | OBE Curriculum |
|---|---|---|---|
| 1 | Duration of the Program (in Year) | 04 | 04 |
| 2 | Total Available Credits | 172 | 174 |
| 3 | Minimum Credit Requirement to Complete the Degree | 160 | 160 |
| 4 | Available Credits from GED Courses | - | 39.5 |
| 5 | Credits from GED Courses (% of Total Credits) | - | 22.7% |
| 6 | Credits from GED Courses (% of Required Credits) | - | 25% |
| 7 | Available Credits from Core Theory Courses* | 113 | 73 |
| 8 | Available Credits from Core Sessional Courses* | 28 | 26.5 |
| 9 | Available Credits from Optional Theory Courses* | 30 | 31 |
| 10 | Available Credits from Optional Sessional Courses* | 01 | 00 |
| 11 | Available Credits from Capstone Courses | - | 04 |
| 12 | Term Duration (in week) | 21 | 22 |
| 13 | Credits from Newly Introduced Courses | - | 07 |
| 14 | Number of Newly Introduced Courses | - | 05 |
| 15 | Number of Omitted Courses | - | - |
| 16 | Change in Course Title (Number of Courses) | - | 11 (minor) |
| 17 | Change in Course Status (Number of Courses) | - | - |
| 18 | Inter-term Shift (Number of Courses) | - | - |
| 19 | Change in Course Contents (Number of Courses) | - | - |
| 20 | Name of Majors (if Applicable) | - | - |
| 21 | Name of Modes (if applicable) | - | - |

* include GED

Appendix 02: Contributors

| Sl. No. | Category | Numbers | Remarks |
|---|---|---|---|
| 01 | Alumni | 16 | |
| 02 | Faculty Members | 08 | |
| 03 | Employers | 04 | |
| 04 | Expert Members from different universities | 02 | |
| 05 | IQAC, KU | 04 | |

Appendix 03: Program Self Assessment Committee (PSAC)

| Sl. No. | Name | Affiliation | Designation |
|---|---|---|---|
| 01 | Dr. Uttam Kumar Majumder | Professor, Statistics Discipline, KU | Chairman |
| 02 | Benojir Ahammed | Associate Professor, Statistics Discipline | Member |
| 03 | Md. Salauddin Khan | Associate Professor, Statistics Discipline | Member |

Appendix 04: Acknowledgement Concerned Committee of the Discipline/POE

| Sl. No. | Name | Affiliation | Designation in committee |
|---|---|---|---|
| 01 | Professor Dr. Uttam Kumar Majumder | Head, Statistics Discipline, KU | Chairman |
| 02 | Benojir Ahammed | Associate Professor, Statistics Discipline, KU | Member |
| 03 | Md. Salauddin Khan | Associate Professor, Statistics Discipline, KU | Member |
| 04 | Sohani Afroja | Assistant Professor, Statistics Discipline, KU | Member |
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| 07 | Md. Alamgir Sarder | Lecturer, Statistics Discipline, KU | Member |
| 08 | Professor Nitai Chakraborty | Department of Statistics, DU | External Member |
| 09 | Professor Dr. Md. Rezaul Karim | Department of Statistics, RU | External Member |

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| 16 | Hasibul Hasan Shanto | Research Assistant, SHLC project Bangladesh. |
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