UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 24th (1/2025) meeting held on 26.08.2025, the Syndicate in its 72nd (4/2025) meeting held on 12.09.2025 has approved the revised curricula of following programs for implementation w.e.f. **Fall 2025**.

I.	Associate Degree in Statistics	(Annex-'A')
II.	BS in Statistics	(Annex-'B')
III.	BS in Statistics (5th Semester Intake)	(Annex-'C')
IV.	M.Phil Statistics	(Annex-'D')
V.	Ph.D in Statistics	(Annex-'E')

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/25/ 1200

Dated: 06.11.2025

Distribution:

- Chairman, Department of Statistics
- Controller of Examinations
- Director Academics

C.C:

- Dean Faculty of Sciences
- Director, QEC
- Additional Registrar (A & R) *{With the request to forward the notification alongwith curriculum to all Principals of affiliated colleges concerned}*
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

SCHEME OF STUDIES AND OUTLINES

FOR

BS STATISTICS
(5th SEMESTER INTAKE)

UNDERGRADUATE PROGRAM IN STATISTICS

(Semester/Term System)

Session: Fall 2025 – Onward

DEPARTMENT OF STATISTICS

UNIVERSITY OF SARGODHA

1. **Title of Degree Program:** BS Statistics (5th Semester Intake)

2. **Introduction and Rationale:**

   In today's data-driven world, statistical expertise is fundamental to informed decision-making across diverse fields such as science, healthcare, business, government, and technology. As organizations increasingly rely on data to guide strategies and operations, the demand for professionals adept in statistical reasoning and data interpretation continues to rise.

   The BS Statistics (5th Semester Intake) program, offered by the Department of Statistics, is structured to equip students with a robust foundation in statistical theory, along with practical proficiency in data analysis, statistical computing, and applied problem-solving. This intake is specifically aligned with the advanced coursework outlined for the final four semesters of the BS Statistics program.

3. **Program Objectives:**

   The program aims to:

   1. Build a solid foundation in probability theory, statistical inference, and modeling.
   2. Develop skills in data acquisition, management, analysis, and interpretation.
   3. Foster competency in the use of modern statistical software and programming tools.
   4. Prepare students to apply statistical methods to real-world challenges across various domains, including public policy, health, social sciences, and industry.

4. **Program Learning Outcomes:**

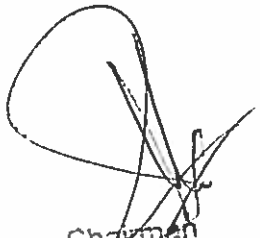
   Upon successful completion of the program, graduates will be able to:

   1. Demonstrate a comprehensive understanding of core statistical concepts and methodologies.
   2. Design, implement, and evaluate statistical surveys and experimental studies.
   3. Analyze and interpret data using appropriate statistical techniques and tools.
   4. Effectively communicate statistical findings to both technical and non-technical audiences.
   5. Uphold ethical standards and apply critical thinking in statistical practice and decision-making.

5. **Career Opportunities for Graduates:**

   Graduates of the BS Statistics (5th Semester Intake) program will be well-positioned for employment in a variety of sectors. Potential career roles include:

   - Statistician
   - Data Analyst
   - Biostatistician
   - Risk Analyst
   - Research Analyst
   - Statistical Consultant
   - Survey Methodologist
   - Market Researcher
   - Quality Control Analyst
   - Policy Analyst



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6. Program Structure

Component	Details
Program Duration	Minimum: 2 Years, Maximum: 4 Years (further extendable by another year subject to approval of the university's statutory body)
Admission Requirements	At leat 45% marks in BA/BSc/ADA/ADS or equivalent with Statistics of 200 Marks.
Degree Completion Requirements:	63 credit hours
Major Courses:	51 credit hours (17 courses including 7 mandatory elective courses)
Interdisciplinary Courses:	6 credit hours (2 courses)
Internship:	3 credit hours
Capstone Project:	3 credit hours
Semester Duration:	16-18 weeks for regular semesters (1–2 weeks for examination). 8–9 weeks for summer semesters (1 week for examination).
Course Load (per semester):	15–18 credit hours for regular semesters. Up to 8 credit hours for summer semesters (for remedial/deficiency/failure/repetition courses only).
3 Credit Hours (Theory):	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester.

7. List of Interdisciplinary Courses

S.N.	Course Code	Course Title	Credit Hours	Prerequisite
1	MATH-5127	Linear Algebra	3 (3-0)	MATH-5102
2	BIOT-6112	Bioinformatics	3 (1-2)	Nil
3	CMPC-5201	Programming Fundamentals	3 (2-1)	Nil
4	CMPC-5203	Database Systems	3 (2-1)	Nil
5	ITDC-5202	Cyber Security	3 (2-1)	Nil
6	AIDC-5101	Artificial Neural Networks & Deep Learning	3 (2-1)	Nil
7	DSDE-6207	Cloud Computing	3 (2-1)	Nil

8. Major (Statistics) Courses

S.N.	Course Code	Course Title	Credit Hours	Prerequisite
1	STAT-6101	Probability Distributions	3 (3-0)	STAT-5102
2	STAT-6102	Design and Analysis of Experiments	3 (3-0)	STAT-5107
3	STAT-6103	Sampling Techniques	3 (3-0)	STAT-5103
4	STAT-6104	Biostatistics	3 (3-0)	Nil

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5	STAT-6105	Statistical Inference	3 (3-0)	STAT-6101
6	STAT-6106	Regression Analysis	3 (3-0)	STAT-5104
7	STAT-6107	Programming in R and Python	3 (3-0)	Nil
8	STAT-6108	Research Methodology	3 (3-0)	Nil
9	STAT-6109	Statistical Quality Control	3 (3-0)	Nil
10	STAT-6110	Applied Multivariate Analysis	3 (3-0)	Nil

9. **List of Deficiency Courses**

S.N.	Course Code	Course Title	Credit Hours
1	STAT-5101	Introduction to Statistics	3 (3-0)
2	STAT-5102	Introduction to Probability & Probability Distributions	3 (3-0)
3	STAT-5103	Introduction to Sampling Theory	3 (3-0)
4	STAT-5104	Basic Statistical Inference	3 (3-0)
5	STAT-5105	EDA and Visualization	3 (3-0)
6	STAT-5106	Official Statistics	3 (3-0)
7	STAT-5107	Intro to Regression and ANOVA	3 (3-0)
8	STAT-5108	Data Wrangling	3 (3-0)
9	STAT-5109	Statistical Packages	3 (3-0)
10	STAT-5110	Non-Parametric Methods	3 (3-0)
		Total Credits	**30**

10. **List of Electives Courses**

S.N.	Course Code	Course Title	Credit Hours
1	STAT-6111	Categorical Data Analysis	3(3-0)
2	STAT-6112	Stochastic Process	3(3-0)
3	STAT-6113	Reliability Analysis	3(3-0)
4	STAT-6114	Survival Analysis	3(3-0)
5	STAT-6115	Actuarial Statistics	3(3-0)
6	STAT-6116	Bayesian Statistics	3(3-0)
7	STAT-6117	Operation Research	3(3-0)
8	STAT-6118	Decision Theory	3(3-0)
9	STAT-6119	Data Mining	3(3-0)
10	STAT-6120	Mathematical Models and Simulation	3(3-0)
11	STAT-6121	Statistical Tools for Data Science	3(3-0)
12	STAT-6122	Statistics for Deep Learning	3(3-0)
13	STAT-6123	Statistical Machine Learning	3(3-0)
14	STAT-6124	Applied Artificial Intelligence	3(3-0)
15	STAT-6125	Big Data Analytics	3(3-0)
16	STAT-6126	Digital Analytics	3(3-0)
17	STAT-6127	High-Dimensional Data Analysis	3(3-0)
18	STAT-6128	Epidemiology	3(3-0)
19	STAT-6129	Analysis of Repeated Measurements	3(3-0)
20	STAT-6130	Design and Analysis of Medical Studies	3(3-0)

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21	STAT-6131	Pharmaceutical Statistics	3(3-0)
22	STAT-6132	Clinical Trials	3(3-0)
23	STAT-6133	Financial Econometrics	3(3-0)
24	STAT-6134	Time Series Analysis and Forecasting	3(3-0)
25	STAT-6135	Predictive Modeling	3(3-0)
26	STAT-6136	Structural Equation Modeling	3(3-0)
27	STAT-6137	Applied Econometrics	3(3-0)
28	STAT-6138	Spatial Statistics	3(3-0)
29	STAT-6139	Population Studies and Demographic Techniques	3(3-0)
30	STAT-6140	Environmental Statistics	3(3-0)
31	STAT-6141	Functional Data Analysis	3(3-0)
32	STAT-6142	Robust Methods	3 (3-0)

11. **Scheme of Studies**

Semester I					
1	STAT-6101	Probability Distributions	3 (3-0)	STAT-5102	Major
2	STAT-6102	Design and Analysis of Experiments	3 (3-0)	STAT-5107	Major
3	STAT-6103	Sampling Techniques	3 (3-0)	STAT-5103	Major
4	STAT-6104	Biostatistics	3 (3-0)	Nil	Major
5	MATH-5127	Linear Algebra	3 (3-0)	MATH-5102	IDS
6	STAT-5105	EDA and Visualization	3 (3-0)	Nil	**Deficiency**
7	STAT-5106	Official Statistics	3 (3-0)	Nil	**Deficiency**
		Total Credits	**15**		
Semester II					
1	STAT-6105	Statistical Inference	3 (3-0)	STAT-6101	Major
2	STAT-6106	Regression Analysis	3 (3-0)	STAT-5104	Major
3	STAT-61xx	Elective I	3 (3-0)	Nil	Major
4	STAT-61xx	Elective II	3 (3-0)	Nil	Major
5	CMPC-5203	Database Systems	3 (3-0)	Nil	IDS
6	STAT-5107	Intro to Regression and ANOVA	3 (3-0)	Nil	**Deficiency**
7	STAT-5108	Data Wrangling	3 (3-0)	Nil	**Deficiency**
8	URCG-5129	Understanding of Holy Quran - I/Fehm-e-Quran - I	1 (0-1)	Nil	GE
9	URCG-5131	Ethics-I (for non Muslims)	1 (0-1)	Nil	GE
		Total Credits	**15**		
Semester III					
1	STAT-6107	Statistical Programming using R and Python	3 (3-0)	Nil	Major
2	STAT-6108	Research Methodology	3 (3-0)	Nil	Major
3	STAT-6109	Statistical Quality Control	3 (3-0)	Nil	Major

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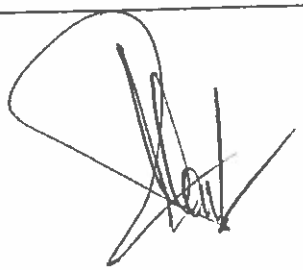
4	STAT-61xx	Elective III	3 (3-0)	Nil	Major
5	STAT-61xx	Elective IV	3 (3-0)	Nil	Major
6	STAT-5109	Statistical Packages	3 (3-0)	Nil	**Deficiency**
7	URCG-5129	Understanding of Holy Quran - II/Fehm-e-Quran - II	1 (0-1)	Nil	GE
8	URCG-5132	Ethics-II (for non Muslims)	1 (0-1)	Nil	GE
		Total Credits	**15**		

Semester IV

1	STAT-6110	Applied Multivariate Analysis	3 (3-0)	Nil	Major
2	STAT-61xx	Elective V	3 (3-0)	Nil	Major
3	STAT-61xx	Elective VI	3 (3-0)	Nil	Major
4	STAT-61xx	Elective VII	3 (3-0)	Nil	Major
5	STAT-6170	Capstone Project	3 (0-3)	Nil	Compulsory
6	STAT-5110	Non-Parametric Methods	3 (3-0)	Nil	**Deficiency**
		Total Credits	**15**		

Internship (Summer)

1	STAT-6150	Internship (*Internship will be preferably offered in summer break after 5th semester*)	3 (0-3)	Nil	Compulsory



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Course Outlines for Deficiency Courses

1. Introduction to Statistics (STAT-5101) 3(3-0)

Course Brief

This foundational course introduces students to the basic principles and applications of statistics. It emphasizes the role of statistics in natural and social sciences, highlighting its importance as a tool for data-driven decision-making. Students will gain hands-on experience in collecting, presenting, analyzing, and interpreting data using descriptive statistical techniques.

Key topics include types of data and variables, levels of measurement, organization and presentation of data, measures of central tendency and variability, and the construction of index numbers.

Course Learning Outcomes

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

1. Describe statistics as a field of knowledge, including its scope and relevance to other disciplines in the natural and social sciences.
2. Demonstrate preparedness for advanced coursework in the field of statistics.
3. Apply critical thinking to understand data sources, variable types, and levels of measurement.
4. Present, analyze, and interpret descriptive statistics effectively.
5. Construct and interpret index numbers in real-world contexts.

Course Contents

1. Introduction, Importance, and Scope of Statistics
2. Types of Variables and Data
3. Data Sources and Methods of Data Collection
4. Scales of Measurement: Nominal, Ordinal, Interval, and Ratio
5. Classification and Tabulation of Data
6. Presentation of Data:
   - Stem-and-Leaf Diagrams
   - Box-and-Whisker Plots
   - Bar Charts and Histograms: Creation and Interpretation
7. Measures of Central Tendency: Mean, Median, Mode
8. Measures of Dispersion: Range, Variance, Standard Deviation, IQR
9. Moments, Skewness, Kurtosis, and Shape of Distributions
10. Construction and Interpretation of Index Numbers

Recommended Textbooks

1. Clark, G. M., & Cooke, D. (1998). *A Basic Course of Statistics* (4th ed.). London: Arnold.

Suggested Readings

1. Weiss, N. A. (2015). *Introductory Statistics* (10th ed.). London: Pearson.
2. Agresti, A., & Franklin, C. (2017). *Statistics: The Art and Science of Learning from Data* (4th ed.). Boston: Pearson.
3. Moore, D. S., McCabe, G. P., & Craig, B. A. (2016). *Introduction to the Practice of Statistics* (9th ed.). New York: W. H. Freeman.

2. Introduction to Probability & Probability Distributions (STAT-5102) 3(3-0)

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Course Brief

This course provides a foundational understanding of probability theory and probability distributions, enabling students to model uncertainty and variability in real-world phenomena. It covers core principles such as counting methods, probability rules, and conditional probability including Bayes' Theorem. Students will explore both discrete and continuous random variables and learn to work with key probability distributions.

Through a blend of theory and practical examples, this course equips students with the skills to solve applied problems using binomial, Poisson, hypergeometric, and normal distributions—laying a critical foundation for statistical inference and modeling.

Course Learning Outcomes

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

1. Understand fundamental concepts of probability theory, counting methods, and probability rules.
2. Understand and apply conditional probability and Bayes' Theorem.
3. Demonstrate comprehension of discrete and continuous random variables and their characteristics.
4. Apply probability distributions such as binomial, Poisson, hypergeometric, and normal distributions to model real-world scenarios.

Course Contents

1. Introduction to Probability Theory:
   - Sample Spaces, Events, and Probability Axioms
   - Addition and Multiplication Rules
2. Counting Techniques:
   - Basic Principles of Counting
   - Permutations and Combinations
3. Conditional Probability:
   - Concept and Formula
   - Independence of Events
   - Bayes' Theorem and Applications
4. Random Variables:
   - Discrete and Continuous Types
   - Probability Mass and Density Functions
   - Cumulative Distribution Function
5. Expected Value and Variance:
   - Properties and Applications
   - Moment Generating Functions
6. Discrete Probability Distributions:
   - Binomial, Hypergeometric, Poisson
7. Continuous Probability Distributions:
   - Uniform and Normal Distributions

Recommended Textbooks

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2012). *Probability and Statistics for Engineers and Scientists* (9th ed.). Pearson.
2. Hogg, R. V., & Tanis, E. A. (2010). *Probability and Statistical Inference* (8th ed.). Pearson.

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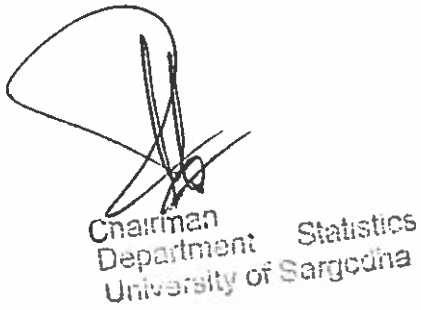
Suggested Readings

1. Ross, S. M. (2014). *Introduction to Probability Models* (11th ed.). Academic Press.
2. Sheldon, R. (2010). *Schaum's Outline of Probability and Statistics* (4th ed.). McGraw-Hill.
3. Spiegel, M. R., Schiller, J., & Srinivasan, R. (2009). *Probability and Statistics* (3rd ed.). McGraw-Hill.
4. Devore, J. L. (2017). *Probability and Statistics for Engineering and the Sciences* (9th ed.). Cengage Learning.



3. Introduction to Sampling Theory (STAT-5103) 3(3-0)

Course Brief

This course introduces students to the foundational principles of sampling theory and its application in the collection and analysis of data. Students will explore various probability and non-probability sampling techniques, the concept of sampling frames, and the importance of representative data in statistical inference. The course also covers computation of sample sizes for different practical needs and an introduction to the sampling distributions of common statistics such as means, variances, and proportions.

The aim is to provide students with the necessary tools to design effective sampling strategies, make informed decisions based on sample data, and understand the variability associated with sampling processes.

Course Learning Outcomes

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

1. Understand basic sampling theory, including the concepts of population, sample, sampling frame, and sampling units.
2. Identify and describe various sampling methods such as simple random sampling, stratified sampling, cluster sampling, and systematic sampling.
3. Calculate appropriate sample sizes for a variety of practical research and survey contexts.
4. Understand the sampling distributions of common statistics such as sample mean, variance, and proportion, and apply this knowledge in data interpretation.

Course Contents

1. Introduction to Sampling:
   - Population vs. Sample
   - Sampling Frame and Sampling Units
2. Types of Sampling Methods:
   - Probability Sampling: Simple Random, Stratified, Systematic, Cluster
   - Non-Probability Sampling: Convenience, Judgmental, Quota, Snowball
3. Sample Size Determination:
   - Estimating Sample Sizes for Means and Proportions
   - Precision, Confidence Levels, and Margin of Error
4. Sampling Distribution:
   - Central Limit Theorem
   - Distribution of Sample Mean, Sample Proportion, and Sample Variance
5. Bias, Accuracy, and Efficiency in Sampling
6. Applications in Survey and Experimental Design

Recommended Textbooks

1. Cochran, W. G. (1977). *Sampling Techniques* (3rd ed.). Wiley.
2. Lohr, S. L. (2019). *Sampling: Design and Analysis* (2nd ed.). Chapman & Hall/CRC.

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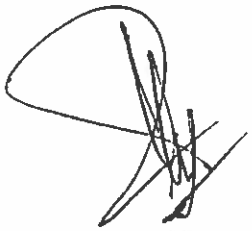
Suggested Readings

1. Kish, L. (1965). *Survey Sampling*. Wiley.
2. Thompson, S. K. (2012). *Sampling* (3rd ed.). Wiley.
3. Scheaffer, R. L., Mendenhall, W., & Ott, L. (1996). *Elementary Survey Sampling* (5th ed.). Duxbury Press.



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4. Basic Statistical Inference (STAT-5104) 3(3-0)

Course Brief

This course introduces students to the core concepts of statistical inference, focusing on estimation and hypothesis testing. It aims to equip students with the skills required to draw conclusions from sample data and to make data-informed decisions. Through theoretical understanding and practical examples, students will learn how to construct confidence intervals, test hypotheses, and evaluate the performance of statistical estimators. The course emphasizes interpreting results within real-world decision-making contexts, building a strong foundation for more advanced statistical analysis.

Course Learning Outcomes

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

1. Use statistical estimation techniques, including point estimation and interval estimation.
2. Understand and evaluate the properties of point estimators such as unbiasedness, consistency, and efficiency.
3. Perform hypothesis testing for population parameters and interpret statistical results in the context of real-world decision-making.
4. Apply the concepts of statistical inference to practical situations involving real datasets.

Course Contents

1. Introduction to Statistical Inference
2. Point Estimation:
   - Methods of Estimation (Method of Moments, Maximum Likelihood)
   - Properties of Estimators: Unbiasedness, Consistency, Efficiency
3. Interval Estimation:
   - Confidence Intervals for Means, Proportions, and Variances
   - Interpretation and Applications
4. Hypothesis Testing:
   - Null and Alternative Hypotheses
   - Type I and Type II Errors
   - p-values and Test Statistics
   - One-sample and Two-sample Tests for Mean and Proportion
5. Decision Making Using Hypothesis Testing
6. Applications of Inference to Real-World Problems

Recommended Textbooks

1. Hogg, R. V., Tanis, E. A. (2013). *Probability and Statistical Inference* (9th ed.). Pearson.
2. Casella, G., Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Cengage Learning.

Suggested Readings

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2012). *Probability and Statistics for Engineers and Scientists* (9th ed.). Pearson.
2. Devore, J. L. (2015). *Probability and Statistics for Engineering and the Sciences* (9th ed.). Cengage Learning.
3. Moore, D. S., McCabe, G. P., Craig, B. A. (2016). *Introduction to the Practice of Statistics* (9th ed.). W. H. Freeman.

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5. Exploratory Data Analysis and Visualization (STAT-5105) 3(3-0)

Course Brief

This course focuses on the foundational techniques of exploratory data analysis (EDA) and the principles of effective data visualization. Students will develop the ability to explore, summarize, and present data using various visualization tools and techniques. Through the use of programming languages such as R and Python, and platforms like Power BI, students will learn to communicate statistical insights effectively. The course emphasizes best practices in visual analytics, detection of data patterns and anomalies, and evaluation of visual representations for bias and clarity.

Course Learning Outcomes

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

1. Apply principles of effective data visualization to communicate statistical insights clearly.
2. Design and interpret various types of charts and graphs, including bar charts, scatter plots, histograms, and heatmaps using R, Python, or Power BI.
3. Implement interactive and dynamic visualizations for exploratory data analysis.
4. Analyze and critique data visualizations for accuracy, bias, and misleading representations.
5. Integrate data visualization techniques into real-world statistical reports and presentations.

Course Contents

1. Introduction to Exploratory Data Analysis (EDA)
2. Principles of Effective Data Visualization
3. Summary Statistics and Data Distributions
4. Visual Tools for Categorical and Numerical Data
   - Bar Charts, Histograms, Boxplots, and Scatterplots
   - Line Charts and Heatmaps
5. Multivariate Data Visualization
6. Identifying Outliers and Patterns in Data
7. Interactive and Dynamic Visualizations using R/Python/Power BI
8. Common Pitfalls and Bias in Data Visualization
9. Case Studies in Visual Analytics
10. Integrating Visualizations in Statistical Reports and Presentations

Recommended Textbooks

1. Wickham, H., & Grolemund, G. (2016). *R for Data Science*. O'Reilly Media.
2. Tufte, E. R. (2001). *The Visual Display of Quantitative Information* (2nd ed.). Graphics Press.

Suggested Readings

1. Healy, K. (2018). *Data Visualization: A Practical Introduction*. Princeton University Press.
2. Cairo, A. (2016). *The Truthful Art: Data, Charts, and Maps for Communication*. New Riders.
3. Few, S. (2012). *Show Me the Numbers: Designing Tables and Graphs to Enlighten*. Analytics Press.
4. McKinney, W. (2022). *Python for Data Analysis* (3rd ed.). O'Reilly Media.

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6. Official Statistics (STAT-5106) 3(3-0)

Course Brief

This course introduces students to the domain of official statistics and their importance in national planning, administration, and public policy. It covers the organization, collection, and dissemination of demographic and social statistics by official bodies. Students will explore the scope of national statistical systems, understand the standards for official data collection, and become familiar with the key institutions involved in statistical reporting in Pakistan. Emphasis is placed on understanding the reliability, interpretation, and practical use of official datasets from sources like NADRA, PBS, and other government agencies.

Course Learning Outcomes

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

1. Understand the official, demographic, and social statistics.
2. Explain the scope and organizational structure of official statistical systems.
3. Understand the roles of planning and administrative statistics in public decision-making.
4. Describe the structure and functions of national statistical organizations.
5. Utilize and interpret data from statistical sources such as NADRA, PBS, and other national agencies.

Course Contents

1. Introduction to Official Statistics
2. Role and Importance of Official Statistics in Policy and Planning
3. Classification: Demographic, Social, Economic, and Environmental Statistics
4. Organization and Scope of National Statistical Systems
5. Functions and Structure of Statistical Bureaus (PBS, NADRA, etc.)
6. Planning and Administrative Statistics
7. Census and Surveys: Methods and Challenges
8. Use of Official Statistics in Research and Development
9. Standards and Ethics in Official Statistics
10. Case Studies using National and International Statistical Reports

Recommended Textbooks

1. United Nations. (2001). *Principles and Recommendations for Population and Housing Censuses*. UN Publications.
2. Government of Pakistan. (Latest editions). *Pakistan Bureau of Statistics Reports*.

Suggested Readings

1. OECD. (2017). *Handbook on Official Statistics*.
2. United Nations Statistical Commission documents and training manuals.
3. Eurostat and World Bank online resources on National Statistical Systems.

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7. Introduction to Regression and Analysis of Variance (STAT-5107) 3(3-0)

Course Brief

This course introduces students to the foundational techniques of regression analysis and analysis of variance (ANOVA). The primary focus is to understand and model relationships between variables using simple and multiple linear regression models. Students will explore the interpretation and diagnostics of regression outputs, evaluate model fit, and conduct hypothesis testing for regression coefficients. Additionally, the course covers the concepts and applications of one-way and two-way ANOVA to compare group means and identify significant factors influencing outcomes. Emphasis will be placed on the practical application of these methods using real-world data.

Course Learning Outcomes

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

1. Understand relationships between variables through correlation and regression.
2. Understand the theory of linear regression models, including simple and multiple regression.
3. Apply linear regression techniques to model and analyze relationships between dependent and independent variables.
4. Demonstrate the concept of one-way and two-way analysis of variance (ANOVA).
5. Evaluate the goodness-of-fit of regression models using metrics such as R^2, adjusted R^2, and residual analysis.

Course Contents

1. Introduction to Correlation: Types and Interpretation
2. Simple Linear Regression: Model, Estimation, and Inference
3. Assumptions of Linear Regression and Diagnostic Tools
4. Multiple Linear Regression: Model Construction and Interpretation
5. Multicollinearity, Model Selection, and Variable Transformation
6. Introduction to ANOVA: Concepts and Terminology
7. One-Way ANOVA: Assumptions, Calculations, and Interpretation
8. Two-Way ANOVA: Factorial Designs and Interaction Effects
9. Residual Analysis and Diagnostics
10. Model Evaluation: R^2, Adjusted R^2, AIC/BIC

Recommended Textbooks

1. Kutner, M. H., Nachtsheim, C. J., & Neter, J. (2004). *Applied Linear Regression Models*. McGraw-Hill.
2. Montgomery, D. C., & Runger, G. C. (2014). *Applied Statistics and Probability for Engineers* (6th ed.). Wiley.

Suggested Readings

1. Draper, N. R., & Smith, H. (1998). *Applied Regression Analysis* (3rd ed.). Wiley.
2. Field, A. (2013). *Discovering Statistics Using IBM SPSS Statistics* (4th ed.). Sage.
3. Fox, J. (2015). *Applied Regression Analysis and Generalized Linear Models* (3rd ed.). Sage.

8. Data Wrangling (STAT-5108) 3(3-0)

Course Brief

This course equips students with practical skills for data wrangling, a crucial step in the data analysis pipeline. Emphasizing real-world datasets, it provides a comprehensive understanding of data acquisition, cleaning, transformation, and preprocessing techniques. Students will explore tools and methods to handle messy, incomplete, or inconsistent data and learn how to transform it into analyzable formats. Emphasis will be placed on building reproducible data workflows that ensure data integrity and readiness for advanced statistical modeling and machine learning applications.

Course Learning Outcomes

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

1. Understand and explain the key concepts, challenges, and importance of data wrangling in the data analysis pipeline.
2. Collect, clean, and preprocess raw data from various sources using appropriate tools.
3. Apply data transformation techniques, including handling missing data, outlier detection, and feature engineering, to improve data quality.
4. Integrate data preprocessing techniques into a reproducible data analysis pipeline, ensuring clean and ready-to-analyze datasets for statistical modeling.

Course Contents

1. Introduction to Data Wrangling and the Data Science Workflow
2. Data Sources and Acquisition (CSVs, APIs, Web Scraping, Databases)
3. Data Cleaning: Removing Duplicates, Handling Missing Values
4. Data Transformation: Data Types, Normalization, Standardization
5. Handling Outliers and Anomalies
6. Feature Engineering and Variable Encoding
7. String and Text Data Processing
8. Merging, Joining, and Reshaping Datasets
9. Creating Reproducible Data Pipelines
10. Introduction to Data Wrangling Tools (R, Python, Excel, SQL)

Recommended Textbooks

1. Wickham, H., & Grolemund, G. (2017). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. O'Reilly Media.
2. VanderPlas, J. (2016). *Python Data Science Handbook*. O'Reilly Media.

Suggested Readings

1. Zumel, N., & Mount, J. (2014). *Practical Data Science with R*. Manning Publications.
2. McKinney, W. (2017). *Python for Data Analysis* (2nd ed.). O'Reilly Media.
3. Dasu, T., & Johnson, T. (2003). *Exploratory Data Mining and Data Cleaning*. Wiley-Interscience.

9. Statistical Packages (STAT-5109)

3(3-0)

Course Brief

This course introduces students to the practical use of statistical software packages commonly employed in data analysis, including tools such as SPSS, R, Python, and Excel. The course provides hands-on experience in data manipulation, statistical analysis, and visualization. Emphasis is placed on applying statistical techniques such as descriptive statistics, hypothesis testing, and regression analysis through software, interpreting output, and producing professional reports. Students will gain critical software skills necessary for real-world data analysis and research tasks.

Course Learning Outcomes

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

1. Demonstrate proficiency in using statistical software to perform data manipulation, analysis, and visualization tasks.
2. Apply various statistical techniques, such as descriptive statistics, hypothesis testing, and regression analysis, using the software tools.
3. Interpret the output generated by statistical software and communicate results effectively, including the creation of graphs and charts.
4. Troubleshoot common issues in data analysis and refine methods based on software capabilities to achieve accurate results.

Course Contents

1. Introduction to Statistical Software Packages (Excel, SPSS, Minitab)
2. Data Entry, Importing, and Exporting Datasets
3. Data Cleaning and Transformation in Software
4. Descriptive Statistics and Summary Measures
5. Graphical Data Representation: Charts, Histograms, Boxplots
6. Hypothesis Testing: t-tests, Chi-square, ANOVA
7. Correlation and Regression Analysis
8. Data Visualization and Report Generation
9. Scripting and Automation in Statistical Tools
10. Troubleshooting and Debugging Data Analysis Procedures

Recommended Textbooks

1. Field, A. (2013). *Discovering Statistics Using IBM SPSS Statistics* (4th ed.). SAGE Publications.
2. Kabacoff, R. (2015). *R in Action: Data Analysis and Graphics with R* (2nd ed.). Manning.

Suggested Readings

1. McKinney, W. (2017). *Python for Data Analysis* (2nd ed.). O'Reilly Media.
2. Diez, D., Barr, C., & Çetinkaya-Rundel, M. (2019). *OpenIntro Statistics.*
3. Dalgaard, P. (2008). *Introductory Statistics with R* (2nd ed.). Springer.

10. Non-Parametric Methods (STAT-5110) 3(3-0)

Course Brief

This course focuses on statistical methods that do not rely on strict distributional assumptions. It is designed to equip students with robust tools for analyzing data when traditional parametric assumptions (such as normality) are violated. Emphasis is placed on understanding the rationale behind non-parametric techniques, applying them to real-world data, and interpreting results. The course covers a variety of non-parametric tests and modern resampling methods like bootstrapping and permutation tests.

Course Learning Outcomes

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

1. Understand the effectiveness and need of non-parametric methods in comparison to parametric techniques.
2. Understand the principles and applications of non-parametric statistical methods, including their advantages.
3. Apply non-parametric tests and resampling techniques on real-world datasets.

Course Contents

1. Introduction to Non-Parametric Statistics and When to Use Them
2. Comparison Between Parametric and Non-Parametric Methods
3. The Sign Test and Wilcoxon Signed-Rank Test
4. Mann-Whitney U Test and Kruskal-Wallis Test
5. Chi-Square Test of Independence and Goodness-of-Fit
6. Spearman's Rank Correlation
7. Run Tests and Median Tests
8. Bootstrap Methods and Confidence Intervals
9. Permutation Tests
10. Real-World Applications and Interpretation of Non-Parametric Tests

Recommended Textbooks

1. Gibbons, J. D., & Chakraborti, S. (2010). *Nonparametric Statistical Inference* (5th ed.). CRC Press.
2. Hollander, M., Wolfe, D. A., & Chicken, E. (2013). *Nonparametric Statistical Methods* (3rd ed.). Wiley.

Suggested Readings

1. Conover, W. J. (1999). *Practical Nonparametric Statistics* (3rd ed.). Wiley.
2. Higgins, J. J. (2004). *Introduction to Modern Nonparametric Statistics*. Cengage Learning.

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Course Outlines for Major Courses

1. Probability Distributions (STAT-6101) 3(3-0)

Course Brief

This course provides a comprehensive foundation in the theory and applications of probability distributions. Emphasizing both discrete and continuous random variables, the course explores key distributions, their derivations, properties, and uses in statistical modeling. Special attention is given to transformations of random variables, bivariate distributions, and order statistics. Students will learn to apply probabilistic reasoning to real-world scenarios and derive meaningful insights from statistical models.

Course Learning Outcomes

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

1. Understand the concepts of discrete and continuous probability distributions.
2. Derive the properties of the discrete and continuous distributions.
3. Apply one-, two-variable(s) transformation of random variables and their probability distributions.
4. Explore the bivariate normal distribution with its properties.
5. Demonstrate the use of order statistics with their probability distributions.

Course Contents

1. Review of Random Variables and Probability Functions
2. Discrete Distributions: Binomial, Poisson, Hypergeometric, Negative Binomial
3. Continuous Distributions: Uniform, Exponential, Gamma, Normal
4. Distribution Functions and Properties (Moments, MGF, etc.)
5. Transformation of One and Two Random Variables
6. Joint, Marginal, and Conditional Distributions
7. Bivariate Normal Distribution: Definition, Properties, and Applications
8. Order Statistics: Definitions, Properties, and Applications
9. Applications in Real-World Statistical Modeling

Recommended Textbooks

1. Hogg, R. V., McKean, J. W., & Craig, A. T. (2018). *Introduction to Mathematical Statistics* (8th ed.). Pearson.
2. Casella, G., & Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Duxbury Press.

Suggested Readings

1. Larsen, R. J., & Marx, M. L. (2018). *An Introduction to Mathematical Statistics and Its Applications* (6th ed.). Pearson.
2. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). McGraw-Hill.

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2. Design and Analysis of Experiments (STAT-6102) 3(3-0)

Course Brief

This course focuses on the design and analysis of experiments in scientific research. Students will learn how to plan, conduct, and analyze experiments efficiently using a variety of experimental designs. Emphasis is placed on the principles of randomization, replication, and blocking. Topics include basic designs such as CRD and RCBD, factorial experiments, split-plot designs, incomplete block designs, and an introduction to response surface methodology. The course equips students with practical tools for applying these techniques in real-life data collection and analysis.

Course Learning Outcomes

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

1. Understand the basic experimental designs and principles with different treatment structures and applications.
2. Understand incomplete block designs.
3. Understand factorial experiments and split-plot designs.
4. Understand basic concepts of response surface methodology.

Course Contents

1. Introduction to Experimental Design and Basic Principles
2. Completely Randomized Design (CRD)
3. Randomized Complete Block Design (RCBD)
4. Latin Square Design (LSD)
5. Incomplete Block Designs: Balanced and Partially Balanced
6. Factorial Experiments: 2^k and 3^k Designs
7. Split-Plot and Strip-Plot Designs
8. Analysis of Covariance in Designed Experiments
9. Introduction to Response Surface Methodology (RSM)
10. Software Applications for Experimental Design (e.g., R, SPSS, MINITAB)

Recommended Textbooks

1. Montgomery, D. C. (2019). *Design and Analysis of Experiments* (10th ed.). Wiley.
2. Kuehl, R. O. (2000). *Design of Experiments: Statistical Principles of Research Design and Analysis* (2nd ed.). Duxbury Press.

Suggested Readings

1. Gomez, K. A., & Gomez, A. A. (1984). *Statistical Procedures for Agricultural Research* (2nd ed.). Wiley.
2. Box, G. E. P., Hunter, J. S., & Hunter, W. G. (2005). *Statistics for Experimenters: Design, Innovation, and Discovery* (2nd ed.). Wiley.

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3. Sampling Techniques (STAT-6103) 3(3-0)

Course Brief

This course provides an in-depth study of various sampling techniques used in statistical surveys and research. Students will learn both theoretical and practical aspects of probability and non-probability sampling, estimation of population parameters, and the application of specialized estimators. Emphasis is placed on designing efficient sampling plans and understanding the implications of different strategies on precision and bias. The course includes practical examples and exercises from fields such as social science, health, and market research.

Course Learning Outcomes

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

1. Use and implement random and non-random sampling with their properties.
2. Estimate population total, mean, and variance for different sampling plans.
3. Distinguish among ratio, regression, and product estimators for different sampling designs and their applications.

Course Contents

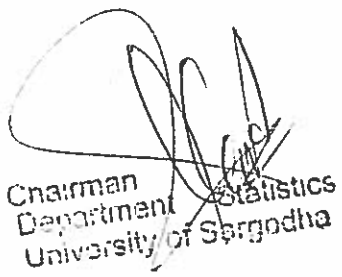
1. Introduction to Sampling: Concepts and Terminologies
2. Simple Random Sampling (With and Without Replacement)
3. Stratified Sampling and Allocation Techniques
4. Systematic Sampling
5. Cluster and Multi-stage Sampling
6. Estimation of Population Total, Mean, and Variance
7. Ratio, Regression, and Product Estimators
8. Comparison of Estimators and Efficiency Measures
9. Non-Probability Sampling Techniques: Quota and Judgment Sampling
10. Sampling Errors and Sample Size Determination
11. Use of Software for Sample Selection and Estimation (e.g., R, STATA)

Recommended Textbooks

1. Cochran, W. G. (1977). *Sampling Techniques* (3rd ed.). Wiley.
2. Singh, D., & Chaudhary, F. S. (1986). *Theory and Analysis of Sample Survey Designs*. Wiley Eastern.

Suggested Readings

1. Lohr, S. L. (2010). *Sampling: Design and Analysis* (2nd ed.). Brooks/Cole.
2. Murthy, M. N. (1977). *Sampling Theory and Methods*. Statistical Publishing Society.



4. Biostatistics (STAT-6104) 3(3-0)

Course Brief

This course introduces statistical methods and their applications in the fields of biology, medicine, and public health. It emphasizes the use of appropriate statistical tools to analyze data collected in biomedical sciences, helping students to interpret and evaluate research findings. Students will gain experience in applying statistical reasoning to solve problems related to clinical trials, epidemiology, genetics, and public health using standard software packages.

Course Learning Outcomes

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

1. Apply the concepts of statistics in health and biomedical sciences.
2. Understand sampling strategies in biomedical sciences.
3. Apply statistical methods in the analysis of biological and health-related data.
4. Demonstrate integration of statistical techniques with data analysis tools and methodologies to extract actionable insights from biological and health datasets.

Course Contents

1. Introduction to Biostatistics and Its Role in Biomedical Sciences
2. Types of Data in Biomedical Research
3. Descriptive Statistics for Health Data
4. Probability Distributions in Biological Contexts
5. Sampling Methods in Medical Studies
6. Hypothesis Testing in Clinical Research
7. Statistical Inference: Confidence Intervals and p-values
8. Analysis of Categorical Data: Chi-Square Tests
9. Correlation and Regression in Medical Studies
10. Survival Analysis Basics
11. Design of Medical and Public Health Studies
12. Use of Statistical Software (e.g., SPSS, R, SAS) in Biostatistical Applications

Recommended Textbooks

1. Dawson, B., & Trapp, R. G. (2004). *Basic & Clinical Biostatistics* (4th ed.). McGraw-Hill.
2. Rosner, B. (2015). *Fundamentals of Biostatistics* (8th ed.). Cengage Learning.

Suggested Readings

1. Pagano, M., & Gauvreau, K. (2018). *Principles of Biostatistics* (2nd ed.). CRC Press.
2. Zar, J. H. (2010). *Biostatistical Analysis* (5th ed.). Pearson.
3. Sokal, R. R., & Rohlf, F. J. (2012). *Biometry: The Principles and Practice of Statistics in Biological Research* (4th ed.). W. H. Freeman.

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5. Statistical Inference (STAT-6105) 3(3-0)

Course Brief

This course provides a comprehensive understanding of statistical inference, equipping students with theoretical knowledge and practical skills required to make valid conclusions from data. The focus is on estimation theory and hypothesis testing, covering the key inferential procedures used in statistical analysis. The course emphasizes both classical methods and their applications in real-world scenarios.

Course Learning Outcomes

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

1. Understand the properties of point estimators.
2. Apply methods for point estimation, including Maximum Likelihood Estimation (MLE) and Method of Moments, and evaluate their properties such as unbiasedness and efficiency.
3. Understand the best critical region, uniformly most powerful test, likelihood ratio test, and sequential probability test.
4. Conduct hypothesis tests for population parameters, including testing for means, variances, and proportions, using classical statistical techniques.
5. Construct and interpret confidence intervals for various statistical parameters, understanding their relationship with the level of significance and margin of error.

Course Contents

1. Introduction to Statistical Inference
2. Properties of Point Estimators: Unbiasedness, Consistency, Efficiency, Sufficiency
3. Methods of Estimation: Method of Moments, Maximum Likelihood Estimation (MLE)
4. Interval Estimation and Confidence Intervals
5. Hypothesis Testing Framework and Concepts
6. Neyman-Pearson Lemma and Most Powerful Tests
7. Uniformly Most Powerful (UMP) Tests
8. Likelihood Ratio Tests
9. Sequential Probability Ratio Test (SPRT)
10. Tests for Means, Variances, and Proportions
11. Relationship between Confidence Intervals and Hypothesis Testing

Recommended Textbooks

1. Casella, G., & Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Duxbury.
2. Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2019). *Probability and Statistical Inference* (10th ed.). Pearson.

Suggested Readings

1. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). *Introduction to the Theory of Statistics* (3rd ed.). McGraw-Hill.
2. Lehmann, E. L., & Romano, J. P. (2005). *Testing Statistical Hypotheses* (3rd ed.). Springer.
3. Bickel, P. J., & Doksum, K. A. (2015). *Mathematical Statistics: Basic Ideas and Selected Topics* (2nd ed.). CRC Press.

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6. Regression Analysis (STAT-6106) 3(3-0)

Course Brief

This course covers fitting and evaluating linear regression models—simple, multiple, and hierarchical—including assessing the overall quality of models and interpreting the significance of individual predictors. Key statistical concepts such as R-squared, correlation, and the use of qualitative predictors are discussed in detail. Emphasis is placed on both theoretical and practical aspects of regression modeling, along with applications in short-term and long-term prediction. The course includes software demonstrations using SPSS, Minitab, Mathematica, and R to support hands-on learning. By the end of this course, students will be able to conduct and interpret their own regression analyses and critically evaluate related research.

Course Learning Outcomes

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

1. Understand and differentiate types of regression and correlation.
2. Fit and evaluate simple, multiple, and hierarchical regression models.
3. Apply least squares and maximum likelihood estimation techniques.
4. Test significance of regression models and parameters.
5. Interpret regression coefficients, confidence intervals, and prediction intervals.
6. Perform model selection using stepwise regression and model fit criteria.
7. Analyze residuals, identify outliers and influential observations.
8. Implement polynomial and orthogonal regression techniques.
9. Use statistical software to apply and interpret regression models.

Course Contents

1. Introduction to regression and its types
2. Introduction to correlation and its types
3. Simple and multiple linear regression models
4. Linear regression and its assumptions
5. Least squares estimator
6. Maximum Likelihood Estimator
7. Tests of significance for regression model and regression parameters
8. Confidence interval for regression parameters
9. Interval estimation for predicted response
10. Regression models with single and multiple qualitative predictors
11. Stepwise regression and regression model selection criteria
12. Test of linearity of regression, use of extraneous information in linear regression
13. Residual analysis, detection and study of outliers and influential observations
14. Polynomial regression
15. Orthogonal polynomial and orthogonal regression analysis
16. Regression analysis with different statistical software

Recommended Textbooks

1. Draper, N. R. & Smith, H. (2004). *Applied Regression Analysis.* New York: John Wiley & Sons.
2. Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). *Introduction to Linear Regression Analysis.* New York: John Wiley & Sons.

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Suggested Readings

1. Rawlings, J. O., Pantula, S. G., & Dickey, D. A. (2001). *Applied Regression Analysis: A Research Tool*. Springer.
2. Dielman, T. E. (2001). *Applied Regression Analysis for Business and Economics*. Pacific Grove.
3. Yan, X., & Zu, X. G. (2009). *Linear Regression Analysis: Theory and Computing*. World Scientific Publications.

7. Statistical Programming Using R and Python (STAT-6107) 3(3-0)

Course Brief

This course introduces students to statistical programming using two widely adopted languages in data science: R and Python. Emphasis is placed on the practical application of programming constructs and statistical functions to real-world data analysis problems. Students will gain hands-on experience in using R packages and Python libraries to write scripts, perform statistical computations, and automate data analysis workflows.

Course Learning Outcomes

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

1. Understand basic programming concepts, including algorithms, data structures, and flow control, using R and Python.
2. Use various R packages and Python libraries (such as `tidyverse`, `pandas`, `numpy`, and `matplotlib`) for statistical computing.
3. Write and execute R and Python programs to solve statistical problems and conduct data analysis tasks.

Course Contents

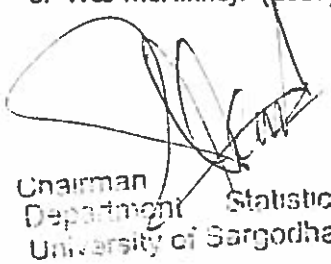
1. Introduction to R and Python Environments
2. Data Types, Variables, and Operators
3. Control Structures: Loops and Conditional Statements
4. Functions and Modules
5. Data Import, Export, and Cleaning
6. Data Manipulation using `dplyr` (R) and `pandas` (Python)
7. Data Visualization using `ggplot2` (R) and `matplotlib/seaborn` (Python)
8. Statistical Computing: Descriptive and Inferential Analysis
9. Writing Reproducible Scripts and Reports
10. Introduction to Automation and Reporting in Statistical Projects

Recommended Textbooks

1. Grolemund, G. (2014). *Hands-On Programming with R*. O'Reilly Media.
2. Lutz, M. (2013). *Learning Python* (5th ed.). O'Reilly Media.

Suggested Readings

1. Wickham, H., & Grolemund, G. (2016). *R for Data Science*. O'Reilly Media.
2. VanderPlas, J. (2016). *Python Data Science Handbook*. O'Reilly Media.
3. Wes McKinney. (2017). *Python for Data Analysis* (2nd ed.). O'Reilly Media.



8. Research Methodology (STAT-6108) 3(3-0)

Course Brief

This course equips students with a comprehensive understanding of the principles and practices of research methodology. It covers the various types and designs of research, introduces data collection tools, and emphasizes ethical considerations and academic integrity in conducting research. Students will also learn how to develop, validate, and analyze research instruments like questionnaires and write scientific research reports.

Course Learning Outcomes

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

1. Understand the fundamental principles of research methodology, encompassing various research types, designs, and pertinent procedures.
2. Use various data collection tools effectively.
3. Develop a questionnaire, and assess its validity and reliability.
4. Understand research ethics and principles of scientific report writing.

Course Contents

1. Introduction to Research and Research Process
2. Types of Research: Basic, Applied, Qualitative, Quantitative
3. Research Design: Exploratory, Descriptive, Experimental
4. Literature Review and Problem Formulation
5. Sampling Techniques and Sample Size Determination
6. Data Collection Methods: Surveys, Interviews, Observations
7. Designing and Validating Questionnaires
8. Measurement Scales and Reliability Testing
9. Ethics in Research and Plagiarism Awareness
10. Writing Research Proposals and Final Reports

Recommended Textbooks

1. Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.
2. Kumar, R. (2019). *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.). SAGE Publications.

Suggested Readings

1. Neuman, W. L. (2013). *Social Research Methods: Qualitative and Quantitative Approaches* (7th ed.). Pearson.
2. Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill Building Approach* (7th ed.). Wiley.
3. Babbie, E. (2020). *The Practice of Social Research* (15th ed.). Cengage Learning.

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9. Statistical Quality Control (STAT-6109) 3(3-0)

Course Brief

This course introduces the fundamental concepts and techniques of Statistical Quality Control (SQC), essential for quality improvement and assurance in industrial and business processes. Students will gain practical skills in monitoring production processes using control charts and conducting acceptance sampling. The course also addresses the roles of consumer's and producer's risk in quality decision-making, enabling students to implement and interpret statistical tools to ensure consistent product quality.

Course Learning Outcomes

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

1. Understand the fundamental principles, techniques, and tools of Statistical Quality Control.
2. Monitor statistical processes using various control charts.
3. Observe consumers' and producers' risk using different acceptance sampling plans.

Course Contents

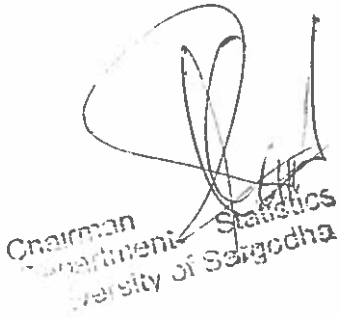
1. Introduction to Quality and Quality Control Concepts
2. Control Charts for Variables (X-bar, R, s Charts)
3. Control Charts for Attributes (p, np, c, and u Charts)
4. Process Capability Analysis and Interpretation
5. Acceptance Sampling: Single, Double, and Sequential Plans
6. Operating Characteristic (OC) Curves and Risk Analysis
7. Consumer's Risk and Producer's Risk in Quality Control
8. Applications of SQC in Industrial and Service Sectors
9. Software Tools for Quality Control (e.g., Minitab, R)

Recommended Textbooks

1. Montgomery, D. C. (2020). *Introduction to Statistical Quality Control* (8th ed.). Wiley.
2. Mitra, A. (2016). *Fundamentals of Quality Control and Improvement* (4th ed.). Wiley.

Suggested Readings

1. Grant, E. L., & Leavenworth, R. S. (1996). *Statistical Quality Control* (7th ed.). McGraw-Hill.
2. Besterfield, D. H. (2012). *Quality Control* (8th ed.). Pearson.
3. Juran, J. M., & Godfrey, A. B. (1999). *Juran's Quality Handbook* (5th ed.). McGraw-Hill.



10. Applied Multivariate Analysis (STAT-6110) 3(3-0)

Course Brief

This course provides comprehensive coverage of multivariate statistical methods used to analyze data involving multiple variables simultaneously. Students will learn how to apply inference in multivariate settings, use multivariate regression models, and understand advanced techniques such as principal component analysis, factor analysis, discriminant analysis, and cluster analysis. The course emphasizes both theoretical understanding and practical implementation for real-world datasets.

Course Learning Outcomes

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

1. Apply statistical inference for multivariate data.
2. Apply multivariate regression and relevant inference techniques.
3. Understand multivariate statistical techniques for dimension reduction such as principal component analysis and factor analysis.
4. Use discriminant analysis and clustering techniques.

Course Contents

1. Introduction to Multivariate Data and Notation
2. Multivariate Normal Distribution and Its Properties
3. Inference About a Mean Vector
4. Comparison of Several Multivariate Means (MANOVA)
5. Multivariate Linear Regression Models
6. Principal Component Analysis (PCA)
7. Factor Analysis and Interpretation
8. Canonical Correlation Analysis
9. Discriminant Analysis
10. Cluster Analysis: Hierarchical and Non-hierarchical Methods
11. Applications Using Statistical Software (e.g., R, SPSS)

Recommended Textbooks

1. Johnson, R. A., & Wichern, D. W. (2018). *Applied Multivariate Statistical Analysis* (6th ed.). Pearson.
2. Rencher, A. C., & Christensen, W. F. (2012). *Methods of Multivariate Analysis* (3rd ed.). Wiley.

Suggested Readings

1. Anderson, T. W. (2003). *An Introduction to Multivariate Statistical Analysis* (3rd ed.). Wiley.
2. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate Data Analysis* (8th ed.). Cengage.
3. Everitt, B., & Hothorn, T. (2011). *An Introduction to Applied Multivariate Analysis with R*. Springer.

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Course Outlines for Interdisciplinary Courses

1. Linear Algebra (MATH-5127)

3(3-0)

Course Brief

This course introduces students to the fundamental principles of linear algebra and its applications in statistics and data science. Topics include matrices, vectors, systems of linear equations, vector spaces, and eigenvalue analysis. The course emphasizes both theoretical understanding and practical problem-solving skills relevant to computational and statistical contexts.

Course Learning Outcomes

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

1. Explain fundamental concepts of matrices, vectors, and linear systems, and demonstrate their application in statistical problems.
2. Apply matrix operations and transformations to solve systems of linear equations in computational contexts.
3. Analyze the properties of vector spaces and eigenvalues to interpret results for data science and statistical models.

Course Contents

1. Introduction to Matrices and Vectors
2. Matrix Operations and Inverses
3. Systems of Linear Equations and Gaussian Elimination
4. Determinants and Cramer's Rule
5. Vector Spaces, Subspaces, Basis, and Dimension
6. Linear Independence and Rank
7. Linear Transformations and Matrix Representation
8. Eigenvalues and Eigenvectors
9. Diagonalization and Applications in Statistics

Recommended Textbooks

1. Lay, D. C., Lay, S. R., & McDonald, J. J. (2016). *Linear Algebra and Its Applications* (5th ed.). Pearson.
2. Strang, G. (2016). *Introduction to Linear Algebra* (5th ed.). Wellesley-Cambridge Press.

Suggested Readings

1. Anton, H., & Rorres, C. (2013). *Elementary Linear Algebra with Applications* (11th ed.). Wiley.
2. Meyer, C. D. (2000). *Matrix Analysis and Applied Linear Algebra*. SIAM.
3. Friedberg, S. H., Insel, A. J., & Spence, L. E. (2003). *Linear Algebra* (4th ed.). Pearson.

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2. Bioinformatics

3(3-0)

Course Brief

Bioinformatics is defined broadly as the study of the inherent structure of biological information. The objective of the course is to introduce students to the rapidly evolving field of bioinformatics. The main objective is to familiarize students with biological data mining from online databases and the use of various bioinformatics tools for extracting and processing biological data. Upon completing this course, students will gain an understanding of the computational challenges (and their solutions) in analyzing large biological datasets. They will also understand how commonly used bioinformatics tools function, how to apply them effectively, and how to critically evaluate research articles in the field.

Course Learning Outcomes

1. Understand the fundamental concepts and scope of bioinformatics.
2. Retrieve and interpret biological data from public repositories and databases.
3. Perform sequence alignment and analyze structural and functional features of biological molecules.
4. Apply bioinformatics tools for genome annotation, protein modeling, and phylogenetic analysis.
5. Evaluate computational strategies for whole genome sequencing and assembly.

Course Contents

1. Introduction; bio-computing
2. Biological databases - types and retrieval of nucleic acid (or genomic) or protein sequence information
3. Sequence alignment - pairwise, multiple
4. Phylogenetics; in silico identification of protein motifs and domains
5. Structural bioinformatics of proteins and RNAs including protein modeling and prediction of their interactions with other proteins and small molecules
6. Identification of genes and promoter regions within genomes; networks
7. Strategies for whole genome sequencing and assembly

Recommended Databases and Tools

- NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG
- BioEdit, RepeatMasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM
- CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript
- Genetic Analysis Software, Phylip, MEGA 4.0

Recommended Textbooks

- Claverie, J.M., & Notredame, C. (2014). *Bioinformatics for Dummies* (4th Ed.). Wiley Publishing.
- Xiong, J. (2016). *Essential Bioinformatics* (3rd Ed.). Cambridge University Press.

Suggested Readings

- Mathura, V., & Kangueane, P. (2016). *Bioinformatics: A Concept-Based Introduction.* Springer.
- Mount, D.W. (2001). *Bioinformatics Sequence and Genome Analysis* (4th Ed.). Cold Spring Harbor Laboratory Press.
- Sperschneider, V. (2016). *Bioinformatics: Problem Solving Paradigms.* Springer.

3. Programming Fundamentals(CMPC-5201) 3(2-1)

Course Brief

This course provides fundamental concepts of programming to freshmen. The course is a prerequisite to many others; therefore, students are strongly advised to thoroughly cover all contents and achieve the course learning outcomes to the fullest extent. While the course may be taught language-independently, the university may choose any modern, market-oriented language for practical/lab sessions.

Course Learning Outcomes

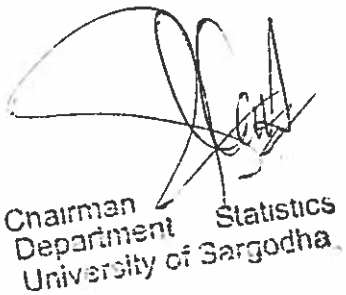
1. Understand basic problem solving steps and logic constructs *(C2: Understand)*
2. Apply basic programming concepts *(C3: Apply)*
3. Design and implement algorithms to solve real-world problems *(C3: Solve)*

Course Contents

The course covers foundational programming concepts beginning with an introduction to problem solving and a brief review of the Von-Neumann architecture. It then explores programming fundamentals including the role of compilers and linkers, and the basics of algorithms. Students will learn about data types, variables, input/output constructs, and various operators (arithmetic, comparison, and logical). Control flow structures such as conditional and repetitive statements are introduced, along with lists, multidimensional lists, and memory organization. Further topics include modular programming, function definition and invocation, stack behavior (rolling and unrolling), string manipulation, pointers/references, and both static and dynamic memory allocation. Finally, the course introduces file input/output operations, equipping students with comprehensive knowledge required for basic software development.

Recommended Textbooks

1. Robert Lafore. *Object Oriented Programming in C++*, latest edition.
2. Tony Gaddis. *Starting Out with Programming Logic and Design*, latest edition.
3. Brian W. Kernighan & Dennis M. Ritchie. *The C Programming Language*, 2nd Edition.
4. Paul Deitel & Harvey Deitel. *C++ How to Program*, latest edition.
5. Jeri R. Hanly & Elliot B. Koffman. *Problem Solving and Program Design in C++*, latest edition.



4. Database Systems (CMPC-5203) 3(2-1)

Course Brief

The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques, and database design methodologies. It places strong emphasis on the relational data model and Database Management System (DBMS) principles, providing students with the practical skills and theoretical foundation necessary to work effectively with modern databases.

Course Learning Outcomes

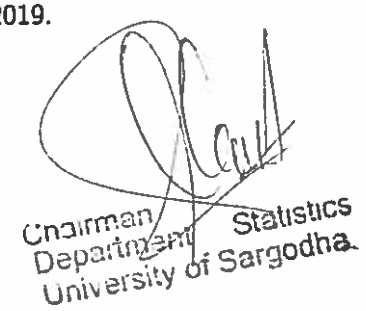
1. Explain fundamental database concepts *(C2: Explain)*
2. Design conceptual, logical, and physical database schemas using different data models *(C5: Design)*
3. Identify functional dependencies and resolve database anomalies by normalizing database tables *(C2: Identify)*
4. Use Structured Query Language (SQL) for database definition and manipulation in any DBMS *(C4: Use)*

Course Contents

This course begins with an overview of basic database concepts and contrasts the database approach with traditional file-based systems. It introduces database architecture and the three-level schema model, highlighting the concept of data independence. The relational data model is thoroughly explored, covering attributes, schemas, tuples, domains, relation instances, keys, and integrity constraints. Students learn relational algebra operations such as selection, projection, Cartesian product, and various types of joins. The course also covers normalization techniques, functional dependencies, and different normal forms. It provides instruction on the Entity-Relationship (ER) model, including entity sets, attributes, relationships, and ER diagrams. SQL is covered in depth, including joins, subqueries, grouping, and aggregation. Advanced topics such as concurrency control, backup and recovery, indexing techniques, and an introduction to NoSQL systems are also included.

Recommended Textbooks

1. Mark L. Gillenson. *Fundamentals of Database Management Systems*, 3rd Edition, 2023.
2. Thomas Connolly and Carolyn Begg. *Database Systems: A Practical Approach to Design, Implementation, and Management*, 6th Edition, 2019.
3. Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom. *Database Systems: The Complete Book*, 2nd Edition, 2013.
4. Avi Silberschatz, Henry F. Korth, and S. Sudarshan. *Database System Concepts*, 6th Edition, 2019.



5. Cyber Security (ITDC-5202) 3(2-1)

Course Brief

The Cyber Security course focuses on safeguarding digital systems and data. It introduces students to the fundamentals of cyber threats, encryption, and risk management strategies, and prepares them to defend against cyberattacks while ensuring the security of information assets.

Course Learning Outcomes

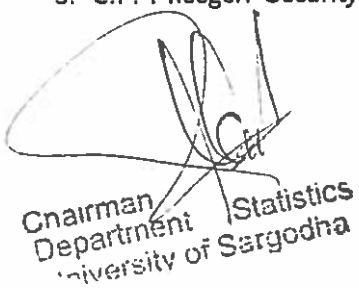
1. To be able to identify computer system threats *(C2: Understand)*
2. To be able to identify malware attacks and understand the stages of attack and payloads *(C2: Understand)*
3. Implement various cryptographic techniques and simulate attack scenarios *(C3: Apply)*

Course Contents

The course covers a wide range of cyber security topics, beginning with an introduction to cyber security and networking fundamentals. It explores the cyber threat landscape, key information security principles (Confidentiality, Integrity, Availability), and common terminology. Students will examine attacker profiles, including Advanced Persistent Threats (APT), and types of malware, along with the malware attack lifecycle. The course delves into social engineering tactics, attack payloads, and industrial espionage in cyberspace. Core cryptographic techniques are introduced, followed by discussions on web application security, database security, the cyber kill chain, and issues of privacy and anonymity. Additional modules include network and wireless security, software and mobile device security, cyber terrorism, information warfare, and an introduction to digital forensics and its various categories.

Recommended Textbooks

1. Chuck Easttom. *Computer Security Fundamentals*, 4th Edition or latest.
2. Mark Ciampa. *Security+ Guide to Network Security Fundamentals*, 5th Edition.
3. C.P. Pfleeger. *Security in Computing*, Prentice-Hall, 4th Edition or latest.



6. Artificial Neural Networks & Deep Learning (AIDC-5101) 3(2-3)

Course Brief

This course introduces Artificial Neural Networks (ANNs) and Deep Learning. It begins with the basic architecture of ANNs and how they emulate the human brain using simple mathematical models. Students will learn the essential concepts and learning laws associated with brain-inspired computing, and how to choose activation functions and train networks for classification tasks. The course progresses to advanced deep learning topics, including convolutional and recurrent neural networks, unsupervised deep learning, reinforcement learning, and state-of-the-art models in computer vision and natural language processing.

Course Learning Outcomes

1. Understand the fundamentals of neural networks in AI *(C2: Understand)*
2. Explain how simple ANNs can be designed *(C2: Understand)*
3. Apply ANN for classification problems *(C3: Apply)*
4. Apply deep learning algorithms to real-world problems *(C3: Apply)*
5. Analyze results from deep learning to select appropriate solutions *(C4: Analyze)*

Course Contents

Introduction and history of neural networks; basic architecture of neural networks; perceptron and Adaline (Minimum Error Learning); basics of deep learning; machine learning theory – training and test sets, evaluation metrics; learning algorithms: gradient descent, Hebbian and neo-Hebbian learning, differential Hebbian learning, reinforcement learning; Kohonen self-organizing maps; associative memory and bi-directional associative memory (BAM); Boltzmann machines; backpropagation and feedforward networks; theory of generalization; multi-layer perceptrons; deep convolutional networks and their computational complexity; unsupervised deep learning: autoencoders, deep belief networks, restricted Boltzmann machines; deep recurrent neural networks including BPTT and LSTM; GPU programming for deep learning using CuDNN; generative adversarial networks (GANs); sparse coding and autoencoders; data augmentation techniques; regularization methods including dropout, batch normalization, dropconnect; recent deep learning architectures such as ResNet and GoogleNet.

Recommended Textbooks

1. Chollet, F. *Deep Learning with Python*, Simon and Schuster, 2021.
2. Goodfellow, I., Bengio, Y., & Courville, A. *Deep Learning*, MIT Press, 2016.
3. Graupe, D. *Deep Learning Neural Networks: Design and Case Studies*, World Scientific Publishing, 2016.
4. Anderson, J. A. *An Introduction to Neural Networks*, MIT Press, 1995.
5. Hassoun, M. H. *Fundamentals of Artificial Neural Networks*, MIT Press, 1995.

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7. Cloud Computing (DSDE-6207) 3(2-3)

Course Brief

This course introduces students to the foundations and applications of cloud computing. It explores distributed computing techniques, cloud ecosystems, and real-world use cases. Emphasis is placed on cloud services, deployment models, and related tools through hands-on labs and a term project.

Course Learning Outcomes

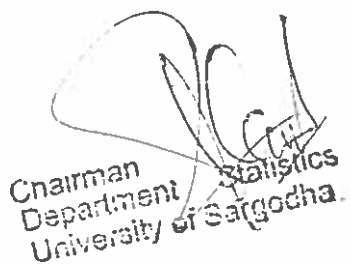
1. Understand fundamental concepts of distributed computing and their implementation in modern cloud systems *(C1: Knowledge)*
2. Understand the basic principles of cloud deployment and service models *(C2: Understand)*
3. Demonstrate deployment of cloud service models using simulators, VMware, or OpenStack *(C2: Understand)*

Course Contents

The course begins with an overview of distributed computing and the emergence of cloud computing, emphasizing the global nature and reliability of cloud models. Topics include cloud-based service offerings such as Communication-as-a-Service (CaaS), Infrastructure-as-a-Service (IaaS), Monitoring-as-a-Service (MaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). Key areas also include virtualization, security in the cloud, privacy and identity management, cloud federation, and mobile access to cloud services. Students will examine common cloud standards, legal considerations, and challenges faced in cloud environments.

Recommended Textbooks

1. Erl, T. (2023). *Cloud Computing: Concepts, Technology, Security, and Architecture.* Pearson Digital Enterprise Series.
2. Rittinghouse, J. W., & Ransome, J. F. (2010). *Cloud Computing Implementation, Management, and Security.* Taylor and Francis Group.
3. Liu, M.-L. (2004). *Distributed Computing: Principles and Applications.* Pearson.
4. Buyya, R., & Dastjerdi, A. V. (Eds.). *Internet of Things: Principles and Paradigms.* Morgan Kaufmann.
5. `https://arxiv.org/abs/1601.02752`
6. `https://www.vmware.com/pdf/virtualization.pdf`
7. `https://www.vmware.com/pdf/virtualization_considerations.pdf`
8. `https://www.researchgate.net/publication/270581440_Cloud_Federation_characteri`
   `and_conceptual_model`
9. `https://xmpp.org/`
10. *Architecting the Cloud: Design Decision for Cloud Computing Service Models (SaaS, PaaS and IaaS).* Wiley India, 2014.



Course Outlines for Elective Courses

1. Categorical Data Analysis (STAT-6111) 3(3-0)

Course Brief

This course provides a comprehensive introduction to the statistical analysis of categorical data, which arises frequently in the social sciences, health studies, marketing, and other applied fields. The course covers methods for analyzing binary, nominal, and ordinal outcomes using both classical and modern approaches.

Students will learn how to construct contingency tables, apply logistic regression models, and interpret results in the context of real-world datasets. Emphasis is placed on practical application, model interpretation, and communication of statistical findings.

Course Learning Outcomes

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

1. Understand the types and structure of categorical data.
2. Construct and interpret contingency tables.
3. Apply chi-square tests for independence and goodness-of-fit.
4. Fit and interpret binary and multinomial logistic regression models.
5. Analyze ordinal data using appropriate statistical models.
6. Evaluate model fit and identify influential observations.
7. Use statistical software (e.g., R, SAS, or SPSS) for categorical data analysis.

Course Contents

1. Introduction to Categorical Data: Types and Examples
2. Contingency Tables and Measures of Association
3. Chi-Square Tests: Independence, Homogeneity, and Goodness-of-Fit
4. Binary Response Models and Logistic Regression
5. Inference in Logistic Regression: Odds Ratios and Confidence Intervals
6. Multinomial Logistic Regression for Nominal Outcomes
7. Ordinal Logistic Regression Models (Proportional Odds Model)
8. Loglinear Models for Multi-way Tables
9. Model Selection and Assessment for Categorical Models
10. Overdispersion and Quasi-likelihood Methods
11. Applications in Epidemiology, Social Sciences, and Marketing
12. Software Implementation and Interpretation of Outputs

Recommended Textbooks

1. Agresti, A. (2018). *Statistical Methods for the Social Sciences.* Pearson.
2. Agresti, A. (2013). *Categorical Data Analysis.* Wiley.

Suggested Readings

1. Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression.* Wiley.
2. Menard, S. (2002). *Applied Logistic Regression Analysis.* Sage Publications.
3. Powers, D. A., & Xie, Y. (2008). *Statistical Methods for Categorical Data Analysis.* Emerald Group Publishing.

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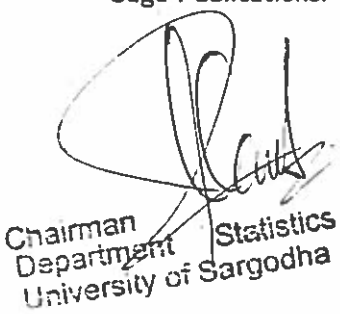
4. Kleinbaum, D. G., & Klein, M. (2010). *Logistic Regression: A Self-Learning Text*. Springer.
5. Long, J. S. (1997). *Regression Models for Categorical and Limited Dependent Variables*. Sage Publications.



2. Stochastic Process (STAT-6112) 3(3-0)

Course Brief

This course provides a comprehensive introduction to stochastic processes, which are collections of random variables representing systems evolving over time under uncertainty. It equips students with analytical tools to model, analyze, and interpret dynamic random phenomena in areas such as queueing theory, finance, biology, telecommunications, and operations research.

Topics include Markov chains, Poisson processes, renewal theory, and Brownian motion, with emphasis on both theoretical foundations and practical applications.

Course Learning Outcomes

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

1. Understand the fundamental concepts and classifications of stochastic processes.
2. Analyze discrete-time and continuous-time Markov chains.
3. Solve problems involving Poisson processes and their properties.
4. Apply renewal theory to systems with repetitive random events.
5. Understand the behavior and applications of Brownian motion.
6. Use stochastic models in applications such as queueing, reliability, and inventory systems.

Course Contents

1. Introduction to Stochastic Processes and Random Variables Review
2. Classification of Stochastic Processes: Discrete vs. Continuous, Markovian vs. Non-Markovian
3. Discrete-Time Markov Chains (DTMCs):
   - Transition Matrices and Chapman-Kolmogorov Equations
   - Classification of States and Limiting Behavior
4. Continuous-Time Markov Chains (CTMCs):
   - Birth-Death Processes
   - Transition Rate Matrix and Kolmogorov Differential Equations
5. Poisson Process and Variants
6. Renewal Processes and Applications
7. Markov Renewal and Semi-Markov Processes
8. Branching Processes
9. Brownian Motion and the Wiener Process
10. Applications in Queueing Theory, Reliability, and Finance
11. Simulation of Stochastic Processes

Recommended Textbooks

1. Ross, S. M. (2014). *Introduction to Probability Models.* Academic Press.
2. Medhi, J. (2009). *Stochastic Processes.* New Age International Publishers.

Suggested Readings

1. Karlin, S., & Taylor, H. M. (1975). *A First Course in Stochastic Processes.* Academic Press.
2. Grimmett, G., & Stirzaker, D. (2001). *Probability and Random Processes.* Oxford University Press.

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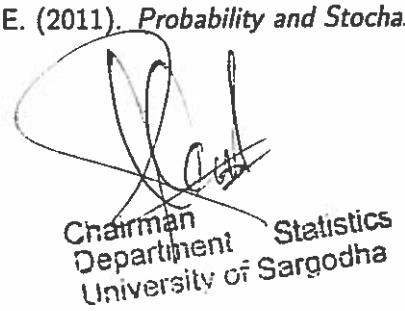
3. Norris, J. R. (1997). *Markov Chains.* Cambridge University Press.
4. Durrett, R. (2019). *Essentials of Stochastic Processes.* Springer.
5. Cinlar, E. (2011). *Probability and Stochastics.* Springer.



3. Reliability Analysis (STAT-6113) 3(3-0)

Course Brief

This course introduces the principles and methods of reliability analysis, focusing on modeling, estimation, and evaluation of the lifetime and performance of systems and components. It covers key concepts such as failure rates, system configurations, life distributions, and maintenance strategies.

Students will learn how to apply statistical techniques to assess system reliability, estimate model parameters, and develop reliability improvement strategies for engineering, industrial, and safety-critical applications.

Course Learning Outcomes

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

1. Understand fundamental concepts such as reliability, hazard function, and mean time to failure (MTTF).
2. Model lifetimes using exponential, Weibull, and other life distributions.
3. Estimate reliability parameters from failure data using statistical methods.
4. Analyze system reliability for series, parallel, and complex configurations.
5. Apply preventive maintenance and reliability-centered maintenance principles.
6. Use reliability software and simulation tools to evaluate system performance.

Course Contents

1. Introduction to Reliability Engineering and Definitions
2. Probability Concepts in Reliability
3. Lifetime Distributions: Exponential, Weibull, Gamma, Lognormal
4. Reliability Functions, Hazard Rate, and Cumulative Hazard
5. Mean Time to Failure (MTTF) and Mean Time Between Failures (MTBF)
6. Parameter Estimation: Maximum Likelihood and Least Squares Methods
7. System Reliability Analysis: Series, Parallel, k-out-of-n Systems
8. Fault Tree and Reliability Block Diagrams
9. Redundancy and Reliability Improvement Techniques
10. Preventive and Corrective Maintenance Policies
11. Accelerated Life Testing and Censoring Techniques
12. Case Studies in Engineering, Electronics, and Industrial Systems

Recommended Textbooks

1. Elsayed, E. A. (2012). *Reliability Engineering*. Wiley.
2. Modarres, M., Kaminskiy, M., & Krivtsov, V. (2016). *Reliability Engineering and Risk Analysis*. CRC Press.

Suggested Readings

1. Lewis, E. E. (1996). *Introduction to Reliability Engineering*. Wiley.
2. O'Connor, P. D. T., & Kleyner, A. (2012). *Practical Reliability Engineering*. Wiley.
3. Kapur, K. C., & Lamberson, L. R. (1977). *Reliability in Engineering Design*. Wiley.
4. Meeker, W. Q., & Escobar, L. A. (1998). *Statistical Methods for Reliability Data*. Wiley.
5. Rausand, M., & Høyland, A. (2004). *System Reliability Theory*. Wiley.

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4. Survival Analysis (STAT-6114) 3(3-0)

Course Brief

This course introduces the statistical methods used to analyze time-to-event data, commonly referred to as survival data. It is widely applied in clinical trials, epidemiology, engineering, social sciences, and reliability studies. The course covers censoring mechanisms, survival and hazard functions, non-parametric and semi-parametric methods, and regression models for survival data. Students will develop the ability to handle censored data, interpret survival curves, and apply appropriate statistical models using both theoretical understanding and hands-on experience with real-world datasets.

Course Learning Outcomes

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

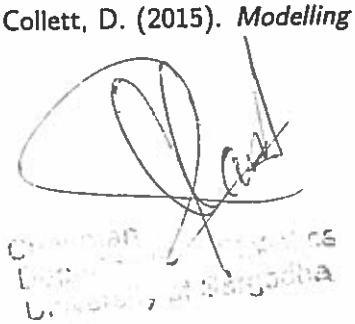
1. Understand the basic concepts of survival analysis including censoring and truncation.
2. Estimate survival and hazard functions using non-parametric methods.
3. Compare survival curves using statistical tests such as the log-rank test.
4. Fit and interpret Cox proportional hazards models.
5. Apply parametric survival models (e.g., exponential, Weibull).
6. Analyze real-life survival data using statistical software (e.g., R or SAS).

Course Contents

1. Introduction to Survival Analysis and Time-to-Event Data
2. Types of Censoring and Truncation
3. Survival Function, Hazard Function, and Cumulative Hazard
4. Non-parametric Estimation:
   - Kaplan-Meier Estimator
   - Nelson-Aalen Estimator
5. Comparing Survival Curves: Log-Rank and Wilcoxon Tests
6. Cox Proportional Hazards Model:
   - Assumptions and Interpretation
   - Model Checking and Diagnostics
7. Parametric Models: Exponential, Weibull, Log-normal
8. Accelerated Failure Time (AFT) Models
9. Time-Dependent Covariates and Stratified Cox Models
10. Competing Risks and Recurrent Event Analysis
11. Applications in Medicine, Reliability, and Social Sciences
12. Software Implementation in R or SAS

Recommended Textbooks

1. Kleinbaum, D. G., & Klein, M. (2012). *Survival Analysis: A Self-Learning Text*. Springer.
2. Collett, D. (2015). *Modelling Survival Data in Medical Research*. CRC Press.



Suggested Readings

1. Kalbfleisch, J. D., & Prentice, R. L. (2002). *The Statistical Analysis of Failure Time Data.* Wiley.
2. Hosmer, D. W., Lemeshow, S., & May, S. (2008). *Applied Survival Analysis.* Wiley.
3. Therneau, T. M., & Grambsch, P. M. (2000). *Modeling Survival Data: Extending the Cox Model.* Springer.
4. Lee, E. T., & Wang, J. W. (2013). *Statistical Methods for Survival Data Analysis.* Wiley.
5. Ibrahim, J. G., Chen, M. H., & Sinha, D. (2001). *Bayesian Survival Analysis.* Springer.

5. Actuarial Statistics (STAT-6115) 3(3-0)

Course Brief

This course provides a rigorous foundation in actuarial statistics, focusing on probability models and statistical methods used in insurance and financial risk management. It covers the modeling of claim distributions, survival models, credibility theory, and estimation techniques. The course prepares students for professional actuarial exams and equips them with analytical tools for real-world actuarial practice.

Students will gain experience applying statistical techniques to model insurance claims, life contingencies, and other uncertain future events, making informed decisions based on probabilistic outcomes.

Course Learning Outcomes

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

1. Understand key concepts in actuarial science including risk, loss distributions, and insurance principles.
2. Apply probability models to assess life, health, and general insurance risks.
3. Estimate parameters and fit models to claim and loss data.
4. Analyze survival and hazard functions using life tables and parametric models.
5. Apply credibility theory for experience rating.
6. Use simulation and numerical methods for pricing and reserve estimation.

Course Contents

1. Introduction to Actuarial Science and Insurance Principles
2. Review of Probability Theory and Common Distributions
3. Loss Models: Frequency and Severity Distributions (Poisson, Binomial, Exponential, Pareto)
4. Aggregate Loss Models and Risk Measures (VaR, TVaR)
5. Estimation Techniques: Maximum Likelihood and Bayesian Estimation
6. Model Selection and Goodness-of-Fit Tests
7. Survival Models and Life Tables
8. Hazard Rates, Force of Mortality, and Parametric Lifetime Distributions
9. Multiple Life and Multiple Decrement Models
10. Credibility Theory: Classical and Bayesian Approaches
11. Simulation Methods in Actuarial Modeling
12. Applications in Life, Health, and Property Insurance

Recommended Textbooks

1. Klugman, S. A., Panjer, H. H., & Willmot, G. E. (2012). *Loss Models: From Data to Decisions*. Wiley.
2. Dickson, D. C. M., Hardy, M. R., & Waters, H. R. (2013). *Actuarial Mathematics for Life Contingent Risks*. Cambridge University Press.

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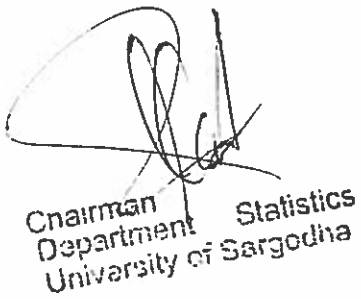
Suggested Readings

1. Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. (1997). *Actuarial Mathematics*. Society of Actuaries.
2. Cunningham, R., Herzog, T. N., & London, R. (2001). *Models for Quantifying Risk*. ACTEX Publications.
3. Kaas, R., Goovaerts, M., Dhaene, J., & Denuit, M. (2008). *Modern Actuarial Risk Theory*. Springer.
4. Frees, E. W. (2010). *Regression Modeling with Actuarial and Financial Applications*. Cambridge University Press.
5. Haberman, S., & Pitacco, E. (1999). *Actuarial Models for Disability Insurance*. Chapman and Hall/CRC.



6. Bayesian Statistics (STAT-6116) 3(3-0)

Course Brief

This course introduces the principles and methods of Bayesian statistics, which offers a coherent framework for updating beliefs in the presence of uncertainty. Unlike classical approaches, Bayesian inference combines prior knowledge with observed data using Bayes' theorem, leading to flexible and interpretable models.

Students will learn to construct Bayesian models, perform inference using both analytical and computational methods, and apply Bayesian thinking to real-world problems in science, business, and engineering. The course includes hands-on experience with Bayesian computation using tools such as R, Stan, or PyMC.

Course Learning Outcomes

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

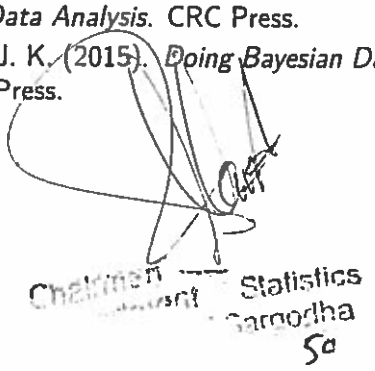
1. Understand the conceptual foundations of Bayesian inference and contrast it with frequentist methods.
2. Specify and interpret prior, likelihood, and posterior distributions.
3. Perform Bayesian inference for parameters in common statistical models.
4. Use Bayesian model comparison criteria such as Bayes factors and DIC.
5. Implement computational techniques including Gibbs sampling and MCMC.
6. Apply Bayesian methods to real-world datasets using appropriate software tools.

Course Contents

1. Introduction to Bayesian Thinking and Bayes' Theorem
2. Prior Distributions: Informative vs. Non-informative Priors
3. Conjugate Priors for Common Models (Binomial, Poisson, Normal)
4. Posterior Distributions and Bayesian Estimation
5. Bayesian Hypothesis Testing and Credible Intervals
6. Bayesian Linear Regression
7. Hierarchical Bayesian Models
8. Introduction to Markov Chain Monte Carlo (MCMC)
9. Gibbs Sampling, Metropolis-Hastings, and Hamiltonian Monte Carlo
10. Model Comparison: Bayes Factors, Posterior Predictive Checks, DIC
11. Bayesian Decision Theory
12. Applications in Medicine, Engineering, Social Sciences, and Machine Learning

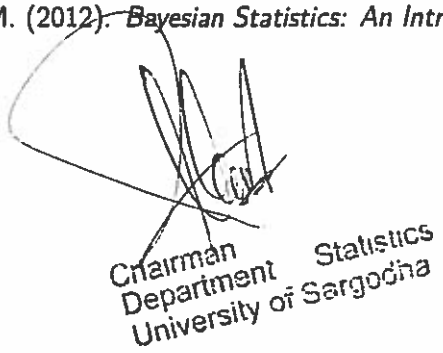
Recommended Textbooks

1. Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2013). *Bayesian Data Analysis*. CRC Press.
2. Kruschke, J. K. (2015). *Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan*. Academic Press.



Suggested Readings

1. McElreath, R. (2020). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan.* CRC Press.
2. Bernardo, J. M., & Smith, A. F. M. (1994). *Bayesian Theory.* Wiley.
3. Hoff, P. D. (2009). *A First Course in Bayesian Statistical Methods.* Springer.
4. Lunn, D., Jackson, C., Best, N., Thomas, A., & Spiegelhalter, D. (2012). *The BUGS Book: A Practical Introduction to Bayesian Analysis.* CRC Press.
5. Lee, P. M. (2012). *Bayesian Statistics: An Introduction.* Wiley.



7. Operation Research (STAT-6117) 3(3-0)

Course Brief

This course provides an introduction to the principles and techniques of Operations Research (OR), a discipline that uses mathematical modeling, optimization, and analytical methods to support decision-making in complex systems. The course covers foundational topics such as linear programming, transportation models, network flows, and queuing theory.

Students will learn to formulate and solve real-world optimization problems and gain proficiency in using computational tools for OR applications in business, engineering, logistics, and public policy.

Course Learning Outcomes

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

1. Understand the scope, methodology, and applications of operations research.
2. Formulate linear programming models for decision problems.
3. Solve optimization problems using the simplex method and duality theory.
4. Analyze and solve transportation, assignment, and network flow problems.
5. Apply dynamic programming and integer programming techniques.
6. Understand the basics of queuing models and simulation in OR.
7. Use OR software tools to model and analyze real-life problems.

Course Contents

1. Introduction to Operations Research and Modeling Principles
2. Linear Programming:
   - Problem Formulation
   - Graphical and Simplex Methods
   - Duality and Sensitivity Analysis
3. Transportation and Assignment Problems
4. Network Models:
   - Shortest Path, Minimum Spanning Tree
   - Max-Flow and Network Optimization
5. Integer Programming and Binary Decision Models
6. Dynamic Programming and Multi-Stage Decision Problems
7. Queuing Theory and Service Systems
8. Decision Theory and Game Theory (Basics)
9. Simulation Techniques and Monte Carlo Methods
10. Case Studies and Applications in Industry, Supply Chain, and Healthcare

Recommended Textbooks

1. Taha, H. A. (2017). *Operations Research: An Introduction*. Pearson.
2. Hillier, F. S., & Lieberman, G. J. (2020). *Introduction to Operations Research*. McGraw-Hill.

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Suggested Readings

1. Winston, W. L. (2003). *Operations Research: Applications and Algorithms.* Cengage Learning.
2. Ravindran, A., Phillips, D. T., & Solberg, J. J. (2007). *Operations Research: Principles and Practice.* Wiley.
3. Sharma, J. K. (2016). *Operations Research: Theory and Applications.* Macmillan.
4. Gupta, P. K., & Hira, D. S. (2014). *Operations Research.* S. Chand Publishing.
5. Pinedo, M. (2016). *Scheduling: Theory, Algorithms, and Systems.* Springer.

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8. Decision Theory (STAT-6118) 3(3-0)

Course Brief

This course introduces the principles and methods of decision theory, focusing on making rational choices under conditions of uncertainty and risk. It explores both classical and Bayesian frameworks, incorporating decision trees, utility theory, and multi-criteria decision-making. Applications span economics, business, healthcare, engineering, and public policy.

Students will learn to structure decision problems, quantify uncertainty, assess outcomes using utility functions, and apply statistical tools to guide optimal decision-making in complex scenarios.

Course Learning Outcomes

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

1. Understand the foundational principles of decision theory and rational choice.
2. Construct decision trees and analyze them using expected utility.
3. Apply decision-making under risk and uncertainty using probability models.
4. Use utility theory to quantify preferences and model individual or group decisions.
5. Incorporate Bayesian decision-making principles and posterior distributions.
6. Solve multi-criteria decision problems and sensitivity analysis.
7. Apply decision theory to real-world problems using statistical software or decision analysis tools.

Course Contents

1. Introduction to Decision Theory: Structure, Scope, and Applications
2. Elements of a Decision Problem: Acts, States, Outcomes, and Preferences
3. Decision-Making Under Certainty, Risk, and Uncertainty
4. Decision Trees and Payoff Tables
5. Expected Value and Expected Utility Approaches
6. Utility Functions and Risk Preferences
7. Bayesian Decision Theory:
   - Prior and Posterior Distributions
   - Bayes Risk and Bayesian Optimal Decisions
8. Value of Information and Decision-Making with Imperfect Information
9. Multi-Attribute Utility Theory (MAUT) and Analytic Hierarchy Process (AHP)
10. Group Decision-Making and Game-Theoretic Approaches
11. Sensitivity Analysis and Robust Decision-Making
12. Case Studies in Economics, Health Policy, and Engineering Systems

Recommended Textbooks

1. Berger, J. O. (1985). *Statistical Decision Theory and Bayesian Analysis*. Springer.
2. Raiffa, H., & Schlaifer, R. (2000). *Applied Statistical Decision Theory*. Wiley Classics Library.

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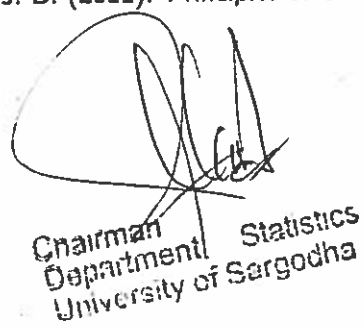
Suggested Readings

1. DeGroot, M. H. (2004). *Optimal Statistical Decisions.* Wiley.
2. Clemen, R. T., & Reilly, T. (2013). *Making Hard Decisions with DecisionTools.* Cengage Learning.
3. French, S. (1986). *Decision Theory: An Introduction to the Mathematics of Rationality.* Ellis Horwood.
4. Keeney, R. L., & Raiffa, H. (1993). *Decisions with Multiple Objectives: Preferences and Value Trade-Offs.* Cambridge University Press.
5. Kadane, J. B. (2011). *Principles of Uncertainty.* CRC Press.



9. Data Mining (STAT-6119) 3(3-0)

Course Brief

This course provides a comprehensive introduction to data mining — the process of discovering patterns, trends, and knowledge from large datasets. It combines statistical analysis, machine learning, and database techniques to extract meaningful insights for decision-making in business, science, and engineering.

Students will explore key concepts including data preprocessing, classification, clustering, association rule mining, and anomaly detection. The course includes practical applications and hands-on experience with data mining tools and programming in R or Python.

Course Learning Outcomes

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

1. Understand the data mining process and its role in knowledge discovery.
2. Preprocess and clean large datasets for analysis.
3. Apply classification techniques such as decision trees, logistic regression, and support vector machines.
4. Perform clustering using k-means, hierarchical, and density-based methods.
5. Discover association rules using the Apriori and FP-growth algorithms.
6. Evaluate and validate data mining models using appropriate metrics.
7. Implement data mining algorithms using software tools (e.g., Python, R, Weka).

Course Contents

1. Introduction to Data Mining and Knowledge Discovery in Databases (KDD)
2. Data Understanding and Preprocessing:
   - Cleaning, Transformation, Normalization, Handling Missing Data
3. Exploratory Data Analysis and Visualization
4. Classification Methods:
   - Decision Trees, Naïve Bayes, Logistic Regression, SVM
   - k-Nearest Neighbors (k-NN), Ensemble Methods (Random Forest, Boosting)
5. Clustering Techniques:
   - k-Means, Hierarchical Clustering, DBSCAN, Gaussian Mixture Models
6. Association Rule Mining:
   - Market Basket Analysis, Apriori, FP-Growth
7. Anomaly Detection and Outlier Analysis
8. Model Evaluation:
   - Confusion Matrix, Accuracy, Precision, Recall, ROC Curve
9. Text Mining and Web Mining (Introductory)
10. Case Studies and Applications in Business, Health, and Social Networks

Recommended Textbooks

1. Han, J., Kamber, M., & Pei, J. (2011). *Data Mining: Concepts and Techniques.* Elsevier.
2. Tan, P. N., Steinbach, M., Karpatne, A., & Kumar, V. (2018). *Introduction to Data Mining.* Pearson.

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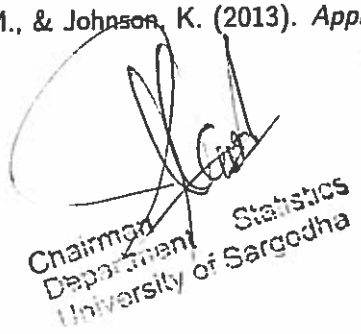
Suggested Readings

1. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). *Data Mining: Practical Machine Learning Tools and Techniques.* Elsevier.
2. Aggarwal, C. C. (2015). *Data Mining: The Textbook.* Springer.
3. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning.* Springer.
4. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning.* Springer.
5. Kuhn, M., & Johnson, K. (2013). *Applied Predictive Modeling.* Springer.



10. Mathematical Models and Simulation (STAT-6120) 3(3-0)

Course Brief

This course provides a systematic introduction to the formulation, analysis, and implementation of mathematical models and simulation techniques for solving real-world problems. Students will learn how to construct mathematical representations of physical, biological, and social systems, and simulate their behavior using analytical and computational methods.

The course emphasizes model validation, sensitivity analysis, and the use of simulation tools for decision-making in engineering, economics, ecology, and operations research.

Course Learning Outcomes

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

1. Understand the modeling process and the role of simulation in applied problem-solving.
2. Formulate mathematical models using algebraic, differential, and probabilistic structures.
3. Analyze the behavior of models and assess their assumptions and limitations.
4. Develop simulation algorithms for deterministic and stochastic systems.
5. Validate and calibrate models using empirical data.
6. Apply simulation software (e.g., MATLAB, Python, AnyLogic) to implement and analyze models.

Course Contents

1. Introduction to Mathematical Modeling and Simulation
2. Classification of Models: Deterministic vs. Stochastic, Static vs. Dynamic
3. Model Formulation Techniques:
   - Empirical, Mechanistic, and Data-Driven Models
4. Linear and Nonlinear Models
5. Differential Equation Models:
   - Population Dynamics, Epidemics, Mechanical Systems
6. Difference Equations and Discrete-Time Models
7. Optimization Models in Operations Research
8. Stochastic Modeling: Markov Chains, Queuing Systems
9. Monte Carlo Simulation and Random Number Generation
10. Simulation Modeling Tools and Software
11. Model Validation, Calibration, and Sensitivity Analysis
12. Case Studies in Engineering, Environment, and Health Sciences

Recommended Textbooks

1. Giordano, F. R., Fox, W. P., & Horton, S. B. (2014). *A First Course in Mathematical Modeling*. Cengage Learning.
2. Law, A. M. (2014). *Simulation Modeling and Analysis*. McGraw-Hill.

Suggested Readings

1. Kreyszig, E. (2011). *Advanced Engineering Mathematics*. Wiley.
2. Higham, D. J., & Higham, N. J. (2016). *Mathematical Modelling: A Chemical Engineer's Perspective*. SIAM.

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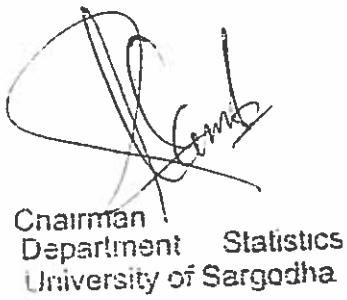
3. Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M. (2010). *Discrete-Event System Simulation*. Pearson.
4. AnyLogic Company. *AnyLogic in Three Days: A Quick Course in Simulation Modeling*.
5. Kloeden, P. E., & Platen, E. (1992). *Numerical Solution of Stochastic Differential Equations*. Springer.



11. Statistical Tools for Data Science (STAT-6121) 3(3-0)

Course Brief

This course introduces the essential statistical tools and techniques used in modern data science. It focuses on data exploration, visualization, statistical inference, and predictive modeling. The course equips students with practical skills to analyze complex datasets, draw valid conclusions, and make data-driven decisions.
Students will use statistical software (e.g., R or Python) for hands-on analysis, developing a foundation for advanced study in machine learning, artificial intelligence, and applied analytics.

Course Learning Outcomes

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

1. Understand core statistical concepts relevant to data science.
2. Explore and visualize data using appropriate graphical techniques.
3. Apply statistical inference methods to estimate population parameters and test hypotheses.
4. Build and evaluate linear and logistic regression models.
5. Perform dimensionality reduction and correlation analysis.
6. Use statistical programming tools to conduct reproducible data analysis.

Course Contents

1. Introduction to Data Science and Statistical Thinking
2. Data Types, Measurement Scales, and Summary Statistics
3. Data Visualization: Histograms, Boxplots, Heatmaps, Scatterplots
4. Probability Concepts and Distributions (Normal, Binomial, Poisson)
5. Sampling Distributions and the Central Limit Theorem
6. Estimation and Confidence Intervals
7. Hypothesis Testing (t-test, z-test, chi-square test)
8. Correlation and Simple Linear Regression
9. Multiple Linear Regression and Model Diagnostics
10. Logistic Regression and Classification Metrics
11. Feature Selection and Dimensionality Reduction (e.g., PCA)
12. Introduction to Statistical Programming in R/Python

Recommended Textbooks

1. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning*. Springer.
2. Verzani, J. (2014). *Using R for Introductory Statistics*. CRC Press.

Suggested Readings

1. Wickham, H., & Grolemund, G. (2016). *R for Data Science*. O'Reilly Media.
2. McKinney, W. (2017). *Python for Data Analysis*. O'Reilly Media.
3. Dasgupta, S., & Jin, C. (2021). *Algorithms for Data Science*. Springer.
4. Gelman, A., & Hill, J. (2006). *Data Analysis Using Regression and Multilevel/Hierarchical Models*. Cambridge University Press.
5. Dean, J. & Tukey, J. W. (1990). *Data Analysis and Regression: A Second Course in Statistics*. Addison-Wesley.

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12. Statistics for Deep Learning (STAT-6122) 3(3-0)

Course Brief

This course bridges fundamental statistical principles with deep learning, enabling students to understand and apply statistical thinking in neural network modeling. The course emphasizes probability theory, estimation, inference, and model evaluation techniques crucial for training, regularizing, and interpreting deep learning models.

Students will explore how statistical reasoning informs design choices in deep architectures and optimization, gain insights into uncertainty quantification, and use statistical tools to assess model robustness, interpretability, and generalization.

Course Learning Outcomes

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

1. Understand core statistical concepts used in deep learning.
2. Analyze and preprocess data using probabilistic and statistical tools.
3. Evaluate deep learning models using statistical performance metrics.
4. Apply regularization and Bayesian techniques for model generalization.
5. Interpret deep learning outputs using statistical methods (e.g., confidence intervals, uncertainty estimation).
6. Utilize statistical diagnostics to detect overfitting, bias, and data imbalance.

Course Contents

1. Review of Probability and Statistical Inference
2. Exploratory Data Analysis for Deep Learning Datasets
3. Probability Distributions and Likelihood Functions
4. Estimation Theory: MLE and MAP
5. Hypothesis Testing and Confidence Intervals in Model Evaluation
6. Loss Functions from a Statistical Perspective (Cross-Entropy, MSE)
7. Regularization Techniques: L1/L2, Dropout, Early Stopping
8. Bayesian Deep Learning and Uncertainty Quantification
9. Statistical Considerations in Training and Validation (Bias-Variance Tradeoff)
10. Evaluation Metrics: Accuracy, Precision, Recall, F1, AUC, Calibration
11. Handling Imbalanced Data: SMOTE, Stratified Sampling
12. Case Studies: Image, Text, and Tabular Data Applications

Recommended Textbooks

1. Murphy, K. P. (2022). *Probabilistic Machine Learning: An Introduction*. MIT Press.
2. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*. Springer.

Suggested Readings

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. MIT Press.
2. Gal, Y. (2016). *Uncertainty in Deep Learning*. PhD Thesis, University of Cambridge.
3. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning*. Springer.

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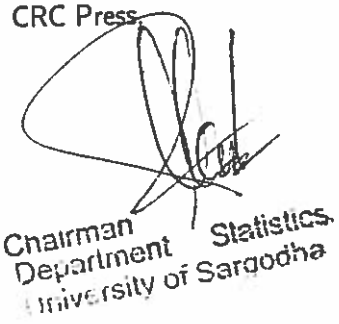
4. Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*. O'Reilly Media.
5. McElreath, R. (2020). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan*. CRC Press.



13. Statistical Machine Learning (STAT-6123) 3(3-0)

Course Brief

This course provides a rigorous foundation in statistical machine learning, combining concepts from statistics, optimization, and computational learning theory. It emphasizes the role of statistical inference in building, evaluating, and interpreting predictive models.

Students will explore both supervised and unsupervised learning algorithms, focusing on the statistical principles that guide model selection, regularization, generalization, and performance evaluation. Practical applications will be implemented using statistical programming tools such as R or Python.

Course Learning Outcomes

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

1. Understand the statistical foundations of key machine learning algorithms.
2. Apply regression, classification, and clustering methods to real-world datasets.
3. Use regularization techniques to prevent overfitting.
4. Evaluate model performance using statistical metrics and cross-validation.
5. Analyze the bias-variance tradeoff and its impact on model generalization.
6. Implement and tune machine learning models using statistical programming environments.

Course Contents

1. Introduction to Statistical Machine Learning and Core Concepts
2. Linear Regression and Model Selection (AIC, BIC, Adjusted R^2)
3. Classification Methods: Logistic Regression, LDA, QDA, Naïve Bayes
4. Resampling Techniques: Cross-Validation and Bootstrap
5. Regularization: Ridge Regression, Lasso, Elastic Net
6. Nonlinear Models: Splines, Generalized Additive Models (GAMs)
7. Tree-Based Methods: Decision Trees, Random Forests, Gradient Boosting
8. Support Vector Machines and Kernel Methods
9. Unsupervised Learning: PCA, K-Means, Hierarchical Clustering
10. Model Evaluation: ROC, AUC, Confusion Matrix, Precision-Recall
11. Introduction to Ensemble Learning and Bagging/Boosting
12. Bayesian Approaches in Machine Learning

Recommended Textbooks

1. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning*. Springer.
2. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning*. Springer.

Suggested Readings

1. Murphy, K. P. (2012). *Machine Learning: A Probabilistic Perspective*. MIT Press.
2. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*. Springer.
3. Kuhn, M., & Johnson, K. (2013). *Applied Predictive Modeling*. Springer.

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4. Efron, B., & Hastie, T. (2016). *Computer Age Statistical Inference*. Cambridge University Press.
5. Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2018). *Foundations of Machine Learning*. MIT Press.

14. Applied Artificial Intelligence (STAT-6124) 3(3-0)

Course Brief

This course provides a practical introduction to Artificial Intelligence (AI) with a focus on real-world statistical applications. It emphasizes hands-on development and deployment of intelligent systems using data-driven approaches. Topics include intelligent agents, AI programming, search techniques, machine learning, knowledge representation, and decision-making.

Students will work on applied problems in areas such as healthcare, finance, natural language processing, and predictive analytics using Python-based AI libraries (e.g., Scikit-learn, TensorFlow, OpenAI Gym). Ethical and societal implications of AI in practice are also discussed.

Course Learning Outcomes

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

1. Understand the fundamentals and scope of applied AI.
2. Implement search and optimization strategies in practical scenarios.
3. Apply supervised and unsupervised machine learning methods to real datasets.
4. Represent and manipulate knowledge using logical and statistical tools.
5. Develop AI-based solutions for domain-specific applications.
6. Use Python libraries to build and evaluate intelligent systems.
7. Critically assess ethical concerns in deploying AI systems.

Course Contents

1. Introduction to Applied AI and Intelligent Systems
2. Python for AI: Libraries and Tools (Scikit-learn, TensorFlow, OpenAI Gym)
3. Search and Optimization Techniques:
   - Uninformed Search (BFS, DFS)
   - Informed Search (A*, Greedy, Hill-Climbing)
4. Knowledge Representation and Logic
5. Decision Making Under Uncertainty: Bayesian Reasoning
6. Machine Learning Foundations:
   - Supervised Learning (Decision Trees, SVM, KNN)
   - Unsupervised Learning (Clustering, PCA)
7. Applications in Natural Language Processing and Image Recognition
8. AI in Statistical Modeling and Predictive Analytics
9. Case Studies in Healthcare, Finance, and Social Sciences
10. Project Work: Building and Evaluating an AI Application
11. AI Ethics, Bias, and Societal Impacts

Recommended Textbooks

1. Russell, S. J., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach*. Pearson.
2. Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*. O'Reilly Media.
3. Poole, D., & Mackworth, A. (2017). *Artificial Intelligence: Foundations of Computational Agents*. Cambridge University Press.

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15. Big Data Analytics (STAT-6125) 3(3-0)

Course Brief

This course introduces students to the principles, technologies, and tools used in big data analytics. It focuses on the storage, processing, and analysis of massive datasets that cannot be handled by traditional systems. Students will learn about distributed computing frameworks, data management techniques, and scalable algorithms for extracting insights from structured and unstructured data.

Through hands-on labs and case studies, students will gain practical experience using big data platforms such as Hadoop, Spark, and NoSQL databases for real-world analytics applications.

Course Learning Outcomes

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

1. Understand the architecture and challenges of big data systems.
2. Use distributed computing tools (e.g., Hadoop, Spark) to process large-scale data.
3. Store and retrieve data using NoSQL databases (e.g., MongoDB, Cassandra).
4. Apply data wrangling, transformation, and aggregation techniques to big datasets.
5. Implement machine learning algorithms on large-scale data using scalable frameworks.
6. Analyze streaming data and real-time analytics pipelines.

Course Contents

1. Introduction to Big Data: Characteristics, Value, and Ecosystem
2. Hadoop Ecosystem: HDFS, MapReduce, YARN
3. Apache Spark: RDDs, DataFrames, Spark SQL, MLlib
4. Data Ingestion Tools: Sqoop, Flume, Kafka
5. NoSQL Databases: MongoDB, Cassandra, HBase
6. Data Preprocessing at Scale: Cleaning, Filtering, Transformation
7. Distributed Algorithms for Classification, Clustering, and Regression
8. Real-Time Data Processing and Stream Analytics
9. Data Visualization Techniques for Big Data
10. Cloud Platforms for Big Data: AWS, Azure, GCP (Overview)
11. Privacy, Security, and Ethical Considerations in Big Data
12. Case Studies in Healthcare, Finance, Marketing, and IoT

Recommended Textbooks

1. Marz, N., & Warren, J. (2015). *Big Data: Principles and Best Practices of Scalable Real-Time Data Systems*. Manning Publications.
2. Rajaraman, A., & Ullman, J. D. (2012). *Mining of Massive Datasets*. Cambridge University Press.

Suggested Readings

1. White, T. (2015). *Hadoop: The Definitive Guide*. O'Reilly Media.
2. Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). *Learning Spark*. O'Reilly Media.

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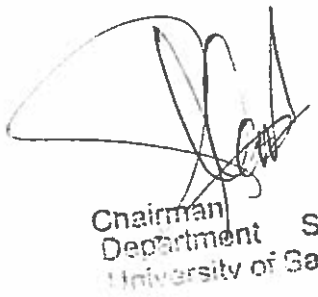
3. Dean, J., & Ghemawat, S. (2008). *MapReduce: Simplified Data Processing on Large Clusters.* Communications of the ACM.
4. Das, T. K., & Mohapatra, S. (2016). *Big Data Analytics: A Practitioner's Approach.* McGraw-Hill.
5. Beaulieu, A. (2015). *Learning SQL.* O'Reilly Media.



16. Digital Analytics (STAT-6126) 3(3-0)

Course Brief

This course provides an in-depth introduction to digital analytics, focusing on the measurement, collection, analysis, and reporting of digital data to optimize user experiences and business outcomes. It covers core principles of web and social media analytics, digital marketing metrics, customer behavior tracking, and data-driven decision-making.

Students will learn to use popular digital analytics platforms and tools, interpret key performance indicators (KPIs), and apply statistical and machine learning techniques to improve digital strategy and ROI.

Course Learning Outcomes

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

1. Understand the role of digital analytics in modern business and marketing.
2. Identify and define KPIs for websites, campaigns, and social platforms.
3. Use tools such as Google Analytics and social media dashboards to track performance.
4. Analyze user behavior, funnel conversion, and customer journeys.
5. Apply A/B testing, segmentation, and predictive analytics in digital environments.
6. Develop actionable insights and recommendations based on digital data.

Course Contents

1. Introduction to Digital Analytics and Marketing Ecosystems
2. Web Analytics Fundamentals: Sessions, Users, Bounce Rate, Conversion
3. Tools Overview: Google Analytics, Google Tag Manager, Data Studio
4. Social Media Analytics: Engagement Metrics, Sentiment, Reach
5. Customer Segmentation and Behavior Analysis
6. Funnel Analysis and Multi-Channel Attribution
7. A/B Testing and Experimentation Methods
8. Predictive Analytics and Machine Learning Applications
9. Dashboards and Reporting for Decision Makers
10. Privacy, Ethics, and Compliance in Digital Analytics (GDPR, CCPA)
11. Case Studies in E-Commerce, Media, Education, and Finance
12. Capstone Project: End-to-End Digital Analytics Solution

Recommended Textbooks

1. Kaushik, A. (2010). *Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity*. Wiley.
2. Clifton, B. (2012). *Advanced Web Metrics with Google Analytics*. Wiley.

Suggested Readings

1. Cutroni, J. (2010). *Google Analytics*. O'Reilly Media.
2. Marshall, G. W., & Johnston, M. W. (2021). *Marketing Management*. McGraw-Hill.
3. Sterne, J. (2010). *Social Media Metrics: How to Measure and Optimize Your Marketing Investment*. Wiley.
4. Chaffey, D., & Ellis-Chadwick, F. (2019). *Digital Marketing*. Pearson Education.
5. Tufte, E. R. (2001). *The Visual Display of Quantitative Information*. Graphics Press.

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17. High-Dimensional Data Analysis (STAT-6127) 3(3-0)

Course Brief

This course explores statistical methods and computational tools for analyzing high-dimensional data, where the number of variables far exceeds the number of observations. Such data arises frequently in genomics, imaging, finance, and text mining. The course emphasizes model selection, regularization, dimensionality reduction, and the challenges of overfitting and interpretability in high dimensions.

Students will gain both theoretical understanding and practical skills for applying sparse models, penalized regression, and machine learning techniques to high-dimensional datasets.

Course Learning Outcomes

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

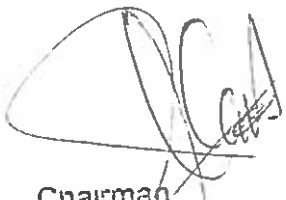
1. Understand the statistical challenges unique to high-dimensional settings.
2. Apply dimensionality reduction techniques such as PCA and factor analysis.
3. Fit penalized regression models including Lasso, Ridge, and Elastic Net.
4. Implement variable selection and regularization in high-dimensional regression.
5. Evaluate model stability, interpretability, and prediction accuracy.
6. Use resampling methods (e.g., cross-validation, bootstrap) for model validation.

Course Contents

1. Introduction to High-Dimensional Data: Examples and Challenges
2. Linear Models in High Dimensions and Multicollinearity
3. Principal Component Analysis (PCA) and Factor Models
4. Shrinkage Methods:
   - Ridge Regression
   - Lasso Regression
   - Elastic Net
5. Model Selection Criteria: AIC, BIC, Cross-Validation
6. Multiple Testing and False Discovery Rate (FDR) Control
7. High-Dimensional Classification:
   - Regularized Logistic Regression
   - Linear Discriminant Analysis in High Dimensions
8. Sparse Matrix Methods and Screening Rules
9. Graphical Models and Covariance Estimation
10. Applications in Genomics, Neuroimaging, and Text Mining
11. Software Implementation using R and Python

Recommended Textbooks

1. Bühlmann, P., & Van De Geer, S. (2011). *Statistics for High-Dimensional Data*. Springer.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning*. Springer.



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Suggested Readings

1. Fan, J., & Lv, J. (2010). *A Selective Overview of Variable Selection in High-Dimensional Feature Space.* Statistica Sinica.
2. Witten, D. M., & Tibshirani, R. (2011). *Penalized Classification Using Fisher's Linear Discriminant.* Journal of the Royal Statistical Society.
3. Zhao, S. D., & Li, Y. (2012). *Principles of High-Dimensional Data Analysis.* CRC Press.
4. Efron, B. (2010). *Large-Scale Inference: Empirical Bayes Methods for Estimation, Testing, and Prediction.* Cambridge University Press.
5. Tenenbaum, J. B., Silva, V. d., & Langford, J. C. (2000). *A Global Geometric Framework for Nonlinear Dimensionality Reduction.* Science.

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18. Epidemiology (STAT-6128) 3(3-0)

Course Brief

This course introduces the foundational concepts, methods, and applications of epidemiology—the study of the distribution and determinants of health-related states in specified populations. It emphasizes study design, disease surveillance, and the evaluation of health interventions. The course equips students with tools to critically assess public health data, interpret associations, and contribute to evidence-based decision-making.

Students will explore real-world epidemiological data and case studies to understand patterns of disease, risk factors, and prevention strategies at the population level.

Course Learning Outcomes

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

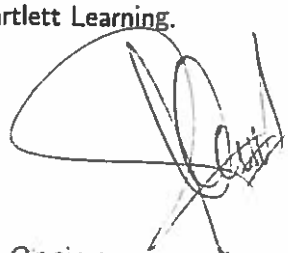
1. Understand the scope, principles, and terminology of epidemiology.
2. Design and interpret descriptive, analytical, and experimental epidemiological studies.
3. Measure disease frequency using incidence, prevalence, and mortality rates.
4. Assess associations using relative risk, odds ratios, and attributable risk.
5. Recognize bias, confounding, and effect modification in studies.
6. Evaluate public health interventions and screening programs.

Course Contents

1. Introduction to Epidemiology: History, Uses, and Key Concepts
2. Measures of Disease Frequency: Incidence, Prevalence, Mortality
3. Epidemiologic Study Designs:
   - Cross-sectional Studies
   - Case-Control Studies
   - Cohort Studies
   - Randomized Controlled Trials
4. Measures of Association: Risk Ratios, Odds Ratios, Risk Differences
5. Bias, Confounding, and Effect Modification
6. Screening and Diagnostic Testing: Sensitivity, Specificity, Predictive Value
7. Outbreak Investigation and Surveillance Systems
8. Causal Inference in Epidemiology: Hill's Criteria
9. Public Health Applications: Chronic, Infectious, and Occupational Diseases
10. Ethics and Data Protection in Epidemiological Research
11. Statistical Software for Epidemiologic Analysis (e.g., Epi Info, R, Stata)

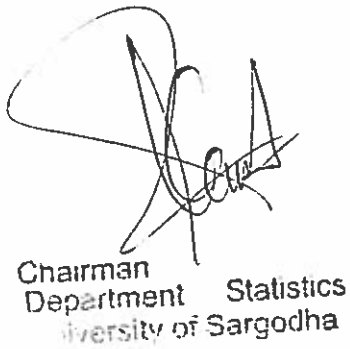
Recommended Textbooks

1. Gordis, L. (2014). *Epidemiology* (5th ed.). Elsevier.
2. Friis, R. H., & Sellers, T. A. (2020). *Epidemiology for Public Health Practice*. Jones & Bartlett Learning.



Suggested Readings

1. Rothman, K. J., Greenland, S., & Lash, T. L. (2008). *Modern Epidemiology*. Lippincott Williams & Wilkins.
2. Hennekens, C. H., & Buring, J. E. (1987). *Epidemiology in Medicine*. Little, Brown and Company.
3. Kleinbaum, D. G., Kupper, L. L., & Morgenstern, H. (1982). *Epidemiologic Research: Principles and Quantitative Methods*. Wiley.
4. Beaglehole, R., Bonita, R., & Kjellström, T. (2006). *Basic Epidemiology*. World Health Organization.
5. Porta, M. (Ed.). (2014). *A Dictionary of Epidemiology*. Oxford University Press.



19. Analysis of Repeated Measurements (STAT-6129) 3(3-0)

Course Brief

This course focuses on statistical methods for analyzing repeated measurements data, where multiple observations are collected from the same subject or experimental unit over time or under different conditions. Emphasis is placed on understanding the correlation structure within subjects and applying appropriate models for longitudinal and within-subject variability.

Students will learn how to formulate, estimate, and interpret linear and nonlinear models for repeated measures using both traditional and modern approaches, with applications in medicine, psychology, agriculture, and industrial experimentation.

Course Learning Outcomes

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

1. Understand the nature and challenges of repeated measurements data.
2. Explore and visualize longitudinal and within-subject variability.
3. Fit and interpret linear models for repeated measures (LMRM).
4. Apply mixed-effects models and generalized estimating equations (GEE).
5. Assess model assumptions and choose appropriate covariance structures.
6. Analyze data using statistical software such as R, SAS, or SPSS.

Course Contents

1. Introduction to Repeated Measures and Longitudinal Data
2. Examples and Applications in Biomedical, Social, and Agricultural Sciences
3. Exploratory Data Analysis for Repeated Measures
4. Linear Models for Repeated Measurements (LMRM)
5. Assumptions and Covariance Structures (Compound Symmetry, AR(1), Unstructured)
6. Introduction to Linear Mixed-Effects Models (LMM)
7. Random Intercepts and Slopes Models
8. Model Selection and Inference in Mixed Models
9. Generalized Estimating Equations (GEE) for Non-Normal Outcomes
10. Comparison with Traditional ANOVA Approaches
11. Software Implementation in R (e.g., 'nlme', 'lme4') and SAS (e.g., 'PROC MIXED')
12. Case Studies and Reporting Results in Scientific Publications

Recommended Textbooks

1. Littell, R. C., Milliken, G. A., Stroup, W. W., Wolfinger, R. D., & Schabenberger, O. (2006). *SAS for Mixed Models.* SAS Institute.
2. Fitzmaurice, G. M., Laird, N. M., & Ware, J. H. (2012). *Applied Longitudinal Analysis.* Wiley.

Suggested Readings

1. Verbeke, G., & Molenberghs, G. (2009). *Linear Mixed Models for Longitudinal Data.* Springer.
2. Diggle, P. J., Heagerty, P., Liang, K. Y., & Zeger, S. L. (2002). *Analysis of Longitudinal Data.* Oxford University Press.

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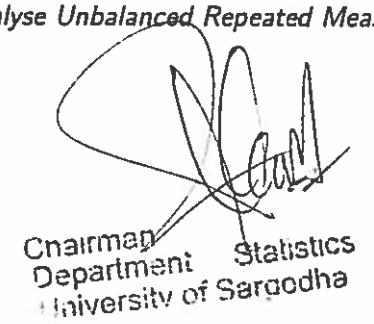
3. Gueorguieva, R., & Krystal, J. H. (2004). *Move Over ANOVA: Progress in Analyzing Repeated-Measures Data and Its Reflection in Papers Published in the Archives of General Psychiatry.* Arch Gen Psychiatry.
4. West, B. T., Welch, K. B., & Galecki, A. T. (2014). *Linear Mixed Models: A Practical Guide Using Statistical Software.* CRC Press.
5. Cnaan, A., Laird, N. M., & Slasor, P. (1997). *Using the General Linear Mixed Model to Analyse Unbalanced Repeated Measures and Longitudinal Data.* Stat Med.



20. Design and Analysis of Medical Studies (STAT-6130) 3(3-0)

Course Brief

This course covers the fundamental principles and practical strategies involved in the design and statistical analysis of medical and clinical studies. It emphasizes sound methodological planning, ethical considerations, and appropriate statistical techniques for various study types, including observational studies, clinical trials, and diagnostic tests.

Students will learn to critically assess published medical literature, design valid and efficient studies, and apply statistical methods to analyze and interpret biomedical data using statistical software.

Course Learning Outcomes

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

1. Understand key principles of study design in medical research.
2. Distinguish between observational and experimental study designs.
3. Plan and calculate sample size and power for medical studies.
4. Analyze data from cohort, case-control, and randomized controlled trials.
5. Apply statistical techniques for comparing groups and modeling associations.
6. Evaluate bias, confounding, interaction, and causality in medical studies.

Course Contents

1. Introduction to Medical Study Design and Clinical Research Workflow
2. Types of Study Designs:
   - Cross-sectional and Case-Control Studies
   - Cohort Studies
   - Randomized Controlled Trials (RCTs)
   - Diagnostic and Screening Studies
3. Ethical Considerations and Institutional Review Boards (IRBs)
4. Sampling Techniques, Randomization, and Blinding
5. Sample Size Determination and Power Analysis
6. Data Collection, Quality Assurance, and Management
7. Statistical Analysis of:
   - Binary and Continuous Outcomes
   - Time-to-Event (Survival) Data
   - Repeated Measures and Longitudinal Data
8. Use of Regression Models: Linear, Logistic, Cox Proportional Hazards
9. Handling Missing Data and Dropouts
10. Meta-analysis and Systematic Review Fundamentals
11. Interpreting and Reporting Medical Study Results

Recommended Textbooks

1. Friedman, L. M., Furberg, C. D., & DeMets, D. L. (2010). *Fundamentals of Clinical Trials.* Springer.
2. Piantadosi, S. (2017). *Clinical Trials: A Methodologic Perspective.* Wiley.

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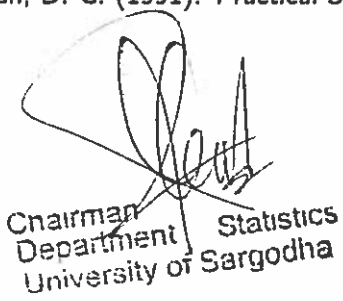
Suggested Readings

1. Hulley, S. B., Cummings, S. R., Browner, W. S., Grady, D. G., & Newman, T. B. (2013). *Designing Clinical Research*. Lippincott Williams & Wilkins.
2. Pocock, S. J. (2013). *Clinical Trials: A Practical Approach*. Wiley.
3. Machin, D., Campbell, M. J., Tan, S. B., & Tan, S. H. (2018). *Sample Size Tables for Clinical Studies*. Wiley-Blackwell.
4. Rothman, K. J. (2012). *Epidemiology: An Introduction*. Oxford University Press.
5. Altman, D. G. (1991). *Practical Statistics for Medical Research*. Chapman and Hall.



21. Pharmaceutical Statistics (STAT-6131) 3(3-0)

Course Brief

This course provides a comprehensive overview of statistical methods applied in the pharmaceutical industry, with an emphasis on drug development, clinical trials, quality control, and regulatory compliance. It covers statistical concepts and techniques critical to preclinical studies, Phase I–IV clinical trials, bioequivalence testing, and pharmacokinetic/pharmacodynamic (PK/PD) modeling.

Students will gain practical experience using statistical tools to design experiments, analyze data, and interpret results in alignment with guidelines from regulatory bodies such as the FDA, EMA, and ICH.

Course Learning Outcomes

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

1. Understand the role of statistics throughout the pharmaceutical R&D lifecycle.
2. Apply statistical methods in the design and analysis of clinical trials.
3. Perform sample size and power calculations for pharmaceutical studies.
4. Evaluate drug efficacy and safety using hypothesis testing and confidence intervals.
5. Conduct bioequivalence studies and analyze PK/PD data.
6. Interpret regulatory statistical guidelines and prepare statistical reports.

Course Contents

1. Introduction to Pharmaceutical Statistics and Drug Development Phases
2. Good Clinical Practice (GCP) and Regulatory Guidelines (FDA, EMA, ICH)
3. Design of Experiments in Preclinical and Clinical Studies
4. Randomization, Blinding, and Control Group Strategies
5. Statistical Methods for Phase I–IV Clinical Trials
6. Hypothesis Testing and Confidence Intervals for Efficacy and Safety
7. Analysis of Variance (ANOVA) and Covariance (ANCOVA)
8. Repeated Measures and Longitudinal Analysis in Clinical Settings
9. Bioequivalence Testing and Two-One-Sided Test (TOST) Procedure
10. Pharmacokinetic and Pharmacodynamic Modeling (PK/PD)
11. Handling Missing Data and Interim Analysis
12. Statistical Software in the Pharmaceutical Industry: SAS, R, and WinNonlin

Recommended Textbooks

1. Chow, S. C., & Liu, J. P. (2013). *Design and Analysis of Clinical Trials: Concepts and Methodologies*. Wiley.
2. Bolton, S., & Bon, C. (2003). *Pharmaceutical Statistics: Practical and Clinical Applications*. CRC Press.

Suggested Readings

1. Berry, D. A. (2006). *Bayesian Approaches to Clinical Trials and Health-Care Evaluation*. Wiley.

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2. Endrenyi, L., & Tothfalusi, L. (2017). *Bioequivalence Studies in Drug Development.* CRC Press.
3. Piantadosi, S. (2017). *Clinical Trials: A Methodologic Perspective.* Wiley.
4. Lesaffre, E., & Spiessens, B. (2001). *On the Effect of the Number of Interim Analyses in Group Sequential Designs.* Statistics in Medicine.
5. ICH E9, E6, and E10 Guidelines on Statistical Principles for Clinical Trials.

22. **Statistical Methods for Clinical Trials (STAT-6132)** **3(3-0)**

Course Brief

This course introduces statistical methods used in the design, conduct, and analysis of clinical trials. It covers essential concepts such as randomization, blinding, power analysis, and the interpretation of trial results. Emphasis is placed on both the theoretical underpinnings and the practical application of statistical tools in real clinical research, enabling students to critically evaluate evidence and contribute to trial design and analysis.

Course Learning Outcomes

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

1. Understand the role and scope of statistics in the planning and analysis of clinical trials.
2. Apply statistical principles to the design of randomized controlled trials.
3. Perform statistical analysis using appropriate models for different clinical trial designs.
4. Interpret the results of clinical studies, accounting for bias, variability, and clinical relevance.
5. Assess statistical validity, power, and sample size considerations in trials.

Course Contents

1. Introduction to Clinical Trials and Role of Statistics
2. Basic Trial Designs: Parallel, Crossover, Cluster-Randomized Trials
3. Randomization and Blinding: Methods and Importance
4. Sample Size Determination and Power Calculations
5. Statistical Inference in Clinical Trials: Parametric and Non-parametric Methods
6. Interim Analyses and Sequential Designs
7. Survival Analysis Techniques in Clinical Trials
8. Analysis of Binary and Longitudinal Outcomes
9. Handling Missing Data and Protocol Deviations
10. Ethical and Regulatory Aspects of Clinical Trials

Recommended Textbooks

1. Piantadosi, S. (2017). *Clinical Trials: A Methodologic Perspective* (3rd ed.). Wiley.
2. Chow, S.-C., & Liu, J. P. (2013). *Design and Analysis of Clinical Trials: Concepts and Methodologies* (3rd ed.). Wiley.

Suggested Readings

1. Machin, D., Campbell, M. J., Tan, S. B., & Tan, S. H. (2018). *Sample Size Tables for Clinical Studies* (4th ed.). Wiley-Blackwell.
2. Meinert, C. L. (2012). *Clinical Trials: Design, Conduct, and Analysis* (2nd ed.). Oxford University Press.

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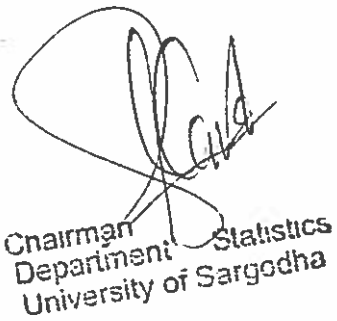
3. Friedman, L. M., Furberg, C. D., & DeMets, D. L. (2015). *Fundamentals of Clinical Trials* (5th ed.). Springer.



23. Financial Econometrics (STAT-6133) 3(3-0)

Course Brief

This course provides students with a comprehensive understanding of econometric techniques used in the analysis of financial data. The focus is on time series modeling, volatility estimation, and forecasting in financial markets. Applications include asset pricing, risk management, and portfolio analysis. Emphasis is placed on real-world data and empirical model implementation using statistical software.

Course Learning Outcomes

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

1. Understand the foundational concepts of financial time series and econometric modeling.
2. Apply econometric techniques to model financial returns, volatility, and market risk.
3. Implement ARIMA, GARCH, and other relevant models for analyzing financial time series.
4. Interpret results from financial econometric models and assess their empirical relevance.
5. Use financial econometrics to inform decision-making in asset pricing, portfolio management, and risk forecasting.

Course Contents

1. Introduction to Financial Econometrics and Financial Data Characteristics
2. Stationarity, Unit Roots, and Cointegration
3. Modeling Asset Returns: AR, MA, ARIMA Models
4. Volatility Modeling: ARCH, GARCH, and Extensions
5. Risk Management: Value at Risk (VaR) and Expected Shortfall
6. High-Frequency Data and Market Microstructure
7. Multivariate Models: VAR, VECM, and Factor Models
8. Empirical Applications in Portfolio Optimization and Asset Pricing

Recommended Textbooks

1. Tsay, R. S. (2010). *Analysis of Financial Time Series* (3rd ed.). Wiley.
2. Brooks, C. (2019). *Introductory Econometrics for Finance* (4th ed.). Cambridge University Press.

Suggested Readings

1. Alexander, C. (2008). *Market Risk Analysis: Practical Financial Econometrics.* Wiley.
2. Campbell, J. Y., Lo, A. W., & MacKinlay, A. C. (1997). *The Econometrics of Financial Markets.* Princeton University Press.
3. Enders, W. (2014). *Applied Econometric Time Series* (4th ed.). Wiley.

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24. Time Series Analysis and Forecasting (STAT-6134) 3(3-0)

Course Brief

This course introduces the core concepts and methodologies for analyzing time-dependent data. Emphasis is placed on identifying patterns, building statistical models for time series, and generating forecasts. Students will learn to apply techniques such as autoregressive models, moving averages, ARIMA models, and exponential smoothing. Real-world applications in economics, business, and environmental sciences will be explored.

Course Learning Outcomes

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

1. Understand the fundamental components of time series data (trend, seasonality, and irregular variation).
2. Identify and apply appropriate models for stationary and non-stationary time series data.
3. Use methods such as AR, MA, ARMA, and ARIMA for modeling time series.
4. Evaluate and validate time series models using diagnostic tools.
5. Apply forecasting techniques to real-world time series problems and assess forecast accuracy.

Course Contents

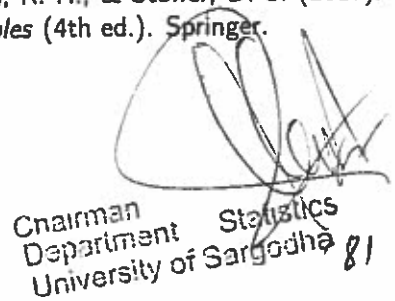
1. Introduction to Time Series Data and Applications
2. Components of Time Series: Trend, Seasonal, Cyclical, and Irregular
3. Stationarity and Differencing
4. Autoregressive (AR), Moving Average (MA), ARMA, and ARIMA Models
5. Model Selection and Parameter Estimation
6. Seasonal ARIMA (SARIMA) Models
7. Forecasting Techniques and Accuracy Metrics
8. Applications in Economics, Business, and Environmental Studies

Recommended Textbooks

1. Brockwell, P. J., & Davis, R. A. (2016). *Introduction to Time Series and Forecasting* (3rd ed.). Springer.
2. Cryer, J. D., & Chan, K.-S. (2008). *Time Series Analysis: With Applications in R* (2nd ed.). Springer.

Suggested Readings

1. Hyndman, R. J., & Athanasopoulos, G. (2021). *Forecasting: Principles and Practice* (3rd ed.). OTexts.
2. Wei, W. W. S. (2006). *Time Series Analysis: Univariate and Multivariate Methods* (2nd ed.). Pearson.
3. Shumway, R. H., & Stoffer, D. S. (2017). *Time Series Analysis and Its Applications: With R Examples* (4th ed.). Springer.



25. Predictive Modeling (STAT-6135) 3(3-0)

Course Brief

This course provides a comprehensive introduction to predictive modeling, equipping students with statistical and machine learning tools to forecast future outcomes based on historical data. Emphasis is placed on understanding model assumptions, selecting appropriate algorithms, evaluating model performance, and interpreting results in a real-world context. Students will apply techniques using statistical software and programming languages such as R or Python.

Course Learning Outcomes

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

1. Understand key concepts in supervised learning and predictive analytics.
2. Develop regression and classification models to make data-driven predictions.
3. Apply model validation techniques such as cross-validation and performance metrics (e.g., RMSE, AUC).
4. Handle issues such as overfitting, bias-variance tradeoff, and model selection.
5. Implement predictive models using R/Python for practical datasets across domains.

Course Contents

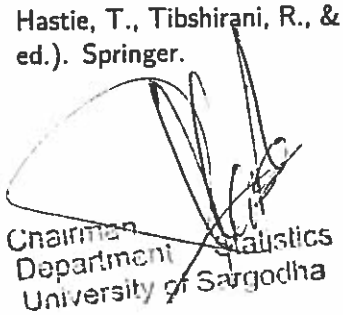
1. Introduction to Predictive Modeling and Applications
2. Data Preprocessing and Feature Engineering
3. Linear and Logistic Regression Models
4. Decision Trees and Ensemble Methods (e.g., Random Forest, Gradient Boosting)
5. Model Evaluation Metrics and Validation Strategies
6. Overfitting, Regularization (Ridge, Lasso)
7. Classification Models: k-NN, SVM, Naive Bayes
8. Model Interpretation and Deployment Considerations

Recommended Textbooks

1. Kuhn, M., & Johnson, K. (2013). *Applied Predictive Modeling*. Springer.
2. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An Introduction to Statistical Learning with Applications in R* (2nd ed.). Springer.

Suggested Readings

1. Provost, F., & Fawcett, T. (2013). *Data Science for Business*. O'Reilly Media.
2. Shmueli, G., Bruce, P. C., Gedeck, P., & Patel, N. R. (2020). *Data Mining for Business Analytics*. Wiley.
3. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning* (2nd ed.). Springer.



26. Structural Equation Modeling (STAT-6136) 3(3-0)

Course Brief

This course introduces students to the theory and application of Structural Equation Modeling (SEM), an advanced multivariate technique used for testing and estimating causal relationships among variables. It integrates factor analysis and multiple regression, allowing the modeling of complex relationships using observed and latent variables. Students will gain hands-on experience using SEM software to build, evaluate, and interpret structural models in real-world contexts.

Course Learning Outcomes

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

1. Understand the fundamental concepts, assumptions, and terminology of SEM.
2. Construct measurement models using confirmatory factor analysis.
3. Specify, estimate, and evaluate structural models representing complex variable relationships.
4. Assess model fit using various goodness-of-fit indices and diagnostics.
5. Use SEM software tools (e.g., AMOS, LISREL, or R and Python packages) to perform SEM analysis.

Course Contents

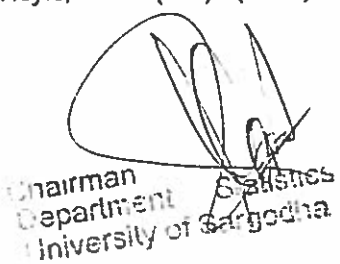
1. Introduction to SEM and its Applications
2. Measurement Models and Confirmatory Factor Analysis
3. Path Analysis and Model Specification
4. Estimation Techniques in SEM
5. Model Identification and Modification
6. Assessing Model Fit (CFI, RMSEA, SRMR, etc.)
7. Latent Variable Modeling and Mediation Analysis
8. Longitudinal and Multigroup SEM
9. Applications in Social Sciences, Psychology, and Health Research

Recommended Textbooks

1. Kline, R. B. (2015). *Principles and Practice of Structural Equation Modeling* (4th ed.). Guilford Press.
2. Byrne, B. M. (2016). *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming* (3rd ed.). Routledge.

Suggested Readings

1. Schumacker, R. E., & Lomax, R. G. (2016). *A Beginner's Guide to Structural Equation Modeling* (4th ed.). Routledge.
2. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). *Multivariate Data Analysis* (8th ed.). Pearson.
3. Hoyle, R. H. (Ed.). (2012). *Handbook of Structural Equation Modeling*. Guilford Press.



27. Applied Econometrics (STAT-6137) 3(3-0)

Course Brief

This course introduces the practical application of econometric methods to real-world economic data. It focuses on understanding, modeling, and interpreting economic relationships using statistical tools. Students will learn to apply regression techniques, detect econometric problems, and use econometric software for estimation and policy analysis. Emphasis is placed on hands-on data analysis, interpretation of results, and communication of findings relevant to economics, finance, and social sciences.

Course Learning Outcomes

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

1. Understand the principles and assumptions of econometric models.
2. Apply linear and multiple regression models to economic datasets.
3. Detect and address issues such as multicollinearity, heteroscedasticity, autocorrelation, and endogeneity.
4. Conduct hypothesis testing and model diagnostics in an econometric framework.
5. Use statistical software (e.g., R, STATA, EViews) for data estimation and policy evaluation.

Course Contents

1. Introduction to Econometrics and Economic Data
2. The Classical Linear Regression Model (CLRM)
3. Functional Forms and Dummy Variables
4. Violation of CLRM Assumptions: Multicollinearity, Heteroscedasticity, and Autocorrelation
5. Instrumental Variables and Endogeneity
6. Qualitative Response Models (Probit, Logit)
7. Time Series Econometrics: Stationarity, Cointegration, ARIMA
8. Panel Data Models and Applications
9. Forecasting and Policy Evaluation

Recommended Textbooks

1. Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics* (5th ed.). McGraw-Hill.
2. Wooldridge, J. M. (2019). *Introductory Econometrics: A Modern Approach* (7th ed.). Cengage Learning.

Suggested Readings

1. Greene, W. H. (2018). *Econometric Analysis* (8th ed.). Pearson.
2. Kennedy, P. (2008). *A Guide to Econometrics* (6th ed.). Wiley-Blackwell.
3. Stock, J. H., & Watson, M. W. (2015). *Introduction to Econometrics* (3rd ed.). Pearson.
4. Cameron, A. C., & Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications.* Cambridge University Press.

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28. Spatial Statistics (STAT-6138)

3(3-0)

Course Brief

This course provides an introduction to statistical methods for analyzing spatial and spatio-temporal data. It covers foundational concepts such as spatial dependence, spatial autocorrelation, and spatial point processes. Students will learn to model, visualize, and interpret spatial data using classical and modern statistical techniques, enabling them to tackle challenges in environmental science, epidemiology, urban planning, and geoinformatics.

Course Learning Outcomes

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

1. Understand key concepts and challenges in analyzing spatial and spatio-temporal data.
2. Apply methods for exploratory spatial data analysis (ESDA), including measures of spatial autocorrelation.
3. Fit spatial statistical models such as geostatistical models (e.g., kriging), lattice models, and spatial point processes.
4. Interpret the output of spatial statistical models for real-world decision making.
5. Use software tools such as R or GIS packages to visualize and analyze spatial datasets.

Course Contents

1. Introduction to Spatial Data Types and Applications
2. Coordinate Systems and Georeferencing
3. Spatial Dependence and Spatial Autocorrelation (Moran's I, Geary's C)
4. Exploratory Spatial Data Analysis (ESDA)
5. Spatial Point Patterns and Quadrat Analysis
6. Geostatistics: Variograms and Kriging
7. Lattice Data and Spatial Regression Models
8. Spatio-Temporal Modeling and Applications

Recommended Textbooks

1. Bivand, R. S., Pebesma, E., & Gómez-Rubio, V. (2013). *Applied Spatial Data Analysis with R*. Springer.
2. Cressie, N. (1993). *Statistics for Spatial Data*. Wiley-Interscience.

Suggested Readings

1. Banerjee, S., Carlin, B. P., & Gelfand, A. E. (2014). *Hierarchical Modeling and Analysis for Spatial Data*. CRC Press.
2. Haining, R. (2003). *Spatial Data Analysis: Theory and Practice*. Cambridge University Press.
3. Schabenberger, O., & Gotway, C. A. (2005). *Statistical Methods for Spatial Data Analysis*. CRC Press.
4. Lawson, A. B. (2013). *Bayesian Disease Mapping: Hierarchical Modeling in Spatial Epidemiology*. CRC Press.

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29. Population Studies and Demographic Techniques (STAT-6139) 3(3-0)

Course Brief

This course introduces the fundamental concepts, measures, and techniques used in population studies and demography. It focuses on analyzing population dynamics, including fertility, mortality, migration, and growth. The course equips students with tools to interpret demographic data and apply statistical techniques to real-world population issues, supporting planning and policy-making in public health, urban development, and resource allocation.

Course Learning Outcomes

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

1. Understand core demographic concepts such as population structure, fertility, mortality, and migration.
2. Apply demographic methods to calculate and interpret rates, ratios, and indices.
3. Analyze population data using life tables, age-sex pyramids, and population projections.
4. Interpret census, survey, and vital statistics data.
5. Evaluate population policies and their impact on demographic trends.

Course Contents

1. Introduction to Population Studies and Demographic Data Sources
2. Basic Measures of Population: Rate, Ratio, Proportion
3. Fertility Measures: Crude Birth Rate, TFR, ASFR, GRR, NRR
4. Mortality Measures: Crude Death Rate, ASDR, IMR, Life Tables
5. Migration: Concepts, Types, and Measurement Techniques
6. Population Age Structure and Dependency Ratios
7. Population Projections and Models of Growth
8. Demographic Transition Theory and Population Policies

Recommended Textbooks

1. Rowland, D. T. (2003). *Demographic Methods and Concepts*. Oxford University Press.
2. Siegel, J. S., & Swanson, D. A. (2004). *The Methods and Materials of Demography*. Elsevier Academic Press.

Suggested Readings

1. Preston, S. H., Heuveline, P., & Guillot, M. (2000). *Demography: Measuring and Modeling Population Processes*. Blackwell.
2. United Nations (2017). *Principles and Recommendations for Population and Housing Censuses*. UN Publications.
3. Shryock, H. S., Siegel, J. S., & Associates (1976). *The Methods and Materials of Demography*. Academic Press.
4. Pathak, K. B., & Ram, F. (1998). *Techniques of Demographic Analysis*. Himalaya Publishing House.

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30. Environmental Statistics (STAT-6140) 3(3-0)

Course Brief

This course provides students with a statistical foundation for addressing environmental challenges. It emphasizes the use of statistical methods to analyze environmental data related to air quality, water resources, climate change, pollution, and ecological monitoring. The course integrates real-world environmental datasets and introduces relevant software tools for modeling, estimation, and inference in environmental contexts.

Course Learning Outcomes

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

1. Understand key concepts and types of environmental data and measurements.
2. Apply appropriate statistical techniques to analyze environmental datasets.
3. Model spatial and temporal environmental data using regression and time series methods.
4. Perform risk and uncertainty analysis in environmental studies.
5. Use statistical tools to support decision-making in environmental management and policy.

Course Contents

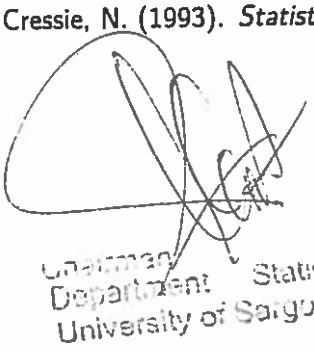
1. Introduction to Environmental Data and Statistical Challenges
2. Exploratory Data Analysis for Environmental Datasets
3. Probability Distributions in Environmental Contexts
4. Sampling Techniques for Environmental Monitoring
5. Temporal Analysis: Trends, Seasonality, and Time Series Models
6. Spatial Data Analysis and Geostatistics
7. Environmental Risk Assessment and Uncertainty Analysis
8. Case Studies: Climate Change, Air and Water Pollution, Ecological Data

Recommended Textbooks

1. Glickman, T. S. (2000). *Glossary of Meteorology*. American Meteorological Society.
2. Millard, S. P., & Neerchal, N. K. (2001). *Environmental Statistics with S-PLUS*. CRC Press.

Suggested Readings

1. Ott, W. R., & Longnecker, M. P. (2008). *An Introduction to Statistical Methods and Data Analysis*. Cengage.
2. Zuur, A. F., et al. (2009). *Mixed Effects Models and Extensions in Ecology with R*. Springer.
3. Manly, B. F. J. (2008). *Statistics for Environmental Science and Management*. CRC Press.
4. Cressie, N. (1993). *Statistics for Spatial Data*. Wiley.



31. Functional Data Analysis (STAT-6141) 3(3-0)

Course Brief

This advanced course introduces the concepts and methods of Functional Data Analysis (FDA), focusing on statistical techniques for analyzing data that can be viewed as functions, curves, or shapes. Students will explore tools for smoothing, functional principal component analysis, and functional linear models. The course is designed for applications in diverse fields such as medicine, finance, and environmental science where data are recorded over a continuum like time or space.

Course Learning Outcomes

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

1. Understand the nature and structure of functional data and its differences from classical multivariate data.
2. Apply functional data representation techniques, including basis function expansion and smoothing.
3. Perform Functional Principal Component Analysis (FPCA) and interpret functional modes of variation.
4. Model relationships using Functional Linear Models (FLM) and functional regression techniques.
5. Apply FDA tools to real-world datasets in domains such as biostatistics, climatology, and finance.

Course Contents

1. Introduction to Functional Data and Motivating Applications
2. Data Smoothing and Basis Function Representations
3. Functional Principal Component Analysis (FPCA)
4. Functional Linear Models and Functional Regression
5. Functional Analysis of Variance (FANOVA)
6. Functional Clustering and Classification
7. Time Warping and Alignment of Functional Data
8. Case Studies in FDA: Biomedical, Environmental, and Financial Data

Recommended Textbooks

1. Ramsay, J. O., & Silverman, B. W. (2005). *Functional Data Analysis* (2nd ed.). Springer.
2. Horváth, L., & Kokoszka, P. (2012). *Inference for Functional Data with Applications*. Springer.

Suggested Readings

1. Ferraty, F., & Vieu, P. (2006). *Nonparametric Functional Data Analysis: Theory and Practice*. Springer.
2. Ramsay, J. O., Hooker, G., & Graves, S. (2009). *Functional Data Analysis with R and MATLAB*. Springer.
3. Ullah, S., & Finch, C. F. (2013). *Applications of Functional Data Analysis: A Systematic Review*. BMC Medical Research Methodology.

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32. Robust Methods (STAT-6142) 3(3-0)

Course Brief

This course introduces robust statistical methods that remain effective under violations of assumptions such as normality or homoscedasticity. It focuses on techniques that mitigate the influence of outliers and leverage points, providing reliable alternatives to classical parametric procedures. Students will learn theoretical justifications for robust procedures, including M-estimators, L-estimators, R-estimators, and breakdown points, and explore robust versions of common models such as regression, ANOVA, and multivariate analysis. Practical implementation using statistical software is emphasized.

Course Learning Outcomes

1. Understand the need for robust statistical procedures in applied data analysis.
2. Define and compare classical estimators with their robust counterparts.
3. Apply robust techniques to regression, location-scale models, and multivariate data.
4. Evaluate robustness criteria such as influence functions and breakdown points.
5. Utilize statistical software to implement and interpret robust methods.

Course Contents

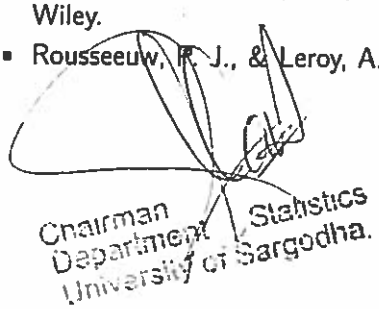
1. Introduction to robustness: concept and historical motivation
2. Influence functions and breakdown point
3. Robust estimators of location and scale: trimmed means, Winsorized means, MAD
4. M-estimators, L-estimators, and R-estimators
5. Robust regression methods: Least Trimmed Squares, MM-estimation
6. Diagnostic tools for robust models
7. Robust ANOVA and hypothesis testing
8. Robust multivariate techniques: robust covariance estimation, robust PCA
9. High breakdown point estimators: S-estimators, MM-estimators
10. Comparison of robust and classical methods using simulations
11. Implementation of robust methods in R and other statistical software

Recommended Textbooks

- Huber, P. J., & Ronchetti, E. M. (2009). *Robust Statistics* (2nd ed.). Wiley.
- Maronna, R. A., Martin, R. D., & Yohai, V. J. (2006). *Robust Statistics: Theory and Methods*. Wiley.

Suggested Readings

- Hampel, F. R. et al. (1986). *Robust Statistics: The Approach Based on Influence Functions*. Wiley.
- Rousseeuw, P. J., & Leroy, A. M. (2003). *Robust Regression and Outlier Detection*. Wiley.



Model Course Outline
for the Course Understanding of Quran – I

Course Title: Understanding of Quran – I **Course Code:** URCG-5129
Course Book: Muallim ul Quran (Volume 1, 2 & 3) by Dr Ubaid ur Rahman
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

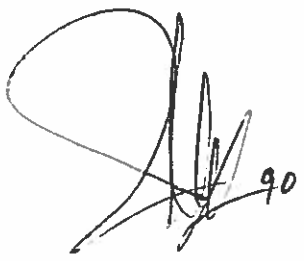
Course Learning Outcomes:

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

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles) , compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the holy Quran.

Provision of material, content and books:

- **Paper book**: All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.



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Course Outline:

Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Rules
1.	1.	1	1-6	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of (و) "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun (This & That for Masculine (هذا- هذه) Demonstrative Noun (This & That for Feminine) (ذلك- تلك)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words , phrases & translation of Sentences 17-19 Quiz	Laam for emphasis (لام التأكيد) Superlative Degree like اكبر Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle ان Preposition "For" (اللام) Preposition (فى)
	2.	2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (على- من- إلى)
4.	1.	2	7- 9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (الباء) Absolute Negation Particle Exceptive Particle (لا النافية للجنس)(ما النافية) (الا)
	2.	2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction(أن), Was (كان), Vocative Particle(حرف النداء)

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5.	1.	Unit 3	1-2	Writing the meaning of Quranic phrases 1-2	Quranic Adjective Compounds (صفة وموصوف)
	2.	3	3-5	Writing the meaning of Quranic phrases & translation of sentences 3-5	Quranic Possessive Construction (مضاف ومضاف اليه)
6.	1.	3	6 -7	Writing the meaning of Quranic phrase translation of sentences 6-7	Quranic Possessive Construction (مضاف ومضاف اليه)
	2.	3	8-10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8-10 Quiz	Active Participle (اسم الفاعل), Passive Participle (اسم المفعول), Dual (مثنى)
7.	1.	Unit 4	1-2	Writing the meaning of Quranic phrase & translation of sentences 1-2	Personal Pronoun He(هو المنفصل) Possessive Pronoun His ـه المتصل)
	2.	4	3-4	Writing the meaning of Quranic phrase & translation of sentences 3 -4	Possessive Pronoun with prepositions like في بيته Pronoun "His" with prepositions like له، منه، فيه
8.	1.	4	5-8	Writing the meaning of Quranic sentences 5-8	Personal Pronoun You(أنت المنفصل) Possessive Pronoun Your ك المتصل) Possessive Pronoun with prepositions like في بيتك Pronoun "your" with prepositions like لك، منك، فيك
	2.	Mid Term			

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9.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She(هي المنفصل) Possessive Pronoun Her ها المتصل) Possessive Pronoun with prepositions like في بيتها Pronoun "Her" with prepositions like لها،
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (أنا المنفصل) Possessive Pronoun Her ي المتصل) Possessive Pronoun with prepositions like في بيتيPronoun "My" with prepositions like لي
10.	1	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (حال)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جمع المذكر السالم و جمع المذكر السالم المسبوق بحرف الجر
11.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جمع المذكر السالم المسبوق بالإضافة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم المنفصل) Possessive Pronoun Their هم المتصل)
12.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like في بيتهمPronoun "Their" with prepositions like لهم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (أنتم المنفصل) Possessive Pronoun Your كم المتصل) Possessive Pronoun with prepositions

					like في بيتكم
13.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	Pronoun "Your" with prepositions like لكم Personal Pronoun We (نحن المنفصل) Possessive Pronoun Our نا المتصل)
	2.	5	15-16	Writing the meaning of Quranic sentences & verses 15-16	Possessive Pronoun with prepositions like في بيتنا Pronoun "Our" with prepositions like لنا
14.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses 17-18	Demonstrative Pronoun These, Those (هؤلاء- أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	ما / الا، إن / إلا، انما، ليس، ما ،) (أم، ان، بل، كان (الا، أليس، اليوم، يومئذ، سبحان، مابينهما، قل، اذن، بئس، نعم، كلا، ما ادراك، حسب، أعلم ب، مصير، مرجع، دينا(تمييز)
15.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs &Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense(فعل مضارع) & Verbal Sentence (جملة فعلية) Present Tense الفعل المضارع صيغة المفرد يعلم
16.	1.	6	3 (From Page 17) & 4 -5	Translation of Quranic Sentences & Verses 3-5	Present Tense الفعل المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense الفعل المضارع صيغة الجمع يعلمون

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Model Course Outline
for the Course Understanding of Quran – II

Course Title: Understanding of Quran – II **Course Code:** URCG-5130
Course Book: Muallim ul Quran (Volume 3, 4 & 5) by Dr Ubaid ur Rahman
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

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

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tense صیغۃ جمع مذکر غائب مثل یعبدون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense صیغۃ جمع مذکر غائب مثل یعبدون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense صیغۃ مفرد مذکر مخاطب (تعبد) وجمع مذکر مخاطب (تعبدون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صیغۃ جمع مذکر مخاطب (تعبدون)

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					صیغۃ المتکلم (اعبد)
3.	1.	6	13	Understanding & Translation of Verses	Present Tense صیغۃ جمع المتکلم (نعبد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative صیغۃ المفرد وصیغۃ الجمع , لا تعبد، لا تعبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar moawal (مصدر موؤل)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttaleel (لام التعلیل) & Laam ul jhood(لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense صیغۃ المفرد الغائب
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صیغۃ المفرد للغائب
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صیغۃ المفرد للغائب
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صیغۃ المفرد للغائب
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صیغۃ المفرد للغائب
	2.	MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صیغۃ الجمع للغائب عبدوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صیغۃ الجمع للغائب عبدوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صیغۃ الجمع للغائب عبدوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صیغۃ الجمع للغائب عبدوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صیغۃ الجمع للمتکلم عبدنا

	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عبدتم
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عبدتم
14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صيغة المتكلم والمخاطب عبدتُ ، عبدتَ
	2.	7	7	Understanding & Translation of Verses	Past Tense صيغة المؤنث للغائب عبدتْ
15.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول للمفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول الجمع
16.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع

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Ethics-II **URCG-5132** **1 (0-1)**

1-Course Description

The course *Ethics-II* is designed to provide students with a deeper understanding of ethical principles and practices from both Semitic and non-Semitic religions, as well as their application in professional and social contexts. Students will engage with Jewish, Christian, Islamic, Hindu, Buddhist, Sikh, Confucian, and Jain ethical traditions. The course emphasizes moral reasoning, decision-making, tolerance, and peacebuilding. It aims to cultivate an inclusive, humanistic, and holistic approach towards ethical living and interfaith engagement.

2- Learning Objectives

The course objectives are to:

1. Understand the fundamental principles and theories of ethics.
2. Introduce the ethical and moral teachings of Judaism, Christianity, Islam, and Hinduism.
3. Explore the ethical teachings of non-Semitic religions such as Buddhism, Sikhism, Confucianism, and Jainism.
4. Develop critical thinking skills to evaluate ethical arguments and theories.
5. Promote ethical leadership and interfaith harmony.

3- Learning Outcomes

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

1. Identify and analyze major ethical theories and teachings from world religions.
2. Understand the role of religions in improving moral values and social behavior.
3. Demonstrate ethical decision-making in various personal and professional contexts.
4. Recognize the impact of ethical decisions on individuals, communities, and society.
5. Apply skills of ethical leadership, including communication, conflict resolution, and inclusive engagement.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents

Unit 1: Ethical Teachings of Semitic Religions

- Judaism and its ethical teachings
- Christianity and its ethical teachings
- Islam and its ethical teachings

Unit 2: Ethical Teachings of Non-Semitic Religions

- Hinduism and its ethical teachings
- Sikhism and Buddhism: ethical values and practices
- Confucian and Jain ethical traditions

Unit 3: Professional Ethics

- Ethics for students and teachers
- Ethics in doctor–patient relationships
- Ethics in trader–customer interactions

Unit 4: Concept and Significance of Tolerance

- Definition, need, and importance of tolerance
- Teachings of Semitic religions on tolerance and their contemporary relevance
- Teachings of non-Semitic religions on tolerance and their contemporary relevance

Unit 5: Foundational Values and Ethics for Peacebuilding in Society

- Respect for sacred scriptures, personalities, places of worship, and religious symbols
- Promotion of tolerance and broadmindedness
- Encouragement of dialogue and harmony
- Benevolence towards humanity
- Establishment of justice and fairness
- Patience, forbearance, and forgiveness

Textbook

- Kidder, R. M. (2009). *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living*. Harper.

Suggested Readings

1. Barash, D. P., & Webel, C. P. (2014). *Peace and Conflict Studies*. Sage.
2. Smart, N. (1998). *The World's Religions*. Cambridge University Press.
3. Nasr, S. H. (2003). *The Heart of Islam: Enduring Values for Humanity*. HarperOne.
4. Sharma, A. (2006). *Hindu Ethics: Purity, Abortion, and Euthanasia*. SUNY Press.
5. Harvey, P. (2000). *An Introduction to Buddhist Ethics: Foundations, Values and Issues*. Cambridge University Press.
6. Coward, H., & Perkinson, J. (2013). *A Cross-Cultural Dialogue on Ethical Leadership*. Wilfrid Laurier University Press.
7. Confucius. (1998). *The Analects*. Oxford University Press.

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Chairman
Department
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Ethics-I **URCG-5131** **1 (0-1)**

1-Course Description

The Ethics-I course is designed to provide students with a comprehensive understanding of ethical principles, practices, and theories in various societal contexts. Throughout this degree program, students will explore the complexities of ethical theories of semitic and non-semitic religions along with decision-making and develop critical thinking skills to navigate moral dilemmas. This course will also enable the students to interact with others religious identities with humanistic, inclusive and holistic approach

2- Learning Objectives

This course aims to:

1. Introduce students to the fundamental concepts, scope, and importance of ethics.
2. Explore the relationship between law, morality, and social values.
3. Develop a clear understanding of virtuous and immoral ethics and their impact on individual and collective life.
4. Study the role of major religious figures in the moral development of human society and enable students to apply ethical principles for personal development, conflict resolution, and social harmony.

3- Learning Outcomes

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

1. Students will be able to identify and analyze major ethical theories, values, and their scope in social and individual life.
2. Differentiate between law and ethics, and analyze their interrelationship.
3. Identify types of virtuous and immoral ethics and assess their social impacts.
4. Examine the ethical teachings of major religions and their relevance in contemporary society.
5. Apply ethical principles to address modern challenges in personal and professional life.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents

Unit 1: Introduction and Fundamentals of Ethics

1. Literal and terminological definition of ethics
2. Literal and terminological definition of values
3. Relationship between law and ethics
4. Need, importance, and scope of ethics

Unit 2: Types of Ethics and Their Impact on Society

- Virtuous ethics: concept, types, benefits, and outcomes
- Immoral ethics: concept, types, and harms
- Role of ethics in social refinement and establishment of peace

Unit 3: Virtuous Ethics (Akhlaq-e-Hasanah)

- Concept, need, and importance of virtuous ethics
- Scope of virtuous ethics in the light of religions
- Major virtues in revealed and non-revealed religions
- Impact of virtuous ethics on individual and collective life

Unit 4: Immoral Ethics (Akhlaq-e-Razilah)

- Concept of immoral ethics
- Social problems caused by immoral ethics
- Practical consequences of immoral ethics
- Major vices in revealed and non-revealed religions

Unit 5: Role of World Religious Figures in Moral Development

- Prophet Moses (AS): introduction, miracles, and role in moral refinement
- Prophet Jesus (AS): introduction, miracles, and role in moral refinement
- Prophet Muhammad (ﷺ): introduction, miracles, and role in moral refinement

Textbook

1. Izutsu, T. (2002). *Ethico-Religious Concepts in the Qur'an*. McGill-Queen's University Press.

Suggested Readings

1. Gert, B. (2005). *Morality: Its Nature and Justification*. Oxford University Press.
2. MacIntyre, A. (2007). *After Virtue: A Study in Moral Theory*. University of Notre Dame Press.
3. Al-Ghazali, Abu Hamid (2001). *The Alchemy of Happiness*. Islamic Texts Society.
4. Nasr, S. H. (1994). *The Heart of Islam: Enduring Values for Humanity*. Harper One.
5. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press.
6. Hasan, Z. (2010). *Ethics in Islam: Key Concepts and Contemporary Challenges*. Islamic Research Institute.

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