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/ 12200

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

MPHIL STATISTICS

POSTGRADUATE PROGRAM IN STATISTICS

Session: Fall 2025 – Onward

DEPARTMENT OF STATISTICS

UNIVERSITY OF SARGODHA

1. **Title of Degree Program:** MPhil in Statistics

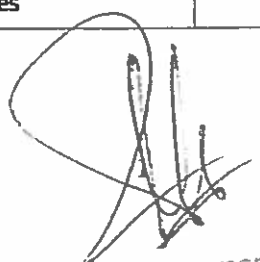
2. **Program Learning Objectives:** The primary objective of the MPhil in Statistics program is to equip students with advanced knowledge of statistical theory, modern statistical software, and robust methodologies for data collection and analysis. The program is designed to develop analytical and research competencies that enable graduates to meet the demands of the job market and contribute effectively to the socio-economic development of Pakistan. Additionally, the program aims to provide a strong academic foundation in statistical theory, preparing students for doctoral studies and independent research in the field of statistics.

3. **Program Structure**

Duration	Minimum 1.5 Years (3 Semesters), Maximum 4 Years (8 Semesters)
Entry Requirements	▪ Candidates having minimum 2nd division in annual system or CGPA 2.0/4.0 in MA/M.Sc/LLB/BS (4-Year) degree (16 years of education) in semester system in Statistics, Data Analytics, Biostatistics, or Data Science subjects from HEC-recognized institutions. ▪ In case of intra-disciplinary terminal degrees, the candidate will have to pass deficiency courses of level 6 and have to pass a separate GRE-Subject/equivalent test (at least 50% marks) in addition to GRE/HAT general test.
Intra-disciplinary Fields Allowed for Admission	▪ BS Biostatistics ▪ BS Data Science ▪ BS Mathematics
Degree Completion Requirements	▪ Total Credit Hours of Course Work: Minimum 26 ▪ Total Credit Hours of Thesis 06 ▪ Total Credit Hours of Program: Minimum 32
Program Mode	▪ Thesis Track

4. **Scheme of Studies**

Semester I				
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**	**Category**
STAT-61XX	Course will be decided from list of Deficiency courses	3 (3-0)	Nil	Deficiency-1*



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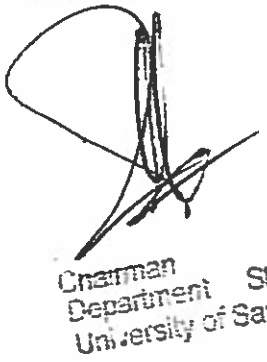
University of Sargodha

STAT-7101	Linear Models and Regression Analysis	3 (3-0)	Nil	Core-1
STAT-7102	Computational Statistics	3 (3-0)	Nil	Core-2
STAT-71XX	Elective-I	3 (3-0)	Nil	Elective
STAT-71XX	Elective-II	3 (3-0)	Nil	Elective
Semester II				
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**	**Category**
STAT-61XX	Course will be decided from list of Deficiency courses	3 (3-0)	Nil	Deficiency-2*
STAT-7103	Advanced Machine Learning Techniques	3 (3-0)	Nil	Core-3
STAT-71XX	Elective-III	3 (3-0)	Nil	Elective
STAT-71XX	Elective-IV	3 (3-0)	Nil	Elective
STAT-71XX	Elective-V	3 (3-0)	Nil	Elective
Semester III				
Course Code	**Course Title**	**Credit Hours**	**Pre-Requisite**	**Category**
STAT-61XX	Course will be decided from list of Deficiency courses	3 (3-0)	Nil	Deficiency-3*
URCG-5129	Understanding of Holy Quran - I/Fehm-e-Quran - I	1 (0-1)	Nil	General Edu.
URCG-5130	Understanding of Holy Quran - II/Fehm-e-Quran - II	1 (0-1)	Nil	General Edu.
URCG-5131	Ethics-I (for non Muslims)	1 (0-1)	Nil	General Edu.
URCG-5132	Ethics-II (for non Muslims)	1 (0-1)	Nil	General Edu.
STAT-7150	Thesis	6	Course Work Completion	Research Work

*For intra-disciplinary admitted candidates only.

5. **List of Deficiency Courses of Level-6 (for intra-disciplinary admissions only)**

Sr. No.	Course Code	Course Title	Credit Hours
1	STAT-6101	Probability Distributions	3(3-0)
2	STAT-6102	Design and Analysis of Experiments	3(3-0)
3	STAT-6103	Sampling Techniques	3(3-0)
4	STAT-6105	Statistical Inference	3(3-0)
5	STAT-6106	Regression Analysis	3(3-0)
6	STAT-6109	Statistical Quality Control	3(3-0)
7	STAT-6110	Applied Multivariate Analysis	3(3-0)



6. **List of Elective Courses**

S.N.	Course Code	Course Title	Credit Hours
1	STAT-7104	Financial Time Series	3 (3-0)
2	STAT-7105	Advanced Bayesian Inference	3 (3-0)
3	STAT-7106	Bayesian Reliability	3 (3-0)
4	STAT-7107	Advanced Design and Analysis of Experiments	3 (3-0)
5	STAT-7108	Statistical Methods in Genomics	3 (3-0)
6	STAT-7109	Advanced Data Visualization	3 (3-0)
7	STAT-7110	Advanced Applied Artificial Intelligence	3 (3-0)
8	STAT-7111	Statistical Methods for Deep Learning	3 (3-0)
9	STAT-7112	Advanced Spatial Data Analysis	3 (3-0)
10	STAT-7113	Operations Research	3 (3-0)
11	STAT-7114	Stochastic Process	3 (3-0)
12	STAT-7115	Functional Data Analysis	3 (3-0)
13	STAT-7116	Deep Reinforcement Learning	3 (3-0)
14	STAT-7117	Decision Theory	3 (3-0)
15	STAT-7118	Advanced Sampling Techniques	3 (3-0)
16	STAT-7119	Advanced Probability Theory	3 (3-0)
17	STAT-7120	Randomized Response Techniques	3 (3-0)
18	STAT-7121	Mathematical Modelling and Simulation	3 (3-0)
19	STAT-7122	Environmental Statistics	3 (3-0)
20	STAT-7123	Non-Parametric Statistics	3 (3-0)
21	STAT-7124	Applied Smoothing Techniques	3 (3-0)
22	STAT-7125	Multilevel Modelling	3 (3-0)
23	STAT-7126	Meta-analysis	3 (3-0)
24	STAT-7127	Generalized Linear Models	3 (3-0)
25	STAT-7128	Panel Data Models	3 (3-0)
26	STAT-7129	Advanced Econometrics	3 (3-0)
27	STAT-7130	Computational Finance	3 (3-0)
28	STAT-7131	Advanced Survival Analysis	3 (3-0)
29	STAT-7132	Advanced Multivariate Analysis	3 (3-0)
30	STAT-7133	Research Methodology	3 (3-0)
31	STAT-7134	Advanced Statistical Inference	3 (3-0)
32	STAT-7135	High Performance Computing (HPC) for Statistical Analysis	3 (3-0)
33	STAT-7136	Quantum Computing	3 (3-0)
34	STAT-7137	Advanced Categorical Data Analysis	3 (3-0)
35	STAT-7138	Statistical Process Control	3 (3-0)
36	STAT-7139	Time Series Analysis	3 (3-0)
37	STAT-7140	Spatial Data Analysis	3 (3-0)
38	STAT-7141	Analysis of Multi-Factor Designs	3 (3-0)

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University of Sargodha.

Course Outlines for Core Courses

1. Linear Models and Regression Analysis (STAT-7101) 3(3-0)

Course Brief

This course is designed for M.Phil. in Statistics students. In many scientific, technological, social science, and medical fields, it is essential to examine how one observable random response is influenced by multiple factors. This course introduces students to statistical model building using linear models and regression analysis the primary tools for studying such relationships. The central objective is to develop mathematical models that can accurately predict the future value of a dependent variable based on explanatory variables.

Regression analysis provides a collection of methods to construct and use such models. The course enhances students' ability to explore the effects of various predictors on a response variable, which is essential for research and decision-making. Furthermore, the curriculum will develop students' research and analytical thinking capabilities while fostering motivation for intellectual growth. Practical implementation using statistical software such as R and Mathematica will also be included to strengthen computing skills in model fitting.

Course Learning Outcomes

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

1. Understand and differentiate between types of regression models and linear models.
2. Apply least squares and generalized least squares estimation methods.
3. Explain and validate the assumptions of the classical linear model.
4. Derive and interpret the best linear unbiased estimator (BLUE) using the Gauss-Markov Theorem.
5. Apply maximum likelihood and robust estimation methods in linear models.
6. Analyze model fit, perform diagnostics, and identify influential data and outliers.
7. Implement various regression techniques for prediction and inference.
8. Use R and Mathematica for model fitting and regression diagnostics.

Course Contents

1. Regression models and their types
2. Definition and forms of linear models
3. Least square estimation method
4. Assumptions of the linear model
5. Best linear unbiased estimator
6. Gauss-Markov Theorem
7. Generalized Least Squares Method
8. Maximum Likelihood Estimation Method
9. Model goodness of fit and related inferences
10. Biased estimation methods
11. Robust estimation methods
12. Robust biased estimation methods
13. Outlier and influence analysis
14. Predictions from regression with different estimation methods
15. Linear model-based profiling
16. Linear model fitting with different statistical software

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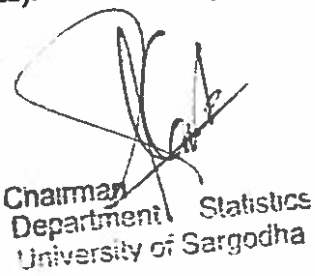
University of Sargodha

Recommended Textbooks

1. Belsley, D. A., Kuh, E., & Welsch, R. (1980). *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York: Wiley.
2. Christensen, R. (2011). *Plane Answers to Complex Questions: The Theory of Linear Models*. Springer.
3. Draper, N. R., & Smith, H. (2004). *Applied Regression Analysis*. New York: John Wiley & Sons.
4. Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W. (2005). *Applied Linear Statistical Models* (5th ed.). McGraw Hill, New York.

Suggested Readings

1. Agresti, A. (2015). *Foundations of Linear and Generalized Linear Models*. New York: John Wiley & Sons.
2. Christensen, J. (2002). *Advanced Linear Modeling*. U.S.A: Springer.
3. Baltagi, B. H. (2011). *Econometrics* (5th ed.). U.S.A: Springer.



2. Computational Statistics (STAT-7102) 3(3-0)

Course Brief:

This advanced course introduces students to computational techniques and algorithms used in modern statistical analysis. It emphasizes simulation-based methods, numerical approaches to statistical problems, and the use of statistical programming languages such as R or Python. Topics include resampling methods (bootstrapping and permutation tests), Monte Carlo methods, Markov Chain Monte Carlo (MCMC) techniques, and numerical optimization. The course is designed to enhance students' ability to perform efficient statistical computations and to interpret the outcomes in applied research settings.

Course Learning Outcomes:

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

1. Understand the principles and applications of simulation-based inference techniques.
2. Implement resampling methods such as bootstrap and permutation tests for statistical estimation and hypothesis testing.
3. Apply Monte Carlo integration and importance sampling in solving statistical problems.
4. Understand and use Markov Chain Monte Carlo (MCMC) techniques, including Gibbs sampling and Metropolis-Hastings algorithms.
5. Perform numerical optimization for parameter estimation in complex models.
6. Utilize statistical programming tools (R/Python) to carry out computational methods and interpret results.

Course Contents:

1. Introduction to computational statistics and programming environments (R/Python)
2. Simulation techniques and generation of random variables
3. Resampling methods: Bootstrap and permutation tests
4. Monte Carlo methods and variance reduction techniques
5. Markov Chain Monte Carlo (MCMC): Gibbs sampling, Metropolis-Hastings algorithm
6. Numerical integration and optimization methods
7. Computational Bayesian methods
8. Application of computational techniques in real-world data analysis

Recommended Textbooks:

1. Gentle, J. E. (2009). *Computational Statistics*. Springer.
2. Robert, C. P., & Casella, G. (2010). *Introducing Monte Carlo Methods with R*. Springer.

Suggested Readings:

1. Efron, B., & Tibshirani, R. J. (1993). *An Introduction to the Bootstrap*. Chapman and Hall/CRC.
2. Gilks, W. R., Richardson, S., & Spiegelhalter, D. (1996). *Markov Chain Monte Carlo in Practice*. Chapman and Hall/CRC.
3. Kroese, D. P., Brereton, T., Taimre, T., & Botev, Z. I. (2014). *Why the Monte Carlo method is so important today*. Wiley Interdisciplinary Reviews: Computational Statistics.

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3. **Advanced Machine Learning Techniques (STAT-7103)** 3(3-0)

Course Brief:

This advanced-level course is designed to equip students with a deep understanding of state-of-the-art machine learning algorithms and their applications to real-world problems. Emphasis is placed on both the theoretical foundations and practical implementation of advanced techniques including ensemble learning, support vector machines, neural networks, deep learning, and unsupervised learning methods. The course involves hands-on programming in R/Python and introduces best practices for tuning, validation, and interpretation of machine learning models. Students will explore recent research trends and evaluate model performance across varied datasets.

Course Learning Outcomes:

1. Understand and explain key concepts behind advanced machine learning models such as SVMs, ensemble methods, and deep neural networks.
2. Implement and optimize advanced machine learning algorithms using software tools like Python or R.
3. Evaluate and compare models using cross-validation, ROC curves, and performance metrics like precision, recall, and F1-score.
4. Analyze real-world datasets to solve classification, regression, and clustering problems using machine learning.
5. Critically assess research literature and identify suitable machine learning methods for new problems.

Course Contents:

1. Review of supervised and unsupervised learning
2. Support Vector Machines (SVM): theory and kernel tricks
3. Ensemble learning: Bagging, Boosting, Random Forest
4. Neural networks and Deep Learning basics
5. Convolutional and Recurrent Neural Networks
6. Model evaluation techniques: Confusion Matrix, AUC-ROC, cross-validation
7. Hyperparameter tuning and regularization
8. Feature selection and dimensionality reduction
9. Advanced unsupervised learning: t-SNE, DBSCAN, and autoencoders
10. Introduction to reinforcement learning
11. Recent advances and research trends in machine learning
12. Case studies and project-based learning

Recommended Textbooks:

1. Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow.* O'Reilly Media.
2. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). *An Introduction to Statistical Learning* (2nd ed.). Springer.

Suggested Readings:

1. Bishop, C. M. (2006). *Pattern Recognition and Machine Learning.* Springer.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning.* MIT Press.
3. Murphy, K. P. (2012). *Machine Learning: A Probabilistic Perspective.* MIT Press.
4. Kuhn, M., & Johnson, K. (2013). *Applied Predictive Modeling.* Springer.

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University of Sargodha

Course Outlines for Elective Courses

1. **Financial Time Series (STAT-7104)** 3(3-0)

Course Brief:

This course introduces students to the modeling and analysis of financial time series data using statistical methods. It covers the fundamentals of time series analysis with specific emphasis on applications in finance, including asset returns, volatility modeling, and risk assessment. Students will gain hands-on experience with real financial datasets and implement various models using software such as R or Python. The course also explores advanced techniques for forecasting and understanding dynamic relationships in financial markets.

Course Learning Outcomes:

1. Understand key characteristics and structures of financial time series data.
2. Apply time series models including ARIMA, ARCH/GARCH, and state-space models to financial data.
3. Use statistical software to analyze, model, and forecast financial time series.
4. Interpret and evaluate volatility and risk measures in financial contexts.
5. Critically assess model performance and forecast accuracy for financial applications.

Course Contents:

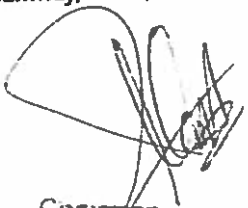
1. Introduction to financial time series and data types
2. Stylized facts of financial returns
3. Stationarity, autocorrelation, and partial autocorrelation
4. ARIMA and seasonal models
5. Volatility modeling: ARCH and GARCH models
6. Forecasting techniques and model diagnostics
7. Value-at-Risk (VaR) and risk management concepts
8. Multivariate time series and cointegration
9. High-frequency data analysis and market microstructure
10. State-space models and Kalman filter applications
11. Applications in portfolio management and algorithmic trading
12. Case studies using financial datasets

Recommended Textbooks:

1. Tsay, R. S. (2010). *Analysis of Financial Time Series* (3rd ed.). Wiley.
2. Ruppert, D. (2011). *Statistics and Data Analysis for Financial Engineering*. Springer.

Suggested Readings:

1. Chan, N. H. (2002). *Time Series: Applications to Finance*. Wiley.
2. Hamilton, J. D. (1994). *Time Series Analysis*. Princeton University Press.
3. Campbell, J. Y., Lo, A. W., & MacKinlay, A. C. (1997). *The Econometrics of Financial Markets*. Princeton University Press.
4. Shumway, R. H., & Stoffer, D. S. (2017). *Time Series Analysis and Its Applications*. Springer.



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2. **Advanced Bayesian Inference (STAT-7105)** 3(3-0)

Course Brief:

This course provides an in-depth exploration of Bayesian statistical methods, focusing on both theoretical foundations and practical applications. It covers prior distributions, posterior analysis, hierarchical modeling, and computational techniques including Markov Chain Monte Carlo (MCMC) methods. Emphasis is placed on Bayesian thinking for complex models and real-world data analysis using statistical software such as R, Stan, or PyMC.

Course Learning Outcomes:

1. Understand the philosophical foundations and mathematical framework of Bayesian inference.
2. Formulate prior distributions and derive posterior distributions for various statistical models.
3. Apply Bayesian models to real data using computational techniques such as Gibbs sampling and Metropolis-Hastings.
4. Analyze hierarchical models and implement them in Bayesian settings.
5. Evaluate convergence diagnostics and interpret Bayesian model outputs in practical scenarios.

Course Contents:

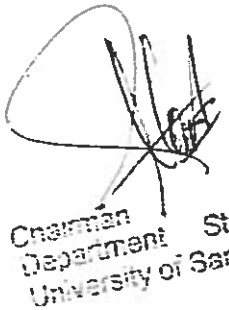
1. Foundations of Bayesian inference: Bayes' theorem and prior-posterior analysis
2. Conjugate priors and analytical posterior derivations
3. Bayesian estimation and credible intervals
4. Bayesian hypothesis testing and model comparison (Bayes factors, DIC)
5. Hierarchical Bayesian models and shrinkage priors
6. Monte Carlo integration and simulation-based inference
7. MCMC methods: Gibbs sampling, Metropolis-Hastings algorithm
8. Bayesian linear and generalized linear models
9. Bayesian decision theory and utility-based inference
10. Practical Bayesian analysis using R, Stan, and/or PyMC
11. Model checking, posterior predictive checks, and sensitivity analysis
12. Case studies in applied Bayesian statistics

Recommended Textbooks:

1. Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2013). *Bayesian Data Analysis* (3rd ed.). CRC Press.
2. Hoff, P. D. (2009). *A First Course in Bayesian Statistical Methods*. Springer.

Suggested Readings:

1. Kruschke, J. K. (2014). *Doing Bayesian Data Analysis* (2nd ed.). Academic Press.
2. Robert, C. P. (2007). *The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation*. Springer.
3. McElreath, R. (2020). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan* (2nd ed.). CRC Press.
4. Carlin, B. P., & Louis, T. A. (2009). *Bayesian Methods for Data Analysis* (3rd ed.). CRC Press.



3. **Bayesian Reliability (STAT-7106)** 3(3-0)

Course Brief:

This course explores the integration of Bayesian methods into reliability analysis, providing a flexible framework for modeling uncertainty in engineering systems, biological processes, and industrial applications. Emphasis is placed on prior specification, posterior reliability estimation, lifetime data analysis, and Bayesian updating in light of new information. Computational techniques including MCMC are used to perform inference when analytical solutions are not feasible.

Course Learning Outcomes:

1. Understand the foundational concepts of reliability theory within the Bayesian framework.
2. Apply Bayesian estimation techniques to model failure times, reliability functions, and hazard rates.
3. Construct and interpret credible intervals for reliability metrics under uncertainty.
4. Use Bayesian updating for system reliability based on prior and observed failure data.
5. Implement computational Bayesian methods such as MCMC to analyze complex reliability problems.

Course Contents:

1. Overview of classical vs. Bayesian reliability analysis
2. Prior selection in reliability models (non-informative, conjugate, informative)
3. Posterior analysis of reliability parameters
4. Bayesian reliability function estimation and credible intervals
5. Lifetime models: Exponential, Weibull, Lognormal in Bayesian context
6. Reliability of systems: series, parallel, and complex configurations
7. Bayesian inference for censored and truncated data
8. Posterior predictive reliability assessment
9. Bayesian updating and maintenance decision-making
10. Monte Carlo simulation and MCMC for reliability models
11. Software implementation using R, WinBUGS, or Stan
12. Case studies in engineering and biomedical reliability

Recommended Textbooks:

1. Hamada, M. S., Wilson, A. G., Reese, C. S., & Martz, H. F. (2008). *Bayesian Reliability*. Springer.
2. Ibrahim, J. G., Chen, M. H., & Sinha, D. (2001). *Bayesian Survival Analysis*. Springer.

Suggested Readings:

1. Berger, J. O. (1985). *Statistical Decision Theory and Bayesian Analysis* (2nd ed.). Springer.
2. Sinha, S. (1986). *Reliability and Life Testing*. Wiley Eastern.
3. Lindley, D. V. (2006). *Understanding Uncertainty*. Wiley.
4. Bernardo, J. M., & Smith, A. F. M. (1994). *Bayesian Theory*. Wiley.

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University of Sargodha

4. **Advanced Design and Analysis of Experiments (STAT-7107)** 3(3-0)

Course Brief:

This course provides a comprehensive treatment of experimental design strategies and their statistical analysis, emphasizing complex and modern experimental settings. The course focuses on factorial designs, blocking, randomization, confounding, split-plot and repeated measures designs, and the use of linear models for analysis. Practical implementation using statistical software will be included throughout, with applications drawn from agriculture, industry, medicine, and social sciences.

Course Learning Outcomes:

1. Design and implement efficient experimental studies using appropriate randomization and blocking techniques.
2. Analyze data from complex experiments using general linear models and ANOVA techniques.
3. Interpret results from factorial, nested, split-plot, and repeated measures designs.
4. Identify and correct for issues such as confounding, heteroscedasticity, and missing data in experimental settings.
5. Use statistical software to conduct advanced experimental analyses and report findings.

Course Contents:

1. Review of basic experimental designs and ANOVA
2. Full and fractional factorial designs
3. Confounding and aliasing in factorial experiments
4. Nested and hierarchical designs
5. Split-plot and strip-plot designs
6. Repeated measures and longitudinal experiments
7. Response surface methodology (RSM)
8. Optimal design and blocking strategies
9. Analysis of covariance (ANCOVA)
10. Mixed effects models in experimental design
11. Handling missing data and outliers
12. Use of R/SPSS/SAS for experimental design and analysis

Recommended Textbooks:

1. Montgomery, D. C. (2017). *Design and Analysis of Experiments* (9th ed.). Wiley.
2. Box, G. E. P., Hunter, W. G., & Hunter, J. S. (2005). *Statistics for Experimenters: Design, Innovation, and Discovery* (2nd ed.). Wiley.

Suggested Readings:

1. Wu, C. F. J., & Hamada, M. (2009). *Experiments: Planning, Analysis, and Optimization* (2nd ed.). Wiley.
2. Dean, A., Voss, D., & Draguljić, D. (2017). *Design and Analysis of Experiments*. Springer.
3. Senn, S. (2002). *Cross-over Trials in Clinical Research*. Wiley.

5. Statistical Methods in Genomics (STAT-7108) 3(3-0)

Course Brief:

This course provides an in-depth understanding of statistical methodologies used in modern genomics. Students will explore the design and analysis of high-throughput biological experiments such as gene expression microarrays, RNA-seq, genome-wide association studies (GWAS), and next-generation sequencing (NGS) data. Emphasis is placed on the development and application of statistical models, multiple testing correction, and computational tools to extract biological meaning from genomic data.

Course Learning Outcomes:

1. Understand the structure of genomic data and the statistical challenges associated with high dimensionality.
2. Apply statistical techniques for preprocessing and normalization of microarray and sequencing data.
3. Perform differential expression analysis using linear models and hypothesis testing.
4. Implement multiple testing correction procedures such as FDR to account for genome-wide significance.
5. Use statistical models for detecting genetic associations in GWAS and interpreting biological relevance.
6. Utilize R and Bioconductor packages to analyze real genomic datasets.

Course Contents:

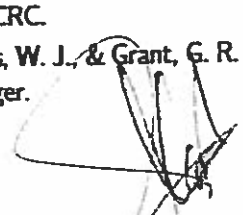
1. Introduction to Genomics and High-throughput Data
2. Microarray Data: Design, Normalization, and Quality Control
3. Statistical Models for Differential Gene Expression
4. Multiple Testing and False Discovery Rate (FDR)
5. RNA-Seq Data Analysis: Count Models and Normalization
6. Principal Component Analysis and Clustering in Genomics
7. Genome-Wide Association Studies (GWAS): SNP Analysis
8. Pathway and Gene Set Enrichment Analysis
9. Bayesian Approaches in Genomic Inference
10. Integration of Multi-Omics Data
11. Use of Bioconductor and R Tools for Genomic Analysis
12. Case Studies from Cancer Genomics and Population Genetics

Recommended Textbooks:

1. Simon, R. M., Korn, E. L., McShane, L. M., & Radmacher, M. D. (2003). *Design and Analysis of DNA Microarray Investigations*. Springer.
2. Berrar, D. (2018). *Computational and Statistical Methods for Bioinformatics*. Wiley.

Suggested Readings:

1. Gentleman, R., Carey, V. J., Huber, W., Irizarry, R. A., & Dudoit, S. (2005). *Bioinformatics and Computational Biology Solutions Using R and Bioconductor*. Springer.
2. Wu, H., & Wu, H. (2020). *Statistical Genomics: Methods and Protocols*. Humana Press.
3. Speed, T. P. (2003). *Statistical Analysis of Gene Expression Microarray Data*. Chapman and Hall/CRC.
4. Ewens, W. J., & Grant, G. R. (2005). *Statistical Methods in Bioinformatics: An Introduction*. Springer.



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6. Advanced Data Visualization (STAT-7109) 3(3-0)

Course Brief:

This course delves into advanced techniques for data visualization, enabling students to transform complex datasets into clear, compelling visual narratives. Emphasis is placed on both theoretical foundations and practical applications, integrating design principles with programming tools for exploratory and explanatory analysis. Students will learn to use advanced plotting libraries and interactive visualizations to support decision-making and data storytelling.

Course Learning Outcomes:

1. Understand the principles of effective data visualization and visual perception.
2. Develop advanced static and interactive graphics for multivariate, time series, spatial, and network data.
3. Utilize visualization libraries (e.g., ggplot2, Plotly, D3.js) within R or Python environments.
4. Critically assess and improve data visualizations for clarity, accuracy, and audience engagement.
5. Apply visual analytics to real-world datasets for exploratory data analysis and presentation.

Course Contents:

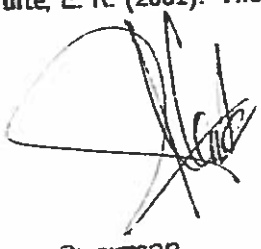
1. Principles of data visualization and cognitive perception
2. Designing for exploration vs. communication
3. Grammar of graphics (ggplot2) and layered visualizations
4. Visualizing high-dimensional and multivariate data
5. Time series and geospatial visualizations
6. Interactive dashboards and web-based graphics (Plotly, Shiny, D3.js)
7. Visualizing model diagnostics and statistical uncertainty
8. Storytelling with data: narrative structure and audience focus
9. Color theory, scales, and accessibility in design
10. Visualization ethics and misrepresentation
11. Best practices for visualization in publications and presentations
12. Case studies from public health, finance, and social sciences

Recommended Textbooks:

1. Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer.
2. Healy, K. (2018). *Data Visualization: A Practical Introduction*. Princeton University Press.

Suggested Readings:

1. Cairo, A. (2013). *The Functional Art: An Introduction to Information Graphics and Visualization*. New Riders.
2. Few, S. (2009). *Now You See It: Simple Visualization Techniques for Quantitative Analysis*. Analytics Press.
3. Tufte, E. R. (2001). *The Visual Display of Quantitative Information*. Graphics Press.



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7. Advanced Applied Artificial Intelligence (STAT-7110) 3(3-0)

Course Brief

This course offers advanced training in the application of Artificial Intelligence (AI) techniques to solve complex, real-world problems. It builds upon foundational AI and machine learning principles, focusing on system integration, deep learning architectures, reinforcement learning, and deployment strategies.

Students will apply AI models in diverse domains such as healthcare analytics, financial forecasting, intelligent transportation, and natural language processing. The course combines theoretical insights with extensive hands-on programming using modern AI frameworks (e.g., TensorFlow, PyTorch, Scikit-learn). Emphasis is placed on interpretability, ethical deployment, and the statistical evaluation of AI models.

Course Learning Outcomes

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

1. Analyze and design intelligent systems for advanced real-world tasks.
2. Implement deep learning models using neural networks and backpropagation.
3. Apply reinforcement learning techniques to sequential decision-making problems.
4. Integrate AI models with statistical methods for interpretable decision-making.
5. Build and deploy scalable AI systems using modern Python frameworks.
6. Evaluate and validate AI models using statistical performance metrics.
7. Address ethical, legal, and social challenges in advanced AI deployment.

Course Contents

1. Review of Core AI Concepts and Tools (Python, Scikit-learn, TensorFlow)
2. Neural Networks and Deep Learning:
   - Multi-layer Perceptrons (MLPs)
   - Convolutional Neural Networks (CNNs)
   - Recurrent Neural Networks (RNNs) and LSTMs
3. Reinforcement Learning:
   - Markov Decision Processes (MDPs)
   - Q-Learning and Policy Gradients
4. Model Evaluation and Validation:
   - ROC, Precision-Recall, Cross-Validation, AUC
5. Interpretability and Explainability in AI
6. AI Applications in:
   - Healthcare Analytics
   - Financial Forecasting
   - Natural Language Processing (transformers, BERT)
   - Image and Video Analysis
7. Deployment of AI Systems (API integration, cloud platforms)
8. Responsible AI: Ethics, Fairness, Transparency
9. Capstone Project: Building an End-to-End AI Solution

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Recommended Textbooks

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. MIT Press.
2. Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*. O'Reilly Media.
3. Sutton, R. S., & Barto, A. G. (2018). *Reinforcement Learning: An Introduction*. MIT Press.
4. Russell, S., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach*. Pearson.

8. **Neural Networks (STAT-7111)** 3(3-0)

Course Brief:

This course provides a comprehensive introduction to neural networks with a focus on statistical understanding and practical applications. It covers fundamental concepts, architectures, training algorithms, and the statistical interpretation of neural networks. Students will explore both theoretical foundations and implementation strategies using real-world data. The course is designed to equip students with the skills to build, train, evaluate, and deploy neural network models for various data analysis tasks.

Course Learning Outcomes:

1. Understand the architecture, functioning, and types of neural networks including feedforward, convolutional, and recurrent networks.
2. Apply backpropagation and optimization techniques to train neural networks.
3. Evaluate neural networks using appropriate performance metrics and validation strategies.
4. Implement neural network models using statistical computing tools such as R, Python (TensorFlow/Keras, PyTorch).
5. Explore the use of neural networks in classification, regression, time series forecasting, and image recognition.
6. Understand challenges such as overfitting, underfitting, vanishing gradients, and model interpretability.

Course Contents:

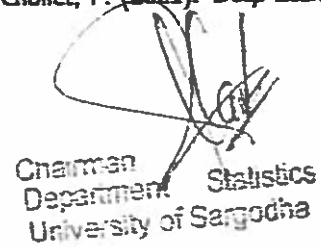
1. Introduction to Neural Networks and Deep Learning
2. Biological Neurons vs. Artificial Neurons
3. Activation Functions and Network Architecture
4. Forward Propagation and Backpropagation Algorithms
5. Loss Functions and Optimization (SGD, Adam, RMSProp)
6. Overfitting, Regularization, and Dropout Techniques
7. Convolutional Neural Networks (CNNs) for Image Data
8. Recurrent Neural Networks (RNNs), LSTM, and GRU for Sequential Data
9. Hyperparameter Tuning and Model Evaluation
10. Implementation Using Python Libraries (TensorFlow, Keras, PyTorch)
11. Interpretability and Explainable AI (XAI) in Neural Networks
12. Applications in Forecasting, Classification, and Image Analysis

Recommended Textbooks:

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. MIT Press.
2. Haykin, S. (2009). *Neural Networks and Learning Machines* (3rd ed.). Pearson.

Suggested Readings:

1. Géron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (2nd ed.). O'Reilly Media.
2. Nielsen, M. A. (2015). *Neural Networks and Deep Learning*. Determination Press.
3. Aggarwal, C. C. (2018). *Neural Networks and Deep Learning: A Textbook*. Springer.
4. Chollet, F. (2021). *Deep Learning with Python* (2nd ed.). Manning Publications.



9. **Advanced Spatial Data Analysis (STAT-7112)** 3(3-0)

Course Brief:

This course provides advanced training in spatial data analysis, emphasizing statistical modeling and inference for data that are geographically referenced. It introduces spatial processes, geostatistical methods, and lattice data analysis, with practical applications in environmental science, epidemiology, and urban planning. The course integrates modern computational tools for visualizing, modeling, and interpreting spatial patterns.

Course Learning Outcomes:

1. Understand the types, structures, and sources of spatial data.
2. Apply spatial descriptive statistics and exploratory data analysis techniques.
3. Model spatial dependence using geostatistical and lattice-based approaches.
4. Conduct spatial interpolation using kriging and related methods.
5. Use GIS and statistical software to analyze real-world spatial datasets.

Course Contents:

1. Introduction to spatial data: point-referenced, areal, and geostatistical data
2. Coordinate systems, spatial projections, and GIS basics
3. Spatial autocorrelation and variogram analysis
4. Geostatistical modeling and kriging techniques
5. Spatial regression and generalized linear models with spatial effects
6. Markov Random Fields and Conditional Autoregressive (CAR) models
7. Spatial point pattern analysis and intensity estimation
8. Bayesian methods for spatial analysis
9. Space-time data modeling
10. Applications in environmental monitoring, public health, and ecology
11. Visualization and mapping of spatial data using R and GIS platforms

Recommended Textbooks:

1. Cressie, N. A. C. (1993). *Statistics for Spatial Data*. Wiley.
2. Banerjee, S., Carlin, B. P., & Gelfand, A. E. (2014). *Hierarchical Modeling and Analysis for Spatial Data* (2nd ed.). Chapman & Hall/CRC.

Suggested Readings:

1. Diggle, P. J., Tawn, J. A., & Moyeed, R. A. (1998). *Model-based Geostatistics*. Springer.
2. Bivand, R., Pebesma, E., & Gómez-Rubio, V. (2013). *Applied Spatial Data Analysis with R*. Springer.
3. Lawson, A. B. (2018). *Bayesian Disease Mapping: Hierarchical Modeling in Spatial Epidemiology* (3rd ed.). CRC Press.

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10. Operations Research (STAT-7113) 3(3-0)

Course Brief:

This course introduces the fundamental concepts, techniques, and applications of operations research in solving real-life decision-making problems. The focus is on modeling, analyzing, and solving optimization problems using mathematical approaches. Students will gain hands-on experience with linear programming, transportation models, network analysis, queuing theory, and simulation techniques. Emphasis is placed on formulating practical problems into mathematical models and interpreting the results effectively.

Course Learning Outcomes:

1. Understand the scope and significance of operations research in decision-making.
2. Formulate and solve linear programming problems using graphical and simplex methods.
3. Apply transportation and assignment models for optimal resource allocation.
4. Analyze network flow problems using techniques such as the shortest path and maximal flow.
5. Understand queuing models and their application in service system optimization.
6. Use simulation methods for modeling complex stochastic systems.
7. Implement operations research models using statistical and mathematical software tools.

Course Contents:

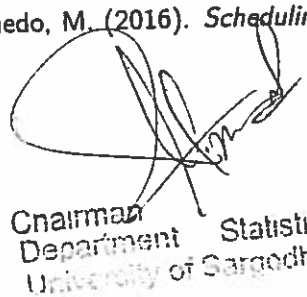
1. Introduction to Operations Research and Modeling Approaches
2. Linear Programming: Formulation, Graphical Method, and Simplex Method
3. Duality Theory and Sensitivity Analysis
4. Transportation and Assignment Problems
5. Network Models: Shortest Path, Minimal Spanning Tree, Maximum Flow
6. Integer and Goal Programming
7. Decision Analysis and Game Theory
8. Inventory Models and Control Systems
9. Queuing Theory and Applications
10. Simulation Modeling and Analysis
11. Project Management: PERT and CPM Techniques
12. Software Tools for Operations Research (e.g., LINGO, Excel Solver, R, Python)

Recommended Textbooks:

1. Hillier, F. S., & Lieberman, G. J. (2021). *Introduction to Operations Research* (11th ed.). McGraw-Hill Education.
2. Taha, H. A. (2017). *Operations Research: An Introduction* (10th ed.). Pearson.

Suggested Readings:

1. Ravindran, A., Phillips, D. T., & Solberg, J. J. (2007). *Operations Research: Principles and Practice* (2nd ed.). Wiley.
2. Winston, W. L. (2003). *Operations Research: Applications and Algorithms* (4th ed.). Duxbury Press.
3. Sharma, S. D. (2010). *Operations Research*. Kedarnath Ramnath & Co.
4. Pinedo, M. (2016). *Scheduling: Theory, Algorithms, and Systems* (5th ed.). Springer.



11. **Stochastic Process (STAT-7114)** **3(3-0)**

Course Brief:

This course provides a rigorous introduction to stochastic processes and their applications in modeling random phenomena that evolve over time. It covers fundamental concepts such as Markov chains, Poisson processes, and continuous-time processes, with real-world examples from queueing theory, reliability, finance, and biological systems. Emphasis is placed on both theoretical understanding and practical implementation.

Course Learning Outcomes:

1. Define and classify different types of stochastic processes.
2. Analyze discrete and continuous-time Markov chains and their long-term behavior.
3. Apply Poisson and renewal processes in modeling random events.
4. Understand and use Brownian motion and its applications.
5. Model real-world systems using stochastic processes and interpret probabilistic behavior over time.

Course Contents:

1. Introduction to stochastic processes: definitions and classifications
2. Discrete-time Markov chains: transition probabilities, classification of states, limiting behavior
3. Continuous-time Markov chains and the Kolmogorov differential equations
4. Poisson process: properties, interarrival times, and non-homogeneous extensions
5. Renewal theory and applications
6. Birth-death processes and queueing models
7. Brownian motion and the Wiener process
8. Martingales and stopping times
9. Applications in reliability, finance, and biological modeling
10. Simulation techniques for stochastic processes

Recommended Textbooks:

1. Ross, S. M. (2014). *Introduction to Probability Models* (11th ed.). Academic Press.
2. Karlin, S., & Taylor, H. M. (1975). *A First Course in Stochastic Processes* (2nd ed.). Academic Press.

Suggested Readings:

1. Grimmett, G., & Stirzaker, D. (2001). *Probability and Random Processes* (3rd ed.). Oxford University Press.
2. Norris, J. R. (1997). *Markov Chains*. Cambridge University Press.
3. Allen, L. J. S. (2010). *An Introduction to Stochastic Processes with Applications to Biology* (2nd ed.). CRC Press.

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12. **Functional Data Analysis (STAT-7115)** **3(3-0)**

Course Brief:

This course introduces the theory and practice of Functional Data Analysis (FDA), where data are viewed as functions rather than traditional scalar or vector observations. Students will learn how to analyze curves, surfaces, or anything that varies over a continuum, with applications in fields such as medicine, finance, and environmental sciences. Topics include smoothing techniques, basis function expansions, functional principal components, and functional regression models.

Course Learning Outcomes:

1. Understand the conceptual framework and motivation for analyzing functional data.
2. Apply smoothing and basis function techniques to represent functional data.
3. Conduct Functional Principal Component Analysis (FPCA) for dimensionality reduction.
4. Develop and interpret functional linear regression and related models.
5. Utilize FDA techniques in real-world applications across various domains.

Course Contents:

1. Introduction to Functional Data Analysis (FDA) and its importance
2. Representation of functional data: interpolation and smoothing
3. Basis functions: B-splines, Fourier, wavelets
4. Functional Principal Component Analysis (FPCA)
5. Functional linear regression and correlation analysis
6. Functional ANOVA and hypothesis testing
7. Functional clustering and classification
8. Handling sparse and irregular functional data
9. Advanced topics: nonlinear FDA and dynamic systems
10. FDA implementation in R using packages like 'fda', 'refund', and 'fdapace'
11. Applications in biostatistics, climate data, and economics

Recommended Textbooks:

1. Ramsay, J. O., & Silverman, B. W. (2005). *Functional Data Analysis* (2nd ed.). Springer.
2. Ferraty, F., & Vieu, P. (2006). *Nonparametric Functional Data Analysis: Theory and Practice*. Springer.

Suggested Readings:

1. Horváth, L., & Kokoszka, P. (2012). *Inference for Functional Data with Applications*. Springer.
2. Morris, J. S. (2015). Functional regression. *Annual Review of Statistics and Its Application*, 2, 321–359.
3. Ullah, S., & Finch, C. F. (2013). Applications of functional data analysis: A systematic review. *BMC Medical Research Methodology*, 13(1), 43.

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13. **Deep Reinforcement Learning (STAT-7116)** 3(3-0)

Course Brief:

This course introduces students to the theoretical foundations and practical implementations of deep reinforcement learning (DRL). It integrates reinforcement learning (RL) principles with deep learning techniques to solve complex decision-making problems in dynamic environments. The course emphasizes policy optimization, value-based methods, exploration strategies, and the use of neural networks for function approximation. Applications span robotics, gaming, autonomous systems, and intelligent agents.

Course Learning Outcomes:

1. Understand the foundational concepts of reinforcement learning including agents, environments, rewards, policies, and value functions.
2. Apply dynamic programming and temporal difference methods for learning optimal policies.
3. Implement deep Q-networks (DQN) and their variants for value-based learning.
4. Explore and apply policy gradient methods including REINFORCE and actor-critic models.
5. Analyze and compare advanced DRL algorithms such as A3C, PPO, and DDPG.
6. Use deep learning libraries (e.g., PyTorch, TensorFlow) to build DRL models for real-world tasks.
7. Evaluate and tune reinforcement learning models using relevant performance metrics.

Course Contents:

1. Introduction to Reinforcement Learning: Agents, Environments, Rewards
2. Markov Decision Processes (MDP)
3. Dynamic Programming for Policy Evaluation and Improvement
4. Monte Carlo and Temporal Difference Learning
5. Deep Learning Foundations for RL
6. Value-Based Methods: Q-Learning, Deep Q-Networks (DQN)
7. Policy-Based Methods: Policy Gradient, REINFORCE
8. Actor-Critic Methods and Advantage Estimation
9. Advanced Algorithms: A3C, PPO, DDPG, TD3, SAC
10. Exploration Strategies and Stability in DRL
11. Imitation Learning and Inverse Reinforcement Learning
12. Applications in Robotics, Games, and Control Systems
13. Tools and Libraries: OpenAI Gym, PyTorch, TensorFlow

Recommended Textbooks:

1. Sutton, R. S., & Barto, A. G. (2018). *Reinforcement Learning: An Introduction* (2nd ed.). MIT Press.
2. Francois-Lavet, V., & Henderson, P. (2023). *Deep Reinforcement Learning Hands-On*. Packt Publishing.

Suggested Readings:

1. Arulkumaran, K., Deisenroth, M. P., Brundage, M., & Bharath, A. A. (2017). A Brief Survey of Deep Reinforcement Learning. *IEEE Signal Processing Magazine*.
2. Li, Y. (2017). Deep Reinforcement Learning: An Overview. *arXiv preprint arXiv:1701.07274*.
3. Lillicrap, T. P. et al. (2016). Continuous Control with Deep Reinforcement Learning. *International Conference on Learning Representations (ICLR)*.
4. OpenAI Spinning Up in Deep RL (https://spinningup.openai.com)

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3(3-0)

14. Decision Theory (STAT-7117)

Course Brief:

This course provides a comprehensive foundation in statistical decision theory, focusing on the principles and methodologies used to make optimal decisions under uncertainty. It bridges classical and Bayesian approaches and introduces loss functions, risk analysis, admissibility, and minimax criteria. Applications span economics, operations research, and data science.

Course Learning Outcomes:

1. Explain the foundational principles of decision theory and its role in statistical inference.
2. Analyze decision problems using loss functions, risk functions, and utility theory.
3. Differentiate between classical and Bayesian decision-theoretic approaches.
4. Apply minimax, Bayes, and admissible decision rules to real-world problems.
5. Solve decision-making problems using decision trees and optimal strategy formulation.

Course Contents:

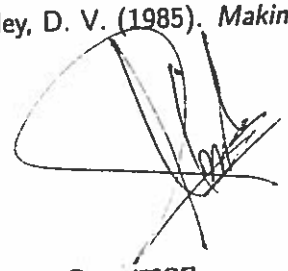
1. Introduction to decision theory: basic concepts and framework
2. Decision rules, decision space, and action space
3. Loss functions: quadratic, absolute, 0-1 loss
4. Risk functions and expected loss
5. Admissibility and completeness
6. Minimax rules and least favorable priors
7. Bayes rules and Bayesian decision theory
8. Decision trees and sequential decisions
9. Utility theory and multi-criteria decision-making
10. Applications in quality control, economics, and machine learning

Recommended Textbooks:

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

Suggested Readings:

1. DeGroot, M. H. (2004). *Optimal Statistical Decisions*. Wiley-Interscience.
2. Parmigiani, G., & Inoue, L. Y. T. (2009). *Decision Theory: Principles and Approaches*. Wiley.
3. Lindley, D. V. (1985). *Making Decisions* (2nd ed.). Wiley.



15. Advanced Sampling Techniques (STAT-7118) 3(3-0)

Course Brief:

This course focuses on advanced methods of survey sampling used in large-scale population and industrial studies. It extends the basic theory of sampling to more complex designs including multistage, multiframe, and adaptive strategies. Emphasis is placed on estimator properties, variance estimation, design effects, and practical considerations for implementation in field studies.

Course Learning Outcomes:

1. Understand the principles of complex survey designs and their real-world applicability.
2. Apply advanced sampling methods such as multistage, cluster, stratified, and systematic sampling.
3. Derive and analyze estimators and their variances under various sampling schemes.
4. Implement ratio, regression, and calibration estimators for improved efficiency.
5. Use statistical software to simulate and analyze data collected via complex sampling designs.

Course Contents:

1. Review of basic sampling techniques
2. Stratified and systematic sampling with unequal probabilities
3. Cluster sampling: single and multistage
4. Double and two-phase sampling
5. PPS (Probability Proportional to Size) sampling
6. Ratio, regression, and difference estimators
7. Variance estimation: Taylor linearization, jackknife, and bootstrap methods
8. Design effects and intra-cluster correlation
9. Adaptive and network sampling techniques
10. Calibration and post-stratification
11. Use of R, SAS, or Stata for survey data analysis

Recommended Textbooks:

1. Cochran, W. G. (1977). *Sampling Techniques* (3rd ed.). Wiley.
2. Lohr, S. L. (2021). *Sampling: Design and Analysis* (2nd ed.). Chapman & Hall/CRC.

Suggested Readings:

1. Sarndal, C. E., Swensson, B., & Wretman, J. (2003). *Model Assisted Survey Sampling.* Springer.
2. Kish, L. (1965). *Survey Sampling.* Wiley.
3. Kalton, G. (1983). *Introduction to Survey Sampling.* Sage Publications.

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16. **Advanced Probability Theory (STAT-7119)** 3(3-0)

Course Brief:

This course delves into the rigorous mathematical foundation of probability theory. It covers measure-theoretic probability, modes of convergence, and limit theorems, preparing students for advanced work in statistical theory, stochastic processes, and Bayesian inference. The course emphasizes proofs, mathematical structure, and real-world relevance of probabilistic concepts.

Course Learning Outcomes:

1. Understand and apply the axiomatic and measure-theoretic foundations of probability.
2. Analyze different types of convergence (almost sure, in probability, in distribution, in mean).
3. Prove and interpret key limit theorems, including the Law of Large Numbers and Central Limit Theorem.
4. Work with probability distributions in both discrete and continuous spaces using advanced tools.
5. Apply probability theory in real-world settings such as reliability, finance, and Bayesian modeling.

Course Contents:

1. Measure theory basics and probability measures
2. Random variables and expectations in measure space
3. Convergence concepts: almost sure, in probability, in distribution, in L^p
4. Borel-Cantelli lemmas and Kolmogorov's 0-1 Law
5. Law of Large Numbers (Weak and Strong)
6. Central Limit Theorem and Lindeberg-Levy conditions
7. Conditional expectation and properties
8. Martingales and stopping times
9. Characteristic functions and their applications
10. Introduction to stochastic processes and Poisson processes

Recommended Textbooks:

1. Billingsley, P. (1995). *Probability and Measure* (3rd ed.). Wiley.
2. Ash, R. B., & Doléans-Dade, C. A. (2000). *Probability and Measure Theory*. Academic Press.

Suggested Readings:

1. Durrett, R. (2019). *Probability: Theory and Examples* (5th ed.). Cambridge University Press.
2. Gut, A. (2005). *Probability: A Graduate Course*. Springer.
3. Kallenberg, O. (2002). *Foundations of Modern Probability* (2nd ed.). Springer.

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17. **Randomized Response Techniques (STAT-7120)** 3(3-0)

Course Brief:

This course introduces the theory, methodology, and practical implementation of Randomized Response Techniques (RRT), a class of survey methods used to collect reliable data on sensitive issues while protecting respondent privacy. These techniques are essential in behavioral sciences, health surveys, criminology, and other fields where truthful responses are difficult to obtain through direct questioning. The course covers classical RRT models, recent advancements, efficiency comparisons, and applications in real-world settings.

Course Learning Outcomes:

1. Understand the ethical and methodological motivations for using randomized response techniques in surveys.
2. Learn various classical RRT models, including Warner's model and Unrelated Question model.
3. Apply quantitative methods to estimate population proportions and means using RRT.
4. Compare efficiency and privacy protection among alternative RRT designs.
5. Design and analyze surveys involving sensitive questions using appropriate RRT models.
6. Interpret results and limitations of RRT applications in real-life research scenarios.

Course Contents:

1. Introduction to Survey Sampling and Sensitive Issues
2. Warner's Randomized Response Model
3. Unrelated Question and Crosswise Models
4. Forced Response and Modified RRT Models
5. Estimation of Population Proportions under RRT
6. Estimation of Means and Variances under RRT
7. RRT Models for Quantitative and Qualitative Sensitive Variables
8. Privacy Protection and Efficiency in RRT Designs
9. Use of Randomization Devices and Technology in RRT
10. Applications of RRT in Social Sciences, Public Health, and Market Research
11. Advanced Topics: Multi-stage RRT, Repeated Measures, and Bayesian RRT

Recommended Textbooks:

1. Chaudhuri, A., & Mukerjee, R. (1988). *Randomized Response: Theory and Techniques.* Marcel Dekker.
2. Singh, S., & Mangat, N. S. (1996). *Elements of Survey Sampling.* Springer. (Chapters on RRT)

Suggested Readings:

1. Warner, S. L. (1965). Randomized Response: A Survey Technique for Eliminating Evasive Answer Bias. *Journal of the American Statistical Association.*
2. Lensvelt-Mulders, G. J. L. M., et al. (2005). Meta-Analysis of Randomized Response Research: Thirty-Five Years of Validation. *Sociological Methods & Research.*
3. Kuk, A. Y. C. (1990). Asking Sensitive Questions Indirectly. *Biometrika.*
4. Greenberg, B. G. et al. (1969). The Unrelated Question Randomized Response Model. *Journal of the American Statistical Association.*

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18. Mathematical Modelling and Simulation (STAT-7121) 3(3-0)

Course Brief

This course explores the principles and techniques of constructing mathematical models to represent real-world systems in science, engineering, economics, and other fields. It emphasizes both deterministic and stochastic modeling approaches, and the use of simulation techniques to analyze, validate, and predict system behavior. Students will gain hands-on experience in formulating models, solving them analytically or numerically, and implementing simulations using programming tools.

Course Learning Outcomes

1. Formulate mathematical models for dynamic, stochastic, and complex systems.
2. Analyze and solve mathematical models using analytical and numerical methods.
3. Apply simulation techniques such as Monte Carlo, discrete-event, and system dynamics.
4. Evaluate model performance and conduct sensitivity analysis.
5. Use computational tools such as MATLAB, Python, or R for modeling and simulation tasks.

Course Contents

1. Introduction to Mathematical Modelling: Types and Process
2. Modelling with Differential and Difference Equations
3. Optimization Models and Game Theory Basics
4. Probabilistic and Stochastic Models
5. Monte Carlo Simulation and Random Number Generation
6. Discrete-Event Simulation and Queuing Systems
7. Model Validation, Calibration, and Sensitivity Analysis
8. Applications in Biology, Engineering, Business, and Social Sciences

Recommended Textbooks

- Giordano, F. R., Fox, W. P., & Horton, S. B. (2014). *A First Course in Mathematical Modeling* (5th ed.). Cengage Learning.
- Law, A. M. (2015). *Simulation Modeling and Analysis* (5th ed.). McGraw-Hill.

Suggested Readings

- Higham, D. J., & Higham, N. J. (2016). *Matlab Guide* (3rd ed.). SIAM.
- Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M. (2010). *Discrete-Event System Simulation* (5th ed.). Pearson.

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19. Environmental Statistics (STAT-7122) 3(3-0)

Course Brief

This course introduces statistical methods and models tailored for environmental and ecological data analysis. It emphasizes handling spatial and temporal variability, non-normal distributions, and censored data often encountered in environmental studies. Applications include air and water quality monitoring, climate change modeling, pollution assessment, and ecological risk analysis. The course integrates real-world datasets and modern computational tools.

Course Learning Outcomes

1. Understand key statistical challenges and data structures in environmental science.
2. Apply classical and modern statistical techniques to environmental monitoring and assessment.
3. Handle censored, missing, and non-normal environmental data appropriately.
4. Model spatial and temporal patterns using relevant statistical methods.
5. Use statistical software to analyze environmental datasets and interpret results for policy and research.

Course Contents

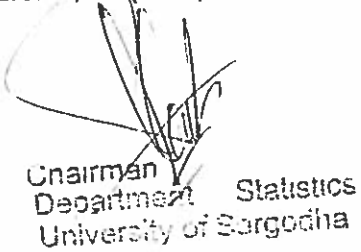
1. Introduction to Environmental Statistics and Data Types
2. Descriptive Techniques and Exploratory Data Analysis
3. Probability Distributions for Environmental Applications
4. Sampling Methods in Environmental Studies
5. Trend Analysis and Change Detection
6. Censored Data and Non-detects (e.g., below detection limits)
7. Time Series and Forecasting for Environmental Data
8. Spatial Statistics and Geostatistical Models (e.g., Kriging)
9. Environmental Risk Assessment and Regulatory Standards

Recommended Textbooks

- Millard, S. P. (2013). *EnvStats: An R Package for Environmental Statistics*. Springer.
- Guttorp, P. (1995). *Statistics and Scientific Method: An Introduction for Students and Researchers*. Wiley.

Suggested Readings

- Ott, W. R., & Longnecker, M. (2015). *An Introduction to Statistical Methods and Data Analysis* (7th ed.). Cengage Learning.
- Cressie, N. (1993). *Statistics for Spatial Data*. Wiley.



20. **Non-Parametric Statistics (STAT-7123)** **3(3-0) Course Brief:**

This course provides a comprehensive overview of statistical techniques that do not require assumptions about the underlying distribution of the data. Non-parametric methods are especially useful when dealing with small sample sizes, ordinal data, or violations of normality assumptions. The course emphasizes both theoretical development and practical application in scientific research.

Course Learning Outcomes:

1. Understand the theoretical foundation and assumptions behind non-parametric methods.
2. Apply common non-parametric tests to compare groups and assess associations.
3. Use rank-based and resampling methods for inference.
4. Evaluate the advantages and limitations of non-parametric techniques compared to parametric counterparts.
5. Implement non-parametric methods using statistical software such as R or SPSS.

Course Contents:

1. Introduction to non-parametric inference and its scope
2. Sign test, Wilcoxon signed-rank test
3. Mann–Whitney U test, Kruskal–Wallis test, Friedman test
4. Kolmogorov–Smirnov goodness-of-fit test
5. Chi-square tests for independence and goodness-of-fit
6. Non-parametric correlation: Spearman's rho, Kendall's tau
7. Rank transformations and permutation tests
8. Kernel density estimation and non-parametric regression
9. Bootstrap and jackknife resampling methods
10. Applications to real-world data and case studies

Recommended Textbooks:

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

Suggested Readings:

1. Conover, W. J. (1999). *Practical Nonparametric Statistics* (3rd ed.). Wiley.
2. Efron, B., & Tibshirani, R. J. (1993). *An Introduction to the Bootstrap*. Chapman & Hall/CRC.

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21. Applied Smoothing Techniques (STAT-7124) 3(3-0)

Course Brief

This course focuses on nonparametric and semiparametric regression techniques used for uncovering patterns in data without imposing strict parametric model assumptions. It emphasizes the use of smoothing methods for curve estimation, density estimation, and trend analysis in complex datasets. Applications span across fields including economics, epidemiology, environmental science, and machine learning.

Course Learning Outcomes

1. Understand the principles and objectives of smoothing in statistical modeling.
2. Apply kernel smoothing, spline methods, and local regression techniques to real-world data.
3. Select appropriate smoothing parameters and evaluate model fit.
4. Compare nonparametric methods to traditional parametric approaches.
5. Implement smoothing techniques using statistical software such as R or Python.

Course Contents

1. Introduction to Smoothing and Nonparametric Regression
2. Kernel Density Estimation and Kernel Regression
3. Local Polynomial Regression and LOESS
4. Smoothing Splines and Penalized Regression
5. Generalized Additive Models (GAMs)
6. Bandwidth Selection and Cross-Validation
7. Multivariate and High-Dimensional Smoothing
8. Applications in Time Series, Epidemiology, and Machine Learning

Recommended Textbooks

- Wand, M. P., & Jones, M. C. (1995). *Kernel Smoothing*. Chapman & Hall.
- Ruppert, D., Wand, M. P., & Carroll, R. J. (2003). *Semiparametric Regression*. Cambridge University Press.

Suggested Readings

- Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning* (2nd ed.). Springer.
- Eubank, R. L. (1999). *Nonparametric Regression and Spline Smoothing* (2nd ed.). CRC Press.

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22. Multilevel Modelling (STAT-7125)

3(3-0)

Course Brief

This course provides a comprehensive introduction to multilevel (hierarchical) modeling, which is essential for analyzing data with nested or clustered structures. Students will learn how to model data with multiple levels of variation, such as individuals within groups, using linear and generalized linear mixed-effects models. Emphasis is placed on interpretation, diagnostics, and implementation using modern statistical software.

Course Learning Outcomes

1. Understand the structure and rationale of multilevel data and models.
2. Formulate and estimate random intercept and random slope models.
3. Analyze hierarchical data using both linear and generalized linear mixed models.
4. Conduct model diagnostics and evaluate model fit using appropriate criteria.
5. Apply multilevel modeling techniques to real-world data using R, Stata, or other statistical software.

Course Contents

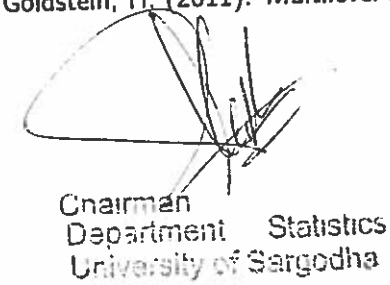
1. Introduction to Multilevel Data and Hierarchical Structures
2. Linear Mixed-Effects Models: Random Intercepts and Slopes
3. Estimation Methods: Maximum Likelihood and Restricted Maximum Likelihood (REML)
4. Inference and Hypothesis Testing in Multilevel Models
5. Multilevel Generalized Linear Models (Logistic, Poisson)
6. Model Diagnostics, Goodness-of-Fit, and Intraclass Correlation
7. Cross-Classified and Multiple Membership Models
8. Applications in Social Sciences, Education, Public Health, and Longitudinal Data

Recommended Textbooks

- Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling* (2nd ed.). Sage Publications.
- Gelman, A., & Hill, J. (2007). *Data Analysis Using Regression and Multilevel/Hierarchical Models*. Cambridge University Press.

Suggested Readings

- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical Linear Models: Applications and Data Analysis Methods* (2nd ed.). Sage.
- Goldstein, H. (2011). *Multilevel Statistical Models* (4th ed.). Wiley.



23. Meta-analysis (STAT-7126)

3(3-0)

Course Brief

This course provides a comprehensive introduction to the theory and application of meta-analysis — the statistical synthesis of results from multiple studies. Students will learn how to combine effect sizes, assess heterogeneity, handle publication bias, and apply both fixed-effect and random-effects models. Applications in medicine, psychology, education, and the social sciences are emphasized, using real datasets and statistical software.

Course Learning Outcomes

1. Understand the rationale, scope, and limitations of meta-analysis in evidence-based research.
2. Calculate and interpret various types of effect sizes (e.g., mean differences, odds ratios, correlations).
3. Apply fixed-effect and random-effects models for combining study results.
4. Assess between-study heterogeneity and conduct subgroup or moderator analyses.
5. Detect and adjust for publication bias and small-study effects.
6. Use statistical software (e.g., R or Stata) to perform meta-analysis and generate forest and funnel plots.

Course Contents

1. Introduction to Systematic Reviews and Meta-analysis
2. Effect Size Metrics: Standardized Mean Difference, Risk Ratios, Odds Ratios
3. Fixed-effect and Random-effects Models
4. Heterogeneity: Q Statistic, I^2, and Tau-squared
5. Meta-regression and Subgroup Analysis
6. Publication Bias: Funnel Plots and Egger's Test
7. Sensitivity Analysis and Robustness Checks
8. Software Tools: Meta, metafor (R), and Comprehensive Meta-Analysis (CMA)

Recommended Textbooks

- Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to Meta-Analysis*. Wiley.
- Cooper, H., Hedges, L. V., & Valentine, J. C. (2019). *The Handbook of Research Synthesis and Meta-Analysis* (3rd ed.). Russell Sage Foundation.

Suggested Readings

- Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions*. Wiley.
- Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, 36(3), 1–48.

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24. Generalized Linear Models (STAT-7127)

3(3-0)

Course Brief

This course explores statistical models for analyzing both quantitative and qualitative data, focusing on the general linear model and its extension—the generalized linear model (GLM). The course emphasizes a broad range of GLMs applicable to various types of data including binary, count, and skewed continuous responses. Students will engage with logistic, probit, Poisson, negative binomial, Gamma, and inverse Gaussian models, developing a deep understanding of model assumptions, estimation techniques, diagnostic procedures, and software implementation. The goal is to equip students with the theoretical insight and practical skills required for modern statistical modeling in applied research.

Course Contents

1. Introduction: review of linear models in matrix notation, model assessment, and foundational concepts
2. The exponential family: definition, examples, variance functions, and scale parameters
3. Generalized linear models: linear predictor, link functions, canonical links, assumptions, MLE, IRLS, Fisher scoring, deviance and residuals
4. Hypothesis testing: Pearson's chi-square, likelihood ratio test, and Wald test
5. Binary and binomial data analysis: logistic regression, odds ratios
6. One-way and two-way logistic regression
7. Count data modeling: Poisson regression
8. Overdispersion and modeling with negative binomial regression
9. Continuous and skewed response models: Gamma and Inverse Gaussian regression
10. Diagnostic techniques and residual analysis in GLMs
11. Implementation of GLM techniques using statistical software

Recommended Textbooks

- Agresti, A. (2015). *Foundations of Linear and Generalized Linear Models.* Wiley.
- McCullagh, P., & Nelder, J. A. (1990). *Generalized Linear Models.* Chapman and Hall.
- Hardin, J. W., & Hilbe, J. M. (2012). *Generalized Linear Models and Extensions* (3rd ed.). Stata Press.

Suggested Readings

- Myers, R. H., Montgomery, D. C., Vining, G. G., & Robinson, T. J. (2010). *Generalized Linear Models with Applications in Engineering and the Sciences* (2nd ed.). Wiley.
- Dobson, A. J. (2001). *An Introduction to Generalized Linear Models.* Chapman & Hall/CRC.

25. Panel Data Models (STAT-7128)

3(3-0)

Course Brief

This course focuses on statistical techniques for analyzing panel data, where multiple entities are observed over time. It covers both theoretical and practical aspects of panel data modeling, including fixed and random effects, dynamic models, and issues such as heterogeneity, autocorrelation, and endogeneity. Applications are drawn from economics, social sciences, business, and health research, with an emphasis on empirical implementation using statistical software.

Course Learning Outcomes

1. Understand the structure and advantages of panel data over cross-sectional and time series data.
2. Apply fixed effects, random effects, and mixed models for panel data analysis.
3. Address issues of heteroskedasticity, autocorrelation, and endogeneity in panel data settings.
4. Estimate and interpret dynamic panel data models using techniques such as GMM.
5. Perform applied panel data analysis using software such as Stata, R, or Python.

Course Contents

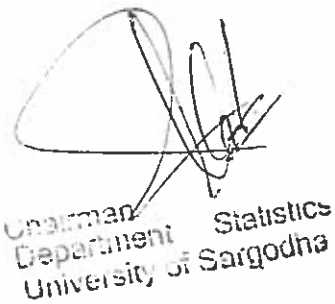
1. Introduction to Panel Data: Structure, Advantages, and Applications
2. Pooled OLS vs. Fixed Effects and Random Effects Models
3. Estimation and Interpretation of Fixed and Random Effects
4. Hausman Test and Model Selection
5. Dynamic Panel Models and the Use of Lagged Variables
6. Generalized Method of Moments (GMM) Estimation
7. Dealing with Heteroskedasticity and Serial Correlation
8. Applications in Economics, Health, and Social Science Research

Recommended Textbooks

- Baltagi, B. H. (2021). *Econometric Analysis of Panel Data* (6th ed.). Springer.
- Hsiao, C. (2014). *Analysis of Panel Data* (3rd ed.). Cambridge University Press.

Suggested Readings

- Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). MIT Press.
- Arellano, M. (2003). *Panel Data Econometrics.* Oxford University Press.



26. Advanced Econometrics (STAT-7129) 3(3-0)

Course Brief

This course provides a rigorous treatment of econometric theory and its applications to empirical research in economics and related fields. It extends basic econometric methods to address endogeneity, panel data structures, limited dependent variables, and time series dynamics. Emphasis is placed on model specification, estimation, inference, and interpretation using real-world data and software such as R, Stata, or Python.

Course Learning Outcomes

1. Develop a strong theoretical understanding of linear and nonlinear econometric models.
2. Address challenges such as omitted variable bias, simultaneity, and measurement errors using instrumental variables and GMM.
3. Apply advanced techniques to panel data, time series, and limited dependent variable models.
4. Critically evaluate econometric assumptions and perform robust inference.
5. Conduct empirical research using modern econometric software and interpret the results effectively.

Course Contents

1. Review of Classical Linear Regression and Violations of Assumptions
2. Instrumental Variables and Two-Stage Least Squares
3. Generalized Method of Moments (GMM)
4. Panel Data Models: Fixed and Random Effects
5. Limited Dependent Variable Models: Logit, Probit, Tobit
6. Time Series Econometrics: ARIMA, VAR, Cointegration, Error Correction Models
7. Model Selection, Specification Testing, and Robust Standard Errors
8. Applications in Labor, Development, Financial, and Health Economics

Recommended Textbooks

- Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). MIT Press.
- Greene, W. H. (2018). *Econometric Analysis* (8th ed.). Pearson.

Suggested Readings

- Stock, J. H., & Watson, M. W. (2020). *Introduction to Econometrics* (4th ed.). Pearson.
- Cameron, A. C., & Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications.* Cambridge University Press.

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27. Computational Finance (STAT-7130) 3(3-0)

Course Brief

This course introduces students to computational techniques and statistical models used in financial data analysis and decision-making. It covers asset pricing, portfolio optimization, risk management, derivatives valuation, and time series modeling using computational tools. Emphasis is placed on simulation methods, numerical algorithms, and the use of software such as R, Python, or MATLAB to solve practical problems in finance.

Course Learning Outcomes

1. Understand key financial concepts including asset returns, risk, and market efficiency.
2. Apply statistical and machine learning models to financial time series and forecasting.
3. Implement Monte Carlo simulations and numerical techniques for asset pricing and option valuation.
4. Optimize investment portfolios using computational tools.
5. Analyze and manage financial risk using Value-at-Risk (VaR) and other quantitative techniques.

Course Contents

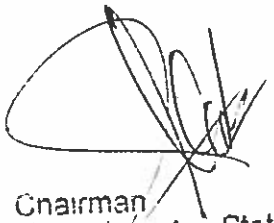
1. Introduction to Financial Markets and Instruments
2. Portfolio Theory and Asset Allocation
3. Financial Time Series Analysis and Forecasting
4. Monte Carlo Methods in Finance
5. Option Pricing: Black-Scholes Model and Binomial Trees
6. Numerical Methods: Finite Difference and PDEs in Option Valuation
7. Risk Measures and Credit Risk Modeling
8. Applications using R, Python, or MATLAB

Recommended Textbooks

- Ruppert, D. (2010). *Statistics and Data Analysis for Financial Engineering*. Springer.
- Tsay, R. S. (2010). *Analysis of Financial Time Series* (3rd ed.). Wiley.

Suggested Readings

- Hull, J. C. (2021). *Options, Futures, and Other Derivatives* (11th ed.). Pearson.
- Glasserman, P. (2003). *Monte Carlo Methods in Financial Engineering*. Springer.



28. Advanced Survival Analysis (STAT-7131) 3(3-0)

Course Brief

This course provides an in-depth exploration of advanced methods in survival analysis, focusing on time-to-event data encountered in medical research, epidemiology, engineering, and social sciences. Topics include censoring mechanisms, time-dependent covariates, competing risks, frailty models, and advanced regression techniques. Both theoretical development and computational implementation using statistical software are emphasized.

Course Learning Outcomes

1. Understand different types of censoring and truncation in survival data.
2. Apply semi-parametric and parametric survival models including Cox and accelerated failure time models.
3. Incorporate time-dependent covariates and stratification into survival models.
4. Analyze competing risks and use frailty models for unobserved heterogeneity.
5. Perform survival analysis using statistical software such as R or SAS.

Course Contents

1. Review of Basic Concepts: Survival Function, Hazard Function, Kaplan-Meier Estimator
2. Cox Proportional Hazards Model: Assumptions and Diagnostics
3. Parametric Models: Exponential, Weibull, Log-normal, and Log-logistic
4. Time-Dependent Covariates and Extended Cox Models
5. Competing Risks and Cumulative Incidence Functions
6. Frailty Models for Shared and Unobserved Effects
7. Model Assessment and Goodness-of-Fit
8. Applications in Clinical Trials and Reliability Studies

Recommended Textbooks

- Klein, J. P., & Moeschberger, M. L. (2003). *Survival Analysis: Techniques for Censored and Truncated Data* (2nd ed.). Springer.
- Collett, D. (2015). *Modelling Survival Data in Medical Research* (3rd ed.). CRC Press.

Suggested Readings

- Kalbfleisch, J. D., & Prentice, R. L. (2002). *The Statistical Analysis of Failure Time Data* (2nd ed.). Wiley.
- Therneau, T. M., & Grambsch, P. M. (2000). *Modeling Survival Data: Extending the Cox Model*. Springer.

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29. Advanced Multivariate Analysis (STAT-7132) 3(3-0)

Course Brief

This course provides an advanced treatment of multivariate statistical methods, equipping students with theoretical foundations and practical tools for analyzing data involving multiple variables simultaneously. Emphasis is placed on understanding multivariate distributions, estimation and inference, and advanced dimensionality reduction techniques. The course introduces canonical correlation, discriminant analysis, MANOVA, factor analysis, and clustering methods, with a focus on application to real-world datasets using statistical software.

Course Learning Outcomes

1. Understand the theoretical foundations of multivariate statistical methods and their assumptions.
2. Apply appropriate multivariate analysis techniques such as PCA, MANOVA, and cluster analysis to real-world datasets.
3. Interpret the output of multivariate models and evaluate their validity.
4. Utilize statistical software for performing complex multivariate analyses.
5. Communicate findings from multivariate data analyses in technical and applied contexts.

Course Contents

1. Review of matrix algebra and multivariate normal distribution
2. Estimation and hypothesis testing in multivariate settings
3. Hotelling's T^2 statistic and its applications
4. Multivariate analysis of variance (MANOVA)
5. Profile analysis and repeated measures designs
6. Principal component analysis (PCA)
7. Factor analysis: exploratory and confirmatory
8. Canonical correlation analysis
9. Discriminant function analysis and classification techniques
10. Cluster analysis: hierarchical and non-hierarchical methods
11. Multidimensional scaling (MDS)
12. Correspondence analysis
13. Structural equation modeling (SEM): introduction and basic models
14. Applications in psychological, educational, and social sciences
15. Multivariate analysis using statistical software

Recommended Textbooks

- Anderson, T. W. (2003). *An Introduction to Multivariate Statistical Analysis* (3rd ed.). Wiley.
- Johnson, R. A., & Wichern, D. W. (2007). *Applied Multivariate Statistical Analysis* (6th ed.). Pearson.

Suggested Readings

- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate Data Analysis* (7th ed.). Pearson.
- Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics* (6th ed.). Pearson.
- Rencher, A. C. (2002). *Methods of Multivariate Analysis* (2nd ed.). Wiley.

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30. Research Methodology (STAT-7133) 3(3-0)

Course Brief

This course introduces students to the principles and practices of scientific research, with a focus on statistical research in both theoretical and applied domains. It covers the formulation of research problems, design of studies, data collection strategies, and ethical considerations. The course also emphasizes literature review techniques, research proposal writing, and the preparation of scientific manuscripts and theses.

Course Learning Outcomes

1. Understand the fundamentals of scientific inquiry and research design.
2. Develop skills for reviewing literature and identifying research gaps.
3. Formulate testable hypotheses and appropriate research questions.
4. Design effective qualitative and quantitative studies with valid data collection methods.
5. Prepare structured research proposals and scholarly reports with adherence to ethical standards.

Course Contents

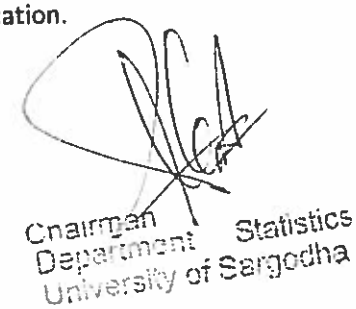
1. Introduction to Scientific Research and Philosophy of Science
2. Research Problem Formulation and Hypothesis Development
3. Research Designs: Exploratory, Descriptive, Analytical, Experimental
4. Sampling Designs and Data Collection Techniques
5. Measurement Scales, Validity, and Reliability
6. Literature Review and Citation Management
7. Writing Research Proposals and Reports
8. Ethical Issues in Research and Publication Standards

Recommended Textbooks

- Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd ed.). New Age International Publishers.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.

Suggested Readings

- Kumar, R. (2019). *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.). SAGE Publications.
- Cooper, D. R., & Schindler, P. S. (2014). *Business Research Methods* (12th ed.). McGraw-Hill Education.



31. Advanced Statistical Inference (STAT-7134) 3(3-0)

Course Brief

This course provides an in-depth exploration of modern statistical inference, extending beyond classical theory. Emphasis is placed on the theoretical underpinnings of estimation and hypothesis testing, asymptotic methods, decision-theoretic perspectives, and recent developments in robust and Bayesian inference. Applications are illustrated through advanced problems in the natural, social, and computational sciences.

Course Learning Outcomes

1. Understand the theoretical foundations of statistical inference including likelihood, sufficiency, and information measures.
2. Apply advanced techniques for point and interval estimation under various loss functions.
3. Analyze large-sample properties of estimators and test statistics using asymptotic theory.
4. Evaluate inference procedures from a decision-theoretic and Bayesian perspective.
5. Critically assess robustness and efficiency of statistical inference methods in practical applications.

Course Contents

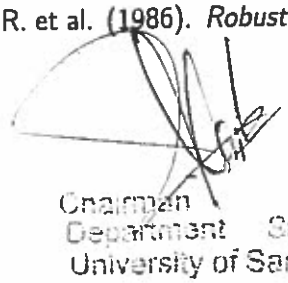
1. Review of Likelihood-Based Inference
2. Sufficiency, Ancillarity, and Completeness
3. Bayesian vs. Frequentist Paradigms
4. Advanced Hypothesis Testing: Likelihood Ratio, Wald, and Score Tests
5. Asymptotic Theory: Consistency, Efficiency, and Normality
6. Decision Theory and Risk Functions
7. Robust Inference and Influence Functions
8. Modern Applications and Computational Considerations

Recommended Textbooks

- Casella, G., & Berger, R. L. (2002). *Statistical Inference* (2nd ed.). Duxbury.
- Lehmann, E. L., & Casella, G. (1998). *Theory of Point Estimation*. Springer.

Suggested Readings

- Bickel, P. J., & Doksum, K. A. (2015). *Mathematical Statistics: Basic Ideas and Selected Topics*, Volumes I & II. CRC Press.
- Hampel, F. R. et al. (1986). *Robust Statistics: The Approach Based on Influence Functions*. Wiley.



32. High Performance Computing (HPC) for Statistical Analysis (STAT-7135) 3(3-0)

Course Brief

This course equips students with the knowledge and practical skills necessary to perform statistical analyses using high performance computing (HPC) environments. Topics include parallel computing architectures, distributed systems, cloud computing frameworks, and GPU acceleration. The course emphasizes the application of HPC tools to large-scale statistical problems, simulations, and data-intensive workflows using platforms such as MPI, OpenMP, CUDA, and Spark.

Course Learning Outcomes

1. Understand the core principles of high performance and parallel computing.
2. Apply HPC techniques to optimize statistical computations and simulations.
3. Analyze large datasets efficiently using parallel programming paradigms.
4. Utilize cloud-based HPC tools for scalable statistical workflows.
5. Implement real-world statistical analysis in HPC environments using R, Python, or C++.

Course Contents

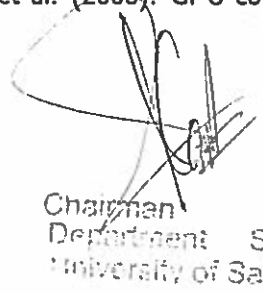
1. Introduction to High Performance Computing
2. Parallel and Distributed Computing Architectures
3. MPI and OpenMP for Statistical Computing
4. GPU Computing with CUDA
5. Big Data Analysis using Apache Spark
6. Cloud Computing Platforms for Statistical Analysis
7. HPC for Monte Carlo Simulations and Bootstrapping
8. Benchmarking and Performance Optimization Techniques

Recommended Textbooks

- Ewing, G. (2017). *High Performance Computing for Scientists and Engineers.* SIAM.
- Gropp, W., Lusk, E., & Skjellum, A. (1999). *Using MPI: Portable Parallel Programming with the Message Passing Interface.* MIT Press.

Suggested Readings

- Gentzsch, W., & Toonen, B. (2011). *Cloud Computing and HPC: Synergy for Scientific Research.* Springer.
- Owens, J. D., et al. (2008). GPU computing. *Proceedings of the IEEE*, 96(5), 879–899.



33. Quantum Computing (STAT-7136) 3(3-0)

Course Brief

This course introduces the fundamental principles of quantum computing and its statistical applications. It explores how quantum mechanics can be harnessed to solve problems that are intractable for classical computers. Topics include qubits, quantum gates, quantum circuits, quantum entanglement, and measurement. Emphasis is placed on quantum algorithms such as Grover's search and Shor's factorization, as well as their relevance to optimization, cryptography, and statistical inference.

Course Learning Outcomes

1. Understand the foundational concepts of quantum mechanics relevant to computation.
2. Describe the structure and behavior of qubits and quantum gates.
3. Develop and analyze basic quantum circuits and algorithms.
4. Evaluate the advantages and limitations of quantum algorithms in solving statistical problems.
5. Implement simple quantum programs using contemporary quantum computing frameworks (e.g., Qiskit or PennyLane).

Course Contents

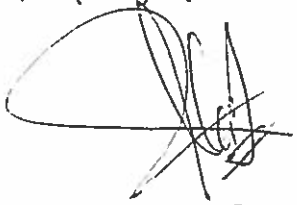
1. Introduction to Quantum Mechanics and Qubits
2. Quantum Gates and Circuits
3. Quantum Entanglement and Superposition
4. Measurement and Quantum Interference
5. Grover's and Shor's Algorithms
6. Quantum Computing for Optimization and Cryptography
7. Introduction to Quantum Machine Learning
8. Practical Quantum Programming with Qiskit or PennyLane

Recommended Textbooks

- Nielsen, M.A., & Chuang, I.L. (2010). *Quantum Computation and Quantum Information*. Cambridge University Press.
- Yanofsky, N. S., & Mannucci, M. A. (2008). *Quantum Computing for Computer Scientists*. Cambridge University Press.

Suggested Readings

- Schuld, M., & Petruccione, F. (2018). *Supervised Learning with Quantum Computers*. Springer.
- Montanaro, A. (2016). Quantum algorithms: an overview. *npj Quantum Information*, 2(1), 15023.



34. Advanced Categorical Data Analysis (STAT-7137) 3(3-0)

Course Brief

This course is designed to introduce foundational and advanced concepts in categorical data analysis, equipping students with practical tools and theoretical understanding to apply in research across disciplines—particularly social and behavioral sciences. The course emphasizes logistic regression modeling, interpretation, and practical implementation using statistical software, rather than abstract mathematical theory. Topics include generalized linear models, multinomial response models, Poisson and log-linear regression, and quasi-likelihood methods. The course prepares students to critically evaluate research involving categorical outcomes and supports informed statistical decision-making in applied settings.

Course Learning Outcomes

1. Understand core statistical models for categorical data and their application contexts.
2. Develop and interpret logistic, multinomial, and Poisson regression models.
3. Evaluate independence and association in contingency tables.
4. Apply generalized linear models and quasi-likelihood estimation in research.
5. Conduct practical data analysis using statistical software for matched and unmatched categorical data.

Course Contents

1. Introduction to categorical data analysis, principles of likelihood-based inference, sampling distributions for contingency tables
2. Measures of association for 2x2 tables
3. Testing independence in contingency tables
4. Exact inference for two-way tables, inferences for three-way tables
5. Introduction to generalized linear models
6. Logistic model building
7. Alternative link functions for binary outcomes, diagnostics, exact methods
8. Conditional logistic regression
9. Methods for analyzing matched case-control data
10. Multinomial response models for nominal data
11. Multinomial response models for ordinal data
12. Poisson regression model, Poisson regression for rates
13. Log-linear models for contingency tables
14. Negative binomial models
15. Quasi-likelihood and Generalized Estimating Equations

Recommended Textbooks

- Agresti, A. (2010). *Analysis of Ordinal Categorical Data* (2nd ed.). Wiley.
- Andersen, E. B. (1994). *The Statistical Analysis of Categorical Data*. Springer.

Suggested Readings

- Bishop, Y. M., Fienberg, S. E., & Holland, P. W. (2007). *Discrete Multivariate Analysis*. Springer.

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35. Statistical Process Control (STAT-7138) 3(3-0)

Course Brief

This course provides a rigorous and application-focused treatment of statistical process control (SPC) techniques for monitoring and improving manufacturing and service systems. Students will develop both conceptual and mathematical foundations in SPC, including control chart construction, process capability analysis, and quality improvement strategies. Special emphasis is given to monitoring location and dispersion under univariate and multivariate frameworks. The course also covers performance evaluation metrics like average run length and probability of detection, as well as robust, nonparametric, and Bayesian approaches. Contemporary tools such as acceptance sampling plans, Taguchi methods, and software implementation are included to support practical research and decision-making.

Course Contents

1. Introduction to statistical process control and its tools
2. Univariate EWMA control charts
3. Univariate CUSUM control charts
4. Multivariate process monitoring through Hotelling T^2 charts
5. Chi-square chart
6. Generalized variance chart
7. Multivariate EWMA and CUSUM charts
8. Robustness approaches for process monitoring
9. Nonparametric approaches for process monitoring
10. Bayesian structures for quality control
11. Covariates and process improvement
12. Process capability study and six sigma introduction
13. Designed experiments and process monitoring
14. Acceptance sampling and ISO standards
15. Advanced techniques for quality improvement
16. Taguchi's methods and evolutionary operation
17. Statistical software for SPC implementation

Recommended Textbooks

- Montgomery, D. C. (2013). *Introduction to Statistical Quality Control* (9th ed.). Wiley.
- Qiu, P. (2013). *Introduction to Statistical Process Control*. Taylor & Francis.
- Oakland, J. S. (2007). *Statistical Process Control* (6th ed.). Elsevier.

Suggested Readings

- Alwan, L. C. (2000). *Statistical Process Analysis*. McGraw-Hill.
- Farnum, N. R. (1994). *Statistical Quality Control and Improvement*. Duxbury.

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36. Time Series Analysis (STAT-7138) 3(3-0)

Course Brief

This course offers a comprehensive study of time series analysis, focusing on the statistical techniques used to model, interpret, and forecast temporal data. It emphasizes the understanding of stochastic processes and their role in explaining observed time-dependent patterns. Key themes include univariate and multivariate time series modeling, stationarity, forecasting, and structural modeling techniques. This course also introduces advanced tools such as ARIMA, GARCH, state-space models, and vector autoregressive processes, with applications in economics, finance, and scientific forecasting.

Course Contents

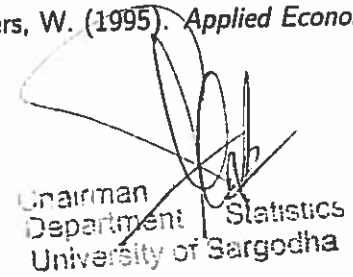
1. Types of data and components of time series
2. Stochastic processes
3. Stationary and non-stationary processes
4. Forms and tests of nonstationarity
5. Purely random processes
6. Random walk models
7. Lag operators, difference equations, and solutions
8. Smoothing and decomposition methods
9. Univariate time series models: ARMA, ARIMA, Box-Jenkins, ARCH, GARCH
10. Model estimation, selection, and diagnostic checking
11. State space models
12. Kalman filtering for dynamic systems
13. Multivariate time series and Granger causality
14. Vector Autoregressive (VAR) models
15. Transfer function and intervention analysis
16. Time series forecasting and cointegration analysis
17. Vector Error Correction Models (VECM) and Johansen approach

Recommended Textbooks

- Asteriou, D. (2006). *Applied Econometrics.* Palgrave Macmillan.
- Anderson, T. (1976). *The Statistical Analysis of Time-Series.* Wiley.

Suggested Readings

- Box, G. E. P., & Jenkins, G. M. (1994). *Time-Series Analysis: Forecasting and Control* (3rd ed.). Prentice Hall.
- Chatfield, C. (2003). *The Analysis of Time Series: An Introduction.* Taylor & Francis.
- Enders, W. (1995). *Applied Econometric Time Series.* Wiley.



37. Spatial Data Analysis (STAT-7140) 3(3-0)

Course Brief

This course provides an in-depth examination of spatial data and statistical methods for spatial analysis. It introduces key concepts such as spatial structures, spatial autocorrelation, and variogram modeling, and progresses to advanced techniques like spectral analysis, Kriging, and autoregressive spatial models. Emphasis is placed on real-world applications including environmental science, geography, and epidemiology. The course also explores big spatial data handling, eigenfunction analysis, spatial GLMs, and higher-order spatial autoregressive structures, supporting data-driven decision-making in geospatial contexts.

Course Contents

1. Introduction to spatial data: types, properties, and modeling structures
2. Spatial processes and classical interpolation methods
3. Stationarity assumptions in spatial processes
4. Estimation and modeling of spatial correlations: variogram estimation
5. Fitting parametric models: Matern covariance family
6. GLMs for geostatistical data: Poisson, logistic, survival models
7. Parameter estimation: MLE and REML
8. Point pattern analysis
9. Spatial autocorrelation: SAR, CAR, and geographically weighted regression
10. Buffering, proximity, and neighborhood analysis
11. Polyline and network analyses
12. Geometric properties of area objects
13. Multivariate spatial data handling
14. Emerging approaches in spatial analysis and spatial big data

Recommended Textbooks

- Cressie, N. (2015). *Statistics for Spatial Data* (revised ed.). Wiley.
- Diggle, P. J. (2006). *Model-Based Geostatistics*. Springer.
- Le, N. D., & Zidek, J. V. (2006). *Statistical Analysis of Environmental Space-Time Processes*. Springer.
- Webster, R., & Oliver, M. A. (2007). *Geostatistics for Environmental Scientists* (2nd ed.). Wiley.

Suggested Readings

- Banerjee, S., Carlin, B. P., & Gelfand, A. E. (2004). *Hierarchical Modeling and Analysis for Spatial Data*. Chapman & Hall.
- Haining, R. P. (2003). *Spatial Data Analysis: Theory and Practice*. Cambridge University Press.

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38. Analysis of Multi-Factor Designs (STAT-7141) 3(3-0)

Course Brief

This course offers an in-depth exploration of experimental design strategies for analyzing systems influenced by multiple factors. Students will learn how to construct, execute, and analyze factorial and fractional factorial experiments, focusing on efficiency, robustness, and cost-effectiveness. The course emphasizes blocking techniques, resolution-based design classification, and model parameter estimation under resource constraints. Advanced topics include response surface methodology (RSM), Taguchi methods, nested designs, and robust design principles that ensure experimental accuracy and reproducibility across complex real-world settings.

Course Contents

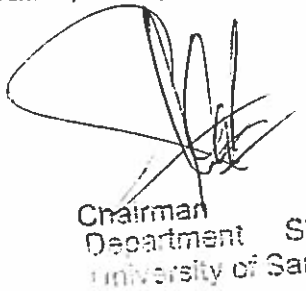
1. Review and analysis with unequal subclass numbers; 2^n, 3^n and mixed factorial experiments
2. Blocking in factorial design
3. Estimation of model parameters
4. Fractional replication and alias structure
5. Resolution III, IV, and V designs
6. Unreplicated factorial designs
7. Lenth's method for unreplicated designs
8. Daniel's graphical method
9. Sequential experimentation in time and space
10. Response surface methods (RSM)
11. RSM analysis: 1st and 2nd order models, method of steepest ascent
12. Blocking in RSM, saturated designs and analysis
13. Nested designs: two-stage and general-m-stage
14. Robust designs and cross-arrayed structures
15. Taguchi methods for quality and process optimization

Recommended Textbooks

- Montgomery, D. C. (2012). *Design and Analysis of Experiments* (8th ed.). Wiley.
- Boniface, D. R. (1995). *Experimental Design and Statistical Methods.* Chapman and Hall.

Suggested Readings

- Garcia-Diaz, A., & Auth, J. (1995). *Principles of Experimental Design and Analysis.* Chapman and Hall.
- Harold, R. L. (1992). *Analysis of Variance in Experimental Design.* Springer.
- Cochran, W. G., & Cox, G. M. (1992). *Experimental Designs.* 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)

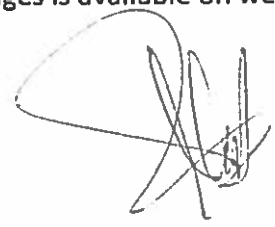
Course Learning Outcomes:

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 أكبر 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 إن Preposition "For" (اللام) Preposition (في)
	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) (إلا)
	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 إليه)
6.	1.	3	6 -7	Writing the meaning of Quranic phrase translation of sentences 6-7	Quranic Possessive Construction (مضاف ومضاف إليه)
	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

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					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 / إلا، إن / إلا، إنما، ليس، ما ، (أم/أم، ان، بل، كان (ألا، أليس، اليوم، يومئذ، سبحان، مابينهما، قل، إذن، بئس، نعم، كلا، ما أدراك، 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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					صيغة المتكلم (أعبد)
3.	1.	6	13	Understanding & Translation of Verses	Present Tense صيغة جمع المتكلم (نعبد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative صيغة المفرد وصيغة الجمع , لا تعبدْ، 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 التعليل) & 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 صيغة المفرد الغائب
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صيغة المفرد للغائب
	2.	MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا

	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صیغة الجمع للمتکلم عبدنا
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صیغة الجمع للمتکلم عبدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صیغة الجمع للمتکلم عبدنا
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صیغة الجمع للمخاطب عبدتم
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صیغة الجمع للمخاطب عبدتم
14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صیغة المتکلم والمخاطب عبدتُ ، عبدتَ
	2.	7	7	Understanding & Translation of Verses	Past Tense صیغة المؤنث للغائب عبدَتْ
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-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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Department Statistics
University of Sargodha

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.

Chairman
Department Statistics
University of Sargodha