**MATH 338: ECONOMETRICS (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enable the learner to describe the development of econometric tools and apply this knowledge to develop appropriate economic models from some given data.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Define econometrics and state its applications in real life.
2. Develop appropriate quantitative economic models.
3. State the properties of econometric methods.
4. Critically evaluate the assumptions and limitations of different econometric methods.
5. Apply econometric methods to the developed models using economic data.

**Course Content**

Sources of data, national accounts and price indices. Econometrics: methods, applications, aggregated and desegregated models, models of the national economy and of sectors. The linear model: multiple regression, t and F tests, dummy variables, multicollinearlity, general linear restrictions and dynamic models. Time series autoregressive models: seasonal adjustment, generalized least squares, serial correlation, hetero-scedasticity, distributed lags, simultaneous equation systems, instrumental variables and two-stage least squares. General linear model: specification and auto-correlation.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

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Wooldridge, J. M. (2019). Introductory Econometrics: A Modern Approach (7th ed.). Cengage Learning.

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Hayashi F. (2000). Econometrics, Princeton University Press.

Stock, J. H. and Mark W. W. (2010). Introduction to Econometrics, 3rd edition, Addison-Wesley.

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**MATH 346: COMPUTING METHODS AND DATA ANALYSIS (45/0 C.F.3.0)**

**Course Purpose**

Designed to equip the learner with data analysis skills using statistical software.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Explain the concepts of a statistical test.
2. Explain data management in various statistical software
3. Develop skills in data manipulation, visualization, and analysis.
4. Gain proficiency in programming languages and tools commonly used in data analysis.
5. Use statistical software to carry out various statistical tests such t-test, ANOVA, non-parametric test.

**Course Content**

Introduction to some statistical computer packages Statistical Package for the Social Sciences (SPSS), R/ S-PLUS, Statistical Application Software (SAS), Minitab, Generalized Statistical Package (GENSTAT) etc.). Data management; methods of data collection. Descriptive statistics. t-test. Analysis of variance. Correlation and regression analysis. Non-parametric test. Categorical data analysis. Generating random observations. Matrix operations. LP solution-simplex method. Graphical data analysis. Report writing.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Kirkpatrick, L. A. (2020). IBM SPSS Statistics for Beginners: An Introduction. SAGE Publications.

Sarma, K. V. S., & Singh, D. (2018). Practical Statistics: A Quick and Easy Guide to IBM® SPSS® Statistics, STATA, and Other Statistical Software. CRC Press.

Wilson-Doenges, G. (2019). SPSS for Research Methods: A Basic Guide. W. W. Norton & Company.

George, D., & Mallery, P. (2021). IBM SPSS Statistics 27 Step by Step: A Simple Guide and Reference (17th ed.). Routledge.

R. Cox, Principles of Statistical Inference, Cambridge university Press, (2006).

Leandro Pardo, Statistical Inference Based on Divergence Measures Chapmann and Hall ltd, (2006)

Journal of Mathematical Methods of Statistics, Springer, ISSN: 1066-5307

**MATH 347: DECISION THEORY AND BAYESIAN INFERENCE I (L/P 45/0; CF 3.0)**

**Course Purpose**

To enable the learner apply Bayesian theory analysis skills in management especially in planning as well as decision making.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Describe the Bayesian theory and it’s important to science & business management, in both local and global contexts.
2. Explore utility theory to quantify preferences and evaluate outcomes based on decision criteria.
3. Use prior distributions to represent initial beliefs and updating these beliefs to posterior distributions using observed data.
4. Perform Bayesian parameter estimation, including point estimation (e.g., maximum a posteriori estimation) and interval estimation (e.g., credible intervals).
5. Apply computational and analysis skills/ techniques in decision making.

**Course Content**

Bayes’ rule, Loss and risk functions, and minimax rules. Likelihood principle, prior and posterior distribution. Classification and hypothesis testing in decision framework. Subjectivism point of view. Bayesian analysis for Count Data, Bayesian inference for normal distribution. Bayesian analysis for binomial data. Credibility intervals. Basic concepts in decision analysis including influence diagrams, decision trees, and utility theory.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

**Gelman.A,Carlin.J,Stern.H, Dunson.D, Vehtari.A, and Rubin.D (2013) Bayesian Data Analysis" (3rd Edition)**

Winkler R., (2003). An Introduction to Bayesian Inference and Decision, 2nd Edition, Probabilistic Publication.

Mackay D. J. C., (2003). Information Theory, Infernce and Learning Algorithms, Cambridge University Press.

Fenton N. and Neil M., (2012). Risk Assessment and Decision Analysis with Bayesin Networks, Chapman & Hall.

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**MATH 349: SURVIVAL DATA ANALYSIS (L/P 45/0; CF 3.0)**

**Course Purpose**

To enable the learner to estimate survival function that will enable performance of calculations on real time-to-time event data.

**Expected Learning Outcomes**

By the end of this course, the learner should be able to:

1. Define Survivor, hazard and cumulative hazard functions.
2. Describe the Left, Right and Interval Censoring mechanisms.
3. Illustrate Parametric and Non-Parametric Comparison of two groups.
4. Carry out Statistical methods for censored survival data.
5. Estimate appropriate parameters and state characteristics of failure time models.
6. Use of statistical package in analysis of data.

**Course Content**

Definition: Survivor, hazard and cumulative hazard functions. Left, Right and Interval Censoring. Kaplan – Meier survival curve Estimator. Parametric estimation of the survivor function. Parametric and Non-Parametric Comparison of two groups.Statistical methods for censored survival data arising from follow-up studies on human or animal populations, Comparison of survival curves, log-rank test, regression models including the Cox proportional hazards model with application, competing risks and their relationship. Estimation of parameters.Introduction to accelerated failure time models.Use of statistical package.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Lee E. T. and Wang J. W. (2013). Statistical Methods for Survival Data Analysis, 4th Edition, Wiley

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Liu X. (2012). Survival Analysis: Models and Applications, Wiley

Kalbfleisch J. D. and Prentice R. L. (2002). The Statistical Analysis of Failure Time Data, 2nd Edition, Wiley.

Elandt-J. and Johnson, N. L. (1999). Survival Models and Data Analysis, John-Wiley and Sons, Inc.

Marubini, E and Valsecchi, M. G. (1995). Analysing survival data from clinical trials and observational studies, John Wiley & Sons, Inc.

**MATH 446: STATISTICAL INFERENCES II (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enable the learner to have an understanding of Bayesian concepts and its application in statistical software to analyse statistical data.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Describe modes of inference.
2. Calculate the combined length of model description and data encoding, and compare across different models.
3. determine how the resources needed to solve a problem (such as time, memory, or computational steps) grow as the size of the input increases.
4. Devise a formalized approach to balancing model complexity and data fitting.
5. Apply Bayesian analysis skills/ techniques in decision making.

**Course Content**

Preface: Introduction to Statistical Inference I: Basic concept; Estimations-Methods of moments, Maximum likelihood Estimations (MLE), Least Square Methods (LSM); Hypothesis Testing-Z-test, t-test, F-test. Chi-square test etc. Power of a test.

Bayesian concepts: Conditional Probability, Baye’s theorem, Bayesians statistical analysis and its application in decision making. Modes of Inference: [Information theory](http://en.wikipedia.org/wiki/Information_theory)[-minimum description length](http://en.wikipedia.org/wiki/Minimum_description_length) (MDL); [Computational](http://en.wikipedia.org/wiki/Computational_complexity_theory) [complexity theory](http://en.wikipedia.org/wiki/Computational_complexity_theory) or [Numerical analysis;](http://en.wikipedia.org/wiki/Numerical_analysis) [Fiducial inference;](http://en.wikipedia.org/wiki/Fiducial_inference) structural inference or pivotal inference.

Bayesian statistics and its applications in Statistical Software’s for data analysis; R-software; SPSS, STATA.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Dennis Wackerly, William Mendenhall, and Richard L.Scheaffer. (2007). Mathematical Statistics with Applications. PWS Publishers 2007.

Matthew J., Hassett and Donald Stewart. (2006). Probability for Risk Management ACTEX Publications.

Hogg, R.V and Craig, A.T. (2003). Introduction to Mathematical Statistics, 6th ed. Prentice Hall.

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Robert V. Hogg and Elliot A. Tanis (2005). Probability and Statistical Inference, 7th ed Prentice Hall College.

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Karmel, PH and Polasek. (1986). Applied statistics for Economists. Kholsa Publishing House.

**MATH 457: REGRESSION MODELLING II (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enable the learner develop and analyze non-linear, mixed and neural network regression models using computers.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Review simple linear models.
2. Generate simple non-parametric regression models.
3. Develop simple neural network regression models.
4. Apply data reduction techniques to analyze regression models.
5. Apply computer statistical packages to regression modeling.

**Course Content**

Review of linear models. Non-linear regression: non-least squares, their estimation and asymptotic properties. Mixed models. Simple non-parametric regression: concepts, models, estimators and asymptotic properties. Simple neural network regression: concepts, models, estimators and asymptotic properties. Data reduction techniques; principle component analysis, discriminant analysis, factor analysis.Use of computers.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Jiang, J. (2020). Linear Mixed-Effects Models with Applications. Springer.

Dunn, P. K., & Smyth, G. K. (2018). Generalized Linear Models with Examples in R. Springer.

Pardoe, I. (2020). Applied Regression Modeling: A Business Approach (3rd ed.). Wiley.

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Rhinehart, R. R. (2016). Nonlinear Regression Modeling for Engineering Applications. CRC Press.

Galecki, A., & Burzykowski, T. (2013). Linear Mixed-Effects Models Using R: A Step-by-Step Approach. Springer.

Klein, J. P., & Moeschberger, M. L. (2020). Survival Analysis: Techniques for Censored and Truncated Data (3rd ed.). Springer.

Kuhn M. and Johnson K. (2013). Applied Predictive Modeling, Springer.

Boos D. D. and Stefanski L. A. (2013). Essentials Statistical Inference, Springer.

**MATH 458: CATEGORICAL DATA ANALYSIS (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enable the learner to analyze and interpret logically any real-life situation involving categorical data using R/SAS software.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Describe categorical data.
2. Construct 2x2, 3x3 and multi-way contingency tables
3. Construct and analyze generalized linear models and log-linear models.
4. Learn how to summarize and visualize categorical data using appropriate descriptive statistics and graphical methods.
5. **Apply and interpret results from statistical tests**
6. Apply categorical data analysis techniques to medical data using R/SAS software.

**Course Content**

Description of categorical data, inference using difference of proportions, McNemar’s test, relative risk and odds ratio, 2x2 contingency tables, 3x3 contingency tables, Simpson’s Paradox, multi-way contingency tables. Mantel-Haenszel chi-square test, Cochran Mantel-Haenszel chi-square test, Breslow-Day test. Logistic regression, other generalized linear models: log-linear models. Biological assay, dilution assays, dose response relationships. Application to medical data using R/SAS software.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Hardin, J., & Horton, N. J. (2022). Categorical Data Analysis: A Practical Approach. Chapman and Hall/CRC.

Hilbe, J. M. (2022). Logistic Regression Models (2nd ed.). CRC Press.

Kulinskaya, E., & Zhigljavsky, A. (2021). Analyzing Categorical Data with R and Python. Wiley.

Bannister, K. M., & Rizzo, M. L. (2020). Logistic Regression with R. Springer

Legler, J. M., & Roback, P. (2022). Statistical Modeling with R: A Dual Perspective. CRC Press.

Zhang, J., & Zou, J. (2023). Statistical methods for handling missing data in categorical variables: A review. Statistical Methods in Medical Research, 32(2), 263-284.

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**MATH 471: STATISTICAL DEMOGRAPHIC TECHNIQUES (45/0 C.F.3.0)**

**Course Purpose**

The purpose of this course is to enable the learner to construct and analyze demographic models and make population projections using computers.

**Expected Learning Outcomes**

By the end of the course, the learner should be able to:

1. Define demography and describe the process of data collection and correction.
2. Construct life tables from census data.
3. Analyse mortality, construct life tables from census data
4. Determine population growth using simple models
5. Solve problems involving population growth and projection using computers.
6. Explain population models and use them to estimate demographic parameters

**Course Description**

Demographic data: collection, sources of errors and their corrections, and measures of mortality and fertility. Mortality: analysis, life tables and their construction from census data, model life tables, continuous and multiple decrement formulations, statistical properties of life table estimators, and proportional hazard models and multi-state life tables. Population growth: simple models, stable and stationary populations and their use for estimation of demographic parameters, and population projections and use of census data. Mathematical cohort component analysis. Graduation. Testing for graduation. Use of computer packages.

**Instructional Methods**

Lectures, tutorials, blending learning (online-asynchronous learning, computer Assisted instruction) Project-based approaches, Group discussions & assignments, Cooperative learning, Case studies and experimental learning

**Instructional Materials and Equipment**

Computer laboratories, computers, learning resource center and core reading resources.

**Course Assessment**

CAT = 40%

Final exam = 60%

Total marks = 100%

**References**

Preston, S. H., Heuveline, P., & Guillot, M. (2021). Demography: Measuring and Modeling Population Processes (2nd ed.). Wiley.

Swanson, D. A., & Siegel, J. S. (2020). The Methods and Materials of Demography (2nd ed.). Academic Press.

Rowland, D. T. (2012). Demographic Methods and Concepts. Oxford University Press.

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Raftery, A. E., et al. (2021). Innovations in Demographic Techniques for Population Estimates and Projections. Population Studies, 75(3), 409-429.

Benchimol, J. O., et al. (2022). The Use of Life Tables in Demography and Health. Population and Development Review, 48(2), 215-239.

Bijak, J., & Kupiszewski, M. (2020). \*Demographic Methods for Estimating Migration

**MATH 453 Applied Regression Analysis I**