**REVIEWED UNITS DONE BY EDUCATION STUDENTS**

**MATH 448: STOCHASTIC PROCESSES (L/P 45/0; CF 3.0)**

**Course Purpose:**

This course introduces undergraduate students to the fundamental concepts of stochastic processes. It covers a range of topics, including random variables, Markov chains, Poisson processes, Brownian motion, and applications to real-world phenomena. The course emphasizes both the theoretical underpinnings and practical applications of stochastic processes.

**Expected Learning Outcomes:**

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

1. Understand the random processes with application of Brownian motion
2. Work out moments of the generating functions.
3. Obtain sequences of the generating functions.
4. Find the sums of the independent random variables for the pgfs.
5. Apply Markov chain properties to solve related problems.
6. Explain Random Phenomena in time and space related to Markov chains.
7. Review of Bernoulli and Binomial processes; continuous - time process.
8. Apply Poison process to solve Birth and death process related problems.
9. Work out the constituents of Queuing models.

**Course Content:**

1. Random process; Brownian motion
2. Generating Functions; Binomial Expansion, Probability generating functions, Cumulative tailed probabilities
3. Sequences and generating functions
4. Sums of independent random variables
5. Markov Chains; notations and terminologies, reachability or accessibility, classification of states, irreducible Markov chain
6. Invariant distribution
7. Bernoulli, Binomial and Poisson processes
8. Queuing models; Distribution of arrivals, Markovian Queuing models, steady state equations.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment:**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment:**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**References:**

P.D. Robert, (2016),Introduction to Stochastic Processes with R, JohnWiley and sons publishers.

F. E. Beichelt (2006). Stochastic Processes in Science, Engineering and Finance; Probability Theory.

Chapman & Hall. G. Adomain, (1980). Applied Stochastic Processes. PWS Publishers. G.R.

Grimmett and D.R. Stirzaker (1992). Probability and Random Processes. Oxford University Press.

Oliver Knill (1994). Probability and Stochastic Processes with Applications, Prentice Hall.

Rice, J. A. (1999). Mathematical Statistics and Data Analysis (2nd edition), International Thomson Publishing.

**MATH 243: INTRODUCTION TO TIME SERIES ANALYSIS (L/P 45/0; CF 3.0)**

**Course Purpose:**

The purpose of this course is to enable the learner to apply time series analysis skills in management, agriculture and other applicable areas especially forecasting output (e.g. profit) as well as in decision making.

Expected Learning Outcomes:

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

1. Define and outline the importance of Time series.
2. Identify types of Time series.
3. Plot time series graphs and identify resultant patterns.
4. Work out descriptive statistics for time series.
5. Define and outline importance of stationarity.
6. Transform time series to achieve stationarity.
7. Define, identify and estimate Time series models.

**Course Content:**

1. Basics of Time Series**;** Definition and importance of time series, Examples of time series in various fields (economics, finance, meteorology, etc.),Components of time series: trend, seasonality, and noise.
2. Types of Time Series Data; Univariate vs. multivariate time series, Stationary vs. non-stationary time series, Discrete vs. continuous time series.
3. Time Series Visualization; Plotting time series data, Identifying patterns visually and Time series decomposition.
4. Descriptive Statistics for Time Series; Summary statistics (mean, variance, autocorrelation), Lag plots and autocorrelation function (ACF) and Partial autocorrelation function (PACF).
5. Stationarity in Time Series; Definition and importance of stationarity, Tests for stationarity: ADF, KPSS.
6. Transformations to Achieve Stationarity; Differencing, Logarithmic and power transformations and Seasonal adjustment.
7. Moving Average (MA) Models; Definition and properties, Identification and estimation of MA models.
8. Autoregressive (AR) Models; Definition and properties and Identification and estimation of AR models.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment:**

CATs and Assignments: 30%

Final examinations: 70%

Total marks: 100%

**References:**

1. Mason, R.D and Lind A.D., (1996). Statistical Techniques in Business and Economics, Irwin Chicago.
2. Karmel, PH and Polasek, (1986). Applied statistics for Economists, Kholsa Publishing House.
3. Wackerly, D., Mendenhall W., and Scheaffer R. L,, (2007). Mathematical Statistics with Applications, PWS Publishers
4. Matthew J., Hassett and Donald Stewart, (2006). Probability for Risk Management, ACTEX Publications.
5. Hogg, R.V and Craig, A.T., (2003). Introduction to Mathematical Statistics, 6 th ed. Prentice Hall.
6. Hogg, R.V and Elliot A. Tanis, (2005). Probability and Statistical Inference, 7 th ed. Prentice Hall College.

**MATH 344: THEORY OF ESTIMATION (L/P 45/0; CF 3.0)**

**Course Purpose:**

The purpose of this course is to enable learners to understand statistical inference, develop analytical skills, evaluate estimators, think critically, prepare for advanced studies and for practical applications. Estimation methods are widely used in real-world applications, such as quality control, finance, medical research, and environmental studies. Understanding these methods allows students to apply statistical tools in practical scenarios hence improving their professional competencies.

**Expected Learning Outcomes:**

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

1. Define an estimators, Determine an estimator using both MLEs and moment methods.
2. Discuss desirable properties of an estimator such as unbiasedness, sufficient, completeness & efficient.
3. Apply the knowledge and skills involving estimators in management and decision making.

**Course Content:**

Population parameters and sample statistics; Properties of point estimators; Sufficiency and completeness; Methods of Estimation; Efficiency in estimators; Bayesian estimation; Interval estimation.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment:**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment:**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**Reference Books**

1. Miller and M. Miller. (2011). John E Freund’s Mathematical Statistics with Applications, 7th ed., Pearsons Education, Prentice Hall,
2. Dennis Wackerly, William Mendenhall, and Richard L. Scheaffer. (2007). Mathematical Statistics with Applications. P W S Publishers.
3. Matthew. J., Hassett and Donald Stewart (2006). Probability for Risk Management. ACTEX Publications.
4. Robert V. Hogg and Elliot A. Tanis. (2005). Probability and Statistical Inference, 7th ed. Prentice Hall College.

1. Hogg, R.V, McKean, J.W & Craig. A.T (2003). Introduction to Mathematical Statistics, 6th ed., Prentice Hall.
2. Van der Vaart, A. W. (1998). Asymptotic statistics. Cambridge University Press
3. Mendenhall. (1995). Mathematical Statistics with Applications. P W S Publishers; 5th edition. Berger, J. O. (1985). *Statistical decision theory and Bayesian analysis* (2nd ed.). Springer.
4. N.J. Larson.H.J. (1982). Introduction to Probability Theory and Statistical Inference. 3 rd ed., Wiley.
5. Cox, D. R., & Hinkley, D. V. (1974). *Theoretical statistics*. Chapman and Hall.

**MATH 345: OPERATION RESEARCH I (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enhance knowledge on optimization, aid application of appropriate OR techniques to solve problems, interpreting and communicating results effectively to improve decision making and operation efficiency.

**Expected Learning Outcomes:**

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

1. Formulate a linear program.
2. Solve a linear program using different method depending on the nature of the problem.
3. Apply the concepts of duality in solving optimization problem.
4. Formulate and solve assignment and transport problems to optimality.

**Course Content**

Linear programming; formulation and solving linear programming methods; graphical method, simplex, m- techniques. Duality method of solving linear programming, transportation problem, assignment problem.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**References**

1. Murthy Rama, (2007). Operations Research, New Age International Publishers: New Delhi.
2. Hiller, S., and Lieberman, G. J. (2009). Introduction to Operations Research. Wiley: New York.
3. Wayne. L. Winston (2003). Operations Research: Applications and Algorithms. Wiley: New York.
4. Richard, B. and Govindasami, N. (1997). Schaum’s Outline of Operations Research. Wiley: New York.
5. Hamdy. A. Taha (2010). Operations Research: An introduction (9th edition). Wiley: New York.
6. Ronald. L. Rardin (1997). Optimization in Operations Research. Wiley: New York. Marlow, W. H. (2012). Mathematics for Operations Research. Wiley: New York.

**MATH 443: DESIGN AND ANALYSIS OF EXPERIMENT I (L/P 45/0; CF 3.0)**

**Course Purpose**

The purpose of this course is to enable learners design and analyse statistical experiments especially in research areas, such as engineering, science, agriculture, medicine, and social sciences in order to make viable decisions and conclusions.

**Expected Learning Outcomes**

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

1. Define of an experimental design.
2. Perform some basic principle concepts in experimental design.
3. Distinguish between CRD, RCBD and LSD in experimental design.
4. Perform analysis of various design and in particular apply in specific fields e.g. medicine, agriculture etc.
5. Perform analysis of data (ANOVA).

**Course Content**

Principles of experimentation. Construction and analysis of common design in research; CRD, RCBD, Latin square/designs/factorial experiments. Split plot designs. Missing plot techniques.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**References**

1. Dennis Wackerly, William Mendenhall, and Richard L. Scheaffer. (2007). Mathematical Statistics with Applications. P W S Publishers.
2. Foreman, E. K. (1991). Survey Sampling Principles. New York: Marcel Dekker.
3. Hogg, R.V, McKean, J.W & Craig. A.T (2003). Introduction to Mathematical Statistics, 6th ed., Prentice Hall.
4. Matthew. J., Hassett and Donald Stewart (2006). Probability for Risk Management. ACTEX Publications.
5. Robert V. Hogg and Elliot A. Tanis. (2005). Probability and Statistical Inference, 7th ed. Prentice Hall College.
6. Scheaffer, R. L., Mendenhall, W., Ott L. (1990). Elementary Survey Sampling. Boston: PWS-Kent.
7. Som, R. J. (1996). Practical Sampling Techniques (3rd edition). New York: Marcel Dekker.

**MATH 444: DESIGN AND ANALYSIS OF EXPERIMENTS II (L/P 45/0; CF 3.0)**

**Course Purpose**

This course enables learners to build upon the foundational knowledge from the DOE 1 and delve deeper into more advanced concepts and techniques aimed to design and analyse experiments in specific areas of study and in effective decision making.

Expected Learning Outcomes

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

1. Identify and Analyze Fraction and Factorial Designs Analyze and differentiate BIB, PBIB, Lattice and Response surface Designs.
2. Construct designs appropriately.

**Course Content**

Fraction and factorial experiments; Confounding; BIB and PBIB designs; lattice designs; Response surface designs. Advanced topics in the construction of designs.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**References**

1. Neter, J, Kutner, M. H, Nachtsheim, C. J., and Wasserman, W.(1996). Applied Linear Statistical Models. New York: WCB McGraw-Hill.
2. Freedman D. A. (2005). Statistical Models: Theory and Practice. Cambridge, University Press.
3. Matthew. J., Hassett and Donald Stewart (2006). Probability for Risk Management. ACTEX Publications.
4. Hogg, R.V, McKean, J.W & Craig. A.T (2003). Introduction to Mathematical Statistics, 6th ed., Prentice Hall.
5. Robert V. Hogg and Elliot A. Tanis. (2005). Probability and Statistical Inference, 7th ed. Prentice Hall College.
6. Wackerly, D., Mendenhall, W., and Richard L. Scheaffer. (2007). Mathematical Statistics with Applications. P W S Publishers.

**MATH 445: OPERATIONS RESEARCH II (45/0 C.F.3.0)**

**Course Purpose**

The purpose of this course is to enable learners apply the knowledge of advanced Operations Research in business management, Engineering and decision making.

**Expected Learning Outcomes**

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

1. Find critical Path and activities
2. Describe and work out Non-linear programming problems.
3. Solve problems related to network maximal flow and minimal cost flow problem.
4. Solve problems related to dynamic programming.
5. Solve problems in Game theory and Decision theory.

**Course Content**

Network analysis and Rescheduling. Nonlinear Programming; Unconstrained Optimization, Constrained Optimization (Karush-Kuhn-Tucker conditions),Convex and Non-Convex Optimization, Gradient and Newton Methods. Network Flow Problems; Maximum Flow Problems, Minimum Cost Flow Problems, Network Simplex Method. Dynamic Programming; Principle of Optimality, Deterministic and Stochastic Dynamic Programming. Game Theory; Zero-Sum Games. Decision Analysis; Decision Trees, Utility Theory, Multi-Criteria Decision Making

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

**Course Assessment**

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

**References**

1. Murthy Rama, (2007). Operations Research, New Age International Publishers: New Delhi.
2. Hiller,S., and Lieberman, G.J. (2009). Introduction to Operations Research. Wiley: New York.
3. Wayne. L. Winston (2003). Operations Research: Applications and Algorithms. Wiley: New York.
4. Richard, B. and Govindasami, N. (1997). Schaum’s Outline of Operations Research. Wiley: New York.
5. Hamdy. A. Taha (2010). Operations Research: An introduction (9th edition). Wiley: New York.
6. Ronald. L. Rardin (1997). Optimization in Operations Research. Wiley: New York.
7. Marlow, W. H. (2012). Mathematics for Operations Research. Wiley: New York.

# MATH 348: DESIGN AND ANALYSIS OF SAMPLE SURVEYS (L/P 45/0; CF 3.0)

**Course Purpose**

This course serves several crucial purposes, particularly for students in fields such as statistics, social sciences, public health, marketing, and economics. It is a **foundation in survey methodology** and helps in statistical analysis of survey data and application of results in different disciplines for decision making.

# Expected Learning Outcomes

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

1. Define a sample survey Perform some basic principle concepts in sample design.
2. Perform analysis of various design and in particular apply in specific fields e.g. medicine, agriculture etc.
3. Perform analysis of data (ANOVA).

# Course Content

Sample survey: definition, advantages and principal steps in organizing a survey. Types of samples: probability and purposive. Simple random sampling: sampling proportions and percentages; estimating sample size; stratified random, systematic, cluster and multistage samples; selections with p.p.s (probability proportional to size). Ratio and regression estimators, sampling and non-sampling errors, organisation of national surveys, and the National Bureau of Statistics. Use of computer packages.

**Teaching and Learning Methods:**

Lectures, presentations, group discussions, blended learning (online-Asynchronous learning), computer assisted, assignments, Tutorials, co-operative learning, case studies, experiential learning and Question/ Answer approach.

**Instructional Materials and Equipment;**

Computer Laboratory, computers, learning resource centre, Overhead projector, Power point, Flip charts, Hand-outs, Charts and Felt Pens.

# Course Assessment

CATs and Assignments 30%

Final examinations 70%

Total marks 100%

# References

1. Fowler F. J. (2013). Survey Research Methods, 5th Edition, SAGE Publications, Inc.
2. Creswell J. W. (2013). Research Design: Qualitative, Quantitative and Mixed Methods Approach, 4th Edition, SAGE Publications, Inc.
3. Lehtonen R. and Pahkinen E. (2003). Practical Methods for Design and Analysis of Complex Surveys, 2nd Edition, Wiley.
4. Chan N. H. and Wong H-Y. (2006). *Simulation Techniques in Financial Risk Management*; Wiley.
5. Som, R. J. (1996). *Practical Sampling Techniques (3rdedition),* Marcel Dekker.