P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF STATISTICS
COTTON UNIVERSITY

PAPER: STA1001C

STOCHASTIC PROCESSES
(Credits: 4+0+0=4)

Unit I: (Lectures: 16)

Review of Basic Probability Concepts. Introduction to Stochastic Processes. Stationary and Evolutionary Processes.
Markov Chains: Transition Probability Matrices, Chapman- Kolmogorov equations, Generalization of independent Bernoulli trials, Sequence of chain dependent trials, Some Examples and Classification of States and Chains. Stability of Markov System, Graph theoretic approach, Markov chain with denumerable number of states.
Random walk and Gambler's Ruin problem.

Unit II: (Lectures: 16)

Poisson Processes: Postulates and Properties of Poisson Process, Time dependent Poisson Process, Weighted Poisson Process, Arrival, Inter arrival and Conditional Arrival Distributions. Pure Birth process, Yule Process, Polya Process, Pure Death Process, Birth and Death Process, Chiang's Illness Death Process.

Unit III: (Lectures: 16)

Branching Process: Introduction, Properties of Generating Functions of Branching Processes. Probability of Extinction, Distribution of Total Number of Progeny, Discrete Time Branching Process and Results, Continuous Time Branching Process and applications.
Idea of Brownian Motion : Limit of Random Walk, its Defining Characteristics.

Unit IV: (Lectures: 16)

Renewal Processes: Preliminaries, Distribution of the Forward and Backward Recurrence Time, Queueing Paradox, Asymptotic Renewal Theorem, Elementary Renewal Theorem (without proof), Diffusion Process.
Martingales: Definitions and Some Examples, Martingales from Markov Chain, Stopping Times, Optional Stopping Theorem, Wald's Martingale.

SUGGESTED READING :

1. Bhat, B.R. (2000). Stochastic Models- Analysis and Applications, New Age International Publishers.
2. Biswas, S. (2012). Applied stochastic Processes, New Age International Publishers.
3. Feller, William (1968). An Introduction to Probability Theory and its Applications, Vol. 1(Third Ed.), John Wiley.
4. Hoel, P.G., Port, S.C. and Stone C.J. (1972). Introduction to Stochastic Processes, Houghton Miffin & Co.
5. Karlin, S. and Taylor, H.M. (1975). A first course in Stochastic Processes, Second Ed.Academic Press.
6. Medhi, J. (1994). Stochastic Processes, 2nd Edition, Wiley Eastern Ltd.
7. Parzen, Emanuel (1962). Stochastic Processes, Holden-Day Inc.

8. Prabhu, N.U. (2007). Stochastic Processes: Basic Theory and its Applications, World Scientific.
9. Ross, Sheldon M. (1983). Stochastic Processes, John Wiley and Sons, Inc.
10. Takacs, Lajos (1967). Combinatorial Methods in the Theory of Stochastic Processes, John Wiley and Sons, Inc.
11. Williams, D. (1991). Probability with Martingales, Cambridge University Press.

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SPECIAL PAPERS (Any one)

PAPER: STA1002SP1

BIOSTATISTICS
(Credits: 4+1+0=5)

Unit I: (Lectures: 16)
Introduction to survival data, time and event. Functions of survival time, survival distributions and their applications viz. Exponential, Gamma, Weibull, Rayleigh, Lognormal, death density function for a distribution having bath-tub shape hazard function. Censored data: different types of censoring viz. right (type I, type II and type III), left and interval censoring with real life examples. Estimation of mean survival time and variance of the estimator for type I and type II censored data with numerical examples. Non-parametric methods for estimating survival function and variance of the estimator and confidence intervals viz. Acturial and Kaplan–Meier methods. Methods for comparing two survival distributions: parametric methods viz. Likelihood Ratio test, Cox's F-test and non parametric methods viz. Log Rank test, Wilcoxon test. Semi parametric model for survival data: Cox Proportional hazard model.

Unit II: (Lectures: 14)
Analysis of Epidemiologic and Clinical Data: Studying association between a disease and a characteristic: (a) Types of studies in Epidemiology and Clinical Research (i) Prospective study (ii) Retrospective study (iii) Cross-sectional data, (b) Dichotomous Response and Dichotomous Risk Factor: 2X2 Tables (c) Expressing relationship between a risk factor and a disease (d) Inference for relative risk and odds ratio for 2X2 table, Sensitivity, specificity and predictivities.

Unit III: (Lectures: 14)
Competing risk theory: Indices for measure-ment of probability of death under competing risks and their inter-relations. Estimation of probabilities of death under competing risks by maximum likelihood and modified minimum Chi-square methods. Theory of independent and dependent risks. Bivariate normal dependent risk model. Conditional death density functions. Idea of DNA sequence.

Unit IV: (Lectures: 12)
Stochastic epidemic models: Simple and general epidemic models (by use of random variable technique). Basic biological concepts in genetics, Mendels law, Hardy- Weinberg equilibirium, random mating, distribution of allele frequency (dominant/co-dominant cases), Approach to equilibirium for X-linked genes, natural selection, mutation, genetic drift, equilibirium when both natural selection and mutation are operative, detection and estimation of linkage in heredity.

Unit V: **(Lectures: 8)**
Planning and design of clinical trials, Phase I, II, and III trials. Consideration in planning a clinical trial, designs for comparative trials. Sample size determination in fixed sample designs.

SUGGESTED READING:

1. Biswas, S. (1995): Applied Stochastic Processes. A Biostatistical and Population Oriented Approach, Wiley Eastern Ltd.
2. Collett, D. (2003): Modelling Survival Data in Medical Research, Chapman & Hall/CRC.
3. Cox, D.R. and Oakes, D. (1984): Analysis of Survival Data, Chapman and Hall.
4. Elandt Johnson R.C. (1971): Probability Models and Statistical Methods in Genetics, John Wiley & Sons.
5. Ewens, W. J. (1979): Mathematics of Population Genetics, Springer Verlag.
6. Ewens, W. J. and Grant, G.R. (2001): Statistical methods in Bio informatics: An Introduction, Springer.
7. Friedman, L.M., Furburg, C. and DeMets, D.L. (1998): Fundamentals of Clinical Trials, Springer Verlag.
8. Gross, A. J. And Clark V.A. (1975): Survival Distribution; Reliability Applications in Biomedical Sciences, John Wiley & Sons.
9. Indrayan, A. (2008): Medical Biostatistics, Second Edition, Chapman & Hall/CRC.
10. Lee, Elisa, T. (1992): Statistical Methods for Survival Data Analysis, John Wiley & Sons.
11. Li, C.C. (1976): First Course of Population Genetics, Boxwood Press.

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PAPER: STA1002SP2

ECONOMETRICS
(Credits: 4+1+0=5)

Unit I: (Lectures: 18)
Nature of econometrics. The Classical Linear Normal Regression Model (Matrix Approach): Estimation, test and their properties.
Heteroscedasticity, Autocorrelation and Multicollinearity: implications and consequences, tests and solutions.

Unit II: (Lectures: 10)
Generalized least squares (GLS) estimation: Heteroscadatic and autocorrelated structure. Zelner's SURE method.

Unit III: (Lectures: 12)
Distributed lag models, Polynomial lag models, Almon's lag model, Determination of degree of polynomial and lag length. Adaptive expectation model, Partial adjustment model, Compound Geometric lag model. Methods of estimation. Vector Auto Regression (VAR), The Granger Causality Test.

Unit IV: (Lectures: 12)
Simultaneous-equation models: Identification problems. Restrictions on structural parameters – Rank and Order Condition for identification. Restrictions on variances and covariances.

Unit V: (Lectures: 12)
Simultaneous-equation methods: Estimation - Recursive systems, Two Stage Least Squares(2SLS) estimators, Limited Information(Least Variance Ratio) estimators, k-class estimators.

SUGGESTED READING:

1. Greene W.H (2000): Econometric Analysis, 4th Edition, Prentice Hall.
2. Gujarati, D., Porter D.C and Gunasekar S. (2016): Basic Econometrics, 13th Edition, McGraw Hill Companies.
3. Johnston, J. (1985): Econometric Methods, 3rd Edition, McGraw Hill International.
4. Kmenta J (1986): Elements of Econometrics, 2nd Edition, Macmillan, New York.
5. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan Limited.
6. Madnani G.M.K (2008): Introduction to Econometrics, Principles and Applications, Oxford & IBH Publishing Co. Pvt Ltd, Delhi□□
7. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, Wiley & Sons.
8. Theil H (1971): Principles of Econometrics, John Wiley & Sons Inc, New York

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PAPER: STA1002SP3

ACTUARIAL STUDIES
(Credits: 4+1+0=5)

Unit I: (Lectures: 12)
Introduction to insurance systems.
Risk theory: Utility theory and the economics of insurance, individual risk models for a short term, common loss distributions. Collective risk models for a single period and for an extended period, ruin theory, applications.

Unit II: (Lectures: 12)
Mortality and Life Tables: Survival models, life tables. Multiple decrement tables. Stationary Population.

Unit III: (Lectures: 12)
Mortality estimation: exposure to risk, approximation for incomplete data.
Smoothing /graduation: Parametric, tabular and graphical methods, tests of graduation.

Unit IV: (Lectures: 14)
Actuarial Statistics: Life insurance, life annuities, net premiums, net premium reserves, mortality profit/loss and Theiele's equation. Joint insurance.
Reinsurance: deductibles, retention limits, proportional and excess of loss/stop-loss reinsurance.

Unit V: (Lectures: 14)
Credibility Theory: credibility premium, credibility factor, Bayesian and empirical approaches, applications to credibility premiums for standard models.
Special topics: Experience rating, runoff triangles.

SUGGESTED READING:

1. Bowers et al. (1997): Actuarial Mathematics. Second Edition. Society of Actuaries.
2. Rob Kaas Marc Goovaerts, Jan Dhaene and Michel Denuit (2008): Modern Actuarial Risk Theory using R, Springer.
3. Slud, E.V. (2001): Actuarial Mathematics and Life-Table Statistics, University of Maryland, USA.

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(Open Elective)

PAPER: STA1003OP1

LINEAR PROGRAMMING PROBLEM AND RELIABILITY
(Credits: 3+0+1=4)

OPE2
Linear Programming Problem and Reliability
(Credits: 3+0+1=4)

Unit I: (Lectures: 18)

LPP: The general linear programming problem, Properties of the solutions to a linear programming problem.

Generation of extreme points development for an optimum feasible solution, the simplex algorithm, the artificial variable technique, the two – phase algorithm.

Unit II: (Lectures: 18)

Duality in linear programming, the symmetric and asymmetric duals, Dual simplex method.

Sensitivity analysis: Changes in cost coefficient and elements of requirement factors.

Application of linear programming: the assignment problem (solution of balanced and unbalanced problem), the transportation problem (optimum solution of balanced and unbalanced problem).

Unit III : (Lectures: 14)

Reliability Theory: Concept and Measures, Notion of Ageing, Hazard rate, IFR and DFR distributions and related Theorem, Structure Function, Coherent Systems, Component and Systems, Reliability of Coherent Systems, bath tub model.

Unit IV : (Lectures: 14)

Life distributions (Exponential, Gamma, Weibull), Estimation of parameters by the method of MLE and Baysian methods, Stress- Strength Model. System Reliability under Markovian setup – Series and Parallel.

SUGGESTED READING:

1. Bain, L. J and Engelhardt, M. (1991). Statistical Analysis of Reliability and Life Testing Models, Marcel Dekker.
2. Barlow, R. E. And Proschan, F (1985): Statistical Theory of Reliability and Life Testing, Holt, Rinehart and Winston.
3. Biswas, S. (1996): Statistics of Quality Control, Sampling Inspection and Reliability, New Age International Publishers.

4. Goel, B., Mittal, S.K. (23001): Operations Research Pragati Prakshan.
5. Hadley, G: (2002) : Linear Programming, Narosa Publications.
6. Hillier, F. S. and Lieberman, G.J. (2001): Introduction to Operation Research, 7th Edition, Irwin.
7. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.
1. Taha, H. A. (2006): Operation Research: An Introduction, Eighth Edition, Prentice Hall.
2. Sharma, S. D. (2002): Introduction to Operation Research, thirteenth Edition, Kedar Nath and Ram Nath & Co.
3. Winston, W.L. and Goldberg, J.B. (2004). Operations Research: Applications and Algorithms, Thomson Brooks/Cole.

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PAPER: STA1004DPW

DPW
DISSERTATION / PROJECT WORK
Credit 6(0+0+6)

The aim of the course is to initiate students to prepare and present a dissertation, under the supervision of a faculty, on some area of human interest. The project work will provide hands on training to the students to deal with data emanating from some real life situation and should be chosen so that there is an enough scope to apply and demonstrate the statistical techniques learned in the theory course.

The dissertation shall clearly state the problem(s) addressed, the methodology adopted, the assumptions and hypothesis formulated, review of literature consulted, statistical analyses performed and inferences drawn.

Assessment shall be based on dissertation, presentation and viva-voce. There shall be an external examiner and internal examiner (preferably the supervisor) for the evaluation of the project work.

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