B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Note: Students have to choose elective subject either MTH360E or STA360E.

Course Title : Models ***Semester-VI***
Course Code : MTH351C
Credit hrs. : 5

Course Objective: The main objective of this course is to apprise the students about the existence of several stochastic processes in real life situations and to equip them with the techniques to study their statistical behavior as a sequence of dependent random variables.

Unit I: Concept of a stochastic process, counting process, discrete and continuous time processes, mixed process, examples and applications of mixed processes. Transition probability matrices, classification of states, Markov property, Markov chains with stationary transition probabilities, some Markov Chain Models, Chapman-Kolmogorov equations;

Unit II: Markov process, Kolmogorov equations for Markov process, Poisson process, birth and death processes,

Unit III: Survival models, sickness and marriage models in terms of Markov processes, force of mortality, hazard rate. Actuarial symbols tp_x and tq_x and integral formulas, Gompertz-Makeham laws of mortality, life tables

Unit IV: Lifetime distributions and estimation, Failure rate, mean residual life and their elementary properties, types of censoring, Estimation of survival function, Kaplan-Meier estimate, Nelson-Aalen estimate and their applications, Semi-parametric regression for failure rate, Cox proportional hazard model

Recommended Textbooks:

- Stochastic Processes by Sheldon Ross
- A First Course in Stochastic Processes by Karlin and Taylor
- An Introduction to Stochastic Modeling by Karlin and Taylor
- Stochastic Processes by J. Medhi
- Stochastic Models: Analysis and Application by B.R. Bhat
- Cox, D.R. and Oakes, D., *Analysis of Survival Data*, Chapman and Hall, New York.
- Gross A.J. and Clark, V. A., *Survival Distributions: Reliability, Applications in the Biomedical Sciences*, John Wiley and Sons.
- Elandt - Johnson, R.E. Johnson N.L., *Survival models and Data Analysis*, John Wiley and Sons
- Miller, R.G., *Survival Analysis* (Wiley)
- Zacks, S., *Reliability*
- Deshpande, J.V. and Purohit S.G., *Life-Time Data: Statistical Models and Methods* , World Scientific Book Publishing
- Actuarial Mathematics, Bowers et al, Society of Actuaries, USA

B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Course Title : Insurance ***Semester-VI***
Course Code : MTH352C
Credit hrs. : 4

Course Objective: Introduces the students to understand the insurance mechanism and to identify the relationship between insurers and their customers.

Unit -1: Concept and nature of insurance, purpose and need of insurance, specific principles of insurance, general principles or essentials of insurance contract, miscellaneous principles of insurance. Re-insurance, co-insurance, assignments. Recent developments in insurance.

Unit-2: Concept of risk, types of risk, sources and measurement of risk, risk evaluation and prediction. Risk retention and risk transfer. Pooling in insurance: concept, forms of pooling, costs and benefits of pooling. Introduction to mutual funds and pension funds.

Unit-3: General insurance: Motor, marine, fire, miscellaneous .Life insurance: clauses in life policy, types (whole Life, endowment, annuity, term, joint policy)

Unit-4: Control of mal-practices, negligence, loss assessment and loss control, exclusion of perils, actuaries, computation of insurance premium. Role, power, and functions of IRDA, LIC, and GIC.

Suggested Readings:

- Dinsale, W.A:Elements of Insurance, Pitman.
- Hubner, S.S and Keneth Black: Life Insurance.
- Majumdar, P.I and Diwan, M.G:Principles of Insurance, Insurance of India, Mumbai.
- Sharma,R.s:Insurance: Principles and Practice, Vora Publications, New Delhi.
- George, E. Rejda, Principles of Risk Management and Insurance, Pearson Education.
- Gupta. P.K, Insurance and Risk Management, Himalaya Publishing House.
- Mishra, M. N., Principles and Practices of Insurance, S. Chand and Sons.
- Principles of Insurance: IC-01 Insurance Institute of India.

B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Course Title : Financial Derivatives ***Semester-VI***
Course Code : MTH353C
Credit hrs. : 4

Course Objective: Introduces the students regarding the fundamentals of financial derivatives. The students' will also get overview of stock markets and trading strategies involving options.

Unit I: Forward Contracts-Future Contracts-Settlement –Regulation Standardization-Options-Interest Rates and Bond Prices-Zero Coupon Bond Prices-Discretely and continuously compounded interest rates.

Unit II: Asset-Price Dynamics-Lognormal Distribution-The Bi-nominal approximation to the Lognormal Distribution-Stochastic Differential Equation Representation- Complications-Lognormal Distribution, Continuous Trading, Continuously Changing Prices.

Unit III: Binomial Pricing Model- Single Period Example- Multi period Example-Constructing Synthetics Option- Risk Neutral Valuation- Hedge Ratio (Delta), Lattice Parameters- Replicating an option on spot with Future.

Unit IV: Black-Scholes Model, Continuous Time Representative of Stock Price Changes-Ito's Lemma- The Equivalent Martingale Probability Distribution- Hedging-Option Strategies-Partial Differences Equations.

Unit V: SWAPS-Interest Rate Swaps-Pricing, Warehousing, Valuation, Par Swaps, Variants-Foreign Currency Swaps- Valuation- Commodity Swaps- Valuation and Variants- Equity Swaps- Valuation and Variants.

Suggested Reading:

- Bhalla, V.K. Investment Management: Security analysis and Portfolio Management, New Delhi, S. Chand, 2001.
- Brennet, M. Option Pricing: Theory and Applications. Toronto, Lexington Books, 1993.
- Cox John C and Rubinstein, Mark Options Markets, Englewood Cliffs, New Jerxey, Prentice Hall Inc., 1985.
- Huang, Stanley S.C. and Randall, Maury R. Investment Analysis and Management. London, Allyn and Bacon, 1987.
- Hull, John C. Options, Futures and other Derivative Securities. 2nd ed. New Delhi, Prentice Hall of India., 1996.
- Sharpe, William F. et al. Investment, New Delhi, Prentice Hall of India, 1997.

B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Course Title	**:**	Topology	***Semester-VI***
Course Code	**:**	MTH360E	
Credit hrs.	**:**	4	

Course Objective: Introduces students the basic fundamentals of Topology and its applications like structural topology optimization.

Unit I: Topological spaces: open sets, closed sets, neighborhoods, bases, subbases, the order topology, product topology on XxY, subspace topology, closed sets and limit points, closures, interiors, continuous functions, homeomorphisms.

Unit II: Product topology, metric topology, order topology. Quotient Topology Construction of cylinder, cone, Mobius band, torus and Klein Bottle.

Unit III: Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, components and local connectedness, Compact spaces, Heine-Borel Theorem, Local –compactness, limit point compactness

Unit IV: Separation Axioms: Hausdorff spaces, Regularity, Normality, Urysohn Lemma, Urysohn Metrization Theorem (statement only), Tietze Extension Theorem.

Textbook:

Topology (2nd Edition) by James Munkres (Prentice Hall)

Supplementary texts

- Principles of Topology by Fred Croom (Cengage Learning)
- *Lecture Notes on Elementary Topology and Geometry* by Singer and Thorpe (Springer)
- Introduction to Topology and Modern Analysis by G. Simmons (McGraw-Hill)
- General Topology by S. Willard (Addison Wesley)

B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Course Title : Introduction to Demography ***Semester-VI***
Course Code : STA360E
Credit hrs. : 4

Course Objective: This course provides a comprehensive survey of the field of social demography the scientific study of population. The course begins by focusing on understanding the core social demographic variables (e.g., fertility, mortality, morbidity, migration), and how these variables influence population growth, composition, and structure.

UNIT I:
Introduction and definition of vital Statistics, coverage and content errors in demographic data, use of balancing equations, Chanderasekharan-Deming formula to check completeness of registration data. Accuracy of age data on sex and age: Whipple's and Myer's indices. Dependency ratio.

UNIT II:
Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on fertility and human reproduction process. Distributions of time to first birth, inter-live birth intervals and of number of births, estimation of parity progression ratios from open birth interval data.

Unit III:
Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life table and its construction: Complete and abridged. Greville's and Reed-Merrels methods. Relationship between life table functions and their estimation. Relationship between abridged life table functions.

Unit IV:
Population projection: Methods for population projection. Use of Leslie matrix. Frejka's component method. Logistic Model for population growth and their fitting to population data. Migration: concepts and rates. Uses of place of birth and duration of residence data.

TEXT BOOKS:

- Bartholomew, D.J. (1982). Stochastic Models for Social Processes, John Wiley.
- Benjamin, B. (1969). Demographic Analysis, George, Allen and Unwin.
- Ching, C. L. (1968). Introduction to Stochastic process in Biostatistics, John Wiley.
- Cox. P. R. (1970). Demography, Cambridge University Press
- Keyfitz, N. (1977). Applied Mathematical Demography, Springer Verlag.
- Spiegelman, M. (1969). Introduction to Demographic Analysis; Harvard University Press

B.Sc. ACTUARIAL AND FINANCIAL MATHEMATICS

Course Title **:** Senior Project/ Internship ***Semester-VI***
Course Code **:** MTH391C
Credit hrs. **:** 4