TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY

SCHOOL OF MATHEMATICAL SCIENCES

Bachelor in Mathematical Sciences (B.Math.Sc.)

Course of Study

Code No.: MSST 252 *Full Mark*: 75
Paper: **Mathematical Statistics** *Pass Mark*: 30
Nature: Theory *Credit*: 3

Course Description:

The course covers stochastic processes and Markov Chains, Markov Processes, survival models and renewal theory.

Learning Objectives: On successful completion of the course the student will be able to:

- Describe and classify stochastic processes.
- Define and apply a Markov chain.
- Define and apply a Markov process.
- Explain concept of survival models.
- Describe estimation procedures for lifetime distributions.
- Derive maximum likelihood estimators for transition intensities..
- Estimate transition intensities dependent on age (exact or census).
- Graduation and graduation tests
- Describe the process of graduation
- State reasons for graduation
- Conduct graduation tests
- Know mortality projections models
- Explain and apply elementary principles of machine learning

Mode of Delivery:

The course will be taught by lecture (48 hrs), and problem solving and class discussion (24 hrs). The use of spreadsheet software for problem solving will be encouraged.

Contents:

UNIT 1 Stochastic Processes and Markov Chain **10hrs**

Stochastic processes and it's classification, Markov chain, Chapman- Kolmogorov equations that represent a Markov chain, Stationary distribution for a Markov chain , System of frequency based experience rating in terms of a Markov chain, Time-inhomogeneous Markov chain model and it's applications, Markov chains as a tool for modeling.

UNIT 2 Markov Processes **10hrs**

Markov process, Features of a Markov process model, Poisson process, Kolmogorov equations for a Markov process, Survival models, sickness models and marriage models in terms of Markov processes, Other simple applications of a Markov process.

UNIT 3 Survival Models **12hrs**

Survival models, Model of lifetime or failure time from age x as a random variable, Gompertz and Makeham laws of mortality, Expected value and variance of the complete and curtate future lifetimes, Estimation procedures for lifetime distributions, Various ways in which lifetime data

might be censored, Kaplan-Meier (or product limit) estimator of the survival function in the presence of censoring, Nelson-Aalen estimator of the cumulative hazard rate in the presence of censoring, Models for proportional hazards, Cox model for proportional hazards.

UNIT 4 Survival Models (Contd.) **10hrs**

Derive maximum likelihood estimators for transition intensities, Estimation of transition intensities dependent on age (exact or census), Graduation and graduation tests, Mortality projection, Elementary principles of machine learning and their application.

UNIT 5 Renewal Theory **6 hrs**

Renewal function, Integral equation of renewal theory, Stopping time and Wald's equation, Spent and residual time distribution, Elementary renewal theorem.

Reference Books:

1. Bhat, B. R. (2000), Stochastic Models- Analysis and Applications, New Age International Publishers.
2. Feller, William (1968), An Introduction to Probability Theory and its Applications, Vol. 1 (Third Edition.), John Wiley.
3. Ross, Sheldon M. (1983), Stochastic Processes, 2nd Edition, John Wiley and Sons, Inc.
4. Shrestha, H.B. (2009). Stochastic Processes, An Introductory Text, Ekta Books

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