Course title: Stochastic Modelling for Urban Development			
Course code: MEU 174	**No. of credits:** 3	**L-T-P:** 28-14-0	**Learning hours:** 42
Pre-requisite course code and title (if any): none			
Department: Department of Policy Studies			
Course coordinator: Prateek Sharma	**Course instructor:** Prateek Sharma		
Contact details: prateeks@teri.res.in			
Course type: Compulsory	**Course offered in:** Semester 1		

Course description:

Management of urban development in sustainable manner is a complex task, which results in problems where decision making is required to be done under conditions uncertainty. This is especially true in situations where the outcome of a "process/phenomenon" is subject to chance fluctuations and cannot be explained by the laws of cause and effect due to its dependence of several causative variables, some of which may or may not be known a priori. In order to bring necessary objectivity in decision making the quantification and treatment of this uncertainty is essential for developing stochastic models that can be used in the evaluation of practical problems.

This course is intended to better prepare the techno-managers in grasping the fundamentals of stochastic processes and to develop skills to model these processes in the context of urban development.

Course objectives:

- Need for studying stochastic modelling
- Become aware of a wide range of applications of stochastic modelling in the context of urban development
- Understand the relation between probability and statistics
- Apply probability theory in reliability and risk analysis of systems

Course contents

Module	Topic	L	T	P
1	**Module 1: Introduction** a) Mathematical models–deterministic and stochastic b) Stochastic processes in environment c) The nature of random variables d) Populations and samples e) Parameters and statistics.	1		
2	**Module 2: Introduction to probability theory** a) Probability theory: probability concepts b) Probability distribution functions and their applications – discrete and continuous distributions.	6	2	
3	**Module 3: Inferential statistics** a) Sampling theory, sampling distributions; parameter estimation, point and interval estimates; confidence interval estimation of–means, differences of means, proportions, difference of proportions, variances, ratio of variances sample size determination for different sampling designs b) Hypothesis testing–parametric and non-parametric tests (concerning means, differences of means, proportions, difference of proportions, variances, ratio of variances)	6	2	
4	**Module 4: Statistical distribution modeling** a) Probability plotting methods for different distributions; Goodness-of-fit tests – Chi-square, Kolmogorov-Smirnov and Anderson-Darling test b) Methods of parameter estimation; simulation; applications.	6	2	
5	**Module 5: Correlation and simple regression analysis** a) Correlation analysis: graphical analysis, bivariate correlation, covariance,	3	1	

	correlation coefficient, distribution of correlation coefficient and its statistical significance. b) Simple regression analysis: assumptions and definitions, principle of least squares, regression parameters their distribution and statistical significance, applications in process description and prediction			
	Module 6: Reliability and risk analysis of systems a) Reliability of systems: systems in series, parallel, mixed systems; fault tree analysis, event tree analysis. b) Risk analysis	6	2	
	Case Studies: a) Applications relating to urban transport, water supply, flooding and air pollution etc.		5	
	Total	**28**	**14**	

Evaluation criteria:

	Weightage (%)
Minor Test 1	:15%
Minor Test 2	:15%
Tutorials	:20%
Final Examination	:50%

Learning outcomes:

On completion of this course, the students would:

1. distinguish between a deterministic and stochastic process and situations under which the statistical methods are to be applied
2. develop an intuitive statistical sense
3. analyse, model and quantify uncertainty
4. extract information and draw scientific inference from the data to solve problems related to urban development
5. develop probabilistic models for predicting outcomes of stochastic processes
6. apply the concepts of inferential and to take informed decisions under conditions of uncertainty

Pedagogical approach:

The course will be delivered through classroom lectures and tutorials.

Materials:

Text Books

1. Ayyub B.M. and McCuen R.H. (2011) Probability, Statistics and Reliability for Engineers and Scientists. CRC Press, Boca Raton.
2. Kottegoda N.T. and Rosso R. (2008) Applied Statistics for Civil and Environmental Engineers, McGraw-Hill, International Edition.

Suggested Readings

1. Berthouex P.M. and Brown L.C. (1994) Statistics for Environmental Engineers, Lewis Publishers, CRC Press.
2. Gilbert R.O. (1987) Statistical Methods for Environmental Pollution Monitoring, New York, Van Nostrand Reinhold.
3. Ginevan M.E. and Splistone D.E. (2004) Statistical Tools for Environmental Quality Measurement. John Wiley & Sons Hoboken, NJ.
4. Haan C.T. (1977) Statistical Methods in Hydrology. The Iowa State University Press/Ames.
5. Manly B.F.J. (2001) Statistics for Environmental Science and Management, Chapman & Hall/CRC, Boca Raton, FL.
6. McBean E.A. and Rovers R.A. (1998) Statistical Procedures for Analysis of Environmental Monitoring Data & Risk Assessment, Prentice-Hall PTR, Upper Saddle River, NJ.
7. McBride G.B. (2005) Using Statistical Methods for Water Quality Management: Issues, Problems and Solutions. John Wiley & Sons, Hoboken, NJ, USA.
8. Moore D.S., McCabe G.P. and Craig B.A. (2009) Introduction to the Practice of Statistics, W.H. Freeman and Co., New York.

Additional information (if any): NA

Student responsibilities:
Attendance, feedback, discipline: as per university rules.

Course Reviewers:

Prof. Bilal M. Ayyub, University of Maryland, USA
Prof. Richard H. McCuen, University of Maryland, USA