Course title: Spatiotemporal Data Analysis			
Course code: NRC 171	**No. of credits:** 3	**L-T-P:** 35-07-0	**Learning hours:** 42
Pre-requisite course code and title (if any): NRE 115 Environmental Statistics			
Department: Department of Energy and Environment			
Course coordinator (s): Dr Neeti	**Course instructor (s):**		
Contact details:			
Course type: Compulsory	**Course offered in:** Semester 3		

Course Description

The course is conceptualised to introduce students to statistical analysis in temporal and spatial domain. It leads students into analysis and interpretation of spatial and temporal data, using different tools. There has been tremendous growth of interest in the analysis of spatial data and the application of statistical methodologies for the same in recent times. The goal of the course is to familiarize the students with the basic techniques for use in further research. It will include physical interpretation of the results and limitations of applicability. The course would enable the students to analyse environmental data for improved decision-making, enabling efficient resource management.

Course objectives

To create an overall idea about various statistical distributions and their properties.

1. To understand basic time series components and means to compute them.
2. To analyze a data with time series techniques and apply some basic spatio model.

Course content

SNo	Topic	L	T	P
1.	Introduction: types of data, collection of temporal and spatial data, preparation of data	2		
2.	Generation of Random Numbers: Uniformly distributed Random numbers, Gaussian Random Numbers, Gamma distributed random numbers	4	1	
3.	Time series: classification, components, concept of stationarity	2		
4.	Analysis for trend detection and slope estimation: Parametric approach - Linear Regression; Non-Parametric approach – Turning Point test, Man-Kendall Test, Pre Whitened Mann Kendall test, Theil and Sen's Median Slope	4	1	
5.	Analysis for shift detection: Buishand's test, t- test, Pettitt-Mann-Whitney test	3	1	
6.	Autocorrelation analysis: Estimation of Autocorrelation coefficient, Correlogram, Moving Average process, Autoregressive Process, Autoregressive Integrated Moving Average Process, Cross correlation analysis, application of time series analysis in analyzing environmental and water resources data, forecasting	6	3	
7.	Spectral Analysis: Smoothing of Spectral Density–Barlett' swindow, Blackman and Tukey Window, Spectral Density function of an independent process	2	1	
8.	Preliminary analysis of spatial data: general distributional properties, spatial trends, detecting spatial pattern, testing for spatial autocorrelation	2		

9.	Spatial Interpolation: IDW, Polynomial Interpolation, Spline	2		
10.	Kriging: concept of support, semivariogram, lags and bins, fitting a semivariogram model, assessing accuracy of prediction	4		
11.	Analyzing multivariate data sets: measures of spatial correlation, regression modelling, co-kriging	4		
	Total	**35**	**7**	

Evaluation criteria

- Minor tests: 20% each
- Major test: 50%
- Tutorials/Assignments: 10%

Learning outcomes

After completion of this course students should be able to

1. To generate random samples from different distributions using various algorithms which are useful for sampling from population.
2. Critically analyze a time series data and provide important findings based on them.
3. Execute basic spatial correlation analysis on spatial data.

Pedagogical approach

Materials

Required text

1. Barnett V. (2004) *Environmental Statistics, Methods and Applications*, John Wiley & Sons, 293pp.
2. Box G.E.P., Jenkins G.M. and Reinsel G.C. (2007) *Time Series Analysis Forecasting and Control*, 3e, Pearson Education, Delhi, 598pp.
3. Isaaks E.H. and Srivastava R.M. (1989) *Applied Geostatistics*, Oxford University Press, New York, 561pp.

Suggested readings

1. Anderson D.R., Sweeny D.J and Williams T.A. (2002) *Statistics for Business and Economics*, 8e, Thomson Asia Pte Ltd, Singapore, 885pp.
2. Burrough P.A. and McDonnel R.A. (2007) *Principles of Geographical Information Systems*, 3e, Oxford University Press, New York.
3. Chatfield C. (2003) *The Analysis of Time Series: An Introduction*, 6e, Chapman and Hall, London, 333pp.
4. Conover W.J. (2006) *Practical Nonparametric Statistics*, John Wiley & Sons, 584pp.
5. Daniel W.W. (2000) *Applied Nonparametric Statistics*, Houghton Miffin Company, USA, 510pp.
6. Draper N.R. and Smith H. (1998) *Applied Regression Analysis*, 3e, Wiley & Sons, Inc., 706pp.
7. Helsel D.R. and Hirsch R.M. (1992) *Statistical Methods in Water Resources*, 510pp.
8. Longley P. and Batty M. (eds.) (1996) *Spatial Analysis: Modelling in a GIS Environment*, Geoinformation International, Cambridge, 392pp.
9. McCuen R.H. (2003) *Modelling Hydrologic Change: Statistical Methods*, Lewis Publishers, Florida, 432pp.
10. Piegorsch W.W. and Bailer A.J. (2005) *Analyzing Environmental Data*, John Wiley & Sons, Ltd., 496pp.
11. Ppal S. (1998) *Statistics for Geoscientists: Techniques and Applications*, Concept Publishing Company, New Delhi.
12. Rao A.R., Hamed K.H. and Chen H.L. (2003) *Nonstationarities in Hydrologic and*

Environmental Time Series, Kluwer Academic Publishers, Dordrecht, The Netherlands, 362pp.
13. Reddy P.J. (1997) *Stochastic Hydrology*, Laxmi Publications (P) Ltd., Dew Delhi, 259pp.
14. Webster R. and Oliver M.A. (2007) *Geostatistics for Environmental Scientists*, 2e, John Wiley and Sons Ltd., Chichester, England, 315pp.
15. Zhang C. (2007) *Fundamentals of Environmental Sampling and Analysis*, John Wiley & Sons, Inc., 436pp.

Case studies
Websites

Journals
1. International Journal of Forecasting
2. Journal of Time Series Analysis

Additional information (if any)

Student responsibilities
Attendance, feedback, discipline, guest faculty etc.