



- Singh PK. 2000. *Watershed Management (Design and Practice)*. e-media publications, Udaipur.
- Suresh R. 2006. *Soil and Water Conservation Engineering*. Fourth Edition Standard Publishers and Distributors, Delhi.
- Singh Raj Vir. 2003. *Watershed Management*. Second Edition, Yash Publishing, Bikaner.

**I. Course Title : Stochastic Hydrology**

**II. Course Code : SWCE 504**

**III. Credit Hours : 2+1**

**IV. Aim of the course**

To acquaint students about the stochastic processes in hydrology including statistical characteristics of hydrological time series data, modeling hydrologic uncertainty and analysis of multivariate hydrologic series,

**V. Theory**

**Unit I**

Hydrologic cycle, Systems concept, Hydrologic systems model. Classification of hydrologic models, Statistical, stochastic and deterministic approaches. Statistical characteristics of hydrological data, probability distribution of hydrologic variables. Deterministic and stochastic hydrology, Cause and effect analysis. Hydrologic time series analysis – nature, stationarity and ergodicity, components of time series, trend, periodicity and stochastic parts, parameter estimation of probability distributions. Analysis of hydrologic extremes.

**Unit II**

Multivariate regression analysis, correlation analysis, correlation coefficient and its significance in regional analysis. Developing prediction equation by simple and multiple linear regression. Reliability of the Model.

**Unit III**

Stochastic Process: Classification, stationary process. Time series: Classification, component of time series. Methods of investigation: Auto correlation coefficient, moving average process, auto regressive process, auto regressive moving average process, auto regressive integrated moving average process. Spectral analysis, analysis of multivariate hydrologic series.

**Unit IV**

Thomas Fiering model, Box Jenkins model. Model formulation: Parameter estimation, calibration and validation. Application to hydrologic data. Generation and forecasting. Regional flood frequency analysis. Transformations, Hypothesis testing.

**Unit V**

Modeling hydrologic uncertainty. First order Markov process, Markov chain, Data generation, Hydrologic time series analysis, Modelling of hydrologic time series.

**VI. Practical**

To estimate various statistical parameters of the hydrologic variables, estimating missing data in historical series, various parameter estimation methods like method of moments, method of maximum likelihood, method of mixed moments, probability of weighted moments fitting discrete and continuous distribution functions to



variables, application of transformation techniques to historical data for estimating variables at different return periods, determining correlation and regression coefficients, analyzing multivariate regression, autocorrelation coefficient for independent and correlated events, fitting ARMA models, fitting Markov models of first and second order, regional frequency analysis, time series analysis of the historical data, estimating and fitting Thomas Fiering Model.

### VII. Learning outcome

The students are enabled to understand the stochastic process of hydrology including statistical based analysis of hydrological time series data. They are exposed to stochastic and deterministic modeling of small watersheds.

### VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Hydrologic cycle, Systems concept, Hydrologic systems model	1
2.	Hydrological models, processes and systems - Physical Characterization of watersheds; Rainfall measurements	1
3.	Classification of hydrologic models, Statistical, stochastic and deterministic approaches	1
4.	Statistics and probabilities in hydrology – Basic concepts – Experiment, Sample space, element, event, complement, intersection, disjoint, union, statistical parameters; Uncertainty in hydrological event; Statistical homogeneity, Permutation, combination, probability, conditional probability; Independent events, random variables, discrete and continuous sample space, Probability and Return period	3
5.	Statistics and probabilities in hydrology- Frequency Analysis – Mean, Median, Mode, Variance, Frequency Analysis - Standard deviation, Coefficient of Variance, Skewness, Kurtosis Theorems on Probability; Total probability theorem and Baye's theorem	3
5.	Statistics and probabilities in hydrology- Discrete and Continuous probability - Random Variable and Variate; Probability Distribution of hydrological variables; Co-relation and regression analysis.	3
6.	Introduction and examples of stochastic processes; Specification of stochastic process- nature, stationarity and ergodicity, components of time series,	2
7.	Hydrologic time series analysis –trend, periodicity	1
8.	Stochastic time series analysis- Methods of analysis -Auto correlation coefficient,	1
9.	Stochastic time series analysis- moving average process, auto regressive process,	2
10.	Stochastic time series analysis- auto regressive moving average process,	2
10.	Stochastic time series analysis- auto regressive integrated moving average process.	2
11.	Spectral analysis, analysis of multivariate hydrologic series	2
12.	Thomas Fiering model, Box Jenkins model	2
13.	Model formulation: Parameter estimation, calibration and validation.	2
14.	Application to hydrologic data	2
15.	Generation and forecasting- Regional flood frequency analysis Transformations,	1
16.	Hypothesis testing	1
	<b>Total</b>	<b>32</b>

**IX. List of Practicals**

S.No.	Topic	No. of Practicals
1.	Development of regression models	1
2.	Estimation of missing data in historical series	1
3.	Parameter estimation-Method of Moments	1
4.	Parameter estimation-method of maximum likelihood	1
5.	Parameter estimation- method of mixed moments, Probability of weighted moments	1
6.	Fitting discrete and continuous distribution functions to variables	1
7.	Transformation techniques to historical data for estimating variables at different return periods	1
8.	Regression analysis, Correlation analysis,	1
9.	Analyzing multivariate regression,	1
10.	Autocorrelation coefficient for independent and correlated events,	1
11.	Fitting ARMA models to rainfall runoff data	1
12.	Fitting Markov models of first and second order,	1
13.	Regional frequency analysis,	1
14.	Estimating parameters of Thomas Fiering Model	1
15.	Fitting of Thomas Fiering Model	1
	<b>Total</b>	<b>15</b>

**X. Suggested Reading**

- Clarke RT. *Mathematical Models in Hydrology*. FAO Publication.
- Haan CT. 2002. *Statistical Methods in Hydrology*. Iowa State Press.
- Kotteguda NT. 1982. *Stochastic Water Resources Technology*. The Macmillan Press, New York.
- McCuen RH and Snyder WM. *Hydrological Modelling–Statistical Methods and Applications*. Prentice Hall Inc., New York.
- Yevjevich V *Stochastic Processes in Hydrology*. Water Resources Publications, Colorado.

**I. Course Title : Watershed Management and Modeling**

**II. Course Code : SWCE 505**

**III. Credit Hours : 2+1**

**IV. Aim of the course**

To acquaint students with watershed management concept and its benefit for sustainable rural development through participatory approach, including environmental impact as well as policy frame work.

**V. Theory****Unit I**

Concept of watershed, its hydrological and geomorphological characteristics. Status of watershed management programs in India. Problems of desertification and degradation.

**Unit II**

Concept of watershed management and sustainability, participatory approach and operational watershed. Surveys, monitoring, reclamation and conservation of agricultural and forest watersheds, hill slopes and ravines.