Course title: Hydrology

Course code: NRE 162	**No. of credits:** 3	**L-T-P:** 29-13-0	**Learning hours:** 42

Pre-requisite course code and title (if any):

Department: Department of Energy and Environment

Course coordinator(s):	**Course instructor(s):** Prof. Prateek Sharma and Ms Ranjana Ray Chaudhuri

Contact details: prateeks@terisas.ac.in; ranjana.chaudhuri@terisas.ac.in

Course type: Elective	**Course offered in:** Semester 2

Course description

This course will introduce the core concepts of hydrology. It would provide an understanding of the basic methods and techniques to analyse the different processes governing the hydrological cycle. It would provide the students with an overview of monitoring and evaluation models of key hydrologic parameters. A field-trip or experiment will provide an exposure to the monitoring of hydro-meteorological parameters in practice and improve student's understanding of hydrological modelling. It would prepare students to take up water resource management projects in future with a clear understanding of linkage of water to sustainable development.

Course objectives

1. To analyse precipitation data in detail, including assessment of missing precipitation data and carry out mean areal and intensity duration frequency calculations
2. Assess precipitation losses like evaporation, transpiration and infiltration
3. Understand methods to measure stream discharge and calculate runoff using empirical formulae
4. To develop basic understand of reservoir capacity and flood routing

Course content

Module	**Topic**	**L**	**T**	**P**
1.	Definition, need, history, world water inventory, the Indian scenario, the hydrologic cycle, the monsoon system	2		
2.	Precipitation: process, forms, types, measurement, assessment of precipitation in ungauged basins	2		
3.	Analysis of Precipitation data: required number of rain gauges, data consistency check and data gap fill up, presentation of rainfall data–mass curve and hyetograph, precipitation variability, calculation of required number of rain gauges, estimation of mean precipitation over an area, depth area relationship, intensity-duration-frequency relationship, probable maximum precipitation	4	2	
4.	a. Losses from precipitation: Evaporation-process, measurement and estimation b. Evapotranspiration- process, measurement and estimation of potential maximum evapotranspiration; Interception, Depression storage c. Infiltration-process, measurement and estimation, Horton's equation and phi index method	3	2	
5.	Measurement of Discharge, requirements of a good gauge-discharge site, direct and indirect estimation methods, measurement of stage	3	2	
6.	a. Runoff: components, water yield, flow duration curve, flow mass curve, hydrograph, factors affecting flood hydrograph b. Unit Hydrograph-definition, assumptions, limitation, derivation of UH from storm hydrograph, derivation of UH of longer duration from UH of shorter duration, derivation of UH of shorter duration from UH of longer duration, derivation of storm hydrograph from UH	5	3	
7.	Determination of reservoir capacity using mass curve method and sequent peak algorithm, estimation of sedimentation using area increment	2	1	

	method and empirical area reduction method			
8.	a. Estimation of flood peak-Rational method, empirical formulae, Unit Hydrograph techniques, flood frequency studies b. Flood Routing concept and techniques, hydrologic routing, hydrologic reservoir routing using Modified Puls method, hydrologic channel routing using Muskingum method, introduction to hydraulic routing	5	2	
9.	Introduction to ground water hydrology, concept of aquifers, flow of water to a well in confined and unconfined aquifers	3	1	

Evaluation criteria

Test 1: Written test [at the end of teaching of modules 1,2 3 and 4] - 20%
Test 2: Written test [at the end of teaching module 5,6 and 7]- 20%
Test 3: Written test [at the end of the semester, full syllabus] - 40%
Assignments, one midterm assignment and another at the end of the semester- 20%
One assignment is designed to include field work, where students are encouraged to carry out hydrological study of neighbourhood bio diversity parks, lakes, streams and present hydrological model for the same.
Second assignment contains questions on conceptual models to assess grasp of content

Learning outcomes

After completing this course, the students will be able to

- Ability to quantify rainfall data, estimate return period of extreme rainfall events [Test 1]
- Ability to estimate flood peaks, fix capacity reservoir of reservoirs [Test 2]
- Prepare to take up advanced courses in water resources in future semesters [Test 1 to 3 and assignments]

  [Assessment mechanism for learning outcomes: The three tests and assignments spread over the entire semester]

Pedagogical approach

Classroom lectures, tutorial assignment along with relevant case studies.

Materials

Textbooks

The following textbooks independently cover all the modules.

1. Chow V.T. (1988) *Applied Hydrology,* Tata McGraw Hill Publishing Co.
2. Patra K.C. (2011) *Hydrology and Water Resources Engineering,* Narosa Publishing House.
3. Subramanya K. (2004) *Engineering Hydrology,* Tata McGraw-Hill, New Delhi (compulsory reading).

Suggested readings

Suggested readings may be referred to for getting more insights and additional relevant examples for the more interested student

a. Black P.E. (1996) *Watershed Hydrology,* Lewis Publishers.
b. Chow V.T. (1988) *Applied Hydrology,* Tata McGraw Hill Publishing Co.
c. Jain S.K., Agarwal P.K. and Singh V.P. (2007) *Hydrology and Water Resources of India,* Springer, The Netherlands.
d. Patra K.C. (2001) *Hydrology and Water Resources Engineering,* Narosa Publishing House.
e. Shaw E.M (2004) *Hydrology in Practice,* 3rd Ed, Routledge.
f. Singh G., Venkataraman C., Sastry G. and Joshi B.P. (1990) *Manual of Soil and Water Conservation Practices,* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
g. Singh V.P. (1989) *Hydrologic Systems, Vol–I and II,* Prentice Hall, New Jersey.
h. Singh V.P. (1993) *Elementary Hydrology,* Prentice Hall, Englewood, New Jersey.
i. Suresh R. (2005) *Watershed Hydrology,* Standard Publishers Distributors, New Delhi.
j. Viessman W., Lewis and Gary L. (2002) *Introduction to Hydrology,* Prentice Hall.

k. Ward A.D. and Elliot W.J. (eds.) (1995) *Environmental Hydrology,* Lewis Publishers.

Journals
1.Journal of Hydrology
2.Water Resources Research
3.Journal of Hydrology: Regional Studies

Advanced Reading Material

Additional information (if any)
The students are expected to submit assignments in time and come prepared with readings when provided

Student responsibilities
The students are expected to submit assignments in time and come prepared with readings when provided.

Course reviewers

1. Peter E. Black, Professor Emeritus, Faculty of Forestry and Natural Resources Management, SUNY College of Environmental Science & Forestry, Syracuse, New York.
2. Prof N.K. Goel, Professor of Hydrology, Department of Hydrology, IIT Roorkee, Uttarakhand, India