Course Name:
Advanced Hydrology

Course Number:
20664

Credit:
3

Course Content (outline):

- Overview of Basic Concepts in River Basin Hydrology
    - Hydrologic cycle
    - Hydrologic processes
    - Runoff generation processes
    - Water and energy balance in hydrologic systems

- River Basin Hydro-Geomorphologic Characteristics
    - Principles of channel network initiation
    - Ordering of channel network
    - Hortan laws
    - Physiographic attributes of a river basin
    - Scaling relationships between geometric and topographic attributes of a river basin
    - Stream channel hydraulic-geometry relationships
    - The width function

- Fractal Characteristics of River Basins
    - Fractals and fractal dimensions
    - The box counting dimension
    - Self-similarity in river basins
    - Tests of self-similarity
    - Self-affinity in river basins
    - Hack's law

- Wavelet Transform and its Application in Analyzing Hydrologic and Topographic Datasets
    - Overview of Fourier transform and spectrum
    - The wavelet transform
    - Continuous wavelet transform
    - Contentious models of wavelet functions
    - Wavelet-based energy and power spectra
    - Edge detection and feature extraction
    - Discrete wavelet transform
    - The Haar and Daubechies wavelets
    - Redundancy in wavelet transform and synthesis
    - Spectral properties of river basin topography

- Travel-Time Based Modeling of Transport in Hydrological Systems
    - Lumped hydrologic modeling: opportunities and challenges
    - Overview of unit hydrograph theory and assumptions
    - Residence versus travel time of water
    - A brief overview of tracer and isotope hydrology
    - Theory of time-variant travel time distribution
    - Storage selection function and its estimation methods
    - Stochastic soil-moisture models of transport
    - Modeling river hydrochemistry using dynamic travel time distribution

- Distributed Hydrologic Modeling
    - Flow components
    - Mechanisms of runoff generation
    - Continuum consideration
    - Potential and head
    - Darcy's equation
    - Richards' equation
    - Moisture-release equations
    - Interaction between surface and subsurface flows
    - Principles of Land Surface Models (LSMs)
    - Energy balance at the land surface
    - Modeling latent and sensible heats in hydrologic systems
    - Snowmelt modeling

- Evaluation and Calibration of Hydrologic Models
    - Calibration vs. validation
    - Parameter estimation and uncertainly
    - Sensitivity analysis
    - Overview of statistical approaches for evaluation of hydrologic models

References:

- "Land Surface Hydrology, Meteorology, and Climate: Observations and Modeling", Lakshmi V., J. Albertson, and J. Schaake, American Geophysical Union, 2013.
- "Fractal river basins: chance and self-organization", I. Rodríguez-Iturbe & A. Rinaldo, Cambridge University Press, 2001.
- "The illustrated wavelet transform handbook: introductory theory and applications in science, engineering, medicine and finance", P.S. Addison, CRC press, 2017.