IIT Mandi
Proposal for a New Course

Course number : CE517
Course Name : Hydroinformatics
Credit Distribution : 3-1-0-4
Intended for : B.Tech. (4th year), PG and Ph.D. students
Prerequisite : None; however, familiarity with any computer programming language (e.g., Python, R, MATLAB, etc.) will be helpful during the course.
Mutual Exclusion : None

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1. Preamble:

Hydroinformatics is a newly evolving interdisciplinary subject that utilizes techniques developed in information technology for hydrological applications. With the increasing quantity of large datasets, such as remote-sensing imagery and data from hydro-meteorological simulations, it has become important to derive useful information from these datasets for efficient decision-making. However, traditional spreadsheet-based analysis tools can hardly be used to generate useful information from such large datasets. In this course, students will learn to utilize programming-based advanced hydroinformatics techniques for analyzing climate data, hydrometeorological data, and geospatial data. Students will also get an opportunity to learn to develop automatic calibration tools based on multiobjective optimization for hydrological modeling.

2. Course Modules with quantitative lecture hours:

Module I: Introduction: 6 Hours
Introduction to Hydroinformatics, hydrology, water resources, Smart water management; Forecasting and Early warning system; Major sources of meteorological, climatic, and hydrologic data

Module II: Databases and Data Models 8 Hours
Data life cycle, Data structures, Database management, Data Storage and retrieval, and use data from data models; CSV; NetCDF; Big Data; query aggregate and pivot data using Structured Query language (SQL), Entity Relationship Model; Introduction to Programming and computational tools Python, R, excel, etc.

Module III: Data Analysis and Visualization 8 Hours
Exploratory data analysis techniques; Introduction to data visualization tools; Basic and Specialized Visualization Tools; Visualization tools for geospatial data; interactive data visualization; Creating data dashboards

Module IV: Geospatial Analysis 8 Hours

Analysis of vector and raster datasets; Map Scale and projections; Introduction to GDAL; raster and vector conversions; Analysis and visualization of DEM; Watershed analysis and characterization; Watershed assessment and susceptibility/ vulnerability mapping; Raster querying; Stack Mosaic; Introduction to WebGIS, Introduction to Google Earth Engine and Microsoft Planetary Computer

Module V: Modelling and Simulations 12 Hours

Time series analysis, Rainfall-runoff modeling; statistical analysis: Regression, probability distributions, interpolation, autocorrelation, hypothesis testing, frequency analysis, and return period estimation; Missing data; Hydrological modeling: Uncertainty and sensitivity analysis; Calibration and validation using Monte Carlo (MC), Markov Chain Monte-Carlo (MCMC), Maximum likelihood estimation (MLE), Shuffled Complex Evolution Algorithm (SCE-UA), Dynamically Dimensioned Search algorithm (DDS); Machine learning techniques in Hydrology

3. Text books:

1. Kumar, P., Folk, M., Markus, M., & Alameda, J. C. (2005). Hydroinformatics: data integrative approaches in computation, analysis, and modeling. CRC Press.
2. Remesan R., Mathew J. (2015). Hydrological Data Driven Modelling: A Case Study Approach. Springer.

4. References:

1. Tomer, S. K. (2011). Python in Hydrology. Green Tea Press.
2. Beven, K. J. (2011). Rainfall-runoff modelling: the primer. John Wiley & Sons.
3. Lee, T., Singh, V. P., & Cho, K. H. (2021). Deep Learning for Hydrometeorology and Environmental Science. Springer.

Note: Some research papers, reports and handouts will also be provided as study material during the class.

4. **Similarity with the existing courses:**
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.	Course Code	Similarity Content	Approx. % of Content
1	CE 601	10	25%

6. Justification of new course proposal if cumulative similarity content is >30%:

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