Course Name:

Numerical Methods in Water Engineering

Course Number: 20-640	**Credit:** 3
Program: Graduate	**Course Type:** Technical Selective
Prerequisite: Advanced Engineering Mathematics	**Corequisite:** -

Course Description (Objectives):

The objective of this course is to familiarize graduate students in water engineering, environmental engineering, and hydraulic structures with finite difference methods for modeling flow, pollution dispersion, and suspended materials in rivers, lakes, and seas. Coding exercises are an essential part of the course evaluation.

Course Content (outline):

- Chapter 1: Review of First- and Second-Order Partial Differential Equations (PDEs)
- Chapter 2: Introduction and Comparison of Numerical Methods
- Chapter 3: Fundamentals of Finite Difference Methods (FDM)
- Chapter 4: Discretization and Solution of the Wave Equation
- Chapter 5: Discretization and Solution of the 1D Diffusion (Heat) Equation
- Chapter 6: Discretization and Solution of the 2D Diffusion Equation Using ADI (Alternating Direction Implicit) Methods
- Chapter 7: Discretization and Solution of Laplace and Poisson Equations (2D)
- Chapter 8: Numerical Convergence and Numerical Dispersion/Diffusion in Time-Dependent Equations
- Chapter 9: Solution of Unsteady Hydraulic Equations in One Dimension (Saint-Venant Equations)
- Chapter 10: Numerical Solution of Shallow Water Equations (2D)
- Chapter 11: Introduction to Finite Volume Method (FVM)
- Chapter 12: One Optional Topic from the Following**:**
- Introduction to laterally-averaged models for stratified reservoirs.
- Introduction to groundwater modeling.
- Introduction to multiphase flow simulations.
- Modeling considerations for Iranian lakes and water bodies such as Lake Urmia or Gorgan Bay

Department of Civil Engineering

References:

- Anderson, D. A. et al. (1984), *Computational Fluid Mechanics and Heat Transfer*, Hemisphere Publishing Co.
- Fletcher, C. A. J. (1991), *Computational Techniques for Fluid Dynamics, Vol. 1 & 2*, Springer.
- French, R.H. (2007), *Open Channel Hydraulics*, McGraw-Hill.
- Wu, W. (2007), *Computational River Dynamics*, CRC Press.
- Tsanis, I. et al. (2007), *Environmental Hydraulics, Volume 56: Hydrodynamic and Pollutant Transport Models of Lakes and Coastal Waters (Developments in Water Science)*, Elsevier.
- Ferziger, J.H. et al. (2020), *Computational Methods for Fluid Dynamics*, Springer.