Course Name:

Numerical Methods in Geotechnical Engineering

Course Number:

20408

Credit:

3

Course Content (outline):

1. **Preliminaries and Basic Concepts**
   1.1   What is Modelling?
   1.2   Mathematical, Physical, and Numerical Modellings and their Relationship
   1.3   Main Differential Equations in Civil Engineering Mitigation of Seismic Hazards
   1.4   Numerical Solution of Differential Equations - Spatial and Temporal Discretization

2. **Finite Difference Method (FDM)**
   2.1   Taylor Series Expansion as the Mathematical Base of the FDM
   2.2   FDM Solution of Ordinary Differential Equations
   2.3   FDM Solution of Parabolic PD Equations
   2.4   FDM Solution of Hyperbolic PD Equations
   2.5   FDM Solution of Elliptic PD Equations
   2.6   Stability and Accuracy of Numerical Schemes - Lax Theorem

3. **Finite Element Method (FEM)**
   3.1   Differences between FDM and FEM
   3.2   Transforming the Differential Equations to Integral Equations
   3.3   Interpolation (Shape) Functions for 1 and 2 Dimensional Elements
   3.4   Iso-Parametric, Sub-Parametric and Super-Parametric Elements
   3.5   Transforming Differential Form of the Equilibrium Equation to Integral Form
   3.6   Numerical Integration
   3.7   Transforming the Integral Form of the Equilibrium Equation to System of Algebraic Equations

4. Numerical Modelling of Common Geotechnical Problems Using FEM

References:

Cook, Malkus and Plesha, "Concepts and Applications of Finite Element Analysis", (1989) John Wiley

Bathe, K.J., "Finite Element Procedures in Engineering Analysis", (1996), Prentice Hall

Zienkiewicz & Taylor, "The Finite Element Method", vol. 1, 4th Edition, (1989), McGraw Hill

Smith, I.M., & Griffith, D.C., "Programming the Finite Element Method", 2nd Edition (1992), John Wiley & Sons

Reddy, J.N., An Introduction to the Finite Element Method, McGraw-Hill, 1993