Indian Institute of Technology Kanpur

Revision of CE736

1. **Course Number**: CE736
2. **Course Title**: Computational Hydraulics
3. **Per Week Lectures**: 3L-1T-0P-0A
   - Credits: 3-1-0-0 [11]
   - Duration of Course: Full semester
4. **Proposing Department/ IDP**: Civil Engineering
   - Other Departments which may be interested: Earth Sciences
   - Other faculty members interested in teaching the proposed course: Nil
5. **Proposing Instructor**: Gourabananda Pahar
6. **Course Description**:
   (a) Objective: Computational models are essential tools for designing statutory risk management guidelines of flood propagation. This course aims to develop basic understanding of:
      - overland flow
      - progression of floodwave through rivers and floodplains
      - Analysis and solution of Shallow Water Equations

   (b) Contents:
      i. Overview [5]: Mathematical Behavior of PDEs; Depth-Averaging of conservation laws: Approximation of Shallow Water Equation: Kinematic Wave, Diffusive Wave, Local Inertia, Full Dynamic Models.
      ii. Gradually Varied Flow [5]: IVP, solution mechanisms: convergence, consistency, stability, implicit and explicit schemes.
      iii. Overland Flow [5]: Basics of Finite Volume Methods, Derivation and solution of non-linear Zero Inertia Model.
      iv. Notions on Hyperbolic Equations [3] : The Linear Advection Equation and Basic Concepts, Riemann Problem, Linear Hyperbolic Systems, Eigenstructure and Hyperbolicity, Diagonalization and Characteristic Variables
      v. Linear Shallow Water Equations [4]: Linearised Models, Eigenstructure and Characteristic Variables, Method of Characteristics
      vi. Elementary Waves in Shallow Water [4]: The Riemann Problem and Wave Patterns, Shock-Rarefaction-Contact Discontinutiy
      vii. Exact Riemann Solver [5]: Wet Bed, Passive Scalars, Dry Bed, Admissible Wet/Dry Interface Waves, Tests with Exact Solution
      viii. Notions of Numerical solution of SWE [6]: Monotonicity, Accuracy and Godunov's Theorem, Initial, Boundary and Stability Conditions

ix. Approximate Riemann Solver [4]: Roe, HLL, and HLLC, treatment of source-Sink terms, channel network.

*[ ] indicates number of tentative lectures.

(c) Prerequisites, if any: None

(d) Short summary for including in the Courses of Study Booklet: Flow through river/ channel networks, Overland flow, Flood inundation models: kinematic, diffusive, local and dynamic variants

7. **Recommended books**:

(a) Textbooks: Selected chapters from following books

i. Computational Fluid Dynamics the Basics with Applications, 2017, John D. Anderson, McGrawhill.

ii. Computational Algorithms for Shallow Water Equations, Second Edition, Eleuterio F. Toro, Springer

iii. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, H. K. Versteeg and W. Malalasekera, PHI.

(b) Reference books:

i. Open Channel Flow, 2nd Edition, M Hanif Chaudhry, Springer.

ii. Applied Hydraulic Transients, 4th Edition, M Hanif Chaudhry, Springer.

iii. Applied Hydrology, Chow, Maidment, Mays, McGrawhill.

iv. Riemann Solvers and Numerical Methods for Fluid Dynamics, 3rd Edition, E. F. Toro, Springer.

8. **Any other Remarks**: None

Proposer: Gourabananda Pahar
Date: /03/25
DUGC/ DPGC Convenor:
Date:
The Course is approved/not approved
Chairman SUGC/ SPGC:
Date: