Course Performa

1. Course code and Title : **CE2040: Hydraulic Engineering**

2. Course category : PMT

3. Course credit : (3-1-0-4)

4. Prerequisite course : None

5. Consent of Teacher : Not Required

6. Learning Objectives:

- To develop a basic knowledge of fluid statics and fluid kinematics to solve civil engineering problems
- To gain expertise in applying the conservation laws of mass, momentum and energy to solve fluid flow problems in civil engineering applications
- To introduce the Navier-Stokes equation and its applications in hydraulic engineering
- To develop a basic knowledge of flow measurement techniques, flow through pipes and open channels

7. Learning Outcomes: At the end of the course, the student should be able to:

- Determine pressure variations, and hydrostatic forces on surfaces
- Apply Bernoulli's equation, and Euler's equation to solve problems
- Solve problems using principles of conservation of mass, momentum, and energy
- Solve problems using Navier-Stokes equation
- Solve problems involving flow in open channels

8. Course content:

Introduction: liquids and gases, continuum concept, engineering analysis, applications and connections

Fluid properties: properties involving mass and weight, concept of viscosity, stress tensor, constitutive equations for Newtonian fluid

Statics: pressure variation, manometry, force on an inclined plane, force on curved surface, buoyancy

Kinematics: Eulerian vs. Lagrangian analysis, local and convective acceleration, steady and unsteady flow, one, two and three dimensional flows, Flow visualization: path line, stream line and streak line

Control volume approach: Reynolds transport theorem, conservation of mass, momentum equation, water hammer, conservation of energy; pump and turbine heads and efficiency, Navier-Stokes Equations –derivation and solution for idealized cases; Euler's and Bernoulli's equations; HGL and EGL

Dimensional analysis: need, dimensions, Ispens method

Similitude and Modeling: Model laws (Froude, Reynolds).

Flow measurements: weirs/notches - rectangular, triangular, trapezoidal, errors, velocity of approach, broad-, narrow-crested weirs, ogee weir, submerged weir

Boundary layer concept: derivation of boundary layer equations, laminar boundary layer (thickness, shear, drag)

Pipe flow: Laminar pipe flow - Darcy-Weisbach equation, friction factor, velocity profile, shear stress, Turbulent pipe flow -velocity fluctuation; shear stress, velocity distribution, concept of smooth and rough pipes, friction factor (Nikuradse experiment, Moody Diagram)

Pump-pipe analysis: types of pumps, pump characteristic curves, nondimensional characteristics, specific speed and selection of pump, operating point, pipe network analysis
Open channel flow - channel and flow classifications, geometric elements, flow regimes – Reynolds and Froude numbers, energy equation, concept of specific energy, flow transitions -width and bottom step problems, concept of uniform flow, most efficient channels and channel design, gradually varied flow (GVF)- derivation of equation, normal depth, channel classifications, flow profiles, profile sketches, GVF computations- standard and direct step methods.

9. Text books:

- Roberson, J.A., Crowe, C.T. Engineering Fluid Mechanics. 4th Ed., Jaico Publishing House.
- Subramanya, K., Flow in Open Channels. 4th Ed., McGraw Hill Education (India) Pvt. Ltd.

Proposing Faculty: Dr. Athira

Department / Centre: Civil Engineering

Proposal Type: same as IIT Madras

Programme: B.Tech