Course Number: CE 251 **Approval**: 9th senate meeting

Course Name: Hydraulics Engineering

Credits: 3-0-0-3

Prerequisites: None

Intended for: UG

Distribution: Discipline Core

Semester: Odd/Even

Preamble: This course is an introductory course in fluid mechanics. It begins by asking the question what constitutes a fluid. In the first part the continuum concept, various classifications of fluids are discussed. The second part introduces concepts of statics, kinematics and dynamics of fluids and underlying governing equations. Finally, solutions to various problem involving internal pipe flows and external flows are treated in the third part. Concepts of compressible flow and computational fluid dynamics are introduced at the end of the course. The course also gives an opportunity to learn various methods in EXCEL and MATLAB to solve simple flow problems. The course content have been modified to meet the requirement of civil engineering which will cover the basic of open channel flow and hydrology.

Learning outcomes of this course are anticipated as follows:

- Students will understand the basics of hydraulics, viscosity, pascal's law for pressure distribution
- Students will learn the concepts of fluid static, fluid kinematic and fluid dynamics
- Students will develop the skills to analyze the internal flow profile by concept of Navier stokes equation
- Students will also learn the concepts of dimensional analysis with idea to understand the scale analysis and Buckingham –pie theorem
- Student will be expose to the basic flow application such as open channel, external flow and hydrological system

Course Outline:

- Hydraulic engineering course has flowing outline
- Students will be given tutorials to develop numerical solutions in any of the programming language (FORTRAN, C, C++ or MATLAB)

Modules:

1 **Introduction:** definition of fluid, liquids and gases, continuum hypothesis, Newtonian and non-Newtonian fluids. **(6 contact hours)**

2 **Fluid Statics:** Pascal's law, Manometry, Buoyancy, metacentric height, rigid body motion.

(6 contact hours)

3 **Fluid Kinematics:** Lagrangian and Eulerian fluid motion, vorticity and circulation, rotational and irrotational flows. **(6 contact hours)**

4 **Fluid Dynamics:** Reynolds transport theorem, Equation of mass momentum and inertia, Integral formulation of governing equations, Euler's equation, Bernoulli's equation, Navier-Stokes equation. **(8 contact hours)**

5 **Internal Flows:** Couette Flow, Hagen-Poiseuille flow, flow through pipe, channels, Venturi, Orifice, head loss calculations, Moody's chart. **(8 contact hours)**

6 **Dimensional Analysis:** scaling and similarity, Buckingham π – theorem, model testing. **(4 contact hours)**

7 **External Flows**: Boundary layer flows, laminar and turbulent flows, flow separation, lift and drag, Stokes Law, displacement and momentum thickness. **(4 contact hours)**

8 **Flow in open channel:** Discharge measurements in open channel, Concept of Specific Energy, Critical flow and depth computation, application of specific energy. **(2 contact hours)**

9 **Introduction to hydrology:** Meteorological cycle, rainfall and runoff calculation. **(1 contact hour)**

Text Books:

a) Hunter Rouse, 'Elementary Mechanics of Fluids', John Wiley & Sons, 2011.
b) V.L. Streeter and E.B. Wylie, 'Fluid Mechanics', McGraw Hill Book Co., 1962.
c) P.N. Modi and S.M. Seth, 'Hydraulics & Mechanics', Standard Book House, New Delhi, 2002.
d) K S. Massey, 'Mechanics of Fluids', Van Nostrand Reinhold Co., 1979.
e) J. Frabzini, 'Fluid Mechanics with Engineering Applications', McGraw Hill, 1997.
f) J.H. Spurk, 'Fluid Mechanics – Problems and Solutions', Springer, 2003.
g) Wilson, E. M., 'Engineering hydrology (Vol. 4)', Indianapolis, Indiana,, USA: Macmillan, 1990.
h) Subramanya, K., 'Engineering hydrology', Tata McGraw-Hill Education, 1994.

Reference Books:

a) Lewitt, Ernest H., 'Hydraulics and Fluid Mechanics: A Text-book Covering the Syllabuses of the B. Sc.(Eng.), ICE and I. Mech. E. Examinations in this Subject', Pitman, 1958.
b) Dixon, S. L., and Hall, C., 'Fluid mechanics and thermodynamics of turbomachinery', Butterworth-Heinemann, 2013.