**CE435: FLUID DYNAMICS AND FLUID MACHINES (3-1-0: 4)**

**Course Objectives:** This course aims to introduce the student to the fundamentals of fluid dynamics giving emphasis on the different laws and principles of viscous flow and turbulent flow. Further, the student shall be able to understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

**Dynamics of Viscous Flows**

Viscosity- dynamic and kinematic, Navier Stoke equation, plane Poiseuille flow and its application, Couette flow, Hagen Poiseuille flow, kinetic energy and momentum correction factor, determination of co-efficient of viscosity.

**Turbulent Flow**

Classification of turbulence, Reynolds stresses, Eddy viscosity, Prandtl mixing length theory, velocity distribution over smooth and rough surfaces, continuity equation for turbulence flow, Reynolds Navier-stockes equation.

**Boundary Layer Theory**

Boundary layer thickness-displacement, momentum and energy thickness, laminar sub-layer, Von-Karman integral momentum equation, turbulent boundary layer over a flat plate, separation of boundary layer.

**Forces on Submerged Bodies**

Force exerted by flowing fluid on a stationary body-drag and lift, drag on a sphere, terminal velocity, lift on a circular cylinder, stagnation point, magnus effect, lift on an airofoil.

**Impact of Jet**

Impact of jet on stationary plane and curved surface, impact of jet on hinged surface, impact of jet on moving surface, jet propulsion.

**Hydraulic Machines – Turbines**

Classification of turbines, head and efficiency of a turbine, Pelton wheel, radial flow impulse turbine, Kaplan turbine, mixed flow turbine, surge tank, performance of hydraulic turbine, unit quantities, specific speed.

**Centrifugal Pumps**

Work done by centrifugal pump, efficiency, minimum starting speed, multi stage pump, characteristic curve, maximum suction lift, cavitation.

**Reciprocating Pumps**

Working of reciprocal pump, slip of reciprocating pump, variation of velocity and acceleration, maximum speed of the rotating crank, air vessels.

**Text Books:**

1. S. K. Sam, G. Biswas and S. Chakraborty, “Introduction to Fluid Mechanics and Fluid Machines”, McGraw Hill Education.

2. C. S. P. Ojha, R. Berndtsson and P. N. Chandramouli, “Fluid Mechanics and machinery”, Oxford University Press.

**References:**

1. C. Pozrikidis, “Introduction to Theoretical and Computational Fluid Dynamics”, Oxford University Press.

2. B. F. White, “Fluid Mechanics”, McGraw Hill.

3. J. Frabzini, “Fluid Mechanics with Engineering Applications”, McGraw Hill Education.

**Expected outcome:** At the end of this course, the student will be able to develop the basic competence in derivation of different laws related to fluid movement. They will be able to apply knowledge to the wide spectrum of real life problems. They will be capable of simplifying complicated fluid problems using suitable assumptions. Students will be aware of the importance, function and performance of hydro machinery specifically for centrifugal pump, reciprocating pump and turbines,