Course Number: 28069

Course Name: Advanced Fluid Mechanics

Course Type: Theory	Type & Max Unit: 3 units
Prerequisite: -	Corequisite:-
Level: Graduate	First Presentation:
Group: Energy conversion	Last Edition: November, 2017

Objectives: The goal of this course is to instruct the principal concepts and methods in fluid motions. Then, at the end of this course, students should be able to analyze the fluid motion in every conduit or motion of different bodies in a fluid. It is also expected that they can write the governing equations of the problem in hand in fluid flow.

Topics:

Section 1-Governing equation of fluid motion

1-Tensor Analysis: Index notation, tensor algebra in Cartesian coordinate, tensor calculus, eigenvalues and eigenvectors, tensor algebra in non-Cartesian coordinate, isotropic tensors.
2-Kinematics of a fluid particle: continuum mechanics, Eulerian and Lagrangian spaces, motion mechanisms in a fluid, fluid motion patterns, circulation and vorticity, rotation and vortex.
3-Conservation laws: fluid properties, Reynolds transport theorem, conservation equations, constitutive equation of a Newtonian fluid, governing equations in rotating frame, Kelvin's theorem, Bernoulli equation, Boundary conditions of governing equations.

Section 2- Ideal Flows

4-2D Potential flows: stream function and potential function, application of complex variables, simple flows (Uniform, source and sink, vortex, doublet flows), Superposition(Half body, flow around a circular cylinder, circular cylinder with circulation), flow into a corner, image method, Blasius integral laws, conformal mapping, airfoil theory and Kutta condition.
5- 3D Potential: axisymmetric 3D flows, Laplace equation and its solution, flows in 3D axisymmetric, kinetic energy, added mass in accelerated flows.
6- Surface waves: Small amplitude plane wave, propagation of surface waves, effects of surface tension, complex potential in surface waves, particle paths in surface waves, standing waves, propagation of waves at the interface of two fluids.

Section 3-Viscous, incompressible flows

7- Exact solution of N-S equations: Couette and Poisseluie flow, flow between rotating cylinders, Stokes problems, flow in a converging-diverging channel, pulsatile flows.
8- Laminar boundary layer: Flat plate boundary layer, boundary layer around blunt bodies, Falkner-Skan method, flow around a wedge, stagnation point flows, approximation methods.

References:

C. Currie, Fundamental Mechanics of Fluids, *CRC Press, Inc., 4nd ed.*, 2012.
K. Karamcheti, Principles of Ideal-Fluid Aerodynamics, *Krieger Publishing Company, 1966*
R. L. Panton, Incompressible flows, 3nd *ed., John Wiley & Sons*, 2005.
P.K. Kundu, I.M. Kohen, Fluid Mechanics, 6nd *ed., academic Press*, 2016.
W.P. Graebel, Advanced Fluid Mechanics, *Academic Press*, 2007.