CE 505: Advanced Fluid Mechanics (3-0-0-3)

Course objectives: To enable students deriving the partial differential equations governing the conservation of mass, momentum, and energy of an incompressible fluid, exact solution of Navier stokes equation for simple cases and to solve boundary layer and closed conduit real life flow problems.

Introduction
Introduction to Cartesian tensors and tensor operations, Spatial (Eulerian) and Material (Lagrangian) approach.

Body motion
Description of motion of deformable bodies, Rotation and vorticity, Strain rate tensor, Time rate of change of volume and line integrals, Reynold's transport theorem, Stress tensor, Continuity and equilibrium equations, Constitutive equations.

Fluid dynamics
Derivation of Navier-Stoke's equation and its applications, Introduction to laminar flow, Blasius equation, Karman momentum equation.

Turbulent flow
Description of turbulent flow, Kelvin-Helmholtz instability, Mean flow equations, Prandtl's mixing length, Turbulent Poiseuille flow, Jets and wakes.

Flow of Ideal Fluids
Analysis of Incompressible Flow, Vortex Flow, Flow About a Cylinder without Circulation, Flow Past a Source, Flow About a Rotating Cylinder

Texts Books and References:

1. Ligett, J. A., "*Fluid Mechanics",* McGraw-Hill International Editions.
2. Batchelor, G. K., "*An Introduction to Fluid Mechanics",* Cambridge University Press.
3. Shames, L. H., "*Mechanics of Fluids",* McGraw-Hill.
4. Chatterjee, R., "*Mathematical Theory of Continuum Mechanics",* Narosa Publishing House.
5. Chung, T. J., "*Continuum Mechanics",* Prentice Hall.

Expected outcomes: The students will be able to formulate and solve problems involving partial differential equations governing the conservation of mass, momentum, and energy of an incompressible fluid; obtain dimensionless form of Navier stokes equations; Apply integral form of the boundary layer equations to derive expressions for boundary layer thickness, displacement thickness, momentum thickness and overall drag and be able to solve pipe flow problems

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