OE2044: SHIP HYDRODYNAMICS

Course Content:

Continuity, Euler, Laplace, Navier-Stokes (N-S) and Bernoulli equations; Divergence and Stokes theorems; Potential flow and stream function; Elementary potential flows: parallel flow / source and sink (2D & 3D) sink / vortex / doublet, flow over circular cylinder with and without circulation.Role of compressibility; Vector and tensor forms of fluid dynamic equations; Common dimensional groups (Froude / Reynolds / Cavitation / Euler / Weber / Strouhal numbers); Stokes law of viscosity for shear and normal stresses; Circulation and Stokes theorem (2D & 3D); Helmholtz's vorticity theorems; Vortex line and tube; Vorticity transport equation, convection and diffusion of vorticity; Boundary conditions - rigid and oscillating body or surface, free surface etc., Superposition of elementary flows, Rankine half and closed bodies etc., method of images, source or vortex near wall; Kutta-Joukowski theorem and lift; D'Alembert's paradox; Unsteady flow past circular cylinder and sphere: added mass; Munk moment; Cavitation; Lifting surfaces; Foil section characterizations; Flow around a foil: generation of lift, Kutta condition; Linearised lifting surface theory of thin 2D hydrofoil, thickness and camber problems and their solutions, lift and moment coefficients.N-S equations to Prandtl boundary layer (BL) equations by order of magnitude analysis; Dynamic similarity and boundary conditions; Laminar flow, BL thickness, displacement and momentum thicknesses; BL separation, bluff and streamlined bodies; Vortex shedding by cylinders, Karman vortex street, role of Strouhal no.; Vortex induced vibration; Skin friction, BL along a flat plate at zero incidence, its solution; Blasius formula; Plane Couette flow and Poiseuille flow; Impulsively started plate; Momentum integral equation of BL; Characteristics of turbulent flow; Drag crisis in circular cylinder and sphere; Friction due to turbulent BL over flat plate, power law, roughness effect;

Text Books:

1. **J.N.Newman**, Marine Hydrodynamics, MIT Press, 1977
2. **O.M.Faltinsen**, Hydrodynamics of High Speed marine Vehicles, Cambridge Press, 2005
3. **V.Betram**, Practical Ship Hydrodynamics, B&H, 2000

ReferenceBooks:

1. Principles of Naval Architecture, **E. V. Lewis (Ed.),** SNAME Publications, 1989

Prerequisite: