Fluid Dynamics
(for Sem- II) of M.A/M.Sc (Mathematics)

Classification of fluids, the continuum model, Differentiation following fluid motion. Irrotational flow, vorticity vector, equi-potential surfaces. Streamlines, pathlines, streak lines of the particles, stream tube and stream surface. Mass flux density, conservation of mass leading to equation of continuity. (Euler’s form.) Conservation of momentum and its mathematical formulation: Euler’s form. Integration of Euler’s equation under different conditions. Bernoulli’s equation, steady motion under conservative body forces.

Theory of irrotational motion, Kelvin's minimum energy and circulation theorem, potential theorems. Some two and three dimensional flows, sources, sinks, doublets and vortices, their images with respect to a plane and sphere. Milne –Thompson circle theorem, Butlers sphere theorem, Kelvin's inversion theorem and Weiss's sphere theorem. Axi-symmetric flows and stream function. Motion of cylinders and spheres. Two dimensional flows of irrotational, incompressible fluids, complex potential and its applications to two dimensional singularities. Blasius theorem, D’Alembert’s paradox

Viscous flow, stress and strain analysis. Stokes hypothesis, The Navier-Stokes equations of motion. Some exactly solvable problems in viscous flows, steady flow between parallel plates, Poiseuille flow, steady flow between concentric rotating cylinders.

REFERENCES


Guidelines

Unit-1:

1. Classification of fluids, the continuum model. Differentiation following fluid motion: Ref: 2.1 of F.Chorlton + other types of fluids must be taught from any book, Ref Art 2 of Rutherford, and Art 4 (pp 4) of Kundu, Ref 2.6 of F.Chorlton.

2. Irrotational flow, vorticity vector, equi-potential surfaces. Ref: 2.4, 2.5 of F.Chorlton

3. Streamlines, pathlines, streak lines of the particles, stream tube and stream surface: Ref: 2.3 of F.Chorlton and Sec 4 (pp 54) of Kundu.

4. Mass flux density, conservation of mass leading to equation of continuity. (Euler’s form): Ref: Art- 1 of pp 77 to Art 3 of pp 81 of Kundu and Sec 2.7 of F. Chlotron.

5. Conservation of momentum and its mathematical formulation: Euler’s form. Integration of Euler’s equation under different conditions. Bernoulli’s equation, steady motion under conservative body forces. Ref: Art 5, pp 82-84 and Art 8: pp 88-89 of Kundu, and Art 3.1,3.2,3.3,3.4 3.5,3.6,3.7 of F. Chorlton.


Unit-2:

7. Two dimensional flows of irrotational, incompressible fluids, complex potential of some two dimensional flows and its applications to some two dimensional flows, sources, sinks, doublets and vortices, their images with respect to a plane and circle. Ref: Art 2 pp 155- Art 8 pp 165 of Kundu and Art 5.1,5.2 (only theory and Art 5.3,5.4,5.5,5.7 of F. Chorlton

8. Milne-Thompson circle theorem and its applications, and two dimensional singularities, Blasius theorem and its applications. Ref: Art 5.8, 5.9 of F. Chorlton

Unit-3:
9. Some three dimensional flows, sources, sinks, doublets and vortices, their images with respect to a plane and sphere Ref: Art 4.1, 4.2, 4.3 of F. Chorlton


11. Motion of cylinders and spheres D’Alembert Paradox: Ref: Art 9,10 of pp 165-170 of Kundu and example 1 of F. Chorlton; Examples 2,3,4, pp 115-120 of F. Chorlton.

Unit-4: