BAKER COLLEGE
STUDENT LEARNING OUTCOMES

ME4410 Advanced Fluid Mechanics
3 Semester Hours

Student Learning Outcomes & Enabling Objectives

1. Explore Inviscid irrotational flows
   a. Define Inviscid flows, Irrotational flows, velocity potential lines and stream lines.
   b. Define 2-D and 3-D irrotational flows, Hele-Shaw flows.
   c. Discuss the Superposition and the method of images for Rankine half body, Rankine oval, sphere in a uniform stream.
   d. Explain the Theorems for irrotational flow.
2. Analyze Irrotational Two-Dimensional Flows.
   a. Apply Complex variable theory to two-dimensional irrotational flows.
   b. Compare Flow past a circular and elliptical cylinder with circulation.
   c. Apply Joukowski, Kármán-Trefftz and Jones-McWilliams theorems for NACA airfoils.
   d. Explain Lifting line theory and Kármán vortex street e. Exercise Conformal mapping and the Schwarz-Christoffel transformation.
3. Distinguish Surface and interfacial waves.
   a. Explain Linearized free surface wave theory for Infinitely long channel.
   b. Analyze Waves in a container of finite size, accelerating container and at the interface of two dissimilar fluids.
   c. Derive Stability of a round jet.
   d. Calculate the Local surface disturbance on a large body of fluid - Kelvin's ship wave, Shallow depth free surface waves - cnoidal and solitary waves.
   e. Apply Ray theory of gravity waves for non-uniform depths
4. Formulate Exact solutions of the Navier-Stokes equations.
   a. Calculate Solutions to the steady-state Navier-Stokes equations when convective acceleration is absent.
   b. Analyze 2-D flow between parallel planes, Poiseuille flow in a rectangular conduit, round tube and Couette flow.
   c. Explain Steady and Unsteady flows when convective acceleration is absent.
   d. Explain Stokes' first and seconds problem-impulsive motion, oscillation of a plate.
   e. Solve problems on flows due to round laminar jet and rotating disk.
5. Estimate The Boundary Layer Approximation.
   a. Explain boundary layer theory.
   b. Derive the boundary layer equations and Boundary layer thickness.
   c. Calculate Falkner-Skan solutions for flow past a wedge.
   d. Explain Boundary layer on a flat plate and rotating flows.
   e. Derive the integral form of the boundary layer equation.

   f. Explain Falkner, Von-Mises, Combined Mises-Falkner, Crocco's and Mangler transformations.
6. Analyze Low Reynolds number Flows.
   a. Explain Stokes approximation and Doublet.
   b. Define Stokeslet and Rotlet flows for steady and Unsteady conditions.
   c. Solve Slow steady flow past a solid and liquid sphere.
   d. Estimate Oseen's approximation for slow viscous flow.
   e. Explain Resolution of the Stokes/Whitehead paradoxes
7. Examine Flow stability.
   a. Explain Linear stability theory of fluid flows.
   b. Analyze Thermal instability in a viscous fluids.
   c. Analyze Stability if flow between rotating circular cylinders.
   d. Define Couette-Taylor instability.
   e. Calculate Stability of plane flows
8. Model Turbulence and transition to turbulence.
   a. Explain turbulence and turbulence modeling.
   b. Compare Zero, one, two-equation and stress equation turbulent models.
   c. Explain Equations of motion in Fourier space.
   d. Discuss Quantum theory models and Large eddy models.
9. Apply Computational Fluid Dynamics.
   a. Explain boundary conditions and discretization methods.
   b. Differentiate FDM, FEM and FVM.
   c. Solve Numerical calculus and integration of ordinary differential equations.
   d. Determine Linear stability using invariant imbedding and Riccati methods.
   e. Estimate Errors, accuracy, and stiff equations.

These SLOs not approved for experiential credit.

Effective: Fall 2017