ME 656 Numerical Simulation and Modelling of Turbulent Flows (3-0-0-6)

Introduction: Physical description and significance of turbulent flows. Transition and onset of turbulence; Turbulent free shear and wall-bounded flows; Challenges and complexities. Direct Numerical Simulation (DNS): Introduction; Governing Equations; Computational cost; Examples of DNS of channel and free-shear flows. Large Eddy Simulation (LES): Introduction; Filtering; Filtered conservation equations; Smagorinsky's model; Appraisal and perspective. Reynolds Averaged Equations: Reynolds averaging; Reynolds averaged equations; Closure problem. Turbulent Viscosity Models: Turbulent viscosity hypothesis; Algebraic models; Turbulent-kinetic-energy models; Exact and modelled equations for turbulent-kinetic-energy and its dissipation; Modifications for wall effects and buoyancy-driven flows. Reynolds-Stress Models: Introduction; Closure relations; Examples; Limitations

References:

[1] Tennekes, H., and Lumley, J.L., 1972, *A First Course in Turbulence*, MIT Press, Cambridge, Massachusetts, USA.

[2] Pope, S.B., 2000, *Turbulent Flows*, Cambridge University Press.

[3] Ferziger, J.H., and Peric, M., 2002, *Computational Methods for Fluid Dynamics*, Springer.

[4] Schlichting, H., and Gersten, K., 2000, *Boundary Layer Theory*, Springer.

[5] Garde, R.J., 2000, *Turbulent Flow*, New Age International.

[6] Wilcox, D.C., 1993, *Turbulence Modelling for CFD, DCW Industries*, California, USA.

[7] White, F.M., 1991, *Viscous Fluid Flow*, McGraw-Hill.

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