Amirkabir
University of Technology
Tehran Polytechnic

Department of Aerospace Engineering

Turbulent Flow — Winter 2019

Instructor: Dr. Mehran Tadjfar

Course Objectives: To provide understanding of physics and fundamentals of turbulence, a general introduction of different approaches to turbulent flows, k-ε turbulence model.

Textbook: Class notes provided by the instructor.

Main References:
Tennekes, H. and Lumley, J. H., A First course in turbulence, The MIT Press, 1972.
Hinze, J. O., Turbulence, McGraw-Hill, 1975.
Pope, S. B., Turbulent Flows, Cambridge University Press, 2000.

Further Readings:
Davidson, P. A., Turbulence, Oxford University Press, 2004.
Mathieu, J., Scott, J., An intro. to turbulent flow, Cambridge Univ. Press, 2000.
Durbin, P. A. and Pettersson Reif, B. A., Statistical Theory and Modeling for Turbulent Flows, John Wiley & Sons, 2011.

- Introduction.
- Reynolds decomposition:
  - RANS equations.
  - Reynolds stress equations.
  - Closure problem.
  - Early turbulence models.
- Dynamics of Turbulence:
  - Kinetic Energy Relations.
  - Energy Balance.
  - Homogenous Turbulence.
- Vorticity Dynamics.
- Statistical Description of Turbulence:
  - Two point correlations.
  - Isotropic turbulence.
  - Third order correlation tensors.
- Fourier Space:
  - Auto-correlation function.
  - Energy Spectra.
  - Dynamics of Energy Spectra.
  - Energy transfer function.
- Kolmogrov's Theory of Local Isotropy:
  - Energy Cascade.
  - Modern Criticism.
- Turbulent Shear Flows:
  - Wall Bounded Flows.
  - Channel Flow.
  - Flow at near wall regions.
  - Turbulent Boundary Layer.
- k-ε Turbulence Model:
- More Topics (if time allows) will be added.