MT-621: Turbulence and its Modeling

INTRODUCTION The nature of turbulence, Methods of analysis, The origin of turbulence, Diffusivity of turbulence, Length scales in turbulent flows.

TURBULENT TRANSPORT OF MOMENTUM AND HEAT, The Reynolds equations, Elements of the kinetic theory of gases, Estimates of the Reynolds stress, Turbulent heat transfer, Turbulent shear flow near a rigid wall.

THE DYNAMICS OF TURBULENCE, Kinetic energy of the mean flow, Kinetic energy of the turbulence, Vorticity dynamics, The dynamics of temperature fluctuations.

BOUNDARYFREE SHEAR FLOWS, Almost parallel, two dimensional flows, Turbulent wakes, The wake of a selfpropelled body, Turbulent jets and miXing layers, Comparative structure of wakes, jets, and miXing layers, Thermal plumes.

WALLBOUNDED SHEAR FLOWS, The problem of multiple scales, Turbulent flows in pipes and channels, Planetary boundary layers, The effects of a pressure gradient on the flow in surface layers.The downstream development of turbulent boundary layers.

THE STATISTICAL DESCRIPTION OF TURBULENCE, The probability density, Fourier transforms and characteristic functions, Joint statistics and statistical independence, Correlation functions and spectra, The central limit theorem.

TURBULENT TRANSPORT, Transport in stationary, homogeneous turbulence, Transport in shear flows, Dispersion of contaminants, Turbulent transport in evolving flows.

TURBULENCE MODELING, The Closure Problem, Reynolds Stress Modeling, Modeling the Eddy Viscosity, One-Equation Models, Two-Equation Models, Reynolds Stress Transport Equation.

NEW HORIZONS, Direct Numerical Simulation, Large Eddy Simulation, Detached EddySimulation.

Reference Books:

1. First course in Turbulence, by H. Tennekes and J. L. Lumley, 17th Printing 1999.
2. Turbulent Flows, by S. Pope, Cambridge University Press 2000.