Physics of Turbulence
PHY672

Instructor: Mahendra K. Verma, Physics Dept., IITK

Units: 3 lectures, 9 credits

Prerequisite: None, yet basic knowledge of Navier-Stokes equation and programming is required.

Who can take the course: Ph. D., M. Sc., M. Tech., Advanced UG (final year) students.

Course Contents: Review of Navier-Stokes equations, Spectral descriptions, Homogeneity and isotropy in turbulence, Kolmogorov's theory of turbulence, Two-dimensional turbulence, Higher-order structure functions and intermittency, Application of renormalization groups to turbulence and renormalized (eddy) viscosity. Large-eddy simulations.

Transition to turbulence, Instabilities and Saturation. Pattern formation

Magnetohydrodynamic Turbulence, Magnetic field generation in turbulent flows (Dynamo), Liquid metal flows, Astrophysical applications, Buoyancy-driven turbulence, Rotating turbulence

Direct numerical simulation of turbulence. Hands on experience with some of the codes

This evaluation in this course will be based on exams and projects.

Selected Readings:

(1) M. K. Verma, Energy Transfers in Fluid Flows, Cambridge University Press (2019).
(2) M. Lesieur, Turbulence in Fluids, Springer (2008).
(3) P. A. Davidson, Turbulence, Oxford University Press (2004).
(4) P. Sagaut and C. Cambon, Homogeneous Turbulence Dynamics, Cambridge University Press (2008).