PHYSICS OF TURBULENCE

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TYPE OF COURSE : New | Elective | UG/PG
COURSE DURATION : 12 weeks (29 Jul'19 - 18 Oct'19)
EXAM DATE : 16 Nov 2019

PRE-REQUISITES : Basic fluid dynamics, Calculus, Fourier transforms

INTENDED AUDIENCE : Advanced UG and PG (Masters & PhD) students

INDUSTRIES APPLICABLE TO : Companies working in CFD, turbulence

COURSE OUTLINE :
Turbulence is everywhere in the interiors and atmospheres of planets and stars, galaxies, biological systems including human body, engineering flows, etc. In this course, we will cover fundamental aspects of turbulence Kolmogorov's theory of turbulence in spectral and real space; Two-dimensional turbulence; Energy transfers; Enstrophy and kinetic helicity cascades; more complex applications, such as passive scalar, Turbulent thermal convection, and Magnetohydrodynamic turbulence.

ABOUT INSTRUCTOR :
Prof. Mahendra Verma received his Ph.D. degree from University of Maryland. Presently he is a Professor at the Physics Department of Indian Institute of Technology Kanpur, India. He is a recipient of Swarnajayanti fellowship, INSA Teachers Award, and Dr. A.P.J. Abdul Kalam Cray HPC Awards. He has authored the books "Introduction to Mechanics", "Physics of Buoyant Flows: From Instabilities to Turbulence", and "Energy Transfers in Fluids Flows: Multiscale and Spectral Perspectives". His research interests include turbulence, Nonlinear dynamics, High-performance computing, and Non-equilibrium statistical physics. He and his group have developed a spectral code TARANG that can simulate variety of fluid flows.

COURSE PLAN :

Week 1**:** Introduction; Basic equations of hydrodynamics in real space, Conservation laws

Week 2**:** Fourier Space Description of Hydrodynamics;

Week 3**:** Fourier description (contd), Craya-Herring basis

Week 4**:** Instabilities

Week 5**:** Saturation of nonlinearity, Patterns

Week 6**:** Energy transfers in fluid flows

Week 7**:** Kolmogorov's theory of turbulence (in Fourier space)

Week 8**:** Kolmogorov's theory of turbulence (in real space)

Week 9**:** Enstrophy, Two-dimensional turbulence, Kinetic helicity

Week 10**:** Turbulence with a scalar; Passive scalar;

Week 11**:** Turbulent thermal convection

Week 12**:** Turbulence with a vector, Magneto hydrodynamic turbulence