MANIPAL
ACADEMY of HIGHER EDUCATION
(Institution of Eminence Deemed to be University)

Manipal Centre for Natural Sciences, *Centre of Excellence*, MAHE

A microcredential course

The Physics of Fluid Mechanics

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Fluid mechanics is one of the oldest branches of theoretical physics, founded by Leonhard Euler in 1755. Yet it contains one of the deepest unsolved problems in physics: that of understanding turbulence. Applications to engineering (airplanes, submarines, engines) and weather prediction are thriving because of numerical modeling using various approximations. There are also many applications to other branches of physics (e.g. astrophysics, geophysics). It is useful to understand the basic physics in parallel to learning these applications. Also, physicists need to learn ideas from applied mathematics (e.g., Hidden Markov Models) which are successful in modeling chaotic dynamical systems, which may be useful in developing approaches to turbulence.

This course has two parts:

- An introduction to the basic physics of fluids, starting with the ideas of Euler and Navier-Stokes equations and some simple solutions (1 Credit – 15 hrs) (Jan 20 – Feb24)
- A glimpse of research into turbulence. We will focus on some toy models (dynamical systems with chaos) and test out ideas in small research projects. (0.5 credit – 9 hrs) (April-May timeframe)

You need to know basics of mechanics and vector calculus (e.g., Gauss and Stokes theorems). They will be reviewed at the start of the course. No previous knowledge of fluid mechanics is needed.

Register at: https://bit.ly/reg_micro_mcns

(**Hybrid mode** with in-class and online presence.
In-class participation: restricted to max 30 first-come first-served bases)

Part 1 : January 20 - February 24, 2026 (15 lectures ; 1 hr each)

5 PM- 6 PM on Tuesdays, Thursdays and Saturdays

Class Room II, Dr. T.M.A. Pai Planetarium Building, Manipal
Link will be provided to online registered participants

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SUSTAINABLE DEVELOPMENT GOALS

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About the Instructor

Prof. S. G. Rajeev is a renowned theoretical physicist and a Professor Emeritus of the University of Rochester's Department of Physics and Astronomy. He is known for his contributions in high-energy physics, quantum field theory, string theory, and mathematical physics. His recent research interests include frontier problems in fluid mechanics. Prof. Rajeev has authored books like: Advanced Mechanics: From Euler's Determinism to Arnold's Chaos; Fluid Mechanics: A Geometrical Point of View; Physics Through Symmetries and Fluid Mechanics.

The Course Contents

Review of Vector Calculus
Divergence, curl, commutator of vector fields, Gauss and Stokes theorems.

Ideal Fluids
Derivation of Euler equations for an ideal fluid from Newton's laws, relation to conservation of momentum and mass.

Viscosity and Vorticity
Viscosity and Navier-Stokes equation, scale-invariance and Reynolds number.
Vorticity as the basic dynamical variable.

Simple Solutions for Ideal Incompressible Flow
Laplace's equation, airfoil, conformal transformations (without viscosity).
More realistic examples with viscosity.

Boundary Layer Theory
Classic work of Prandtl/Blasius.

Assessments

Assignments (Minimum for pass – 50%)
Minimum attendance of 75% is also required for the credit.