

ADVANCED FLUID DYNAMICS AND APPLICATIONS: RECAP 2016-17

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Background

- Movement is described by **vectors**, having **direction and magnitude**.
- Wherever we assign a vector to every point in space, e.g. a wind flow velocity map, we need the **vector calculus**.
- Vector fields may be assigned without a physical material present, e.g. gravitational and electromagnetic forces.
- A deformable medium, e.g. rubber, plasticine, liquids, certain plasmas we call a continuum.
- Newtonian fluids, e.g. air, oil and water, are much easier to describe than deformable solids, and provide intuitive examples for the developing the vector calculus.
- Force and motion are related through Newton's laws. The same laws for point objects extend to the continuum.
- Most **fluids** we encounter are **liquids and gases**, but many materials that we consider 'solid' also **flow** on long timescales, e.g. formation of mountain ranges from flow of rock.
- Plasma is the 4th state of matter in the Universe; 99% of matter is in plasma state
- **Applications**: Fluid dynamics, Magneto-hydrodynamics Micro-fluidics (esp. in biology), engineering, climate dynamics,... involving e.g.: Waterways, waves, pipelines, irrigation, micro-fluids (esp. in biology), mixing of chemicals or food, heating/ventilation systems, hydraulics, engines, aerodynamics, weather and climate models, solar and planetary interiors...

Recap Aims

- To revise ability to use the vector calculus.
- To recognise and understand key maths features for fluid, magneto-fluid and plasma motion.

Prerequisites Solid knowledge of Calculus.

Recap Syllabus Grad, Div, Curl, suffix notation, integral theorems; Coordinate systems; Inviscid fluids and irrotational flow.

References

- Matthews, "Vector calculus", IC 515.63(M).
- Acheson, "Elementary fluid dynamics", IC 532.5(A).
- Paterson, "A first course in fluid dynamics", IC 532.51(P).

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Timetable

- Lectures: 5-7pm, 12-22 Sep, PH-8, IIT-BHU, Varanasi
- Tutorials: As per need
- ES = Example Sheet,
HW = Homework (not assessed),

Remarks

- **Collaboration is encouraged.** Help each other to *learn* by discussing principles and methods. For the HWs **you may** show by example, but **you may not** give each other solutions! Help and encourage learning instead by providing *ideas*.
- If you're offered work to copy, say "I'd better work it out for myself". Or say "I've already assigned some time to work on it this week". If someone asks to copy your work, ask what they're stuck on and give ideas and clues instead.