Proposal for a new modular course

1. Modular Course No: SPA 6xx
2. Modular Course Name: Introduction to fluid mechanics in space
3. Class strategy: Lectures per week: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional hours: (0-2): 0 (A), Duration of Course: half semester, Module credit: 5 (3-0-0-0)
4. Proposing department: SPASE
5. Proposing Instructor: Kartick Sarkar, Ishan Sharma
6. Course Description:
A. Objective: Fluid mechanics is used to describe the flows in a range of systems, starting from plane tary atmosphere and the interior of stars to the flow of matter in the largest scale of the universe. This course intends to teach basics of the fluid mechanics and its applications to different astrophysical/geo physical systems.

B. Content:
i. **Basics of Fluids (3-4 L):** Fluid equations (in a rotating frame), concepts of Maxwell-Boltzmann distribution, equations of state in gas and radiation, concepts of viscosity and conduction ii. **Fluid properties (2-3L)**: Steady flow, vorticity (in planetary atmosphere), Reynolds number, Rossby number, hydrostatic equilibrium (planetary atmosphere, stellar atmosphere, adiabatic lapse rate), sound waves
iii. **Applications to geophysical system (4L):** Solar heating; global wind patterns: jet streams, Hadley circulation; shallow water approximation; geostrophic balance; Thermal wind; Taylor-Proudman theo rem; sub- & super-geostrophic balance; cyclostrophic balance; potential vorticity; planetary waves iv. **MHD (3L)**: MHD equations and simple applications (flux freezing etc, magnetic pressure, alfven velocity)
v. **Applications to astrophysical systems (4L):** Supersonic flow (nozzle flow), stellar wind, parker's spiral, accretion disk
vi. **Instabilities (3L):** Rayleigh-Taylor (example in a supernova remnants), Kelvin-Helmholz, convec tion (examples in stellar interior and planetary mantles), Jeans instability (example in star formation) vii. **If time permits:** shocks and geo-dynamo

C. Prerequisites: None
D. Short summary for including in the course study booklet: Basics of fluid mechanics, Magneto hydrodynamics, applications to astrophysical and geophysical systems.

7. Books and references:

1. *The Physics of Fluids and Plasmas*: Arnab Rai Choudhuri
2. *Atmospheric and Oceanic fluid dynamics:* G. K. Vallis
3. *Geophysical Fluid Dynamics:* J. Pedlosky