

Proposal for a new course

Course title: **Introduction to Celestial Mechanics**

Course no.: SPA XYZ **614M**

Proposer: Ishan Sharma, Sharvari Nadkarni-Ghosh, Amitesh Omar

Department: Space, Planetary & Astronomical Sciences and Engineering (SPASE)

Credits: 5 (3-0-0-0)

Pre-requisite: Basic course in mechanics and adequate exposure to calculus.

Note: This **modular** course will be part of the PG **compulsory** course basket in the department.

Course description and contents:

This course helps describe various astronomical observations, primarily within the Solar System, employing relatively simple mechanical models. An introduction to galactic dynamics will also be given. The distribution is given below in terms of 50 minute lectures.

1. Introduction to the Solar System, stars and galaxies – 1 lecture
2. The 1- and 2- body problems: Kepler's laws, Newton's law of gravitation, Equations of motion, Mean and eccentric anomalies, Barycentric orbits, Orbital elements, Applications, e.g. Hohmann transfer – 4 lectures
3. Introduction to galactic dynamics: Collisionless N-body system (Coulomb logarithm, relaxation time, dynamical crossing time), Examples of galactic potentials, Orbits of stars in axisymmetric and non-axisymmetric potentials, Lindblad resonances – 4 lectures
4. The restricted 3- body problems: Equations of motion in a rotating frame, Tisserand relation, Jacobi integral, Lagrangian equilibrium points, Zero velocity curves, Perturbed orbits, Tadpole and Horseshoe orbits, Effect of drag, Applications to small moons – 6 lectures
5. Rotational and tidal effects: Tidal bulge, Potential theory, Tidal and rotational deformation, Shapes of solar system bodies, Roche zone, Tidal torques, Application to small moons – 6 lectures

Textbooks and references:

1. Bertotti, B., P. Farinella and D. Vokrouhlicky 2003. *Physics of the Solar System: Dynamics and Evolution, Space Physics, and Spacetime Structure*. Springer.
2. Binney, J., and S. Tremaine 2008. *Galactic Dynamics*, 2nd ed. Princeton U. Press.
3. Danby, J. M. A. 1964. *Fundamental of Celestial Mechanics*. New York: Macmillan.
4. Diacu, F., and P. Holmes 1996. *Celestial Encounters*. Princeton U. Press.
5. Fitzpatrick, R. 2012. *An Introduction to Celestial Mechanics*. Cambridge U. Press
6. Gurzadyan, G. A. 1996. *Space Dynamics*. London: Taylor & Francis.
7. Murray, C. D., and S. F. Dermott 1999. *Solar System Dynamics*. Cambridge Univ. Press.
8. Roy, A. E. 2005. *Orbital Motion*, 4th ed. CRC Press.

Signature of the Proposer

This course is APPROVED/NOT APPROVED Convener, DPGC
This course is APPROVED/NOT APPROVED Chairman, SPGC

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