MATH0054 Analytical Dynamics

Year:	2021–2022
Code:	MATH0054
Level:	6 (UG)
Normal student group(s):	UG: Year 3 Mathematics degrees
Value:	15 credits (= 7.5 ECTS credits)
Term:	2
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	MATH0009, MATH0011
Lecturer:	Prof A Sokal

Course Description and Objectives

Analytical dynamics develops Newtonian mechanics to the stage where powerful mathematical techniques can be used to determine the behaviour of many physical systems. The mathematical framework also plays a role in the formulation of modern quantum and relativity theories. Topics studied are the kinematics of frames of reference (including rotating frames), dynamics of systems of particles, Lagrangian and Hamiltonian dynamics and rigid body dynamics. The emphasis is both on the formal development of the theory and also use of theory in solving actual physical problems.

Recommended Texts

Relevant books are: (i) Gregory, *Classical Mechanics*; (ii) T L Chow, *Classical Mechanics*; (iii) Goldstein, *Classical Mechanics*; (iv) Taylor, *Classical Mechanics*; (v) Marion, *Classical Dynamics of Particles and Systems*

Detailed Syllabus

- Review of the fundamental principles of Newtonian mechanics; Galileo's principle of relativity.
- Systems of particles and conservation laws: linear momentum, angular momentum, energy (internal and external potentials).
- Systems of coupled linear oscillators: normal modes.
- Introduction to perturbation theory for anharmonic oscillators.
- Lagrangian dynamics: generalised coordinates, variational principles, symmetries and conservation laws.
- Hamiltonian dynamics: phase space, Poisson brackets, introduction to canonical transformations.
- Kinematics and dynamics in noninertial reference frames: centrifugal and Coriolis pseudoforces.
- Rigid bodies: Eulerian angles, inertia matrices, Euler's equations of motions, force-free motion, tops.