MTH5106, Dynamics of Physical Systems

Description

Major developments in mathematics have been driven by the desire to describe and explain phenomena in the natural world. This course introduces students to the mathematical and physical concepts used in modelling physical systems. In particular, the course will explore the laws of motion that govern how systems of particles develop and react to various forces, including gravity, electricity and magnetism, pressure gradients and etc. Mathematical definitions, applications and solutions are reviewed or introduced as necessary. Physical analysis is emphasised.

Parameters

Unit value	1 cu
Level	2
Semester	3
Timetable[1]	

Lectures

Tuesday	12:00-13:00	Queens EB1
Thursday	10:00-11:00	FB 115
Friday	10:00-11:00	Queens EB1

Tutorials

Tuesday	10:00-11:00	Maths 103
Thursday	11:00-12:00	Eng 216

Website	hhttp://www.maths.qmul.ac.uk/~cho/MTH5106.html
Prerequisites	MAS102 (Calculus II) and MAS118 (Differential Equations), or equivalent level of mathematics
Assessment	10% coursework[2], 10% in-course test, 80% final exam
Organiser	Dr. J. Cho Office: Maths 353 Tel: 020 7882 5498 Email: J.Cho@qmul.ac.uk Website: http://www.maths.qmul.ac.uk/~cho/ Office Hours: TU 11:05-11:50, TH 13:00-14:00, FR 15:45-17:00, (or by appointment).

Syllabus

- *Review of motion in space*; displacement, velocity and acceleration using vectors; equation of motion; concept of constants of motion, energy and potentials; circular motion (plane polar coordinates)
- *Mathematical modelling skills*; from statement of problem to mathematical model; evaluating results and model (illustrated with simple example).

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[1] subject to change
[2] one or two random problem(s) will be chosen from the coursework for marking; all problems should be attempted

- *Using equations of motion*; for example, charge particle moving in electric and magnetic fields (simple configuration only); practical uses, such as electron beam deflection; Lorentz force, uniform acceleration, gyration, solution of coupled ordinary differential equations.
- *Newtonian model of gravity*; Newton's universal law of gravity; sphere theorem; projectile motion and escape speed.
- *Central forces* (e.g., gravity and Coulomb electrostatic forces); conditions for conservative force (application of Stoke's theorem); conservation of angular momentum; orbit theory; definition of terms, polar equation of motion, types of orbit; Kepler's Laws of planetary motion; application to solar system and other astrophysical systems – e.g., planets, comets and asteroids.

Aims and Learning Outcomes

Aims

- To introduce students to the mathematical and physical concepts used in modelling physical systems.
- To introduce and illustrate the concepts and use of equations of motion in physical systems.
- To explain and illustrate concepts, such as force, energy, momentum, etc., used in modelling systems as particles.
- To reinforce material introduced in earlier courses, such as *Modelling Dynamical Systems* and *Calculus II*, to give experience in solving problems from the physical sciences, using previously introduced techniques.

Learning Outcomes

By the end of this course, the successful student should:

- Gain a mastery of use of physical concepts to solve simple problems involving point particles.
- Gain familiarity with the use of the laws of motions as applied to systems, including Newtonian gravity
- Understand how mathematical models of physical systems are constructed and how various simplifications and approximations are applied.
- Understanding the importance of evaluating the results of such mathematical models.
- Have a grasp of solving differential equations associated with equations of motion for particle motion.

Texts[3]

- D. Kleppner & R. Kolenkow, *An Introduction to Mechanics* (McGraw-Hill) [primary ref]
- P. Smith & R. C. Smith, *Mechanics* (Wiley) [supp]

J. Cho
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[3] *recommended* only (i.e., need not purchase); few copies of each are available in the library