MATHEMATICS 7302 (Analytical Dynamics)
YEAR 2017–2018, TERM 2

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Lectures: Mondays 12–1 and 4–5, and Wednesdays 10–11, all in Room 706
Office hours: To be negotiated with you later this week

Recommended Texts: One excellent text for the topics of this course is

Gregory, *Classical Mechanics*

You may wish to purchase it. Other good reference books are

Taylor, *Classical Mechanics*
Marion [or Marion–Thornton], *Classical Dynamics of Particles and Systems*
Goldstein [or Goldstein–Poole–Safko], *Classical Mechanics*

Two excellent references for some background topics are

Kleppner and Kolenkow, *An Introduction to Mechanics*
Morin, *Introduction to Classical Mechanics*

I will also hand out my own notes when I feel (modestly) that I can explain a topic better than any of the existing texts.

Prerequisites: You are assumed to have a good background in Newtonian mechanics at the level of MATH 1302. We will devote the first week to reviewing some of the needed material from a unified perspective.

Approximate Outline:

1. Review of the fundamental principles of Newtonian mechanics; Galileo's principle of relativity. Review of solvable cases of one-dimensional motion.

2. Systems of particles and conservation laws: linear momentum, angular momentum, energy (internal and external potentials). Review of central-force motion.

3. Systems of coupled linear oscillators: normal modes. Introduction to waves.

4. Introduction to perturbation theory for anharmonic oscillators.

5. Motion with fixed or moving constraints: Newtonian approach.

6. Lagrangian dynamics: generalised coordinates, variational principles, conservation laws, Noether's theorem.

7. Hamiltonian dynamics: phase space and canonical coordinates, Poisson brackets.

8. Kinematics and dynamics in noninertial reference frames: centrifugal and Coriolis pseudo-forces.

9. Rigid bodies: Eulerian angles, inertia matrices, Euler's equations of motion, force-free motion, tops.

Problem Sets: One cannot learn mathematics solely by watching *someone else* do mathematics (even if that "someone" is a UCL professor). To learn mathematics, you must solve mathematics problems — lots of them — by *yourself*. Therefore, I will assign problem sets every week; they are to be handed in at the following week's problem class. *These problem sets are the most important part of the course.*

It is essential that you do the problem sets faithfully each week; if you put them off, even a little bit, you will have an *extremely* hard time catching up. Give yourself lots of time — mathematics is not a speed race — and do *not* expect to do a whole problem set in one sitting. If you get completely stuck on a problem, go on to another problem, and come back to the first one on a later day — your unconscious mind will be working on it in the meantime! I suggest therefore that you start on the problem set early in the week.

I do not expect you to get everything right on the problem sets the first time around. (Indeed, if you do get everything right, then you should complain to me that the problem sets are not challenging enough!) Rather, the purpose of the problem sets is to give you an opportunity to struggle with the ideas discussed in class by applying them to concrete physical and mathematical problems, and in this way to solidify your understanding of those ideas. Only by such an intellectual struggle can you learn mathematics (or anything else of value, for that matter).

In writing up the problem sets, therefore, you must attempt to explain, as clearly and precisely as you can, the logic behind what you are trying to do: what is the physical or mathematical situation, what are the givens, what are the unknowns, what are the principles to be applied, how you intend to apply those principles, etc. (Please use full English sentences, and large clearly-labelled drawings.) This explanation is especially important if you are *not* able to complete the problem: you should try to pinpoint, as clearly as possible, at what point you got stuck and why — this will serve as the basis for the class discussion. The coursework grade will be based on the logic and clarity of your explanation.

Grading formula:

Coursework	10%
Final exam	90%