P101: Mathematics for Physicists

Course Materials

- The recommended books are

  R. Lambourne and M. Tinker, "Basic Mathematics for the Physical Sciences" and "Further Mathematics for the Physical Sciences" Wiley, 2000.

  There are a number of copies in the library; if they are not available place a reservation (which will trigger the buying of more copies). It may make sense to buy these books yourself; they cost about £20 each.

- Electronic materials related to the course are (and more will be) available on the web at **http://walet.phy.umist.ac.uk/P101**. At the moment this includes a preliminary version of the *lecture notes* (as a pdf file) and all example sheets. There is also an *online discussion forum* (for questions and answers). Please try it out!

- In addition you may find one or more of the following useful for reference. Other similar books which are also suitable may be found in the library in the same section.
  - E. Kreyszig, 'Advanced Engineering Mathematics', Wiley, 1993.
  - P.V. O'Neil, 'Advanced Engineering Mathematics', PWS, 1995.
  - A. Jeffrey, 'Mathematics for Engineers and Scientists', Chapman and Hall, 1996.
  - D. W. Jordan & P. Smith, 'Mathematical techniques: an introduction for the engineering, physical, and mathematical sciences', Oxford University Press, 1997.
  - K.A. Stroud, 'Engineering Mathematics', Macmillan

  Note: The Lambourne and Tinker books are excellent, I prefer them over any of the other books. Jeffrey is not as comprehensive as the other ones, but you may find the style clearer. Stroud is a 'Programmed learning' text which is very popular with some students (and I dislike it!)

Style

There will be lectures on Wednesday and Friday (9 am), and a two-hour workshop on Tuesdays at 11am. Attendence will be taken at all of these events; more details on the following pages.

You are expected to spend about 6 hours/week of your own time on the course; part of this will be through an assigned reading, that will be tested in the workshops.

There are also three pieces of course work; when these are due no reading will be asigned.

Assigned reading, 1st week

All assigned readings will be from R. Lambourne and M. Tinker, "Basic Mathematics for the Physical Sciences", and you are expected to finish the reading *before* the workshop, where you will be tested.

For the first week (i.e., **before next Tuesday!!!**), please attempt the fast track questions (F1-F3) on page 4 and 5, and F1-F3 on page 34 and 35. If you can answer those questions, just read through the chapter quickly. If you have problems answering the questions on the first chapter, work through that chapter in detail (ignore chapter 2). If you have problems with the second chapter only, please work through that chapter.

Module Title: Mathematics for Physicists I

Module Co-ordinator: Dr. Niels R. Walet (Niels.Walet@umist.ac.uk)

Other Staff: Dr. Tobias Brandes, Dr. Philippa Browning

Number of Hours per week: 2 (taught)+2(workshop)

Method of Assessment: Coursework(30%)+1.5 hour exam (70%)
Workshop: Continuous Assessment (100%)

Pass Mark: 40

Credit Rating: 10+5(workshop)=15

Module offered in: 1st semester

Module Description

Mathematics is the language of most of modern physics, and unfortunately the artificial separation of mathematics from physics at A level causes great difficulties at university.

This course builds on the A level knowledge in mathematics and physics the students possess. To overcome the differences between A-level syllabuses, and the possible choices in modular exams, it stresses those elements of mathematics that are crucial to university physics. At every stage connections will be made between the mathematics and the physics it is useful for. The first week of the course will be fully integrated with the core courses in mechanics and fields (and possibly others), where we shall show the students how mathematics can be used to describe and solve A-level physics problems.

Particular emphasis shall be placed on specific weaknesses of the students, as determined by an entrance test on the first day of term. Part of the workshop will be particularly targeted at those weaknesses, and we intend to run at least two streams according to ability, so that all students will have a similar load.

Module Aims

To provide the students with a detailed understanding of basic calculus and algebra, as applicable to physical problems. To help the students appreciate mathematics as the language of physics. To provide a common basis in mathematics to all students, independent of their A-level syllabus.

Learning Outcomes

By the end of this module, it is expected that the student shall be able to: Understand how calculus and algebra are used to describe physical problems. To differentiate functions of one or more variables To perform classes of one-dimensional integrals To solve 1st order differential equations To perform simple vector calculus

Learning Style

The course is taught in 2 1 hour lecture sessions, a 2 hour workshop targeting specific problems identified in the initial test, as well as more specific problems in mathematical physics. The workshop will contain a combination of a short discussion of a topic with a set of problems the students will have to work to. The workshop will be streamed according to capability.

Assessment

Taught part

Students will be expected to hand in three pieces of coursework, each counting for 10areas of "basic" mathematics, the first one will be based on handing in a number of worked examples in those areas. Others will be set a more wide-ranging set of questions.

Workshop

Students will be expected to hand in one problem each week at the workshop. These will be marked, and a record of marks will be kept to judge where problems occur. Students will be awarded 10 marks for each piece of coursework that reaches an adequate standard.

Lecture Content

The use of mathematics in physics. (1 lecture)

Revision of basic material. (2 lectures) Exponentials, logarithms, (base e and base 10), basic algebra. Polynomials, Trig formulae.

vector calculus (5 lectures) Vectors in component form, vector addition, parallelogram and triangle of vectors.
Vector equation of a straight line.
Scalar and vector products of two vectors, scalar and vector triple products and applications.

differentiation Revision of product, quotient and chain rules.
Logarithmic, parametric and implicit differentiation.
Introduction to partial differentiation.
Differentiation of vector functions.

integration Revision (opposite of differentiation, definite and indefinite integrals, area under a curve, methods of integration).
Integration by substitution, integration by parts.
Partial fractions, integration of rational functions.
Application of integration - volumes of revolution.

1st order differential equations Introduction (Examples of Equations and role of arbitrary constants).
Solution of first order ODEs - separable and homogeneous forms.
First order linear ODEs, integrating factors.

Workshop

There will be three academic staff (Drs. Brandes, Browning and Walet), and a similar number of PGs/PDRAs to assist at workshop. There will be two streams, one per room. In case of specific weaknesses additional work can be done by one of the academics in a small (≈ 4) group setting.

A new sheet will be handed out at the beginning of each workshop. We shall use the same sheet for all abilities, but a different set of problems will be done in each room. Problems will be announced at start of workshop.

Structure of a sheet

5 Physics problems (in order of difficulty) using the mathematics discussed in today's workshop.
2 sets of basic mathematics practice problems.
2 sets of abstract mathematics practice problems on today's topic.

Time-plan (fast stream)

30 Minutes Work on physics problems that require mathematics
20 Minutes Tutor works advanced problem/ students explain work in form of board.
10 Minutes Break
30 Minutes A level reinforcement/mathematics practice
20 Minutes Test questions (no collaboration, contains material based on assigned reading)

Time-plan (normal stream)

30 Minutes Work on physics problems that require mathematics
20 Minutes Discuss the basic topic studied over the past week
10 Minutes Break
30 Minutes A level reinforcement/mathematics practice
20 Minutes Test questions (no collaboration, contains material based on assigned reading)

Hand in All work/Everything marked and returned next week. Assessment based on number of times work of an acceptable standard was handed in.

Test

- Some short basic mathematics problems (revision).

- Some short questions on last week's and today's subject.
- All questions must have short answers (maybe even multiple choice on some?) so that they can be marked quickly in detail.
- Record results on test questions for progress monitoring

assigned reading Reading set for next week (typically $\frac{1}{2} - 1$ chapter from the "Basic Maths" textbook), plus a selection of problems from that book.