2A Multivariable Calculus 2013

COURSE

Student Responsibilities

The information contained on this sheet may change! It is your responsibility as a student to check regularly for updates:

- this course's Moodle site;
- your student email.

Lectures

the first lecture is on Tuesday 24th September.

Lectures take place in Semester 1 of the academic year 2013/14 on Tuesdays and Thursdays, weeks 1-11 inclusive, as follows:

$2A_1$ 9am Tuesdays in room 513 (Lecture Theatre D) of the Boyd Orr Building, and 9am Thursdays in room 203 of the Mathematics Building.

$2A_2$ 10am on both Tuesdays and Thursdays in room 354 (Stevenson Lecture Theatre) of the James Watt South Building.

$2A_3$ 11am Tuesdays in Lecture Theatre 208 of the Sir Alexander Stone Building, and 11am Thursdays in room 224 (Main Lecture Theatre) of the Graham Kerr Building.

Tutorials

You will have tutorials fortnightly on Mondays at either 9am, 10am or 11am, starting in either week 2 or week 3. (Ideally, your tutorial will happen at the same time as your set.) You must enrol for both the course and your tutorial section via MyCampus. You should consult Moodle and/or M yCampus for your tutorial room.

Assessment and Examinations

Typically, in weeks 2–11 you will have the following continuous assessment exercises to complete:

a) online Assignment, from WebAssign.

Together these make up 20% of your final grade. There will be a degree exam at the end of the semester, in December. The degree exam makes up 80% of your final grade.

Course Aims

This course deals with calculus of functions of more than one variable, in contrast to First Year Calculus, which is entirely concerned with functions of one variable. The generalisation to two variables is the crucial step. Once this is achieved the generalisation to any number of variables is fairly routine. This course covers mathematical methods useful in Physical and Chemical Sciences and in Statistics. The emphasis is on being able to apply these methods rather than on the underlying theory. The two central topic are differentiation and integration of functions of more than one variable. This includes vector-valued functions as well as scalar-valued functions.

Course Prerequisites

We will assume that everyone is familiar with basic material on differentiation, integration and vector algebra. This includes:

- differentiation
  - product rule,
  - quotient rule,
  - chain rule,
  - implicit differentiation.
- integration
  - method of substitution
  - integration by parts,
  - partial fractions and integrals of rational functions
- vectors in $\mathbb{R}^3$,
  - manipulating expressions involving vector notation,
  - scalar product and its properties (e.g. the scalar product of two non-zero vectors is zero if and only if the vectors are perpendicular),
  - vector product and its properties
  - triple scalar product and triple vector product

A summary of some of this key material from Level 1 courses has been posted on the 2A Moodle page for convenience, but you are also strongly encouraged to review your Level 1 lecture notes.

In calculating your continuous assessment grade we will discard your worst TWO submissions. Your remaining assignments will then make up 20% of your final grade.

The deadlines for weekly submission will normally be:

a) 2A Assignment n must be submitted online using WebAssign by **3am Saturday** of week $n+1$. The first assignment, 2A Assignment 1, is due 3am Saturday 5th October.

The Exercise Sheets will be available on Moodle at mid-day Monday each week (except Exercise Sheet 1, which will be available in the first lecture) . The Assignments will usually be available on WebAssign mid-day on Friday each week. There is a revision WebAssign 2A Assignment 0 which will not count for assessment, and is due 3am Saturday 28th September.

Instructions for submission of assignments to WebAssign are available on the 2A Moodle site.

Lecture Notes and the Recommended Text

We encourage and expect you to take notes during lectures. Lectures will follow the printed notes available on Moodle and solutions to examples from the lecture notes will be covered in class and gaps are left in the notes for students to take notes on these. As a main reference, however, we will follow closely several of the chapters from the book of Stewart:

- *Multivariable Calculus, (international edition)* by James Stewart, published by Brooks Cole; 7th edition; ISBN-10: 0538498862.

This book is available free electronically on WebAssign, initially in flash-only form. If you are running a Mac, you should use a browser that allows flash, for example Chrome. Most students will benefit enormously from the wealth of examples in the recommended text.

Course content

To give you an idea of the content of each chapter, we write [Stewart §x.y] to indicate that the content of Section x.y of the recommended text may be covered. Also included is a rough indication of how many lectures may spend on each topic:

a) **Partial Differentiation:** Drawing and identifying surfaces in 2D and 3D; partial differentiation; partial differential equations. [Stewart §14.1–14.3 & 14.5] **[5 lectures]**

b) **Double and triple integration:** Double integrals; change of variables; double integrals using polar coordinates; triple integrals, triple integrals using spherical coordinates. [Stewart §15.1–15.7 & §15.9–15.10] **[6 lectures]**

Learning objectives

Students should be familiar with all definitions and results covered in lectures, should be able to apply the results and methods covered in lectures to solve problems. Students should also learn to be rigorous and logical in their presentation of solutions. Students should be able to:

- find the parametric description of lines, circles, ellipses and parabolas in two and three dimensions and draw surfaces in three dimensional spaces;
- find partial derivatives of functions of two or more variables using standard techniques such as the product and quotient rules and, in partcular, the chain rule;
- solve first order partial differential equations by a given change of variables;
- solve double and triple integrals in both Cartesian and polar coordinates;
- solve double integrals by change of variables using the Jacobian;
- use beta functions to solve integrals of powers of sine and cosine;
- find the gradient, directional derivative and Laplacian of a scalar field and the divergence and curl of a vector field;
- prove and use identities involving grad, div and curl;
- determine whether or not a vector field is conservative and find a potential if it is;
- find line and surface integrals and be able to state and use Green's Theorem and Gauss' Divergence Theorem.

c) **Differentiation of vectors:** Gradient and directional derivative of a scalar field; divergence and curl of a vector field; Laplacian; proof of nabla identities [Stewart §14.6, §16.1 & §16.5] **[4 lectures]**

d) **Line and surface integrals:** Line integrals and Green's Theorem; line integrals in $\mathbb{R}^3$ and conservative vector fields; surface integrals and Gauss' Divergence Theorem. [Stewart §16.2–16.4, §16.6 & §16.9] **[6 lectures]**

Advice on how to succeed in Level 2 Mathematics

a) After each lecture and before attempting the homework exercises, read and understand your lecture notes. This means that you should ask yourself whether you understand each line of working. If you don't understand something, ask someone else in the class and/or try reading the relevant section in the recommended text. If you still don't understand, ask your lecturer before/after class or during office hours.

b) Form a study group and solve problems together. It's not cheating! Your goal is to understand the content of the course. Learning from someone who already understands something is normally much faster than learning on your own, while having to explain something to someone else is a great way to test your understanding.

c) Memorise every definition. I will ask you to repeat these during lectures, tutorials and exams. If you don't know definitions by heart then it's impossible to make progress in mathematics.

d) Attempt the homework problems before the tutorial and write out full solutions for yourself. If you're stuck, read your lecture notes and the recommended text for inspiration.

e) Go to each tutorial so that you can test the understanding that you've built up so far. If you're puzzled about something, just ask. The tutorial is the time where we give as much feedback as we can. You're also welcome to come to office hours.

This demands a significant amount of your time, probably about 4-6 hours after each lecture (not including lecture and tutorial time). The wonderful thing about mathematics is that it's like riding a bike: once you really understand something, you don't know why it seemed hard in the first place.