UNSW

THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE

SCHOOL OF MATHEMATICS & STATISTICS

MATH5785 GEOMETRY

Semester 1 2011

MATH5785 – Course Outline

Information about the course

Course Authority: Professor Michael Cowling

Lecturer: Professor Michael Cowling RC-5113, email `m.cowling@unsw.edu.au`.

Consultation: Please contact the lecturer before or after lectures, or use email to arrange an appointment.

Credit, Prerequisites, Exclusions:

This course counts for 6 Units of Credit (6UOC).

There is no formal assumed knowledge for this course, but you will need to have seen some Euclidean Geometry, and also to have been exposed to advanced mathematics (such as the usual core 2nd year higher maths subjects), or be in the Advanced Mathematics program. If you are not an Honours student, you will need permission to take the course from the Director of Undergraduate Studies or the Head of Department, and will be enrolled manually—you cannot enrol yourself. As a first step, contact the course authority, Michael Cowling.

Exclusions: none, but see the course authority if you are also taking Transformations, Groups and Geometry (MATH3511).

There is no ordinary version of this subject.

Lectures: There will be three lecturers per week: timetable to be arranged.

Tutorials: There will be one tutorial per week, to be arranged in the first lecture.

Blackboard: Further information, skeleton lecture notes, and other material will be provided via the University's online learning system.

Course aims

This course aims to examine key developments in Geometry from a historical perspective. After a review of Euclid's axioms, we discuss projective geometry, and then spherical and hyperbolic geometries. We finish with a brief introduction to Riemannian geometry, and see how many earlier results can be interpreted and generalised in the language of algebraic geometry.

Relation to other mathematics courses

Pure mathematics may be divided into the broad categories of analysis (calculus), algebra, geometry and logic.

Obviously, this subject fits into the geometry category, but there are overlaps with analysis (order), algebra and logic. It attempts to give an overview of the subject over a three thousand year period, and show how ideas needed for practical crafts such as building, surveying, and navigation led to mathematical formalism; this in turn raised questions whose answers underpin modern inventions like GPS and ATMs.

This course is very useful for those majoring in Pure Mathematics, those planning to teach, or those students of Mathematics who are interested in Geometry, or in the History of Ideas.

Student Learning Outcomes

At the end of this course, you will be able to appreciate the development of one of the finest intellectual achievements of mankind, and will understand how geometry underpins modern science and technology. You will have developed:

- your geometrical intuition and your problem-solving capabilities;
- your understanding of which tool is appropriate to tackle which problem;
- your ability to find information through tools like the world-wide web to solve problems;
- your ability to use computers to illustrate your arguments;
- your competency in mathematical presentation, and your written and verbal skills.

Relation to graduate attributes

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: 1. **Research, inquiry and analytical thinking abilities**, 4. **Communication**, 5. **Teamwork, collaborative and management skills**, 6. **Information literacy**

Teaching strategies underpinning the course

New ideas and skills are introduced and demonstrated in lectures, then you develop these skills by applying them to specific tasks in tutorials and assessments.

Rationale for learning and teaching strategies

We believe (and experience suggests) that effective learning is best supported by a climate of inquiry, in which you are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem-solving tasks in tutorials and in assessment tasks, and you are expected to devote the majority of your class and study time to the solving of such tasks.

Assessment

Assessment in this course will consist of two short assignments, each worth 10% each; a project, to be carried out individually or in teams, worth 20%; and a final examination, worth 60%.

Knowledge and abilities assessed: All assessment tasks will assess the learning outcomes outlined above, specifically, your ability to present logical and coherent geometric arguments, and to solve geometric problems using a variety of methods.

The project will also develop your skills in finding, organising, and presenting information.

Assessment criteria: The main criteria for marking all assessment tasks will be clear and logical presentation of correct solutions; for the project, creativity will also be valued.

Assignments and Project

Rationale: Assignments and the project will give an opportunity for you to try their hand at more difficult problems requiring more than one line of argument and also introduce you to some aspects of the subject which are not explicitly covered in lectures.

The two assignments will involve solving problems that are reasonably close to those presented in the course, and similar to those which will appear on the final examination; these should be done individually. The project will involve you researching topics that may be set by the Lecturer or chosen by you. The topics may be the history of related geometrical themes, the many different proofs that can be found for some theorems, applications of geometry in the modern world, or even using computers to illustrate geometrical proofs. You can choose to do the project individually or in groups. A detailed handout will be provided about the project.

Assessment Schedule:

Task	Date Avail.	Date Due	Form of Submission	Weighting
Assignment 1	Week 2	Mon Week 5	Written	10%
Assignment 2	Week 6	Mon Week 9	Written	10%
Project	Week 4	Mon Week 13	Written or Electronic	20%

Late assessments will be penalised by 10% per day of the available assessment mark.

Every class is different, and to accommodate this, some variation from the above schedule may be prudent. Hence the above schedule should be considered as a guide only, as it may be varied slightly. In the case of assessment dates, no changes will be made without consultation with the class; confirmation of any changes will being posted as an announcement on Blackboard.

Appropriate acknowledgement of the work of others in all assessed work that you do is essential. For more information, see the University web page on plagiarism: `www.lc.unsw.edu.au/plagiarism`.

Examination

Duration: Two hours.

Rationale: The final examination will assess your mastery of the material covered in the lectures.

Weighting: 60% of your final mark.

Further details about the final examination will be available in class closer to the time.

Additional resources and support

Tutorial Exercises

A set of tutorial exercises will be handed out in class. These problems are for you to do to enhance mastery of the course.

Some of the problems will be done in tutorials, but you will learn a lot more and be better prepared for the final examination if you try to do them before the tutorial.

Lecture notes

A set of skeleton notes will be provided for the bulk of the course on Blackboard.

Textbooks

There is no set text for this course. The content of the course will be defined by the lectures. Any book on Geometry may prove useful.

Blackboard

All course materials and handouts will be available on Blackboard. You should check regularly for new materials.

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider your responses and their implications for course development. It is common practice to discuss informally with students in the course how the course and their mastery of it are progressing. In 2011, this course will be running for the first time, and your feedback will be highly valued in order to improve it for future years.

Administrative matters

Additional Assessment

See attached handout.

School Rules and Regulations

Fuller details of the general rules regarding attendance, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web page at:
`http://www.maths.unsw.edu.au/students/current/policies/studentpolicy.html`.

Plagiarism and academic honesty

Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at `http://www.lc.unsw.edu.au/plagiarism` and `http://www.lc.unsw.edu.au/plagiarism/plagiarism_STUDENTBOOK.pdf`.

Detailed course schedule

It is intended that the following topics will be covered in the given order. Any variation from this will be indicated by the lecturer.

Chapter1-EUCLIDEANGEOMETRY

Euclid's axioms, theorems on triangles (the different centres of triangles; Menelaus', Ceva's and Napoleon's theorems), Pappus's theorem. Flaws in the axioms and Hilbert's improvements. Transformations and tilings.

Historical notes: pre-Euclid, Euclid, Alexandria, Hilbert.

Chapter2-PROJECTIVEGEOMETRY

Projective planes and spaces, axiomatic projective planes, coordinatisation and fields.

Historical notes: perspective and renaissance painters.

Chapter3-SPHERICALGEOMETRY

Spherical trigonometry, spherical triangles. Transformations and tilings.

Historical notes: navigation.

Chapter4-HYPERBOLICGEOMETRY

Hyperbolic trigonometry, hyperbolic triangles, Klein and Poincar´ models for hyperbolic spaces, distance and lengths of curves. Transformations and tilings.

Chapter5-RIEMANNIANGEOMETRY

Definition of Riemannian and pseudo-Riemannian manifolds, afne connections, and metrics. Curvature in a manifold.

Historical notes: Einstein and Riemannian geometry, general relativity.

Chapter6-ALGEBRAICGEOMETRY

Projective and afne coordinate systems, algebraic varieties. Introduction to elliptic curves. Bezout's and Chasles's theorems.

Historical notes: Pappus, Pascal and Poncelet's theorems, Fermat's last theorem (work of Faltings, Frey and Wiles).