COURSE INFORMATION

Teaching staff

Course authority: Professor James Franklin
Red Centre rm 6109, Phone:  9385 7093, j.franklin@unsw.edu.au
Consultation times will be advised but you are welcome to call anytime, or send an email suggesting a time to meet.

Course description

The course is worth 6UOC. It is a pass level third year pure mathematics course, suitable for students aiming at a wide range of mathematical careers, in teaching, graphics, data analysis and other areas of mathematics. It is also relevant to the physics of relativity.

**Differential geometry** is about curves, surfaces and higher dimensional analogues of surfaces. We will examine how they bend and twist, find a definition of curvature, and will examine the properties of surfaces which do not change under rigid motions.

**Combinatorial topology** is about the properties of surfaces which do not change if we are allowed to stretch and bend them continuously (without tearing). We will find three properties in particular which will totally classify all surfaces up to such transformations, and find a surprising theorem relating these to the total curvature of a surface.

**Prerequisites:** 12 units of credit in Level II Mathematics courses, including MATH2011 or MATH2111 or MATH2510 or MATH2610. Excluded: MATH3701, MATH3690, MATH3760.

If you are aiming for a distinction or higher, it would be better to take the parallel higher course, MATH3701 Higher Topology and Differential Geometry.

Classes:

The class times and locations are
- Tues 4-5 RC-M010 (lecture, weeks 1-12)
- Thurs 11-12 OMB-115 (lecture, weeks 1-12)
- Fri 9-10 OMB-115 (lecture, weeks 1-12)
- Fri 10-11 RC-1040 (tutorial, weeks 2-13)

Course aims:

The principal aim is to develop a working knowledge of the geometry and topology of curves and surfaces, one of the central and most fascinating topics of mathematics.
The cissoid of Diocles

It builds on material in earlier years on geometry, multivariable calculus and linear algebra, combining these areas in understanding the geometry and topology of smooth curves and surfaces in two, three and higher dimensions. Although it has applications in other areas, especially physics and computer graphics, its main aim is pure understanding of geometry.

Maple is used to display examples but is not a principal part of the course.

Thus student learning outcomes are a sound appreciation and understanding of the basic geometrical and topological properties, constructions and reasoning, with an ability to calculate, prove and draw (with Maple or other mathematical package, such as Matlab).

The course relates especially to the graduate attributes of 1. Research, inquiry and analytical thinking abilities, 4. Communication and 6. Information literacy.

ASSESSMENT

A 50 minute mid-session test in the tutorial of week 6 on Sections 1 and 2 of the course, worth 25%
Two assignments due in weeks 6 and 11, worth 15% each
A 2 hour exam (on the whole course but weighted towards the last half), worth 45%.

The tests and exam are to ensure basic understanding of the material and the assignments encourage longer-term thinking and the construction of proofs. Assignment solutions may be either handwritten or typed. Marking criteria for assignments include clarity and logic of the presentation as well as correctness. See below for academic honesty policy related to assignments.

Late assignments are accepted but with a gradual decay of marks after the due date. Any medical or similar problems affecting tests or assignments should be discussed with the course authority as well as being reported according to UNSW procedures.

Information on additional assessment is at
http://www.maths.unsw.edu.au/currentstudents/additional-assessment

Note especially that an additional assessment exam is automatically allowed for those achieving a mark after the final exam of 40-49, but there is no individual notification of it.

COURSE SCHEDULE

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1 http://xahlee.info/SpecialPlaneCurves_dir/CissoidOfDiocles_dir/cissoidOfDioclesGen.png
1. **Plane curves.**
Classical curves, parametrization, unit speed curves, curvature of a curve, evolutes, total curvature.

2. **Space curves.**
Curves in space, Serret-Frenet equations, fundamental theorem, arbitrary speed curves.

3. **Differential geometry of surfaces.**
Parametrized surfaces, tangent plane and normal, first fundamental form, Gaussian and mean curvature, Gauss map, minimal surfaces, geodesics, Theorema Egregium and isometry, Gauss-Bonnet theorem.

4. **Topology of surfaces.**
Euler characteristic, triangulations, Platonic polyhedra, topological surfaces, Möbius band, real projective plane, classification of surfaces.

**ACADEMIC HONESTY AND PLAGIARISM**

Work on assignments must conform with University policy on academic misconduct. Preliminary discussions on ideas for starting assignment questions are permitted but after that assignments must be the student’s own work. A signed standard declaration should be attached to each assignment. (See end of the document for the form).

Material may be taken from a book or website. The source must be acknowledged.

Maple, Matlab or other software may be used; a printout should be included. (All mathematics students are provided with a computing account and may use the computing labs in RC M020 and G012.)

Standard information on the University’s academic honesty policy is as follows:

The University regards academic misconduct as a very serious matter.

It is the responsibility of each student to use correct methods of acknowledging other people’s ideas. In cases where students collaborate with other students, the extent of collaboration should be included as well as the names of all students who contributed to the piece of work. Anyone not already familiar with correct forms of acknowledgement is strongly advised to consult the UNSW Learning Centre Web Page on *Avoiding Plagiarism* ([http://www.lc.unsw.edu.au/plagiarism/index.html](http://www.lc.unsw.edu.au/plagiarism/index.html))

The School’s information is at [http://www.maths.unsw.edu.au/currentstudents/policy-academic-misconduct](http://www.maths.unsw.edu.au/currentstudents/policy-academic-misconduct)

**RESOURCES FOR STUDENTS**

**Lecture notes:** There are no printed notes available yet so students will need to take notes in lectures. Hopefully students will volunteer to take turns to create notes – e.g. a scan of neat handwriting – which the lecturer will put on the Moodle course page.

**Problem sheets:**
A new set of problems will be created in 2014 as we go along. There are three types of problems in the problem sheets: filling the gaps from the lectures (treat these as compulsory), typical applications of the theory (some will be used later), and few problems on further topics (optional). Much of the exam and mid-session test will contain problems similar to those on the problem sheets.
The main resources will be made available on Moodle, but otherwise not much use will be made of it.

There is no textbook, but useful books are:
For preliminaries, consult *Calculus* by Sallas and Hille (chapters 9, 13); or *Calculus of several variables* by R.A. Adams (chapter 5 and Appendix I), or *Calculus and Analytical Geometry* by Thomas and Finney, or *Vector Calculus* by Marsden and Tromba.
For the early chapters, consult *Elementary Differential Geometry* by B.O’Neill; or *Differential Geometry* by Lipschutz (Schaum outline series), M. do Carmo: *Differential geometry of curves and surfaces* or A. Gray, *Modern Differential Geometry of Curves and Surfaces*.
Check the library for books with “differential geometry” in the title (typically in numbers 516.7), but avoid books on abstract differential geometry on manifolds, which are too advanced for this course.
For topology, *Elementary Topology* by D. Blackett is a standard reference, but perhaps more useful is the book *An Initiation to Combinatorial Topology* by Frechet and Fan.
Many pictures can be found at [http://xahlee.info/](http://xahlee.info/) which has a ‘Visual dictionary of special plane curves’ and a ‘Surface gallery’.

**CONTINUAL COURSE IMPROVEMENT**

Student feedback is very important to continual course improvement. This is demonstrated within the School of Mathematics and Statistics by the implementation of the UNSW Course and Teaching Evaluation and Improvement (CATEI) Process, which allows students to evaluate their learning experiences in an anonymous way. The resulting evaluations are ultimately returned to the course convenor, who will use the feedback to make ongoing improvements to the course.
(Students in 2008, found there was too much examination and it has been reduced; those in 2010 suggested a better balance of marks between mid-session and final, which has been done. It seemed from 2012 that a better set of problem sheets may be needed, which will be done.)

**Plagiarism Declaration for Assignments:**

Declaration by Student Submitting this Assignment

I declare that this assessment item is my own work, except where acknowledged, and has not been submitted for academic credit elsewhere, and acknowledge that the assessor of this item may, for the purpose of assessing this item:

Reproduce this assessment item and provide a copy to another member of the University; and/or,

Communicate a copy of this assessment item to a plagiarism checking service (which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking).

I certify that I have read and understood the University Rules in respect of Student Academic Misconduct.

signed............................ date.................