UNSW SYDNEY

FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND STATISTICS

MATH3531

DIFFERENTIAL GEOMETRY & TOPOLOGY

Term 2, 2019

MATH3531 – Course Outline

Information about the course

Course Authority & lecturer:
Dr John Steele, Red Centre 5103, email `j.steele@unsw.edu.au`

On-line course: This course is not usually offered in odd years, and is restricted to those MATHV14075 stream students who will be otherwise unable to complete the geometry requirement in time to graduate.

Consultation: My consultation hours will be announced in week 1, but you can either drop in at other times (if I'm free) or use email to arrange an appointment.

Credit, Prerequisites, Exclusions:

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

The pre-requisites are 12uoc of level 2 maths including MATH2011 or MATH2111. In practice, you will also need a good knowledge of Linear Algebra too.

Excluded courses: MATH3701, MATH5700

Lectures: The lectures will be completely online, using the recordings made in semester 2 2018 as a basis. They will be posted on moodle. I may add other lectures, or cover some of the material in the allotted tutorial time if that proves possible or useful.

Tutorials: There will be one tutorial per week at 1pm on Wednesdays. It is currently listed as taking place in SEB G02, but we may look to move it somewhere more convenient.

e-learning: Further information, skeleton lecture notes, and other material will be provided via Moodle.

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. It builds on earlier courses in linear algebra and multivariable calculus.

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.

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

Assessment

Assessment in this course rewards students for working consistently at the tutorial problems throughout the session. It encourages the development of analytical thinking, the ability to understand and solve problems, and to express mathematics clearly in written form.

In tests and exams, marks will be awarded for correct working and appropriate explanations and not just the final answer. Test and exam questions will largely be based on tutorial problems and/or sample tests and exams.

Assessment in this course will consist of the following:

Revision Tests	formative	available on moodle as a self-check your knowledge of pre-requisite material.
Mid session Test	worth 20%	A 45 minute test held in the **week 5** class covering the material from sections 1 and 2.
Assignment 1	worth 15%	Due at the end of week 6.
Assignment 2	worth 15%	Due at the end of week 9.
Exam	worth 50%	A 2 hour exam (on the whole course but weighted towards the last half)

Assignment solutions may be either handwritten or typed; diagrams may be drawn with either hand or computer (e.g. Maple or GeoGebra). see the assignment instructions for details.

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.

Assessment criteria: UNSW assesses students under a standards based assessment policy. For how this policy is applied in the School of Mathematics and Statistics see

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

The main criteria for marking all assessment tasks will be clear and logical presentation of correct solutions, in particular in the construction of proofs.

Absence from test:

If you are absent from the test, you must apply for special consideration using the UNSW Special Consideration online service. For details, and all other MathsStats policies of assessment, see

https://student.unsw.edu.au/special-consideration

https://www.maths.unsw.edu.au/currentstudents/assessment-policies

Resit of class test:

If you miss a class test and provide valid documentation, you will be permitted to take a resit version of the test. This resit will be offered a week or two after the original test, at a time outside the usual class times, probably at either 8am or 6pm on a day to be agreed (and depending on availability of a room).

If you are absent without a medical certificate you will receive an A which gives a mark of zero for that task.

Examination

Duration: Two hours.

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

Weighting: The final examination will count for 50% of your final mark. It will cover the whole course but be weighted towards the last half.

Calculator: You may bring a UNSW approved calculator to the exam, so long as it carries a UNSW sticker which shows that the calculator has been checked. These stickers may be obtained from the School of Mathematics and Statistics Office, and other Faculty Student Centres or Schools. See
https://student.unsw.edu.au/exam-approved-calculators-and-computers
for a link to the list of approved calculators.

Additional resources and support

Lecture notes

A set of outline lecture notes will appear on moodle.

Problem sheets

There will be a range of degrees of difficulty in the problems, from easy to hard, as well as filling in gaps in the lectures. Much of the exam and mid-session test will contain problems similar to those on the problem sheets and/or sample tests and exams.

Textbooks

There is no textbook as the content of the course will be defined by the lectures.

But some useful books are:

Calculus, one and several variables by Sallas and Hille, which contains some of the elementary material on curves and surfaces, as does *Calculus and Analytical Geometry* by Thomas and Finney. Both are or were recommended first and second year texts. *Vector Calculus* by Marsden and Tromba is an excellent text on the background material.

For the course itself, there are many books on differential geometry of curves and surfaces, Lipschutz's book *Differential Geometry* in the Schaum outline series is a typical example, and is no better or worse than any. O'Neill's *Elementary Differential Geometry* is quite close to the way I will do parts of the course. Check the library for books with "differential geometry" in the title, but note that many of them will deal with abstract differential geometry of manifolds, which is a deeper subject than ours, and many will be more advanced than I will be.

For the combinatorial topology, Donald Blackett's *Elementary Topology* is a standard reference. More useful is Frechet and Fan's lovely little book *An Initiation to Combinatorial Topology*. Many books on recreational mathematics deal with this material in a non-technical way: Martin Gardener's *Mathematical Puzzles and Diversions* series has many interesting articles from his column in *Scientific American*. Again, look through the library, but this time be wary of books on general (point-set) topology and algebraic topology (a very high-powered topic).

Moodle

All course materials and important announcements will be available on moodle. You should check regularly for new materials.

Rough Course Outline:

Wk	Topics
1.	**Plane Curves**: Classical Curves; Descartes' Giant Leap; Parameterisation; General Curves in the Plane; Unit Speed Curves;
2.	**Plane Curves**: Curvature; Serret-Frenet Eqns; Geometric Significance of Curvature; Evolutes and Involutes;
3.	**Plane Curves**: Envelopes; Total Curvature. **Space Curves**: Curves in Space; Serret-Frenet Equations;
4.	**Space Curves**: Fundamental Theorem of Space Curves; Arbitrary Speed Curves. **Differential Geometry of Surfaces**: Parameterised surfaces; Tangent Plane and Normal; First Fundamental Form;
5.	**Diff. Geom. Surfaces**: Shape Operator; Normal Sections; Gaussian and Mean Curvature; Second Fundamental Form;
6.	No lectures
7.	**Diff. Geom. Surfaces**: Gauss Map; Minimal Surfaces; Geodesics; Theorema Egregium & Isometry; Gauss-Bonnet Theorem.
8	**Toplogy of Surfaces**: Euler Characteristic; Topological Surfaces; Platonic Polyhedra; The Möbius band;
9.	**Toplogy of Surfaces**: The Real Projective Plane; Combinatorial Surfaces;
10.	**Toplogy of Surfaces**: Combinatorial Surfaces (continued); Colouring Maps.

Student Learning Outcomes

At the conclusion of this course you should

1. demonstrate an understanding of the differential geometry and topology of curves, including calculating their invarients and using them in applications.
2. demonstrate an understanding of the classical differential geometry of surfaces, including calculating curvature of a surface and the properties of special curves on surfaces and using these in applications.
3. complete a topological classification of a surface.

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**, 6. **Information literacy**

Teaching strategies underpinning the course

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

Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes, in the case of lectures, and, in the case of tutorials, by having made a serious attempt at doing for themselves the tutorial problems prior to the tutorials.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Administrative matters

Special Consideration

The School of Mathematics and Statistics has a strict policy on additional assessment. It can be found at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

If you are ill for a class test then you should use the on-line Special Consideration Application to apply for the resit test: see above.

If you are ill for the final exam then you should also apply on-line for Special Consideration.

If you have a special consideration granted for the final exam, the Exams Unit will email the rescheduled supplementary exam date, time and location to your student zID email account directly. Please ensure you regularly check your student email account (zID account) for the information on new dates to attend an assessment, or dates for any supplementary exam both in Term and Final.

The supplementary exam period/dates for the final exam can be found at this web site:
https://student.unsw.edu.au/exam-dates

Academic Misconduct

The University of New South Wales has rules relating to Academic Misconduct. They can be found at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

Rules for the Conduct of Examinations

The University of New South Wales has rules for the conduct of examinations. They can be found at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

School Rules and Regulations

Fuller details of the general rules regarding attendence, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web page at

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

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
https://student.unsw.edu.au/plagiarism