UNSW SYDNEY

Faculty of Science
School of Mathematics & Statistics

MATH2089
NUMERICAL METHODS
and
STATISTICS
Semester 1, 2018

Course information

- 6 UOC
- Prerequisites: MATH1231 or MATH1241 or MATH1251
- Exclusions: BEES2041, BIOS2041, CVEN2002, CVEN2025, CVEN2702, ECON2215, MATH2049, MATH2099, MATH2301, MATH2801, MATH2829, MATH2839, MATH2841, MATH2859, MATH2899, MATH2901, MINE2700
- MATH2089 is only available to students for whom it is specifically required as part of their program.

Course structure

This course consists of two components – one on **Numerical Methods** and one on **Statistics**. Each component has two hours of lectures and one tutorial class per week. In each component the tutorials alternate (as detailed below) between being held in the Red Centre computer labs and being held in a tutorial classroom.

This course is administered by the School of Mathematics and Statistics. In Semester 1, 2017 it will be taught using the combined resources and staff of the School of Mathematics and Statistics and School of Mechanical and Manufacturing Engineering.

Course staff

The course lecturers are:

- Dr. Victoria Timchenko (Numerical Methods),
  J17 401C, phone 9385-4148, email v.timchenko@unsw.edu.au

- Prof David Warton (Statistics),
  RC-2052, phone 9385 7031, email david.warton@unsw.edu.au

Consultation times will be announced in lectures and on the course web page. You will also be assigned a tutor for the Numerical Methods tutorials and a tutor for the Statistics tutorials. They should be your first point of contact for any questions about this course. A record of your attendance at tutorials will be kept – it is your responsibility to ensure this has been recorded.

Location and Times

- Lectures
  Tuesday 16:00—18:00 -- Mathews A (Numerical Methods) – Weeks 1 -- 12
  Friday 9:00—11:00 -- Mathews A (Statistics) – Weeks 1 -- 12

- Tutorials

  Numerical Methods component
  - Laboratory class even weeks (commencing in week 2)
  - Tutorial class odd weeks

Statistics component

- Introduction to Computing Labs and Matlab (RC-G012, Week 1)
- Laboratory class (RC-G012), Weeks 1, 2, 4, 6-8
- Tutorial class, Weeks 3, 5, 9-13

Note that in Week 1, there is an introductory computer laboratory held in your statistics tutorial time. **Before your introductory computer laboratory in Week 1** you should make sure you can logon to the computers in the Red Centre ground floor computing laboratory (RC-G012) using your **zID** (UNSW User ID) and **zPass**. You can activate or unlock your zPass using the UNSW Identity Manager. If you are having difficulties please go to the Computing Centre helpdesk on the mezzanine level of the Red Centre.

Course Web Site

The MATH2089 course web site will be available through UNSW Moodle

http://moodle.telt.unsw.edu.au/

UNSW Moodle is accessed using your zID and zPass.

You should check the course web site regularly for new and updated information.

Announcements

Announcements may be made in lectures or through the course web site.

Course description

This course gives an introduction to numerical methods and statistics essential in a wide range of engineering disciplines.

- **Numerical methods**: Computing with real numbers. Numerical differentiation, integration, interpolation and curve fitting (regression analysis). Solution of linear and nonlinear algebraic equations. Matrix operations and applications to solution of systems of linear equations, elimination and tri-diagonal matrix algorithms. Introduction to numerical solution of ordinary and partial differential equations.

- **Statistics:** Exploratory data analysis. Probability and distribution theory including the Binomial, Poisson and Normal distributions. Large sample theory including the Central Limit Theorem. Elements of statistical inference including estimation, confidence intervals and hypothesis testing. One sample and two-sample t-tests and F-tests. Simple and multiple linear regression and analysis of variance. Statistical quality control.

In each component, applications will be drawn from a variety of engineering disciplines. Matlab will be used extensively as a practical tool for both numerical and statistical computations and to illustrate theoretical concepts**.**

Expected Learning Outcomes

The **Numerical Methods** component will enable you to understand how mathematical models of problems arising in Engineering (and other areas) can be solved numerically. At the end of this course you will be able to

- identify risks associated with floating point computations
- demonstrate a basic knowledge of the techniques for accurate and efficient solution of models based on linear and nonlinear systems of equations, ordinary differential equations and partial differential equations.
- apply these techniques to practical problems in Engineering.
- use Matlab for the implementation and application of numerical methods and the visualization of results.

The **Statistics** component will enable you to understand the various ways in which random variation arises in engineering contexts and to develop facility at:

- applying various graphical and data analysis methods for summarizing and understanding data;
- applying various statistical models and methods for drawing conclusions and making decisions under uncertainty in engineering contexts;
- applying Matlab for graphical and statistical analysis.

We believe that effective learning is best supported by a climate of inquiry, in which students are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem solving tasks in lectures, in tutorials and laboratories, and in assessment tasks. Students are expected to devote the majority of their class and study time to the solving of such tasks.

New ideas and skills are first introduced and demonstrated in lectures, and then students develop these skills by applying them to specific tasks in tutorials and assessments. Computing skills are developed and practiced in regular computer laboratory sessions.

This course has a major focus on research, inquiry and analytical thinking as well as information literacy. We will also explore capacity and motivation for intellectual development through the solution of both simple and complex mathematical models of problems arising in engineering, and the interpretation and communication of the results.

Course Evaluation and Development

The School of Mathematics evaluates each course each time it is run. Feedback on the course is gathered, using among other means, UNSW's myExperience. Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback. Past comments have highlighted the critical importance of gaining competence in Matlab as early as possible. To this end, the online self-paced Matlab tutorials have been completely updated.

In the past few years we have trialed online quizzes in MATH2089 to encourage consistent engagement with the course. Students found these very helpful. This semester we are using three on-line quizzes in the course, for the Statistics component. The purpose of these is primarily to try to keep you up to

date with the material being covered and to provide feedback on how you are progressing. Thus their weight in the stats component of the course is just 15%.

Assessment

The final grade in MATH2089 will be based on the sum of the marks from each of the Numerical Methods and Statistics components. Final grades may be adjusted by scaling with the approval of the appropriate departmental meeting.

You cannot pass this course unless you have achieved a mark of at least 40 in both the Statistics and Numerical Methods components. If you do not get at least 40 in each component, you will receive the grade UF* -Unsatisfactory Fail, even though your overall course mark may be greater than 50. You will still be entitled to sit the concessional additional assessment exam if your final mark is 40 or above. See the School of Mathematics and Statistics Website for detailed assessment policies.

*The grade UF is awarded if there is unsatisfactory performance in an essential component of the course.

Examples

- You get 60 in the Statistics component and 40 in the Numerical Methods component, averaging 50, which is a pass.
- You get 35 in the Statistics component and 65 in the Numerical Methods component, averaging 50. As the mark for the Statistics component is less than 40, your final grade would be UF, but you can sit the concessional additional assessment.
- You get 55 in the Statistics component and 23 in the Numerical Methods component, averaging 39 which is your final mark, and you are not entitled to sit the concessional additional assessment.

Numerical Methods assessment schedule

ASSESSMENT COMPONENT	DETAILS	MARKS	DUE DATE
Matlab computer Test	Lab Test administrated during labs period	12	Week 6
Mid-semester Test	Test (30-35 minutes long) administered during tutorials	13	Week 7
Matlab computer laboratory participation	Satisfactory participation in laboratory classes	15	Throughout Semester
Final examination	During exam period. The formal exam scripts will not be returned.	60	June 2018
Total		100	

Statistics assessment schedule

ASSESSMENT COMPONENT	DETAILS	WEIGHTING	DUE DATE
Introductory Matlab Quizzes	Available via MapleTA from Moodle web page. Start as early as possible from Week 1.	5%	End of week 2
Statistics on-line Quizzes	Three quizzes during semester, available via MapleTA from Moodle (2 marks each)	15%	End of week 5 End of week 9 End of week12
Mid-semester Test	Test administered on Maple TA during your Week 7 lab class. You must sit the test in the lab class in which you are enrolled	20%	Week 7 lab class
Final Examination	During the exam period. 2 hours (including Numerical Methods)	60%	June 2018
Total		100%	

Rationale for assessment: The on-line quizzes and class tests will give students regular opportunities to get feedback on their progress and mastery of the material.

Details of the material to be assessed in each mid-semester test will be made available in the couple of weeks before the test. Note that **students must sit the test in the class in which they are enrolled** unless they have prior written approval from the lecturer. Note that the numerical methods mid-semester test will be held as a classroom tutorial, while the statistics mid-semester test will be held in the computer labs (and administered via Maple TA). To prepare for your statistics mid-semester test, practice tests will be made available on Maple TA in week 6. Students who are unable to attend a test must give a medical certificate to the lecturer. There will be no opportunity to resit a test.

Many practical problems require use of a computer software package, and in this course students are required to become familiar with Matlab. The Matlab part of MATH2089 is assessed in the following ways:

Numerical methods component

- Matlab computer Test in week 6
- Matlab computer laboratory participation during semester

Statistics component

- Matlab online quizzes due for completion in Week 2 Friday, covering material in the Matlab self-paced tutorial (first work through the tutorial on Moodle, *then* go to Maple TA to do the test.)
- Three statistics online quizzes.
- Mid-semester test to be held in the computer laboratory in Week 7.

All statistics assessments will be administered through MapleTA. Here are some guidelines you should follow when taking each quiz:

- For the Matlab online quizzes due in Week 2 you are allowed as many attempts as you want. Your best mark will count.
- For the Statistics on-line quizzes (due Weeks 5, 9, 12), you are allowed a maximum of 3 attempts.

- For the mid-semester test, you are only permitted one attempt, using a lab computer during your regular lab class. Practice tests will be available on Maple TA in week 6.
- Once you begin an attempt at a quiz, you have a fixed time to finish that attempt.
- You should only start an attempt at a quiz if you plan to finish it in that sitting.
- Once you answer a question, select *Save Answer*. You will still be allowed to modify your response. Selecting *Finish* submits your responses to MapleTA which cannot be changed.
- Do not close MapleTA or your web browser during a quiz. You will **not** be able to continue that attempt the next time you login.
- It is expected that you work on each quiz **alone.**

Finally, the final exam will assess student understanding of the material covered in the lectures, tutorials and laboratory classes.

Help with the course

Your lecturer will have regular consultation times which will be advertised in lectures and on UNSW Moodle. There will also be additional regular consultation times advertised with other members of the school. At these times you are welcome to just turn up! For other consultation times, please email your lecturer for an appointment.

Resources and Syllabus for Numerical Methods component

Recommended Text

- S.S. Rao, Applied Numerical Methods for Engineers and Scientists, Prentice Hall, Upper Saddle River, N.J., 2002. This book is available for purchase in the UNSW bookshop and is also in the UNSW library.

The recommended text will be available in the High Use Collection in the Library.

Additional Reading

- J. H. Mathews and K. D. Fink., Numerical methods using MATLAB, Upper Saddle River, N.J: Pearson, 2004.
- C. Moler, Numerical Computing with Matlab, SIAM, 2004, http://www.mathworks.com/moler/
- A. Gilat, MATLAB: an introduction with applications, New York; Chichester: Wiley, 2005.
- Moore, Holly, MATLAB for Engineers, Pearson Prentice Hall, 2007.

Additional materials provided in UNSW Moodle

Outline lecture notes in PDF format will be made available via the UNSW Moodle web site: https://moodle.telt.unsw.edu.au/.

They are not a substitute for attendance at lectures.

Recommended Internet sites

A listing of the programs from the textbook is available from http://www.prenhall.com/rao/.

Syllabus

Week	Topic	Relevant reading
1	Data representation, error analysis, introduction to MATLAB	1.3-1.6 & class notes
2	Applied MATLAB programming.	class notes
3	Nonlinear equations: bisection method, fixed point iteration, Newton-Raphson and secant methods	2.3 – 2.6,2.14
4-5	Systems of linear equations: elimination methods, LU factorization, Iterative methods, special linear systems	3.3 - 3.19
6	Interpolation and polynomial approximation, curve fitting	5.5 - 5.6,5.8 - 5.10
7	Numerical differentiation	7.1 – 7.10
8	Numerical integration	8.1 - 8.12
9	Euler method, Predictor-corrector methods	9.5-9.6, 9.10
10	Runge-Kutta method. Boundary value problems	9.7, 10.5-10.6
11	Parabolic equations. Methods of solutions	11.5
12	Elliptic and hyperbolic equations. Methods of solution	11.4-11.5, 11.9

The schedule shown may be subject to change at short notice to suit exigencies

Resources and Syllabus for Statistics component

Recommended Text

- J. Devore and N. Farnum, Applied Statistics for Engineers and Scientists, 2nd Edition, 2005 Duxbury Press, Thomson Publishers. (or 3rd edition of this book)

Additional Reading

Basically any text with "Statistics" and "Engineers" in its title. A quite comprehensive reference is

- D. Montgomery and G. Runger, Applied Statistics and Probability for Engineers, 5th Edition, 2011, Wiley (or a previous edition of this book)

Lecture slides in PDF format will be made available via the UNSW Moodle web site. **They are not a substitute for attendance at lectures**. Other material, including data files for computer exercises, and solutions to tutorial exercises will also be available from the web site.

Syllabus and approximate schedule

Note that this syllabus is intentionally only approximate. Some variations will definitely occur as some topics require more time than others.

Week	Topic	Text Reference
1	Presentation and Introduction	1.1
2	Descriptive Statistics	1.2, 1.3, 2.1, 2.2, 2.3
3	Elements of Probability	5.1, 5.2, 5.3
4	Random Variables	5.4
5	Special discrete and continuous probability distributions	1.5, 1.6
6	The Normal distribution. Sampling distributions.	1.4, 5.5, 5.6
7	Inferences concerning a mean (confidence intervals)	7.1, 7.2, 7.4
8	Inferences concerning a mean (hypothesis tests)	7.3, 7.5, 8.3
9	Inference concerning proportions, variances and differences in means	8.1, 8.2, 8.5
10	Regression analysis (I)	11.1, 11.2, 11.3
11	Regression analysis (II)	11.4, 11.5, 11.6
12	Analysis of Variance	Chapter 9

Matlab software
Matlab R2016 is available on the computers in the School of Mathematics and Statistics computer laboratories on the mezzanine level and ground floor of the Red Centre. Information about how to obtain Matlab is available through the UNSW Moodle.

Matlab References

- School of Mathematics and Statistics, Introduction to MATLAB, 2016 (available through the course web site).
- School of Mathematics and Statistics, Statistics using MATLAB (SUM) (available through the course web site).
- A. Gilat, MATLAB: an introduction with applications, New York, Wiley, 2005
- R. Pratap, Getting Started with MATLAB7, Oxford University Press, 2005.
- D. J. Higham and N. J. Higham, MATLAB guide, SIAM Philadelphia, 2004.

Library
The library has a mathematics and statistics subject guide on the web which is a good starting point for mathematical and statistical information. See http://subjectguides.library.unsw.edu.au

Additional Assessment
The School of Mathematics has a strict policy on additional assessment. It can also be found through the School of Mathematics and Statistics student services page http://www.maths.unsw.edu.au/currentstudents/student-services

Plagiarism and academic integrity
Plagiarism is the presentation of thoughts or work of another as one's own, Issues you must be aware of regarding plagiarism and the university's policies on academic integrity can be found at https://student.unsw.edu.au/plagiarism

Academic Misconduct
The University of New South Wales has rules relating to Academic Misconduct. See https://student.unsw.edu.au/conduct

Rules for the Conduct of Examinations
The University of New South Wales has rules for the conduct of examinations. See https://my.unsw.edu.au/student/academiclife/assessment/examinations/examinationrules.html

Occupational Health and Safety
Occupational Health and Safety policies and expectations:
http://www.ohs.unsw.edu.au/ohs_students/index.html

Equity and Disability
Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Student Equity and Disabilities Unit (9385 4734 or https://student.unsw.edu.au/disability). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.