UNSW SYDNEY

Faculty of Science
School of Mathematics & Statistics

MATH2089
NUMERICAL METHODS
and
STATISTICS
Term 2, 2019

Cricos Provider Code: 00098G

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 or three 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.

Course staff

The course lecturers are:

- Dr. Quoc Thong Le Gia (Numerical Methods),
  RC-2084, phone 9385-7049, email: qlegia@unsw.edu.au

- Dr. Gery Geenens (Statistics),
  RC-2053, email: ggeenens@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:**
  2 hours of lecture per week for both Statistics and Numerical Methods streams with additional 1 hour per week alternated between Statistics and Numerical Methods.
  Total: 5 hours of lecture per week, all in **CLB-7.**

  Details:
  Monday 10:00—12:00 (Weeks 1,3—11): Numerical Methods (Mon Week 2 is Public Holiday)
  Tuesday 12:00 —14:00 (Weeks 1—10): Statistics
  Wednesday 15:00 —16:00 (W 1,3,5,7,9 Numerical Methods; W 2,4,6,8,10 Statistics)

- **Tutorials**
  Numerical Methods component

  - Laboratory class (RC-G012), Weeks 1, 3, 5, 7, 9.
  - Tutorial class, Weeks 2, 4, 6, 8, 10.

Statistics component

- Laboratory class (RC-G012), Weeks 2, 4, 6, 8, 10.
- Tutorial class, Weeks 1, 3, 5, 7, 9.

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. Linear regression and analysis of variance.

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;
- using 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 session we are using six on-line quizzes in the course: three for the Statistics component and three for the Numerical Methods

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.

Assessment

The final grade in MATH2089 will be based on the sum of the marks from each of the Numerical Methods and Statistics components. For **each** component (Statistics/Numerical Methods) the mark is made up as

- on-line Matlab quizzes due in Week 2 (5%)
- on-line quizzes during session (5%+5%+5%=15%)
- mid-session tests (20%)
- final exam (60%)

Note that your mark from the Matlab on-line quizzes (due in Week 2) is a common mark for each of the Numerical Methods and Statistics components. The other assessment tasks are separated: there are 3 online quizzes, a mid-session test and a final exam for each component.

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. 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.

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-session test will be made available in the couple of weeks before the test. Note that **students must sit the test in the tutorial in which they are enrolled** unless they have prior written approval from the lecturer. Students who are unable to attend for 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 through o**n-line quizzes due for completion in Week 2**, covering material in the Matlab self-paced on-line tutorial. The marks you obtain for the Matlab on-line quizzes are split equally between the Statistics and the Numerical Methods components.

Matlab R2017 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, 2017 (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.

All on-line quizzes will be administered through UNSW Moodle and 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 and Numerical Methods on-line quizzes, you are allowed a maximum of 3 attempts, and the best mark will count.
- For the statistics mid-session test, you are only permitted one attempt, using a lab computer during your regular lab class. Practice tests will be available the week before.
- 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.

Applications for Special Consideration

Please adhere to the University special consideration policy and procedures provided on the web page below. Special Consideration web site: https://student.unsw.edu.au/special-consideration

For final exams with special consideration granted, 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. Please ensure you are aware of these dates and that you are available during this time.

Help with the course

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

MATH2089 Tutorial and Assessment Schedule for Term 2, 2019

Week Beginning	**Statistics (Stats)**	**Numerical Methods (NM)**	**On-line quizzes**	**Mid-term Tests**	**Stats weight**	**NM weight**
Week 1 3/6/19	Tutorial	Computer Lab				
Week 2 10/6/19	Computer Lab	Tutorial	**Matlab**		5%	
Week 3 17/6/19	Tutorial	Computer Lab				
Week 4 24/6/19	Computer Lab	Tutorial	**Stat**		5%	
Week 5 1/7/19	Tutorial	Computer Lab	**NM**			5%
Week 6 8/7/19	Computer Lab	Tutorial		**Stat mid-term test**	20%	
Week 7 15/7/19	Tutorial	Computer Lab				
Week 8 22/7/19	Computer Lab	Test in tutorial	**Stat**	**NM mid-term test**	5%	20%
Week 9 29/7/19	Tutorial	Computer Lab	**NM**			5%
Week 10 5/8/19	Computer Lab	Tutorial	**Stat + NM**		5%	5%
Total in Session					40%	40%
Exam period	**2 hour exam covering both Statistics and Numerical Methods**				60%	60%
Total					100%	100%

Online quizzes are generally due by **2pm on the Friday** of the week specified.

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.

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

Syllabus and approximate schedule

Week	Topic	Text Reference
1	*Lectures 1,2:* Numbers, floating point arithmetic, errors; Efficiency – time, storage, Flops; Introduction to Matlab. *Lecture 3:* Polynomials, Taylor's polynomials, order notations	**1.3—1.6** **7.3**
2	*Lecture 4*: Horner's method, finite differences, Matlab functions. *Lecture 5:* Nonlinear equations: bisection method, fixed point iteration,	**7.3—7.6** **2.3 – 2.6,**
3	*Lectures 6:* Newton-Raphson and secant methods *Lectures 7,8:* Systems of linear equations: vector and matrix norms, condition numbers	**2.14** **3.3 – 3.7**
4	*Lecture 9:* Elimination methods, LU factorization *Lecture 10:* Special linear systems: symmetric, positive definite, sparse matrices	**3.17**
5	*Lectures 11,12:* Eigenvalues and eigenvectors, orthogonal matrices, least squares *Lectures 13:* Curve fitting: interpolation and polynomial approximation	**4.1 – 4.3** **5.5–5.6, 5.8–5.10**
6	*Lecture 14,15:* Numerical integration (rectangular, trapezoidal, Simpson rules, Gaussian rules)	**8.1—8.12**
7	*Lectures 16, 17:* ODEs: Euler's method, Predictor-corrector method, Runge-Kutta methods *Lectures 18:* PDEs: Boundary value problems	**9.5–9.6, 9.10** **9.7, 10.5–10.6**
8	*Lectures 19, 20:* PDEs: Boundary value problems. Parabolic equations. Methods of solution.	**11.5**
9	*Lectures 21, 22, 23:* PDEs: Elliptic and hyperbolic equations. Methods of solution	**11.4–11.5, 11.9**
10	*Lecture 24, 25:* Review for exam	

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
1	Presentation and Introduction, Descriptive Statistics
2	Probability
3	Random variables
4	Special Discrete and Continuous distributions
5	The Normal distribution, sampling distributions.
6	Inference concerning a mean – point estimation and confidence intervals
7	Inference concerning a mean – hypothesis testing
8	Inference concerning proportions and difference in means
9	Regression analysis
10	Analysis of Variance

Miscellanea

Library

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

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 http://www.lc.unsw.edu.au/plagiarism and http://www.lc.unsw.edu.au/plagiarism/plagiarism_STUDENTBOOK.pdf

Academic Misconduct

The University of New South Wales has rules relating to Academic Misconduct. See https://my.unsw.edu.au/student/academiclife/assessment/AcademicMisconduct.html

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 http://www.studentequity.unsw.edu.au/). 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.