Faculty of Science
School of Mathematics and Statistics

MATH2089
NUMERICAL METHODS and STATISTICS

Semester 1, 2014

Course information

- 6 UOC
- Prerequisites: MATH1231 or MATH1241 or MATH1251
- Exclusions: BEES2041, BIOS2041, CVEN2002, CVEN2025, CVEN2702, ECON2215, MATH2049, MATH2099, MATH2801, MATH2829, MATH2839, MATH2841, MATH2859, MATH2899, MATH2901, MINE270
- 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 one 2 hour lecture and one tutorial or laboratory class per week.

This course is administered by the School of Mathematics and Statistics. In Semester 1, 2014 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 has lecturers

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

  o Dr Joanna Wang (Statistics)
    RC-2070, phone 9385-7036, email: joanna.wang@unsw.edu.au

- Consultation times will be announced later.

- 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
  o Tuesday   09 – 11   Physics Theatre (Statistics)
  o Thursday   11 – 13   Physics Theatre (Numerical Methods)

- Tutorials/Laboratory classes
  o Numerical Methods component
    - Laboratory class (TETB2 G17) even weeks (COMMENCING IN WEEK 2)
    - Tutorial class odd weeks

  o Statistics component
    - Introduction to Computing Labs and Matlab (RC-G012, Week 1)
    - Laboratory class (RC-G012), Weeks 2, 4, 6, 8, 12
    - Tutorial class, Weeks 3, 5, 7, 9, 11, 13

Note that in **Week 1**, there is the introductory computer laboratory held in your statistics tutorial time, and no numerical methods tutorial. **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.

For Numerical Methods component you need to be able to login to the computers in ME306.

Course Web Site
The MATH2089 course web site will be available through the UNSW Moodle web portal

https://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 tridiagonal 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. Design and analysis of experiments. 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; and,
- 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 Course and Teaching Evaluation and Improvement (CATEI) Process. 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 trialled on-line quizzes in MATH2089 to encourage consistent engagement with the course. Students found these very helpful. This session we are using three on-line quizzes in each of the Statistics and Numerical Methods components of the course. 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 each component of the course is just 6%.

Assessment

The final grade in MATH2089 will be based on the sum of the scores from each of the assessment components in 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. 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.

Examples
- You get 60 in stats and 40 in numerical methods, averaging 50, which is a pass.

- You get 35 in stats and 65 in numerical methods, averaging 50. As the stats mark is less than 40, your final mark is 45, but you can sit the concessional additional assessment.
- You get 55 in stats and 23 in numerical methods averaging 39 which is your final mark, and you are not entitled to sit the concessional additional assessment.

Numerical Methods

ASSESSMENT COMPONENT	DETAILS	MARKS	DUE DATE
Matlab computer Test	Lab Test administrated during labs period	12	Week 6
Mid-session Test	Test (30-35 minutes long) administered during the lecture	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 2014
Total		100	

Statistics

Assessment	Details	Weighting	Due Date
Introductory Matlab Quizzes	Available via Maple TA from Moodle web page. Start as early as possible from Week 1. Must be completed by the end of Week 3	4%	Before Thursday 20 March at 2pm
Statistics on-line Quizzes	Three quizzes during session, available via Maple TA from Moodle (2% each)	6%	Before 2pm on 1. Thu 3 Apr (wk 5) 2. Thu 8 May (wk 9) 3. Thu 29 May (wk 12)
*Mid-session Test	Test administered during Week 7 tutorials. You must sit the test in the tutorial in which you are enrolled	15%	Week 7 tutorial
Matlab computer Test	Lab test held in blocks in computer laboratory, arrange a time to do it at your convenience (after mid-session break)	15%	Week 10
Final Examination	During the exam period. 3 hours (including Numerical Methods)	60%	June 2014
Total		100%	

* Students enrolled in Friday tutorials (F12A and F13A) should contact the lecturer (Statistics) regarding alternative times for the mid-session test.

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 class 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 tutor or 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
- Online quizzes due for completion in Week 3, covering material in the Matlab self-paced on-line tutorial.
- Matlab class test to be held in the computer laboratory in Week 10.

You will be required to arrange a time to do your block lab test through the School of Mathematics and Statistics' 'Student Web Portal', to which there will be a link on UNSW Moodle. Further details of the MATLAB test will be made available on UNSW Moodle and in lectures closer to the time. Students are advised to arrange the time for the Matlab block test as soon as possible as there are limited places available at each time. Students who are unable to attend for the test at the time at which they have booked must give a medical certificate to the lecturer.

Statistics quizzes will be administered through UNSW Moodle and MapleTA. Here are some guidelines you should follow when taking each quiz:

- For the Matlab on-line quizzes due in Week 3, you are allowed as many attempts as you want. Your best mark will count.
- For the three on-line quizzes, you are allowed a maximum of 3 attempts.
- 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**.

Because of the block lab test in Week 10, your regular Statistics computer laboratory will **not be held that week; however, the Numerical Methods laboratory will be held as usual.**

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

Resources and Syllabus for Numerical Methods component

Text:
Singiresu 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 bookshop and is also in the UNSW library.

Additional Reading:

- Mathews, John H., Fink Kurtis D., Numerical methods using MATLAB, Upper Saddle River, N.J : Pearson, 2004.
- Cleve Moler, Numerical Computing with Matlab, SIAM, 2004
  http://www.mathworks.com/moler
- Gilat, Amos, 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, Duxbury Press, Thomson Publishers.

Additional readings: Basically any text with "Statistics" and "Engineers" in its title could make it. A quite comprehensive reference is D. Montgomery and G. Runger, Applied Statistics and Probability for Engineers, 5th Edition, 2011, Wiley (previous editions work as well).

Lecture slides: Lecture slides in pdf format will be made available via the UNSW Moodle web site. They are not a substitute for attendance at lectures. In addition, laboratory and tutorial material will also be made available on this website.

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 statistics department. At these times you are welcome to just turn up! For other consultation times, please email your lecturer for an appointment.

Peer Support in Statistics: There will be a peer support session through the Student Support scheme in the School of Mathematics and Statistics, where you can get help in the Statistics component of MATH2089. Details will be announced in lectures and on UNSW Moodle.

Syllabus and approximate schedule

Week of Session	Date	Topic	Text Reference
1	4 March 2014	Introduction	1.1
2	11 March 2014	Descriptive Statistics	1.2, 1.3, 2.1, 2.2, 2.3
3 Online Matlab quizzes due Thursday by 2pm	18 March 2014	Foundations of Probability	5.1, 5.2, 5.3
4	25 March 2014	Random variables	5.4
5 Online quiz 1 due Thursday by 2pm	1 April 2014	Special distributions (discrete and continuous)	1.5, 1.6
6	8 April 2014	The Normal distribution. Sampling distributions.	1.4, 5.5, 5.6
7 Mid-session test in tutorial	15 April 2014	Inferences concerning a mean (confidence intervals)	7.1, 7.2, 7.4
Mid-session Break			
8	29 April 2014	Inferences concerning a mean (hypothesis testing)	8.1, 8.2
9 Online quiz 2 due Thursday by 2pm	6 May 2014	Inferences concerning proportions, variances and differences in means	7.3, 7.5, 8.3
10 Matlab Lab test	13 May 2014	Regression analysis (I)	11.1, 11.2, 11.3
11	20 May 2014	Regression analysis (II)	11.4, 11.5, 11.6
12 Online quiz 3 due Thursday by 2pm	27 May 2014	Analysis of Variance (ANOVA)	Chapter 9
13	3 June 2014	No Lecture this week (There is a tutorial)	

Matlab software

Matlab R2013b 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. It is also available in ME306 and ME 206 in the School of Mechanical and Manufacturing Engineering.

The **Matlab and Simulink Student Version R2013b** is available through the UNSW bookshop for $119. This includes the Symbolic Math, Control Systems, Signal Processing, Statistics, Optimization and Image Processing toolboxes. It will be useful not only in this course but also in other courses. At http://www.bookshop.unsw.edu.au do a quick search for "Matlab student".

Matlab References
- School of Mathematics and Statistics, *Introduction to MATLAB*, 2009 (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 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/

Additional Assessment
- The School of Mathematics has a strict policy on additional assessment. It can be found at 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 http://www.lc.unsw.edu.au/plagiarism and https://my.unsw.edu.au/student/academiclife/Plagiarism.pdf.

Academic Misconduct
- The University of New South Wales has rules relating to Academic Misconduct. They can be found at https://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf.

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

<u>ADMINISTRATION</u>

All general administrative information including course and tutorial enrolment, attendance requirements, student e-mail ,cheating and plagiarism, applications for special consideration and additional assessment may be found here:

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

Library

The library has a mathematics subject guide on the web which is a good starting point for mathematical information. They can be found at http://info.library.unsw.edu.au and http://info.library.unsw.edu.au/psl/guides/math/mathkey.html

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/policy-academic-misconduct

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/rules-exams

Occupational Health and Safety

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

Equity and Diversity

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 Equity Officer (Disability) in the Equity and Diversity 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.