



MONASH University

School of Mathematical Sciences

Honours in

Mathematics, Statistics,

Applied Mathematics, Astrophysics

and Atmospheric Science

(Fourth Year) 2012

REVISED 8 February, 2012 –

<http://www.maths.monash.edu.au/honours>

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| | |
|--|----|
| 1. HONOURS CONTACTS..... | 2 |
| 2. ENTRY REQUIREMENTS AND ENROLMENT..... | 4 |
| 3. HONOURS UNIT REQUIREMENTS | 5 |
| 4. LIST OF HONOURS LECTURE TOPICS..... | 6 |
| 4.0 INTRODUCTION TO HONOURS COMPUTING..... | 7 |
| 4.1 MATHEMATICS LECTURE TOPICS | 7 |
| 4.2 STATISTICS LECTURE TOPICS | 8 |
| 4.3 APPLIED MATHEMATICS LECTURE TOPICS | 9 |
| 4.4 ASTROPHYSICS LECTURE TOPICS | 10 |
| 4.5 ATMOSPHERIC SCIENCE LECTURE TOPICS..... | 10 |
| 5. LITERATURE REVIEWS AND PROJECTS | 11 |
| MARKING GUIDELINES FOR HONOURS PROJECTS | 11 |
| 6. DETAILS OF TOPICS..... | 13 |
| 6.0 INTRODUCTION TO HONOURS COMPUTING..... | 13 |
| M4401 IINTRODUCTION TO HONOURS COMPUTING..... | 13 |
| 6.1 MATHEMATICS..... | 14 |
| M4041 DIFFERENTIAL GEOMETRY | 14 |
| M4051 TOPOLOGY - NOT OFFERED IN 2012 | 15 |
| M4061 BANACH ALGEBRAS - NOW OFFERED IN 2012 ! | 15 |
| M4091 SEMIGROUP THEORY | 16 |
| M4022 PARTIAL DIFFERENTIAL EQUATIONS | 17 |
| M4072 FIELD THEORY | 18 |
| M4082 LIE GROUPS..... | 19 |
| M4382 NEW PURE MATHEMATICS TOPIC – TITLE AND SYLLABUS TO BE ADVISED ...20 | |
| 6.2 STATISTICS..... | 21 |
| M4191 STOCHASTIC CALCULUS AND MATHEMATICAL FINANCE..... | 21 |
| M4271 STOCHASTIC PROCESSES I – LINEAR SYSTEMS | 22 |
| M4341 PROBABILITY AND MATHEMATICAL STATISTICS - PART I - (OFF CAMPUS) ..23 | |
| M4232 STOCHASTIC PROCESSES II – RANDOM WALKS & MARKOV CHAINS | 24 |
| M4322 OPTIMIZATION (APPLIED STATISTICS)..... | 25 |
| M4342 PROBABILITY AND MATHEMATICAL STATISTICS – PART II – (OFF CAMPUS) 25 | |
| M4352 MATHEMATICS OF RISK – (OFF CAMPUS) | 26 |
| M4622 INTRODUCTION TO BIOINFORMATICS | 27 |
| M4300 RESEARCH PAPERS IN STATISTICS..... | 28 |
| 6.3 APPLIED MATHEMATICS | 29 |
| M4411 ADVANCED COMPUTATIONAL MATHEMATICS..... | 29 |
| M4422 ADVANCED METHODS FOR APPLIED MATHEMATICS..... | 30 |
| 6.4 ASTROPHYSICS..... | 31 |
| M4031 GENERAL RELATIVITY | 31 |
| M4111 THE SUN – NOT OFFERED IN 2012 | 31 |
| M4331 PLANETARY DYNAMICS AND EVOLUTION | 32 |
| M4221 RESEARCH TOPICS IN ASTROPHYSICS | 34 |
| 6.5 ATMOSPHERIC SCIENCE | 36 |
| M4511 BOUNDARY LAYER METEOROLOGY | 36 |
| M4541 STATISTICAL INFERENCES IN CLIMATE DYNAMICS | 37 |
| M4571 ADVANCED DYNAMICAL METEOROLOGY..... | 38 |
| M4591 ATMOSPHERE OCEAN INTERACTION AND CLIMATE - (EXTERNAL – UNIVERSITY OF MELBOURNE) | 39 |
| M4582 CONVECTIVE CLOUDS AND STORMS..... | 39 |
| 7. DETAILS OF EXTERNAL COURSES | 40 |
| 8. HONOURS YEAR PRIZES..... | 41 |
| LEO GLEESON PRIZE | 41 |
| CARL MOPPERT PRIZE IN MATHEMATICS..... | 41 |
| THE MoCA PRIZE FOR ASTROPHYSICS | 41 |

| | |
|---|----|
| PURE MATHEMATICS PRIZE..... | 41 |
| STATISTICS PRIZE..... | 41 |
| AMOS PRIZE FOR METEOROLOGY / OCEANOGRAPHY | 41 |
| GEOFF DAVIES PRIZE - (Mathematical Sciences and Geosciences honours geodynamics prize)..... | 41 |

2. Entry Requirements and Enrolment

The normal minimum requirement for honours (fourth year) in mathematics is an average of at least 70 in 24 points of relevant third year units, or equivalent.

A list of relevant units that can be counted in this average is available from the Honours Coordinator (*see Section 1*).

Applications for honours 2013 have to be submitted by (absolutely) no later than **Thursday 15 November, 2012**, at the School of Mathematical Sciences in time for the application to reach the Faculty Office by their deadline **of Friday November 16, 2012**. This is well before you know all of your third-year results. If you are considering doing Honours and think you have a chance, please submit an application. Students who intend on finishing their course at the end of 2012 but are not intending on starting honours until semester two 2013 can apply now. Students who are **not** eligible by the end of 2012 but want to start in semester two, 2013 must apply mid year 2013, not in 2012.

How to apply for Honours 2013.

Obtain an Honours Application Form the Science Faculty Honours website: <http://www.sci.monash.edu.au/undergrad/honours/apply.html> or from the School Administrative Officer (honours) (*see Section 1*), or from the Faculty of Science Office, Building 19 (Clayton).

Discuss your options with the Honours Coordinator and then complete *Section A and B* of the application form. **Section D must be completed by the Applicant in conjunction with the Honours Coordinator. Please make an appointment to do this** (*See Section 1*).

Return the completed application form to the School's Administrative Officer (honours) (*see Section 1*) by no later than Thursday 15 November, 2012, to allow the school to forward the applications to the Faculty of Science by their required deadline of **Friday 16 November, 2012**.

Official offer letters will be sent to successful applicants via email week commencing 12 December 2011. This letter will also outline the procedure for enrolling into your honours 2 x 24 credit point honours units on WES. You then need to contact the School's Honours Coordinator, to discuss your choice of lecturing topics, essays, projects etc.

During mid **January 2013**, you will also be posted the School's ***Internal Lecture Topic / Project enrolment form*** or you can obtain this form directly from the School's Administrative Officer (honours) (*see Section 1*). This form is for internal school records only. **Please take note of the deadline date of return of this form when you receive it.**

3. Honours Unit Requirements

Each honours program, whether full-time or part-time consists of two units:

Astrophysics honours:

ASP4200 / ASP4100

Atmospheric Science honours:

ATM4200 / ATM4100

Mathematics, Applied Mathematics and Statistics honours:

MTH4200 / MTH4100

These vary slightly according to the area of study.

Astrophysics

ASP4200 Astrophysics honours coursework unit - [FY] (24 points total): normally six lecture topics (4 points each).

ASP4100 Astrophysics honours project unit - [FY] (24 points total): normally a major research project (20 points) and a literature review (4 points).

Atmospheric Science

ATM4200 Atmospheric Science honours coursework unit - [FY] (24 points total): normally six lecture topics (4 points each).

ASP4100 Atmospheric Science honours project unit - [FY] (24 points total): normally a major research project (20 points) and a literature review (4 points).

Applied Mathematics, Mathematics and Statistics

MTH4200 Mathematics honours coursework unit - [FY] (24 points total): normally six lecture topics (4 points each) (for statistics it may be 4 x 6 point units *or* 2 x 6 point units plus 3 x 4 pt units)

MTH4100 Mathematics honours project unit - [FY] (24 points total): normally a major research project (16 points), plus a literature review (4 points) and another lecture topic (4 points)

4. List of Honours lecture Topics

The lecture topics fall into five main groups - mathematics, applied mathematics, statistics, astrophysics and atmospheric science. You can select lecture topics from any group, as long as the requirements of your enrolled honours units are met (refer to previous Section 2 Honours unit requirements). It is your own responsibility to ensure that a sufficient number of lecture topics is taken.

Honours topics from other Schools or outside Monash via the Access Grid Facility may also be available in other areas, and you can take these with the permission of the Honours Coordinator.

In addition, ALL Honours students are eligible to attend the ICE-EM/AMSI Summer School organised through the Australian Mathematical Sciences Institute (AMSI) and its International Centre of Excellence for Education in Mathematics (ICE-EM) and have these honours courses offered there count towards their Honours degree. Any one of the four weekly courses or two courses running over two weeks will count as an equivalent to one honours lecture topic being offered by the School of Mathematical Sciences. Courses are open to prospective honours students in the School of Mathematical Sciences. For prospective honours students in mathematical sciences at any of the consortium universities / research establishments the courses will be free of tuition charges, and those from interstate will have their travel and accommodation paid in full (*for further details see Section 7*).

IMPORTANT NOTES:

For Astrophysics, one third-year lecture unit may be counted to replace an honours lecture topic. For Atmospheric Science depending on the student's previous experience and interests, one of the honours lecture topics listed may be replaced by a third-year atmospheric science or mathematics lecture unit. Otherwise, up to two third-year mathematics lecture units may be counted towards honours in Mathematics, Statistics and Applied Mathematics, with the permission of the Honours Coordinator.

If more than the total required number of *points* (using 4 points for third-year lecture units) are taken for any of the two overall honours units then the best weighted 24 points will be used to determine the final mark for that overall unit, and hence your final grade in Honours.

Not all of the lecture topics listed below will necessarily be offered next year, for example if they attract an insufficient number of students, topics may be cancelled. **Thus it is important for you to notify us, at the time of enrolment, which lecture topics you wish to take.** A topic not offered as a lecture course can often be used as the basis of reading course.

Your choice of lecture topics appears only in the School records; you are allowed to change it in the first few weeks of the semester. The important thing is to make sure you meet the honours unit requirements listed above. If in doubt, check your choice of topics with the Honours Coordinator.

4.0 Introduction to Honours Computing

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester.

M4401 Introduction to Honours Computing

Please note, this unit is compulsory for honours students in all 5 disciplines of the School !

4.1 Mathematics lecture topics

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester.

M4041 Differential Geometry

M4051 Topology - **Not offered in 2012**

M4061 Banach Algebras **NOW OFFERED !**

M4091 Semigroup Theory – **New**

M4022 Partial Differential Equations

M4072 Field Theory

M4082 Lie Groups

M4382 New Topic in Pure Mathematics – **Title to Be Advised**

Please note, provided they have completed the appropriate prerequisites, students in the Mathematics honours program **may also take any following units from the Applied Mathematics and Astrophysics honours programs:**

M4411 Advanced Computational Mathematics (*Refer to 6.3 - Applied Mathematics*)

M4422 Advanced Methods for Applied Mathematics (*Refer to 6.3 - Applied Mathematics*)

M4031 - General Relativity (*Refer to 6.4 - Astrophysics*)

As a student in the Mathematics Honours program you may also choose from the topics on offer through the ICE-EM/AMSI Summer School to count as credit towards your honours degree. Either one 4 week course or a two 2 week course can count as 4pts (*see Section 7*).

You may also take external honours units via the AMSI Access Grid to count as 4pt credit towards your honours degree. Teaching is accessed remotely via the School's Access Grid Room 345 (*see Section 7*).

4.2 Statistics lecture topics

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester and those with a code ending in 0 are offered over the full year

M4191 Stochastic Calculus and Mathematical Finance - **6 pt**

M4271 Stochastic Processes I - Linear Systems - 4 pt

M4341 (**Off Campus**) - Probability and Mathematical Statistics - Part I - **6 pt**

M4232 Stochastic Processes II - Random Walks & Markov Chains - **6 pt**

M4322 Optimization - 4 pt (Applied Statistics unit)

M4342 (**Off Campus**) - Probability and Mathematical Statistics - Part II - **6pt**

M4352 (**Off Campus**) - Mathematics of Risk - **6pt**

M4622 Introduction to Bioinformatics - 4 pt

M4300 Research Papers in Statistics - 4 pt - Full year course

Students interested in the Statistics Honours program should bear in mind that two 6 pt honours statistics topics may be taken OFF CAMPUS (these 2 OFF CAMPUS topics are listed above and are shown in **6.2 - Statistics**). Students should contact the Statistics Honours Advisor (see Section 1) first before choosing to take 1 or both of these OFF CAMPUS units.

As a student in the Statistics Honours program you may also choose from the topics on offer through the ICE-EM/AMSI Summer School to count as credit towards your honours degree. Either one 4 week course or a two 2 week course can count as 4pts (*see Section 7*).

In addition, it may also be possible to take Courses from the *Key Centre for Statistical Sciences (KCSS)* to counts as 4 pt credit towards your honours degree. Students should contact the Statistics Honours Advisor (*see Section 1*).

Finally, you may also take external honours units via the AMSI Access Grid to count as 4 pt credit towards your honours degree. Teaching is accessed remotely via the School's Access Grid Room 345 (*see Section 7*).

IMPORTANT. If combinations of 4 pt and 6 pt lecture topics are taken for MTH4200 in the Statistics Honours program then the best **weighted** mark for 24 points of workload will be used to determine the final mark for that unit.

4.3 Applied Mathematics lecture topics

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester.

Core topics:

M4411 Advanced Computational Mathematics

M4422 Advanced Methods for Applied Mathematics

Students in other honours programs in the school may also undertake M4411 and/or M4422, provided they have completed the appropriate pre-requisite requirements.

Elective topics:

Students in the Applied Mathematics honours program must also complete the equivalent of at least four approved *elective* lecture topics, including at least two in an approved area of “applied mathematics” (as approved by the Applied Mathematics honours advisor). The electives may include honours lecture topics offered for the Astrophysics, Atmospheric Science, Mathematics and Statistics honours programs, as listed in this handbook, provided the appropriate prerequisites have been completed. Up to two approved ASP, ATM or MTH units at level-3 may also be taken but will be counted as 4 pts at honours level.

The electives may also include approved honours lecture topics that are: given at the ICE-EM/AMSI Summer School; or formal coursework topics given by other schools in the faculty (with their approval); or are offered by other universities via the Access Grid facility. In those cases the point weighting will be determined by the Applied Mathematics honours advisor, usually based upon that used by the relevant school or university.

Applied Mathematics honours program requirements:

Students in the Applied Mathematics honours program must complete the equivalent of 48 points of approved coursework and research, including:

- The core topics M4401, M4411 and M4422 (12 pts total)
- At least 16 pts of other lecture topics (including at least two in an approved area of “applied mathematics” and no more than two third-year lecture units, each weighted as 4 points) as approved by the Applied Mathematics honours advisor. If more than 16 pts are completed then the best weighted 16 pts will be used to determine the final mark for this component.
- A literature review (4 pts) in their first semester and a full-year honours research project (worth 16 pts). In addition to the written component, both the literature review and the honours project include the completion of an assessed research outline (to be completed by week 4) and assessed oral presentation(s).

4.4 Astrophysics lecture topics

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester.

M4031 General Relativity

M4111 The Sun - Not offered in 2012

M4331 Planetary Dynamics and Evolution

M4411 Advanced Computational Mathematics

M4221 Research Topics in Astrophysics

M4422 Advanced Methods for Applied Mathematics

Compulsory Core Units:

M4401, M4031, M4331

Recommended Units:

M4221, M4411, M4422

4.5 Atmospheric Science lecture topics

Note that topics with code ending in 1 are offered in first semester, those with code ending in 2 are offered in the second semester.

M4511 Boundary Layer Meteorology

M4541 Statistical Inferences in Climate Dynamics

M4571 Advanced Dynamical Meteorology

M4591 Atmosphere Ocean Interaction and Climate (EXTERNAL - The University of Melbourne)

M4582 Convective Clouds and Storms - **New (now Offered in Semester 2 instead!)**

Please note, provided they have completed the appropriate prerequisites, students in the Atmospheric Science honours program **may also take any following units from the Applied Mathematics and Astrophysics honours programs:**

M4411 Advanced Computational Mathematics (*Refer to 6.3 - Applied Mathematics*)

M4422 Advanced Methods for Applied Mathematics (*Refer to 6.3 - Applied Mathematics*)

5. Literature Reviews and Projects

As outlined in Section 3, the general requirements for completing the honours year in the School of Mathematical Sciences includes a major project and various lecture topics.

In Applied Mathematics, Mathematics and Statistics the projects are all worth 20 points, while in Astrophysics and Atmospheric Science the project is worth 24 points. The project in all disciplines consists of two assessable components: a literature review, worth 4 points, and the major research project, worth the remainder of the points.

The 4 point literature review must be completed in the first semester, and its recommended length is 15-25 pages. It comprises a literature survey as well as a discussion of any mathematical and numerical techniques which are necessary to complete the project, but which are unfamiliar to the student. Your supervisor(s) will direct both the literature review and the major project. Students are encouraged to use LaTeX, however submissions in other printed formats are accepted. At the end of the semester you will be required to give a 25 minute talk on your literature review and goals for the major project, which counts 20% towards the overall mark for this component.

For all honours students, the project is due at the end of the final semester and includes a 25 minute talk, which counts 10% towards the overall project mark. The recommended length of the written project is 40-50 pages and also must be submitted in printed format.

Examples of well presented projects and further guidelines can be obtained from the Honours Coordinators, Honours Advisors (see Section 1) or your supervisor.

The time you spend on the literature review and the project should be similar to the time spent on the equivalent number of lecture topics. It is therefore clear that the literature review and project should be commenced at the beginning of your first semester. You should choose a topic and find a supervisor during January or February. It is also advisable to meet your supervisor regularly, say once a week, as soon as lectures begin.

A guide to the good practice and the responsibilities of supervisors and students in undertaking honours research can be found in the Faculty of Science's Honours Policy (<http://sci.monash.edu/undergrad/honours/docs/honours-policy.pdf>).

The School offers a comprehensive range of project topics in advance. However, we will also attempt to satisfy your own interests, provided a supervisor with the appropriate expertise is available. Further information may be obtained when you enrol, but it is not necessary to wait that long. You are welcome to consult the Honours Coordinators or Honours Advisors. If you choose to develop a proposal or undertake one of the prepared proposals, a final proposal must be submitted by Week 4 of your first semester.

As part of the topic M4401 Introduction to Honours Computing, which is compulsory for all students, an introductory module on LaTeX and BibTeX is offered. This module is highly recommended for all students.

MARKING GUIDELINES FOR HONOURS PROJECTS

H1 (80 - 100)

An 'upper H1' (90 - 100) student has strengths in all of the following areas:

- outstanding command of expression and logical argument in a skilfully structured manuscript;
- superior evaluation and integration of existing literature;
- evidence of significant insight and original thought in dealing with the critical issues;
- sophisticated understanding of research methods;
- thoughtful and appropriate choice of data analysis (where appropriate) and outstanding presentation and reporting of results;
- clear and coherent interpretation of the thesis results, and/or the results of other

studies;

- comprehensive understanding of the importance of the results in the context of research topic.

A 'lower H1' (80 -90) student displays many of the above strengths but is less well-balanced in overall quality.

H2A (70 - 79)

The project is characterised by most of the following:

- the manuscript is well written, logically argued and generally well structured;
- the evaluation and integration of the existing literature is very sound without being outstanding;
- reasonable insight and some evidence of original thought in dealing with the critical issues
- evidence of a solid understanding of research methods;
- choice of data analysis (where appropriate) that is appropriate (although less well justified than might be expected of H1 standard), and clear presentation of results;
- generally sound but pedestrian interpretation of results and their importance to the research topic.

H2B (60 - 69)

The project is characterised by most of the following:

- generally competently written, although some problems exist in the logical organisation of the text and the way it is expressed;
- provides an adequate coverage of the literature, although it tends to be more descriptive than evaluative, and arguments are often disjointed;
- occasional evidence of insight into the issues underlying the thesis or essay, but little evidence of original thinking;
- basic but somewhat limited understanding of the research methods;
- serviceable choice of data analysis (where appropriate), although other approaches may have been more appropriate;
- the presentation of results lacks clarity and the interpretation of results or other studies is adequate but limited.

H3 (50 - 59)

The project is characterised by most of the following:

- the work is not well written and shows flaws in the structuring of logical arguments;
- coverage of the necessary literature is weak, with insufficient information provided to support the arguments made, or conclusions drawn, within the thesis or essay;
- little evidence of insight and ideas tend to be highly derivative;
- knowledge of research methods is deficient;
- data analysis techniques (where appropriate) are arbitrary or inappropriate;
- the results are poorly presented;
- interpretations are superficial, demonstrating a weak understanding of the results and their relevance to the research topic.

Fail (0 - 50)

The project is characterised by most of the following:

- the work is very poorly written and shows a serious inability to structure and present a logical argument;
- coverage of the necessary literature is inadequate, with little information provided relevant to the claims made, or conclusions drawn, within the thesis;
- serious misunderstanding of key concepts and issues;

- knowledge of research methods is lacking;
- data analysis techniques (where appropriate) are inappropriate and the results are presented inadequately;
- an inability to show how the results of the research project relate to the research topic; serious misinterpretations of results.

6. Details of topics

6.0 Introduction to Honours Computing

M4401 INTRODUCTION TO HONOURS COMPUTING

- **Level:** 4 pt Honours Topic
- **Coordinator:** Dr Simon Clarke, Rm. 209, ph. 99054421, email: simon.clarke@monash.edu.

Aims: M4401 is a compulsory topic for all honours students in Mathematical Sciences that introduces key concepts and skills in the use of computers to aid research. Students will undertake four self-paced modules and be required to satisfactorily complete the tutorials and exercises for each module. Supervised practical sessions will be provided for each module. The modules will cover general computational skills and discipline specific skills and packages as detailed below.

Syllabus: The learning material for each module of this topic will consist of a booklet comprising reading material, tutorials and exercises. These will need to be completed by Week 8 of the first semester to the satisfaction of the topic coordinator.

Students will need to choose four of the following modules:

- Introduction to the Unix operating system: File structure, Help systems, Manipulating files and directories, System resources, Printing, Shells, Job control, Makefiles;
- Writing mathematical documents in LaTeX and managing a bibliography with BibTeX;
- Using MATLAB for programming and plotting: Variables, functions and operations, Linear algebra and array manipulation, Plotting 1D and 2D functions and arrays, Basic programming concepts, Debugging techniques;
- Introduction to Mathematica: Getting started, More about functions and lists, Differential equations, Data, Statistics, and Optimization, Programming in Mathematica;
- Introduction to Fortran 90: Program structure, Data structures, Control structures, Array features, Intrinsic functions, Input/Output.

Assessment: Each student completing this assessment satisfactorily will be awarded a mark for M4401, based upon their overall average mark for the remaining 44 points of their honours program.

Prerequisites: None.

Last reviewed: 29/09/2010.

6.1 Mathematics

M4041 DIFFERENTIAL GEOMETRY

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Gilbert Weinstein , Kwok- Kun Kwong
- Contact Details: Gilbert.Weinstein@monash.edu, Rm 421, Bld. 28, Tel.: 9905 4462 Kwok-Kun.Kwong@monash.edu, Room 410, Bld. 28, Tel. TBA

Aims: Manifolds are “topological spaces with local coordinates” (e.g. surfaces) i.e. spaces locally homeomorphic to the euclidean m -space. A differentiable structure on such a manifold makes it possible to generalize to these “curved spaces” many basic concepts of calculus, connected with differentiation or integration of functions and maps defined on the “flat” euclidean m -space.

This is an introductory course on differentiable manifolds and related basic concepts, which are the common ground for differential geometry, differential topology, global analysis, (i.e calculus on manifolds including geometric theory of integration) and modern mathematical physics.

Syllabus: Smooth manifolds; coordinate systems. Tangent vectors; tangent and cotangent bundles of a manifold, tensor fields; connections and covariant differentiation. Metrics. Geodesics. Curvature tensor. Relation between geometry and topology of manifolds. Applications to general relativity.

Prerequisites: MTH3132 Analysis and Geometry or MTH2021 Linear Algebra with Applications. M4051 Topology is recommended as a co-requisite.

Recommended reading:

Informal lecture notes may be provided.

Do Carmo, M., “Introduction to Riemannian geometry”, Birkhäuser, 1992.

References:

Spivak, M.A., “A comprehensive introduction to differential geometry”, Vol. I, Publish or Perish Inc., 1979 (1970).

Spivak, M., “Calculus on manifolds”, W.I. Benjamin, Inc., 1965.

M4051 TOPOLOGY - NOT OFFERED IN 2012

M4061 BANACH ALGEBRAS - NOW OFFERED IN 2012 !

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Alan Pryde
- Contact Details: Alan.Pryde@monash.au, Room 424, Building 28, Tel.: 9905 4417.

Aims: The main aim of this unit is to present a number of major theorems in functional analysis. This branch of mathematics is fundamental to the study of various areas of mathematical physics, such as quantum mechanics and to the modern theory of partial differential equations. The unit progresses from Hilbert spaces, through Banach spaces and Banach algebras to C^* -algebras, and provides a background to reading in operator theory. In addition it provides some startling applications of the theory of complex analysis.

Syllabus: Banach spaces. Linear transformations. The closed graph and open mapping theorems. Dual spaces. Hahn-Banach theorem. Alaoglu theorem. Banach algebras. Maximal group. Spectrum and resolvent. Gelfand-Mazur theorem. Maximal ideals of commutative Banach algebras. Gelfand representation theorem. Stone-Weierstrass theorem. C^* -algebras. Gelfand-Naimark representation theorem.

Prerequisites: MTH2140 / MTH3140 Real Analysis.

MTH3160 Analysis and Topology (recommended).

MTH3020 Complex Analysis and Integral Transforms (recommended).

M4051 Topology (recommended as a co-requisite).

Recommended reading:

Simmons, G.F., "Introduction to topology and modern analysis", McGraw-Hill.

M4091 SEMIGROUP THEORY

- Offered Semester One 2012
- Level: 4 pt Honours Reading Topic only
- Lecturer: Tom Hall
- Contact Details: Tom.Hall@monash.edu, Room 432, Building 28, Tel.: 9905 4412.

Syllabus: Semigroups are the most basic of algebras. Two particular types, regular semigroups and inverse semigroups, have a beautiful theory filled with elegant theorems and imaginative proofs.

We shall be reading from the text book by John M. Howie, “Fundamentals of Semigroup Theory”, where topics include the amalgamation property for inverse semigroups.

References:

Please contact Tom Hall

M4022 PARTIAL DIFFERENTIAL EQUATIONS

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Jerome Droniou (New Lecturer 2012)
- Contact Details: To Be Advised

Aims: Partial Differential Equations (PDE) arise naturally whenever natural processes involving change and variation are studied. Applications may be found in fields as diverse as biology and medicine, finance and chemistry, and geometry and physics.

This subject will survey the most important types of PDE (elliptic, parabolic and hyperbolic), studying their distinguishing properties and the techniques used to explore these properties.

Topics include the Cauchy (initial value) problem with various boundary and initial conditions; Dirichlet and Neumann boundary value problems (BVP); the role of explicit solutions; existence and uniqueness proofs; and maximum principles and mean values. The choice of topics may vary - please consult the lecturer for details.

Syllabus: Examples of PDE --- heat equation, wave equation and Laplace's equation, --- mathematical models and variational methods, Euler-Lagrange equations. Harmonic functions: subharmonic, superharmonic functions; mean value properties; maximum principles; representation formulae, Green's functions. Heat equation: heat kernel representation; mean value property; maximum principles, existence and uniqueness. Wave equation: energy estimates and uniqueness; d'Lambert representation; Duhamel's principle. Functional analytic techniques

Overview of L^p -theory; approximation by convolutions.

Weak derivatives; Sobolev spaces; weak solutions.

Embedding theorems; Rellich compactness.

Review of Hilbert space theory; weak convergence; Riesz, Lax-Milgram theorems.

Prerequisites: MTH3160 Analysis and Topology.

Recommended reading: MTH3011 Partial Differential Equations.

References:

John, F., "Partial differential equations", Springer Verlag, 3rd edition, 1978.

Gilbarg, D., Trudinger, N.S., "Elliptic partial differential equations of second order," Springer Verlag, 2nd edition, 1983.

Strauss, W., "Partial differential equations; an introduction", Wiley, 1992.

Evans, L.C., "Partial differential equations", AMS, 1998.

Folland, G.B., "Introduction to partial differential equations", Princeton, 2001.

M4072 FIELD THEORY

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Tom Hall
- Contact Details: Tom.Hall@monash.edu, Room 432, Building 28, Tel.: 9905 4412.

Aims: The aim of this unit is to study fields and their symmetry, and thereby understand some classical problems of geometry and algebra. These problems can all be translated into polynomial equations, and Galois discovered that the solution of such equations depends on their symmetry. He also recognised that symmetry is captured by the group concept, and found a property of groups (now called “solvability”) which detects solvability of equations.

Galois theory develops these ideas systematically to explain why a variety of problems cannot be solved. In the process, some important concepts of group theory are developed and applied.

Syllabus: Formulation of classical problems in field theory. The arithmetic of polynomials. Irreducibility. Unsolvability of the classical ruler and compass problems. Automorphisms of fields and the Galois group. Radical extensions. Unsolvability of the general quintic equation.

Prerequisites: Please see lecturer

References:

Fraleigh, J. B., “A first course in abstract algebra”, Wiley.
Petersen, T., “The French mathematician”, Penguin.
Stillwell, J. C., “Elements of algebra”, Springer-Verlag.

M4082 LIE GROUPS

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Todd Oliynyk
- Contact Details: todd.oliynyk@monash.edu, Rm. 419, Bld. 28, Tel.: 9905 4433

Aims: Lie groups are groups that admit a manifold structure. They are ubiquitous in mathematics playing a key role in a diverse number of areas including geometry, analysis, and algebra. The purpose of this course is to use techniques from differential geometry to study the rich structure of Lie groups. The main aim is to develop the theory far enough so that applications to other areas of mathematics can be pursued.

Syllabus: Vector fields and flows, Lie bracket, Foliations, Lie groups and algebras: definitions and basic theory, Lie subgroups and subalgebras, closed subgroups, and applications as time permits. Some possible applications: homogeneous and symmetric spaces, principal bundles, compact Lie groups, and representation theory.

Prerequisites: MTH2021 Linear Algebra, MTH2140 / MTH3140 Real Analysis, M4041 Differential Geometry

References:

Primary:

1. L. Conlon, "Differentiable Manifolds", A First Course, Birkhauser, 1993.
2. F.W. Warner, "Foundations of Differentiable Manifolds and Lie Groups", Springer, 1983.

Secondary:

1. J. Stillwell, "Naive Lie Theory", Springer, 2008.
2. K. Tapp., "Matrix groups for undergraduates", American Mathematical Society, 2005.
3. A.W. Knap, "Lie groups: beyond an introduction", Birkhauser, 1996. (There is also a 2nd edition from 2002).
4. S. Helgason, "Differential geometry, Lie groups, and symmetric spaces", Academic Press, 1978.

M4382 NEW PURE MATHEMATICS TOPIC – TITLE AND SYLLABUS TO BE ADVISED

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: To Be Advised
- Contact Details: To Be Advised

Aims: To Be Advised

Syllabus: To Be Advised

Prerequisites: To Be Advised

6.2 Statistics

M4191 STOCHASTIC CALCULUS AND MATHEMATICAL FINANCE

- Offered Semester One 2012
- Level: 6 pt Honours Lecture or Reading Topic
- Lecturers: Fima Klebaner , Greg Markowsky
- Contact Details: Fima.Klebaner@monash.edu, Room 352, Building 28, Tel.: 9905 4409. Greg.Markowsky@monash.edu, Room 453, Building 28, Tel.: 9905 4487

Aims: This unit is a 6 point honours lecture topic and provides an introduction to Stochastic Calculus and mathematics of financial derivatives. Stochastic calculus is an extension of calculus to non-differentiable functions. It is a branch of pure mathematics, which found use in applications. Besides finance it is also used in engineering. We teach from the book: Klebaner, Fima “Introduction to stochastic calculus with applications”, 2nd Ed, Imperial College Press, 2005.

Syllabus: Variations and Quadratic variation of functions. Review of Integration and Probability. Brownian motion. Ito integrals and Ito’s formula. Stochastic Differential Equations and Diffusions. Calculation of expectations and PDE’s, Feynman-Kac formula. Martingales and Semimartingales. Change of Probability Measure and Girsanov Theorem. Fundamental Theorems of Asset Pricing. Change of Numeraire. Application to options.

Prerequisites: Some knowledge of probability is required and some knowledge of financial mathematics is desirable.

References:

Hull, John, “Options, futures and other derivative securities”, Prentice Hall.
Klebaner, Fima, “Introduction to stochastic calculus with applications”, 2nd edition, Imperial College Press, 2005.

M4271 STOCHASTIC PROCESSES I – LINEAR SYSTEMS

- **Level:** 4 pt Honours Lecture or Reading Topic
- **Lecturer:** Boris Miller
- **Contact Details:** Boris.miller@monash.edu, Room 464, Building 28, Tel.: 9905 5870.

Aims: This unit is a 4 point honours lecture topic and provides an introduction to general theory of stochastic processes and their applications. Stochastic processes constitute a branch of applied mathematics, which found use in various areas of engineering, resource management, control, and finance. The main uses of stochastic processes are the estimation and filtering, stochastic optimization and control.

Syllabus: Basic concepts of the probability theory and stochastic processes. Theorem of Kolmogorov and examples of random processes. Linear theory of stationary random processes. Stochastic integrals. Spectral analysis of random processes in linear systems. White noise. Random Processes with orthogonal and independent increments. Non-stationary linear systems, state and observation model. Kalman filter and its applications to stochastic optimization and control.

Prerequisites: It would be useful to have MTH2222 and MTH3241 as prerequisites. Some knowledge of basic probability is desirable.

References:

- H. Kramer and M. Leadbetter, Stationary and Related Stochastic Processes. John Wiley & Sons, NY, 1967.
B. Miller and A. Pankov, Theory of Random Processes, Nayka, Moscow, 2002.

M4341 PROBABILITY AND MATHEMATICAL STATISTICS - PART I - (OFF CAMPUS)

- Offered Semester One 2012
- Level: 6 pt Honours Lecture Topic only
- Lecturer: [External](#)

Aims: This subject first reviews the distributions of univariate and multivariate random variables extending the results encountered in previous probability courses. Principles of data reduction including the sufficiency and likelihood principles are discussed along with methods of finding and evaluating estimators and hypothesis tests. Methods of finding interval estimates are given. Decision theory is introduced and Bayes estimators and tests are discussed.

Prerequisites: To be advised

References:

To be advised

M4232 STOCHASTIC PROCESSES II – RANDOM WALKS & MARKOV CHAINS

- Offered Semester Two 2012
- Level: 6 pt Honours Lecture or Reading Topic
- Lecturers: Greg Markowsky and New Statistics Staff Member arriving 2012
- Contact Details: Greg.Markowsky@monash.edu, Room 453, Building 28, Tel.: 9905 4487. Contact details of new staff member to be advised

Aims: This unit is a 6 point honours lecture topic and the aim of the unit is to provide an introduction to general theory of random walks and Markov processes. The basis of the course is martingale theory, which constitutes an important part of all modern probability theory and helps to understand most of the approaches in financial mathematics and actuarial science.

Syllabus: Martingales. Definitions and examples, stopping times. Optional stopping theorem. Convergence of martingales. Applications of martingales to analysis of random walks. Definition and properties of Markov processes, Markov chains in discrete time. Markov chains in continuous time, the birth-and-death processes. Linear stochastic differential equations and Kalman-Bucy filter.

Prerequisites: It would be useful to have MTH2222, MTH3230 and MTH3241 as prerequisites.

References:

- S. Ross, Stochastic Processes, John Wiley & Sons, NY, 1996.
R. Elliott, L. Aggoun, and J. Moor, Hidden Markov Models, Springer, 1998.

M4322 OPTIMIZATION (APPLIED STATISTICS)

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Kate Smith-Miles, Boris Miller
- Contact Details: Kate.Smith-Miles@monash.edu, Room 441, Building 28, Tel.: 9905 3170. Boris.Miller@monash.edu, Room 464, Building 28, Tel.: 9905 5870

Aims: This unit is a 4 point honours lecture topic. The aim of this topic is to introduce students to the techniques for solving optimization problems of various kinds: continuous, combinatorial, unconstrained and constrained, deterministic, stochastic, and optimal control problems. Students then study in more detail the application of the Dynamic Programming method for optimization of discrete and continuous systems.

Prerequisites: Linear algebra, calculus, probability theory

References:

Dimitry Bertsekas, Dynamic Programming and Optimal Control, Athena Scientific, 2005, 2000, 1985.

M4342 PROBABILITY AND MATHEMATICAL STATISTICS – PART II – (OFF CAMPUS)

- Offered Semester Two 2012
- Level: 6 pt Honours Lecture Topic only
- Lecturer: [External](#)

Aims: This is a measure theory based advanced level course on probability theory, with applications to the theory of point estimation. The subject introduces key concepts and presents formal derivations of a number of fundamental results from probability theory. The second part of the course is devoted to the statistical theory of point estimation, where the results presented in the first part play a crucial role.

Prerequisites: To be advised

References:

To be advised

M4352 MATHEMATICS OF RISK – (OFF CAMPUS)

- Offered Semester Two 2012
- Level: 6 pt Honours Lecture Topic only
- Lecturer: [External](#)

Aims: Mathematical modelling of various types of risk has become an important component of the modern financial industry. The subject discusses the key aspects of the mathematics of market risk. Main concepts include loss distributions, risk and dependence measures, copulas, risk aggregation and allocation principles, elements of extreme value theory. The main theme is the need to satisfactorily address extreme outcomes and the dependence of key risk drivers.

Prerequisites: To be advised

References:

To be advised

M4622 INTRODUCTION TO BIOINFORMATICS

- Offered Semester Two - 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Dr Jonathan Keith, Dr Tianhai Tian
- Contact Details: Jonathan.keith@monash.edu, Room 451, Building 28, Tel.: 9902 0890. Tianhai.Tian@monash.edu, Room 454, Building 28, Tel.: 9905 4474.

Aims: Bioinformatics is a broad term for the use of computers in solving information problems in the life sciences. As such it brings together a range of concepts and techniques from mathematics, statistics and computer science and applies them to the analysis of biological data, usually at the molecular level. This unit aims to provide the student with a broad awareness of the field from three perspectives: data, methodology and application.

Syllabus:

1. Sequence Alignment and Analysis
2. Phylogenetics and Comparative Genomics
3. Structure Prediction
4. Functional Genomics
5. Systems Modelling, Inference and Simulation

Assessment: Each student will give a short (10-15min) informal presentation discussing a relevant paper, **each week** for 11 weeks. Students will receive a mark out of 10 for each presentation and the lowest of the 11 marks will be discarded, leaving a total mark out of 100. Marks will be awarded for demonstrating understanding.

Prerequisites: MTH2010; MTH2051 or MTH3051 would be helpful, as would STA2032.

Recommended reading:

Mount, David W., Bioinformatics, Sequence and Genome Analysis, 2nd Edition, CSHL Press, 2004.

References:

Pevsner, Jonathan, Bioinformatics and Functional Genomics, Wiley, 2003
Parida, Laxmi, Pattern Discovery in Bioinformatics, Chapman & Hall, 2008

M4300 RESEARCH PAPERS IN STATISTICS

- Offered as a Full Year Unit - 2012
- Level: 4 pt Honours Lecture Topic only
- Lecturer: Dr Kais Hamza
- Contact Details: Kais.Hamza@monash.edu, Room 458, Building 28, Tel.: 9905 4453.

This year long topic aims at introducing the students to research papers in Probability, Statistics and Stochastic Processes and their applications, introducing them to the various features of a research paper, from structure to content to bibliography, as well as allowing them to expand their personal interest in an area of their choosing. Students will have an opportunity to investigate an area of research through the exploration of research papers instead of a “well digested linearly-structured” body of work. The schedule is as follows:

- Weeks 1 to 3: Features of a research paper – an introduction by examples.
- Week 4: Students choose a “learning” paper from a pre-selected collection of articles.
- Weeks 5 to 10: In turn, each fortnight, students present one part or one aspect of their paper to the rest of the class. Technical help and feedback are given. Emphasis is placed on exploratory processes undertaken and critical thinking employed.
- Weeks 11 & 12: Presentation of the learning papers (a 20-minute summary of the paper considered).
- Week 13: Students choose a second paper from a small selection of journals (in consultation with staff).
- In the second half of the year, students will, autonomously (but always with technical support), work through their respective second papers with the aim to comprehend and summarise their content. A second 20-minute presentation will conclude the semester.

6.3 Applied Mathematics

Students undertaking the Applied Mathematics honours program must complete the three core lecture topics, M4411, M4422 (listed below) and M4401 (as described in §6.0 Introduction to Honours Computing) plus at least 16 points of other approved lecture topics, as described in §4.

M4411 ADVANCED COMPUTATIONAL MATHEMATICS

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Daniel Price, Simon Clarke and Tianhai Tian
- Contact Details: Daniel.Price@monash.edu, Room 352, Tel.: 9905 1760;
Simon.Clarke@sci.monash.edu, Room 209, Tel.: 9905 4421.
Tianhai.Tian@monash.edu, Room 454, Tel.: 9905 4474.

Aims: To appreciate some of the important computational techniques which have broad applicability to solving research problems in applied mathematics, especially the main approaches and key factors involved in the numerical approximation of partial differential equations by finite difference methods.

Syllabus: The main topics covered are:

- A brief overview of classes of methods for multidimensional problems; non-uniform grids and coordinate transformations; truncation error, stability, consistency and convergence.
- Direct and iterative solution of elliptic PDEs, including conjugate gradient and multigrid approaches.
- Direct and operator splitting methods for the solution of parabolic PDEs in multiple dimensions, including FFT and ADI methods.
- Methods for the accurate solution of the advection equation and hyperbolic PDEs, including upwind and flux-splitting techniques.

Prerequisites: MTH3011 and satisfactory completion of (or exemption from) *M4401 Introduction to Honours Computing*. MTH3051 recommended.

Textbook (access essential):

LeVeque, Randall, *Finite Difference Methods for Ordinary and Partial Differential Equations*, SIAM, 2007.

M4422 ADVANCED METHODS FOR APPLIED MATHEMATICS

- Offered Semester Two 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Paul Cally and Anthony Lun
- Contact Details: Paul.Cally@monash.edu, Room 322, Tel.: 9905 4471;
Anthony.Lun@monash.edu, Room 318, Tel.: 9905 4447.

Aims: To appreciate some of the key principles of approximation of solutions of differential equations and integrals by asymptotic analysis.

Syllabus: The syllabus will follow the textbook (Bender & Orszag) quite closely, so it is essential that students have access that that book. Some “lectures” will also be set as reading.

The main topics covered are:

- Local analysis of linear ODEs, including irregular singular points and asymptotic series;
- Asymptotic expansion of integrals, including stationary phase and steepest descent;
- Perturbation series, including singular series and asymptotic matching;
- Boundary-layer theory, including matching between layers;
- WKB theory.

Assessment: Continuous assessment (problems from textbook and problem sheets) 50%
Exam 50%

Prerequisites: MTH3060 recommended.

Textbook (access essential):

Bender, C.E., and Orszag, S.A., *Advanced Mathematical Methods for Scientists and Engineers*, Springer 1999 (originally McGraw-Hill 1978).

6.4 Astrophysics

Compulsory Core Units are M4401, M4031, M4111 & M4331.
Recommended Units are M4221, M4411, M4422.

M4031 GENERAL RELATIVITY

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Leo Brewin
- Contact Details: Leo.Brewin@monash.edu, Room 317, Building 28, Tel.: 9905 4456.

Aims: The aim is to study General Relativity: to understand its claims as a gravitational theory, its relationship with special relativity and Newtonian gravitational theory and to examine its predictions and their observational verification (or even non-verification). This topic is also designed to serve as an introductory course for anyone who wants to do further study in GR.

Syllabus: Differential geometry: Riemannian manifolds, covariant differentiation, geodesics, curvature tensor. Einstein's equations, black holes, experimental tests of general relativity.

Prerequisites: MTH2010 Multivariable Calculus and ASP2051 /ASP3051 Relativity and Cosmology.

Recommended book:

D'Inverno, R., *Introducing Einstein's relativity*, Oxford, 1992.

References:

Schutz, B.F., "A first course in general relativity", CUP, 1985.

Wald, R.M., "General relativity", U. of Chicago Press, 1984.

M4111 THE SUN – **NOT OFFERED IN 2012**

M4331 PLANETARY DYNAMICS AND EVOLUTION

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturers: Rosemary Mardling and Louis Moresi
- Contact Details: Rosemary.mardling@monash.edu, Room 314, Building 28, Tel.: 9905 4506, Louis.moresi@monash.edu, Room 335, Building 28, Tel.: 9905 4450.

Part 1: Planetary Dynamics

Since 1995, over 300 planets have been discovered orbiting nearby Sun-like stars including 30 multiple-planet systems. None of these systems is anything like the Solar System; most contain planets with significantly eccentric orbits and many are extremely short-period. A huge amount of international effort is going into the search for planets residing in the “habitable zones” of their stars. Since most of these planets are likely to have companion planets (and many will have companion stars), there is much interest in understanding the dynamical evolution of such systems and, in particular, the implications for the existence of life on planets in the habitable zone.

In this part of the course you will learn how the orbits of planets, moons and stars evolve under the influence of each other's gravity, and how tidal and spin-orbit coupling affect this evolution. We will derive the governing equations from first principles, and apply them to (1): a short-period planet with a moon, (2): a planet with a binary star companion, and (3) the Earth-Moon-Sun system. For the latter you will show that the current configuration is consistent with the Moon having formed from the debris from a giant collision between a Mars-sized body and the Earth, that is, you will show that the Moon's orbital period was once very much shorter. You will also show that without the Moon, the Earth's obliquity (the angle between its spin axis and the orbit normal) would be very much greater, that is, the Earth would “fall over” under the influence of the Sun.

References:

Murray, C & Dermott, S, “Solar System Dynamics”, 2000, CUP

Part 2: Planetary Evolution

In this part of the course you will gain a basic introduction to mathematical planetary physics. You will learn about the processes within the solid planets and moons of the solar system which produce the wealth of distinctive “geology” observed in planetary missions. You will appreciate the ubiquitous nature of geological processes, and the distinctive expression of those processes on each planetary body. You will have a good understanding of the continuum mechanics of slow deformation and the rheology of rocks and ice under planetary conditions. There is a significant component of background knowledge to this subject which is taught through directed background reading during the semester.

M4331 continued over the page\...

In this section of the course you will gain a basic introduction to mathematical planetary physics.

We will undertake an overview of the structure of all the planets of the solar system and the techniques used to probe their structure.

You will learn about the evolutionary processes within the solid planets and moons of the solar system which produce the wealth of distinctive "geology" observed in planetary missions. You will appreciate the ubiquitous nature of geological processes, and the distinctive expression of those processes on each planetary body.

You will have a good understanding of the continuum mechanics of slow deformation and the rheology of rocks and ice under planetary conditions. There is a significant component of background knowledge to this subject which is taught through directed background reading during the semester.

References

[1] G. Schubert, D. L. Turcotte, and P. Olson. *Mantle Convection in Earth and Planets*. Cambridge University Press, UK, 2001.

[2] D. Turcotte and G. Schubert. *Geodynamics*. John Wiley and Sons, New York, 1982.

Prerequisites

Enrolled in Astrophysics, Applied or Atmospheric Sciences honours, or physics honours (with prior consent)

M4221 RESEARCH TOPICS IN ASTROPHYSICS

- Offered Semester One 2012
- Unit Coordinator: Dr Alina Donea
- Contact Details: Alina.Donea@monash.edu, Room 319, Building 28, Tel.: 9905 4488.
- The lecture topic "Research topics in Astrophysics" has three parts:

PART I 33.3 % (4 2-hour lectures each) week 1,2,3,4

PART II 33.3 % (4 2-hour lectures each) week 5,6,7,8

PART III 33.3 % (4 2-hour lectures each) week 9,10,11,12

Each part will be taught by researchers in the school. The unit is taught in the first semester 2010 over 12 weeks.

Each part:

20% assignment (the assignment will be handed in week 3 of each teaching). According to the school rules if a student hands an assignment over after 48 hours, and they did not contact the lecturer, we are not supposed to receive the assignment at all. 13.3% exam. Exam (2 hr exam): 2 questions from each part, each question should not take more than 20 minutes to solve, equal marks.

PART I: Topic To Be Advised

- Lecturer: Joe Monaghan
- Contact Details: Joseph.Monaghan@monash.edu, Room 347, Building 28, Tel.: 9905 4463.

Synopsis To be Advised

PARTS II and PARTS III over the page\...

PART II: Introduction to Helioseismology

- **Lecturer:** Hamed Moradi
- **Contact Details:** Hamed.Moradi@monash.edu, Room 328, Building 28, Tel.: 9905 4420.

Aims:

To gain a basic understanding of some of the physical processes in the sun and the structure of the solar atmosphere.

To understand the physics of solar oscillations.

To understand the various diagnostic tools employed in helioseismology and their applications.

To understand and be able to interpret helioseismic observations from ground and space-based instruments.

Assignment type: Problem solving and computational exercise

Lecturing style: Powerpoint

PART III: Astrophysical X-ray data analysis – measurement, uncertainty, and inference

- **Lecturer:** Duncan Galloway
- **Contact Details:** Duncan.Galloway@monash.edu, Room 327, Building 28, Tel.: 9905 4422.

This part of the course will introduce the various methods by which X-rays from cosmic objects are detected and characterised, as well as broadly covering the statistical tools commonly used. A brief summary of the types of objects and emission mechanisms which may produce high-energy photons will be followed by a discussion of descriptive statistics which may be used to characterise observations. I will discuss spectral fitting, which will lead into the statistical component of the course, and which will cover commonly encountered probability distributions, parameter estimation and hypothesis testing. Finally, I will briefly cover a few other useful topics, including nonparametric and Bayesian statistics.

Learning objectives:

- (1) Basic understanding of the physics behind and technical limitations of modern X-ray detector hardware
- (2) Knowledge of some of the commonly-encountered statistical problems for astrophysics
- (3) Understanding of the strengths and weaknesses of various statistical tests and tools which will be introduced in the course

Teaching methods:

Lectures, complemented by group collaborative computational and/or analytic work.

Assignment type: Written, with a computational component.

6.5 Atmospheric science

M4511 BOUNDARY LAYER METEOROLOGY

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Danijel Belušić
- Contact Details: Danijel.Belusic@monash.edu, Room 208, Building 28, Tel.: 9905 4411.

Aims: To study the behaviour of the atmospheric boundary layer, and how it interacts with the surface and the free troposphere. This topic will introduce air pollution meteorology; turbulence and turbulent closure.

Syllabus: Introductory survey, turbulent fluxes, Reynolds decomposition, Mixed Layer models, Ekman Boundary Layer and Nocturnal Jets, mixing length theory, Monin-Obukhov Similarity Theory, turbulent kinetic energy, closure and higher order closure, air pollution meteorology.

Prerequisites: Contact lecturer.

References: Contact lecturer.

M4541 STATISTICAL INFERENCES IN CLIMATE DYNAMICS

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Dietmar Dommengeset
- Contact Details: Dietmar.Dommengeset@monash.edu, Room 212, Building 28, Tel.: 9905 4495.

Aims: The course should discuss some basic statistical methods for analyzing climate dynamics, with the aim of understanding the physical mechanisms driving the observed structures (statistics). The course will start with the principles of decision making in statistical analysis (significance tests), will then discuss the basics of probability theory, time series, stochastic models and multi-variate data (pattern) analysis. The focus here will not be on deriving statistical parameters, but will rather be on discussing how these methods could be applied and what the potential pitfalls in interpreting the statistical results could be.

Prerequisites: No specific course is needed, but it is assumed that the students have some basic knowledge of statistics/math and climate dynamics. The MATLAB programming does not require any prior knowledge or experience, but some interest in it would help.

Assesment: Continues assessment 60% and Oral examination 40%

References:

The lecture will provide a 250pp lecture script. The statistical methods are well described in:

-Statistical Analysis in Climate Research

Hans von Storch and Francis W. Zwiers; Cambridge University Press, Cambridge, 1999, x+484pp., US\$ 110, ISBN 0-521-45071-3 (hardback)

- Wilks, D.S., 2006. Statistical Methods in the Atmospheric Sciences, 2nd Ed. International Geophysics Series, Vol. 59, Academic Press, 627 pp

M4571 ADVANCED DYNAMICAL METEOROLOGY

- Offered Semester One 2012
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Michael Reeder
- Contact Details: Michael.Reeder@monash.edu, Room 219, Building 28, Tel.: 9905 4464.

Aims: The aim of the course is to explore the basic dynamical principles governing flow in a rotating frame of reference (the earth's frame of reference), and to use these principles to understand the dynamics of the atmosphere. The specific topics covered include:

- Scale analysis of the equations of motion for midlatitude synoptic systems
- Quasigeostrophic approximation
- Potential vorticity and extratropical cyclones
- Baroclinic instability and its relationship to extratropical cyclones
- Scale analysis of the equations of motion for the tropical atmosphere
- Hadley circulation
- Tropical waves
- Fronts and vertical motion
- Small amplitude gravity waves
- Flow over orography

Prerequisites: Students should have taken an introductory course in dynamical meteorology (e.g. ATM3011 Weather and Climate Phenomena, ATM3040 Dynamical and Physical Processes in Meteorology, ATM3050 Dynamical Meteorology, or 625-331 Atmosphere-Ocean Interaction at Melbourne University). An introductory course in fluid mechanics is useful also (e.g. MTH3360)

References:

Four assignments each worth 10%

60% by oral examination

M4591 ATMOSPHERE OCEAN INTERACTION AND CLIMATE - (EXTERNAL –UNIVERSITY OF MELBOURNE)

- Offered Semester One 2011
- Level: 4 pt Honours Lecture Topic
- Lecturer: Kevin Walsh (University of Melbourne)
- Contact Details: Kevinwalsh@unimelb.edu.au

Aims: The learning objective of this honours topic is to understand the theories that describe the coupling between the atmosphere and ocean

Syllabus: This course aims to introduce the student to processes of atmosphere-ocean interaction, their importance in the climate system and its variability, with a particular emphasis on tropical meteorology. Specific topics will include: wind and buoyancy driven ocean circulation, atmospheric convection, atmospheric and oceanic wave phenomena, SST and atmospheric circulation, El Nino Southern Oscillation (ENSO), decadal to centennial scale variability and large scale modeling.

Pre-requisites: Either ATM2020 or ATM2030, or their equivalent.

Assessment: To be Advised **References:** To be Advised

M4582 CONVECTIVE CLOUDS AND STORMS

- Offered Semester Two 2011 **(changed from Semester One To Semester Two)**
- Level: 4 pt Honours Lecture or Reading Topic
- Lecturer: Hamish Ramsay
- Contact Details: Hamish.Ramsay@monash.edu, Room 119, Building 28, Tel.: 9905 24213.

Aims: The aim of this course is to explore processes governing convection in the atmosphere, with a particular emphasis on severe convective storms and tropical cyclones. Specific topics covered include buoyancy, local convection, cellular convection, stability, severe storms - including supercell storms and squall lines, tornadoes, and tropical cyclones. Forecasting techniques for severe convective storms may also be explored if time permits.

Prerequisites:

ATM 2030
ATM 3050 (Dynamical Meteorology) or equivalent

7. Details of External Courses

In 2012, the ICE-EM / AMSI Summer School will be hosted by The University of NSW from 9 January to 3 February 2012. To receive more information about the Summer School please visit: <http://www.amsi.org.au/events/forthcoming-events/691-amsi-summer-school-2012>

The 2012 Access Grid lecture Topics will be published on the following link during February 2012: <http://www.amsi.org.au/research-a-higher-education/access-grid/subjects-a-courses>

If you are interested in taking either one of these AMSI summer semester topics over summer 2012 OR AMSI Access Grid lecture Topics within the 2012 teaching semesters, please speak to the Honours Coordinator (*see Section 1*).

The Key Centre For Statistical Sciences (KCSS):
<http://www.latrobe.edu.au/mathstats/kcss/>.

If you are interested in taking one of these KCSS units, please contact the Statistics Honours Advisor (*see Section 1*).

8. Honours year prizes

All students enrolled in honours are eligible for the following prizes:

LEO GLEESON PRIZE

Prize for the best honours student completing the Applied Mathematics honours program.

CARL MOPPERT PRIZE IN MATHEMATICS

Prize for the best all-round mathematics honours student.

THE MOCA PRIZE FOR ASTROPHYSICS

Prize for the best honours student in Astrophysics.

PURE MATHEMATICS PRIZE

Prize for the outstanding honours student in pure mathematics.

STATISTICS PRIZE

Prize for the best honours student in statistics.

AMOS PRIZE FOR METEOROLOGY / OCEANOGRAPHY

Prize for the best honours student in atmospheric science.

GEOFF DAVIES PRIZE - (MATHEMATICAL SCIENCES AND GEOSCIENCES HONOURS GEODYNAMICS PRIZE)

Prize for the best honours student in geodynamics, computational geophysics, global tectonics or planetary physics.

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