

Department of Mathematics Retreat  
Eaglehawk Resort  
Thursday 12 April 2007 - Friday 13 April 2007  
Notes on our Deliberations

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## 1 Introduction

The first day consisted of looking at our first and second year courses, and the the question of the appropriate entrance requirements to our honours program. The second day concentrated more on organisational details. The following notes provides an informal outline of the deliberations. Thank you to Lilia and Kelly for putting these together. At the end of each section are some indications to possible actions.

## 2 First Year Courses

### 2.1 MATH1003

Bryan Wang - The results from the diagnostic test suggested the need to provide a review of material (3 lectures) - Bryan has been tracking weak students to make sure they are OK. The textbook is excellent with lots of applications. Several students are from medical sciences. Bryan gives lots of exciting examples (e.g. on global warming).

Linear systems prove to be difficult to students. Matrix operations (applications - e.g. how to write down in matrix form store sales). Eigenvalues and eigenvector problems good for problems. Excellent results in mid-semester exam. Students are capable of doing Maths but need motivation. Content of MATH1003 overlaps with MATH1013. However, the content of MATH1013 is covered at a deeper conceptual level.

We discussed the possibility of going from MATH1003 to MATH1014: Not possible because of the linear algebra part. Students will struggle. The idea was not for students to do MATH1003 to skip MATH1013. Hence, how do we change MATH1013 to make it more interesting to all different students taking it? Adams may be the wrong book. Starting from Chapter 10 won't help because students do not have enough in-depth knowledge of topics from Chapters 1-9, even if they think they do.

National curriculum will help in homogenising student backgrounds.

### Further Questions and Actions

- Need to better link with MATH1013.
- Advertise to Commerce and Biology students.

### 2.2 MATH1013

Students in this course are from very different backgrounds and have diverse Maths abilities. The course starts at a very low level (rational numbers, equations of lines, circles, etc.) Then calculus comes. Many students have already seen the material and do exceedingly well. Many other students are very weak and cannot do simple basic maths manipulation. These students will fail, repeat MATH1013 in second semester and fail again. There isn't enough time to cover the syllabus in a proper way with enough examples. The Mid-Semester test results are bimodal reflecting this trend. Very weak students need some serious remedial Maths (pre-calculus). Why don't we seem to have the same problem with MATH1003? We have to change the diagnostic test to find out where problems are and be more firm if some students need to be moved into MATH1003. Sometimes pre-requisites are waived and students are allowed to enroll with a weak Maths background into MATH1013.

Same problems in Physics. This year, a group of 20-30 students is very weak. Where do they come from? All these students (Physics included) should be encouraged to do MATH1003. Solution: Tutoring? Centrally sponsored Faculty of Science/Engineering/Economics Maths Resource Centre where the students could go if they need help?

MATH1013 has lost synchronisation with MATH1115, so the switch from one of the other has to be done quickly.

### **Further Questions and Actions**

- Identify group of weak students
- Diagnostic test as early as possible. Use for all three levels with a wide range of questions.
- Current syllabus seems to have too much revision. Problem, how to get the right depth of presentation without just starting at chapter 10 of Adams
- Consider new text books, not necessarily the same as MATH1115/1116

### **2.3 MATH1115/MATH1116**

This is another mixed course. Although students are very bright, the majority of them are now taking this course because they have to and in this respect now it has become more like a service course. MATH1115 covers a lot of material and the depth, as a consequence, is not the same as it used to be. There is an overlap of material between MATH1115 and MATH1116, since both have complex numbers and vectors. If these topics were to be removed from MATH1116, some lectures will be available to Jim Borger to cover additional Algebra material. Alternatively, they could be removed from MATH1115 and have a few more Calculus/Algebra lectures. However, this material (vectors and complex numbers) may be required to be covered in MATH1115 by the Economics Faculty for the Actuarial students. We should check what the story is.

Another possibility is that bright Maths oriented students do MATH1116 skipping MATH1115. But this would be difficult, since some background from MATH1115 is necessary for MATH1116 (and definitely not covered in school). Alternatively, a new course with the old calculus material (of the type offered prior to 2006) could be put up, while the Algebra lectures would be shared with the current MATH1115 taken by the Actuarial students. An additional lecturer would be required to teach Calculus (Maths) Honours.

### **Further Questions and Actions**

- We have two cohorts, how to deal with this. Meet with Finance and Applied Stats to discuss.
- We should have a more extensive diagnostic to recommend to student which course as early as possible. Sydney Uni has an only test. We should look into this.
- MATH1013 and MATH1115 are moving away from each other. So it is not necessary for them to have the same textbook.
- Look into new textbooks

## 2.4 MATH1007

This course was offered jointly with the Dept. of Philosophy. It was a first year Maths course and a recommended 2nd year Philosophy course. The lecturer was Peter Roeper, a theoretical physicist by training who moved into the field of Philosophy of Science. However, Peter Roeper retired at the end of 2006. Dayal Wickramasinghe is now teaching the whole course while the tutorials are run by a Philosophy PhD student. The Dept. of Philosophy is likely to take part again in the running of the course through a new appointment in the Philosophy of Science area.

The course contains simple Maths (e.g. twin paradox), which can be understood by Arts students. The participation of Philosophy students is crucial, particularly at tutorial sessions (students are more mature - there is more in-depth discussion).

This course has about 40 Science students (+ 20 Philosophy students when it is recommended by the Philosophy Dept.) but it has never been advertised. With some advertisement it could grow to a substantial number. The Big Questions (offered by Physics) was also very popular. When Craig Savage used to teach it, the course had up to 80 students. The average was about 60, which dropped to 20 when it was offered only on-line.

MATH1007 could be advertised to PhB students (Andrew Hassell suggestion) with possible addons. Maybe add some Maths? Link it with the "Science/Research Method" course of the Faculty of Science? The material covered by these two courses is too different, though. Students cannot do both (not enough room). Sharing of the course with other Science Depts? Probably not, it would be watered down.

The "Science/Research Method" course might be a pre-requisite for all PhB students and if so, one may expect an enrollment of 100+. John Hutchinson: Bad idea to make it compulsory! it would cut student options out (chemistry, biology etc.). It may be important to learn how to approach science methods/writing, but other subjects may be as (if not more) important. It has very little overlap with the Poetry of the Universe. Maybe the Maths Dept. should become more involved with MATH1007 (e.g. fractal structure of the Universe; platonic Mathematical world and how it latches on to the Physical world).

### Further Questions and Actions

- Change name.
- Share it with Philosophy (important)
- Advertise it better.
- Could it become part of a major if placed in 3rd year? It may look better on a student academic transcript. Steve Roberts likes the 3rd year idea. It is good for a 2nd year Philosophy Dept and a 3rd year Science course. However, if it becomes part of a Maths major, students won't do enough "serious" Maths.
- Discuss with Philosophy

## 3 Entrance to Honours

There should be an Applied Maths program and a Mathematical Physics Program. Which pre-requisite should we set to enter the Honours program? Some students do not do the standard

core Maths courses, but could nevertheless do projects with CRES, SRES, Computational, Astro projects, etc., etc. under the Maths banner. They are interested, good students and we shouldn't lose them by putting stringent pre-requisites. So, what should we require from them? Should these students graduate under a "Mathematical Sciences" banner? These students would not have done Analysis and/or Algebra. Should "applied mathematicians" be required to do the second year core courses in Analysis and Algebra? The feeling is that they should do something like that.

PhB students cannot do 4 courses in 2nd year and 4 courses in 3rd year plus add-ons. According to Aidan (Byrne), this is far too prescriptive.

Maths students divide into

- (i) Theoretical students.
- (ii) Multi-disciplinary stream: Very good quantitative students (Astro, computational mathematics, financial maths etc.) who have taken many core Maths courses.
- (iii) All others (pass stream).

Suggestion: A possibility to reduce the number of core courses for stream (ii) would be to replace the Analysis and Algebra courses with one single course. The major question is: Is this simply a problem of re-ordering the material in these courses? Aidan stresses again that Maths Dept. rules are too prescriptive and for this reason we lose students to Physics. After all, as Aidan points out, the subset of pure Maths students is really tiny (4 or 5 per year in the Honours program, if that?) and still, the whole program is geared up for this handful of students. That is good for Physics (which is less prescriptive and more flexible), and that is the reason why we lose students to Physics (Aidan keeps on stressing this).

Is it possible to teach Analysis at two different levels? Not many students are willing to do too many courses in pure Maths. If they are interested also in other areas, they simply do not have the space. However John Hutchinson does not think that it is possible to change these courses to accommodate two streams by delivering the same lectures.

We have also talked about the possibility of having different names for different Honours streams. One possibility we discussed is to have only one name for all "Mathematical Sciences" with all streams contained into it. Pure Maths would be one of these streams. Sydney University already has a scheme of this type. It should be clear from the start what a student ought to do in order to flow into the pure Maths stream to end up, perhaps, into a PhD program. John H. wonders... Is this going to "downgrade" our Pure Maths degree? According to many staff members, it would all boil down to references. If a student does not have the correct background, would not get a reference that would allow him access into a pure Maths PhD program anywhere. But John.H. still wonders: What if some (naughty) members of the Dept. use our hard-earned international reputation to recommend undeserving students to pure Maths Departments around the World? John H. wonders again: Is it possible to compare students across streams? The general feeling is that ultimately students are compared across all kind of disciplines when it comes to University Medals, so we should be able to compare them across Maths streams.

It appears that the general consensus is to learn to live with only one name. We are a small Department and cannot subdivide our students too much. Added to which, we do not want to give the impression of creating a two-class-citizen situation, with the pure students at the top and the applied at the bottom. So the question arises again: How do we re-jig

the Analysis and Algebra courses into one to create a common background for all students of streams (i) and (ii)?

### Further Questions and Actions

- Consensus is to have all our honours streams under the one banner (Mathematics). There would be themes corresponding to our research groups and current majors.
- Each research group should define their recommended choice of courses for prospective honours students
- Similarly for each quantitative major where we have supervision capability, e.g., computational modelling, environmental modelling, mathematical finance, Quantitative Biology & Bioinformatics ,etc.
- Need to think about criteria that might be used to judge performance that allow us to make sensible rankings of students who do not do the traditional fundamental maths courses at Level 3.

## 4 MATH2305/MATH2306

MATH2306 has about 60 students. These students divide into 50% pass + 50% honours. As a consequence, Peter Bouwknecht claims that it is hard to teach. Should we break it up into two courses: Maths +Physics Honours students and Engineering and Pass level Physics students. Kelly Wicks also states that administratively it is difficult to keep track of mixed classes (pass + honours). When students need to re-enrol for the following semester, ESP does not acknowledge the Hons level students. It cannot pick up annotations stating they are HPO students. It is easier to keep them separate from the start. Suggestion from Peter Bouwknecht: Move vector calculus back to MATH2405. Fourier Series and Complex Calculus would be moved to MATH2406 (which would be called Mathematical Methods 1 - new course) from the 3rd year current Mathematical Methods 2 course. Hence, with virtually all the course matter removed, the 3rd year Mathematical Methods course MATH3322 would be dropped.

Changes in Honours stream:

- (i) MATH2405: Maths Methods 1 - ODEs + Vector Calculus.
- (ii) MATH2406: Maths Methods 2 - PDEs, Complex Calculus, Fourier Series.
- (iii) MATH3322: Removed.

Changes in pass/Engineering stream:

- (i) MATH2305: ODEs with Laplace Transform - no changes.
- (ii) MATH2306: PDEs, Vector Calculus, Fourier Series.

Bifurcation here as in MATH1115? Should Eng/Physics students be separated and taught different topics (Vectors/Laplace Transforms)? As it stands above, MATH2306 is useless to the Physicists. It is done too late and would not be recommended by the Department of Physics. It takes up a slot and does not add anything because the necessary Mathematics has already been taught in Physics courses (PDEs and Vector Calculus).

Rob Mahony says that the Engineering Department is planning to make MATH2305 a compulsory subject for all Engineering student, as it was in the past. As far as MATH2306 is concerned, it would be impossible to make it compulsory because of the lack of space for more Mathematics courses in the Engineering Degree structure. Thus, this course (MATH2306) with no support from Physics or Engineering may have to be dropped altogether, since it would have very few students.

Suggestion: How about removing 1/3 of linear algebra from first year pass level courses and introduce vector calculus in first year? Linda Stals wonders: If the LA is reduced by 1/3, where would this 1/3 go? A possibility would be to remove it altogether, since students may not need too much knowledge of abstract vector spaces in most cases.

If this route is selected, there would be a need to look for new textbooks in Calculus and Linear Algebra. Linear Algebra, however, would be done in depth in MATH1115/MATH1116, since no material would be excised from these courses.

### **Further Questions and Actions**

- Recommend breaking MATH2306 into MATH2306 for engineering and physics students and MATH2406 for mathematics and theoretical physics students. MATH2306 would become more like MATH2305 as a hands on PDE course.
- Move vector calculus back to MATH2405. Bring Complex calculus from MATH3322 to MATH2406.
- Drop MATH3322 Math Methods 2.
- Change names on MATH2405, MATH2306 and MATH2406.
- Leave MATH2305 alone (it is working well).

## **5 Engineering/Pass level stream**

Games Graphs and Machines is doing well. Algebraic structures and Coding Theory are not doing so well, but were doing OK in the past. Proposal of a new course on Cryptography and Coding Theory which should be popular among Engineering students. However Engineering students do not seem to have enough space for this course and the prediction (from Rob Mahony) is that not more than about 5 students mainly from Software Engineering would end up enrolling in this course. Master degree students might be interested in a course of this kind. Rob will provide a set of names of people we should contact. Chris Johnson would like to see some statistics being taught somewhere (in MATH1005?). Maybe this could be done in some Engineering courses (as suggested by Rob).

### **Further Questions and Actions**

- Drop the course MATH2303 Algebraic Structures and Coding Theory

## 6 Joint Honours Programs

Graduate program in Environmental Modelling: presentation by Tony Jakeman (with hand-out). Perhaps use the Grad Cert. as a fall back degree for people who cannot finish the Graduate Diploma. Also students who cannot finish the Master may end up with a Grad. Dip.

Graduate students may have problems with work commitments. VC asks to look at what we offer and whether we could put it on the Web, such as with the Master of Cont. Science.

Central ANU marketing is useless and Engineering has setup its own marketing section. The College of Science hasn't done that yet.

### Further Questions and Actions

- Agreed to support this program.

## 7 Preliminary Discussion Day Two

John Urbas has an interesting idea: start Calculus with multi-variable calculus. There is an on-line textbook from Georgia-Tech which can be useful. This book would not be appropriate for the Honours stream, but should be OK for the Pass level students. It is a nice (free!) book of about 200 pages with lots of exercises.

In the US, students may get an exemption from doing 1st year Calculus if they have done it at school. In the US, the Advance Placement Test is used to check student knowledge to see whether they can skip courses.

Pass level students should be given a geometrical approach to Algebra. A computational approach would also be preferable (particularly for Engineering students). Students should have an understanding of numerical methods and know when to trust (or distrust) results. Too deeply abstract concepts should be avoided. Lay is the wrong book for this geometrical/numerical approach. We need to introduce some excitement in Linear Algebra. We are not in need of a major restructuring, just in a shift in the emphasis. MATH1014 Linear Algebra is far too abstract for the students. At the end of the course they have absorbed very little. They tend to do very badly in Linear Algebra and often they only pass the course because they do very well in Calculus.

We need to solve the problem of the 50+ students at the bottom of the MATH1013 class. On-line test before lectures start?

### Further Questions and Actions

- Investigate the idea of changing Linear Algebra emphasis (different text book). Perhaps concentrate on matrix techniques.
- Investigate a revamped of calculus in MATH1013/1014 which might still provide revision, but in the context of multi-variate calculus.
- Investigate introduction of vector calculus into MATH1014

## 8 Organisation Questions

### 8.1 WebCT

WebCT may be a problem for new staff members. It is easy to use for standard things, but if one tries to do anything out of the normal it is not very intuitive. Groups can be organised for WebCT training. WebCT has the capability to organise tutorial groups. It works quite nicely.

#### Further Questions and Actions

- Run an introductory session for the department to show off a few tricks and to show the new tutorial signup system.

### 8.2 Tutors

Rules for tutors. 1/2 hour weekly meeting lecturers/tutors is desirable. However, if the tutorials are 2 hour long, the tutors can't be expected to find the additional time to meet the lecturer. Should the Dept. pay a little extra for an additional 1/2 hour meeting every second week (or maybe every week)? (I guess they would be paid at a much lower rate for a meeting - minimal wage?). Alternatively, should tutorials be cut down to 1 and 1/2 hours? Bryan Wang is not keen on shorter tutorials.

Tutors should keep a hard copy of the marks at least till the end of semester.

Fraction level A position - some kind of top-up for PhD students (\$ 5,000 per years). These students would have some kind of teaching responsibilities (lead focus groups?). There isn't any longer a penalty for students taking more than 4 years to complete their PhD. So, TA work for PhD student running out of time might help.

#### Further Questions and Actions

- Provide information sheet to tutors to list duties and expectations. Get help from current experience tutors to help on this.

### 8.3 Exam Marks Backup

Exam papers are kept for 4 years. Maybe it would be a good idea to download all the marks from WebCT and send them to Kelly. Hardcopy too or just trust Nick (IT)?

#### Further Questions and Actions

- Kelly to collect hard copy of marks spreadsheet at time marks are collected.

### 8.4 Drop-in Centre

Drop-in Centre seems to be a good idea generally. Maybe the Fractional A position could run a service of this type. Usually the Drop-in Centre is used by the same students who come all the time. These students are usually quite good. Unfortunately, the weak students (bottom 50 in MATH1013) do not use it at all. As a result, the Drop-in Centre is staffed for many hours a week to serve the middle/top 5% of students in each first year course. Students

prefer to see a tutor than their lecturers at the Drop-in Centre. Should lecturers have to staff the Drop-in Centre? Or should they be allowed to see the students when and where they want to see them? Maybe a targeted help for the bottom students of each class (like Bryan does for MATH1003)) would be more useful to weak students and staff would feel they are doing something for all students (not only the top 5% turning up every week). Maybe a tutorial room where students meet and work together would be a better idea. Honours and PhD students could staff this drop-in type facility at some of the times. It would be a more relaxed atmosphere.

### **Further Questions and Actions**

- The idea of a “tutorial room” should be considered in any move to a new building.

## **8.5 Student Feedback**

ANUSET forms have effectively replaced Departmental Committee meeting of lecturers with student Reps. However, they are not as good as they could be, particularly for tutors. CEDAM forms at the end of semester are also not useful, since the feedback to improve the lecturing/assessment/tutorials comes far too late. We should have a system where feedback is sought half way through the course and students see that we are acting on their complaints.

Focus groups facilitated by people outside the course are generally a good option that Tim Brown likes. Facilitators ask what works and what doesn't. They collect general information, etc. They are more personal than anonymous forms where students often do not give enough information on what they do not like about the course.

Student Reps should be selected and made contactable by the rest of the class. Should we be handing their E-mail addresses out? Yes, but we need their permission. Should we give them a Maths E-mail address? These are all details that need to be worked out.

### **Further Questions and Actions**

- Reps to be chosen for each undergraduate course.

## **9 Outreach**

### **9.1 ANU College**

Time effective way to meet teachers and students (better than visiting individual Colleges). Teachers seem to be enthusiastic.

### **9.2 Math Day**

Very successful. Sometimes there is the need to hunt around for suitable questions. Ben Andrews will be send an E-mail around with examples of typical questions. Big event for students. College of Science provides a lot of support (even accommodation). It is a very good advertising campaign for the ANU. This year is being held on the 25 May.

### **Further Questions and Actions**

- Need to help Ben with poster and questions

### 9.3 Archimedes Day

coming up on the 7 June. Steve and Linda run some workshops and tutorials.

### 9.4 Open Day

We need to jazz up our display. At the moment it appears to be the worst of the Faculty of Science. Animation displays? We need to get started soon, since Open Day is coming.

#### Further Questions and Actions

- Follow up with improved display. Posters and animation.

### 9.5 Other Ideas

We need to smarten up the corridors of the MSI. We should put attractive posters on the walls (start with ground floor and replace blu-tak pictures with something better looking). Andrew Hassell may have interesting colour posters that we could frame and display.

#### Further Questions and Actions

- Follow up with Alan to help with sprucing up our corridors.
- Get some fancy posters for honours and graduate program

## 10 PhB

We need to give suggestions (a few sentences) to Andrew Hassell for Advance Studies Courses. An E-mail sent out a while ago was not successful (very few people replied). PhB Advance Studies Course and Addons demand a huge amount of a lecturer's time. With a workload that is already quite heavy, to take on one or more undergraduate research students is another big demand on departmental resources. However, apparently students are allowed to work in groups for these projects and this could save some time.

The course Poetry of the Universe has potentially interesting topics for addons. Dayal Wickramasinghe will give a list to Ben Andrews.

How are PhB students associated to Departments? Where do Astrophysics students go (into a black hole)?

#### Further Questions and Actions

- Get ASC ideas to Andrew
- Check how Astro PhB students are linked to mentors.

## 11 3rd Year Courses

Two types: Core courses that need to be staffed every year and Special Topics courses that are offered on a voluntary basis. Staff in the Dept. are assigned a 3rd year course. We have to identify a Maths core. Mathematical Methods II will be dropped and its material re-distributed (see above).

### Further Questions and Actions

- Have a look at the current course to ascertain whether the department should guarantee them, or should they move to special topics.

## 12 Honours Program

Should we recommend 4 or 5 courses? How do we integrate Maths with Physics (e.g. Mathematical Physics). Physics requires 5 courses (50% coursework +50% project). Physics courses are worth 3 CP and are run intensively over a few weeks, sometimes with breaks in the middle to allow for Lab work. Tim Brown is trying to have the same Honours rules across the College.

Honours seminars: Are they working? Apparently students are not receiving any feedback (anomaly of 2006 Honours year?). We must make sure that this feedback does exist, because that is the idea of having these seminars

Outside supervisors should be informed well in advance of what we expect from them. Additional material should be handed out to supervisors, since what we currently have is insufficient.

### Further Questions and Actions

- Ensure honours students get feed back to their seminars.
- Improve our rules with respect to what courses can be used in the course work component of the honours program.
- Specify 4 courses are necessary.
- Improve instructions to outside supervisors.

## 13 Research Students

Where should they go? For the PhD students the best place is DoM. For the others, anywhere the supervisor is located. The VC has put aside some money for student travel. The idea is for students to stay overseas longer than the conference period to establish contacts with overseas researchers.

How do we attract more students? Shall we work on a new better flyer? We are advertising on our walls other institution PhD programs, but not our own! Students may decide to go where they are offered top-ups. Maybe top-ups might be advertised in the flyer (for outstanding students). In some areas of the ANU these top-ups are quite large (up to \$ 10,000 per year?). Furthermore, some areas advertise trips overseas and personal laptops. We could do something similar, since our students do get their own workstations and they are also given overseas trips (at least one). It is believed that roughly half of the PhB students stay at the ANU for their PhD.

Applications from overseas are increasing and now there are fee-waivers for outstanding students. Some of these students come also with overseas support (e.g. China). New Zealand is another good country to target, since New Zealanders are not charged fees.

## Further Questions and Actions

- Improve graduate flyer, noting the possibility of fee waivers for overseas student, top ups, support for overseas travel, personal laptops?

## 14 Retreat Attendees

Michael Barnsley

Jim Borger

Aidan Byrne

Alan Carey

Florica Cirstea

Lilia Ferrario

Andrew Hassell

John Hutchinson

John Jakeman

Tony Jakeman

Robert Mahony

Anmon Neeman

Elizabeth Ormerod

Rishni Ratnam

Steve Roberts

Adam Sikora

Linda Stals

Melissa Tacy

John Urbas

Bryan Wang

Alan Welsh

Kelly Wicks

Dayal Wickramasinghe