

Australian Mathematical Society

Accreditation Review Bachelor of Mathematics Programs University of Wollongong

Assessor's Report¹

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¹This report has been prepared for the Review Committee of the Australian Mathematical Society and for the School of Mathematics and Statistics, University of Wollongong. The contents of the report are not to be released to external parties without consent of the University of Wollongong.

Executive Summary

The School of Mathematics and Applied Statistics at the University of Wollongong offers undergraduate students a broad range of degree programs and combined degree programs in Mathematics. These programs all contain solid foundation courses in calculus, linear algebra, statistics, discrete mathematics, differential equations, complex variables, group theory and mathematical modelling. Graduates achieve skills in constructing proofs, numeracy and problem solving, using computers in mathematics, and mathematical communication. All of the degree programs offer the possibility of an honours year requiring completion of a substantial thesis component, and advanced courses including modern topics such as wavelets and chaos. The honours year is good preparation for PhD studies in many areas of Mathematics, most particularly in differential equations, dynamical systems and mathematical modelling.

All lecturing staff have PhD qualifications in the mathematical sciences. Subjects are reviewed at least once every five years. The School monitors student achievement through mid session exams, final exams and projects, and supports students through mentoring and additional classes. Teaching quality is monitored through student surveys and peer monitoring.

The School of Mathematics and Applied Statistics has particular strengths in Applied Mathematics, Mathematical Modelling, Engineering Mathematics and Financial Mathematics. The School also has an innovative Advanced Mathematics degree in which students undertake project work in addition to their courses. The School offers good training in Pure Mathematics and has strengthened this area further through the recent appointment of four international experts in operator algebras.

This review recommends that all of the Mathematics degree programs and combined Mathematics degree programs in The School of Mathematics and Applied Statistics at the University of Wollongong be accredited by the Australian Mathematical Society.

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1 Background to the Review

On 3 August 2007 the Head of the School of Mathematics and Applied Statistics, University of Wollongong, A/Prof Tim Marchant contacted A/Prof Ian Doust, Chair of the Australian Mathematical Society Review Committee for accreditation and review of its undergraduate mathematics programs ². The request asked if the process could be completed in 2007.

In addition to, or conjoint with, those matters under consideration for accreditation purposes it was requested that the review should report on the following specific issues; the number and range of degrees offered; the targeting of degrees to the pool of potential students; how well the degrees prepare students for future careers; the currency of subjects at all levels; the use of computers and mathematical software packages; whether there are new markets that should be explored in degrees and subjects.

A/Prof Ian Doust contacted me on 28 September 2007 to ask if I would agree to prepare this review. After a preliminary perusal of materials on the University of Wollongong website I contacted the Head of School, A/Prof Tim Marchant to arrange a suitable date for a site visit. We agreed to a visit for 7 November 2007. The Head of School forwarded printed details of all mathematics programs including enrolments, as well as copies of subject outlines, copies of exam papers for compulsory subjects, and details about academic qualifications of members of staff. This material was received on 29 October.

I carried out a site visit on 7 November 2007. During this visit I met with the Head of School A/Prof Tim Marchant; two lecturers with major responsibilities in First Year core teaching, Dr Maureen Edwards and Dr Caz Sandison; Research Professor Ian Raeburn; the Associate Dean for Teaching A/Profs Graham Williams; and the Chair of the School Education Committee (SEC), A/Prof Peter Nickolas. I forwarded an initial draft of this report to A/Prof Tim Marchant on 15 November 2007 and received written comments on 22 November 2007. I am grateful for the open access and assistance provided to me by these members of the School.

This final report was completed on 18 December 2007 after receiving feedback from the Program Review Committee of the Australian Mathematical Society on 13 December 2007.

²The School is seeking an independent professional accreditation for its statistics programs through the Statistical Society of Australia. It is possible to do a statistics major as part of the BMath degree and recommendations in this review about the BMath degree apply to this major too.

2 Mathematics Programs

The School of Mathematics and Statistics is one of the four schools composing the Faculty of Informatics at the University of Wollongong. The other schools in this faculty are Electrical, Computer and Telecommunications Engineering; Computer Science and Software Engineering; Information Systems and Technology. In addition to providing training for mathematics graduates the School is a major teaching service provider for undergraduate engineering students. The following undergraduate degrees are administered by the School.

Bachelor of Mathematics	BMath
Bachelor of Mathematics (Advanced)	BMathAdv
Bachelor of Mathematics Education	BMathEd
Bachelor of Mathematics and Finance	BMathFin
Bachelor of Mathematics and Finance(Dean's Scholars)	BMathFin(Dean's Scholars)
Bachelor of Mathematics and Economics	BMathEcon
Bachelor of Mathematics and Economics(Dean's Scholars)	BMathEcon(Dean's Scholars)

The following combined undergraduate degrees are administered jointly by the School.

Bachelor of Mathematics – Bachelor of Computer Science	BMath, BCompSci
Bachelor of Mathematics – Bachelor of Laws	BMath, LLB
Bachelor of Science – Bachelor of Mathematics	BSc, BMath
Bachelor of Science(Physics) – Bachelor of Mathematics	BSc(Physics), BMath
Bachelor of Engineering – Bachelor of Mathematics	BE, BMath

The BMathFin and BMathEcon degrees have articulated Honours degrees with the fourth year of study different to the fourth year of study in the standard BMathFin and BMathEcon degrees. It is possible to complete an Honours degree in each of the other degrees too, if entry requirements are met. This involves an additional year of study requiring completion of an Honours thesis and advanced mathematics courses. Double majors are also possible within the various degrees and this involves additional study beyond the minimum degree requirements.

3 Accreditation Standards

3.1 Syllabus

Each mathematics subject counts as six credit points (c.p.) towards the degree. Each academic session consists of thirteen weeks of classes. The formal weekly contact hours in six credit point subjects are different at different levels as summarized in the table below.

Level I	Level II	Level III/IV
4 hrs lec	3 hrs lec	2 hrs lec
1 hr tut (or lab)	1 hr tut (or lab)	1 hr tut (or lab)

The total number of credit points to be completed for each degree is summarized in the table below. Student enrolments for 2007 and approximate UAI entry requirements are also listed.

Degree	Code	Duration	c.p.	Enrol	UAI
BMath	762	3 years	144	56(3)	75
BMathAdv	762A	3 years	144	15(8)	92
BMathEd	886	4 years	192	27	75
BMathFin	767	4 years	192	62	82
BMathEcon	767A	4 years	192	12	82
BMath-LLB	774	5 years	288	3	90
BMath-BCompSci	769	4 years	216	15	80
BSc(Physics)-BMath	792	4 years	216	3	80
BSc-BMath	892	4 years	216	1	80
BE-BMath	791	5 years	264	7	90
BE-BMath	738	5 years	264	8	90

The numbers shown in () are honours enrolments. The two different BE-BMath degrees are to cater for Engineering specializations in different Faculties as follows:

Code 738 Engineering: Computer, Telecommunications, Electrical, Internet

Code 791 Engineering: Civil, Environmental, Materials, Mechatronics, Mining

All of the mathematics degrees listed above contain a significant proportion of mathematics. The table below lists the minimum mathematics content as a percentage of the total requirements in each year of study.

Degree	Year I	Year II	Year III
BMath	25 ^a	62.5	75 ^b
BMathAdv	50	62.5	62.5
BMathEcon	37.5	62.5	37.5 ^c
BMathFin	50	50	37.5 ^d
BMathEd	37.5	50	62.5

^aMost students take 50% or more of their first year in mathematics subjects

^bIf the BMath degree includes a double major then the minimal mathematics content at Level III is reduced to 62.5% or 50% if that double major is with Computer Science

^cThis is a four year degree with further mathematics content in Year IV

^dThis is a four year degree with further mathematics content in Year IV

3.1.1 Courses in calculus, matrices, linear algebra

In first year all students study calculus and linear algebra through the two core subjects MATH187 (which includes topics on differentiation, integration, polar coordinates, matrix algebra, and vectors) and MATH188 (which includes topics on complex numbers, sequences, series, Taylor series, partial differentiation, real analysis, and numerical integration)³.

All students are also required to take courses in several variable calculus and linear algebra through the core subjects MATH201 Multivariate and Vector Calculus and MATH203 Linear Algebra.

3.1.2 Courses in differential equations, statistics, discrete mathematics, complex variables

All students are required to take courses in discrete mathematics, differential equations, complex variables and statistics through the core subjects MATH121 Discrete Mathematics (or MATH222 Continuous and Finite Mathematics⁴); STAT131 Understanding Variation and Uncertainty (or STAT231 Probability and Random Variables); MATH202 Differential Equations 2; and MATH204 Complex Variables and Group Theory⁵.

³Students in BMathAdv are assumed to have superior levels of mathematical knowledge on entry and they study instead the special subject MATH110 (which includes topics on matrix methods, differential equations, vector geometry)

⁴For students in the BMathFin and BMathEcon, MATH222 is not compulsory but is an elective.

⁵For students in the BMathFin and BMathEcon, MATH204 is not compulsory but is an elective.

3.1.3 Exposure to the ideas of proofs and axiomatic systems

Students are exposed to proofs and axiomatic systems throughout a range of courses but most particularly through the core subject MATH121 Discrete Mathematics where students are introduced to appropriate methods of proof for deriving results in set theory, number theory and elementary theory of relations and functions. Students are also introduced to the construction of truth tables for logical expressions, and how to represent mathematical statements in predicate logic.

3.1.4 Exposure to the use of mathematics in applications

All students are exposed to the use of mathematics in applications through the core mathematical modelling subject MATH111 Applied Mathematical Modelling 1 (or MATH212 Applied Mathematical Modelling 2). Examples of mathematical modelling are also provided through many of the Level III subjects and there are dedicated Level III elective subjects on modelling; MATH312 Applied Mathematical Modelling 3, MATH313 Industrial Mathematical Modelling, and MATH371 Special Topics in Industrial and Applied Mathematics III.

3.1.5 Exposure to the use of computers in mathematics

The core mathematical modelling subjects MATH111 Applied Mathematical Modelling 1 (and MATH212 Applied Mathematical Modelling 2) include exposure to the use of computers in mathematics. Assessment in MATH111 includes assignments and exam questions based on the MAPLE computer package. The core subject MATH202 Differential Equations 2 introduces students to numerical methods for solving differential equations using MAPLE. Students in this subject are required to attend computing laboratory classes and MAPLE based assignments are used as part of the course assessment. The core subject MATH203 Linear Algebra introduces students to numerical methods for solving systems of linear equations. Students in this subject are also required to attend computing laboratory classes based on the numerical package MATLAB and computing assignments form part of the course assessment. Some of the questions in the final exam are based on sample MATLAB sessions. Computer based assignments using MAPLE or MATLAB are also common in Level III subjects. The statistics package JMP is used in teaching for many of the statistics courses including the core subject STAT231 Probability and Random Variables. Knowledge of the use of JMP is assessed in assignments and the final exam.

3.1.6 Advanced courses

All students are required to complete 36 c.p. in Level III/IV mathematics subjects unless they are undertaking a double major⁶ or the BMathEd degree⁷. Level III subjects include traditional areas such as Math322 Algebra, MATH321 Numerical Analysis, Math 305 Partial Differential Equations as well as more modern areas such as MATH323 Topology and Chaos, MATH325 Wavelets, MATH317 Financial Calculus and MATH313 Industrial Mathematical Modelling.

3.1.7 Honours

In the BMathFin and BMathEcon degrees the Honours degree (and the Dean's Scholars degree) has the fourth year as an articulated year of study that is different to the fourth year for the standard BMathFin, BMathEcon degrees. Entry to the Honours year in these degrees is restricted to students with a WAM greater than or equal to 67.5 across 144 credit points. In the Honours year students undertake 12 c.p. in Maths Honours subjects as well as 12 c.p. in Advanced Finance or Economics subjects, another 12 c.p. in elective subjects and an Honours thesis that counts for 12 cp. The class of honours in these degrees is awarded based on combined coursework/thesis marks (weighted according to credit points) as follows: Class I, (>77.5%); Class II, Division I (72.5%–77.5%); Class II, Division 2 (67.5%–72.5%); Class III (62.5%–67.5%); No Hons (<62.5%).

In all of the other degree programs excluding the BMathAdv degree (but including the combined degrees) the Honours degree involves an additional year of study requiring satisfactory completion of advanced mathematics courses (36 c.p.) and a thesis (12 c.p.)⁸. Students may complete 42 c.p. of advanced mathematics courses in which case the Honors grade is obtained from the thesis mark and the best performance over 36 c.p. of subjects. Entry to the Honours program in these degrees is restricted to students with a Credit average or better. The class of honours is awarded based on combined coursework/thesis marks (weighted according to credit points) as follows: Class I, (85%–100%); Class II, Division I (75%–84%); Class II, Division 2 (65%–74%); Class III (50%–64%); Fail (0–49%).

⁶Here the minimal requirements are 30 c.p. in Level III/IV Maths unless the double major is with Computer Science in which case 24 c.p. at Level III/IV are required in Maths

⁷The minimal requirements are 24 c.p. Level III

⁸In the BMathAdv degree the thesis counts towards 18 c.p. and the subjects count towards 30 cp.

Students achieving a grade of Hons Class I in any of the Mathematics programs are well prepared for further studies at the PhD level. Many past honours students from these programs have gone on to complete PhDs and indeed some of the current academic staff were past undergraduates in Mathematics from the University of Wollongong.

3.1.8 Comment on Level of Courses

Syllabus sheets and past exam papers were investigated in this review for the courses: MATH110 Advanced Mathematics, MATH111 Applied Mathematical Modelling 1, MATH121 Discrete Mathematics, MATH187 Mathematics 1A Part 1, MATH188 Mathematics 1A Part 2, MATH201 Multivariate and Vector Calculus, MATH202 Differential Equations 2, MATH203 Linear Algebra, MATH204 Complex Variables and Group Theory, MATH212 Applied Mathematical Modelling 2, MATH222 Continuous and Finite Mathematics, MATH302 Differential Equations 3, MATH305 Partial Differential Equations, MATH317 Financial Calculus, MATH321 Numerical Analysis, MATH322 Algebra, MATH323 Topology and Chaos, MATH371 Special Topics in Industrial and Applied Mathematics. This assessor was entirely satisfied with the content and level of the courses and the rigour of the exams. Most papers were three hour exams consisting of six questions with multiple parts for each question.

In general there was a marked increase in understanding and mathematical maturity required by students in later level courses. For example in the exam for the Level I modelling subject, MATH111, the governing equations for various models were provided and students were asked questions relating to the model equations; in the exam for the Level II modelling subject, MATH212, students were required to develop model equations for themselves (albeit in clearly defined 'model' dynamics problems); and in the exam for the Level III modelling subject, MATH371, the questions had a distinct real world flavour requiring thoughtful model development by the students.

3.2 Teaching

3.2.1 Staff

The School has thirty members of academic staff, including four Research Professors, and an Honorary Fellow. The School also has four postdoctoral fellows. All members of academic staff have tertiary qualifications at the PhD level in

mathematical sciences. The academic staff are composed of eight professors (including four research professors), nine associate professors, nine senior lecturers, and four lecturers. Nine out of twenty six academic staff are female, representing excellent gender balance in academic staffing for a School of Mathematics.

Lectures are conducted by academic staff. Academic staff are also expected to undertake tutorials related to their lecturing duties. Some tutorial teaching is undertaken by casual staff, including PhD students, honours students and external casual tutors.

3.2.2 Monitoring Teaching Quality

Teaching quality is monitored in several ways.

All new academic staff undertake training through three University run modules on Introduction to Tertiary Teaching. In the first of these modules staff attend a one week training course. In the second module, staff are reviewed by other staff attending some of their lectures. In the third module, staff participate in curriculum development or review.

It is routine for academic staff to also obtain feedback from students about their teaching and the course they teach through student surveys. Reporting on student surveys of teaching is not compulsory but this is a requirement for staff seeking promotion. Subject surveys are mandatory at least once every five years. It is not uncommon for the Head of School or other senior members of staff to sit in on lectures of more junior staff to help to prepare them for promotion.

The School of Mathematics and Applied Statistics has a healthy culture of sharing or passing on notes between lecturers. This supports lecturers coming into the subject for the first time and it also operates as a form of quality control with shared notes constantly updated and modified.

All casual teachers are required to undergo an initial induction course on teaching. Their teaching is assessed by other members of academic staff who also maintain an ongoing mentoring relationship.

Any student dissatisfaction with teaching can be reported, initially through the subject coordinator, then the Head of School, and then the Associate Dean for Teaching.

The School of Mathematics and Applied Statistics has a School Education Committee; to ensure that University policies on teaching and learning are implemented, and also to review curriculum.

3.2.3 Teaching Methods

Courses are taught through a combination of lectures, tutorials and laboratory classes.

Large class lectures are conducted in lecture theatres where most lecturers use a combination of set notes and 'live notes'. Typically a lecturer will show students a theorem, or method through projection of set notes and then elaborate on aspects of this and show illustrative examples through a separate projection facility. In most cases the set notes are available for students to purchase or download. Many lecturers post copies of teaching materials on a Web Portal. Textbooks are not commonly prescribed for students. Instead the School publishes course notes for most subjects and these notes are for sale through the UniCentre Bookshop. The notes are of high quality. Recommended reference texts are suggested for all subjects. Copies of the reference texts are available in the University Library. The recommended reference texts are usually classic modern texts in the field.

Tutorials are usually limited to twenty students and these classes are conducted using innovative 'blackboard in the round' methods. Students work in small groups (three or four) through problems on whiteboards right around the room and tutors move around the boards to offer suggestions. This style of tutorial requires active participation by students.

The School of Mathematics and Applied Statistics also has a room set aside with an Access Grid and Video Conferencing Facilities. Their honours students attend AMSI lecture courses through the access grid. The Video Conferencing is used to simulcast lectures between different campuses.

The School also has access to a Computer Laboratory with thirty PCs loaded with mathematical software including MAPLE, MATLAB, SPSS, SAS(JMP) and EXCEL. Students are issued with computing accounts and many subjects provide instruction and set tasks using mathematical software packages through computing laboratory classes. The Laboratory is booked for teaching class use about one third of the time and the remaining time is free use for students enrolled in one of the mathematics programs or students undertaking mathematics courses with computing components. Students also have access to other more generalist computing facilities (not loaded with the Mathematics and Statistics software) and students can also connect their laptops to a wireless network.

3.2.4 Assessment Methods

A final exam of two or three hours (plus fifteen minutes reading time) forms the major component of the assessment in all core subjects. The core subjects also have mid term exams (typically one hour or one and one half hours) and assignments (often including computing assignments). Typically the final exam counts towards 70% of the overall mark with the mid term exam counting towards 20% and assignments making up 10%. In the modelling course MATH111 the final exam may count towards 50% of the overall mark with 20% from the mid term test and the remaining 30% from computing assignments (25%) and tutorial assignments (5%).

Sample exam papers were investigated in this review for all of the core courses and found to be of an appropriate standard.

The University intolerance to cheating and plagiarism is communicated to students in all subject handouts.

3.2.5 Student Support

The School of Mathematics and Applied Statistics implements several student support strategies.

Each new student is assigned a member of staff to be their mentor throughout their degree. This mentoring involves an initial one on one meeting with the student at the start of Session I. This is followed up by a second one on one meeting at the start of Session II. In this second meeting the progress of the student is discussed. A third group meeting is convened at the end of Session II to advise students of courses related to their areas of interest. The mentoring continues through the second and third years.

Students are encouraged to seek help from their lecturers and tutors in all subjects. Additional tutorials are also conducted in the large first year subjects at three time slots each week for those students seeking further help.

The large core first year mathematics subjects are repeated over a summer session enabling students who have failed, or students who have had to complete bridging courses that affected their progress, the opportunity to catch up.

A student grievance program is advertised to students through initial subject handouts letting students know whom to consult on grievance issues.

3.2.6 Student Handouts

Course handouts are provided in all subjects. These handouts advertise class times, the course syllabus, reference texts, subject learning outcomes, assessments, policy on cheating and plagiarism, consultation contacts. Most of the course handouts follow the same template. The descriptions of subject learning outcomes are informative.

3.2.7 Other

The School is in the process of setting up an Advisory Committee with two thirds of the members from industry and one third from education. This committee will help to monitor standards and currency of programs.

3.3 Graduate Attributes

3.3.1 Numeracy and problem solving

The core subject MATH111 Applied Mathematical Modelling exposes students to a range of numeracy and problem solving skills as do the later year elective subjects in Applied Mathematical Modelling. In these subjects students learn how to model real world problems as idealized mathematical systems, how to solve the mathematical problem and how to interpret the results. Students develop these skills by undertaking laboratory based assignments. The skills are also tested in exams.

More generally, skills in thinking logically and analytically are fundamental to all of the mathematics (and statistics) courses in the School.

3.3.2 Communication of technical information

Students gain some skills in communicating technical information throughout their courses by carrying out assignment tasks and answering exam questions. Students are encouraged to show all working leading up to their answers.

Students also gain experience in communicating technical information by participating in tutorials.

Students in the BMathAdv degree gain higher level skills in communicating technical information through the two subjects MATH235 Mathematics Project A and MATH345 Mathematics Project B. In these subjects projects are individually chosen for students and they involve one of the following: placement

in business or industry using mathematical techniques and then reporting on this, independent mathematical investigations reported through written and oral communications, or research collaborations with staff members reported through written and oral communications. The written and oral reports are assessed. A similar project based subject MATH250 is available to students in the BMathEd degree.

Skills in communication of technical information are developed through the Honours thesis component of all Honours degree courses. As part of the Honours project all students are required to present a seminar which counts towards 10% of the total project mark.

3.3.3 Use of information technology

All students in the Mathematics programs require students to undertake the core subject CSCI114 Procedural Programming⁹. In the BMathEd degree students also take the core subject EDIC101 Teaching and Learning with Technology.

More generally all starting undergraduate students at the University of Wollongong are required to complete the subject ILIP100 Information Literacies Introductory Program. This subject is taught as an online module and it is assessed through an online assignment. The subject teaches skills in locating, interpreting, evaluating and using information and it teaches about technologies available to assist in this.

3.3.4 Secondary school mathematics teaching ability

All of the Mathematics programs would equip students with sufficient mathematical content (in both depth and breadth) to enable them to teach all of secondary school mathematics. The specialist BMathEd degree also equips students with practical teaching skills. These teaching skills can also be obtained through completion of a one year GradDipEd. All students in Mathematics programs at the University of Wollongong who undertook this additional year would be qualified to teach all of secondary school mathematics.

⁹Students in the BMathEcon degree may instead enroll in BUSS111 Business Programming

3.3.5 Student Experience

Student ratings of Mathematics programs in terms of Teaching Quality, Generic Skills and Overall Satisfaction are better than average (compared with Mathematics programs at other Australian universities) in all categories¹⁰

3.4 Facilities

The University of Wollongong has an attractive campus with modern facilities including a Library with more than half a million books, more than fifty thousand journal titles, two hundred and fifty data bases, and four thousand e-books.

The School of Mathematics and Applied Statistics conducts lectures in lecture theatres with modern projection facilities. The School also maintains its own access grid room with electronic whiteboards and video conferencing facilities.

All students in mathematics programs have computer accounts with electronic access to library facilities and access to a well equipped computer laboratory and mathematical software packages such as MAPLE, MATLAB, SPSS, SAS(JMP) and EXCEL.

The School has a dedicated room for 'blackboard in the round' style tutorials.

¹⁰Source: 2008 Good Universities Guide.

4 Specific Issues

In requesting the review, The Head of School asked that the review should report on a number of issues. Some of these issues have been addressed in section 3 of this report.

4.1 Number, Range and Targeting of Degrees

The nine degrees (including combined degrees) administered by the School provide training for approximately one hundred and fifty to two hundred students annually with an average of thirty to forty completions annually. The range of degrees covers most mathematical areas of employment as well as many areas for further study in mathematics.

The degree programs in Mathematics at the University of Wollongong are 'named degrees'. This is a useful marketing strategy that clearly targets different client groups. The strength of numbers in the BMathFin degree is partial evidence that this strategy is successful. The downside of this strategy is that prospective students with interests in an area of Mathematics not articulated in one of the degree names may conclude that their needs would not be met by this university. However the strength in numbers in the standard BMath degree is perhaps evidence that this is not a major concern.

4.2 Career Preparation

Career preparation in the joint degrees; Mathematics and Engineering, Mathematics and Computer Science, Mathematics and Law, are met by the allied discipline with the mathematics training an additional asset.

The composite named degrees BMathFin, BMathEcon, BMathEd have been structured to provide specialist training for careers in the areas of finance, economics and education respectively. The BMathEd degree includes thirteen weeks of practical teaching experience and is a recognized qualification for secondary school teaching. The School is currently seeking creditation for some of the specialist courses in the BMathFin degree from allied bodies in finance and this will strengthen the case of career preparation in this degree. Currently all graduates from this degree qualify for Associate Membership of the Institute of Securities Finance and Banking.

In addition to specialist training, most employers are seeking general skills such as the ability to formulate, model and solve problems; the flexibility to apply

mathematics and problem solving across different applications; computational skills; written and verbal communication skills; teamwork skills; the ability to learn new skills. The BMathAdv degree is particularly well structured for engendering these general skills with project based courses part of the degree requirements. The core mathematical modelling subject MATH111 covers some of these skills as do later year modelling subjects. The elective Level III subject MATH313, involving group project work, covers all of these skills at some level. Career preparation in general skills across all areas could be improved if a group project based course was part of the core requirements for all Mathematics graduates.

One measure of career preparedness is data from Graduate Destination Surveys administered to graduates four months after completion of their degree requirements. Summary data in the 2008 Good University Guide on 2005 Graduate Destinations in Mathematics at the University of Wollongong is as follows: 43% employed in the public sector, 29% employed in private industry, 41% undertaking further study and 13% seeking work. This 'performance' is ranked average by the Good University Guide.

Anecdotal evidence is that many students with undergraduate qualifications in Mathematics from the University of Wollongong find jobs in the financial sector and the popularity of the BMathFin degree supports this.

4.3 Currency of subjects

Many of the traditional Mathematics subjects at the University of Wollongong have been modernized through the inclusion of numerical methods and associated computer laboratory classes. Examples include MATH202 Differential Equations and MATH203 Linear Algebra.

The School also offers modelling subjects (concerned with real world problems) at all levels and it has a range of modern subject offerings including Discrete Mathematics, Wavelets, Topology and Chaos, Financial Calculus.

The School offers alternation of some 3rd year subjects to enable broader subject choices for students in the four year Honours degrees and for part timers.

It is not feasible for the School to attempt to offer subjects in all areas of Mathematics but in keeping with the overall direction of the School it would be useful to ensure that subjects in Optimization and Operations Research are available each year.

4.4 Use of computers and mathematical software packages

Many of the Mathematics subjects incorporate computing in their teaching and assessments. This is a very important component of the mathematical training that is done well at the University of Wollongong.

4.5 New Markets

The Table below lists the number of undergraduate students in total, in Mathematics, in Engineering and in Sciences for the major providers of undergraduate mathematics training in Australia. The data was obtained from the 2008 Good Universities Guide. This data is not complete (and not entirely reliable). It is clear from the Table entries that the University of Wollongong is already one of the major providers of tertiary mathematics training in Australia with an enviable market share of Mathematics graduates relative to the overall University enrolments and enrolments in allied disciplines.

University	Total	Maths	Engineering	Sciences
Australian National University	8819	11	636	1510
Central Queensland University	15400	28	647	635
Curtin University of Technology	28527	191	2942	1465
La Trobe University	19202	50	467	1702
Macquarie University	17593	151	65	947
Monash University	38015		3655	4780
Murdoch University	10767	53	250	2041
Queensland University of Technology	29831	341	2001	1704
RMIT University	28015	97	2942	1736
University of Adelaide	13094	476	1996	1795
University of Melbourne	27957		3420	6332
University of New England	12771	34	43	746
University of New South Wales	23218	55	4202	3478
University of Southern Queensland	14737		2303	1686
University of Newcastle	16987	125	1923	1192
University of Queensland	26509	21	2345	3720
University of South Australia	23113	35	1058	575
University of Sydney	30366		2583	4456
University of Tasmania	13981		508	1168
University of Technology Sydney	19129	408	2834	1599
University of Western Australia	12852		1969	2703
University of Western Sydney	26792	208	1099	1609
University of Wollongong	14146	178	1102	1118
Victoria University	14982	52	888	513

The most obvious difference between UTS, where mathematics numbers are very strong, and UNSW where (reported) mathematics numbers are (apparently) weak is that UNSW does not have named degrees in Mathematics whereas UTS does. This may account for the relative strength in mathematics undergraduate numbers at the University of Wollongong too.

UTS offers many of its Mathematics degrees as combined degrees with a BA(IntSt) (i.e, BA in International Studies). With the world becoming increasingly globalized and with Mathematics accepted as a globally transferrable qualification this is a sound strategy. This coupling would work particularly well with the BMathFin degree as many finance industry employers have global operations. This coupling could be achieved at the University of Wollongong by ensuring the

opportunity for students in the BMathFin degree to undertake sufficient preparation within this degree to prepare them for entry to the one year Master of International Relations degree currently offered at the University of Wollongong.

A new market that the School of Mathematics and Applied Statistics could pursue would be a combined BMathBEnvSci degree. The BEnvSci degree at the University of Wollongong currently has very little mathematical content. There will be a growing need for mathematical modelling in environmental science to provide better quantitative advice to decision makers. The School already has strengths in mathematical modelling and this would be a natural synergy.

Another new market could be explored through a degree such as BMathIndus (Bachelor of Mathematics - Industrial). Again this option could build on existing strengths in the School, including the School's close relationship with the Mathematics in Industry Study Group. Wollongong is well located for this type of degree with Port Kembla Harbour, Bluescope Steel Limited, and other manufacturing industries nearby. Over time it should be possible to develop a Work Integrated Learning Scholarship in this area.

5 Strengths and Weaknesses

5.1 Strengths

- Modern campus and facilities.
- Good gender balance among staff (approx one third female).
- Good gender balance among students (approx one third female).
- Excellent integration of modelling and computing in mathematics courses.
- A comprehensive selection of traditional and modern subject offerings.
- Student mentoring and support.
- Innovative blackboard in the round tutorials.
- An exemplary BMathFin degree with very strong enrolments.
- A strong offering of named degrees.
- An excellent BMathAdv degree for talented students featuring project based courses.
- Good use of modern technologies in teaching and learning.
- Good emphasis on graduate attributes in courses.
- Healthy Honours numbers.
- Strong postgraduate numbers.

5.2 Weaknesses

- Sporadic monitoring of teaching methods.
- Too much focus on dynamics in modelling subjects with too little focus on optimization and data analysis.
- Space constraints on expanding computer laboratory resources and blackboard in the round rooms.

6 Recommendations

Having reviewed the programs at the University of Wollongong, the Assessor makes the following recommendations:

6.1 Recommendation 1

This review recommends that the Australian Mathematical Society accredits the following undergraduate degrees (including with Honours) in the School of Mathematics and Applied Statistics at the University of Wollongong:

Bachelor of Mathematics	BMath
Bachelor of Mathematics (Advanced)	BMathAdv
Bachelor of Mathematics Education	BMathEd
Bachelor of Mathematics and Finance	BMathFin
Bachelor of Mathematics and Finance (Dean's Scholars)	BMathFin(Dean's Scholars)
Bachelor of Mathematics and Economics	BMathEcon
Bachelor of Mathematics and Economics (Dean's Scholars)	BMathEcon(Dean's Scholars)

This recommendation applies to all majors¹¹ offered within these degree programs

This recommendation also applies to any of the double degree programs such as Bachelor of Mathematics – Bachelor of Computer Science etc., which include a BMath component.

It is recommended that the Accreditation be for a five year period from 1 January 2008 to 31 December 2012.

6.2 Recommendation 2

This review recommends that student Teaching evaluations are carried out by each member of staff in at least one subject in each year of teaching and that summary evaluations be reported to the Head of School.

¹¹The School is also seeking an independent professional accreditation for its statistics major through the Statistical Society of Australia.

6.3 Recommendation 3

This review recommends that Level II or Level III subjects in Optimization/Operations Research should be available to students each year and that some components of Optimization/Operations Research should be introduced in the core mathematical modelling subjects.

6.4 Recommendation 4

This review recommends that one of the core subjects in the Mathematics degrees be revised to include group project work as part of the overall assessment.

6.5 Recommendation 5

This review recommends that the BMathFin degree be scrutinized and altered if necessary to ensure that students undertaking this degree would satisfy the requirements for admission to the one year Master of International Relations degree at the University of Wollongong. Students in the BMathEcon degree would meet the current entry requirements.

6.6 Recommendation 6

This review recommends that the School of Mathematics and Applied Statistics consults with the School of Earth and Environmental Sciences with the view to offering the joint degree BMathBEnvSci in Mathematics and Environmental Science.

6.7 Recommendation 7

This review recommends that the School of Mathematics and Applied Statistics should investigate the potential market for a new named undergraduate degree (such as BMathIndus) in Industrial Mathematics with the view of setting up a Work Integrated Learning Scholarship in this area.

7 Appendix: Australian Mathematical Society Accreditation Standards

The information in this Appendix is an extract from the Australian Mathematical Society web site:

<http://www.austms.org.au/AMSInfo/Accred/>

Accreditation should take place with respect to agreed standards for the various degrees. On the other hand, one needs to recognise that most mathematics undergraduate programs are undertaken as part of generalist degrees such as BSc or BA, and so it would be inappropriate to be too prescriptive about the structure of a degree. We should not define a mathematics degree as something that looks like the program at UNSW or the University of Melbourne. The criteria listed below define a core set of characteristics for each of the common types of degrees available. The importance of each of the criteria will obviously depend on the nature and focus of the degree. Programs which do not meet these criteria, whilst not being deemed ineligible for accreditation, would need to explain how the program makes up for the omissions.

In all cases, the physical facilities should be appropriate to allow the academic program to proceed successfully. Apart from the use of appropriate teaching rooms, this would include the provision of suitable computing and library resources.

7.1 3 year pass degree

This is typically a generalist Arts or Science degree. Graduates are expected to have developed a reasonable level of specialist knowledge. An average graduate should be able to apply standard mathematical techniques with some direction, but will not necessarily be capable of significant independent mathematical work.

Syllabus:

The syllabus will be assessed with regard to both its depth and breadth.

A significant proportion of the degree must be in mathematics. Traditionally this has consisted of, minimally, 25% of first year, 33% of second year and 50% of third year studies being in mathematics. Perturbations of this model are acceptable, although it is unlikely that a program would be approved in which less than one third of the total degree was in mathematics, or in which there is insufficient advanced content. Both the mathematics and non-mathematics

sections of the degree should be of a suitable intellectual level. Programs should include first and second year courses in

Calculus in one and several variables;

Matrices and linear algebra.

A typical program should contain a broad range of standard topics from across mathematics. All students should be required to see a certain amount of most, if not all, of:

Differential equations;

Statistics;

Discrete mathematics;

Complex variables;

The use of computers in mathematics.

Students should have some exposure to the ideas of proof and to axiomatic systems.

Students should have some exposure to the use of mathematics in applications.

Additional notes on the interpretation of these criteria is given below.

Teaching:

Most staff should have postgraduate qualifications in mathematics.

Within the context of the institution and the chosen delivery methods, teaching should be undertaken with care and professionalism.

The assessment methods should enable independent monitoring of student achievement.

There should be processes for monitoring the quality of teaching.

Students should be able to obtain additional assistance, if necessary, outside of their timetabled classes.

Graduates:

Should be able to demonstrate high levels of numeracy and problem solving.

Should be able to communicate technical information effectively.

Should be comfortable with the use of information technology.

Should have sufficient mathematical training to comfortably teach all of secondary school mathematics.

7.2 4 year Honours degree

The Honours degree is a qualification with greater depth and breadth than the pass degree. This degree typically develops a wider range of skills (such as research and report writing) than the pass degree. The Honours degree is a certification of a high level of skill in undergraduate mathematics. As well as providing preparation for postgraduate study, the Honours degree should provide suitable training for graduates in order that they may apply the mathematics they have seen with a certain degree of independence.

Syllabus:

Entry to the Honours year should require more than satisfying the minimal conditions for the pass degree. Most of the third year should be taken in mathematics or a cognate discipline. The final year should usually comprise a combination of advanced courses and a supervised research project. The topics covered will depend on the area of specialisation, but should be at a high enough level, and cover a broad enough range, to meet the broader objectives described above.

Teaching:

The requirements in terms of qualifications and experience are higher than for the provision of a pass degree.

Graduates:

Students attaining the equivalent of Honours Class IIA (or equivalent) should be sufficiently prepared to undertake postgraduate study. A grade of Honours Class I should be a clear indication of suitability to attempt a PhD. Convincing evidence of this would be the success of past graduates in postgraduate programs at other universities. Graduates should have superior skills in the areas of numeracy and problem solving. They should be capable of presenting technical information in either written or verbal form with limited supervision.

7.3 Other degrees

Joint degrees:

The standards for these degrees should be substantially the same as those for the Pass and Honours degrees considered above. At present the Society has only accredited undergraduate programs. In the event of an institution requesting accreditation for higher degrees, the Society will need to develop suitable criteria for these degrees as well.

Masters degrees by coursework:

The standard for these degrees should be at least equal to that of the final year

of the Honours degree considered above.

Research degrees:

The criteria here should be that the department possesses sufficient research experience to suitably supervise students across a range of topics, and that standards are moderated by the use of external examiners for theses. Notes on the syllabus elements of the accreditation criteria for a pass degree

7.4 Additional Notes

Ideally, all students graduating from the program being reviewed should meet at least a minimal amount of each of the topics listed under items 3, 4 and 5. For example, students should

See that some important real-world systems can be modelled by differential equations and that there are standard techniques for solving some classes of equations. See the notion of a random variable and understand about its mean and variance. Be exposed to one or more mathematical computer packages or languages. Know what a theorem is! The criteria in items 3, 4 and 5 should not be viewed a set of independent topics to be ticked off. As an analogy, one might declare that a cake recipe should usually contain eggs, butter, sugar and flour. Clearly not every combination of these ingredients makes a decent cake, and one can find good cakes recipes that omit one or more of the ingredients. The important thing here is that each graduate should have seen a range of subject areas and should have seen some subject areas in depth. Of course, the depth and breadth requirements might be satisfied by different students within a program in different ways. A student concentrating on Pure Mathematics should almost certainly have done a reasonable first course on complex functions, and have seen abstract systems like vector spaces and groups. A student concentrating on Applied Mathematics may see little in the way of formal axiom driven proofs, but would presumably need to have seen more differential equations than one gets in a 'standard' first year calculus course.