The University of New South Wales

Applied Science

1990 Faculty Handbook

Arms of

The University of New South Wales

Granted by the College of Heralds, London
3 March 1952

Heraldic Description of Arms

Argent on a Cross Gules a Lion passant guardant between four Mullets of eight points Or a Chief Sable charged with an open Book proper thereon the word SCIENTIA in letters also Sable.

The lion and the four stars of the Southern Cross on the Cross of St George have reference to the State of New South Wales which brought the University into being; the open book with SCIENTIA across its page reminds us of its original purpose. Beneath the shield is the motto 'Manu et Mente' ('with Hand and Mind'), which is the motto of the Sydney Technical College, from which the University has developed. The motto is not an integral part of the Grant of Arms and could be changed at will; but it was the opinion of the University Council that the relationship with the parent institution should in some way be recorded.

The University of New South Wales

Applied Science

1990 Faculty Handbook

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Subjects, courses and any arrangements for courses including staff allocated, as stated in the Calendar or any Handbook or any other publication, announcement or advice of the University, are an expression of intent only and are not to be taken as a firm offer or undertaking. The University reserves the right to discontinue or vary such subjects, courses, arrangements or staff allocations at any time without notice.

Information in this Handbook has been brought up to date as at 9 October 1989, but may be amended without notice by the University Council.

Contents

Calendar of Dates 1

Foreword 3

Staff 5
Faculty Information 5
Some People Who Can Help You 5
Enrolment Procedures 6
Student Clubs and Societies 6
Library Facilities 6
Bachelor of Social Degree Course (3420) 6
Conditions for the Award of the Degree of Bachelor of Science or Bachelor of Engineering 6
Conditions for the Award of the Degrees of Bachelor of Science (Technology) and Bachelor of Science (Engineering) 7
General Education Requirements 7

Undergraduate Study: Course Outlines 8
Graduate Study: Course Outlines 9
Graduate Enrolment Procedures 9
Graduate Study 9

Subject Descriptions 10
Identification of Subjects by Number 11

School of Applied Bioscience (ABIO) 13
Staff 16
Department of Biotechnology 16
Department of Food Science and Technology 16

Undergraduate Study: Course Outlines 18
3060 Food Technology (BSc) Full-time 18
3070 Food Technology ((BSc)Tech) Part-time 18

Graduate Study: Course Outlines 20
5015 Biotechnology (GradDip) 20

8042 Biotechnology MAppScBiotech 20
8030 Food Technology (MAppSc) 21
8035 Food Engineering (MAppSc) 21
5020 Food Technology (GradDip) 22

Undergraduate Study: Subject Descriptions 23
Food Science and Technology 23
Biotechnology 25

Graduate Study: Subject Descriptions 26
Food Science and Technology 26
Biotechnology 28

School of Chemical Engineering and Industrial Chemistry (CEIC) 31
Staff 34

Undergraduate Study: Course Outlines 35
3040 Chemical Engineering (BE) Full-time 35
Professional Electives in Course 3040 Chemical Engineering 36
3129 Chemical and Mineral Engineering (BE/BSc) 36
3100 Industrial Chemistry (BSc) Full-time 36
3110 Industrial Chemistry (BSc(Tech) Part-time 37
3045 Petroleum Engineering (BE) Full-time 38

Graduate Study: Course Outlines 39
8015 Chemical Engineering and Industrial Chemistry (MAppSc) 39
8060 Fuel Technology (MAppSc) 39
5010 Corrosion Technology (GradDip) 39
Centre for Petroleum Engineering 40
5031 Petroleum Engineering (GradDip) 40

Undergraduate Study: Subject Descriptions 41
Centre for Petroleum Engineering 41
Chemical Engineering and Industrial Chemistry 42
Fuel Technology 48
Polymer Science 48

Graduate Study: Subject Descriptions 50
Centre for Petroleum Engineering Studies 50
Chemical Engineering and Industrial Chemistry 50
Fuel Technology 52
Polymer Science 52

School of Fibre Science and Technology (FScT) 55
Staff 58

Undergraduate Study: Course Outlines 59
3170 Textile Technology (BSc) Full-time 59
3175 Textile Management (BSc) Full-time 60
3220 Wool and Pastoral Sciences (BSc) Full-time 62

Graduate Study: Course Outlines 63
5090 Textile Technology (GradDip) 63
5081 Wool and Pastoral Sciences (GradDip) 63
5025 Arid Land Management (GradDip) 64

Undergraduate Study: Subject Descriptions 65
Wool and Animal Science 65
Textile Technology 66

Graduate Study: Subject Descriptions 69
Wool and Animal Science 69
Textile Technology 69

School of Geography (Geog) 71
Staff 73

Undergraduate Study: Course Outlines 74
3010 Applied Geography (BSc) Full-time 74

Graduate Study: Course Outlines 77
8024 Land and Geographic Information System (MAppSc) 77
8025 Arid Lands Management (MAppSc) 78
5025 Arid Lands Management (GradDip) 80
8026 Remote Sensing (MAppSc) 81
5026 Remote Sensing (GradDip) 82
8045 Environment Studies (MEnvStudies) 82

Undergraduate Study: Subject Descriptions 84

Graduate Study: Subject Descriptions 88

School of Materials Science and Engineering (MScE) 91
Staff 94

Undergraduate Study: Course Outlines 95
3025 Ceramic Engineering (BE) Full-time 95
3030 Ceramics (BSc(Tech) Part-time 95
3125 Metallurgical Engineering (BMetE) Full-time 96
3130 Metallury (BSc(Tech) Part-time 97

Graduate Study: Course Outlines 98
5035 Graduate Diploma in Materials 98

Undergraduate Study: Subject Descriptions 99

Graduate Study: Subject Descriptions 104

School of Mines (Mines) 105
Staff 108

Undergraduate Study: Course Outlines 110
3000 Applied Geology (BSc) Full-time 110
3126 Mineral Engineering (BE) Full-time 111
3129 Chemical Mineral Engineering (BE/BSc) Full-time 112
3140 Mining Engineering (BE) Full-time 112

Graduate Study: Course Outlines 114
8020 Engineering Geology-Hydrogeology-
Environmental Geology (MAppSc) 114
8091 Mineral Exploration (MAppSc) 114
8092 Exploration Geophysics (MAppSc) 115
8093 Exploration Geochemistry (MAppSc) 115
8021 Hydrogeology and Groundwater Management (MAppSc) 116
8085 Waste Management (MAppSc) 116
5070 Waste Management (GradDip) 116
8055 Mineral Engineering (MAppSc) 117
8056 Mining Geomechanics (MAppSc) Part-time External 117
5040 Mining and Mineral Engineering (GradDip) 117

Undergraduate Study: Subject Descriptions 119
Mining Engineering and Mineral Processing and Extractive Metallurgy 119
Applied Geology 124

Graduate Study: Subject Descriptions 130
Mining Engineering and Mineral Processing and Extractive Metallurgy 130
Applied Geology 133

Servicing Subjects 137
Undergraduate Study: Subject Descriptions 139
Physics 139
Chemistry 141
Mechanical and Industrial Engineering 143
Electrical Engineering and Computer Science 144
Civil Engineering 145
Mathematics 145
Accounting 146
Commerce and Economics 147
School of Biological Science 149
Industrial Engineering 151
Information Systems 151
Marketing 151
Surveying 152
Town Planning 152
Landscape Architecture 152
Biochemistry 152
Biotechnology 153
Microbiology 153
Political Science 153

Graduate Study: Subject Descriptions 155
Chemistry 155
Electrical Engineering and Computer Science 155
Civil Engineering 155
Surveying 157
Industrial Relations and Organizational Behaviour 159
Town Planning 159
Graduate School of the Built Environment 159
Librarianship 159

Graduate Study: Conditions for the Award of Higher Degrees 161
Doctor of Philosophy 163
Master of Applied and Master of Environmental Studies 165
Master of Enginering and Master of Science 166
Master of Science, Master of Engineering and Master of Surveying
without supervision 167
Graduate Diploma 168

Scholarships and Prizes 171
Scholarships 171
Undergraduate 171
Graduate 175
Prizes 178
Undergraduate 178
Graduate 182

Calendar of dates

	1990	1991
Session 1 (67 teaching days)		
	26 February to 12 April	4 March to 28 March
Recess	*13 April to to 22 April*	*29 March to 7 April*
	23 April to 7 June	8 April to 14 June
Study Recess	*8 June to 13 June*	*15 June to 20 June*
Examinations	14 June to 2 July	21 June to 9 July
Midyear Recess	*3 July to 22 July*	*10 July to 28 July*
Session 2 (67 teaching days)		
	23 July to 21 September	29 July to 27 September
Recess	*22 September to 1 October*	*28 September to 7 October*
	2 October to 31 October	8 October to 6 November
Study Recess	*1 November to 6 November*	*7 November to 12 November*
Examinations	7 November to 23 November	13 November to 29 November
Vacation weeks common to Australian universities	16 April to 22 April	1 April to 7 April
	2 July to 8 July	8 July to 14 July
	24 September to 30 September	30 September to 6 October

Important Dates for 1990

January

M	1	New Year's Day – Public Holiday
F	5	Last day for acceptance of applications by office of the Admissions Section for transfer to another undergraduate cour within the University
W	10	Last day for applications for review of assessment
M	15	Term 1 begins – Medicine IV and V
F	26	Australia Day – Public Holiday

February

M	5	Enrolment period begins for new undergraduate students and undergraduate students repeating first year
F	9	Re-enrolment period begins for second and later year undergraduate and graduate students enrolled in formal course
F	23	Last day for acceptance of enrolment by new and re-enrolling students
M	26	Session 1 begins – all courses except Medicine IV and V and the University College

March

M	5	Session 1 begins – University College, Australian Defence Force Academy
F	9	Last day applications are accepted from students to enrol in Session 1 or whole year subjects
F	30	Last day for students to discontinue Session 1 and whole year subjects so as not to incur HECS liability
S	31	HECS Census Date for Session 1

April

Th	12	Last day for students to discontinue without failure subjects which extend over Session 1 only
F	13	Good Friday – Public Holiday Mid-session Recess begins
S	14	Easter Saturday – Public Holiday
M	16	Easter Monday – Public Holiday

April

S	14	Easter Saturday – Public Holiday
M	16	Easter Monday – Public Holiday
Su	22	Mid-session Recess ends
W	25	Anzac Day – Public Holiday

May

T	8	Publication of provisional timetable for June examinations
W	16	Last day for students to advise of examination clashes
T	29	Publication of timetable for June examinations

June

Th	7	Session 1 ends
F	8	Study Recess begins
M	11	Queen's Birthday – Public Holiday
W	13	Study Recess ends
Th	14	Examinations begin

July

M	2	Examinations end
Th	12	Assessment results mailed to students
F	13	Assessment results displayed on University noticeboards
Su	22	Mid-year Recess ends
M	23	Session 2 begins

August

Th	2	Last day for applications for review of Session 1 assessment results
F	3	Last day for students to discontinue without failure subjects which extend over the whole academic year. Last day applications are accepted from students to enrol in Session 2 subjects.
F	31	HECS Census Day for Session 2. Last day for students to discontinue Session 2 and whole year subjects so as not to incur HECS liability

September

F	7	Last day for students to discontinue without failure subjects which extend over Session 2 only
S	22	Mid-session Recess begins
F	28	Closing date for applications to the Universities and Colleges Admission Centre

October

M	1	Labour Day – Public Holiday Mid-session Recess ends
T	2	Publication of provisional timetable for November examinations
W	10	Last day for students to advise of examination clashes
T	23	Publication of timetable for November examinations
W	31	Session 2 ends

November

Th	1	Study Recess begins
T	6	Study Recess ends
W	7	Examinations begin
F	23	Examinations end

December

M	10	Assessment results mailed to students
T	11	Assessment results displayed on University noticeboards
T	25	Christmas Day – Public Holiday
W	26	Boxing Day – Public Holiday
M	31	Public Holiday

Foreword

Engineering and science disciplines that are directly concerned with aspects of Australia's resources have been established in the Faculty of Applied Science. Inter-disciplinary and multidisciplinary course options are available to students through the various Schools within the Faculty – Applied Bioscience, Chemical Engineering and Industrial Chemistry, Fibre Science and Technology, Geography, Materials Science and Engineering, and Mines.

Undergraduate courses available are:

- Applied Geology (including specialization in Mineral and Energy Resources, Engineering Geology, and Geophysics)
- Ceramic Engineering
- Chemical Engineering (including Fuel Engineering)
- Food Science and Technology
- Geography (including Applied Physical Geography, Applied Economic Geography, and Human and Physical Resources)
- Industrial chemistry (including Polymer Science)
- Mining Engineering
- Metallurgical Engineering
- Mineral Engineering
- Mining Geology
- Petroleum Engineering
- Textile Technology (including Textile Chemistry, Textile Engineering, Textile Management, and Textile Physics)
- Wool and Pastoral Sciences
- Biotechnology, through an honours degree course in the Faculty of Science.

In most schools a variety of options are available, including joint degrees in other faculties (Science, and Law). Students should discuss their programmes with appropriate staff to ensure that their chosen course of study is appropriate to their aims and aspirations.

The importance of applied science to the University of New South Wales, and to the wider community, is fully recognized and is especially referred to in the University Act of Incorporation. The Faculty of Applied Science is dynamic, with changing activities and programmes to meet the rapid technological developments in the applied sciences. Many of the staff of the Faculty have achieved international recognition for their work, and there is a continuing and wide range of research programmes underway. The staff are enthusiastic, and I hope that you will share their enthusiasm.

Once the term begins, it is essential that you participate fully in your study programme from the first day of the first year. You are also urged to play an active role in the extra-mural activities of the University, especially in the student societies in the Schools.

The format of this Handbook has been changed this year to make it more useful to you; we would welcome your comments. Also explanatory pamphlets and brochures are issued at enrolment and these, together with the Calendar, should be consulted for further information: you should not hesitate to contact the appropriate School offices if you have questions or problems.

G.J.S. Govett

Dean
Faculty of Applied Science

Staff

Comprises Schools of Applied Bioscience, Chemical Engineering and Industrial Chemistry, Fibre Science and Technology, Geography, Materials Science and Engineering, and Mines.

Dean
Professor G.J.S. Govett

Chairman
Associate Professor J.P. Kennedy

Executive Officer
John David Collins, BSc PhD *N.S.W*, Ctext, ATI

Senior Administrative Officer
Graham John Baldwin, BA *A.N.U.*

Project Manager
.Otto Zubzanda, Dipling, *T.U. Bratislava*, PhD *N.S.W*

Officer-in-charge, Drawing Office
Narendra Mohan Saha-Chaudhury, BME *Jadavpur*, MIEInd, MIEAust

Electron Microscope Unit of the Faculty of Applied Science

Physical Sciences Electron Microscopist
Vacant

Faculty Information

Some People Who Can Help You

If you require advice and information of a general nature contact: Mr. G. Baldwin, Senior Administrative Officer, Room 1013, Applied Science Building. Tel. 697 4469

For information and advice of a specific nature, contact the appropriate school representative below:

Applied Geology Miss L. Bruce, Administrative Assistant
Room 915, Applied Science Building. Tel. 697 4262
Applied Bioscience Ms. R. Lee, Administrative Assistant
Room 110A Biological Sciences Building. Tel: 697 2050
Chemical Engineering and Industrial Chemistry
Miss L. Woodcock, Administrative Officer.
Room 207, Applied Science Building. Tel. 697 4319.
Food Science and Technology Mr. R. Greenwood, Administrative Officer.
Room 411, Applied Science Building. Tel. 697 4364.
Geography Professor B. Garner.
Room G10, Geography and Surveying. Tel. 697 4390.
Materials Science and Engineering Mr. O. Andersen, Administrative Assistant.
Room 110B, Materials Science and Engineering Building. Tel. 697 4436.
Mineral Engineering Dr J.D. Navratil.
Room 213, Materials Science and Engineering Building. Tel. 697 4429.
Mining Engineering Ms S. Howard, Administrative Assistant.
Room 37, Main Building. Tel. 697 4516.
Textile Technology Mr D. Rose, Administrative Officer.
Room 102, Sir Robert Webster Building. Tel. 697 4477.
Wool and Animal Science Assoc. Professor J. Kennedy
Room 256, Sir Robert Webster Building. Tel. 697 4498.

Faculty of Applied Science Enrolment Procedures

All students re-enrolling in 1990 should obtain a copy of the free leaflet *Re-Enrolling in 1990* available from School Offices and the Admissions Office. This leaflet provides detailed information on enrolment procedures and fees, enrolment timetables by Faculty and course, enrolment in miscellaneous subjects, locations and hours of Cashiers and late enrolments.

It is University policy to promote equal opportunity in education (refer to EOE Policy Statement, University of New South Wales *Calendar* and the *Guide for Students 1990*).

Student Clubs and Societies

Students have the opportunity of joining a wide range of clubs and societies. Many of these are affiliated with the Students' Union. There are numerous religious, social and cultural clubs and also many sporting clubs which are affiliated with the Sports Association.

Clubs and societies seeking to use the name of the University in their title, or seeking University recognition, must submit their constitutions either to the Students' Union or the Sports Association if they wish to be affiliated with either of these bodies, or to the Registrar for approval by the University Council.

Applied Sciences Library Facilities

Although any of the university libraries may meet specific needs, the staff and students of the Faculty of Applied Science are served mainly by the Biomedical Library and the Physical Sciences Library.

The Biomedical Library

The Biomedical Library provides library services for staff and students from the Faculties of Medicine and Biological Sciences, and from the Schools of Biological Technologies Health Administration and Fibre Science and Technology It is closely associated with the libraries of the teaching hospitals of the University.

The Biomedical Library is located on Levels 2, 3 and 4 of the Mathews Building Annexe and is connected to the other Special Libraries via a link through Level 3.

Professional staff are available at the Reader Assistance Unit on Level 2 to provide reference services and to assist in the use of the catalogues. Instructional classes in the use of the library and in specific subject material can be arranged.

Computerized literature searches and interlibrary loans are also available.

Biomedical Librarian — Monica Davis

The Physical Sciences Library

This library, situated on Levels 6 and 7 of the Library tower, caters for the information needs of staff, graduate and undergraduate students in the pure and applied sciences, engineering and architecture. Details of the books, series and microfilms in the Physical Sciences Library are included in the microfiche monograph and serial catalogues and the items themselves are identified by the prefix 'P'. Serials with the prefix 'PJ' are not available for loan, but self-service photocopying facilities are located on Level 7. This library provides reference, reader assistance and reader education services and also, where appropriate, inter-library loan and literature-searching services. Trained staff are available on Level 7 to assist readers with their enquiries.

Physical Sciences Librarian — Rhonda Langford

The Bachelor of Social Science Degree Course (3420)

The Bachelor of Social Science (BSocSc) is a degree course of special interest to students wishing to pursue careers in research, teaching, social planning and social administration. It enables students to gain a broad view of social issues, and introduces them to diversity of social data. The program combines depth and breadth by requiring students to undertake a range of studies and to complete compulsory courses in the theories and methods of the various social sciences.

Although administered by the Faculty of Arts, the BSocSc degree course allows for in-depth study in two major disciplines drawn from various faculties. These disciplines are economic History, Economics, Industrial Relations, Geography, History, History and Philosophy of Science, Mathematics, Philosophy, Political Science, Psychology, Sociology and Statistics.

It may be possible for a limited number of students who have completed a year of study in a faculty other than Arts to transfer into the second year state of the course if their performance in at least two of the above disciplines is of a sufficiently high standard (Credit grade or better).

For further enquiries, contact the Arts Faculty Office, Room G1, Morven Brown Building. Tel. 697 2288.

Conditions for the Award of the Degree of Bachelor of Science or Bachelor of Engineering

The courses leading to the award of the degree of Bachelor of Science or Bachelor of Engineering in the Faculty of Applied Science are programmed over four years of full-time study. The normal programs may be varied by the Head of the School

in which the student is enrolled. The regulations governing the award of these degrees are as follows:

1. A candidate for the award of the degree of Bachelor of Science or Bachelor of Engineering shall;
(1) comply with the requirements for admission;
(2) follow the prescribed course of study in the appropriate School, and satisfy the examiners in the necessary subjects;
(3) complete an approved program of industrial or similar training for such periods as are prescribed.

2. A student may be granted advanced standing by the Professorial Board on the recommendation of Faculty, but in each case must complete the appropriate period of approved industrial training before being eligible for the award of the degree.

3. The degree shall be awarded at Pass or Honours levels. Honours may be awarded in the following categories:Honours Class I; Honours Class II, Division I; Honours Class II, Division II.

4. Students shall be required to conform with the general rules relating to University courses.

Conditions for the Award of the Degree of Bachelor of Science (Technology) or Bachelor of Science (Engineering)

The courses leading to the award of the degree of Bachelor of Science (Technology) or Bachelor of Science (Engineering) in the Faculty of Applied Science are normally programmed over six years of part-time study in the University whilst the student is employed in industry. The normal programs may be varied by the Head of the School in which the student is enrolled. The regulations governing the award of these degrees are as follows:

1. A candidate for the award of the degree of BSc(Tech) or BSc(Eng) shall:
(1) comply with the requirements for admission;
(2) follow the prescribed course of study in the appropriateschool and pass the necessary examinations;
(3) complete an approved program of industrial or similar training for such periods as are prescribed.

2. A student may be granted advanced standing by the Professorial Board on the recommendation of Faculty.

3. The degree of BSc(Tech) and BSc(Eng) shall be awarded at Pass level only but in the case of superior performance throughout the course the degree shall be conferred 'with merit'.

4. Students shall be required to conform with the general rules relating to University courses.

General Education Requirement

The University requires that undergraduate students undertake a structured program in General Education as an integral part of studies for their degree.

Among its objectives, the General Education program provides the opportunity for students to address some of the key questions they will face as individuals, citizens and professionals.

The program requires students to undertake studies in three areas:

A. An introduction in non-specialist terms to an understanding of the environments in which humans function.

B. An introduction to, and a critical reflection upon, the cultural bases of knowledge, belief, language, identity and purpose.

C. An introduction to the development, design and responsible management of the systems over which human beings exercise some influence and control.

The exact form of category C is still being decided and should be clearly defined in 1990. This could involve, however, a slight subsequent change to the structure of the later years of degree programs.

There are differing requirements for students commencing **before** and **after** 1988:

1. Students who commenced their undergraduate program before 1988.

Students must complete a program of General Education in accordance with the requirements in effect when they commenced their degree program. Students yet to complete their General Education requirement may select subjects from any of the three categories of the new program.

2. Students commencing their undergraduate program in or after 1988.

Students must complete a program of subjects selected from each of the three categories of study in accordance with the rules defined in the General Education Handbook and in sequences specified in the requirements for individual courses.

Further information may be obtained from the office of the Centre for Liberal and General Education, Room G58, Morven Brown Building, and the **General Education** Handbook.

Undergraduate Study:

Course Outlines

The Faculty of Applied Science consists of the Schools of Applied Bioscience, Chemical Engineering and Industrial Chemistry, Fibre Science and Technology, Geography, Materials Science and Engineering, Mines and the Centre for Petroleum Engineering. These Schools offer full-time undergraduate courses leading to the degree of Bachelor of Science or Bachelor of Engineering, and some of the Schools also offer part-time courses leading to the award of the degree of Bachelor of Science (Technology).

Full-time Courses

Full-time courses of four years' duration leading to the award of the degree of Bachelor of Science are offered in Applied Geography, Applied Geology, Food Technology, Industrial Chemistry, Mining Geology, Textile Technology and Wool and Pastoral Sciences. Four-year courses leading to the award of the degree of Bachelor of Engineering are offered in Ceramic Engineering, Chemical Engineering, Mineral Engineering, Mining Engineering and Petroleum Engineering. A four-year course leading to the award of a Bachelor of Metallurgical Engineering is offered in Metallurgical Engineering.

Honours: In all courses the degree may be awarded with Honours. The award of Honours is determined by performance in subjects and in the final-year project. Honours are awarded in Class 1; Class 2 Division 1; and Class 2 Division 2.

Industrial Training Requirements: In the scientific and technological courses close association with industry is maintained on the practical aspects of the professions. This is achieved in most of the courses of the Faculty by expecting students to complete an approved industrial training program prior to graduation. This is normally carried out during the Summer Recess. In the case of Wool and Pastoral Sciences, students are required to complete twenty-four weeks' approved practical work. In Mining Engineering students will undertake a program of practical training of at least 100 days.

Part-time Courses

Six-year part-time courses leading to the award of the degree of Bachelor of Science (Technology) are offered by the School of Food Science and Technology; in Industrial Chemistry by the School of Chemical Engineering and Industrial Chemistry; and in Metallurgy and Ceramics by the School of Materials Science and Engineering.

The BSc(Tech) degree courses are intended for students who are employed in relevant industries and who wish to prepare for a degree mainly by part-time attendance. As part of the requirements for the award of the BSc(Tech) degree, students are required to complete an approved program of industrial training of not less than one year prior to the award of the degree. Industrial training should normally be completed concurrently with attendance in the course, but with the approval of the Head of School, may be completed after completion of the prescribed course of study.

Students who qualify for the award of the BSc(Tech) degree in the Faculty of Applied Science and who wish to proceed to the award of a BSc or BE degree will normally be required to complete further work which will involve at least one year of full-time attendance.

Holders of the degree of BSc(Tech) or BSc(Eng) will be eligible to proceed to the award of the degree of Master of Science, Master of Engineering or Master of Applied Science, subject to the regulations relating to these degrees.

Transfer is also possible from full-time courses to the part-time BSc(Tech) degree course, but a period of approved industrial experience must be gained before graduation. This requirement will apply to students transferring from BSc and BE degree courses within the Faculty.

Graduate Study:

Course Outlines

Graduate Enrolment Procedures

All students enrolling in graduate courses should obtain a copy of the free leaflet *Re-Enrolling 1990 for Postgraduate Students* available from School Offices and the Admissions Office. This leaflet provides detailed information on enrolment procedures and fees, enrolment timetables by faculty and course, enrolment in miscellaneous subjects, locations and hours of Cashiers and late enrolments.

Graduate Study

The Faculty provides facilities for students to proceed to the award of the higher degrees of Doctor of Philosophy, Master of Engineering, Master of Science, Master of Applied Science, and Master of Environmental Studies. Courses leading to the award of a Graduate Diploma are also offered. The degree of Doctor of Science is awarded for a contribution of distinguished merit in the fields of science, engineering or applied science.

The degrees of Doctor of Philosophy, Master of Engineering and Master of Science are all awarded for research and require the preparation and submission of a thesis embodying the results of an original investigation or design. Candidates for the Doctorate of Philosophy are normally involved in at least three years work. The work for the award of a Master's degree may be completed in a minimum of one year, but normally requires two years of study for full-time students, and equivalent time for part-time students.

The Faculty offers courses leading to the award of the degree of Master of Applied Science. The institution of this degree springs from the recognition of the considerable advance of knowledge in the fields of applied science and engineering which has marked recent years and the consequent increased scope for advanced formal instruction in these fields. Students are usually in attendance at the University for one year on a full-time basis, or for two years part-time.

The Faculty offers a course leading to the award of the degree of Master of Environmental Studies. This is an interdisciplinary course designed to study the nature of environmental problems and the evaluation methodology. Students are usually in attendance at the University for one year on a full-time basis or for two years part-time.

Courses are also offered at the graduate level leading to the award of a Graduate Diploma. Students are required to attend courses of study for one year full-time or two years part-time. The courses available for the Graduate Diploma are Arid Lands Management, Biochemical Engineering, Biotechnology, Corrosion Technology, Food Technology, Mining and Mineral Engineering, Remote Sensing, Textile Technology and Wool and Pastoral Sciences.

Candidates may register for all the research degrees subject to adequate research facilities and satisfactory supervision being available in the candidate's particular field of study. Where special conditions can be met the Faculty may grant permission to a candidate to enrol for the degree of Doctor of Philosophy on a part-time basis.

The conditions governing the award of the various higher degrees and graduate diplomas are set out later in this handbook in **Conditions for the Award of Higher Degrees.**

Short, intensive graduate and special courses are provided throughout each year designed to keep practising scientists and technologists in touch with the latest developments in their various fields.

Subject Descriptions

Identification of Subjects by Number

A subject is defined by the Professorial Board as 'a unit of instruction approved by the University as being a discrete part of the requirements for a course offered by the University'.

Each approved subject of the University is identifiable both by number and by name as this is a check against nomination of a subject other than the one intended.

Subject numbers are allocated by the Registrar and the system of allocation is based on the following guidelines:

1. The authority offering the subject, normally a School of the University, is indicated by the number before the decimal point.

2. Each subject number is unique and is not used for more than one subject title.

3. Subject numbers which have previously been used are not used for new subject titles.

4. Graduate subjects are indicated by a suffix 'G' to a number with three digits after the decimal point. In other subjects three or four digits are used after the decimal point.

Subjects taught are listed in full in the handbook of the faculty or board of studies responsible for the particular course within which the subjects are taken. Subject descriptions are contained in the appropriate section in the handbooks.

Appropriate subjects for each school appear at the end of each school section.

The identifying numerical prefixes for each subject authority are set out on the following page.

Servicing Subjects are those taught by a school or department outside its own faculty. Their subject descriptions are published in the handbook of the faculty which originates the subject and are also published in the handbook of the faculty in which the subject is taught. These subjects will be found at the back of this handbook.

The following pages contain descriptions for most of the subjects offered for the courses described in this book, the exception being General Education subjects. For General Education subjects see the General Education Handbook which is available free of charge.

HSC Exam Prerequisites

Subjects which require prerequisites for enrolment in terms of the HSC Examination percentile range, refer to the 1978 and subsequent Examinations.

Candidates for enrolment who obtained the HSC in previous years or hold other high school matriculation should check with the appropriate school on what matriculation status is required for admission to a subject.

Information Key

The following is the key to the information which may be supplied about each subject:

S1 Session 1, **S2** Session 2
F Session 1 *plus* Session 2, ie full year
S1 or **S2** Session 1 *or* Session 2, ie choice of either session
SS single session, but which session taught is not known at the time of publication
CCH class contact hours
L Lecture, followed by hours per week
T Laboratory/tutorial, followed by hours per week
hpw hours per week
C credit or Credit units
CR Credit level
DN Distinction
HD High Distinction
X External

	School, Department etc *Subject also offered for courses in this handbook	Faculty	Page
1	School of Physics*	Science	
2	School of Chemistry*	Science	
3	**School of Chemical Engineering and Industrial Chemistry (New Course)**	**Applied Science**	**31**
4	**School of Materials Science and Engineering**	**Applied Science**	**91**
5	School of Mechanical and Industrial Engineering*	Engineering	
6	School of Electrical Engineering and Computer Science*	Engineering	
7	**School of Mines (Mineral Processing and Extractive Metallurgy and Mining Engineering)**	**Applied Science**	**105**
8	School of Civil Engineering*	Engineering	
9	**School of Fibre Science and Technology (Wool and Animal Science)**	**Applied Science**	**55**
10	School of Mathematics*	Science	
11	School of Architecture	Architecture	
12	School of Psychology	Biological Sciences	
13	**School of Fibre Science and Technology (Textile Technology)**	**Applied Science**	**55**
14	School of Accounting*	Commerce and Economics	
15	School of Economics*	Commerce and Economics	
16	School of Health Services Management	Professional Studies	
17	Faculty of Biological and Behavioural Sciences*	Biological and Behavioural Sciences	
18	School of Mechanical and Industrial Engineering (Industrial Engineering)	Engineering	
19	School of Information Systems	Commerce and Economics	
20	**Centre for Petroleum Engineering**	**Applied Science**	**40**
21	Department of Industrial Arts	Architecture	
22	Faculty of Professional Studies	Professional Studies	
23	School of Primary and Computer Education	Professional Studies	
25	**School of Mines (Applied Geology)**	**Applied Science**	**105**
26	Centre for Liberal and General Studies	Liberal and General Studies	
27	**School of Geography**	**Applied Science**	**71**
28	School of Marketing*	Commerce and Economics	
29	School of Surveying*	Engineering	
30	School of Industrial Relations and Organizational Behaviour	Commerce and Economics	
31	School of Optometry	Science	
32	Centre for Biomedical Engineering	Engineering	
33	School of Sports and Leisure Studies	Professional Studies	
35	School of Building	Architecture	
36	School of Town Planning *	Architecture	
37	School of Landscape Architecture*	Architecture	
39	Graduate School of the Built Environment	Architecture	
40	Academic Board		
41	School of Biochemistry*	Biological and Behavioural Sciences	
42	**School of Applied Bioscience (Biotechnology)**	**Applied Science**	**13**
44	School of Microbiology*	Biological and Behavioural Sciences	
45	School of Biological Science	Biological and Behavioural Science	
46	**Faculty of Applied Science**	**Applied Science**	
47	Centre for Safety Science	Engineering	
48	**School of Chemical Engineering and Industrial Chemistry (Old course)**	**Applied Science**	**31**
49	**School of Applied Bioscience (Food Science and Technology)**	**Applied Science**	**13**
50	School of English	Arts	
51	School of History	Arts	
52	School of Philosophy	Arts	
53	School of Sociology	Arts	
54	School of Political Science*	Arts	
55	School of Lbrarianship	Professional Studies	
56	School of French	Artts	
57	School of Theatre Strudies	Arts	
58	School of Education	Professional Studies	
59	Department of Russian Studies	Arts	
60	Faculty of Arts	Arts	
61	Department of Music	Arts	
62	Scjhool of Science and Technology Studies	Arts	
63	School of Social Work	Professional Studies	
64	School of German Studies	Arts	
65	School of Spanish and Latin Ameriocan Studies	Arts	
66	Subjects Available from Other Universities		
67	Faculty of Science	Science	
68	Board of Studies in Science and Mathematics	Board of Studies in Science and Mathematics	
69	School of Arts Education	Professional Studies	
70	School of Anatomy	Medicine	
71	School of Medicine	Medicine	
72	School of Pathology	Medicine	
73	School of Physiology and Pharmacology	Medicine	

	School, Department etc	Faculty	Page
	*Subject also offered for courses in this handbook		
74	School of Surgery	Medicine	
75	School of Obstetrics and Gynaecology	Medicine	
76	School of Paediatrics	Medicine	
77	School of Psychiatry	Medicine	
78	School of Medical Education	Medicine	
79	School of Community Medicine	Medicine	
80	Faculty of Medicine	Medicine	
81	Medicine/Science/Biological Sciences	Medicine	
85	Australian Graduate School of Management	AGSM	
90	Faculty of law	Law	
97	Faculty of Engineering	Engineering	
98	School of Banking and Finance	Commerce and Economics	
99	Department of Legal Studies and Taxation	Commerce and Economics	

School of Applied Bioscience

School of Applied Bioscience

Head of School
Professor P. P. Gray

Administrative Assistant
Ms R. Lee

The former Schools of Biotechnology and of Food Science and Technology were amalgamated in January 1986 to form the School of Biological Technologies. The School was renamed the School of Applied Bioscience in 1988. The School consists of the Departments of Biotechnology and of Food Science and Technology.

Department of Biotechnology

Biotechnology employs a body of multidisciplinary expertise directed towards the utilization and recycling of natural resources by controlled biological action, usually in a reactor. Its study provides an appreciation of the capabilities of biological systems and the skills required to maximize these capabilities on the industrial scale. Particular attention is given to: the selection of the appropriate systems and their maximization by genetic and or enzyme tailoring; the design of biological reactors and their ancillary equipment; optimization and control of the processes. It is by these means that products are manufactured at ensured standards of quality. The products include certain foods and beverages, baker's yeast, antibiotics, steroids, vaccines, enzymes, amino acids, nucleotides, vitamins, organic acids, alcohols, metals, plant growth regulators and insecticides. Specific mammalian proteins, such as insulin and growth hormone, are also produced by microorganisms which have been genetically engineered to contain the appropriate mammalian gene.

Students proceeding to the BSc degree course through the Board of Studies in Science and Mathematics and who seek to undertake training in biotechnology may do so by combining such training with a major in another relevant discipline, preferably biochemistry, microbiology or chemistry.

The fourth Honours year includes further formal training as well as research in biotechnology. Alternatively, students with no previous training in biotechnology may undertake the biotechnology honours year, provided they have the necessary background training in biochemistry and microbiology; in such cases the Level III biotechnology units constitute the formal component.

Details of courses majoring in biotechnology are given in the Faculty of Science handbook.

Department of Food Science and Technology

Food Technology is the application of basic science to the management of foods from the time of production until their use by the consumer. It is concerned with optimum food quality and quantity, with nutritional status and safety, and with means of production, processing, preservation, distribution and utilization.

A study of food science and technology demands an interdisciplinary and integrated approach, one that brings many scientific disciplines into focus. Its basis is in areas of chemistry, biochemistry and microbiology, and its borders merge with those of agriculture, engineering, nutrition and commerce.

The food technologist acquires new knowledge by laboratory and process research, and applies it to the development of acceptable foods by optimum processes and equipment. Foods are studied in terms of their basic constituents and the changes they undergo when subjected to modern processing and distribution. The technologist is equally concerned with the development and selection of raw materials from agricultural, horticultural, animal and marine sources.

There is a demand, both national and international, for professionally trained people who are prepared to accept responsibility for the quality and safety of humans' food supply, who can contribute to the solution of one of the greatest problems of our age, how to make food supplies grow faster than population.

The Department offers a four-year full-time course leading to the award of the degree of Bachelor of Science and six-year parttime course leading to the award of the degree of Bachelor of Science Technology. Graduates of both courses qualify for membership of the Royal Australian Chemical Institute, the Australian Institute of Food Science and Technology, and the US Institute of Food Technologists.

A Graduate Diploma course in Food Technology of one year fulltime or two years part-time is designed for graduates in science or agriculture wishing to familiarize themselves with the principles of food technology.

General Education Electives

For details of the General Education requirements see Faculty Information.

Staff

School of Applied Bioscience

Professor of Biotechnology, Head of School and Head of Department of Biotechnology
Peter Philip Gray, BSc *Syd.*, PhD *N.S.W.*, FIEAust, MAmerIChE, MABA

Professor of Food Technology and Head of Department of Food Science and Technology
Ronald Alexander Edwards, BSc PhD *N.S.W.*, ASTC, FAIFST, FTS

Professor of Molecular Biology
*John Shine, BSc PhD *A.N.U.*

*Conjoint appointment with The Garvan Institute of Medical Research.

Department of Biotechnology

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Mark Ronald Quinlan, BAppSc *N.S.W.I.T.*
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Administrative Assistant
Robin Lee

Department of Food Science and Technology

Professor and Head of Department of Food Science and Technology
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Honorary Visiting Fellow
Kevin Joseph Scott, BSc(Agr) Dip Ed *Syd.*

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Director
Professor Ronald Baden Howe Wills, BSc *N.S.W.*, PhD *Macq.*, ASTC, FAIFST, FRACI

Senior Research Officer
Francis Ann Warnock, BSc *N.S.W.*, GDipEd *Adel. C.A.E.*, GDipND *Flin.*

Administrative Assistant
Joyce Weeks

Course Outlines

Undergraduate Study

3060
Food Technology – Full-time Course

Bachelor of Science
BSc

This course is designed to provide depth and breadth in the relevant physical and biological sciences on which food technology is based. Students completing the Year 1 requirements are eligible for selection for admission to Year 2 of the course.

Year 1		Hours per week S1	S2
1.001	Physics 1 *or*		
1.021	Introductory Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
10.001	Mathematics 1 *or*		
10.011	Higher Mathematics 1 *or*		
10.021B	General Mathematics 1B *and*	6	6
10.021C	General Mathematics 1C		
17.031	Biology A	6	0
17.041	Biology B	0	6
		24	24

Year 2			
2.102A	Physical Chemistry	0	6
2.102B	Organic Chemistry	5	1
2.102D	Chemical and Spectroscopic Analysis	0	6
10.301	Statistics SA	2	2
41.101	Introductory Biochemistry	6	6
44.141	Microbiology	8	0
49.321	Introductory Nutrition	3	0
49.421	Introductory Food Engineering	0	3
		24	24

Year 3			
2.043B	Food Chemistry	6	0
49.131	Food Preservation	6	0
49.132	Plant Food Science	2	0
49.133	Animal Food Science	3	0
49.134	Quality Evaluation and Control	0	2
49.135	Food Technology Laboratory	0	6
49.231	Food Microbiology	4	0
49.331	Nutrition	0	3
49.431	Food Process Engineering	0	4
49.432	Computer Applications	0	2
42.102D	Principles of Biotechnology	3	0
2.0433	Analytical Instrumentation	0	3
	General Education Subject	0	4
		24	24

Year 4		Hours per week S1	S2
49.140	Project	8	8
49.141	Field Excursions	3	0
49.142	Food Legislation	2	0
49.143	Food Industry Management	2	0
	General Education Subjects	2	6
		17	14

Plus *three* or more of the following electives to a total of not less than 8.5 hours per week.

2.003B	Organic Chemistry	0	6
18.121	Production Management	3	3
18.551	Operations Research	3	3
28.012	Marketing Systems	4	0
28.052	Marketing Research	0	4
42.102E	Biotechnology Laboratory	0	3
49.144	Food Quality and Product Development	0	6
49.145	Food Processing Wastes	0	3
49.146	Cereal Technology	6	0
49.147	Postharvest Technology of Foods	6	0
49.241	Advanced Food Microbiology	0	6
49.341	Advanced Nutrition	0	6
49.441	Advanced Food Engineering	3	0
49.442	Food Packaging	3	0

or such other electives, to a total of not less than 8.5 hours per week, as approved by the Head of School.

During Years 3 and 4 of the course excursions are made to various food industries. Detailed reports of some of these visits are required.

Detailed reports of the students' activities during their periods in industry are required.

3070
Food Technology – Part-time Course

Bachelor of Science (Technology)
BScTech

This course is designed for students who are employed in the food processing industries. It extends over six part-time years of study, and leads to the award of the degree of Bachelor of Science Technology. Students are required to complete an approved program of industrial training of not less than twelve months prior to the award of the degree. Industrial training should normally be completed concurrently with attendance in the course, but with the approval of the Head of School may be completed after completion of the prescribed course of study.

The course covers the same subject matter as the first three years of the full-time course. For the first two years students follow a common course in which general biology is taken, and thereafter specialize in the biological sciences, which are fundamental to the study of food science and technology. The subjects of Stages 4, 5 and 6 may be available only in day-time classes, and substantial day-time release from industry may be required. Students who have completed the requirements of this course and have qualified for the award of the degree of Bachelor of Science Technology may proceed to the award of the degree of Bachelor of Science by attending for one

full-time year and completing the subjects listed in Year 4 of the full-time course. Students desiring to proceed to the award of a BSc degree must apply to the Head of the School not later than 31 December of the year in which the sixth stage is completed.

Stages 1 and 2*		**Hours per week** S1	S2
1.001	Physics 1 *or*		
1.021	Introductory Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
10.001	Mathematics I *or*		
10.011	Higher Mathematics 1† *or*	6	6
10.021B	General Mathematics 1B *and*		
10.021C	General Mathematics 1C		
17.031	Biology A	6	0
17.041	Biology B	0	6

*Physics and Mathematics are usually taken as Stage 1, the other subjects as Stage 2.
†There are no evening lectures in this subject.

Stage 3			
2.102B	Organic Chemistry	5	1
2.102D	Chemical and Spectroscopic Analysis	0	6
41.101	Introductory Biochemistry	6	6
		11	13

Stage 4			
2.102A	Physical Chemistry	0	6
10.301	Statistics SA	2	2
44.141	Microbiology	8	0
49.321	Introductory Nutrition	3	0
49.421	Introductory Food Engineering	0	3
		13	11

Stage 5			
2.043B	Food Chemistry	6	0
49.231	Food Microbiology	4	0
42.102D	Principles of Biotechnology	3	0
49.331	Nutrition	0	3
49.431	Food Process Engineering	0	4
49.432	Computer Applications	0	2
	General Education Subject	0	4
		13	13

Stage 6			
49.131	Food Preservation	6	0
49.132	Plant Food Science	2	0
49.133	Animal Food Science	3	0
49.134	Quality Evaluation and Control	0	2
49.135	Food Technology Laboratory	0	6
2.0433	Analytical Instrumentation	0	3
	General Education Subject	2	2
		13	13

Graduate Study

The School of Applied Bioscience conducts formal courses leading to the award of Master of Applied Science degrees in Biotechnology, Food Technology and Food Engineering and Graduate Diplomas in Biotechnology, Biochemical Engineering and Food Technology.

In addition, the School welcomes enquiries from graduates in Chemistry, Biochemistry, Microbiology, Applied Science, Chemical Engineering, Physiology, Nutrition and Agriculture who are interested in pursuing research in biotechnology or in food science and technology for the award of the degrees of Master of Science and Doctor of Philosophy.

The Head of School provides information on research scholarships, fellowships, grants-in-aid and School research activities. Graduates are advised to consult the Head of School before making a formal application for registration.

Department of Biotechnology

5015
Biotechnology Graduate Diploma Course

Graduate Diploma
GradDip

The graduate diploma course provides the opportunity for graduates with no previous tuition in biotechnology to undertake training in this discipline.

A degree in a science-based course is required for admission. If the degree course has not included a biology component, the candidate is required to undertake some basic biology training as a prerequisite or co-requisite.

Under normal circumstances, students whose previous training has included a substantial component of biotechnology will not be admitted to the course.

The course comprises study of undergraduate and graduate formal subjects, plus extensive laboratory training in biotechnology.

The diploma is awarded after one year's full-time study, consisting of an average of 18 hours per week, or two years part-time study, consisting of an average of 9 hours per week. The program includes the listed obligatory subjects plus sufficient of the listed elective subjects to meet the hours of study required. The electives include subjects necessary for students without previous tuition in biochemistry and/or microbiology, as well as alternatives for those with previous tuition in these disciplines.The choice of electives in each individual case is subject to approval by the Head of School.

		Hours per week S1	S2
Obligatory Subjects			
42.102A	Biotechnology A	6	0
42.102B	Biotechnology B	0	6
42.215G	Practical Biotechnology	6	6
Elective Subjects			
42.102C	Microbial Genetics	6	0
42.104G	Graduate Seminars	2	2
42.407G	Biological Principles	3	0
42.408G	Bioengineering Principles	3	0
44.121	Microbiology 1	0	6

Other suitable electives from the Department of Food Science and Technology and/or other Schools.

8042
Master of Applied Science (Biotechnology) Graduate Course

Master of Applied Science (Biotechnology) MAppSc(Biotech)

The Department offers a formal graduate course at the masters' level. The course includes advanced treatments of all areas of biotechnology. It is open to graduates with a four-year degree in biotechnology or a related discipline, or who have, in the opinion of the Higher Degree Committee, acquired equivalent qualifications or experience. Intending students are referred to Conditions for the Award of Graduate Degrees set out later in this handbook.

The course consists of lectures, tutorials, practical sessions, case history studies and a supervised project. The minimum period of registration before the award of the degree is two sessions for full-time students and four sessions for part-time students.

An acceptable course would be a program of subjects involving a minimum of 18 hours per week for two sessions full-time or a minimum of 9 hours per week for four sessions part-time. Course details are as follows:

		Hours per week S1	S2
42.401G	Applied Genetics	0	5
42.402G	Peptide and Protein Technology	0	5
42.403G	Biochemical Engineering	0	5
42.404G	Microbial Mineral Processing	3	0
42.405G	Biodeterioration	2	0
42.406G	Applied Cellular Physiology	5	0
42.407G	Biological Principles	3	0
42.408G	Bioengineering Principles	3	0
42.306G	Biotechnology Project Major	8	8
42.502G	Biotechnology Project Minor	4	4

Elective components:

Elective subjects, including some undergraduate subjects, may be selected from those offered by the School of Applied Bioscience, or from those offered by other Schools in the University subject to approval.

Each individual course must be approved by the Higher Degree Committee of the Faculty of Applied Science and would comprise:

1. A major strand of related material comprising approximately 75% of the total program, including a project comprising not less than 15% nor more than 50% of the program.

2. A minor strand of broader based material comprising up to 25% of the total program.

3. Undergraduate material (generally designated as subjects without a suffixed G or X number) may be included in one or both strands but may not exceed 25% of the non-project component.

4. At least 60% of the non-project component must be taken in the Department of Biotechnology unless otherwise approved by the Head of School. The remainder, subject to approval and availability, may be undertaken elsewhere in the University. Full details of all subjects are listed under Disciplines of the University in the Calendar.

Department of Food Science and Technology

The Department conducts formal courses leading to the award of the Master of Applied Science degrees and of the Graduate Diploma in food technology.

Master of Applied Science Degree Courses

The MAppSc degree courses provide for a comprehensive study of theoretical and applied aspects of the science, technology and engineering of foods. The courses are elective in nature providing an opportunity for graduates to apply their basic skills in areas relevant to these fields of applied science in which the School has developed special expertise.

Graduate courses are available for Master of Applied Science degree programs in the following areas:

Food Technology Course 8030
Food Engineering Course 8035

Intending candidates are invited to contact the Head of the School for advice and recommendation. The basis of an acceptable program would be formal study aggregating at least 18 hours weekly for 2 sessions full-time or 9 hours weekly for 4 sessions or 6 hours weekly for 6 sessions part-time, and which would comprise:

1. A major strand of related material comprising approximately 75% of the total program, including a project comprising not less than 15% nor more than 50% of the program.

2. A minor strand of broader based material comprising up to 25% of the total program.

3. Undergraduate material (generally designated as subjects without a suffixed G or X number) may be included in one or both strands but may not exceed 25% of the non-project component.

4. At least 60% of the non-project component must be taken in the School of Applied Bioscience unless otherwise approved by the Head of School. The remainder, subject to approval and availability, may be undertaken elsewhere in the University. Full details of all subjects are listed under Disciplines of the University in the Calendar.

8030
Food Technology Graduate Course

Master of Applied Science
MAppSc

The MAppSc course in Food Technology is particularly relevant to graduates in Agriculture, Applied Science and Science with principal interests in chemistry, biochemistry, microbiology, physiology, nutrition and engineering. This is a formal course consisting of core components (including a project), and an elective component that allows reasonable flexibility and a choice of subjects in food science and technology based on the candidate's background, subject to the availability of staff and resources.

The course comprises:

Core components		Hours per week*
49.152G	Principles of Food Preservation	3
49.155G	Food Technology Laboratory	3
49.170G	Seminar	1
49.171G	Major Research Project	9
OR		
49.172G	Research Project	6
OR		
49.173G	Minor Project	3

*Weekly equivalent of total hours for subject. These hours may be concentrated in one session.

Elective components
Elective subjects making up the remainder of the hours, including undergraduate subjects, may be selected from those offered by the School of Applied Bioscience, or from those offered by other Schools in the University subject to approval by the Head of School.

The work involved in the project must be embodied in a report and submitted in accordance with the requirements of the Faculty.

Depending on the candidate's background, enrolment in some of the above subjects may be accompanied by enrolment in related undergraduate subjects as prerequisites or co-requisites. A particular subject may not necessarily be conducted in any one year.

8035
Food Engineering Graduate Course

Master of Applied Science
MAppSC

The MAppSc course in Food Engineering is a formal course designed for graduates in Engineering or related disciplines and who have an interest in the processing of biological resources for human consumption. The formal components of the course provide professional training at an advanced level in food engineering and food science. The studies in food engineering are designed to strengthen and broaden the

engineering background of candidates and emphasises the use of fundamental principles in solving problems associated with food processing. Problem solving skills in engineering are developed further in a research project devoted to an area of food engineering.

The course comprises:

Core components	Hours per week*	
49.170G	Seminar	1
49.452G	Advanced Food Engineering	2
49.455G	Food Engineering Laboratory	1.5
49.171G	Major Research Project	9
OR		
49.172G	Research Project	6
OR		
49.173G	Minor Project	3

*Weekly equivalent of total hours for subject. These hours may be concentrated in one session.

Elective components
The elective subjects making up the remainder of the hours, including undergraduate subjects, may be selected from those offered by the School of Applied Bioscience, or from those offered by other Schools in the University subject to approval by the Head of School.

5020
Food Technology Graduate Diploma Course

Graduate Diploma
GradDip

The Graduate Diploma course is designed to provide professional training at an advanced level for graduates in Science, Applied Science or Engineering who have not had previous training in Food Technology.

Requirements are a first degree and, in some cases, the successful completion of assignments or examinations, as directed by the Head of School.

The course is a blend of formal lectures and laboratory work at the undergraduate and graduate levels. The Graduate Diploma in Food Technology (GradDip) is awarded on the successful completion of one year of full-time study (17 hours/week), or two years of part-time study (8.5 hours/week). It involves the following program:

Core components	Hours per week*	
49.152G	Principles of Food Preservation	3
49.153G	Plant Food Products	1
49.154G	Animal Food Products	1.5
49.155G	Food Technology Laboratory	3
49.251G	Food Microbiology	2

*Weekly equivalent of total hours for subject. These hours may be concentrated in one session.

Elective components
The elective subjects making up the remainder of the hours, including undergraduate subjects, may be selected from those offered by the School of Applied Bioscience, or from those offered by other Schools in the University subject to approval by the Head of School. In all cases the hours devoted to graduate subjects constitute at least 50% of the total course hours.

Subject Descriptions

Undergraduate Study

Department of Food Science and Technology

49.131 Food Preservation **S1 L3 T3**

Prerequisites: 2.102A, 2.102B, 2.102D, 41.101, 44.141, 49.421, 49.321.

Introduction to food preservation; spoilage control by traditional and modern techniques. Technology of food preservation by heat, chilling and freezing, sun drying and dehydration. Use of salt, sugar, acid, chemical preservatives, ionizing radiations, modified atmospheres in food preservation. Chemical and microbial stability of foods. Packaging requirements for preserved foods. Water relations of foods. An integrated program of laboratory and pilot plant exercises designed to illustrate the principles and procedures presented in the lecture course.

49.132 Plant Food Science **S1 L2**

Prerequisites: 2.102A, 2.102B, 2.102D, 41.101, 44.141, 49.421, 49.321.

Cereals. Structure, composition, properties and uses of cereal grains with emphasis on wheat; processing and technology of wheat and rice. *Sugars.* Sources, types, properties of sugars in foods; sugar milling and refining. *Fruit and vegetables.* Nutrient composition; principles of postharvest physiology, storage and handling. *Lipids.* Sources and composition of fats and oils, methods of extraction and processing. *Non-microbial hazards in foods.* Minerals, proteins, acids, goitrogens, cyanogens, carcinogens; spices and flavours. *Plant protein.* Sources, composition, extraction and uses in foods with emphasis on soybean. *Tea, cocoa and coffee.* Production, composition and processing.

49.133 Animal Food Science **S1 L3**

Prerequisites: 2.102A, 2.102B, 2.102D, 41.101, 44.141, 49.321.

Nature and distribution of world animal food resources. *Meat:* Muscle structure, function, slaughter, conversion of muscle to meat; chemical, biochemical factors in postmortem glycolysis; meat microbiology; chilling, freezing, curing, processing of meat and meat-derived products; processing equipment; meat marketing systems; nutritional and sensory properties of meats. *Milk and dairy products.* Chemical, physical properties, microbiology of milk; technology of milk-derived products including cheese, fermented products, butter; frozen, chilled and dried milk-derived foods. *Marine products.* Nature and distribution of world fishery resources; teleostean and elasmobranch species, spoilage mechanisms, quality assessment; preservation by chilling, freezing, salting, drying, smoking, marinading and fermentation; fish meal and fish protein concentrate. *Egg products.* Structure and composition of the avian egg; changes during storage of whole eggs; egg quality assessment; functional properties of egg components; preservation of the intact egg; pulping, freezing and drying of whole egg pulp, yolk and albumen.

49.134 Quality Evaluation and Control **S2 L1 T1**

Prerequisites: 10.301, 49.131, 49.132, 49.133, 49.231

An introduction to food quality, its nature, assessment and control during handling, processing and storage; the use of objective and sensory methods of assessment; an introduction to HACCP, TTT and PPP concepts.

49.135 Food Technology Laboratory **S2 T6**

Prerequisites: 49.131, 49.132, 49.133, 49.231

A program of exercises integrating elements of the chemical, physical, sensory and microbiological analysis of foods and the impact of processing on these factors. The program is designed to demonstrate the application of laboratory methods to food systems. Ability to carry out test methods and to interpret results will be a major component in student assessment.

49.140 Project **F T8**

Prerequisite: Completion of Year 3 subjects

The student undertakes an individual project involving a literature survey, an experimental investigation, the preparation of a detailed report on a selected topic in food science and technology, and presentation of seminars on a literature review and experimental results.

49.141 Field Excursions **S1 T3**

Prerequisite: Completion of Year 3 subjects

Inspection of food processing plants, growing areas and research stations in the Sydney metropolitan area, New South Wales and interstate.

49.142 Food Legislation **S1 L2**

Prerequisite: Completion of Year 3 subjects

An overview of Federal and State regulations affecting the production and marketing of foods; food imports and exports. Mechanisms for development of food standards. Principles of approval and usage of food additives. Codex standards. Implementation of food regulations.

49.143 Food Industry Management **S1 L2**

Prerequisite: Completion of Year 3 subjects

An introduction to food industry management, accounting, finance, marketing, industrial relations and communication skills.

49.144 Food Quality and Product Development **S2 L2 T4**

Prerequisite: Completion of Year 3 subjects

The steps involved in new product development; role of market research and advertising. Costing procedures, new product failure, case studies. Practical exercises in new food product development.

49.145 Food Processing Wastes **S2 L2 T1**

Prerequisite: 49.135

Effects of waste discharges into waterways. Treatment of water for domestic and industrial applications; water re-use; process modifications for effluent reduction. Origin, composition, treatment, disposal and utilisation of wastes from food

processing operations. Legal and economic aspects of waste disposal. Inspections of water and waste treatment plants.

49.146 Cereal Technology **S1 L2 T4**

Prerequisite: 49.135

A treatment in greater depth of the following topics dealt with in 49.132: production, storage, marketing and quality of cereal grains; current trends in these areas, technology of bread, biscuit and cake manufacture; chemical, physical and biochemical interactions in wheat flour doughs; flour milling and assessment of flour quality; cereal protein analysis, properties and behaviour; wheat variety identification; meat cereal combinations; cereal enzymes; non-food uses of cereals; preparation and uses of cereal protein, starches and lipids.

49.147 Postharvest Technology of Foods **S1 L2 T4**

Prerequisite: 49.135

Preharvest considerations, postharvest physiology and biochemistry, postharvest factors affecting quality, methods of storage and handling, marketing strategies for selected food commodities.

49.231 Food Microbiology **S1 L2 T2**

Prerequisite: 44.141

A lecture and laboratory program on the ecology, biochemistry, isolation, enumeration and identification of bacteria, yeasts, fungi and viruses associated with foods and beverages. *Food spoilage:* specific food – microorganism associations; taxonomy and biochemistry of major spoilage species; chemical and physical changes to food properties; control; spoilage of specific commodities. *Food-borne microbial disease;* foods as vectors of disease and food poisoning; statistics and epidemiology; ecology and taxonomy of food-borne pathogenic microorganisms; control and prevention by hygiene, microbiological standards and legislation. *Food fermentation:* microbial ecology and biochemistry of fermentations; fermentations of alcoholic beverages, bakery products, dairy products, meats, vegetables, cocoa beans, soy sauce; production of food ingredients and processing aids by fermentation. *Microbiological examination of foods:* sample preparation and sampling plans; sub-lethal injury; standard methods for determination of total plate counts, indicator organisms, food-borne pathogenic species, principal spoilage species. *Microbiological quality control:* specifications and standards; decision criteria; hazard analysis and critical control point (HACCP) concept.

49.241 Advanced Food Microbiology **S2 L2 T4**

Prerequisite: 49.231

An advanced theoretical and practical treatment of the ecology, taxonomy, biochemistry and analytical technology of bacteria, yeasts, fungi and viruses associated with food spoilage, food-borne disease and food fermentations. Emphasis on: new developments in food microbiology; economic consequences of microorganisms in foods; exploitation of microorganisms in novel processes for the production of food ingredients and processing aids; new technologies for the detection of microorganisms in foods, including enzyme immunoassay, DNA-probes, bioluminescence, impedance, epifluorescent-filtration methods; practical problems associated with the microbiological analysis of foods and interpretation of data.

49.242 Yeast Technology **S1 L2 T1**

Prerequisite: 49.231

The ecological, taxonomic and biochemical fundamentals of yeasts. The role of yeasts in alcoholic fermentations: beer, wine, cider, distilled spirits. Baker's yeast production and the role of yeasts in baking. Yeast fermented foods. The spoilage of foods by yeasts. Yeasts and yeast extracts as food for animals and humans. Yeast enzymes in the food industry.

49.321 Introductory Nutrition **S1 L2 T1**

Co-or prerequisite: 41.101

Role of nutrients in human structure and function. Effects of diet on growth and body size. Food habits, beliefs and choice; dietary patterns. Assessment of nutritional status; anthropometry, dietary intake studies, use of dietary recommendations, food groups, tables of food composition.

49.331 Nutrition **S2 L2 T1**

Prerequisite: 49.321

Nutritional needs of vulnerable groups: infants, pregnant and lactating women, the aged. Dietary intolerance, disorders related to the affluent diet including coronary heart disease, dental caries, diabetes, hypertension and cancer. Problems of undernutrition including protein, energy, mineral and vitamin deficiencies. Physiological and nutritional aspects of dietary fibre, alcohol and food intolerance. Measurement of nutrient intake using computer systems, on individual and group basis.

49.341 Advanced Nutrition **S2 L3 T3**

Prerequisite: 49.331

Nutrition topics in relation to food and nutrition policy; the food industry and community nutrition in developing and industrialised countries; food enrichment, food allergies, supplementary feeding programs and nutrition education. Principles of the nutrient evaluation of foods. Practical sessions and computing using nutrient data bases.

49.421 Introductory Food Engineering **S2 L2 T1**

Prerequisites: 1.001 or 1.021 and 10.001 or 10.011 or 10.021B and 10.021C

Units and dimensions, dimensionless groups, dimensional analysis; material and energy balances; steady state and unsteady state heat transfer; selection of insulation, heat exchangers and heat transfer equipment; refrigeration, freezing, filtration.

49.431 Food Process Engineering **S1 L2 T2**

Prerequisite: 49.421

Food rheology, fluid flow, thermal properties of foods, evaporation, psychrometry, dehydration, extraction, size reduction, extrusion, measurement and control of process variables. Laboratory exercises in food rheology, fluid flow, heat transfer, evaporation, psychrometry, drying, instrumentation and process control.

49.432 Computer Applications **SS L1 T1**

Prerequisite: 10.301

Introduction to VAX/VMS, VM/CMS, MS-DOS and other control languages; the use of statistical, graphics and other program packages to solve problems in food science and technology.

49.441 Advanced Food Engineering **S1 L2 T1**

Prerequisites: 44.431, 49.432.

Physical properties and measurement of food texture; numerical techniques, integrated food processing operations and process control; economics of process development; recent developments in food engineering.

49.442 Food Packaging **S1 L2 T1**

Pre- or co-requisite: 49.131

Chemical and physical properties of packaging materials; interaction between package and food, selection of packaging materials and systems, evaluation of packaging materials and systems, package design criteria; laboratory work on physical properties of package materials and evaluation of packaging materials and systems.

Department of Biotechnology

Biotechnology is a Department within the School of Applied Bioscience.

42.102A Biotechnology A **S1 L3 T3**

Prerequisites: 41.101 and 44.141

The basic principles involved in the operation of microbial processes on an industrial scale. Includes: the selection, maintenance and improvement of microorganisms; the influence of physical and chemical factors on the microbial environment; the control of environmental factors; the effects of operational patterns on batch and continuous flow cultivation; aeration and agitation; scale-up of microbial processes; air and media sterilization;, the harvesting, purification and standardization of products; the principles involved in microbial processes for chemical, pharmaceutical and food production, microbial waste treatment and environmental control. The laboratory component includes manipulation of microorganisms, laboratory-scale fermenter operation, microbial enzyme isolation, visits to industrial fermentation plants and industrial seminars.

42.102B Biotechnology B **S2 L2 T4**

Prerequisite: 42.102A

Application of principles of biotechnology to the analysis and design of microbial processes of industrial relevance (antibiotics, microbial enzymes, single cell protein from carbohydrates and hydrocarbons, fermented foods and beverages, amino acids and vitamins, microbial polysaccharides, activated sludge and photosynthetic processes for waste treatment, microbial leaching of low-grade minerals). Emphasis on quantitative approach: mass and heat balance calculations, kinetic and thermodynamic analysis, detailed equipment design and specification, process design and layout, process simulation, plant location, application of optimization techniques. The economics of microbial processes are considered and comparison made with alternative modes of production or treatment. The economics of agroindustry in Australia using microbial processes. Marketing of fermentation products, clinical trials required, legal constraints, patent rights. Technical and economic feasibility studies, and a design project.

42.102C Microbial Genetics **S1 L2 T4**

Prerequisites: 17.050, 17.601, 41.101 and 44.121A
Excluded: 44.152

This unit is suitable for students majoring in Microbiology, Biochemistry, Biotechnology or Genetics. It deals with major aspects of the genetics of bacteriophage, bacteria and yeast. Topics include plasmids and transposible genetic elements, gene transfer, mutagenesis and DNA repair, mutants, bacteriophage genetics, gene cloning (vectors, recombinant DNA techniques) and genetics of nitrogen fixation.

42.102D Principles of Biotechnology **S1 L3**

Prerequisite: 41.101 and 44.141

Lecture component of 42.102A Biotechnology A.

42.102E Biotechnology Laboratory **S1 T3**

Prerequisite: 42.102D

Laboratory component of 42.102A Biotechnology A.

42.103 Biotechnology Honours

Advanced formal training in selected areas of biotechnology and participation in one of the school's research projects.

42.105 Biological Process Engineering **F L2 T4**

Prerequisite: 44.101

Structure of Metabolism: Growth of an undifferentiated organism as a physico-chemical process leading to quantification of growth processes. Structure and function of a single cell. The structure of metabolic processes. Energy metabolism balances. Small metabolite production. Macro-molecule production. Coordination and control of cellular processes. *Industrial Bio-processes:* A review of bio-process industries. The selection, screening and maintenance of commercial cultures. The optimization of bio-processes. Batch and continuous fermentations. Enzyme engineering, single cell protein. Biodeterioration and microbiological stability. Sanitation. Fermentation practice. *Microbial Dynamics and Energetics:* Principles used in the quantification of complex systems. Quantification of biomass and the growth process. Balanced growth. The Monod model and further extensions of the model. Uncoupling of growth processes. Quantification of product formation. Distributed, segregated, unstructured and structured models. Stochastic models. Overall energetics of growth processes. Entropy and free energy relationships in complex reaction sequences. Principles and requirements of driven reactions. The energetics of cell processes and the prediction of yields and metabolic heat evolution.

42.114 Fermentation Processes

Factors governing the use of microorganisms in industrial processes, including the selection, maintenance and improvement of microorganisms, the control of environmental factors, batch and continuous flow operational patterns, product recovery, process optimization and waste disposal. Demonstrations of the operation and control of fermenter systems and of microbial process simulation.

Graduate Study

Department of Food Science and Technology

Food Science and Technology is a Department within the School of Applied Bioscience.

49.150G Introductory Food Science **S1 L1 S2 T1**

An introduction to the history of food preservation and human nutrition. Current world food patterns, organizations and trade. Food development programs, regional and international agencies and activities. Parameters of food quality; food choice and social behaviour, food and society. Students present a seminar on aspects of food science in Session 2.

49.151G Food Chemistry and Enzymology **S1 L2 T1**

Chemistry and function of carbohydrates, proteins, lipids, vitamins, minerals and pigments; non-enzymic browning reactions and autoxidation; effects of food processing on the functional properties of food components. *Characteristics of enzymes:* factors affecting enzyme action; the hydrolases and oxidoreductases; respiration, glycolysis, autolysis, enzymic browning and fat decomposition. Basic laboratory techniques for the analysis of food components.

49.152G Principles of Food Preservation **S1 L3 T3**

Spoilage control by traditional and modern techniques. Technology of food preservation by heat, chilling and freezing, sun drying and dehydration, salt, sugar, acid, chemical preservatives, ionizing radiations, modified atmospheres. Chemical and microbial stability of foods. Packaging requirements for preserved foods. An integrated program of laboratory and pilot plant exercises designed to illustrate the principles and procedures presented in the lecture course.

49.153G Plant Food Products **S1 L2**

Cereals: structure, composition, properties and uses of cereal grains with emphasis on wheat; processing and technology of wheat and rice. *Sugars:* sources, types, properties of sugars in foods; sugar milling and refining. *Fruit and vegetables:* nutrient composition; principles of postharvest physiology, storage and handling. *Lipids:* sources and composition of fats and oils, methods of extraction and processing. *Non-microbial hazards in foods:* minerals, proteins, acids, goitrogens, cyanogens, carcinogens; spices and flavours. *Plant protein:* sources, composition, extraction and uses in foods with emphasis on soybean. *Tea, cocoa and coffee:* production, composition and processing.

49.154G Animal Food Products **S1 L3**

Nature and distribution of world animal food resources. *Meat:* muscle structure, function, slaughter, conversion of muscle to meat; chemical, biochemical factors in postmortem glycolysis; meat microbiology; chilling, freezing, curing, processing of meat and meat-derived products; processing equipment; meat marketing systems; nutritional and sensory properties of meats. *Milk and dairy products:* chemical, physical properties, microbiology of milk; technology of milk-derived products including cheeze, fermented products, butter, frozen, chilled and dried milk-derived foods. *Marine products:* nature and distribution of world fishery resources; teleostean and elasmobranch species, spoilage mechanisms, quality assessment; preservation by chilling, freezing, salting, drying, smoking, marinading and fermentation; fish meal and fish protein concentrate. *Egg products:* structure and composition of the avian egg; changes during storage of whole eggs; egg quality assessment; functional properties of egg components; preservation of the intact egg; pulping, freezing and drying of whole egg pulp, yolk and albumen.

49.155G Food Technology Laboratory **S2 T6**

Prerequisites: 49.152G, 49.153G, 49.154G or their equivalent

A program of laboratory and pilot plant exercises integrating elements of the chemical, physical, sensory and microbiological analysis of foods and the impact of processing on these factors. The program is designed to demonstrate the application of laboratory methods to food systems.

49.160G Dairy Technology **S2 L1 T1**

Prerequisite: 49.154G or equivalent

A detailed review of trends in dairy industries at the national and international levels. The microbiology and biochemistry of dairy products with particular reference to the technology of milk, butter and cheese production. The development of new dairy products, the use of dairy products in other foods. Emphasis is placed upon the use and development of new technologies in the broad areas of dairy product processing.

49.161G Oenology **S1 L2**

History of wine production, statistics and classification. Viticulture. Grape composition. Technology and biochemistry of production of table wines, sparkling wines, vermouths, sherries; quality control procedures. Legal, cultural, climatic factors in French, Spanish, Portuguese, Italian, German, Californian and Australian wine production. Principles of sensory testing and evaluation of wines.

49.162G Technology of Cereal Products **S2 L2**

Prerequisite: 49.153G or equivalent

World production of cereals: cultivation, diseases, harvesting and storage of cereal crops. Grain morphology and components, cereal quality, quality and yield improvements by breeding. Milling of wheat, flour types, flour testing, suitability for different purposes, flour component interactions in doughs, flour bleaches and dough improvers, baking technology. The use of non-wheat flours in bread and baked goods. Pasta products and breakfast cereals. Nutritional aspects of cereals. Starch-gluten separation, starch syrups. Malting, brewing, distilling and industrial alcohol production from cereals. Preparation, properties and uses of modified starches.

49.163G Marine Products **S2 L2**

Prerequisite: 49.154G or equivalent

World fisheries, oceanographic factors and fish populations. Biochemistry and microbiology of growth, culture, harvesting and postharvest handling. Cultivation of fish, molluscs, crustacea – modern and traditional methods. Biochemistry and microbiology of marine products in relation to freezing and preservation by the use of heat, chemicals and fermentation.

Quality control parameters and fish inspection. Role of marine products in world nutrition. Possibilities for further exploitation of marine resources.

49.164G Food Additives and Toxicology **S1 L2**

Functions, modes of action of food additives, consequences of use, ethical and legislative considerations. National, State and international attitudes and standards. Principles of toxicological testing, the evaluation of results.

49.165G Postharvest Physiology and Handling of Fruit and Vegetables **S1 L1 T5**

Pre or co-requisite: 49.153G or equivalent

Biochemistry and physiology of metabolism in fresh fruit and vegetables; respiration measurements as an index of metabolism, maturation and senescence; concept of climacteric and nonclimacteric produce; physiological and metabolic changes occurring during ripening. Effect of temperature on metabolism – constraints of high and low temperatures; role of humidity control and water loss in quality maintenance; use of atmosphere control to delay senescence and ripening. Physiological disorders of stored produce; microorganisms of importance to postharvest tissue; physical and chemical methods of control; postharvest disinfestation and quarantine measures. Examination of current commercial storage and marketing operations.

49.166G Postharvest Storage of Foods **S1 L2 T4**

Prerequisite: 49.155G or equivalent

Preharvest considerations, postharvest physiology and biochemistry, postharvest factors affecting quality, methods of storage and handling, marketing strategies for selected food commodities.

49.170G Seminar **F T1**

Students present material arising from literature and/or laboratory assignments and/or plant investigations in the food and related industries. Critical assessments are made of the results of research in food science and technology.

49.171G Major Research Project **F T9**

A detailed investigation of a selected topic in food science and technology including submission of a project report.

49.172G Research Project **F T6**

An investigation of an aspect of food science and technology and submission of a project report.

49.173G Minor Project **F T3**

A study of an aspect of food science and technology and submission of a project report.

49.174G Special Topics in Food Science and Technology **S1 or S2 T6**

An individually supervised program of investigation in specialised aspects of food science and technology not otherwise offered. Embraces a literature review, laboratory work and/or industrial liaison as may be appropriate. Available only to appropriately qualified students.

49.175G Special Topics in Food Science and Technology **S1 or 2 T3**

A similar but shorter investigation to that outlined in 49.174G

49.176G Reading Assignment **SS T1**

A reading assignment in an area supporting candidates' major disciplines or commodity interests. Presentation of a seminar may be required.

49.250G Introductory Food Microbiology **S1 L1 T1**

An integrated lecture and laboratory program providing an introduction to food microbiology; microorganisms associated with food; factors affecting microbial growth and survival; enumeration of microorganisms in foods; microbial food spoilage; food-borne microbial disease and food hygiene; food fermentations.

49.251G Food Microbiology **S1 L2 T2**

Prerequisite: 49.250G or other introductory microbiology subject

A lecture and laboratory program on the ecology, biochemistry, isolation, enumeration and identification of bacteria, yeasts, fungi and viruses associated with foods and beverages. *Food spoilage:* specific food – microorganism associations; taxonomy and biochemistry of major spoilage species; chemical and physical changes to food properties; control of spoilage of specific commodities. *Food-borne microbial disease:* foods as vectors of disease and food poisoning; statistics and epidemiology; ecology and taxonomy of food-borne pathogenic microorganisms; control and prevention by hygiene, microbiological standards and legislation. Food fermentation: microbial ecology and biochemistry of fermentations; fermentation of alcoholic beverages, bakery products, dairy products, meats, vegetables, cocoa beans, soy sauce; production of food ingredients and processing aids by fermentation. Microbiological examination of foods: sample preparation and sampling plans; sub-lethal injury; standard methods for determination of total plate counts, indicator organisms, foodborne pathogenic species, principal spoilage species. Microbiological quality control: specifications and standards; decision criteria; hazard analysis and critical control point HACCP concept.

49.252G Advanced Food Microbiology **S2 L2 T4**

Prerequisite: 49.251G or equivalent

An advanced theoretical and practical treatment of the ecology, taxonomy, biochemistry and analytical technology of bacteria, yeasts, fungi and viruses associated with food spoilage, food-borne disease and food fermentations. Emphasis on: new developments in food microbiology; economic consequences of microorganisms in foods; exploitation of microorganisms in novel processes for the production of food ingredients and processing aids; new technologies for the detection of microorganisms in foods, including enzyme immunoassay, DNA-probes, bioluminescence, impedance, epifluorescent-filtration methods; practical problems associated with the microbiological analysis of foods and interpretation of data.

49.350G Introductory Nutrition **S1 L2 T1**

Role of nutrients in human structure and function. Effects of diet on growth and body size. Food habits, beliefs and choice;

dietary patterns. Assessment of nutritional status; anthropometry, dietary intake studies, use of dietary recommendations, food groups, tables of food composition.

49.351G Nutrition **S2 L2 T1**

Prerequisite: 49.350G or equivalent

Nutritional needs of vulnerable groups: infants, pregnant and lactating women, the aged. Dietary intolerance, disorders related to the affluent diet including coronary heart disease, dental caries, diabetes, hypertension and cancer. Problems of undernutrition including protein, energy, mineral and vitamin deficiencies. Physiological and nutritional aspects of dietary fibre, alcohol and food intolerance. Measurement of nutrient intake using computer systems, on individual and group basis.

49.352G Advanced Nutrition **S2 L3 T3**

Prerequisite: 49.351G or equivalent

Nutrition topics in relation to food and nutrition policy; the food industry and community nutrition in developing and industrialised countries; food enrichment, food allergies, supplementary feeding programs and nutrition education. Principles of the nutrient evaluation of foods. Practical sessions and computing using nutrient data bases.

49.450G Food Engineering Principles **S2 L2 T1**

Prerequisites: First year mathematics and physics or equivalents

Units and dimensions, dimensionless groups, dimensional analysis; material and energy balances; steady state and unsteady state heat transfer; selection of insulation, heat exchangers and heat transfer equipment; refrigeration, freezing, filtration.

49.451G Unit Operations in Food Engineering **S2 L2 T2**

Prerequisite: 49.450G or equivalent

Food rheology, fluid flow, thermal properties of foods, evaporation, psychrometry, dehydration, extraction, size reduction, extrusion, measurement and control of process variables. Laboratory exercises in food rheology, fluid flow, heat transfer, evaporation, psychrometry, drying, instrumentation and process control.

49.452G Advanced Food Engineering **S2 L2 T2**

Prerequisites: 49.451G, 49.453G or their equivalent

Mathematical representation of heat and mass transfer and fluid mechanics in food processing. Numerical techniques and computer modelling; design of integrated food processing operations and process control; economics of process development and control; recent advances in food engineering.

49.453G Computing in Food Science **S2 L1 T1**

Prerequisite: An introductory statistics subject or equivalent

Introduction to VAX/VMS, VM/CMS, MS-DOS and other control languages; the use of statistical, graphics and other program packages to solve problems in food science and technology.

49.454G Technology of Food Drying **S2 L2 T1**

Psychrometry. Derivation and application of psychrometric equations for air-water systems. Principles of drying. Calculation of mass and energy balances around drying equipment. Calculation of drying time. Commercial drying equipment. Principles of liquid food evaporation. Diffusion of gases. Assessment of package performance. Prediction of shelf life.

49.455G Food Engineering Laboratory **S2 T3**

Co-requisite: 49.452G

Laboratory and pilot plant exercises illustrating the principles and procedures involved in food processing and food quality assessment.

49.456G Food Engineering Field Work **S1 T3**

Inspection of food processing factories, agricultural and food research establishments and food producing areas.

49.457G Principles of Food Packaging **S1 or S2 L2 T1**

Co-requisite: 49.152G

History of food packaging; chemical and physical properties of package materials; interaction between food and package; evaluation of packaging materials and systems; selection of packaging materials and systems; design criteria; laboratory work on physical properties of package materials and on evaluation of packaging materials and systems.

Department of Biotechnology

Biotechnology is a Department within the School of Applied Bioscience.

General

Units are offered separately subject to specified prerequisites as well as the restrictions on those units designed as bridging materials.

42.104G Graduate Seminars

42.111G Reading List in Biotechnology (Microbiology)

42.112G Reading List in Biotechnology (Biochemistry)

42.214G Biotechnology **SS L2 T1**

The selection, maintenance and genetics of industrial organisms; metabolic control of microbial synthesis; fermentation kinetics and models of growth; batch and continuous culture; problems of scale-up and fermenter design; control of the microbial environment; computer/fermentor interactions. Industrial examples will be selected from: antibiotic and enzyme production, alcoholic beverages, single cell protein (SCP), microbial waste disposal and bacterial leaching. *Tutorial practical sessions* include: problem solving, instrumentation, continuous culture techniques, and mathematical modelling and simulation of industrial processes.

42.215G Practical Biotechnology **F T6**

Illustration, demonstration and operation of laboratory-scale and pilot-scale equipment. Visits to appropriate industries. Experimental project or critical review.

42.306G Biotechnology Project (Major) **F T8**

An experimental or technical investigation or design project in the general field of biotechnology.

42.401G Applied Genetics **SS L2 T3**

Isolation of commercially useful microorganisms. Mutagenesis and the isolation of mutants of the following types: auxotrophs; catabolic mutants; feedback inhibition and repression resistance; constitutive; catabolite repression resistance; resistance to antimicrobial agents and to viruses; extended enzyme substrate specificity; altered enzyme properties; changes in promoter and attenuator activity.

Techniques of genetic exchange: transformation; conjugation; transduction; cell fusion; sexual and parasexual cycles. The use of these techniques in strain construction.

Recombinant-DNA technology: plasmid and virus technology; cloning vectors for use in microorganisms, plant and animal cells. Strain construction using rec-DNA techniques. Properties of expression, excretion and genetic stability of constructs.

42.402G Peptide and Protein Technology **SS L2 T3**

Industrial scale production of enzymes, peptide hormones, antibodies including monoclonal antibodies, vaccines; regulation of synthesis by environmental control and genetic manipulation; recovery and down-stream processing techniques; immobilization by entrapment and binding.

Applications of proteins in medical therapy and diagnosis and as analytical tools including ELISA and affinity chromatography: applications of enzymes in the food and beverage industries.

42.403G Biochemical Engineering **SS L2 T3**

Design of bioreactors; range of biocatalysts from free enzymes to immobilized cells; heat and mass transfer, scale-up, economic feasibility studies as applied to bioprocesses; design of equipment and facilities for sterile operation and to meet recDNA guidelines; downstream processing, design and operation; instrumentation and control; use of computer-linked systems; mathematical simulation.

Detailed examples of bioprocesses including: amino acid production, single cell protein and liquid fuels, secondary metabolite production, growth and product formation of animal and plant tissue cultures. Patent and commercial aspects of bioprocesses.

42.404G Microbial Mineral Processing **SS L1 T2**

Role of autotrophic and heterotrophic microbes in low-grade ore decomposition and pollution control. Microbial weathering of copper and iron sulphides, manganese oxides and silicates. Formation of manganese oxides.

The laboratory component includes column and shakeflask leaching studies on mined copper and manganese ores. Microbial physiology, enumeration and quantification of biological contributions in biohydrometallurgical processes.

42.405G Biodeterioration **SS L2 T1**

Material and microbe interactions and ecology. Rates of decomposition, distribution of microorganisms and the effects of temperature, pH, Eh and water activity. Microbial breakdown of hydrocarbons, oils and surfactants. Corrosion of metals. Cellulosic and aromatic compound catabolism. Waste-water treatment.

42.406G Applied Cellular Physiology **SS L2 T3**

Elemental and molecular composition of cells; formulation of growth media; stoichiometry of growth processes and product formation; metabolic regulation; stringent response; mechanisms of metabolite uptake and product release; maintenance energy; thermodynamics of cellular growth and activities. Effect of mutation on cellular physiology; recombinant-DNA products. Fermentation processes: inoculum preparation, physiology of selected processes.

42.407G Biological Principles **S1 L3**

A study of the characteristics of living systems. Biological molecules: carbohydrates, lipids, proteins and nucleic acids. Cell structure and function: prokaryotic and eukaryotic cells. Basic biochemistry: thermodynamics and catalysis of metabolism; catabolic and anabolic processes; properties of enzymes; DNA replication; protein synthesis. Comparative metabolism of viruses, bacteria, fungi, plants and animals. Metabolic regulation. Modes of nutrition and nutrient cycles. Reproduction and genetics: eukaryotic and prokaryotic systems; sexual and asexual reproduction; bacterial genetics; recombinant DNA technology. Microorganisms of commercial significance. Biodeterioration and biodegradation. Pathogenic microorganisms: aetiology and epidemiology of infection; host defence mechanisms; chemotherapy; mechanisms of drug action; drug resistance.

42.408G Bioengineering Principles **S1 L3**

A subject designed to provide an introductory course for students in the MAppSc Biotech program who have not previously undertaken any bioengineering studies.

Steady state and differential balances as a basis for quantification of complex real systems. Concepts in rate processes and kinetic analysis with application to biological systems. Experimental determination of rate data. Correlation of simple lumped rate processes and simultaneous distributed processes and the concepts involved in dimensionless numbers.

Lamina and turbulent flow. The structure of homogeneous and boundary layer turbulence flow in pipes and channels. Mixing theory. Process vessel reactor models.

Fluid viscosity, Newtonian and non-Newtonian fluids, convective and molecular transport processes. Heat and mass transport, film coefficients. Film, boundary layer, penetration and surface renewal theories descriptive only.

Quantification of complex systems. Empirical and mechanistic models in biological systems.

42.502G Biotechnology Project Minor **F T4**

A small experimental or design project, or an extensive literature review and analysis of a selected topic in biotechnology.

School of Chemical Engineering and Industrial Chemistry

School of Chemical Engineering and Industrial Chemistry

Head of School
Professor D.L. Trimm

Administrative Officer
Ms L.A. Woodcock

The School contains the Departments of Chemical Engineering and Industrial Chemistry and the Centre for Petroleum Engineering which service three degree courses, and the Departments of Fuel Technology and Polymer Science which offer professional electives in these degree courses. A professional elective in Biological Process Engineering is also available from the Department of Biotechnology.

Chemical engineering is the application of the principles of the physical sciences, together with the principles of economics and human relations, to fields in which matter undergoes a change in state, energy content or composition. The chemical engineer is generally responsible for the design, construction and operation of plant and equipment used in the chemical processing industries.

Fuel engineering is primarily concerned with the practical and economic applications of scientific knowledge and engineering experience to the production, processing and utilization of fuels and energy.

Industrial Chemistry is the discipline in which the scientific work of the research chemist is translated into the activities of the chemical industry. The thermodynamic feasibility of a reaction in inorganic or organic chemistry, the conditions under which the reaction might proceed, the kinetics of the reaction and the means whereby the reaction might be controlled to produce the desired product are the fundamentals of the course.

Petroleum Engineering is a specialised engineering discipline which prepares graduates for a career in the oil and natural gas industries and its related operations. Petroleum engineers apply physical, mathematical and engineering principles to identify and solve problems associated with exploration, exploitation, drilling, production, processing, transportation and all the related economic and management problems associated with recovery of hydrocarbons from deep beneath the earth's surface.

For the award of Honours in the Chemical Engineering, Industrial Chemistry and Petroleum Engineering degree courses, students need to have distinguished themselves in the formal work, in other assignments as directed by the Head of the School, and in the final year project, for which a thesis is required.

It is compulsory that, before completion of the course, students in Chemical Engineering and Petroleum Engineering must obtain a minimum of twelve weeks' professionally oriented or industrial experience.

It is compulsory that, before graduation, students in the fulltime courses in Industrial Chemistry obtain a minimum of twelve weeks' professionally oriented or industrial experience. Students in the part-time courses in Industrial Chemistry must complete an approved program of industrial experience of not less than twelve months prior to the award of the degree.

Staff

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Department of Chemical Engineering

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Associate Professor M. S. Wainwright

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Centre for Membrane and Separation Technology

Director
Professor C.J.D. Fell

Director, Chemical Engineering
Associate Professor A. G. Fane

Centre for Particle and Catalyst Technologies

Director
Professor M. S. Wainwright

Course Outlines

Undergraduate Study

3040
Chemical Engineering – Full-time Course

Bachelor of Engineering
BE

This course extends over four years and students study full-time during the day for twenty-eight weeks of each year (excluding examination and recess periods).

Successful completion of the BE degree course is accepted by the Institution of Chemical Engineers, the Institution of Engineers, Australia, and Royal Australian Chemical Institute as sufficient academic qualification for corporate membership.

The revised new course commenced in 1988 with prefix 3. and the old course with prefix 48. for Chemical Engineering subjects and will be phased out over the next two to three years.

Various course patterns involving full-time or part-time study may be approved by the Head of School. Evening classes are only available in most Year I subjects.

Year 1 (New Course)		**Hours per week** S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A *and*	6	0
2.131	Chemistry 1B *or*	0	6
2.141	Chemistry 1M	6	6
3.110	Introduction to Chemical Engineering	2	2
5.0011	Engineering Mechanics 1	0	4
5.0302	Engineering Drawing and Descriptive Geometry	4	0
10.001	Mathematics 1	6	6
	General Education Subject	2	2
		26	26

Year 2 (New Course)			
2.102A	Physical Chemistry	6	0
2.002E	Organic and Inorganic Chemistry (for Chemical Engineers)	4	0
3.021	Instrumental Analysis	3	3
3.022	Computing	1.5	1.5
3.121	Material and Energy Balances	2	2
3.122	Flow of Fluids	2	2
3.123	Heat Transfer	0	3
3.124	Chemical Engineering Laboratory 1	0	2
6.854	Electrical Power Engineering	0	3
10.031	Mathematics	2	2
10.301	Statistics SA	2	2
	General Education Subject	2	2
		24.5	22.5

Year 3 (New Course)		**Hours per week** S1	S2
3.031	Engineering Thermodynamics	3	1
3.032	Reaction Engineering	1	2
3.033	Numerical Methods	1	2
3.034	Process Control	1	1
3.131	Fluids II	1	1
3.132	Mass Transfer and Separation	3	3
3.133	Particle Mechanics	0	3
3.134	Process Plant Engineering I	3	3
3.135	Chemical Engineering Laboratory II	1.5	1.5
3.136	Chemical Engineering Applications*	4	4
8.6110	Structures	3	0
10.032	Mathematics	2	2
	General Education subject	2	2
		25.5	25.5

(*Students electing to take a coherent Fuel and Energy Engineering Elective over years 3 and 4 take 3.331 Fuel and Energy Engineering 1 in lieu of 3.136)

Year 4 (New Course)			
3.140	Research Project*	6	6
3.141	Process Dynamics and Control	3	2
3.142	Advanced Reaction Engineering*	2	0
3.143	Multicomponent Separation Processes	0	2
3.144	Process Plant Engineering II	4	0
3.145	Safety and Environmental	2	0
3.146	Process Plant Operation*	3	0
3.147	Management	0	2
3.148	Design Project	1	4
3.149	Professional Electives*	4	4
		25	20

(*Students taking the Fuel and Energy Engineering Elective take 3.341 Fuel and Energy Engineering 2 and 3.340 Fuel and Energy Research Project in lieu of 3.142, 3.146, 3.149 and 3.140)

Year 4 (Old Course)			
48.041	Chemical Engineering 3A	4	0
48.042	Chemical Engineering 3B	4	0
48.043	Chemical Engineering 3C	3	2
48.044	Chemical Engineering Laboratory 2	3	0
48.047	Chemical Engineering 3D Project*	2	4
		1	11
		17	17

*The project is selected from
48.040 Chemical Engineering Project
48.240 Biological Process Engineering Project
48.340 Fuel Engineering Project

Plus one or more of the following to total 168 hours for the year

4.934	Designing with Advanced Materials	3	3
7.746	Mineral Process Chemistry	6	6
48.113	Chemistry of Industrial Processes	3	3
42.105	Biological Processes Engineering	6	6
48.331	Fuel Engineering 3	6	6
48.403	Polymer Science	3	3
48.046	Chemical Engineering Projects (additional)	6	6

Any other elective approved by Head of School

Professional Electives in Course 3040 Chemical Engineering

Fuel and Energy Engineering

The Department of Fuel Technology offers a coherent professional elective in Fuel and Energy Engineering designed for those students interested in the application of fuel and energy technologies in industry, commerce, government, education or research and development. The Department is the only one of its kind in Australia and has a long history of teaching and research in the fossil fuels area. The elective covers the broad areas of properties constitution, processing, conversion and utilization of fuels. Topics include combustion science and engineering; radiation and flames; design and performance evaluation of fuel using plant such as furnaces, boilers and heat recovery appliances; coal and oil conversion processes; energy management and conservation; and progress in fuel science and fuel processing.

Students choosing this professional elective should take 3.331 Fuel and Energy Engineering 1 in Year 3 and 3.341 Fuel and Energy Engineering 2 and 3.340 Fuel and Energy Engineering Project in Year 4. Part-time students should take these subjects at equivalent stages of the part-time degree.(See BE Chemical Engineering 3040 Degree structure for the subjects that the Fuel and Energy Engineering courses replace).

This elective may qualify graduates for membership of the Australian Institute of Energy and the Institute of Energy UK.

3129
Combined Degree in Chemical and Mineral Engineering

Bachelor of Engineering /Bachelor of Science BE/BSc

This combined degree course of five years full-time study enables a student from the School of Chemical Engineering to qualify for the award of the two degrees of Bachelor of Engineering and Bachelor of Science (BE BSc). The course enables such combined degree students to major in the areas of mineral processing and extractive metallurgy . It is jointly offered by the School of Chemical Engineering and Industrial Chemistry and the Department of Mineral Processing and Extractive Metallurgy, and is administered by the Faculty of Applied Science.

A part of the requirement for this double degree will be an 8 week Vacation Work Experience in the mineral industry during the summer vacation, at the end of the fourth year in Chemical Engineering.

Students enrolled in this BE BSc degree course will be awarded their degrees at the conclusion of five years study. Distinguished performance over five years may lead to the award of Honours. Years 1 to 4 of the course are equivalent to the first four years of the Chemical Engineering Course 3040.

Students must have completed the BE course in Chemical Engineering with the Mineral Subjects in Years 3 and 4 (i.e. including a Year 4 project which is minerals oriented) to have the opportunity to enrol in Year 5 which is set out below.

Year 5		**Hours per week** S1	S2
7.622/2	Mineral Engineering I Unit 2	3	0
7.632	Mineral Engineering II	3	3
7.642	Mineral Engineering III	6	6
7.643	Mineral Engineering Projects and Laboratory	6	9
25.520	Geology for Mining Engineers	2	2
25.523	Mineralogy	2	2
7.142	Mine Development	1	1
7.113	Mining Methods	2	2
		25	25

3100
Industrial Chemistry – Full-time Course

Bachelor of Science BSc

To accommodate changes in the Chemical Engineering course minor changes will take place in the Industrial Chemistry course from 1988 onwards.

Year 1		**Hours per week** S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A and	6	0
2.131	Chemistry 1B	0	6
or			
2.141	Chemistry 1M	6	6
10.001	Mathematics 1	6	6
3.210	Industrial Chemistry 1	2	2
5.3000	Engineering Mechanics	0	4
and			
5.0302	Engineering Drawing and Descriptive Geometry	4	0
		24	24

Year 2		S1	S2
1.9222	Electronics	3	0
2.102A	Physical Chemistry	6	0
2.102C	Inorganic Chemistry	0	6
2.102B	Organic Chemistry	2	4
10.031	Mathematics	2	2
10.301	Statistics SA	2	2
3.021	Instrumental Analysis	3	3
3.220	Introduction to Fluid Flow	2	0
3.221	Mass and Energy Balances	2	0
3.222	Heat Transfer and Temperature Measurement	0	2
3.022	Computing	1.5	1.5
	General Education Subject	2	2
		25.5	23.5

Year 3		Hours per week S1	S2
2.103B	Organic Chemistry	6	0
3.032	Reaction Engineering	1	2
48.113	Chemistry of Industrial Processes	3	3
48.121	Corrosion in the Chemical Industry	0	2
48.135	Thermodynamics	3	0
48.137	Industrial Chemistry 2A	2	0
48.138	Industrial Chemistry 2B	0	3
48.139	Experimental Design	0	2
48.163	Instrumentation and Process Control 1	0	3
48.171	Chemistry of High Temperature Materials	0	2
48.172	Instrumental Analysis 2	4	0
48.403	Polymer Science	3	3
	General Education Subject	2	2
		24	22

Year 4			
18.1211	Production Management A	3	0
42.114	Fermentation Processes	0	2
48.0471	Management	0	2
48.124	Applied Kinetics	2	0
48.134	Applied Thermodynamics	2	0
48.165	Laboratory Automation Science	4	0
48.174	Seminars	2	2
48.194	Project	8	16
48.404	Advanced Polymer Science	2	0
	General Education Subject	2	2
		25	24

Plus one of the following:*

3.303	Fuel Science for Industrial Chemists	2
48.115	Industrial Electrochemistry	2
48.116	Water Chemistry	2
48.166	Microprocessors in Analytical Instrumentation	2

*Only one of these is offered in any one year as selected by student preferences.

3110
Industrial Chemistry – Part-time Course

Bachelor of Science (Technology)
BSc (Tech)

Stages 1 and 2*		Hours per week S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A and	6	0
2.131	Chemistry 1B	0	6
3.210	Industrial Chemistry 1	2	2
10.001	Mathematics 1	0	6
Plus:			
5.0011	Engineering Mechanics 1	0	4
or			
17.031	Biology A	6	0
or			
25.110	Earth Materials and Processes	6	0
and			
5.0302	Engineering Drawing and Descriptive Geometry	4	0

*Physics and Mathematics are usually taken in Stage 1 and the other subjects in Stage 2.

Stage 3		Hours per week S1	S2
2.102A	Physical Chemistry	6	0
10.031	Mathematics	2	2
10.301	Statistics SA	2	2
48.122	Instrumental Analysis	3	3
	General Education Subject	2	2
		15	9

Stage 4			
1.9222	Electronics	3	0
2.102B	Organic Chemistry	6	0
2.102C	Inorganic Chemistry	0	6
3.220	Introduction to Fluid Flow	2	0
3.221	Mass and Energy Balances	2	0
3.222	Heat Transfer and Temperature Measurement	0	2
3.022	Computing	1.5	1.5
		14.5	9.5

Stage 5			
48.121	Corrosion in the Chemical Industry	0	2
48.135	Thermodynamics	3	0
48.136	Reactor Design 1	1	2
48.137	Industrial Chemistry 2A	2	0
48.138	Industrial Chemistry 2B	0	3
48.139	Experimental Design	0	2
48.171	Chemistry of High Temperature Materials	0	2
48.172	Instrumental Analysis 2	4	0
	General Education Subject	2	2
		12	13

Stage 6			
2.030	Organic Chemistry	6	0
48.113	Chemistry of Industrial Processes	3	3
48.163	Instrumentation and Process Control 1	0	3
48.403	Polymer Science	3	3
		12	9

Centre for Petroleum Engineering Studies

The Centre of Petroleum Engineering has a four-year course leading to the award of a Bachelor of Engineering in Petroleum Engineering.

The first two years of the Petroleum Engineering Course are identical to the first two years of the Chemical Engineering Course. The University has approved an arrangement whereby, upon recommendation of the Head of School, students who satisfy the requirements of the first two years of the Mechanical Engineering. Civil Engineering or Mining degree course at the University may be admitted into the final two years of the BE degree course in Petroleum Engineering.

Such students would complete an appropriately modified Year 3 program as approved by the Head of School.

The University has also approved an arrangement whereby, upon the recommendation of the Head of School, students who satisfy the requirements of the first two years of the Chemical, Mechanical, Civil or Mining Engineering full-time degree courses at any other Australian tertiary institution may be admitted to the final two years of the Petroleum Engineering course. Such students will be required to undertake an appropriately modified Year 3 program as approved by the Head of School. Acceptance into the course will be on the basis of academic merit.

3045
Petroleum Engineering – Full-time Course

Bachelor of Engineering
BE

Year 3		Hours per week S1	S2
6.854	Electrical Power Engineering	0	3
8.6110	Structures	3	0
10.032	Mathematics	2	2
20.301	Properties and Phase Behaviour of Petroleum Reservoir Fluids	0	2
20.302	Reservoir Rock Properties and Fluid Flow in Porous Media	2	0
20.303	Well Drilling and Completions	3	0
20.304	Reservoir Engineering 1	0	2
20.305	Drilling and Production Lab	3	0
20.306	Petroleum Production Economics	0	1
20.307	Petroleum Thermodynamics	2	0
20.308	Formation Evaluation 1	2	2
20.5331	Physical Geology for Petroleum Engineers 1	3	0
25.5332	Physical Geology for Petroleum Engineers 2	0	3
25.5302	Structural Geology	0	3
3.132	Mass Transfer and Separation	3	3
3.034	Process Control	1	1
	General Education Subject	2	2
		26	27

Year 4			
20.401	Reservoir Engineering 2	0	3
20.402	Reservoir Fluids Laboratory	3	0
20.403	Production Engineering	3	0
20.404	Formation Evaluation	2	2
20.405	Oil and Gas Law and Regulation	0	2
20.406	Reservoir Simulation	0	3
20.407	Advanced Recovery Methods	0	3
20.408	Natural Gas Engineering	0	3
20.409	Petroleum Engineering Project	8	4
20.410	Well Pressure Testing	2	0
3.134	Process Plant Engineering 1 (Modified for Petroleum Engineers)	3	3
3.141	Process Dynamics and Control	3	2
3.145	Safety and Environmental	2	0
		26	25

Graduate Study

Formal courses in the School of Chemical Engineering and Industrial Chemistry lead to the award of the Master of Applied Science or the Graduate Diploma.

Master of Applied Science Degree Courses

The MAppSc degree courses involve a project which must integrate and apply the principles treated in the course. It may take the form of a design feasibility study or an experimental investigation. Evidence of initiative and of a high level of ability and understanding is required in the student's approach, and the results must be embodied in a report and submitted in accordance with the University's requirements.

The following graduate courses are available to Master of Applied Science degree course candidates. Candidates may specialize in the following areas:

Chemical Engineering and Industrial Chemistry	Course 8015
Fuel Technology	Course 8060
and	
Petroleum Engineering	Course being arranged

The MAppSc degree courses provide for a comprehensive study of theoretical and practical aspects of many advanced topics. The courses are formal and elective in nature and provide an opportunity for graduates to apply their basic skills in fields in which the School has developed special expertise.

The courses specializing in Chemical Engineering and Industrial Chemistry, Fuel Technology and Petroleum Engineering are primarily intended for graduates in Applied Science, Engineering, or Science with principal interests in Chemistry, Mathematics and/or Physics. They are designed to allow the maximum flexibility consistent with the standing of the award.

Intending candidates are invited to submit proposed study programs to the Head of the School for advice and recommendation. Each individual course must be approved by the Higher Degree Committee of the Faculty of Applied Science. An acceptable course would be a program of formal study aggregating approximately 18 hours weekly for two sessions full-time or 9 hours weekly for four sessions part-time, and which could comprise:

1. A major strand of course material making up 75% of the total program. This includes a project constituting not less than 15% and not more than 30% of the program;

2. A minor strand of broader-based supporting material making up to 25% of the total program; and

3. Undergraduate material (generally designated as subjects without a suffixed G number), which may be included in one or both strands but may not exceed 25% of the total program.

Approximately 60% of the program (including the project) must be undertaken in the School of Chemical Engineering and Industrial Chemistry. The remainder, subject to approval and availability, may be undertaken in other Schools within the University. Full details of all subjects are listed under Disciplines of the University in the Calendar.

Courses will be run in any year only if sufficient applications are received. A minimum number of 5 registrations is usually required.

8015
Chemical Engineering and Industrial Chemistry Graduate Course

Master of Applied Science
MAppSc

This course is designed to allow students to select areas of specialization appropriate to their needs. The areas of specialization include Industrial Chemistry, Chemical Engineering and Industrial Pollution Control. Students are asked to consult the area supervisors in the School to develop a program of study which complies with regulations for the Master of Applied Science degree. Students may undertake a Major Project (48.900G) amounting to six hours per week for a year or take a Minor Project (48.901G) of three hours per week for a year and select an extra elective subject.

8060
Fuel Technology Graduate Course*

Master of Applied Science
MAppSc

This is a formal course leading to the award of the degree of Master of Applied Science. It is a two-year part-time course designed to provide professional training and specialization in fuel science or fuel and energy engineering for graduates in science, applied science or engineering who have not had substantial previous formal education in these subjects. The course may be offered over 1 year full time with a sufficiently high enrolment.

The course is based on the general formula for a MAppSc degree program, whereby the subject 3.331 can comprise the undergraduate component, the project (30% or 15% of the program) is 3.900G or 3.901G, and the remainder of the hours can be taken from the units offered in the 3.38G and 3.39-G series of subjects. There are also compulsory seminar and laboratory practice subjects.

The course allows reasonable flexibility with a choice of subjects, and units within subjects, subject to the availability of staff. Provision is made for subjects outside those offered by the Department to be incorporated in the program at either graduate or undergraduate level.

5010
Corrosion Technology Graduate Diploma Course

Graduate Diploma
GradDip

The Graduate Diploma course in Corrosion Technology is open to graduates in Engineering, Applied Science or Science

who wish to undertake formal studies to promote their careers in industry. At present it may only be taken as a two-year part-time course and is offered every second year.

The course is designed for those professionals in industry who are faced with the problem of combating corrosion. Its aim is to develop an appreciation of the fundamentals and principles of corrosion and of the available methods of overcoming it.For graduates from Engineering (non-chemical) or Science (in a particular major) a bridging course may be necessary.

Year 1 of the course introduces elementary aspects of corrosion technology and suitably orientates students depending on their initial qualifications. Year 2 of the course contains more detailed instruction at a graduate level in corrosion theory and prevention, together with a suitable project.

Year 1		**Hours per week**	
		S1	S2
48.121	Corrosion in the Chemical Industry	0	2
48.180G	Corrosion Materials	2	2
48.181G	Industrial Coatings for Corrosion Protection	2	0
		4	4

Year 2			
		S1	S2
48.171	Chemistry of High Temperature Materials	0	2
48.182G	Non-metallic Materials for Corrosion Resistance	2	0
48.183G	Corrosion Technology	3	3
48.184G	Corrosion Project	6	6
		11	11

For further information on this course contact Associate Professor D J Young, Head, School of Materials Science and Engineering.

Centre for Petroleum Engineering

The Centre offers courses that cover the areas of Reservoir Engineering, Production Engineering and Formation Evaluation. Suggested course outlines are available from the Director of the Centre.

5031
Petroleum Engineering Graduate Diploma Course

Graduate Diploma in Engineering (Petroleum) GradDip

The oil industry traditionally employs personnel who, although working as Petroleum Engineers, have no formal qualifications in petroleum engineering. The Diploma Program in Petroleum Engineering is designed to provide these people with a means of obtaining formal qualifications in a short intensive full-time study program over one academic year.

The course work, carried out under the guidance and supervision of academic staff of the Centre, and in close co-operation with the oil industry, will incorporate a significant percentage of practical work in major areas of petroleum engineering. At the end of the formal course, satisfactory completion of a two-months practical assignment in the oil industry will be required, for the diploma to be awarded.

Candidates for the program must hold a Bachelors Engineering or Science Degree and some relevant field experience in the industry. Acceptance into the program is at the discretion of the Director of Centre for Petroleum Engineering.

The one year (two session) program course consists of the following subjects:

Session 1		**Hours Per Week**
20.302G	Reservoir Rock Properties	2
20.303G	Well Drilling and Completions	3
20.3035G	Drilling and Production Lab.	3
20.403G	Production Engineering	3
20.410G	Well Pressure Testing	2
20.411	Formation Evaluation	2
25.5331	Physical Geology for Petroleum Engineering I	3
		18

Session 2		**Hours Per Week**
20.301G	Properties and Phase Behaviour	2
20.306G	Petroleum Production Economics	1
20.309G	Reservoir Engineering	2
20.406G	Reservoir Simulation Fundamentals	3
20.409G	Petroleum Engineering Project	6
20.411G	Formation Evaluation	2
25.5332	Physical Geology for Petroleum Engineering II	3
20.501G	Practical Assignment*	
		19

*Two months practical assignment taken at end of formal course.

Subject Descriptions

Undergraduate Study

Centre for Petroleum Engineering

20.301 Properties and Phase Behaviour of Petroleum Reservoir Fluids **S1 L3**

Chemical, physical and thermodynamic properties of petroleum and reservoir fluids. Phase behaviour of multicomponent hydrocarbon systems. Use of computers to predict complex phase behaviour, real gas law, liquid mixtures, flash calculations, pressure, volume and temperature calculations for reservoir fluids. Application of these concepts to the prediction of gas and gascondensate reservoir behaviour.

20.302 Reservoir Rock Properties and Fundamentals of Fluid Flow in Porous Media **S1 L3**

Structure, properties and fluid content of reservoir rocks. Darcy's Law and the concept of permeability for single and multiple flow. Capillary phenomena and static distribution of fluids. Calculation of hydrocarbon volume in place. Elementary flow processes in reservoirs.

20.303 Well Drilling and Completions **S2 L3**

Well drilling methods and elements of rock mechanics. Rheology of Newtonian and non-Newtonian fluids, chemical properties and carrying capacity of drilling fluids, rotary drilling hydraulics, bit hydraulics and factors affecting rate of penetration. Prediction and control of abnormal pressures. Casing and tubing design, principles of cementing, well completion materials, well perforating, equipment and operative standards, acidizing, fracturing, problem well analysis and remedial treatment design.

20.304 Reservoir Engineering I **S2 L3**

Prerequisite: 20.301, 20.302.

Classification of reservoirs by type and recovery mechanism, reserve and production rate estimates based on material balance calculations. Introduction to displacement processes in petroleum reservoirs. Design of reservoir development.

20.305 Drilling and Production Lab **S2 L3**

Prerequisite: 20.301, 20.302. Co-requisite: 20.303.

Properties of drilling fluids. The design, composition amd measurement of the properties of drilling fluids. Measurement of basic rock properties such as porosity, permeability and capillary pressure.

20.306 Petroleum Production Economics **S1 L1**

Basic elements of profitability analysis. Depreciation, financial statements, interest, time value of money. The financial plant, outside share, planning and scheduling, pricing and costs. Profitability. Criteria, applications of present value profiles, risk and risk adjustment.

20.307 Petroleum Thermodynamics **S1 L2 T1**

Thermodynamic theory for phase behaviour of complex hydrocarbon mixtures at high temperature and pressure. Kinetic theory of gases, theory of liquids and liquid mixtures. Equations of State. Principle of corresponding states. Introduction to commercial phase behaviour and thermodynamic property evaluation packages used in the petroleum industry.

20.308 Formation Evaluation 1 **F L2**

Principles of petrophysics. Petrophysical parameters: their measurement with well logs. Relationships between log and reservoir parameters. Study of resistivity and porosity logs. Case study in an Australian oilfield. A course of lectures and practical problem solving.

20.401 Reservoir Engineering II **SI L3**

Prerequisite: 20.304.

Basic unsteady-state flow for single phase fluids in porous media. Diffusivity equation and solutions. Application to practical well test analysis methods. Pressure build-up, drawndown, interference and pulse testing to evaluate reservoir properties. Extension to multiphase flows and introduction to displacement processes in petroleum reservoirs.

20.402 Reservoir Fluids Laboratory **S1 L3**

Prerequisite: 20.301.

Physical properties of petroleum and its products, gravity, viscosity, surface tension, chromatography. PVT analysis of reservoir fluids.

20.403 Production Engineering **S1 L3**

Prerequisite: 20.304

Analysis, specification and characteristics of production systems. Well inflow performance. Single amd multiphase flow in vertical pipes. Methods and design of artificial lift systems. Surface separation, fluid transmission and processing.

20.404 Formation Evaluation 2 **F L2**

Prerequisite: 20.308

Study of open-hole crossplots. Irreducible water saturation, permeability index. Shaly sands. Carbonates. Fracture detection. Sample taking. Case studies in 2 Australian oilfields. Cased-hole logs. Gun perforating. A course of lectures and practical problem solving.

20.405 Oil and Gas Law and Regulation **S1 L2**

Introduction to government legislation and control. Jurisdiction over onshore and offshore petroleum resources. The basic title system. Allocation of permits and licences. Expenditure commitments. Rental and royalty payments. Pipeline licences. Discretionary government controls, Aboriginal land rights. Environmental acts and regulations.

20.406 Reservoir Simulation Fundamentals **S2 L3**

Prerequisites: 20.401, 10.032, 48.032.

Development of reservoir simulation equations and their solution by finite-difference methods. Standard black oil models and their application to predicting reservoir behaviour. Hands-on use of commercial reservoir simulators: input data preparation, simulator operation, interpretation of simulator output.

20.407 Advanced Recovery Mechanisms **S2 L3**

Prerequisites: 48.041, 20.401.

A comprehensive review of secondary and tertiary oil recovery methods. Secondary water and gas flooding. Mechanisms of miscible and partially miscible displacements of oil and water related to enhanced oil recovery. Influence of phase behaviour on fluid displacement efficiency in surfactant, alcohol, hydrocarbon-miscible, and carbon dioxide flooding processes. Compositional numerical reservoir simulators. Field applications of EOR technologies.

20.408 Natural Gas Engineering **S2 L3**

Basic gas reservoir engineering. Study of the composition and properties of natural gas, production methods, estimation of gas reserves, recovery of liquifiable products from gas, conditioning, transmission, compression and measurement of natural gas. Gas well testing including flow-after-flow, isochronal testing, transient testing, deliverability forecasting.

20.409 Petroleum Engineering Project **S14 S2 L11**

A major design or research project on a problem relevant to petroleum engineering and concluding in the submission of an individual thesis. Projects of relevance to the research efforts in the School plus approved topics of particular interest to industry.

20.410 Well Pressure Testing **S1 L2**

Theory of transient well testing. Practical aspects of design and performance of field tests. Analysis of transients pressure data, effects of boundaries, reservoir hetrogeniety, multiphase flow. Study of production, DST and formation interval tests. Pulse testing and multi-well tests. Computer assisted well test analysis techniques.

Chemical Engineering and Industrial Chemistry

General

Students are expected to possess a calculator having exponential capabilities (ln x and exp x or 'x to the y'), and this will normally be allowed to be used in examinations. However, it should be noted that calculators with very much greater capabilities than the above might not be allowed in examinations, because they could give the user an unfair advantage over other candidates. Further information may be obtained from the Head of the School.

Students of both Chemical Engineering and Industrial Chemistry are expected to have a copy of Perry J. H. ed. *Chemical Engineers' Handbook* 6th ed. McGraw-Hill. This book is used extensively for most subjects and units. Certain subjects and units do not have specified textbooks and in these cases reference books are used or printed notes supplied.

3.021 Instrumental Analysis **F L1 T2**

Data treatment, error analysis and propagation of errors. Basic principles of volumetric analysis. Solubility and pH calculations. Electronic analysis – potentiometric, voltametric and coulometric. Spectrophotometric analysis – UV/visible, atomic emission, atomic absorbtion, X ray diffraction and fluoresence. Chromatographic analysis – gas chromatography, high performance liquid chromatography, and ion chromatography.

3.022 Computing **F L1 T.5**

Prerequisite: 10.001

Computing for technical applications. Operating systems: VAX computers, the VMS operating system and the EDT editor. The FORTRAN language Elementary numerical methods; library subprograms; structures of program modules for technical calculations. The BASIC language.

3.031 Engineering Thermodynamics **S1 L2 T1 S2 L1**

Co or Prerequisites: 2.102A, 3.121, 3.122

Review of first law of thermodynamics; thermochemistry; second law of thermodynamics. Auxiliary functions and conditions of equilibrium. Thermodynamic properties of fluids; thermodynamic properties of homogeneous mixtures. Chemical reaction equilibria; calculation of equilibrium compositions for single reactions. Phase equilibria; the phase rule, equilibrium. Engineering applications of thermodynamics. Heat engines, refrigeration.

3.032 Reaction Engineering **S1 L1 S2 L1 T1**

Prerequisites: 2.102A, 3.022, 3.121, 3.122, 3.123

Introduction to reactor design: ideal batch, steady state mixed flow, steady state plug flow, size comparisons of ideal reactors, optimization of operating conditions. *Multiple reactor systems:* reactors series and parallel, mixed flow reactors of different sizes in series, recycle reactors, autocatalytic reactions. *Multiple reactions:* reactor design for reaction in parallel and reactions in series, series-parallel reactions. *Temperature effects:* heat of reaction, equilibrium constants, optimum temperature progression, adiabatic and non-adiabatic operation, product distribution and temperature. *Kinetics of rate processes:* Significance of the rate laws and models for distributed and lumped parameter systems. Experimental measurement and correlation of process rates.

3.033 Numerical Methods **S1 L1 S2 L1 T1**

Prerequisites: 3.022, 10.031, 10.301

Basic concepts of numerical methods. Solution of single and multiple, linear and non-linear, non-differential equations. Numerical solutions of ordinary differential equations. Optimization techniques: single and multiple dimensional search, linear programming, dynamic programming. Use of subroutine libraries. Application to process industry problems.

3.034 Process Control **F L1**

Prerequisites: 3.021, 3.022, 10.031

Unsteady state modelling of simple processes: linearisation, transfer function, concept of input-output models. Lumped parameter versus distributed parameter systems. *Process identification:* transient, frequency, pulse and correlation analysis. *Control system hardware:* transducers, valves, measuring devices for flow, pressure, temperature.

3.110 Introduction to Chemical Engineering **F L1 T1**

Introduction to the processing industry and chemical engineering practice. The role and responsibilities of the chemical engineer. Introduction to materials of construction for the processing industries. Application of process calculations in chemical process operations. Conventions in methods of analysis and measurement. The chemical equation and stoichoimetry. Introduction to material balancing. Process calculations associated with gases, vapours and liquids.

3.121 Material and Energy Balances **F L1 T1**

Prerequisites: 2.121, 3.110, 5.0011, 10.001

Material Balances: Revision of material balances. Problems involving bypass, recycle and purge. Problems involving staged operations. Differential material balances. *Energy Balances:* Thermodynamic background. First law; phase rule; reference states. General equation and its integro/differential form. Open and closed systems. Shaft work and enthalpy. Application of energy balances to constant composition systems; enthalpy data; heat capacity data; phase change. Application to varying composition systems: Mixing; Heat of solution; Enthalpy concentration diagrams. Reactions. Heats of formation and combustion. Integrated Material and Energy balance problems. Students not taking 3.110 will be required to complete a 28-hour bridging course offered by the School early in Session 1.

3.122 Flow of Fluids **F L1 T1**

Prerequisites: 1.001, 3.110, 5.0011, 10.001.

Units and dimensions. Fundamental concepts of Fluids. Simplification of the Navier-Stokes Equation: Fluid statics, continuity, Bernoulli's equation, momentum and energy equations. Flow in closed conduits, including laminar and turbulent flow and losses due to friction. Flow in open channels; hydraulic jump. Pumps and pumping; blowers and compressors, pipes and fittings. Measurement in Fluid Mechanics; viscosity, pressure, velocity, flowrate. Compressible flow.

3.123 Heat Transfer **S2 L2 T1**

Prerequisites: 1.001, 3.110, 5.0011, 10.001.

Conduction: Steady state, one dimensional heat flow. Resistance concept, series and parallel. Unsteady state conduction. *Convection:* Laminar and turbulent flow. Analogies between Momentum and Heat Transfer. Correlations for flow in and across tubes and other surfaces. Free convection. *Radiation:* Black and grey bodies. Shape factors, reciprocity. Radiation from gases. *Heat Transfer with phase change:* Nucleate and film boiling. Condensation and effect of presence of inerts. Applications: Introduction to Heat Exchangers. Log mean temperature difference. Effectiveness – NTU relationships. Extended surfaces.

3.124 Chemical Engineering Laboratory I **F T1**

Prerequisites: 1.001, 2.121, 2.131 or 2.141, 3.110, 5.0011, 5.0302, 10.001

An introduction to laboratory work in chemical engineering including information retrieval techniques.

3.131 Fluids 2 **F L1**

Prerequisites: 3.022, 3.122, 10.031.

Single and Two-phase flow. Derivation of Navier Strokes Equation and solutions for inviscid flow, boundary layer flow, non-Newtonian flow.

3.132 Mass Transfer and Separation **F L2 T1**

Prerequisites: 2.102A, 3.121, 3.122, 3.123, 3.124.

Fundamentals: Diffusion. Models for mass transfer at fixed and free interfaces. Calculation of mass transfer rates at surfaces with simple geometry. Mass transfer in dispersions. *Stagewise Processes:* Phase equilibrium. Absorption. Binary distillation. Liquid-liquid extraction. *Design of Mass Transfer Equipment:* Equipment design for absorption, distillation, liquid-liquid extraction and adsorption processes. Unit design for stagewise and differential contact. Design of equipment for membrane and other surface separation processes. *Simultaneous Heat and Mass Transfer:* Psychrometry. Cooling Towers. Drying.

3.133 Particle Mechanics **S2 L2 T1**

Prerequisites: 3.022, 3.122, 10.031, 10.301.

Particle characterisation: Size analysis, sphericity, surface area, density. *Fluid-particle interactions:* drag coefficient, effect of Reynolds number. Terminal velocity, effect of shape, concentration. Drops and bubbles. Particle-particle interactions including flocculation. Flow through porous media. Darcy, Carman-Kozeny, Ergun equations. *Applications of fluid-particle systems:* Sedimentation and thickening. Elutriation. Cyclones. Packed beds. Single phase flow. Two phase flow in trickle beds. *Filtration:* constant pressure theory, specific resistance, equipment, filter aids, centrifugal. *Fluidisation:* minimum fluidisation velocity, two phase theory, bubble properties, applications. Spouting. Pneumatic and hydraulic conveying. *Solids Handling:* Properties of granular solids and powders affecting storage and movement. Stockpiles, silos and hoppers: Feeders, conveyor belts and elevators.

3.134 Process Plant Engineering 1 **F L2 T1**

Prerequisites: 3.022, 3.121, 3.122, 3.123. 6.854, 10.031.

Processing Engineering I: All activities required from the conception of the idea to produce a product through to the finalisation of the process flow diagram including process selection and evaluation, process design, process simulation, process representation, process acquisition and licensing. *Project Engineering I:* Outline of scope of a process plant including plant location and layout, processing facilities and offsites including utility system design, statutory regulations, facilities for storage, processing and transport of materials

within the plant including design of piping systems. *Process Equipment Design:* Materials of construction. Procedures for the selection, design, specification and representation of process equipment. Pressure vessel and heat exchanger design. Engineering standards and procedures. *Process Economics I:* Capital and operating costs of a process plant. Fixed and variable costs. Break-even analysis. Cost estimation methods.

3.135 Chemical Engineering Laboratory 2 **F T1.5**

Prerequisites: 2.002E, 2.102A, 3.021, 3.022, 3.121, 3.122, 3.123, 3.124, 10.031, 10.301.

An integrated chemical engineering laboratory incorporating experiments in fluid flow, heat transfer, mass transfer, thermodynamics and kinetics, instrumentation and process dynamics and control. The objectives of this laboratory are: to demonstrate, reinforce and extend the principles of chemical engineering which are covered elsewhere in the course; to introduce various laboratory techniques which are used in the experimental investigation of chemical engineering problems; to develop an interest in experimentation, and to develop a proficiency in technical report writing.

3.136 Chemical Engineering Applications **F L2 T2**

Prerequisites: 2.102A, 3.022, 3.121, 3.122, 3.123, 10.031, 10.301.

Application of chemical engineering principles to biochemical engineering, fuel engineering, solids handling, alumina and aluminium industries and polymer technology. Integrated problems illustrating skills in process analysis.

3.140 Research Project **F T6**

Prerequisites: All Year 3 subjects.

The experimental investigation of some aspect of chemical engineering.

3.141 Process Dynamics and Control **S1 L2 T1 S2 L1 T1**

Prerequisites: 3.032, 3.033, 3.034, 10.031.

Common types of feedback controllers; translating control problems into block diagrams. Closed loop relationships and response; stability analysis for SISO systems; feedback controller tuning. Open and closed loop dynamic behaviour of systems of different order and how best to control these systems. Effect of dead time on control; introduction to dead time compensation. Introduction to cascade, feed forward and ratio control. Application of digital computers to real time control; interfacing computers with processes; distributed control systems; data acquisition and process monitoring; digital implementation of control algorithms. Introduction to multivariable control.

3.142 Advanced Reaction Engineering **S1 L1 T1**

Prerequisites: 3.032, 3.033, 3.131, 3.132, 10.032.

Heterogeneous Systems: Kinetics of uncatalysed gas-solid and liquid-solid reactions. Kinetic models for catalytic reactions. Inter and intra-particle diffusional effects in fluid-solid systems. Design of fixed bed catalytic reactors in adiabatic and non-adiabatic and non-isothermal operation. Trickle bed reactors. Slurry reactors for batch and continuous operation. Laboratory reactors for determining kinetic parameters in heterogeneous systems.

3.143 Multicomponent Separation Processes **S2 L1 T1**

Prerequisite: 3.031, 3.033, 3.132, 10.032.

Separation of multicomponent systems by stagewise operations. Multicomponent separations using modern computer techniques. Phase equilibrium relationships for liquid-vapour and liquid-liquid systems. Azeotropic and extractive distillation.

3.144 Process Plant Engineering 2 **S1 L2 T2**

Prerequisites: 3.033, 3.034.

Process Engineering II: Process Synthesis and analysis techniques for process sequence selection. Heat exchanger networks. Optimum energy utilisation methods. Process simulation for steady and unsteady state. *Project Engineering II:* All activities required from the finalisation of the process flow diagram for a process plant through the development of P and ID's, plant design and engineering, construction, commissioning and operation. Project management and process contracting. *Economics II:* Project economic evaluation. Discounted cash flow methods. Project financing. Sensitivity analysis and uncertainty. Financial and cost accounting methods.

3.145 Safety and Environmental **S1 L2**

Prerequisites: 3.131, 3.132, 3.133, 3.134.

Safety: Techniques for assessing safety of existing and proposed plants. Systems reliability, HAZOP and HAZAN. Pressure and explosion relief. Laboratory Safety. *Pollution Control:* Water pollution – design and operation strategies; treatment operations; economic aspects. Air pollution-effluent dispersions: types of gas cleaning units, choice of gas cleaning equipment. Noise pollution and pollution control legislation.

3.146 Process Plant Operation **S1 L1 T2**

Prerequisite: All 3rd year subjects

Practical studies of the operation of computer controlled chemical plant. Process diagnostics. Troubleshooting.

3.147 Management **S2 L2**

Prerequisite: 3.134.

A workshop comprising exercises and case studies to introduce the human and organizational aspects of managing process or engineering enterprises. Includes discussion of typical organization structures and reasons for choosing them; problems of managing people in organizations, industrial relations questions.

3.148 Design Project **S1 T1 S2 T4**

Prerequisite: All 3rd year subjects

This project will cover the engineering of a small process plant or part thereof requiring the application of material covered within the undergraduate course. The minimum requirements of this project are as specified by the relevant engineering institution's accreditation standards.

3.149 Professional Electives **F L2 T2**

Prerequisite: All 3rd year subjects

To be chosen from offerings yet to be finalised in:

Biochemical Engineering
Industrial Chemistry
Materials Science and Engineering
Minerals Processing and Extractive Metallurgy
Polymer Science

which will be offered by the relevant Schools or Departments.

3.210 Industrial Chemistry I **F L1 T1**

Prerequisites: 1.001, 10.001

Introduction to the chemical industry. The role of the industrial chemist in society. The ethical responsibility of the industrial chemist. Introduction to materials for the chemical industry. Information retrieval. Communication skills. Factory visits.

Application of process calculations in chemical process operations. Conventions in methods of analysis and measurement. The chemical equation and stoichiometry. Introduction to materials balancing. Process calculations associated with gases, vapours and liquids.

3.220 Introduction to Fluid Flow **S1 L1 T1**

Prerequisites: 1.001, 10.001

Fundamental concepts of Fluids. Simplification of the Navier-Stokes Equation, continuity, Bernoulli's equation, momentum and energy equations. Flow in closed conduits, including laminar and turbulent flow, and losses due to friction. Measurement in Fluid Mechanics; viscosity, pressure, velocity, flowrate.

3.221 Mass and Energy Balances **S1 L1 T1**

Prerequisites: 2.121, 3.210, 10.001

Material Balances: Revision of material balances. Problems involving bypass, recycle and purge. Problems involving staged operations. Differential material balances. Energy Balances: Thermodynamic background. First law; phase rule; reference states. General equation and its integral differential form. Open and closed systems. Application of energy balances to constant composition systems; enthalpy data; heat capacity data; phase change. Application to varying composition systems; Mixing; Heat of solution; Enthalpy concentration diagrams. Reactions. Heats of formation and combustion.

Students not taking 3.110 will be required to complete a 28 hour bridging course offered by the School early in Session 1.

3.222 Heat Transfer and Temperature Measurement **S2 L1 T1**

Prerequisites: 1.001, 10.001.

The course will deal with conduction, convection and radiation. Conduction will cover Fourier's Law and the thermal resistance concept. Convection will deal with passage of fluid over a surface and the importance of the Reynolds number in calculating the convection heat transfer coefficient. Radiation will deal with blackbody radiation and Stefan's Law. Applications to industrial heat transfer equipment will be discussed.Temperature measurement devices and circuits. Pyrometry.

48.025 Chemical Engineering for Ceramic Engineers

Consists of Units 1 and 3 of 48.022.

48.040 Chemical Engineering Project **S1 T1 S2 T11**

Prerequisites: 48.031, 48.032, 48.033, 48.036, 48.135, 48.136, 48.163.

The design of plant for the production of chemicals and the estimation of product costs or an experimental investigation of some aspect of chemical engineering.

48.041 Chemical Engineering 3A

Prerequisite: 48.031.

Unit 1 Convective Mass Transfer **S1 L1**

Models for convective mass transfer are fixed and free interfaces. Calculation of mass transfer rates at surfaces with simple geometry. Mass transfer in dispersions and in systems involving chemical reaction.

Unit 2 Simultaneous Heat and Mass Transfer **S1 L1**

Psychometry, principles of design calculations for cooling towers and for humidication-dehumidification operations. Topics selected from: drying of solids, crystallization, sublimation, molecular distillation, gaseous and thermal diffusion.

Unit 3 Multicomponent Separation **S1 L1**

Prerequisites: 48.031 Unit 1, 48.135.

The separation of multicomponent systems by stagewise operations. Brief review of conventional graphical calculation methods leading to a graphical treatment of ternary distillation. Multicomponent separations using modern computer techniques. Phase equilibrium relationships for liquid-vapour and liquid-liquid systems. Azeotropes and azeotropic distillation.

Unit 4 Transport Phenomena **S1 L1**

A generalized treatment of the continuum approach to momentum, energy and mass transport. Application of the conservation equations to chemical engineering problems. Discussion of the advantages and limitations of the transport approach.

48.042 Chemical Engineering 3B

Prerequisites: 10.032, 48.163.

Unit 1 Process Dynamics and Control 1 **S1 L2 T1**

Analysis of dynamic systems: derivation of equations for lumped parameter systems, linearization, reduction to transfer functions, numerical solutions. *Control hardware:* basic measuring instruments, control valves, analog controllers, digital computer-based controllers. *Process control:* analysis and synthesis of single feedback loops, using root-locus techniques, stability criteria, and criteria for satisfactory control.

Unit 2 Optimization **S1 L1**

An introduction to some of the techniques of optimization and their application to problems from the process industries. The methods covered will include single and multiple dimensional search, linear programming and dynamic programming.

48.043 Chemical Engineering 3C

Prerequisites: 48.031, 48.032.

Unit 1 Design Workshop **S1 L1 T2**

Consideration of the ways and means of attempting a design project, emphasizes to students the need **1.** to study the history and alternatives to the design project, and **2.** to use proper design techniques for the assigned process and equipment. Students are each given a design project or some aspect of it and are expected to produce an appropriate report on their assignments.

Unit 2 Industrial Pollution Control **S1 L2**

Introduction, atmospheric dispersion of pollutants, source and ambient measurement and monitoring. Industrial air pollution control. Water usage in the chemical industry. Pollutants and their effects. Water quality standards. Industrial options, source reduction, water reuse, effluent disposal. Performance and selection of treatment methods. Reliability of treatment methods. Economic aspects. Legislative aspects. Factory visit. Solid waste management. Noise pollution.

48.044 Chemical Engineering Laboratory 2 **S1 T3**

Prerequisites: 48.031, 48.032, 48.033, 48.036, 48.136, 48.163.

An integrated chemical engineering laboratory at a more advanced level than the 48.036 laboratory and with an emphasis on open-ended experiments.

48.046 Chemical Engineering Project **F T6**

Prerequisites: Meritorius performance in Year 3 Chemical Engineering subjects.

48.047 Chemical Engineering 3D

Prerequisites: 48.031, 48.032, 48.033, 48.163, 48.042.

Unit 1 Management **S2 L2**

A workshop comprising exercises and case studies to introduce the human and organizational aspects of managing process or engineering enterprises. Includes discussion of typical organization structures and reasons for choosing them; problems of managing people in organizations, industrial relations questions.

Unit 2 Process Engineering 2 **S1 L1 S2 T1**

Process synthesis and analysis with particular reference to separation process sequences and heat exchanger networks. Process diagnostics: detection, location and indentification of malfunctions in a simulated chemical plant. Selection of most appropriate remedies. Studies of repair and maintenance practices, onstream corrections versus those requiring process shutdown. Temporary and permanent corrections. Exercise in fault analysis and correction using cases from practice.

Unit 3 Process Dynamics and Control 2 **S2 L1 T1**

Frequency response analysis and synthesis techniques. Control of dead time and distributed systems. Cascade feedforward and other multiloop systems. Introduction to analysis of multivariable systems. Identification and estimation techniques. Digital implementation of control algorithms.

48.090 Industrial Experience

Students are expected to accumulate, by the end of the four year course, twelve weeks of industrial experience gained during recesses.

48.113 Chemistry of Industrial Processes **F L1 T2**

Prerequisite: 2.102A. Co or prerequisites: 2.102B, 2.102C.

The production of inorganic industrial chemicals from the standpoint of the application of the basic principles of inorganic and physical chemistry (acid industries, alkali industries, industrial gases electric furnace products, superphosphates, aluminum and glass); a study of some sections of the organic industrial chemical industry – cellulose, industrial alcohols, formaldehyde, phenol, urea, phenolic and urea resins, acetic acid, polymers based on enthylene and acetylene, elastomers. Laboratory: students are required to attend lectures on report writing, carry out laboratory assignments and attend factory inspections at local and country centres as required.

48.115 Industrial Electrochemistry **S1 or S2 L2**

Prerequisites: 48.113, 48.138.

Fundamentals of electrodes, the Butler-Volmer equation, current/potential laws in relationship to reaction mechanism. Electrocatalysis, gas evolution and co-deposition. Technological aspects of electrochemistry; energy conversion systems, storage systems and plating. Industrial processes – cell design and side reactions, gas bubble effect, current distribution and mass transfer effects. Developments in electrode technology, diaphragms and cell construction.

48.116 Water Chemistry **S1 or S2 L2**

Prerequisite: 3.021.

Introduction to stability diagrams for aqueous systems. Characteristics of waters and wastewaters. Treatment of process water and boiler water. Water reclamation and wastewater treatment.

48.121 Corrosion in the Chemical Industry **S2 L1 T1**

Prerequisite: 2.102A.

Selection of materials for chemical plant. Strength and corrosion resistance of less common materials of fabrication. Chemical and electrical aspects of corrosion and their application to corrosion problems encountered in the chemical process industries. Design factors for corrosion prevention. Methods of corrosion prevention.

48.124 Applied Kinetics **S1 L1 T1**

Prerequisites: 48.138, 48.136.

Adsorption theory, kinetics of catalytic and non-catalytic fluid-solid reactions, rates of surface reaction, kinetics of heterogenous reactions affected by diffusion, catalyst characterization.

48.134 Applied Thermodynamics **S1 L1 T1**

Prerequisites: 48.135, 48.171.

Calculation of thermodynamic properties for non-ideal liquid and solid solutions. Development of statistical models for real solutions of industrial importance. Thermodynamics of

interfaces. Phase equilibria in binary and ternary systems. A study of chemical equilibria in multicomponents, polyphase systems including appropriate computational methods.

48.135 Thermodynamics **S1 L2 T1**

Co- or prerequisite: 2.102A.

Review of first law of thermodynamics; thermochemistry; second law of thermodynamics. Auxiliary functions and conditions of equilibrium. Thermodynamic properties of fluids; thermodynamic properties of homegeneous mixtures. Chemical reaction equilibria; calculation of equilibrium compositions for single reactions. Phase equilibria; the phase rule, equilibrium.

48.137 Industrial Chemistry 2A **S1 L2**

Prerequisites: 3.221, 2.102A.

Selected aspects of unit operations for industrial chemistry students such as distillation, liquid-liquid extraction, gas absorption, filtration evaporation and crystallization.

48.138 Industrial Chemistry 2B **S2 L2 T1**

Prerequisite: 3.022.

Basic concepts of numerical methods. Solution of single and multiple, linear and non-linear, non-differential equations. Numerical solutions of ordinary differential equations and a course on electrochemical kinetics.

48.139 Experimental Design **S2 L1 T1**

Prerequisite: 10.301.

Design of experiments, correlation and regression, quality control. Use of graphical methods, fitting empirical equations to experimental data. Preparation of nomograms using constructional determinants.

48.163 Instrumentation and Process Control 1 **S2 L2 T1**

Prerequisites: 10.031, 48.122 or 2.102D. Co- or prerequisite: 48.113.

Analog Computation: theory and application of basic analog computing elements; magnitude and time scaling; solution of linear differential equations. *Instrumentation:* theory and application of transducers and transmitters for measurement of process variables. *Process Dynamics:* behaviour of linear, lumped paramater dynamics systems; first, second and higher order and integrating systems. *Process Control:* closed loop, block diagrams, controllers and controller tuning.

48.165 Laboratory Automation Science **S1 L1.5 T2.5**

Prerequisite: 48.163.

The application of computers, eg microcomputers, to real-time data acquisition and process control in chemical laboratories and selected processes of interest to industrial chemists. Introduction to real-time digital operations and data manipulation. Organization of a process control computer. Hardware considerations. The process computer interface. Sequential and programmable logic control of batch processes. Data acquisition and process monitoring techniques. Digital process control PID controller tuning. Graphics in process monitoring and control. Direct Digital Control.

48.171 Chemistry of High Temperature Materials **S2 L2**

Prerequisite: 2.102A.

Chemical aspects of high temperature materials; thermodynamics and kinetics of reactions in the solid state; phase equilibria in condensed systems; gas-solid and liquid-solid reactions.

48.172 Instrumental Analysis 2 **S1 L2 T2**

Prerequisite: 3.021.

Theory and application of advanced instrumental techniques including: high performance liquid chromatography, infra-red spectroscopy, particle size analysis, surface area analysis, thermal analysis (TGA, DSC/DTA, DMA), ion chromatography, capillary gas chromatography.

48.174 Seminar **F T2**

Students are required to deliver two lecturettes on selected topics, one related to some aspect of chemical technology, and the other to their research project. The intention is to develop skill in oral expression, as well as ability in critical evaluation and logical presentation. Opportunity is taken, where appropriate, to arrange for guest lecturers.

48.194 Project (Industrial Chemistry) **S1 T8 S2 T16**

An experimental or technical investigation related to some aspect of industrial chemistry. Prerequisites and/or co-requisites will be determined depending on the nature of the project.

Servicing Subjects

These are subjects taught within courses offered by other faculties.

For further information regarding the following subjects see the Combined Sciences Handbook.

48.412 Polymer Materials **S1 2 S2 4**

The structure and synthesis of commercially important polymers including thermoplastics, fibres, rubbers and composites. The effect of chemical and molecular structure upon properties. Degradation. Mechanical properties including time dependent behaviour. Fabrication processes. Polymer selection for various applications.

42.105 Biological Process Engineering **F L2 T4**

Prerequsite: 44.101.

Structure of Metabolism: Growth of an undifferentiated organism as a physico-chemical process leading to quantification of growth processes. Structure and function of a single cell. The structure of metabolic processes. Energy metabolism balances. Small metabolite production. Macro-molecule production. Coordination and control of cellular processes. *Industrial Bio-processes:* A review of bio-process industries. The selection, screening and maintenance of commercial cultures. The optimization of bio-processes. Batch and continuous fermentations. Enzyme engineering, single cell protein. Biodeterioration and microbiological stability. Sanitation. Fermentation practice. *Microbial Dynamics and Energetics:* Principles used in the

quantification of complex systems. Quantification of biomass and the growth process. Balanced growth. The Monod model and further extensions of the model. Uncoupling of growth processes. Quantification of product formation. Distributed, segregated, unstructured and structured models. Stochastic models. Overall energetics of growth processes. Entropy and free energy relationships in complex reaction sequences. Principles and requirements of driven reactions. The energetics of cell processes and the prediction of yields and metabolic heat evolution.

48.240 Biological Process Engineering Project **S1 T1 S2 T11**

Project in Biological Process Engineering for students in Chemical Engineering.

Department of Fuel Technology

3.301 Fuel Engineering (Mining and Mineral Processing Engineers) **F L2 T1**

Properties and classification of fuels. Basic principles of combustion. Introduction to thermal design and configuration of furnaces, kilns, boilers, fuel using equipment. Fuel processing.

3.302 Fuels and Energy **S2 L3 T1**

A servicing subject for students in Electrical Engineering which covers the topics, sources and properties of fuels and energy, energy use patterns, principles of combustion, combustion calculations, the technology of boilers and other fuel plant, thermodynamic cycles, new and emerging energy technologies, including solar, wind and nuclear energy.

3.303 Fuel Science for Industrial Chemists **S1 or S2 L2**

Combustion science, mechanisms of major oxidation reactions, flames, mechanism of formation of carbon, NOx and SOx. Measurements of gas flow, gas composition, temperature in flames and furnaces. H-t relationships and their application.

3.304 Fuel Engineering for Ceramic Engineers **F L1**

An introduction to combustion technology, combustion calculations, burner design, furnace, kiln and boiler thermal design.

3.331 Fuel and Energy Engineering 1 **F L3 T1**

Sources, properties and classification of fuels and energy sources. Introduction to combustion engineering and science, the thermal design of furnaces, boilers and other fuel using plant, radiation. Basic principles of fuel processing,oil refining, gasification, liquefaction, carbonisation etc. Laboratory work on the properties of petroleum products, coal and gaseous fuels.

3.341 Fuel and Energy Engineering 2 **S1 L5 T4 S2 L2 T2**

Combustion engineering. Furnace and fuel plant design. Energy management. Technologies for the efficient use of fuel. Properties and evaluation of fuels for their application. Laboratory work on burners, furnaces, combustion, efficiency, etc.

3.340 Fuel and Energy Research Projects **S1 T6 S2 T6**

Investigation of some aspect of fuel engineering.

48.331 Fuel Engineering 3

Unit 1 Combustion Engineering **S1 or S2 L1**

Droplet burning, combustion of sprays. Flame stabilization. Coal combustion, burn out. Effects of fuel impurities.

Unit 2 Furnace Design **S1 or S2 L1**

Furnace design for continuous or intermittent operation.

Unit 3 Fuel Plant Design **S1 or S2 L1**

Heat recovery plant design. Flow in furnaces. Refractories. Process steam.

Unit 4 Fuel Conservation and Efficiency **S1 or S2 T1**

A case history and investigative approach to energy saving in industrial, commercial and domestic applications.

Unit 5 Liquid Fuels **S1 or S2 L1**

Constitution of mineral oils. Classification. Specifications. Correlation of properties. Properties of liquid fuels from petroleum and for synthesis, hydrogenation and pyrolysis of coal.

Unit 6 Coal and its Evaluation **S1 or S2 L1**

Constitution, classification and evaluation of coals. Carbonization: blending, additives, plastic behaviour.

Unit 7 Laboratory **F T3**

48.340 Fuel Engineering Project **S1 T1 S2 T11**

Projects selected involving the design of fuel plant or experimental aspects of fuel science and or processing and utilization.

Department of Polymer Science

48.403 Polymer Science **F L2 T1**

Prerequisites: 2.102A, 2.102B, 10.031, 10.301. Co- or prerequisites: 48.001, 48.113.

Polymerization processes; step growth and chain growth (free radical and ionic), stereospecific catalysts. Methods of polymerization: bulk suspension, emulsion, solution, high pressure. Industrial examples. Principles of analysis of polymers using chemical and instrumental methods. Molecular weight applied to macromolecules: number-, weight-, viscosity- and z-average weights. Molecular weight distribution. Thermodynamics of polymer solutions, theta solvent. Measurement of molecular weight. Fractionation methods. Conformation of a polymer chain. The crystalline state. The amorphous state. Stress strain behaviour. Creep. Impact. Rubber elasticity. Dynamic mechanical properties. Principles of operation of polymer processing equipment; safety procedures. Polymer compound design.

48.404 Advanced Polymer Science **S1 or S2 L2**

Prerequisite: 48.403.

Selected topics from basic texts and the original literature covering polymer analysis: physics of glassy polymers, viscoelasticity, polymer rheology, polymer morphology fracture and environmental stress cracking, rubber elasticity, anionic cationic and Ziegler-Natta catalysis in polymer chemistry, emulsion polymerization, silicon polymers and polymers for high temperature service.

Graduate Study

Centre for Petroleum Engineering Studies

20.303G Well Drilling & Completions

Rotary drilling hydraulics. Factors affecting rate of penetration. Directional drilling. Fishing operations. Coring. Formation damage. Casing design. Cementing. Gun perforating. Acidizing. Fracturing. Surfactants for remedial treatment. Sand control.

20.305G Drilling & Production Laboratory

Drilling and mud chemistry and rheology. The design of drilling fluids and their applications. Measurement of basic properties. Analysis and evaluation of petrophysical parameters.

20.306G Petroleum Production Economics

Need for economic reservoir analysis. Cash flow. Time value of money. Profitability of a venture. Valuation of oil and gas properties. Analysis of risk and uncertainty.

20.309G Reservoir Engineering

Basics of phase behaviour, equation of state modelling of gas-liquid systems, reservoir material balances. Identification of major recovery drive mechanisms. Water influx calculations. Well productivity.

20.403G Production Engineering

Well inflow performance. Simple and multiphase flow in horizontal, vertical and inclined pipe. Choke performance. Natural flow. Methods and design of artificial lift systems. Gas lift. Pluner lift. Sucker rod pumping. Hydraulic pumping. Jet pumping. Electric submersible pumps and others. Surface facilities.

20.406G Reservoir Simulation Fundamentals

Formulation of reservoir simulation equations. Explicit and implicit solution procedures. Cartesian and radial geometry. Single dimensional, two-phase flow. Description and use of commercial reservoir simulation software. Planning and execution of reservoir simulation projects. Effective use of reservoir simulation as a management and development tool.

20.409G Petroleum Engineering Project

An applied research project on a field problem of relevance to the research effort of the Centre and of practical interest to the oil industry. To be submitted as an individual thesis. Topic must be approved by the Director of the Centre.

20.410G Well Pressure Testing

Theory of transient well testing. Practical aspects of design and performance of field test instrumentation. Pressure build-up tests. Pressure draw-down tests. Fall-off tests. Multirate tests. Gas well testing. Flow-after-flow. Isochronal and Isochronal modified. Interference testing. Pulse testing. Drillstem tests.

20.411G Formation Evaluation

Theoretical/practical course in log analysis and its relation to other sources of subsurface data. Petrophysical data integration. Study of basic formation parameters and their well log responses. Data handling by computer. Evaluation of results. Case histories of Australian reservoirs.

20.501G Practical Assignment

A work experience assignment involving the equivalent of 280 hours work over a two month period in the oil industry. Suitable work assignments are arranged through the Centre for Petroleum Engineering in co-operation with industry. Students are required to complete a comprehensive report describing the work carried out. Assessment is based on the report submitted by the student and a student evaluation report by the student's immediate supervisor in the workplace.

Chemical Engineering and Industrial Chemistry

General

Graduate subjects will only be offered if class numbers exceed 5. Some subjects will only be offered every alternate year. Contact School for further details.

48.063G Industrial Water and Wastewater Engineering — **S1 or S2 L3**

Environmental consequences of water pollution. Water quality criteria and regulations related to industrial use and disposal. Water sources and requirements of industry. Theoretical and practical aspects of treatment methods, including screening, sedimentation, oil separation, coagulation and flocculation, filtration, biological treatment, adsorption, ion exchange, membrane processes. Strategies for industry including waste surveys, prevention at source, correction before discharge water reuse. Economic aspects. Seminars. Factory visits/ laboratory.

48.070G Process Principles

Material and energy balances and their application in chemical combustion processes. Introduction to rate process theory. Applications of equilibria. Principles of analysis.

48.081G Advanced Process Dynamics

Distributed-Parameter Linear Systems: Selected distributedparameter and mathematically similar systems. Methods of analysis and features of their response. Feedback systems containing deadtime. Heat exchangers. Distillation columns. *Non-linear Systems:* Selected non-linear systems, eg chemical reactors, flow systems, radiant heat transfer. Numerical solutions. Phase plane analysis. Limit cycles.

48.082G Process Optimization

Multivariable analytical and numerical optimization in free and constrained parameter space. Optimization of functions of a

continuous variable. Dynamic programming. Applications of these techniques to specific chemical engineering problems.

48.084G System Simulation and Control

This is a participatory course in which case studies, discussion of recent papers, development of digital simulation programs and analog computer laboratory work play an important part.

Topics are selected from the following areas:

Unit 1 System Simulation

Numerical methods for digital simulation; programming languages and packages for system modelling of distributed parameter systems; use of analog computers in systems simulation. Application of these techniques to the study of process plant and equipment, environmental systems, and similar areas.

Unit 2 Advanced Process Control

System identification and parameter estimation; control of multiloop systems; non-linear systems; digital control and data-logging, sequencing control.

48.085G Interphase Mass Transfer

Advanced theories of mass transfer. The effect of interfacial instability and methods for predicting its presence. Theoretical prediction of mass transfer in dispersed systems. Multicomponent mass transfer.

48.086G Fluid Particle Interactions

Fundamentals. Particle drag in an infinite laminar fluid, effect of turbulence and acceleration. Drag and rotation in shear flow. Multiparticular systems with homo- and heterogeneously sized particles. Co-current systems. Limiting particle transport velocity. Instabilities, various criteria. Transport line feed systems, transport line driers and reactor. Design of co-current fluid-particle systems. Gas-fluidized beds. Gross behaviour, bubblephase theories, instability theories, grid-bed geometry and resistance relationships, elutriation, residence-time and size-distribution studies. Heat and mass transfer; design of catalytic and non-catalytic fluidized reactors.

48.089G Graduate Colloquia

Colloquia on research developments in the School of Chemical Engineering and Industrial Chemistry. Students are required to participate actively in the colloquia and give at least one dissertation based on their own investigations.

48.090G Specialist Lectures

48.091G Advanced Thermodynamics

Equilibrium: liquid-liquid, liquid-solid and liquid-vapour phase equilibria for high pressure and multicomponent system; chemical reaction equilibrium for complex systems. *Molecular theory and statistical thermodynamics:* partiton functions, monatomic and diatomic gases; Chapman-Enskog theory, evaluation of thermodynamic potentials and virial coefficients. *Compressible flow:* flow of compressible fluids in ducts including supersonic flow, shock waves and stagnation properties.

48.092G Computer-aided Design

A workshop type of course with considerable time devoted to discussion, seminars, writing and running of programs. *Programming:* methods, conventions, and standards; program design, flow-charting, co-ordination and documentation. *Design:* individual plant units and components, flowsheets, optimization and economic analysis. Physical property estimation. *Simulation:* continuous change and discrete change systems.

48.093G Safety in Laboratories **S1**

Storage of hazardous materials. Disposal of hazardous materials. Air pollution and ventilation. Electrical and mechanical aspects of machinery. General laboratory safety. Microbiological safety precautions. Toxicology. Carcinogens and safety. Ionizing and non-ionizing apparatus. Protective clothing. Precautions against hearing loss. Chemistry and physics of flames. Fire precautions in the laboratories. Fire fighting training.

48.131G Catalysts and Applied Reaction Kinetics **S1 or S2 L2 T4**

Methods of catalyst preparation and characterization; adsorption theories; general mechanisms for gas-phase reactions catalyzed by solids; poisoning and catalyst decay; effectiveness factors; techniques in catalytic research; special topics in reaction kinetics including gas-solid non-catalytic reactions, polymer kinetics, electrochemical reaction kinetics and electrocatalysis; industrial catalytic processes; application of statistical methods to the solution of complex chemical data.

48.150G Instrumental Analysis for Industry **F L1 T2**

Role of analysis in process optimization. Accuracies of analytical methods compared to needs for equality control. Frequency of analysis in relationship to control and analytical costs. Importance of speed of analysis for information feed-back. Case studies for selected processes in relation to selecting the analytical method.

48.161G Electrochemical Techniques for Control and Analysis **S1 or S2 L2 T4**

In-depth study of selected electroanalytical methods with respect to theoretical principles, instrumentation and practical utilization. The importance of adsorption and reaction mechanism on accuracies and application. Steady state and rapid scan voltammetry, stripping voltammetry, chronopotentiometry, chronocoulometry, classical coulometry and potentiometry. Instrument design and modification for specific needs.

48.180G Corrosion Materials **F L2**

Metallic: types available, properties and applications for each of the following: cast irons, alloy cast irons, carbon steels, low alloy steels, stainless steel, special alloys. The following metals and their alloys: aluminium, copper, nickel, titanium, lead, zinc, magnesium, tin cadmium, chromium, cobalt. Refractory metals: molybdenum, tantalum, tungsten, zirconium. Noble metals: gold, platinum, silver.

48.181G Industrial Coatings for Corrosion Protection **S1 L2**

Special topics on heavy-duty organic, inorganic and metallic coatings used in atmospheric, marine and industrial environments.

48.182G Non-metallic Materials for Corrosion Resistance **S1 L2**

Thermosetting and thermoplastic polymers; natural and synthetic rubbers; glasses and glass linings; acid resisting ceramics; refractories.

48.183G Corrosion Technology **F L3**

Environmental fracture; corrosion in specific environments; corrosion of specific equipment types; principles of materials selection and design; surface preparation and maintenance coatings; polymeric materials and linings; inhibitors and electrochemical tests methods; cathodic protection.

48.184G Corrosion Project

A substantial project on some aspect of corrosion science or technology.

Department of Fuel Technology

Note: One Session Unit (SU) is equal to 1 hour per week for session of 14 weeks.

3.380G Fuel Seminar

1 (SU) to be given in Session 2, compulsory in MAppSc degree course in Fuel Engineering. Content bias to choice of G subjects.

3.382G Fuel Constitution

Unit 1 1 (SU) Coal constitution and pyrolytic behaviour.
Unit 2 1 (SU) Constitution and classification of oils.
Unit 3 2 (SU) Advanced fuel constitution.

3.383G Fuel Processing

Unit 1 2 (SU) Carbonization and gasification processes.
Unit 2 1 (SU) Liquid fuels from coals.
Unit 3 1 (SU) Chemicals from coals.

3.384G Fuel Plant Engineering

Unit 1 1 (SU) Furnace design and heat recovery.
Unit 2 1 (SU) Process heat transfer and efficient use of steam.
Unit 3 2 (SU) Furnaces and boiler control system.
Unit 4 2 (SU) Fuel plant heat transfer.

3.385G Combustion and Energy Systems

Unit 1 1 (SU) Combustion technology.
Unit 2 1 (SU) Fuel impurities, removal of and deposits from.
Unit 3 1 (SU) Efficiency in energy utilization.
Unit 4 1 (SU) Combined cycles and integrated systems.

3.386G Unit Operations in Waste Management **C3**

Unit 1 (3 SU) The unit operations and processes associated with modern waste management practices, ie the origin, nature, characterization, handling, transportation, size reduction and storage of various waste materials; reduction at source and disposal by composting, landfill, incineration and chemical processing; recovery and re-use of marketable products. Case histories.

3.388X Unit Operations in Wastewater, Sludge and Solid Waste Management

Physical wastewater treatment processes including sedimentation, flotation, flocculation, procipitation. Sludge management including conditioning, filtering, lagoons, drying. Introductory fuel engineering. Combustion principles. Incineration. Pyrolysis. Gasification. Resource recovery and recycling. Incinerator and afterburner design.

3.387G Fuel Technology Practice

Compulsory in MAppSc (Fuel) (4 SU). Content bias towards choice of G subjects.

3.391G Atmospheric Pollution and Control (Theory) **S1 or S2 L3**

Causes, properties, dispersion, measurement and monitoring control and legislation of air pollution in ambient and industrial environments.

3.391X Atmospheric Pollution and Control (Theory) **S1 or S2 L3**

Causes, properties, dispersion, measurement and monitoring, control and legislation of air pollution in ambient and industrial environments.

3.392G Practical Aspects of Air Pollution Measurement and Control **S1 or S2 T3**

Prerequisite: 3.391G or equivalent.

Laboratory and tutorial programs in the measurement and analysis of ambient and industrial air pollutants. Computation tutorials in advanced dispersion models, aerosol dynamics and control equipment design parameters.

3.900G Major Project

A substantial project on some aspects of chemical engineering, industrial chemistry, polymer science, fuel technology or biological process engineering.

3.901G Minor Project

A minor investigation on some aspect of chemical engineering, industrial chemistry, polymer science, fuel technology or biological process engineering.

Department of Polymer Science

48.400G Polymer Science **F L3 T3**

Polymer Processes: Classification of polymers, methods of polymerization; bulk, solution, emulsion, suspension, high pressure; processes; step growth, chain growth; the chemistry

and applications of polymer systems including polyesters, polyamides, phenolic condensation resins, vinyl polymers, synthetic elastomers. Natural polymers. *Mechanism and Kinetics:* Step growth polymerization, kinetics, structure effects; chain growth polymerization. Free radical polymerization, chemistry and properties of free radicals and initiators; kinetics of propagation and termination reactions; co-polymerization; monomer radical structure and reactivity. Cationic and anionic polymerization; stereoregular polymers. *Polymer Characterization:* Molecular weight: averages and distributions; thermodynamics of polymer solutions; theta temperature; fractionation methods; measurement of number-average molecular weight and weight-average molecular weight. *Polymer Physics:* Principles of operation of conven tional polymer processing equipment; safety procedures; polymer compound design; stress strain behaviour of polymers in tension, compression, shear and flexure; elementary rheological behaviour of polymers; rubber elasticity; thermal characteristics of polymers.

48.410G Analytical Characterization of Polymers **S1 or S2 L3 T3**

Composition of formulated polymeric material. Group reactions, specific and colour reactions. Instrumental characterization of polymers, and co-polymers and associated additives, eg plasticizers, anti-oxidants, etc by UV and IR spectrophotometry and pyrolysis gas chromatography. Analysis of films by transmission and reflectance spectrophotometric methods. Thermal analysis.

48.430G Polymer Engineering **S1 or S2 L4 T2**

Natural and synthetic elastomers; vulcanization, theory and method. Cross-linked thermoplastics. Extrusion. Press, injection and transfer moulding. Adhesives. Heat sealing and welding. Latices. Films. Cellular polymers. Fibre reinforced plastics. Mould design. Physical testing-standards and air conditioning; basic principles; testing machines, thermal, electrical and optical properties; accelerated ageing; preparation of standard test compounds; creep; dynamic mechanical tests; rubber in shear; abrasion; flammability. Polymer engineering applications and design data.

48.440G Polymer Physics **S1 or S2 L4 T2**

Chain dimensions. Diffusion and viscosity. Segmental motion and the glass temperature Tg: factors affecting Tg. Crystallinity, thermodynamic and kinetic parameters. Viscoelastic behaviour of polymers; creep, Maxwell fluid and Kelvin-Voigt solid models, Boltzmann superposition principle; stress relaxation, relaxation and retardation time spectra, WLF curves; dynamic behaviour, elastic hysteresis, damping. Stress strain behaviour in polymers. Chemical stress relaxation in elastomeric networks. Fracture mechanisms and impact strength of polymers. Kinetic theory of rubber elasticity.

48.900G Major Project

A substantial project on some aspects of chemical engineering, industrial chemistry, polymer science, fuel technology or biological process engineering.

48.901G Minor Project

A minor investigation on some aspect of chemical engineering, industrial chemistry, polymer science, fuel technology or biological process engineering.

School of
Fibre Science and Technology

School of Fibre Science and Technology

Head of School
Associate Professor R. E. Griffith

The School of Fibre Science and Technology was established in 1986 to bring together the University's activities in Wool and Pastoral Sciences and Textile Technology. The objectives of the School include the provision of comprehensive education of undergraduate and postgraduate students in the science and technology of: (i) production and marketing of wool fibre and other ruminant animal products, with special emphasis on wool fibre; (ii) production and marketing of other textile fibres; (iii) processing of textile fibres and their manufacture into consumer and industrial products; and (iv) performance and properties of textile and related fibre products.

These objectives are achieved by providing an undergraduate course in Wool and Pastoral Sciences which emphasises the plant and animal sciences relevant to production in the sheep industry, as well as preparation of wool for market, specification of wool, marketing of wool and the relationship between wool production and wool processing; and by providing undergraduate courses in Textile Technology (in which there are options in Textile Chemistry, Textile Engineering and Textile Physics) and Textile Management. While Wool and Pastoral Sciences mainly deals with wool and similar fibres such as cashmere and mohair produced by goats, as well as more general features of animal production, Textile Technology covers all fibres and all aspects of their utilization in consumer and industrial products.

Rapidly advancing developments in the primary and secondary fibre industries make close collaboration between workers from the production and processing sides essential. Many of these developments have been stimulated by objective measurement of fibre properties - a special area of expertise of the Department of Wool and Animal Science; and the objective specification of textile products in which the Department of Textile Technology is a world leader. In the sheep industry these developments have major implications for systems of wool production particularly in areas such as nutrition, genetics, breeding and management. The establishment of the School provides a unique opportunity for integration of educational and research efforts right through from production of fibres to finished textile products. The School provides a stimulating environment for students who wish to make careers in fibre based rural and manufacturing industries, both of which are critically important in the economy of Australia.

Department of Textile Technology

Head of Department
Associate Professor R.E. Griffith

Textile Technology is concerned with the conversion of both natural and man-made fibres into an extremely wide variety of finished products. These range from fabrics for apparel, soft furnishings, floor coverings and industrial use to such specialized textiles as tyre cord, ropes, protective clothing, sailcloth, parachute fabrics, medical dressings, composite materials, and many others.

In Australia, the textile Industry has developed mainly in the past sixty years and today it is one of our largest manufacturing groups. As in overseas countries, the impact of science is bringing rapid changes to the Industry, and a consequence of this has been a strong demand for personnel skilled in Textile Technology and Management.

Department of Wool and Animal Science

Head of Department
Associate Professor J.P. Kennedy

Agricultural products, particularly wool, still contribute a significant share of Australia's export income. The pastoral industry has also played a major role in the development of the continent and the largest single form of land-use still is grazing by sheep and cattle.

Farming has advanced technologically in recent years, however innovations are continually being sought to increase productivity, raise quality and improve marketing of rural products within the framework of local and international economics. There is a continual need for the feeding and clothing of humans on a planet with finite mineral and fuel resources. This challenge must be balanced with the need for conservation and careful manipulation of a pool of renewable living resources. Wool and pastoral scientists are required to research, communicate and administer the changes which are occurring.

Staff

School of Fibre Science and Technology

Associate Professor and Head of School
Ross Ernest Griffith, BSc *N.S.W.*, PhD *Leeds*, CText, ATI

Visiting Professor
Euan Maurice Roberts, MAgrSc *N.Z.*, PhD *N.S.W.*

Project Scientist
Baden-Singh Deol, MSc *Panj.(I).*, PhD *Syd.*

Administrative Officer
Douglas John Rose, AACS

Department of Textile Technology

Associate Professor and Head of Department
Ross Ernest Griffith, BSc *N.S.W.*, PhD *Leeds*, CText, ATI

Professor of Textile Physics
Ronald Postle, BSc *N.S.W.*, PhD *Leeds*, CText, FTI, FAIP

Associate Professor
Michael Thomas Pailthorpe, BSc PhD *N.S.W.*, CText, FTI

Senior Lecturers
John Ilmar Curiskis, BSc PhD *N.S.W.*, GAIP
Nigel Anthony Gull Johnson, BSc *N.S.W.*, PhD *Leeds*, CText, ATI

Lecturer
Shantha David, MSc *Waik.*, PhD *Br.Col.*

Professional Officers
Jindrich Vavrinec Brancik, MSc *Brno*, PhD *N.S.W.*, MACS, FRSC
Rup Chand Dhingra, BSc *Punj.*, MTech *I.I.T.Delhi*, PhD *N.S.W.*, FTI
Michael David Young, BSc PhD *N.S.W.*, CText, ATI

Department of Wool and Animal Science

Associate Professor and Head of Department
John Patrick Kennedy, MSc *N.S.W.*, BSc *Oxf.*, FAIAS

Associate Professors
John William James, BA *Qld.*, DSc *N.S.W.*
Walter Raghnall McManus, BScAgr *Syd.*, PhD *N.S.W.*

Senior Lecturers
David John Cottle, BSc *N.S.W.*, PhD *U.N.E.*, MAIAS
Stephen James Filan, BAgrEc *N.E.*, MSc *N.S.W.*, MAIAS
Douglas McPherson Murray, BAgrSc PhD *Melb.*, MRurSc N.E.

Lecturer
Gordon Whitfield King, BSc PhD *N.S.W.*, DipFinMgt *N.E.*, MAIAS, AASA

Senior Instructor
Ronald Edward Sallaway

Professional Officer
David John Petrie, BSc *N.S.W.*

Course Outlines

Undergraduate Study

The School of Fibre Science and Technology participates in the Co-operative Education Program. The program applies to all three undergraduate courses taught in the School. Students in the program will complete their degree in four years, with several supervised terms of industry employment spread throughout the course. Students participating in the program will receive financial support of $8,800 per annum for each of the four years of the program. Selection into the program is based on high academic achievement and strong personal motivation for a successful career in the wool or textile manufacturing fields.

Department of Textile Technology

The Department of Textile Technology offers courses in Textile Technology and Textile Management. Both courses extend over four years full-time study and lead to the award of the degree of Bachelor of Science. For the award of Honours, students need to have distinguished themselves in formal studies, laboratory exercises, and in their final year project. Graduates of both courses qualify for membership of the Textile Institute.

Students in both courses must complete a minimum of 40 working days approved industrial training, of which at least 30 working days training must be taken at the end of the third year of study.

It is important to stress that the specialised nature of the training provided within the Department of Textile Technology does not mean a restricted range of job opportunities after graduation. Career possibilities extend through the textile industry, allied industries (such as the production of textile chemicals and surgical dressings), private consultants, government departments and authorities, teaching at secondary and tertiary levels, and pure or applied research in various organisations.

Graduates may be employed in quality control, technical management, research and development, international trade, production or general management. Within the textile industry graduates may, for example, enter any of the following areas: the manufacture of natural and or man-made fibres, yarns, fabrics, etc.; dyeing, printing and finishing of textiles; quality assurance; marketing and retailing, etc.

3170
Textile Technology – Full-time Course

Bachelor of Science
BSc

Textile Chemistry, Textile Physics, Textile Engineering Options

The conversion of textile raw materials into their finished products is simply a succession of, and an interaction between, a number of chemical, physical and engineering processes. It follows, therefore, that the disciplines involved in the study of textile technology, in addition to the technological aspects, includes a study in depth of one of the following: chemistry, engineering or physics.

Graduates will qualify for membership of one of the following professional bodies, depending upon which option of the course is taken: the Royal Australian Chemical Institute; the Institute of Engineers, Australia; or the Australian Institute of Physics.

All students take a common first year, and they need not choose the option they desire to follow until the end of that year.

In Year 2 and Year 3 students specialize in one of three options of the course, viz. Textile Chemistry, Textile Physics, or Textile Engineering. In Year 4 all students take the same subjects, except that the Advanced Textile Option is in the area of their own specialization.

Year 1 All options		**Hours per week** S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
9.510	Natural Fibre Production	6	0
10.001	Mathematics 1	6	6
13.100	Fibre Science	0	6
		24	24

Textile Chemistry

Year 2			
2.102A	Physical Chemistry	6	0
2.102B	Organic Chemistry	0	6
3.021	Instrumental Analysis	3	3
10.301	Statistics SA	2	2
13.200	Computing Applications	4	0
13.201	Fibre Science 2	0	4
13.203	Yarn Technology 1	0	6
13.204	Fabric Technology 1	6	0
	General Education Elective	2	2
		23	23

Year 3			
2.103B	Organic Chemistry	6	0
Plus one of the following Chemistry electives			
2.102C	Inorganic Chemistry and Structure, *or*	0	6
2.113B	Synthetic Organic Chemistry, *or*	0	6
2.133B	Applied Organic Chemistry	0	6

Year 3

		Hours per week S1	S2
or an alternative as approved by the Head of the School			
13.208	Textile Engineering 1	0	2
13.300	Textile Quality Control	0	2
13.301	Textile Structures 1	0	4
13.303	Yarn Technology 2	6	0
13.304	Fabric Technology 2	0	6
13.305	Finishing Technology A	5	0
13.306	Colour Science	3	0
18.1211	Production Management A	3	0
	General Education Elective	0	4
		23	24

Textile Physics

Year 2

		Hours per week S1	S2
1.002	Mechanics, Waves and Optics	4	0
1.012	Electromagnetism and Thermal Physics	0	4
1.022	Modern Physics	2	2
10.301	Statistics SA	2	2
10.2111	Vector Calculus	2.5	0
10.2112	Mathematical Methods for Differential Equations	0	2.5
13.200	Computing Applications	4	0
13.201	Fibre Science 1	0	4
13.203	Yarn Technology 1	0	6
13.204	Fabric Technology 1	6	0
	General Education Elective	2	2
		22.5	22.5

*Note: because of pre-requisite requirements students wishing to take certain year 3 electives may substitute 1.032 Laboratory in year 2, and take 1.022 Modern Physics in year 3.

Year 3

1.032	Laboratory *	3	3
Plus Physics electives averaging not less then 3 hours per session, selected from the following:			
1.023	Statistical Mechanics and Solid State Physics	4	0
1.0343	Advanced Optics	0	2
1.0533	Experimental Physics B1	4	0
1.0543	Experimental Physics B2	0	4
1.1433	Biophysics	3	0
1.1533	Biophysical Techniques	0	3
1.3033	Mechanical Properties of Materials	2	0
1.713	Advanced Laser and Optical Applications	2	2
1.9422	Introduction to Physics of Measurement	3	0
or an alternative as approved by the Head of the School			
13.208	Textile Engineering 1	0	2
13.300	Textile Quality Control	0	2
13.301	Textile Structures 1	0	4
13.303	Yarn Technology 2	6	0
13.304	Fabric Technology 2	0	6
13.305	Finishing Technology A	5	0
13.306	Colour Science	3	0
18.1211	Production Management A	3	0
	General Education Elective	0	4
		23	24

Textile Engineering

Year 2

		Hours per week	
5.0011	Engineering Mechanics 1	4	0
5.0300	Graphical Analysis and Communication	0	3
6.854	Electrical Power Engineering	0	3
6.856	Electronics for Measurement and Control	3	0
8.6110	Structures	3	0
10.031	Mathematics	2	2
10.301	Statistics SA	2	2
13.200	Computing Applications	4	0
13.201	Fibre Science 2	0	4
13.203	Yarn Technology 1	0	6
13.204	Fabric Technology 1	6	0
	General Education Elective	0	4
		24	24

Year 3

5.3021	Engineering Mechanics 2A	3	0
5.3022	Engineering Mechanics 2B	0	3
5.620	Fluid Mechanics 1	2	2
5.626	Thermodynamics 1	2	2
13.208	Textile Engineering 1	0	2
13.300	Textile Quality Control	0	2
13.301	Textile Structures 2	4	0
13.303	Yarn Technology 2	6	0
13.304	Fabric Technology 2	0	6
13.305	Finishing Technology A	5	0
13.306	Colour Science	3	0
18.1211	Production Management A	0	4
	General Education Elective	0	4
		24	24

Year 4 (All Options)

13.308	Textile Engineering 2	0	3
13.400	Textile Industry Studies	3	0
13.401	Textile Structures 2	0	3
13.405	Finishing Technology B	0	4
13.406	Colouration Technology	0	4
Plus one advanced textile option			
13.451	Advanced Textile Physics, or	0	2
13.456	Advanced Textile Chemistry, or	0	2
13.458	Advanced Textile Engineering	0	2
13.460	Processing Laboratory	3	0
13.470	Seminar	1.5	1.5
13.480	Project	14	0
18.1212	Production Management B	0	3
or an alternative as approved by the Head of the School			
46.002	Social Issues and Applied Science	0	2
		21.5	22.5

3175
Textile Management – Full-time Course

Bachelor of Science
BSc

The production and marketing of textile products involves a number of manufacturing processes, and requires an understanding of basic management principles. The Textile

Management course provides a comprehensive knowledge of all the textile sciences and technologies. In addition the course includes studies in economics, accounting, marketing, management, and other areas of commerce.

The course is designed to meet the need for executives in the textile and allied industries. A wide choice of electives is available in the third year of the course. This allows students to either gain a broad knowledge of the various areas of commerce, or to specialise in one of the following areas: Applied Economics; Accounting and Financial Management; or, Managerial Marketing.

Year 1		**Hours per week** S1	S2
1.001	Physics 1, *or*	6	6
1.021	Introductory Physics		
2.111	Introductory Chemistry, *or*	6	0
2.121	Chemistry 1A		
10.001	Mathematics 1, *or*	6	6
10.021B	General Mathematics 1B *and*	6	0
10.021C	General Mathematics 1C	0	6
15.101E	Microeconomics 1	4	0
15.102E	Macroeconomics 1	0	4
13.100	Fibre Science 1	0	6
		22	22
Year 2			
10.301	Statistics SA	2	2
13.200	Computing Applications	4	0
13.201	Fibre Science 2	0	4
13.203	Yarn Technology 1	0	6
13.204	Fabric Technology 1	6	0
14.501	Accounting and Financial Management 1A	4.5	0
14.511	Accounting and Financial Management 1B	0	4.5
28.012	Marketing Systems	4	0
28.052	Marketing Research	0	4
	General Education Electives	2	2
		22.5	22.5
Year 3			
13.208	Textile Engineering 1	0	2
13.300	Textile Quality Control	0	2
13.301	Textile Structures 1	0	4
13.303	Yarn Technology 2	6	0
13.304	Fabric Technology 2	0	6
13.305	Finishing Technology A	5	0
13.306	Colour Science	3	0
Plus 2 Commerce electives selected from the following			
14.522	Accounting and Financial Management 2A	4.5 or	4.5
14.542	Accounting and Financial Management 2B	4.5 or	4.5
15.201H	Management and Business Development	3	0
15.203E	Applied Microeconomics	3.5 or	3.5
15.204E	Applied Macroeconomics	3.5 or	3.5
19.602	Computer Information Systems 1	3 or	3
19.603	Computer Information Systems 2	0	3
28.073	Strategic Marketing	4	0
28.083	Managerial Marketing	0	4
30.511	Industrial Relations 1A	3.5 or	3.5
98.613	Business Finance 2A	3 or	3
99.774	Legal Environment of Commerce	3 or	3
99.776	Legal Regulation of Commerce	3 or	3
or an alternative as approved by the Head of the School			
18.1211	Production Management A	3	0
	General Education Elective	0	4
		20	20
Year 4			
13.308	Textile Engineering 2	0	3
13.400	Textile Industry Studies	3	0
13.401	Textile Structures 2	0	3
13.405	Finishing Technology B	0	4
13.457	Advanced Textile Management	0	2
13.460	Processing Laboratory	3	0
13.470	Seminar	1.5	1.5
13.480	Project	14	0
18.1212	Production Management B	0	3
or an alternative as approved by the Head of School			
46.002	Social Issues and Applied Science	0	2
		21.5	21.5

Department of Wool and Animal Science

The Department offers a full-time course of four years duration leading to the award of a Bachelor of Science degree at either Honours or Pass level. The course is the only one in Australia in which special emphasis is given to wool science. In addition, studies concentrate on the most important animal industries (sheep and cattle).

Students receive a thorough grounding in the appropriate basic scientific disciplines as well as the theory and application of principles which are relevant to all aspects of pastoral production, including production and utilization of pastures; reproduction, nutrition, health, genetic improvement, ecology and management of grazing animals and the production, preparation for sale and specification of wool and meat. The course also includes study of the design and interpretation of experimental investigations, economics and business management as well as elective options on crop production, range land management and rural communications. Relevant subjects offered by other schools may also be included. An important component is the final year project whereby students engage in an area of personal research on a theoretical or experimental topic on which they are required to submit a thesis.

The course provides students with a broad overview of the pastoral industries. It aims to produce generalists rather than specialists and, although there is some scope for studying topics of special interest, the course is designed so that certain core subjects must be undertaken. Because of the broad education received, graduates are equipped for a wide variety of careers in and associated with agricultural production including research, advisory work, education, marketing, management and administration. Graduates are eligible for corporate membership of the Australian Institute of Agriculture Science.

Industrial Training Requirements

1. Students are required to obtain twenty-four weeks practical experience on commercial properties. At least twenty weeks of experience must be obtained concurrently with the course, while up to four weeks may be allowed for practical experience obtained immediately prior to the commencement of the course.

2. Students are encouraged to obtain experience in a diversity of pastoral enterprises, ie cattle, sheep and cropping, in different climatic zones.

3. A maximum of eight weeks shall be allowed for practical experience on any one property, including home properties. Up to eight weeks employment at research or teaching institutions is allowed towards the industrial training requirement.

4. In order to obtain recognition for practical work carried out, students shall, within six weeks of the commencement of the session immediately following the period of employment:

(1) Submit written evidence from the owner manager of the property or the director of the institution as to the length of employment.

(2) Submit a written report along the guidelines which are available from the Department.

3220
Wool and Pastoral Sciences – Full-time Course

Bachelor of Science
BSc

Year 1

		Hours per week S1	S2
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
9.510	Natural Fibre Production	6	0
10.001	Mathematics 1 or	6	6
10.021B	General Mathematics 1B and	6	0
10.021C	General Mathematics 1C	0	6
13.100	Fibre Science	0	6
17.031	Biology A	6	0
17.041	Biology B	0	6
		24	24

Year 2

2.003J	Agricultural and Biological Chemistry	6	0
9.111	Livestock Production 1	2	2
9.201	Agronomy	3	6
9.301	Agricultural Economics and Management	3	3
9.501	Wool Science 1	3	3
9.601	Animal Physiology 1	0	6
10.301	Statistics SA	2	2
13.200	Computing Applications	4	0
	General Education Elective	2	2
		25	24

Year 3

		Hours per week S1	S2
9.131	Animal Health and Welfare	3	0
9.202	Pastoral Agronomy	4	4
9.421	Animal Nutrition	0	4
9.502	Wool Science 2	3	3
9.801	Genetics 1	3	3
9.811	Biostatistics 1	4	0
41.101	Biochemistry	6	6
	General Education Elective	2	2
		25	22
Plus one of the three available options			
9.112	Livestock Production 2	0	3
9.203	Crop Agronomy*	0	3
9.204	Range Management*	0	3
9.504	Wool Marketing	0	3
		25	25

*Available in alternate years

Year 4

9.001	Project	6	6
9.002	Seminar	2	2
	General Education Elective	2	2

Plus at least 14 hours each session of optional subjects. Not more than one subject in each session may be chosen from Group B.

Optional subjects

Group A

		Hours per week S1	S2
9.112	Livestock Production 2	0	3
9.113	Livestock Production 3	3	3
9.132	Animal Health 2	3	0
9.203	Grop Agronomy*	0	3
9.204	Range Management*	0	3
9.503	Wool Science 3	4	4
9.504	Wool Marketing	0	3
9.802	Genetics 2	4	4
9.812	Biostatistics 2	0	4
9.901	Rural Extension	4	0

* Available in alternate years.

Group B

27.175	Introduction to Remote Sensing	4	0
27.176	Remote Sensing Applications	0	4
28.012	Markeitng Systems	4	0
28.052	Marketing Research	0	4
17.713	Enrivonmental Botany	6	0
44.101	Introductory Microbiology	6	0

Or such other subjects as may be approved by the Head of Department

Graduate Study

Department of Textile Technology

The Department conducts a course which leads to the award of a Graduate Diploma in Textile Technology.

In addition, the Department welcomes enquiries from graduates in Science, Engineering and Applied Science who are interested in doing research leading to the award of the degrees of Master of Science or Doctor of Philosophy.

The Head of the Department is pleased to give information about research scholarships, fellowships and Department research activities. Graduates are advised to consult the Head of Department before making a formal application for registration.

5090
Textile Technology Graduate Diploma Course

Graduate Diploma
GradDip

The course leading to the award of Graduate Diploma in Textile Technology is designed to prepare graduates for careers in the textile and allied industries. It also provides formal studies for graduates who are already employed in the textile industry. The normal requirement for admission to the course is a Bachelor degree or equivalent tertiary qualification.

The following program, which comprizes both formal lectures and laboratory work, may be taken as a one year full-time course or two-year part-time course.

		Hours per week S1	S1
13.711G	Fibre Science A	6	0
13.721G	Fibre Science B	0	4
13.722G	Textile Quality Control	0	2
Plus two electives per session (averaging not less than 9 hours per session), selected from the following:			
13.713G	Yarn Technology A	5	0
13.723G	Yarn Technology B	0	5
13.714G	Fabric Technology A	5	0
13.724G	Fabric Technology B	0	5
13.715G	Finishing Technology A	5	0
13.725G	Finishing Technology B	0	5
13.716G	Colour Science	4	0
13.726G	Dyeing Technology	0	4
or an alternative as approved by the Head of School			
13.717G	Textile Technology	1.5	1.5
13.727G	Textile Technology Dissertation	1.5	1.5
		18	18

Candidates wishing to specialize in the theory and practice of yarn and fabric technology (engineering/physics orientation) should undertake the optional subjects 13.713G, 13.723G, 13.714G and 13.724G. Candidates wishing to specialize in the science and technology of textile dyeing and finishing (chemistry orientation) should undertake the optional subjects 13.715G, 13.725G, 13.716G, and 13.726G.

Department of Wool and Animal Science

The Department conducts a course which leads to the award of a Graduate Diploma in Wool and Pastoral Sciences.

In addition, the Department welcomes enquiries from graduates in Science, Agriculture and Applied Science who are interested in doing research leading to the award of the degrees of Master of Science or Doctor of Philosophy.

The Head of Department is pleased to give information about research scholarships, fellowships and Department research activities. Graduates are advised to consult the Head of Department before making a formal application for registration.

5081
Wool and Pastoral Sciences Graduate Diploma Course

Graduate Diploma
GradDip

The course leading to the award of the Graduate Diploma in Wool and Pastoral Sciences is specially designed for graduate students preparing themselves for careers in the pastoral industry. One of the principal functions of the course is to provide a bridge from other disciplines such as Agriculture, Veterinary Science and Pure Science for graduates who wish to study and work in the field of Wool and Pastoral Sciences, which is of such overall importance to Australia.

The normal requirement for admission to the course is a degree in Agriculture, Applied Science, Veterinary Science or Science in an appropriate field. In addition, students may be required to take a qualifying examination. Such qualifying examination will be of a standard which will ensure that the student has sufficient knowledge of the subject and the principles involved to profit by the course.

The following program may be completed either in one year on a full-time basis or over two years on a part-time basis. Students are required to carry out full-time study or its equivalent to the extent of eighteen hours lecture and laboratory work per week for two sessions. Both graduate subjects and undergraduate subjects may be chosen to suit the requirements of the student subject to their availability and the approval of the Head of the School.

Full-time Course

18 hours per week of which at least 10 must be chosen from:

		Hours per week
9.105G	Livestock Production	6
9.205G	Range Management	4
9.504G	Wool Science	6

9.803G	Animal Breeding	4
9.813G	Quantitative Methods	4

A maximum of 8 hours per week of study may be selected from approved undergraduate subjects.

Graduate Diploma students are expected to work at the level of honours students in the undergraduate courses and to carry out prescribed study of current research material in the appropriate field.

Graduate Programs in Arid Lands Management

Programs are available leading to the award of Graduate Diploma in Arid Lands Management (Course 5025) in the following areas of study:

- Range Management
- Management of Pastoral Enterprises

For course details see Graduate Study in the School of Geography section of the handbook.

Subject Descriptions

Undergraduate Study

Department of Wool and Animal Science

9.001 Project **F T6**

Students are required to conduct an experimental or theoretical investigation under supervision and to submit a thesis describing the results of their investigations. Throughout the year students are required to submit progress reports to their supervisors and to present seminars. The written reports of the project shall be submitted by the last day of Session 2.

9.002 Seminar **F T2**

Seminars deal with research and or development work being undertaken or recently completed by students and staff of the Department of Wool and Animal Science, other University schools and research organizations. There are also seminars on communication in wool and pastoral sciences and on problems facing rural industries.

9.111 Livestock Production 1 **F L2**

The sheep and beef cattle industries and their place in the economic life of Australia; levels of production and trends. The physical, biological, managerial and economic conditions influencing production. Sheep producing zones. Sheep breeds for wool production. Cross breeding, prime lamb production. Sheep and cattle management; nutrition, reproduction, survival.

A field excursion of one week's duration is held in Session 1.

9.112 Livestock Production 2 **S2 L2 T1**

Prerequisite: 9.111.

The scope for intensification of ruminant production. The behaviour, nutrition, environmental physiology and health of intensively managed animals. Housing and environmental control of facilities. Examples of intensification, eg feed lots, sea transport.

9.113 Livestock Production 3 **F L1 T2**

Principles of livestock production applied to reproduction and fertility; growth and development. The meat industry. Carcass conformation and composition. Pre and post mortem factors affecting meat quality. Meat marketing.

9.131 Animal Health and Welfare 1 **S1 L2 T1**

Prerequisite: 9.111.

Managerial control of grazing livestock health and welfare. The concept of economic approach to animal health. Introductory immunology. Skin health in sheep and cattle. Control of external parasites, particularly by insecticides. Reproductive health in sheep and cattle. Internal parasites. Legal and Public Health responsibilities; Acts of Parliament relating to animal health and welfare.

9.132 Animal Health 2 **S1 L2 T1**

Prerequisite: 9.131.

Use and misuse of products used in animal health work. Internal parasitism. External parasitism. Feedlot health. Transport health. Problems causing disease and death. Health of horses and dogs used in livestock management.

9.201 Agronomy **S1 L2 T1 S2 L3 T3**

Agricultural climatology, soil science, and soil conservation. Pastures in land use and land development. Principles of tillage, crop rotation, irrigation, conservation of fodder and fertilizer usage. Weeds and weed control. Practical work in the systematics of selected plant families.

9.202 Pastoral Agronomy **F L3 T1**

Prerequisite: 9.201.

Pasture ecology. Establishment, management and utilization of pastures and fodder crops. Pasture-animal relationships, stocking rates, mixed stocking. Vegetation management in arid and semi-arid areas. Pasture evaluation and pasture research techniques.

9.203 Crop Agronomy **S2 L2 T1**

Prerequisite: 9.201.

Field crop production associated with the pastoral industries. Crop physiology. Cropping practices. Pests and diseases.

9.204 Range Management **S2 L1 T2**

Co or prerequisite: 9.202.

Basic range ecology and rangeland ecosystems. Plant physiology – growth and development of rangeland plants. Rangeland management practices. Monitoring of long-terms trends in productivity. Applications of remote sensing and ground truth sampling. Wild life resources and feral animals and their management. Sheep and beef cattle production in arid and semiarid environments. Administration of rangelands (eg the functions of the Western Lands Commission, the National Parks and Wildlife Service, and the Soil Conservation Service in New South Wales).

Involves one week of instruction at Fowlers Gap Research Station.

9.301 Agricultural Economics and Management 1 **F L2 T1**

Farm planning methods. Budgeting, gross margins, simplified programming and introduction to linear programming. Use of VAX computers: introduction to operating system, text editor, and linear programming software. Introduction to farm management implications of land tenure and title; valuation; depreciation; discounting; taxation.

Economic principles. Introduction to production economics theory, cost curves, and price theory.

9.421 Animal Nutrition **S2 L3 T1**

Composition and classification of foodstuffs and pastures. Physiology of ruminant digestion. Digestion absorption and metabolism of carbohydrates, proteins, fats, mineral and vitamins. Digestibility of foodstuffs. Nutrient and energy

balances and requirements of livestock. Feeding standards and the quantitative application of nutritional data with particular reference to Australian conditions. Utilization of forage by grazing ruminants. Supplementary and drought feeding. Consideration of disorders due to nutrition.While particular emphasis is given to nutritional requirements of sheep, those of other farm livestock are dealt with in this section.

9.501 Wool Science 1 **F L2 T1**

Fibre structure; physical and chemical properties, variability of fibre properties. Physical fleece characteristics; fleece defects. Early stage processing and yarn manufacture.

9.502 Wool Science 2 **F L2 T1**

Clip preparation. Wool metrology raw wool. Wool marketing procedures. Fabric manufacture, dyeing and finishing.

9.503 Wool Science 3 **F L2 T2**

Evaluation and typing of wool. Topmaking and special processes. Wool metrology semi-processed and processed. Controlling mill quality control. The cashmere and mohair industries. Research developments.

9.504 Wool Marketing **S2 L2 T1**

Wool marketing systems; comparison with other countries, modelling. Wool commerce; financial factors. Information systems. Future directions.

9.510 Natural Fibre Production **S1 L3 T3**

Wool and other animal fibres: fibre and skin biology; mechanisms of, and factors affecting, fibre growth, fibre morphology; introduction to fibre production, harvesting, preparation for sale and marketing. Cotton: cotton growth; fibre morphology; factors affecting fibre growth; fibre production harvesting, handling and marketing.Production statistics and economics of natural fibre production in Australia contrasted to world fibre production.

9.601 Animal Physiology 1 **S2 L3 T3**

Prerequisite: 17.041.

Physiology systems of mammalia are treated with special attention to homeostasis. Cell-membranes; blood and body fluids; the immune reaction. Cardiac control, functions and haemodynamics. Respiration. The endocrine system with particular emphasis upon growth, reproduction, lactation and stress. The nerve impulse, its excitation and transmission. Physiology of digestion, the gastro-intestinal tract and of the kidney. Heat tolerance and climatic adaptation.

9.801 Genetics 1 **F L2 T1**

Mendelian inheritance. Chromosomes, linkage and the physical basis of heredity. Gene action in physiology and development. Elements of molecular genetics. Principles of quantitative genetics, strength of inheritance and relationships. Selection and crossbreeding. Genetics applied to animal and plant improvement. Applications of genetics in sheep and wool production.

9.802 Genetics 2 **F L2 T2**

Prerequisite: 9.801.

Genetic structure of populations. Forces causing genetic change. Partition of genetic and phenotypic variation. Resemblance between relatives and estimation of genetic parameters. Direct and correlated selection responses. Aids to selection and selection indexes. Inbreeding and genetic drift. Genetic homeostasis, Genotype environment interaction. Heterosis and its utilization. Interaction of natural and artificial selection. Limits of selective progress.

9.811 Biostatistics 1 **S1 L2 T2**

Design and analysis of comparative experiments, for continuous and discrete random variables. Analysis of variance for fixed, mixed and random models. Linear regression and correlation. Multiple comparison methods.

9.812 Biostatistics 2 **S2 L2 T2**

Least squares methods, applied to multiple regression and experimental design models. Factorial experiments. Analysis of covariance. Elements of multivariate analysis.

9.901 Rural Extension **S1 L2 T2**

Development of communication skills through experiential or active learning situation. Educational, psychological and sociological factors relating to the diffusion of innovations. Program planning and evaluation.

Department of Textile Technology

Students should note that enrolment in all later year subjects taught by the Department is subject to satisfactory course progression and approval of the Head of School.

13.100 Fibre Science 1 **S2 L4 T2**

Fibre classification and raw materials. Necessary and desirable attributes of textile fibres. Production of natural and man-made fibres. Physics and chemistry of natural and man-made fibres. Introduction to fibre morphology and fibre structure. Introductory statistics and sampling theory. Basic techniques for the measurement of fibre properties. Fibre transverse dimensions and length. Practical fibre identification. World production and consumption of textile fibres.

13.200 Computing Applications **SS L2 T2**

Introduction to hardware and software concepts; Operating systems. Introduction to computer programming: simple algorithms and data organization. Computer applications in fibre science and technology: computer-aided design and manufacture CAD CAM; process monitoring and control, computer-integrated manufacture CIM; data acquisition; data analysis, statistical packages; modelling and optimisation techniques; databases, spreadsheets, text wordprocessing.

13.201 Fibre Science 2 **SS L2 T2**

Fibre microscopy. Electron microscopy. Fibre reflection and lustre. Morphological and fine structure of fibres. X-ray Crystallography. Polymer crystallisation. Molecular structure of proteins. Optical properties and fibre orientation. Infra-red spectroscopy. Fibre rheology. Mechanical properties. Moisture sorption and swelling. Addition and condensation

polymerisation. Chemical constitution and reactivity of blended fibres and manmade fibres. Blended fibres.

13.203 Yarn Technology 1 **SS L3 T3**

The preparation of staple fibres for yarns and non-woven fabrics: processes for tow conversion, opening, cleaning, blending, carding, drawing, and combing. Short-staple, worsted and woollen preparation systems. Computer blend selection; drafting theory; theory and measurememt of irregularity; levelling of slivers.

13.204 Fabric Technology 1 **SS L3 T3**

Principles of weaving. Mechanisms of shedding, picking, and beating up. Secondary and auxilliary mechanisms of looms. Cam, dobby and jacquard shedding. Shuttle, projectile, rapier and jet weft insertion. Multiphase weaving, circular weaving, woven cloth construction principles and weave represenation; basic weave structures. Leno and narrow fabric weaving, woven pile fabric constructions. Yarn preparation for weaving. Mechanics of woven fabric formation. Introduction to knitting technology.

13.208 Textile Engineering 1 **SS L2**

The application of engineering principles to textile machines and processes including elements of strength of materials; mechanics of solids; mechanical transmission of power; applied electricity; illumination design; process control. Analysis of engineering interactions in textile processes.

13.300 Textile Quality Control **SS L T2**

User-seviceability testing. Fibre content and care-labelling. Process and quality control. Consumer problems.

13.301 Textile Structures 1 **SS L2 T2**

Fibrous structures and textile assemblies. Fibre friction and viscoelasticity. Lubrication. Static electrification of textiles. Yarn structures. Fibre migration in yarns. Mechanics of continuous filament yarns, staple-fibre yarns, plied and textured yarns. Fabric testing; structure and dimensions; tensile strength; tear strength; fabric abrasion. Fabric low-stress mechanical and surface properties. Drape and handle. Fabric tailorability.

13.303 Yarn Technology 2 **SS L3 T3**

Properties of yarns. Introduction to geometry and mechanics of twisted structures. Staple yarn forming by ring, rotor and unconventional spinning methods. Twisting and winding processes. Throwing and texturing of continuous filament yarns. On-line monitoring of production and quality; automation. Measurement of yarn properties.

13.304 Fabric Technology 2 **SS L3 T3**

Principles of knitting. Techniques of loop formation in weft and warp knitting; essential machine mechanisms. Knitted cloth construction principles and knitted structure representations; basic knitted structures. Techniques of jacquard needle selection and loop transfer for extended design effects in weft knitting; derivative weft knitted structures. Shaped weft knitted structures, including fully-fashioned knitting, hosiery manufacture, integral knitting techniques. Use of multiple guide bars, part-set threading, and auxillary mechanisms for extended design effects in tricot and raschel warp knitting; derivative warp knitted structures. Double needle bed warp knitting. Mechanisms of knitting fabric formation. Stitch-bonded and non-woven fabric manufacture. Tufting; recent developments in fabric forming technology.

13.305 Finishing Technology A **SS L3 T2**

Objects of finishing and typical flow diagrams for wool and cotton. The principles and technology of textile finishing processes for protein and cellulosic fabrics, including the removal of impurities and discoloration, the elimination or minimisation of deficiencies in properties, the development of specific properties. Properties of surfactant solutions, micelle formation, surfactants as emulsifiers and detergents, detergency. Manufacture, chemical constitution and properties of special purpose polymers.

13.306 Colour Science **SS L2 T1**

Aspects of colour, colour mixing and colour vision. Absorptiometry, spectrophotometry and tristimulus colorimetry. Measurement and specification of colour and colour difference. Applications of colour measurement. Computer aided colour match prediction.

13.308 Textile Engineering 2 **SS L3 T1**

Thermodynamic principles and applications in textile processing including laws of thermodynamics; states and processes; fluid properties. Cycles and efficiency. Properties and use of steam. Air conditioning. Heat transfer. Flow of fluids. Energy use in textile processes. System dynamics in textile processes and procedures.

13.400 Textile Industry Studies **SS L T3**

Econometrics of the textile and clothing industries. Models of production, import and export and consumption of textiles and clothing in Australia, and comparison with world data. Case studies in textile and clothing manufacture operations. Environmental considerations in relation to pollution from the textile industry. Wastewater treatment methods. Biodegradable polymers. The employment function of the textile and clothing industries. Social and political consequences of automation: polarisation of workforce into highly-skilled and unskilled workers; conflict between maintaining a viable industry and maintaining employment levels.

13.401 Textile Structures 2 **SS L1 T2**

Structural mechanics of woven, knitted and non-woven fabrics. Composite materials, fabric membrane properties. Clothing mechanics. Fabric rheology. Physical equilibration processes. Wrinkling properties. Clothing comfort and physiology. Thermal insulation. Diffusion of moisture. Heat and mass transfer. Capillary action of textiles.

13.405 Finishing Technology B **SS L2 T2**

The production of specified dimensions in textile fabrics; heat, chemical and mechanical processes, surface finishes, protective finishes. The application of special finishes including flame-proof finishes, crease-resistant finishes, etc. Dimensional stability and its measurement. Recent developments in finishing technology.

13.406 Colouration Technology **SS L2 T2**

Classification of dyes and pigments and their methods of application. General properties of dyes, dyeing auxillaries and after treatments. Assessment of colourfastness properties of dyes and pigments. Mill water supplies and their treatment. Aspects of dyehouse effluent treatment. Textile printing methods. Textile dyeing machinery. Textile printing methods. Recent developments in dyeing and printing technology.

13.451 Advanced Textile Physics **SS L2**

Varieties of macromolecules. Polymeric solids. Nature of water and water theories. Generalized structural mechanics of textile assemblies. Yarn bending properties. Development of torque in twisted yarns. Structure of complex knitted fabrics. Tensile properties of woven and knitted fabrics. Warp-knitted structures. Fabric bending properties. Fabric shear properties. Fabric objective measurement technology.

13.456 Advanced Textile Chemistry **SS L2**

Dyestuff aggregation in the dyebath and in the fibre. Fibre structure and dye sorption. Physical chemistry of dyeing; dyeing equilibria and dyeing kinetics of selected dye-fibre systems.

13.457 Advanced Textile Management **SS L2**

Government policy in the textile, clothing and footwear industries. Production and marketing in the Australian environment. Case studies in management of textile operations.

13.458 Advanced Textile Engineering **SS L2**

Dimensional analysis and theory of similitude. Heat and mass transfer. Drying. Motion of particles in fluids. Pumps and fans. Mechanics of machines.

13.460 Processing Laboratory **SS T3**

Students undertake a project involving the design, production and assessment of textile products. Such as: rib jacquard outer fabric, towelling, printed tea towels, woven furnishing fabric, raschel outerwear fabric, etc.

13.470 Seminar **F T1.5**

Students prepare and present a seminar before an audience consisting of staff of the Department, final year students, Graduate Diploma students, and any other interested undergraduate or postgraduate students, on a subject of topical and specific interest in the field of textile science, technology or management, and subsequently submit the seminar in writing.

13.480 Project **SS T14**

Students are required to carry out a research project and to submit a thesis describing their investigations. It is usual for students to be allocated projects in areas related to the particular course option they are studying.

Graduate Study

Department of Wool and Animal Science

9.105G Livestock Production **F L2 T4**

Biology of reproduction and reproductive performance of sheep and cattle; growth and body composition; meat production and quality.

9.205G Range Management **F L1 T3**

Objectives in the utilization and management of rangelands. Ecology of rangelands, with emphasis on the impact of grazing. Degradation of rangelands. Morphology and physiology of range plants in relation to management. Grazing management. Burning as a management practice. Assessment of range condition and trend. Applications of remote sensing. Sheep and cattle production in arid and semi-arid environments. Native and feral animals and their management. Diet selection of different species. Administration of rangelands. Assignment work and field studies, including a week at Fowlers Gap Arid Zone Research Station.

9.206G Project in Range Management **F T9**

A theoretical and or experimental investigation of some aspect of management of rangelands.

9.504G Wool Science **F L2 T4**

Biology and histology of fibre growth and fibre structure. Wool physics and chemistry. Objective characteristics of the Australian wool clip. Preparation for sale, measurement, specification, valuation and marketing of wool. Wool metrology and conditioning house procedures. Fibre parameters in processing.

9.803G Animal Breeding **F L2 T2**

Co-requisite: 9.802.

Definition of breeding objectives; case studies of production recording and breed improvement programs for sheep and beef cattle. Development of performance recording systems: choice of traits to be recorded, recording and processing methods. Estimation of breeding value from performance records. Breed evaluation. Optimal design for breeding programs. The impact on genetic improvement of techniques for controlling reproduction.

9.813G Quantitative Methods **F L2 T2**

Selected topics in: biostatistics, with emphasis on experimental design and on least squares procedures; mathematical programming methods for rural industries; data processing and computer programming; systems analysis and simulation methods.

Department of Textile Technology

13.711G Fibre Science A **SS L4 T2**

Fibre classification and raw materials. Necessary and desirable attributes of textile fibres. Production of natural and man-made fibres. Physics and chemistry of natural and man-made fibres. Introduction to fibre morphology and fibre structure. Introductory statistics and sampling theory. Basic techniques for the measurement of fibre properties. Fibre transverse dimensions and length. Practical fibre identification. World production and consumption of textile fibres.

13.713G Yarn Technology A **SS L3 T2**

The preparation of staple fibres for yarns and non-woven fabrics: processes for tow conversion, opening, cleaning, blending, carding, drawing, and combing. Short-staple, worsted and woollen preparation systems. Computer blend selection; drafting theory; theory and measurememt of irregularity; levelling of slivers.

13.714G Fabric Technology A **SS L3 T2**

Principles of weaving. Mechanisms of shedding, picking, and beating up. Secondary and auxilliary mechanisms of looms. Cam, dobby and jacquard shedding. Shuttle, projectile, rapier and jet weft insertion. Multiphase weaving, circular weaving, woven cloth construction principles and weave represenation; basic weave structures. Leno and narrow fabric weaving, woven pile fabric constructions. Yarn preparation for weaving. Mechanics of woven fabric formation. Introduction to knitting technology.

13.715G Finishing Technology A **SS L3 T2**

Objects of finishing and typical flow diagrams for wool and cotton. The principles and technology of textile finishing processes for protein and cellulosic fabrics, including the removal of impurities and discoloration, the elimination or minimisation of deficiencies in properties, the development of specific properties. Properties of surfactant solutions, micelle formation, surfactants as emulsifiers and detergents, detergency. Manufacture, chemical constitution and properties of special purpose polymers.

13.716G Colour Science **SS L2 T2**

Aspects of colour, colour mixing and colour vision. Absorptiometry, spectrophotometry and tristimulus colorimetry. Measurement and specification of colour and colour difference. Applications of colour measurement. Computer aided colour match prediction.

13.717G Textile Technology **F T1.5**

Students gain an overview of textile technology by reviewing the technology relating to one or more textile products, through a series of tutorials and exercises.

13.721G Fibre Science B **SS L2 T2**

Fibre microscopy. Electron microscopy. Fibre reflection and lustre. X-ray Morphological and fine structure of fibres. Crystallography. Polymer crystallisation. Molecular structure

of proteins. Optical properties and fibre orientation. Infra-red spectroscopy. Fibre rheology. Mechanical properties. Moisture sorption and swelling. Addition and condensation polymerisation. Chemical constitution and reactivity of blended fibres and manmade fibres.

13.722G Textile Quality Control **SS L T2**

User-seviceability testing. Fibre content and care-labelling. Process and quality control. Consumer problems.

13.723G Yarn Technology B **SS L3 T2**

Properties of yarns. Introduction to geometry and mechanics of twisted structures. Staple yarn forming by ring, rotor and unconventional spinning methods. Twisting and winding processes. Throwing and texturing of continuous filament yarns. On-line monitoring of production and quality; automation. Measurement of yarn properties.

13.724G Fabric Technology B **SS L3 T2**

Principles of knitting. Techniques of loop formation in weft and warp knitting; essential machine mechanisms. Knitted cloth construction principles and knitted structure representations; knitted structures. Techniques of jacquard needle selection and loop transfer for extended design effects in weft knitting; derivative weft knitted structures. Shaped weft knitted structures, including fully-fashioned knitting, hosiery manufacture, integral knitting techniques. Use of multiple guide bars, part-set threading, and auxillary mechanisms for extended design effects in tricot and raschel warp knitting; derivative warp knitted structures. Double needle bed warp knitting. Mechanisms of knitting fabric formation. Stitch-bonded and non woven fabric manufacture. Tufting; recent developments in fabric forming technology.

13.725G Finishing Technology B **SS L3 T2**

The production of specified dimensions in textile fabrics; heat, chemical and mechanical processes, surface finishes, protective finishes. The application of special finishes including flame-proof finishes, crease-resistant finishes, etc. Dimensional stability and its measurement.Recent developments in finishing technology.

13.726G Dyeing Technology **SS L2 T2**

Classification of dyes and pigments and their methods of application. General properties of dyes, dyeing auxillaries and after-treatments. Assessment of colourfastness properties of dyes and pigments. Mill water supplies and their treatment. Aspects of dyehouse effluent treatment. Textile printing methods. Textile dyeing machinery. Recent developments in dyeing and printing technology.

13.727G Textile Technology Dissertation **F T1.5**

Students review a particular aspect of textile technology, by conducting a literature survey and conferring with experts. The review is presented orally to the staff and students of the department, and submitted in written form.

School of Geography

School of Geography

Head of School
Professor B. J. Garner

Administrative Assistant
Ms. T. Bean

Geographers study the spatial relationships of the phenomena which form humans' physical and social environment, and aim to establish principles which govern those relationships. The geographer may concentrate on specific variables, as in systematic geography, or may deal with variables which affect a specific area, as in regional geography.

The cultural significance of geography lies in its contribution to an understanding of the total environment, but the geographer's skills also find practical application in the conservation and planned development of resources. Increasing numbers of geographers are employed as professionals in these applications. For instance, geomorphologists and biogeographers are undertaking resource inventory surveys and environmental assessment, and economic geographers are engaged as urban and regional planners and spatial analysts.

General Education Electives

For details of the General Education requirements see Faculty Information.

Staff

Professor of Geography and Head of School
Barry Jardine Garner, BA *Nott.*, MA PhD *Northwestern*

Associate Professor
Ian Harry Burnley, MA *Cant.*, PhD *Well.*

Senior Lecturers
John Richard Dodson, MSc *Monash*, PhD *A.N.U.*
Stephen James Filan, BAgEc *N.E.*, MSc *N.S.W.*
Michael Dick Melville, BScAgr PhD *Syd.*
Anthony Kinnaird Milne, BA *N.E.*, MA *Syd.*, PhD *Colorado*
Morgan Eugene Cyril Sant, BA *Keele*, MSc PhD *Lond.*
Anthony Shepherd, MA *Oxf.*
Peter Leon Simons, BA PhD *Syd.*
Susanne Rae Walker, MA *Well.*, DPhil *Oxf.*

Lecturers
Wayne David Erskine, BA PhD *N.S.W.*
Bruno Peter John Parolin, BA *Monash*, MS *Oklahoma State*, PhD *Ohio State*, MIAG, MAAG, MRSA

Tutors
David John Edwards, BSc *N'cle (N.S.W.*
Raya Gadir, BA DipEd *Hebrew Jerusalem.*, PhD *N.S.W.*
Scott David Mooney, BSC *N.S.W.*
Beverley Ann Scott, BA *Macq.*

Administrative Assistant
Vacant

Course Outlines

Undergraduate Study

The three vocationally-oriented Applied Geography programs **3010** in the Faculty of Applied Science provide an analytical approach to understanding and investigating some of society's most pressing problems, including the use and management of scarce resources, the interaction between people and environment, soil erosion and conservation, land use conflicts, and spatial inequalities in economic and social well-being. These courses provide elective specialisations in physical geography (with special emphasis on either the biologic or geomorphic aspects), economic geography with emphasis on spatial analysis, and in human and physical resources (with emphasis on the integration of human and physical geography).

Geography is also available as a major sequence in the Arts course **3400,** where the emphasis is on the study of where and how people live, and on their activities in relation to the environment.

Major sequences in Science and Mathematics course 3970, programs **2700** and **6581** study the relationships between people and the physical environment, combining geographical studies, particularly in physical geography, with those in related disciplines, notably the biological and earth sciences.

Geography may also be combined with Civil Engineering in course **3730**, and with Law in course **4770.**

Students may enrol through the School of Geography for higher research degrees, or for formal graduate courses such as the Master of Applied Science in Land and Geographic Information Systems **8024**; Masters' and Diploma courses in Remote Sensing **8026** and **8056**, or Masters' and Diploma in Arid Lands Management **8025** and **5025**, and may undertake projects in the School as part of the Master of Environmental Studies degree **8045**.

Applied Geography – Full-time Courses

Bachelor of Science

The School offers three four-year full-time courses leading to the award of the degree of Bachelor of Science, which aim to train professional geographers for entry into applied fields.

There are elective specializations in physical geography (with special emphasis on either the biologic or geomorphic aspects), economic geography (with emphasis on urban and regional analysis), and in human and physical resources with emphasis on the integration of physical and human geography). First year subjects involve systematic studies of the physical and economic bases of geography. There is progressive specialization in the following years, with heavy emphasis on field observation and data handling. For the award of the degree at Honours level students will be required to have distinguished themselves in formal work, in additional assignments as directed by the Head of the School, and in the final year project for which a Report will be required.

All students are encouraged to spend a period of four to six weeks with organizations concerned with the investigation and planned use of resources et cetera.

Several units in Geography include laboratory and project work involving the use of computer and quantitative techniques. It is required that students provide their own drawing materials such as tracing and graph paper. Details of exact requirements are given at the beginning of the relevant subjects. Compulsory fieldwork incurs personal expenditure.

3010
Applied Geography – Full-time Course

Bachelor of Science
BSc

Students should consult the School before enrolling, as there may be some significant changes to these courses especially for Year 3 before the start of the 1990 teaching year.

Applied Physical Geography, Applied Economic Geography and Human and Physical Resources

Year 1		**Hours per week** S1	S2
10.021B	General Mathematics 1B *and*	6	6
10.021C	General Mathematics 1C *or*		
10.001	Mathematics 1 *or*		
10.011	Higher Mathematics 1	6	6
27.010	Land Studies*	4	0
27.020	Locational Processes	0	4
27.030	Environmental Processes	0	4
27.040	Data Processing Systems	2	2
27.100	Field Project 1	0	3
	and *either*		
15.101E	Microeconomics 1 *and*	3.5	0
15.102E	Macroeconomics 1 *and*	0	3.5
7.829	Australian Social Environments	4	0
	or		
17.031	Biology A *and*	6	0
17.041	Biology B	0	6
	or		
25.110	Geological Processes**and	6	0
25.120	Geological Environments**	0	6
		19.5/18	221/2/25

*Up to 5 days field work, equivalent to 40 tutorial hours, is an essential part of the subject.

**Up to 1 days of field tutorials in 25.110 and up to 3 days in 25.120 are essential parts of these subjects. Attendance is compulsory.

Note: Students will incur personal costs in connection with the field work component. Details will be provided at enrolment.

Applied Physical Geography

Year 2		**Hours per week** S1	S2
27.050	Geographical Data Analysis	4	4
27.175	Introduction to Remote Sensing	4	0
27.183	Geomorphology	0	5
27.200	Field Project 2	0	3
27.824	Spatial Population Analysis*	0	4
and *either*			
2.111	Introductory Chemistry	6	0
or			
2.121	Chemistry 1A	6	0
and *one*			
	General Education Subject (Category A)	0	4
and *either*			
25.211	Earth Materials 1 *and*	6	0
25.221	Earth Materials 2**	0	6
	or any two of the following (one each session)		
17.702	Flowering Plants	0	6
17.733	Population and Community Ecology***	6	0
17.722	Biology of Invertebrates	0	6
17.732	Vertebrate Zoology	6	0
17.601	Introductory Genetics	0	6
		19	19

*An alternative, selected from the Servicing Subjects in Geography listed in this handbook, may be substituted with the permission of the Head of School.

**Field work of up to 3 days, equivalent to 7 tutorial hours, is an essential part of this subject.

***May be taken in either Year 2 or Year 3.

Note: Students will incur personal costs in connection with the Field Project.

Year 3			
27.300	Field Project 3	0	3
27.503	Project Design and Formulation	0	4
27.652	Geographic Information Systems	0	4
27.133	Pedology	5	0
27.143	Biogeography	5	0
and *one*			
	General Education Subject (Category B)	2	2
Plus two of the following			
27.193	Environmental Impact Assessment	0	4
27.176	Remote Sensing Applications	0	4
27.213	Soils and Landforms	4	0
27.223	Environmental Change	0	4
and *either*			
25.510	Geology for Geomorphologists and Pedologists and	2	4
25.622	Hydrological and Coastal Surveying	3	3
or			
17.713	Environmental Botany *and*	6	0
17.733	Population *and* Community Ecology†	6	0
		19/23	16/20

†May be taken in either Year 2 or Year 3. 10.001 or 10.011 is a prerequisite.
Note: Students will incur personal costs in connection with the Field Project.

Applied Economic Geography

Year 2		**Hours per week** S1	S2
15.203E	Applied Microeconomics†	4	0
15.204E	Applied Macroeconomics†	0	4
27.200	Field Project 2	0	3
27.520	Regional Theory	4	0
27.672	Transport and Land Use	4	0
27.050	Geographic Data Analysis	4	4
27.500	Mathematical Methods for Spatial Analysis	4	0
27.510	Project in Spatial Analysis	0	4
27.223	Environmental Change	0	4
and *one*			
	General Education Subject (Category A)	0	4
		20	20

†May be taken in either Session 1 or Session 2.
Note: Students will incur personal costs in connection with the Field Project.

Year 3			
27.431	Computer Cartography	4	0
27.300	Field Project 3	0	3
27.193	Environmental Impact Assessment	0	4
27.503	Project Design and Formulation	0	4
27.633	Geographic Data Analysis*	0	4
27.643	Sample Surveys and Questionnaire Design	4	0
27.713	Marketing Geography	4	0
27.743	Regional Population Analysis	4	0
27.753	Social Welfare and Urban Development	0	4
and *one*			
	General Education Subject (Category B)	4	0
Plus *two* of the following subjects (one each session)**			
15.241E	Economics of Developing Countries	3	0
15.207E	Natural and Environmental Resources Economics	0	3
15.247E	Public Sector Economics	3	0
15.208E	Industry Economics and Australian Industrial Policy	0	3
15.210E	Regional and Urban Economics	3	0
		23/24	22/23

*Not offered in 1990.
**One subject may be substituted for those listed with permission of Head of School.
Note: Students will incur personal costs in connection with the Field Project.

Human and Physical Resources

Year 2		**Hours per week** S1	S2
27.175	Introduction to Remote Sensing	4	0
27.200	Field Project 2	0	3
27.050	Geographical Data Analysis	4	4
27.183	Geomorphology	0	5
27.520	Regional Theory	4	0
and *one*			
	General Education Subject (Category A)	0	4

Year 2		Hours per week S1	S2
and *one* of the following			
27.825	Urban Activity Systems**	4	0
27.223	Environmental Change	0	4
and *either*			
15.204E	Applied Macroeconomics***	0	4
	and		
15.203E	Applied Microeconomics***	4	0
	and		
27.883	Special Topic	0	4
or			
25.211	Earth Materials 1 *and*	6	0
25.221	Earth Materials 2**	0	6
or two of			
17.702	Flowering Plants	0	6
17.722	Biology of Invertebrates	0	6
17.732	Vertebrate Zoology	6	0
		18/20	20/26

*An alternative, selected from the Servicing Subjects in Geography listed in this handbook, may be substituted with the permission of the Head of School.
**Field work of up to 3 days, equivalent to 7 tutorial hours, is an essential part of this subject.
***May be taken in either Year 2 or Year 3. 10.001 to 10.011 is a prerequisite.
Note: Students will incur personal costs in connection with the Field Project.

Year 3			
27.193	Environmental Impact Assessment	0	4
27.300	Field Project 3	0	3
27.431	Computer Cartography	4	0
27.503	Project Design and Formulation	0	4
and *one*			
	General Education Subject (Category B)	2	2
Plus *four* of the following subjects			
27.133	Pedology	5	0
27.143	Biogeography	5	0
27.176	Remote Sensing Applications	0	4
27.643	Sample Surveys & Questionnaire Design	4	0
27.652	Geographic Information Systems	0	4
27.213	Soils and Landforms	4	0
27.713	Marketing Geography	4	0
27.743	Regional Population Analysis	4	0
27.753	Social Welfare and Urban Development	0	4
and *either*			
15.210E	Regional and Urban Economics	3	0
and			
15.207E	Natural and Environmental Resource Economics	0	3
or			
25.510	Geology for Geomorphologists and Pedologists	2	4
or one of			
17.713	Environmental Botany	6	0
17.733	Population and Community Ecology	6	0
		20/24	22/25

Note: Students will incur personal costs in connection with the Field Project.

Applied Physical Geography, Applied Economic Geography and Human and Physical Resources.

Year 4		Hours per week S1	S2
27.180	Field Project	0	8
27.190	Assessment of Human and Physical Resources*	4	0
27.504	Project	16	0
27.514	Practical Applications	0	3
27.524	Advanced Spatial Analysis*	0	4
27.534	Advanced Environmental Analysis	0	4
		20	19

*Up to two subjects may be substituted from those offered by the School of Geography, Department of Applied Geology or School of Biological Sciences, subject to approval by the Head of School.
Note: Students will incur personal costs in connection with project work in the final year of study.

Graduate Study

8024
Graduate Program in Land and Geographic Information Systems

Master of Applied Science
MAppSc

The Masters degree program in Land and Geographic Information Systems is offered in both the Faculty of Applied Science and the Faculty of Engineering. Entry into either Faculty depends on the background of the applicant and the orientation of the proposed program.

Entry qualifications. Four-year Honours degree of appropriate standard in Geography, Geology, Surveying, or a relevant environmental science.

Course requirements. Candidates are required to complete a course totalling 36 credits (1 credit equals 1 hour per week for one session), made up of compulsory subjects, elective subjects and a project or research project. The degree will normally comprise one year of full-time study (two sessions of 18 credits) or two years of part-time study (four sessions of 9 credits each.)

Candidates who are not exempted from any of the compulsory subjects and who opt for the Research Project 18 credits will achieve the required 36 credits without any elective subjects.

Compulsory Subjects		Credits
27.672G	Geographic Information Systems	3
6.005G	Data Base Systems	3
29.604G	Land Information Systems	3
29.532G	Computer-Assisted Mapping	3
Elective Subjects		
27.043G	Remote Sensing Applications	3
27.644G	Computer Mapping and Data Display	3
29.2170	Computer Graphics†	2
27.580G	Image Analysis in Remote Sensing	3
55.817G	Information Storage and Retrieval Systems	6
55.815G	Economics of Information Systems	3
27.925G	Special Topic in Geography	
6.336G	Digital Communication Networks 1	
29.107G	Special Topic in Surveying B	

†Not available as part of this course in 1990.

Project		Credits
27.950G	Project	9
27.951G	Research Project	18

Compulsory subjects not offered in a particular year, and other elective subjects than those listed, may be substituted by equivalent subjects approved by the Head of School.

Graduate Programs in Arid Lands Management

General

The University has considerable experience of research and teaching relating to the management of arid environments, gained over many years by several of its schools. This experience is being mobilized in the provision of graduate programs based at the University campus in Kensington, Sydney, but includes significant field studies using the resources at Fowlers Gap Arid Zone Research Station in western New South Wales.

The programs include the following areas of study:

- Hydrogeology
- Land Evaluation
- Terrain Management
- Soil Conservation
- Range Management
- Management of Pastoral Enterprises

For most of the above study areas, programs are available leading to the award of:

Master of Applied Science in Arid Land Management by Course Work	Course 8025
Graduate Diploma in Arid Lands Management	Course 5025

Entry qualifications. Course 8025 – Four-year degree at an appropriate standard and in an appropriate discipline. Course 5025 – Degree in an appropriate discipline. See details under individual entries.

Course requirements. Candidates are required to complete a program totalling 36 credits to complete Course 8025 or 30 credits to complete Course 5025 during one year of full-time study or two years part-time study. 1 credit equals 1 hour per week for one session. Details of subjects available are listed under individual entries.

Hydrogeology

These programs involve training in groundwater investigations, including geophysical investigations, and the assessment, development and utilization of groundwater resources. They are suited to geologists, engineers, agricultural scientists, planners and resource managers.

Land Evaluation and Terrain Management

These programs are designed to provide graduate training in the evaluation of land management and in the prediction of the environmental impact of land use. They include the two sectors of land evaluation and terrain management, with a close relationship reflected in overlapping core programs. Terrain management also embraces geopollution management, with reference to groundwater and hydrological processes. Terrain evaluation is envisaged as serving a wide range of land management, including agricultural and biological management.

Soil Conservation

These programs are designed to provide graduate training in soil conservation for land management in arid zones. They are appropriate for personnel engaged in or preparing for positions in conservation or reclamation projects, agricultural advisory

services, land-use planning, administration of pastoral lands, or research into problems of arid land management.

Range Management

These programs are designed to provide graduate training in the assessment and management of rangelands, and are also relevant to animal production and soil conservation, national parks and wildlife management, and land evaluation. They are appropriate for personnel engaged in or preparing for positions in project management, pastoral advisory services, and rangeland research or administration.

Management of Pastoral Enterprises

These programs are designed to provide graduate training in the production and management of grazing sheep and beef cattle, the production of pasture, range management, and in the economic management of pastoral enterprises.

8025
Arid Lands Management
Graduate Course

Master of Applied Science
MAppSc

Hydrogeology

Prerequisite: Four-year degree of appropriate standard in geology or in a relevant science.

Compulsory Subjects		Credits
25.915G	Project in Hydrogeology *or*	9
25.916G	Research Project in Hydrogeology	18

Recommended Core Subjects		
8.842G	Groundwater Hydrology	3
8.860G	Investigation of Groundwater Resources 1	3
8.861G	Investigation of Groundwater Resources 2	3
25.325	Engineering and Environmental Geology	6
25.702G	Hydrogeology	3
25.711G	Arid Zone Engineering Geology*	3

Candidates must also include additional subjects selected from core subjects in other programs in Water Resources, or from the listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Applied Geology and the Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
8.701G	Economic Decision Making in Civil Engineering	3
8.703G	Optimization Techniques in Civil Engineering	3
8.833G	Free Surface Flow	3
8.843G	Groundwater Hydraulics	3
8.878G	Flood Design II	3
8.879G	Flood Design III	3
8.847G	Water Resources Policy	3
8.848G	Water Resources System Design	3
8.849G	Irrigation	3
8.850G	Drainage of Agricultural Land	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.910G	Geomorphology of Arid Lands	6
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
27.914G	Terrain Evaluation	6
27.922G	Applied Geomorphology	3
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3

*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Land Evaluation

Prerequisite: Four-year degree of appropriate standard in physical geography, or in a relevant environmental, biological or agricultural science.

Compulsory Subjects†		Credits
27.910G	Geomorphology of Arid Lands	6
27.913G	Soil Studies for Arid Lands Management	6
27.914G	Terrain Evaluation	6
27.950G	Project *or*	9
27.951G	Research Project	18

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Geography and Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
9.205G	Range Management‡	8
25.711G	Arid Zone Engineering Geology*	3
27.043G	Remote Sensing Applications*	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.911G	Soil Erosion and Conservation	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3
45.900G	Ecological Studies in Arid Lands Management	6

†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
‡Includes up to one week of field work, probably at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Terrain Management

Prerequisite: Four-year degree of appropriate standard in geology or physical geography, or in a relevant environmental, biological or agricultural science.

Compulsory Subjects†		Credits
25.702G	Hydrogeology	3
25.707G	Geopollution Management	3
25.711G	Arid Zone Engineering Geology*	3
25.712G	Project in Terrain Management *or*	9
25.713G	Research Project in Terrain Management	18
27.910G	Geomorphology of Arid Lands	6
27.914G	Terrain Evaluation	6

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Applied Geology and Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
8.875G	Hydrological Processes	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3

†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Soil Conservation

Prerequisite: Four-year degree of appropriate standard in physical geography or agricultural science, or in a relevant earth science or biological science.

Compulsory Subjects†		Credits
27.910G	Geomorphology of Arid Lands	6
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
27.950G	Project *or*	9
27.951G	Research Project	18

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Geography and Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
8.864G	Arid Zone Surface Water Hydrology§	3
8.865G	Arid Zone Water Resources Management	3
9.205G	Range Management‡	3
25.711G	Arid Zone Engineering Geology*	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.914G	Terrain Evaluation	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3
45.900G	Ecological Studies in Arid Lands Management	6

§Co-requisites: 8.875G Hydrological Processes, 8.877G Flood Design 1
†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
‡Includes up to one week of field work at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Range Management

Prerequisite: Four-year degree of appropriate standard in agricultural science, or in a relevant biological or earth science.

Compulsory Subject		Credits
9.205G	Range Management‡	8
9.206G	Project in Range Management	18

Recommended Subject**		Credits
45.900G	Ecological Studies in Arid Lands Management	6

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the Department of Wool and Animal Science and Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
9.105G	Livestock Production	12
9.113	Livestock Production	6
9.202	Pastoral Agronomy	8
9.421	Animal Nutrition	4
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.910G	Geomorphology of Arid Lands	6
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
27.914G	Terrain Evaluation	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3
17.713	Environmental Botany	6
17.783	Animal Behaviour	6

**This subject may be omitted with permission of the Head of the Department of Wool and Animal Science.
‡Includes up to one week of field work at Fowlers Gap Research Station.

5025
Arid Lands Management
Graduate Diploma Course

Graduate Diploma
GradDip

Hydrogeology

Prerequisite: Degree in engineering or geology or in a relevant science.

Recommended Core Subjects
As for 8025 MAppSc degree Hydrogeology strand see earlier this section.

Candidates must also include additional subjects selected from core subjects in other programs in Water Resources, or from the listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the Department of Applied Geology and Heads of the other Schools concerned, to complete a program equivalent to an average of 15 hours per week for two sessions of full-time study.

Optional Subjects
As for 8025 MAppSc degree Hydrogeology strand see earlier this section.

Land Evaluation

Prerequisite: Degree in physical geography or geology, or in a relevant environmental, biological or agricultural science.

Compulsory Subjects†		Credits
27.910G	Geomorphology of Arid Lands	6
27.913G	Soil Studies for Arid Lands Management	6
27.914G	Terrain Evaluation	6
27.950G	Project	9

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Geography and Heads of the other Schools concerned, to complete a program equivalent to an average of 15 hours per week for two sessions of full-time study.

Optional Subjects		Credits
9.205G	Range Management‡	8
25.711G	Arid Zone Engineering Geology*	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.911G	Soil Erosion and Conservation	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3
45.900G	Ecological Studies in Arid Lands Management	6

†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
‡Includes up to one week of field work at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Terrain Management

Prerequisite: Degree in geology or physical geography, or in a relevant environmental, biological or agricultural science.

Compulsory Subjects†		Credits
25.711G	Arid Zone Engineering Geology*	3
25.712G	Project in Terrain Management	9
27.910G	Geomorphology of Arid Lands	6
27.914G	Terrain Evaluation	6

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the Department of Applied Geology and Heads of the other Schools concerned, to complete a program equivalent to an average of 18 hours per week for two sessions of full-time study.

Optional Subjects		Credits
8.875G	Hydrological Processes	3
25.702G	Hydrogeology	3
25.707G	Geopollution Management	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	2
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information Systems	3

†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Soil Conservation

Prerequisite: Degree in physical geography or agricultural science, or in a relevant earth science or biological science.

Compulsory Subjects†		Credits
27.910G	Geomorphology of Arid Lands	6
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies for Arid Lands Management	6
27.950G	Project	9

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the School of Geography and Heads of the other Schools concerned, to complete a program equivalent to an average of 15 hours per week for two sessions of full-time study.

Optional Subjects		Credits
8.865G	Arid Zone Water Resources Management	3
9.205G	Range Management	8
25.711G	Arid Zone Engineering Geology*	3
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3

27.914G	Terrain Evaluation	6
29.601G	Remote Sensing Principles and Procedures	3
29.604G	Land Information System	3
45.900G	Ecological Studies in Arid Lands Management	6

†Compulsory subjects jointly include one week of field work, probably at Fowlers Gap Research Station.
‡Includes up to one week of field work at Fowlers Gap Research Station.
*Includes a field exercise of at least three days duration at Fowlers Gap Research Station.

Range Management

Prerequisite: Degree in agricultural science, or in a relevant biological or earth science.

Compulsory Subject		Credits
9.205G	Range Management‡	8

Recommended Subject**		Credits
45.900G	Ecological Studies in Arid Lands Management	6

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the Department of Wool and Animal Science and Heads of the other Sch9ools concerned, to complete a program equivalent to an average of 15 hours per week for two sessions of full-time study.

Optional Subjects		Credits
9.105	Livestock Production	12
9.113	Livestock Production 2	6
9.202	Pastoral Agronomy	8
9.421	Animal Nutrition	4
27.043G	Remote Sensing Applications	3
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.910G	Geomorphology of Arid Lands	6
27.911G	Soil Erosion and Conservation	6
27.913G	Soil Studies and Arid Lands Management	6
27.914G	Terrain Evaluation	6
27.601G	Remote Sensing Principles and Procedures	3
27.604G	Land Information Systems	3
17.713	Environmental Botany	6
17.783	Animal Behaviour	6

**This subject may be omitted with permission of the Head of the Department of Wool and Animal Science.
‡Includes up to one week of field work at Fowlers Gap Research Station.

Management of Pastoral Enterprises

Prerequisite: Degree in veterinary or agricultural science, or in a relevant biological science.

Recommended Subjects		Credits
9.105G	Livestock Production	12
9.205G	Range Management‡	8

Candidates must also include additional subjects selected from the following listed optional subjects, or from other relevant subjects offered within the University, as approved by the Head of the Department of Wool and Animal Science and Heads of the other Schools concerned, to complete a program equivalent to an average of 15 hours per week for two sessions of full-time study.

Optional Subjects		Credits
9.001	Project in Management of Pastoral Enterprises	12
9.113	Livestock Production 3	6
9.131	Animal Health and Welfare 1	3
9.132	Animal Health 2	3
9.202	Pastoral Agronomy	8
9.301	Agricultural Economics and Management 1	6
9.421	Animal Nutrition	4
9.503	Wool Science 3	8
9.504G	Wool Science	12
9.802	Genetics 2	8
9.803G	Animal Breeding	8
9.811	Biostatistics 1	4
9.812	Biostatistics 2	4
9.813G	Quantitative Methods	8
9.901	Rural Extension	4
17.783	Animal Behaviour	6
45.900G	Ecological Studies in Arid Lands Management	6

‡Includes up to one week of field work at Fowlers Gap Research Station

Graduate Programs in Remote Sensing

Programs are available leading to the award of:

Master of Applied Science in Remote Sensing	Course 8026
Graduate Diploma in Remote Sensing	Course 5026

8026
Remote Sensing Graduate Course

Master of Applied Science
MAppSc

The masters degree program in Remote Sensing is offered in both the Faculty of Applied Science and the Faculty of Engineering. Entry into either Faculty depends on the background of the applicant and the orientation of the proposed program.

Entry qualifications. Four-year degree of appropriate standard in engineering, geography, geology, surveying, or in a relevant environmental biological or agricultural science.

Course requirements. Candidates are required to complete a course totalling 36 credits, made up of compulsory subjects, elective subjects and a project or research project. Compulsory subjects not offered in a particular year may be substituted by an equivalent subject, approved by the appropriate Head of School. The degree will normally comprise one year of full-time study (two sessions of 18 credits) or two years of part-time study (four sessions of 9 credits each).

Candidates who are not exempted from any of the compulsory subjects and who opt for the Research Project (18 credits), will achieve the required 36 credits without any elective subjects.

Compulsory Subjects		Credits
27.043G	Remote Sensing Applications	3
29.600G	Principles of Remote Sensing	3
29.602G	Remote Sensing Procedures	3
29.605G	Ground Investigations for Remote Sensing	3
97.580G	Image Analysis in Remote Sensing	3
97.581G	Microwave Remote Sensing	3

Project		
46.101G	Project in Remote Sensing *or*	9
46.102G	Research Project in Remote Sensing	18

Elective Subjects

Candidates are required to include additional subjects selected from the following listed elective subjects, or from other relevant subjects offered within the University, as approved by the appropriate Head of School, to complete a program totalling 36 credits.

		Credits
6.468G	Computer Display Systems and Interactive Instrumentation	3
6.611	Computing 1	4
25.816G	Remote Sensing in Applied Geology	2
27.174G	Remote Sensing Instrumentation and Satellite Programs	
27.644G	Computer Mapping and Data Display	3
27.672G	Geographic Information Systems	3
27.911G	Soil Erosion and Conservation	6
27.914G	Terrain Evaluation	6
29.213G	Physical Meteorology	3
29.604G	Land Information Systems	3

5026
Remote Sensing Graduate Diploma Course

Graduate Diploma
GradDip

The graduate diploma program in Remote Sensing is offered in both the Faculty of Applied Science and the Faculty of Engineering. Entry into either faculty depends on the background of the applicant and the orientation of the proposed program.

Entry qualifications. Three-year degree from an approved university and or qualifications deemed appropriate by the relevant faculty.

Course requirements. Candidates are required to complete a program totalling 30 credits or equivalent to 15 hours per week for two sessions of full-time study, made up of compulsory subjects (15 credits) and elective subjects (15 credits). Compulsory subjects not offered in a particular year may be substituted by an approved equivalent subject.

The course will normally comprise one year of full-time study or two years part-time study. One-third of the credits for elective subjects may be from approved undergraduate subjects.

Compulsory Subjects		Credits
29.600G	Principles of Remote Sensing	3
29.605G	Ground Investigations for Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.043G	Remote Sensing Applications	3
97.580G	Image Analysis in Remote Sensing	3

Elective Subjects

From the following (or as approved by the relevant Faculty):

6.468G	Computer Display Systems and Interactive Instrumentation	3
8.875G	Hydrological Processes	3
8.849G	Irrigation	3
8.861G	Investigation of Ground Water Resources 2	3
8.864G	Arid Zone Hydrology	3
8.865G	Arid Zone Water Resources Management	3
25.704G	Environmental Geology	3
25.801G	Geology in Exploration 1	4
25.816G	Remote Sensing in Applied Geology	2
25.821G	Geology in Exploration 2	2
27.171G	Directed Problems in Remote Sensing	3
27.644G	Computer Mapping and Data Display	3
27.672G	Geographic Information Systems	3
27.914G	Terrain Evaluation	3
29.211G	Introduction to Geodesy	3
29.213G	Physical Meteorology	3
29.532G	Computer Assisted Mapping	3
29.604G	Land Information Systems	3
97.581G	Microwave Remote Sensing	3

Graduate Program in Environmental Studies

8045

Master of Environmental Studies
MEnvStudies

This is an interdisciplinary course designed to study the nature of environmental problems and the methodology of evaluation. Emphasis is placed on the development of relevant skills in environmental analysis, management and planning.

The subject matter covers a set of themes: resource use and conservation, pollution abatement, hazard perception and adjustment. Strong attention will be given to environmental impact assessment and conflict resolution.

The course is designed around three broad components for a minimum of 36 credits (1 credit = 1 hour per week per one session):

- Core subjects Research Project (6 credits)
- Project (9 or 18 credits)
- Electives(12 or 21 credits)

The core subjects and electives will consist of subjects specially designed together with appropriate subjects taken from those offered by a number of Faculties and Boards of Studies within the University of New South Wales.

Prerequisites shall be determined by the relevant Subject Authority.

Core Subjects		Credits
27.202G	Environmental Planning and Evaluation	2
36.945G	The Organisation of Town Planning	3
46.203G	Medical Aspects	2
46.204G	Legislative Aspects	2

Project		
46.200G	Research Project in Environmental Studies	18
or		
46.201G	Project in Environmental Studies	9

Elective Subjects*

Earth Science – Engineering

7.152G	Mining Conservation	3
8.847G	Water Resources Policy	3
8.851G	Unit Operations in Public Health Engineering	3
8.858G	Water Quality Management	3
8.868G	Public Health Science	3
25.325	Engineering and Environmental Geology	6
25.704G	Environmental Geology	3
25.707G	Geopollution Management	3
25.710G	Coastal Environmental Geology	3
27.043G	Remote Sensing Applications	3
27.133	Pedology	5
27.171G	Directed Problems in Remote Sensing	3
27.174G	Remote Sensing Instrumentation and Satellite Programs	3
27.911G	Soil Erosion and Conservation	3
27.914G	Terrain Evaluation	6
27.922G	Applied Geomorphology	6

*Chemistry – Biology**

2.123E	Environmental Chemistry	6
2.251G	Toxicology, Occupational and Public Health	6
9.424G	Minerals and Their Effects on Grazing Animals	2
27.143	Biogeography	5
42.205G	Microbial Biodgradation	3
42.211G	Principles of Biology	3
42.212G	Principles of Biochemistry	3
17.713	Environmental Botany	6
48.043	Chemical Engineering 3C	3
48.063G	Industrial Water and Wastewater Engineering	3
48.116	Water Chemistry	3
48.386G	Unit Operations in Waste Management	3
48.391G	Atmospheric Pollution Control	3
48.392G	Practical Aspects of Air Pollution Measurement and Control	3

*Social-Economic-Planning**

8.402G	Transport, Environment, Community	6
27.004G	Settlement in Australia	3
27.672G	Geographic Information Systems	3
27.644G	Computer Mapping and Data Display	3
27.923G	Population, Health and Environment	2
30.935G	Organization Behaviour A	3
36.830G	Environmental Psychology	3
36.945G	Organisation of Town Planning	3
37.161G	Land Systems and Management	4
37.504G	Conservation Studies	3
37.901G	Landscape Planning	3
39.908G	Community Noise Control	2
53.571	Technology and Society	3
53.573G	Urban Studies	3
53.576	Social and Technological Forecasting	3
85.0204	Resource Markets and Management	3
85.0385	Business – Government Relations	3

*Other subjects may be added on approval of Course Co-ordinator.

Subject Descriptions

Undergraduate Study

27.010 Land Studies **S1 L2 T2**

Concepts, significance and problems of land. Land as territory and land as resource in Australia. Constraints imposed by the physical environment on human occupancy and settlement patterns, the variety of conflicts that result and management strategies. Practical work involves study of the ways in which the attributes and characteristics of land are displayed on maps, air photos and satellite imagery, and introduces these as basic information sources and research tools in applied geography.

27.020 Locational Processes **S2 L2 T2**

Basic theoretical constructs for explaining the location of human activity. Concepts of optimal location and spatial competition, geographical variations in the factors of production, economies of scale and agglomeration, transaction costs and locational decision making under conditions of uncertainty. Practical study links theory and problem solving in economic geography.

27.030 Environmental Processes **S2 L2 T2**

Excluded: 27.818, 26.424

Essential and continuing links between components of the physical environment. Movement of energy and matter in the physical environment, including consideration of Earth's energy balance, the hydrological cycle, nutrient cycles in vegetation and soil, imbalances leading to land degradation and instability, to and movement of materials.

27.040 Data Processing Systems **F T2**

Measurement, processing and display of spatial data. Basic knowledge and skills for using the University's computing system effectively; the use of computer software packages in geographic enquiry; exploratory data analysis and graphic information processing; and the presentation of data in tables, graphs and diagrams.

27.050 Geographical Data Analysis **F L2 T2**

Prerequisite: Both 27.010 and 27.030 or both 27.818 and 27.819. Excluded 27.813, 27.884.

Inferential statistics and hypothesis testing in the analysis of spatial data. Methods of analysing categorical data, identifying spatial correlation and associations, and multivariate methods applicable to topics in physical and economic geography.

27.100 Field Project 1 **S2 T3**

A five days field project normally undertaken during the mid-year recess, designed to support teaching in Year 1 Level 1 subjects and to develop basic field methods and skills. Students will incur some personal expenses in connection with this subject, which is a compulsory part of the course.

27.133 Pedology **S2 L2 T3**

Prerequisites: 27.030 or 27.818 and one of 2.121 or 2.241 or both 25.110 and 25.120 or both 17.031 or 17.041.

Methodology of pedogenic studies and the application of these studies to the understanding of soil-landform relationships. Soil physical and chemical properties and their interrelationships, emphasizing clay-mineral structure and behaviour, soil solution chemistry, soil water movement and the application of these properties to elements of soil mechanics. Soil properties in natural, rural and urban landscapes, including assessment of soil fertility, swelling characteristics, dispersibility, erodibility and aggregate stability. Laboratory analysis of soil physical and chemical characteristics with emphasis on properties associated with land capability assessment. Statistical analysis of soil data and its application to mapping. The use of soil micromorphological and mineralogical studies in pedology.

27.143 Biogeography **S1 L2 T3**

Prerequisites: 27.030 or 27.818 or both 17.031 and 17.041.

Distribution of taxa. Floras of the Southern Hemisphere with particular reference to Australia. Endemic, discontinuous and relict taxa. Dispersal and migration of species. Origin, evolution and geological history of Angiosperms. The development of the Australian biogeographic element. Study of the recent past to understand present distributions of taxa. The role of humans and climatic change on Australian vegetation. Detection of pattern and association and their causes. Classification, ordination and mapping of vegetation. Ecology of selected Australian vegetation types. Management of vegetation in different climate regimes.

27.153 Climatology **S1 L2 T3**

Prerequisites: 1.001 or 27.030 or 27.818 or 25.110 and 25.120 or 17.041.

Physical bases for understanding microclimate. Processes of energy exchange at the earth's surface, and the atmospheric and terrestrial surface controls of the heat and mass budgets. Atmospheric diffusion. Wind profiles and atmospheric turbulence as affected by stability and surface properties. Determinants of the local and site-specific climatic environment, particularly topographic, surface cover and substrate conditions. Urban climate and climate in relation to human comfort and health. Building constructional design aspects of climate and applications of climatology in urban and regional planning. Climatic aspects of the development and regional planning. Climatic aspects of the development and utilization of solar and wind energy sources.

27.175 Introduction to Remote Sensing **S1 L2 T2**

Prerequisite: Successful completion of a Year 1 program in Applied Science, Science or Arts or equivalent as approved by the Head of School.

Principles and technical aspects of remote sensing. Forms of available imagery, their utility and facilities for interpretation. Basic airphoto interpretation techniques relevant to environmental assessment. Introduction to principles of the electromagnetic spectrum, photometry and radiometry. Sensor types, image formation and end products associated with selected satellite programs, including Landsat. Land-cover and land-use interpretation procedures in visual image analysis. Basic procedures in machine-assisted image enhancement.

27.176 Remote Sensing Applications **S2 L2 T2**

Prerequisite: 27.175 or 29.8710.

Spectral characteristics of natural phenomena and image formation. Ground truthing, collection and calibration. Introduction to computer classification procedures. Multitemporal sampling procedures, image to image registration and map to image registration. Major applications of remote sensing in the investigation of renewable and non-renewable resources to include: soils, geology, hydrology, vegetation, agriculture, rangelands, urban analysis, regional planning, transportation and route location and hazard monitoring.

27.180 Field Project **S2 T8**

Develop skills in problem formulation and team-based field work. Preparation and presentation of professional quality reports of applied geographical analysis. Define problem, plan strategy for appropriate investigation. Conduct field studies, and report results of investigation. Field work of five days is compulsory. Students will incur some personal expenses in connection with this subject.

27.183 Geomorphology **S2 L2 T3**

Prerequisites: 25.030 or 27.818 or 25.120.

Hillslope materials, processes and form; models of slope and landscape evolution. Fluvial geomorphology including water movement and sediment transport in river channels, hydraulic geometry, channel patterns, river types, flood plain formation, alluvial fans, river channel changes. Erosional and depositional landforms in coastal, arid, humid and glacial environments. Field work in fluvial and hillslope geomorphology, and laboratories on field measurements of geomorphic processes, sediment analyses and airphotograph interpretation.

27.190 Assessment of Human and Physical Resources **S1 L4 T4**

Assessments of human and physical resources and environments. Specialised study in the following areas: landforms, soils, vegetation, climate and water, resource planning and decision making, human resources, geographical thought and perspectives. Since the units offered in any one year may be affected by the availability of staff, students should obtain information from the School.

27.193 Environmental Impact Assessment **S1 L2 T2**

Prerequisites: 27.030 or 27.818 or by permission from Head of School.

Rationale and basic objectives; standardized types of environmental impact assessment EIA, including matrix approach, adopted methods of EIA in Australia. Frequently used assessment and predictive techniques for meteorological, hydrological, biological, socio-economic impacts. Techniques of impact evaluation in terms of socio-economic criteria. Environmental decision making and planning under conditions of uncertainty. Case studies exemplifying procedures, techniques and issues. Trends, changes and possible future developments in EIA. Practical exercises representing components of typical EIAs.

27.200 Field Project 2 **S1 S2 T3**

A five days field project normally undertaken during a recess designed to support teaching in Year 2 subjects in physical and economic geography and to develop more advanced skills in data collection, observation and field methods. Students will incur some personal expenses in connection with this subject, which is a compulsory part of the course.

27.213 Soils and Landforms **S1 L2 T2**

Prerequisite: 27.133 or 27.183 or 27.828 or by permission from Head of School.

Organization of soil material: stratigraphic layers versus profiles. Models of soil formation zonal, leaching and landscape approaches. Australian and international soil classification systems. Soil development on hillslopes: texture contrast soils. Floodplain landforms: river terraces and chrono-sequences. Lithoand chrono-stratigraphic use of soils in residual aeolian, fluviatile and coastal deposits.

27.223 Environmental Change **S1 L2 T2**

Prerequisite: Successful completion of a Year 2 Programme in Applied Science, Science, or Arts or equivalent as approved by the Head of School.

The nature of environmental change on the land, oceans, biosphere and atmosphere. Evolution of the continents, oceans, life and atmosphere. Techniques for environmental reconstruction and chronology building. Quaternary climatic change and modelling. Human impact on the atmosphere and climatic consequences.

27.300 Field Project 3 **S1 S2 T3**

Prerequisite: One of 27.133, 27.143, 27.183 or 27.183. This prerequisite does not apply to studentgs registered in course 3010.

A five days field project normally undertaken during a recess, designed to support teaching in Year 3 Level III subjects in physical and economic geography and to demonstrate the application of field methods in problem solving and research projects. Students will incur some personal expenses in connection with this subject, which is a compulsory part of the course.

27.431 Computer Cartography **S1 L2 T2**

Theoretical and practical problems in producing thematic maps by computer. Effective use of colour and shading on thematic maps. Design principles. Data entry and digitising. Production of multiple feature displays. Use of symbolism. Emphasis on developing skills in computer cartography through hands-on experience using GIMMS.

27.432 Computer Mapping and Data Display **S1 L1 T3**

Prerequisites: Successful completion of a Year 1 program in Science or Arts or equivalent as approved by Head of School.

Introduction to theoretical and practical problems in displaying data graphically and constructing thematic maps by computer using the GIMMS mapping package. The emphasis is on developing skills in automated cartography through hands-on experience culminating in the preparation of a folio of maps of selected census data. No previous computing expertise is required.

27.500 Mathematical Methods for Spatial Analysis **S1 L1 T3**

Prerequisite: 10.021B and 10.021C or 10.001 or 10.011 and 27.040 or 13.200.

Selected mathematical methods for the analysis of spatial problems, including applications of calculus in constrained and

unconstrained optimisation; mathematical programming methods; network models; input-output analysis; in facility location and allocation problems.

27.503 Project Design and Formulation **S2 L1 T3**

Stages in the design of a research project. Undertaking a literature review relating to the project. Identification and formulation of working hypotheses. Writing up a research proposal. Timetables and planning strategies for project execution and completion.

27.504 Project **S1 T16**

Prerequisite: 27.503

Implementation of the research proposal in Applied Geography prepared for 27.503 Project Design and Formulation under the direction of a supervisor; preparation of a project report.

27.510 Project in Spatial Analysis **S2 L1 T3**

Prerequisite: 27.500.

Supervised application of quantitive methods in selected projects involving the analysis of spatial data and requires integrated applications of skills in data processing, geographic data analysis, and mathematical methods.

27.514 Practical Applications in Geography **S2 T3**

Seminars with practitioners in the fields of urban and regional analysis and environmental studies, including environmental impact statements; research proposals; report writing; the roles of government agencies and consultants; and budgeting for research projects; applying for positions and personal skills development.

27.520 Regional Theory **S1 L2 T2**

Regional theory and analytical methods with a particular focus on the explanation of the Richardson growth model and the practical application of its components, using Australian data. Capital formation and mobility, labour supply and technological change, assessments of recent changes in the Australian regional economic system. Practical work deals with the measurement and analysis of structural change, accessibility and economic interaction and regional economic welfare.

27.524 Advanced Spatial Analysis **S2 L2 T2**

Selected topics in economic and physical geography chosen to illustrate developments at the frontiers of research in spatial analysis.

27.534 Advanced Environmental Analysis **S2 L2 T2**

Selected topics in the study of human and physical environments, chosen to illustrate contemporary frontiers of research and development in environmental studies.

27.633 Geographic Data Analysis 3 **S2 L2 T2**

Advanced methods for spatial analysis; case studies; selected topics in applied economic geography with particular reference to urban and regional analysis and planning.

27.643 Sample Surveys and Questionnaire Design **S1 L2 T2**

Explanation and prediction as distinct research objectives; designing research to achieve reliability and validity; case studies in research design; questionnaire design and implementation; scaling methods; interviewing techniques; sampling problems; directions in Qualitative Research.

27.652 Geographic Information Systems **S2 L2 T2**

Prerequisite: 27.432 or by permission from the Head of School. This prerequisite does not apply to students enrolled in course 3010.

An introduction to information systems of particular relevance for geographers with special reference to computer-based systems for resource evaluation. Case study evaluation, application of the MAP and other GIS software.

27.672 Transport and Land Use **S1 L2 T2**

The relationships between transport and land use, mobility, accessibility, and activity systems in urban and rural environments. Emphasis on policy issues and case studies from Australia. Introduction to simple transport-land use models.

27.713 Marketing Geography **S2 L2 T3**

Prerequisite: 28.042. Note: *This prerequisite does not apply to students enrolled in course 3010.*

Organization and operation of the marketing function and trends in its performance. Merchandising strategies of wholesalers and retailers and the consequent location patterns of consumer oriented enterprises within cities. Retail feasibility studies and the structure and analysis of market areas in intra-urban areas. Consumer spatial behaviour, including search and decision processes. Shopping centre images and spatial choice models.

27.743 Regional Population Analysis **S1 L2 T2**

The primary emphasis is on regional population estimation and forecasting with reference to Australian conditions and the use of Australian data. The population forecasting is handled within the framework of demographic theory and component analysis; migration analysis is given particular attention; multi-region population models; hybrid methods of small area population forecasting; use of population profiles for planning the provision of services.

27.753 Social Welfare and Urban Development **S1 L2 T2**

Prerequisite: 27.010 or 27.829. Note: This prerequisite does not apply to students enrolled in course 3010.

A consideration of welfare aspects of urban development, including social policies and urban structure; social costs and benefits of urban renewal especially in the inner city; growth centres and new towns; distributional aspects of social services; and spatial disparities in social well-being. Servicing SubjectsThese are additional subjects taught within courses offered by other Faculties.For further information regarding the following subjects see the Faculty of Architecture, Arts, Commerce, Engineering and Combined Sciences Handbooks.

27.813 Geographic Methods **S2 L2 T2**

Prerequisites: Both 27.010 and 27.030, or both 27.818 and 27.819. Excluded 27.050.

Statistical procedures and field methods used in both human and physical geography. Includes: measures of dispersion; measures of spatial distribution; samples and estimates; correlation and regression; tests for distribution in space; data collection and analysis; field observations.Three days field

work is a compulsory part of the subject and students will incur some personal expenses with this.

27.818 Australian Environment and Human Response **S1 L2 T2**

Prerequisite: Nil.
Excluded 27.030, 26.424.

Characteristics of the Australian environment viewed in global context. Topics include: the structure, function and origin of the lithosphere, hydrosphere and biosphere; the plate tectonic model and major landforms; atmospheric circulation, energy and radiation balances; the hydrological cycle; floods and droughts; characteristics and distribution of soils and vegetation; analysis of ecosystems. A one day field trip is compulsory. Students will incur some personal expenses in connection with this subject.

27.819 Technology and Regional Change **S2 L2 T2**

Prerequisite: Nil.
Excluded 26.455.

The impact of technological change on the spatial organization of human activities and regional development and disparities. The implications of technological change on population distribution and growth, resource utilization, and settlement patterns are examined at different scales emphasizing the social consequences at the community and regional level. International and intra-national spatial variations in the context of development and modernization theories. Examples are taken from Third World and modernized countries, with particular reference to Australian case studies.

27.824 Spatial Population Analysis **S2 L2 T2**

Prerequisite: 27.829 or 27.010.

Population growth and structure in an international urban and regional context. The components and processes of population change; fertility, mortality and migration set within the framework of demographic transition and development theory. Theories of migration and mobility and of optimal populations. Demographic and social indicators for urban and regional analysis and their implications for inequalities in living conditions, at local, regional, and international scales. The adjustment of immigrant and migrant populations to the urban environment.

27.825 Urban Activity Systems **S1 L2 T2**

Prerequisite: 27.829 or 27.010.

Focus is on trip making, movement, and activity patterns in urban areas. Topics include: the activity concept, travel behaviour and urban spatial structure; constraints to individual travel behaviour and activity pattern linkages; the urban transport disadvantaged; public transport problems and issues in Australian capital cities; travel and activity consequences of transport infrastructure developments.

27.826 Urban and Regional Development **S2 L2 T2**

Prerequisite: 27.829 or 27.010.

Theories of urban and regional change leading to assessment of the role of planning. Emphasis on resource allocation, conflict resolution and evaluation techniques including cost-benefit analysis and environmental impact assessment. Examples are taken principally from the fields of recreation and tourism.

27.828 Australian Natural Environments **S2 L2 T2**

Prerequisite: 27.818 or 27.030.
Excluded 26.425.

Characteristics, origin and development of environments in Australia in terms of their tectonic history, lithology, landforms, climate, vegetation and soils. Analysis of natural physiographic regions and their modification by humans. A two day field trip is compulsory. Students will incur some expenses in connection with this subject.

27.829 Australian Social Environments **S1 L2 T2**

Prerequisite: 27.010 or 27.819.

Focus is on the interaction between human communities and the built environment in Australia: the effects of the natural environment on the evolution of settlement patterns; detailed analysis of rural and metropolitan social environments. Emphasis on inner city, suburbia, behavioural and social area approaches, and to managerialist and structural theories of social change on areas and their communities.

27.844 Honours Geography **F**

Prerequisites: Arts students must satisfy Faculty requirements for entry to the Honours Level program and must have obtained at least 54 credit points in Geography subjects, including 12 Level 1 credit points. A minimum cumulative average at Credit level is required for all Upper Level subjects taken which must include 27.884.

Details of Honours Geography for science students are available from the School of Geography office.

Students are required: **1.** To undertake an original piece of work extending throughout the year and to submit a thesis based upon it. **2.** To participate in seminars and fieldwork as notified by the School of Geography.

27.862 Australian Environment and Natural Resources **S1 L2 T2**

Prerequisite: 28.183 or 27.828.

Continental and regional patterns of land, water and energy resources in Australia and its territorial waters, and natural factors affecting their development, including climate, soils and terrain; problems of limited surface and underground water resources and of conflicting demands, exemplified through particular basin studies; comparable reviews of energy, minerals and forest resources, human resources and development.

27.883 Special Topic **S1 or S2 T4**

Prerequisite: Nil.

Admission by permission to suitable students with good Passes in at least four subjects at Upper Level. A course of individually supervised reading and assignments as an approved topic in Geography not otherwise offered.

27.884 Advanced Geographic Methods **S1 L2 T2**

Prerequisites: 27.813. Excluded 27.050.

Additional quantitative research techniques normally taken by Honours students in their third year. Research organization; computer analysis; collection and organization of data; statistical description; hypothesis testing and sampling; simple and multiple association analysis; nonparametric methods.

Graduate Study

27.043G Remote Sensing Applications **S1 L1 T2 C3**

The application of remotely-sensed data and information in the description, classification and assessment of earth resources and environmental conditions. Different types of remote sensing data and imagery, their attributes, acquisition and uses. Relevance of remote-sensing data and imagery to a range of applications, including assessment of conditions of terrain, soils and surface materials; multitemporal monitoring and inventory of rangelands, croplands and forests; rural and urban land use assessment; surveillance of surface water resources and sedimentation; appraisal of changes in the coastal zone. Use of remote sensing in environmental management and in environmental impact assessment.

27.171G Directed Problems In **S2 T3 C3**

Remote Sensing

A detailed investigation of a particular aspect of remote sensing technology or an area of applications relevant to candidates interests and background.

27.174G Remote Sensing Instrumentation and Satellite Programs **S1 L2 T1 C3**

Aircraft and satellite platforms; sensor types; image formation and end products including panchromatic, colour, colour IR and thermal IR photographic products, microwave imagery and computer tape products. The organization, acquisition, processing and analysis of imagery obtained from the following satellite programs: Landsat, Skylab, Heat Capacity Mapper Mission, Nimbus Coastal Zone Color Scanner, Seasat, Space Shuttle, Spot and Soyuz-Salyut.

27.202G Environmental Planning and EvaluationC3

Lectures and seminars on environmentalism and political economy, environmental information, impact assessment, and economic evaluation.

27.644G Computer Mapping and Data Display **C3**

Introduction to automated cartography and thematic mapping; theoretical and practical problems in displaying and mapping data by computer; review and application of selected computer mapping packages. INFO is used for database management, and ARC-INFO and GIMMS for cartographic manipulation and output.

27.672G Geographic Information Systems **C3**

Study of selected geographic information systems; problems of data capture and display, data storage and manipulation, system design and development; cartographic displays and computer mapping. INFO is used for database management, and ARC-INFO and MAP for spatial data manipulation and display.

27.902G Meteorological and Hydrological Principles **S2 L3 C3**

1. *Meteorology:* Heat and water balances of earth-atmosphere system. Global pressure, wind and climatic patterns. Atmospheric stability, temperature inversions, aerological diagrams. Synoptic and local and wind systems, dispersal of atmospheric pollutants under various conditions of stability and wind. Precipitation and precipitation fallout. Weather forecasting with particular reference to forecasting pollution potential. **2.** *Hydrology:* Catchment morphology. Precipitation: streamflow relationships; frequency analysis in hydrology. Drought and low flow analyses. Channel morphology and stream velocity characteristics, tidal estuaries, ocean currents. Dispersal of pollutants in flowing water.

27.910G Geomorphology of Arid Lands **S1 L2 T4 C6**

Physiugraphic, geologic and climatic determinants of arid landforms and landforming processes. Rock weathering and weathering products under arid environments. Desert hillslopes and hillslope processes. Geomorphic aspects of runoff on desert hillslopes and the initiation of channel networks; characteristics of desert drainage nets. Geomorphic aspects of desert streamfloods; forms of desert channels and floodplains. Desert playa regimes and the associated features of desert lake basins. Transport of sand and dust by wind and related aeolian landforms and surfaces. Inheritance in desert landscapes and geomorphic evidence of climatic change. Geomorphic aspects of accelerated wind and water erosion in deserts. Exercises in the phoot-interpretation of desert landforms and in related geomorphic mapping.

27.911G Soil Erosion and Conservation **S1 or S2 L2 T4 C6**

Climatic, vegetational, geomorphic and pedologic controls of erosion. Physical processes of sediment transport and deposition. Conservational measures for the prevention of erosion including constructional and managmeent practices. Methods of assessing soil loss risk and erosion hazard evaluation.

27.912G Arid Zone Climatology

Definitions of aridity based on climatic data and their relevance at different scales from hydrologic and biologic considerations. Measures of precipitation effectiveness. Meterological controls of aridity at global and regional scales, and distinctive features controls of the radiation, water and heat budgets as commonly found within arid environments. Climate as a fact in resource utilization considered in terms of plant growth and development, animal ecology, insects and diseases, soil erosion, and human adjustments to arid conditions, including problems of comfort, health, buildings design and energy use. Laboratory and field work is directed towards. **1.** instrumentation and measurements of climatic variables of special interest in arid environments, particularly those important to the radiation, water, and heat budgets; and **2.** statistical and other quantitative methods for summarization and interpretation of single and combined climatic elements to provide relevant information required for sound management of arid lands.

27.913G Soil Studies for Arid Lands Management **S1 or S2 L2 T4 C6**

Soil forming processes in arid regions. Physical, ineralogical and chemical characteristics of arid soils, with emphasis on properties significant for land capability. Chemical and physical properties of saline and alkaline soils. Soil response

to irrigation, secondary salinization and alkalinization. Classifications and distribution of arid zone soils and their environmental relationships. Field methods and soils survey techniques, statistical analysis of soil data and its application to mapping. Laboratory analyses of physical and chemical characteristics of soils, with emphasis on properties significant for land capability.

Based on 27.133 Pedology, with additional reading, tutorials, seminars and practical classes to stress the features of arid zone soils.

The formal component of the above teaching is completed at Kensington. However, a number of tutorial and laboratory hours are devoted to a field-based soil mapping project based at Fowlers Gap Research Station.

27.914G Terrain Evaluation **S1 L2 T4 C6**

Principles and techniques for natural resource surveys and land evaluation including: land systems, terrain patterns, land capability and economic aspects of evaluation; examination of mapping, taxonomic and descriptive units; the problem of map scale and accuracy; styles of presentation for practitioners and other uses. Application of principles in selected other contexts.

27.922G Applied Geomorphology **S2 L1.5 T0.5 C3**

Landform expression of lithology and structure. Hillslope, drainage basin and channel forms and processes. Landform evolution, short-term and long-term geomorphic changes. Geomorphological background to soil erosion, stream channel, floodplain and coastal engineering problems. Geomorphological approach to terrain evaluation. Exercises in airphoto and map analysis of fluvial landforms or terrain types. Field excursion on fluvial landform or terrain assessment, as required.

27.923G Population, Health and Environment **C2**

Relationship between environmental factors and disease morbidity and mortality is examined by consideration of the epidemiological transition in different countries, and the spatial and occupational-specific variation in disease incidence in Australia. Methodology for standardising, testing for significance and data quality.

27.950G Project **S2 T9 C9**

A practical application or investigation in land classification as a basis for land management or land-use planning: or an investiation of soil degradation in relation to soil-vegetation characteristics and land use; or a comparative review of existing approaches to land evaluation. Involves preparation of a report, and fieldwork at Fowlers Gap Research Station or in another part of arid or semi-arid Australia. Tutorial hours are equivalent contact hours, but alos involve fieldwork out of session.

27.951G Research Project **F T9 C18**

As for 27.950G Project, but involving more substantial research over a longer period. Tutorial hours are equivalent contact hours, but may also involve fieldwork out of session.

Remote Sensing

46.101G Project in Remote Sensing **C9**

A minor study of some aspects of remote sensing as it relates to investigations within a particular discipline or subject area offered by Schools within the Faculty of Applied Science.

46.102G Research Project in Remote Sensing **C18**

An investigation of a problem in remote sensing which involves an identifiable research-component. Such an investigation should be related to the research interests of particular Schools within the Faculty of Applied Science.

Environmental Studies

46.200G Research Project in Environmental Studies **C20**

Research investigation on an approved topic, conducted either individually or as part of a team.46.201G Project in Environmental StudiesC10 As for 46.200G but involving a smaller research task.

46.203G Medical Aspects **C2**

Aspects of medicine bearing upon physiological – consequences of pollutants. Synergism and antagonisms, photosynthesis and phytotoxicity, metabolic mechanisms; morbidity and mortality surveys; exposure indices. Particular pollutants aldehydes, nitroolefins, carbon monoxide, sulphur dioxide, oxides of nitrogen, hydrocarbons, ozone and oxidants, particulates, carcinogens.

46.204G Legislative Aspects **C2**

Resources in law for the preservation of satisfactory environments. Local government, town planning, environmental, common law. History of Australian legislation consequences in border regions. Types of legislation and machinery measures and actions thereunder. Problems of administration of available law. American experience. Economic and sociological factors.

School of Materials Science and Engineering

School of Materials Science and Engineering

Head of School
Associate Professor D. J. Young

Administrative Assistant
Mr O. S. Andersen

At the basis of most of the technological advances of recent years, the explosion in new highly sophisticated materials is transforming everything in our manufactured environment, from the humble set of scissors to jet aircraft and America's Cup yachts. New advanced ceramics – lighter, harder and more stable at high temperatures than any metal – are finding applications in motor vehicle engines, electronics components and surgical implants. Manufacturers are looking to these and other sophisticated materials to meet the demands of the new high tech industries (such as lasers, electronics and fibre optics), or in the quest for enhanced fuel economy, durability or fabrication streamlining in their products.

Materials Science has been designated as a primary area for increased investment by the Federal Government in order to meet the expected growth of the materials industry in Australia, particularly in the more sophisticated applications such as electronic and electrical ceramics, high temperature materials, surface coatings, machine tool materials and engineering polymers, increases in the number of graduates and postgraduates are anticipated over the coming decade. In addition, if Australia is to be competitive in the area of advanced materials, the manufacturing industry in this country will have to be developed and restructured, and this can be expected also to create new positions for materials graduates.

The School of Materials Science and Engineering is in a good position to provide the increased numbers of graduates necessary to provide the increased numbers of graduates necessary for development of these new initiatives in materials. It is the only school in Australia which offers professional courses in both ceramic engineering and in metallurgical engineering as well as providing postgraduate specialisation in these fields. The School is extremely well equipped with a wide range of advanced computing, mechanical testing. X-ray, optical and electron microscopy facilities.

The School comprises three departments, ceramic engineering and metallurgical engineering which offer the above-mentioned undergraduate courses, and materials engineering which is responsible for materials servicing activities and for the development of a new degree materials and management.

Ceramic Engineering and Ceramics

The ceramic industry produces and enormous volume and variety of products used in engineering applications, building construction and in our everyday life. As well as the traditional bricks, roof tiles, sheet and container glass and tableware, ceramics have been found essential as abrasives, refractories, enamels and in electrical and electronic applications and nuclear fuels. In may of these cases, ceramic articles make possible the manufacture of other products either by being a key component, such as an electronic or magnetic part, or by forming the material of construction of, for example, a blast furnace or an abrasive wheel. Modern ceramics comprise such a varied and complex group of materials that a high level of training is required to control their

manufacture with the required precision and to supervise their proper use. Ceramic engineers are needed in increasing numbers both in Australia and overseas countries and the Department offers the only degree course in Ceramic Engineering in Australasia. The Ceramic Engineering course trains students in the relation between the structure and the properties of ceramic materials, the engineering and process chemistry of their manufacture and the design principles of their use. Careers open to graduates fall into two broad categories. Some go initially into activities associated directly with production, ie the design and layout of plants, supervision of their construction, and control of their operations. Others move into research and development in industrial laboratories or research institutions. In either case, graduates with organizing ability frequently move into managment if they have an interest in this side of the industry.

In Australia, a number of government research organizations are active in ceramic research, eg the Australian Nuclear Science and Technology Organisation, and the Divisions of Materials Science and Building Research of CSIRO. Investigations with more immediate applications are carried out in industrial laboratories. Even when the basic principles of a process have been worked out in the laboratory, its successful transfer to an industrial scale requires a great deal of effort and expertise. This is an area which offers great scope for further development in Australia.

Graduates in Ceramic Engineering are eligible for membership of the Institution of Engineers, Australia, the Institute of Ceramics Great Britain and the Royal Australian Chemical Institute.

Metallurgical Engineering

The metallurgical profession has developed in importance in keeping with the growth of the Australian metal and mineral industries. These industries are recognized as being important to the Australian economy and there is a strong demand for professional metallurgists in all sectors of these industries, as well as manufacturing industry.

Graduate metallurgists have a wide choice of type of employment and location. They may work in production, technical control or development, in metal or mineral producing plants in locations such as Newcastle, Port Kembla, Broken Hill, Mt Isa, Townsville, Gladstone, Port Pirie, Whyalla, Kwinana, Kalgoorlie or Pilbara; or in manufacturing plants, including the automobile, aircraft, construction industries located mainly in the population centres. In the metal industry the opportunities for a career in management are excellent, since it is a tradition in this industry that management should be in the hand of technical people. If the graduates are inclined towards research and development, they will find considerable scope in various government, university, and industrial research laboratories.

The undergraduate courses in metallurgical engineering and metallurgy are broadly based on the physical sciences and have been designed to prepare graduates for employment in any field of metallurgy within the metal and manufacturing industries or in research institutions.

These courses meet the formal educational requirements for admission to the professional institutes, such as the Australasian Institute of Mining and Metallurgy and the Institution of Metals and Materials Australasia.

Staff

School of Materials Science and Engineering

Associate Professor and Head of School
David John Young, BSc PhD *Melb.*, FRACI MAmerIChE

M.M. Chair of Superconductivity
Vacant

Senior Lecturers
Sydney Blairs, BSc PhD *Manc.*, FIMMA
Peter Krauklis, BSc PhD *N.S.W.*, CEng., MIMMA
Sviatoslav Antonovich Prokopovich, MSc *N.S.W.*, ASTC, CEng, *MIEAust*
Charles Christopher Sorrell, BS *Missouri*, MS *Penn*, PhD *N.S.W.*
John Maurice Wheatley, MA PhD *Camb.*, CEng, FIMMA, FAusWI, MWeld *Lond.*

Lecturers
Alan Gordon Crosky, BSc PhD *N.S.W.*, MIMMA
Alan Keith Hellier, MA *Camb.*, PhD *N.S.W.*, AMIM, AMIMechE, MAus IMM

Honorary Visiting Professors
Anthony Vernon Bradshaw, BSc *Lond.*, CEng, ARSM, FTS, FIMM, MAusIMM
Max Hatherly, MSc PhD *N.S.W.*, ASTC, FTS, CEng, FIM

Professional Officers
Frederick Henry Scott, BSc *N.S.W.*, MAIP
John Walton Sharp, BScTech *N.S.W.*

Administrative Assistant
Ole Staer Andersen, Magr *Copenhagen*, MGenStud *N.S.W.*

Course Outlines

Undergraduate Study

Ceramic Engineering and Ceramics

A four-year full-time course in Ceramic Engineering leading to the award of the BE degree and a six-year part-time course in Ceramics leading to the award of the BScTech degree are offered within the School.

3025
Ceramic Engineering – Full-time Course

Bachelor of Engineering
BE

Year 1		Hours per week S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
4.003	Introduction to Computing	0	2
5.0011	Engineering Mechanics 1	0	4
5.0012	Introductory Engineering Design and Materials Science	2	0
5.0302	Engineering Drawing and Descriptive Geometry	4	0
10.001	Mathematics 1	6	6
		24	24

Year 2			
2.102A	Physical Chemistry	6	0
2.102C	Inorganic Chemistry and Structure	0	6
4.202	Ceramic Process Principles 1	2	0
4.212	Phase Equilibria in Ceramics	3	0
4.232	Ceramic Engineering 1	0	3
4.712	Materials Engineering 1A	3.5	0
4.722	Materials Engineering 1B	0	3.5
4.732	Mechanical Properties of Materials	4	0
4.742	Physics of Materials	0	3
4.752	Thermodynamics of Materials 1	0	3
10.031	Mathematics	2	2
	General Education Subject	2	2
		22.5	22.5

Year 3			
4.213	Chemical Ceramics	5	6
4.233	Ceramic Process Principles 2	3.5	3.5
4.713	X-Ray Diffraction & Electron Microscopy	4	0
4.753	Thermodynamics of Materials 2	3.5	0

Year 3		Hours per week S1	S2
7.7341	Mineral Process Engineering	2	0
4.823	Numerical Methods	1.5	1.5
10.301	Statistics SA	2	2
25.523	Mineralogy	2	2
48.163	Instrumentation and Process Control 1	0	3
48.304	Fuel Engineering for Ceramic Engineers	1	1
	General Education Subject	0	4
		24.5	23

Year 4			
4.054	Materials Seminar	2	2
4.214	Electrical Ceramics	0	3
4.224	Physical Ceramics	5	5
4.234	Ceramic Engineering 2	3	4
4.294	Project Ceramic Engineering*	6	6
4.704	Design with Brittle Materials	3	0
48.047	Chemical Engineering 3D Unit 1 Management	0	2
48.165	Laboratory Automation Science	4	0
	General Education Subject	2	2
		25	24

*Project includes additional 42 hours of laboratory work during the mid year recess.

3030
Ceramics – Part-time Course

Bachelor of Science Technology
BScTech

Stages 1 and 2*		Hours per week S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
4.003	Introduction to Computing	0	2
5.0011	Engineering Mechanics 1	0	4
5.0012	Introductory Engineering Design and Materials Science	2	0
5.0302	Engineering Drawing and Descriptive Geometry	4	0
10.001	Mathematics 1	6	6

*Physics and Mathematics are usually taken in Stage 1 and the other subjects in Stage 2.

Stage 3			
2.102A	Physical Chemistry	6	0
2.102	Inorganic Chemistry and Structure	0	6
4.202	Ceramic Process Principles 1	2	0
4.232	Ceramic Engineering 1	0	3
10.031	Mathematics	2	2
		10	11

Stage 4		Hours per week S1	S2
4.212	Phase Equilibria in Ceramics	3	0
4.712	Materials Engineering 1A	3.5	0
4.722	Materials Engineering 1B	0	3.5
4.732	Mechanical Properties of Materials	4	0
4.742	Physics of Materials	0	3
4.752	Thermodynamics of Materials 1	0	3
	General Education Subject	2	2
		12.5	11.5
Stage 5			
4.233	Ceramic Process Principles 2	3.5	3.5
4.713	X-Ray Diffraction and Electron Microscopy	4	0
4.753	Thermodynamics of Materials 2	3.5	0
10.301	Statistics SA	2	2
48.163	Instrumentation and Process Control 1	0	3
	General Education Subject	0	2
		13	10.5
Stage 6			
4.054	Materials Seminar	2	2
4.213	Chemical Ceramics	5	6
4.823	Numerical Methods	1.5	1.5
7.7341	Mineral Process Engineering	2	0
25.523	Mineralogy	2	2
48.304	Fuel Engineering for Ceramic Engineers	1	1
		13.5	12.5

Metallurgical Engineering

A four-year full-time course in metallurgical engineering leading to the award of the BMetE degree and a six-year part-time course in metallurgy leading to the award of the BSc(Tech) degree are offered within the School.

3125
Metallurgical Engineering – Full-time Course

Bachelor of Metallurgical Engineering
BMetE

Year 1 of the course consists of physics, chemistry, mathematics and engineering subjects and is essentially the same as that for a number of other engineering and science courses offered in the Faculty of Applied Science. Year 2 introduces Materials Science and Materials Engineering subjects supported by chemistry and mathematics and is common with Year 2 in the full-time Ceramics Engineering Course. Physical Metallurgy and Metallurgical Engineering are introduced in Years 3 and 4. In Year 3 the major strands are supported by other engineering subjects and in Year 4 by a thesis project, seminar and professional electives. The course has recently been revised. The new course is given for Years 1-2 while the old course is still shown for Years 3-4.

Students are required to have gained at least sixteen weeks of approved industrial experience before graduation, and to have submitted satisfactory reports on such work. Industrial experience is usually obtained during the long recess periods at the ends of Years 2 and 3. During Years 2, 3 and 4 of the course, visits are made to various metallurgical works, and students are required to submit reports on some of these.

Year 1 (New Course)		Hours per week S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
4.003	Introduction to Computing	0	2
5.0011	Engineering Mechanics 1	0	4
5.0012	Introductory Engineering Design and Materials Science	2	0
5.0302	Engineering Drawing and Descriptive Geometry	4	0
10.001	Mathematics 1	6	6
		24	24
Year 2 (New Course)			
2.102A	Physical Chemistry	6	0
2.102C	Inorganic Chemistry and Structure	0	6
4.712	Materials Engineering 1A	3.5	0
4.713	X-Ray Diffraction and Electron Microscopy	0	4
4.722	Materials Engineering 1B	0	3.5
4.732	Mechanical Properties of Materials	4	0
4.742	Physics of Materials	3	0
4.752	Thermodynamics of Materials 1	0	2
4.762	Materials and Design 1	0	2
4.823	Numerical Methods	1.5	1.5
7.7341	Mineral Process Engineering	2	0
10.031	Mathematics	2	2
	General Studies Category A	2	2
		24	24
Year 3 (Old Course)			
4.413	Physical Metallurgy 2A	2.5	0
4.433C	Physical Metallurgy 2C	4	0
4.443	Physical Metallurgy 2D	0	4
4.453	Physical Metallurgy 2E	0	2.5
4.613A	Metallurgical Engineering 2A	3	0
4.623B	Metallurgical Engineering 2B	0	3.5
4.633	Metallurgical Engineering 2C	3.5	3.5
4.643	Metallurgical Engineering 2D	0	3
4.713	X-ray Diffraction and Electron Microscopy	4	0
6.854	Electrical Power Engineering	0	3
7.7341	Mineral Process Engineering	2	0
7.735	Chemical and Extraction Metallurgy 2	3.5	0
	General Education Subject	0	4
		22.5	23.5

Year 4 (Old Course)		Hours per week S1	S2
4.024	Metallurgy Project**	**6	3
4.044	Professional Electives	5	5
4.054	Materials Seminar	2	2
4.414	Physical Metallurgy 3A	2	0

Year 4 (Old Course)		Hours per week S1	S2
4.424	Physical Metallurgy 3B	2	0
4.434	Physical Metallurgy 3C	0	3
4.614	Metallurgical Engineering 3A	2	0
4.624B	Metallurgical Engineering 3B	3	0
4.634	Metallurgical Engineering 3C	3	0
4.644	Metallurgical Engineering 3D	0	4
4.654	Metallurgical Engineering 3E	0	4
	General Education	0	4
		25	25

**Project includes 84 hours of laboratory work during the mid year recess.

3130
Metallurgy – Part-time Course

Bachelor of Science (Technology)
BSc(Tech)

This course is designed for students who are employed in the metallurgical and manufacturing industries and extends over six part-time years of study. Some of the subjects of stages 3, 4, 5 and 6 may be available only in day-time classes, and up to one days of release from industry per week may be required. The course essentially covers the same subject matter as the first three years and part of Year 4 of the full-time metallurgy course and involves the same major strands of study in Physical Metallurgy and Metallurgical Engineering. The course has recently been revised. The new course is given for Stages 1-4 while the old course is still shown for stages 5-6. In the later stages of the course, there is less emphasis on primary metallurgy than in the full-time course and there is more emphasis on secondary Metallurgical Engineering which is developed to Year 4 level, while Physical Metallurgy is taken to Year 3 level. Students are required to complete an approved program of industrial training of not less than twelve months prior to the award of the degree. Industrial training should normally be completed concurrently with attendance in the course, but with approval of the Head of School may be completed after completion of the prescribed course of study.

Stage 1 (New Course)		Hours per week S1	S2
1.001	Physics 1	6	6
10.001	Mathematics 1	6	6
		12	12

Stage 2 (New Course)			
2.121	Chemistry 1A	6	0
2.131	Chemistry 1B	0	6
4.003	Introduction to Computing*	0	2
5.0011	Engineering Mechanics 1	4	0
5.0012	Introductory Engineering Design and Materials Science	2	0
5.0302	Engineering Drawing and Descriptive Geometry	0	4
		12	12

*There are no evening lectures in this subject.

Stage 3 (New Course)		Hours per week S1	S2
2.102A	Physical Chemistry	6	0
2.102C	Inorganic Chemistry and Structure	0	6
4.742	Physics of Materials	3	0
4.752	Thermodynamics of Materials 1	0	3
10.031	Mathematics	2	2
	General Education Subject	2	2
		13	13

Stage 4 (New Course)			
4.712	Materials Engineering 1A	3.5	0
4.713	X-Rays and Electron Microscopy	0	4
4.722	Materials Engineering 1B	0	3.5
4.732	Mechanical Properties of Materials	4	0
4.762	Materials and Design 1	0	2
4.823	Numerical Methods	1.5	1.5
7.7341	Mineral Process Engineering	2	2
	General Studies	2	2
		13	13

Stage 5 (Old Course)			
4.413	Physical Metallurgy 2A	2.5	0
4.443	Physical Metallurgy 2D	0	4
4.453	Physical Metallurgy 2E	0	2.5
4.613A	Metallurgical Engineering 2A	3	0
4.633	Metallurgical Engineering 2C	3.5	3.5
4.643	Metallurgical Engineering 2D	0	3
4.713	X-ray Diffraction and Electron Microscopy	4	0
		13	13

Stage 6 (Old Course)			
4.034	Industrial Metallurgy Project	4	2
4.054	Materials Seminar	2	2
4.433C	Physical Metallurgy 2C	4	0
4.624B	Metallurgical Engineering 3B	3	0
4.644	Metallurgical Engineering 3D	0	4
4.654	Metallurgical Engineering 3E	0	4
6.854	Electrical Power Engineering	0	3
		13	15

Graduate Study

The School welcomes enquiries from graduates in Science, Engineering and Applied Science who are interested in doing research leading to the award of the degrees of Master of Science, Master of Engineering or Doctor of Philosophy in metallurgy or ceramic engineering or who are intereted in programs involving formal course work and research leading to the award of Graduate Diploma in Materials.

Information about research scholarships, fellowships and grantsin-aid is available from the Head of School and graduates are advised to consult him before making a formal application for registration.

5035
Graduate Diploma in Materials

Graduate Diploma
GradDip

The course is designed to provide specialist professional training in Materials at an advanced level for graduates in related courses in Science, Applied Science or Engineering and is aimed at extending the primary disciplines in this regard.

The current emphasis is on metallic and ceramic materials but it is anticipated that other specializations may be offered. Subject to consultation, other subjects may be drawn from graduate subjects available from other Schools by approval from the Heads of both Schools.

Entry Qualifications

Applicants for admission to the course must be graduates of this University or other approved university or have other qualifications deemed appropriate by the university. However, Faculty may require an applicant to take such other prerequisite or concurrent studies and or examinations as it may prescribe. It is expected that the first degree or other qualification contain mathematics, physics and chemistry to an acceptable level but students without these qualifications may be admitted subject to the approval of the Head of School or required to undertake a qualifying program.

In cases in which qualifying programs or bridging courses are required these can be designed to suit the needs of the individual candidates.

Course Requirements

Candidates are required to complete a program of formal study (including a Project) totalling 20 hours per week over two sessions on a full-time basis, or 10 hours per week over four sessions on a part-time basis. The full-time program will comprise a minimum of 12 hours per week drawn from the graduate subjects as listed below.

Students are assessed by written examination in graduate subjects and professional electives. Marks are assigned to each component of the course according to the proportion of time spent in each graduate subject and professional elective.

The subjects in the graduate program shall comply with the following compulsory and elective subjects in which the professional electives are drawn from the undergraduate group of subjects comprising subject 4.044 Professional Electives with extensions as appropriate to the graduate level.

Compulsory Subjects

		Hours per week S1	S2
4.044	Professional Electives	5	5
4.201G	Graduate Seminar	2	2
4.241G	Graduate Materials Project	6	6
4.633	Metallurgical Engineering 2C	3.5	3.5
		16.5	16.5

Elective Graduate Subjects*

Plus not less than 4 hours per week of electives drawn from the following subjects:

4.211G	Metallurgical Practice		
4.221G	Advanced Metallurgical Techniques		
4.231G	Advanced Theoretical Metallurgy		
4.251G	Advanced Materials Technology	4	4
		20.5	20.5

*The program selected by each student must be approved by the Head of School. Not all electives are offered each session, nor is the full range available each year. Subject to consultation other graduate subjects may be drawn from other Schools by approval from the Heads of both Schools.

Subject Descriptions

Undergraduate Study

4.001 Introduction to Materials Engineering S1 or S2 L1

Forms part of 5.0012.

Metals, ceramics, polymers and composites, their structure, chemical, physical and mechanical properties, engineering applications and production, with particular reference to Australian industries.

4.003 Introduction to Computing S2 L2

Introductory computing. Outline of computer architecture. Features of common computing languages, syntax, structure, variable typing, portability. Basic syntax. Common numerical techniques, function evaluation, Monte Carlo techniques; assignments involving application of these techniques.

4.024 Metallurgy Project S1 6 S2 3

An experimental investigation of some aspects of metallurgy. Includes three weeks laboratory work during the mid-year recess.

4.034 Industrial Metallurgy Project S1 4 S2 2

An experimental investigation of some aspects of industrial metallurgy.

4.044 Professional Electives F5

A combination of the following electives giving a total of at least 140 hours over the whole year 28 weeks. The list of electives is

		Hours
4.204	Ceramic Materials Selection	28
4.444	Advanced Crystallography of Phase Transformations	14
4.494	High Temperature Techniques	14
4.664	Surface Treatments and Wear	14
4.674	Mathematical Plasticity	14
4.684	Transport Phenomena in Metallurgical Processes	14
4.694	Air Pollution Control in the Metallurgical Industry	14
4.704	Design with Brittle Materials	42
7.7451	Advances in Pyrometallurgy	28
7.7452	Advances in Hydrometallurgy	28
7.748	Technical Decision Making	28

The program selected by each student must be approved by the Head of School. Not all electives are offered each session, nor is the full range available each year. Students are advised each year of the timetable of available electives.

4.054 Materials Seminar F L2

Lectures on the preparation and presentation of technical papers. Development of encoding and decoding communication skills in the various communication media. Chairpersonship. Professional ethics and etiquette. Organization and direction of conferences. Traditional and on line retrieval of information. Each student is required to prepare and present a paper on a nominated subject.

4.202 Ceramic Process Principles 1 S1 L2

The nature of ceramics. The scope of the ceramic industry. The origin, classification, physical properties and uses of clay minerals and other non-clay raw materials. Principal unit operations used in the ceramic industry. Drying and firing of ceramics, melt forming, hot forming and other forming procedures.

4.212 Phase Equilibria in Ceramics S1 L2 T1

Phase equilibria and thermodynamic basis of the phase rule. The one component system, the importance of pressure, polymorphism of solids. The two component system: the binary eutectic, intermediate compounds, continuous and partial solid solution, liquid immiscibility. Experimental and thermodynamic methods of constructing phase diagrams. Ternary systems without solid solutions in ternary systems. Non-equlibrium in ceramic systems. Introduction to quaternary and multicomponent systems.

4.213 Chemical Ceramics S1 L2 T3 S2 L3 T3

Prerequisites: 2.102A and 2.102C

Structural principles: crystal chemistry, structure of glasses, defect solid state: phase equilibria and transformations; diffusion; solid state reactions. A systematic treatment of the chemistry of ceramic products.Students are required to take part in a series of factory inspections.

4.214 Electrical Ceramics S2 L1 T2

Prerequisite: 4.742

The intrinsic and extrinsic disorder of ceramic phases. Highly conductive ceramics. Grain boundary phenomena. Electronic and surface conduction. Insulators and substrates. Structure and property relations in ceramic capacitor materials. Piezo and pyroelectric ceramics. Processing, applications and sensors.

4.224 Physical Ceramics F L2 T3

Prerequisites: 4.213

Application of the principles of physical chemistry and solid state physics to a study of the preparation and properties of ceramic materials and components. Mechanical, thermal, electrical and magnetic properties. Nucleation and spinodal decomposition. Solid electrolytes. Mechanisms of sintering and vitrification. Techniques for particle size and surface area determination and the identification of clay minerals.

4.231 Introduction to Ceramic Engineering S2 L2

The nature of ceramics. The scope of ceramic industry. The origin, classification, physical properties and uses of clay minerals and other non-clay raw materials. Principal unit operations used in the ceramic industry. Drying and firing of ceramics, melt forming, hot forming and other forming procedures.

4.232 Ceramic Engineering 1 S1 L3

The principles of operation, construction and fields of application of equipment used in the mining, preparation and fabrication of raw materials, and the drying and firing of ceramic products.

4.233 Ceramic Process Principles 2 F L1 T2.5

Review of raw materials and principal unit operations used in the ceramic industry. Plasticity in a clay-water system. Drying and firing calculations. Polymorphism. Firing and heat transfer considerations. Effect of porosity on fired ceramics. Calculations involving ceramic suspensions. Glass, glaze and porcelain enamel calculations. Relationship between the composition and physical properties of glasses. Rational analysis of clay and fluxing materials. Body formulation. Testing methods and instrumentation in quality control.

Students are required to take part in a series of factory inspections.

4.234 Ceramic Engineering S1 L1 T2 S2 L2 T2

Advanced treatment of fluid flow and heat transfer: non-Newtonian fluids and unsteady-state heat transfer. A detailed study of ceramic engineering unit operations: filtration, forming, drying and firing. Ceramic engineering design including design of dryers, kilns and glass tanks. Design of simple steel structures. Pollution control equipment.

Students are required to take part in a series of factory inspections.

4.294 Project (Ceramic Engineering) F T6

An experimental or technical investigation or design related to some aspect of ceramic engineering.

4.412A Physical Metallurgy 1A S1 L3
Unit 1: Phase Equilibria I

Co-requisite: 2.102A, 4.732.

Elements of crystallography. The crystal structure of metallic phases. Defect structures, dislocations, grain boundaries, plasticity, deformation and recrystallization. Phase equilibrium in alloy systems. Genesis of microstructure. Mechanisms of phase transformations, departure from equilibrium, metastable transition phases. Use of free energy principles to determine nature of phase equilibrium, common tangent construction. Application of Hume-Rothery principles to determine liquidus and solidus boundaries, electron compounds. Introduction to nucleation theory.

Unit 2: Phase Equilibria Laboratory S1 T3

Elementary founding principles. Solidification processes in moulds. Metallography of non-ferrous alloys.

4.413 Physical Metallurgy 2A S1 L1 T1.5

Prerequisite: 4.412A.

Metallography of non-ferrous alloys. Structure property relationships in non-ferrous alloys. Hardening mechanisms. Metallography and properties of copper, aluminium, nickel, magnesium, lead, tin and titanium base alloys.

4.414 Physical Metallurgy 3A S1 L2

Prerequisite: 4.433C.

Studies of diffusional and martensitic phase transformations. Diffusional metastable transition phases, special reference to ageing of commercial alloys, Guinier-Preston zones, coherent and semi-coherent precipitates. Metastable solvus boundaries, reversion. General properties of martensitic transformations; relationship between stress and transformation, thermoelastic behaviour. Shape-memory alloys. Nucleation and kinetics of ferrous martensites. Morphology and strengthening characteristics of ferrous martensites, ausforming and maraging steels. Introduction to crystallographic theory of martensitic transformations. Introduction to coincident site thoery, O lattice theory of interface structures; grain boundaries, recrystallization, interphase boundaries.

4.422B Physical Metallurgy 1B S2 L1 T1

Metallographic techniques. Principles of optical microscopy. Quantitative microscopy and stereology.

4.424 Physical Metallurgy 3B S1 LT1

Prerequisite: 4.713

Intensity of diffracted X-ray beams. Geometry of diffraction. Reciprocal lattice. Ewald sphere construction in thin foil transmission electron microscopy. Application to imaging of stacking faults, dislocations and precipitates.

4.432 Physical Metallurgy 1C S2 L1 T3

Prerequisite: 4.412A

Ferrous alloys. Iron-carbon phase equilibrium. Microstructure and properties of plain carbon steels. Austenite decomposition under equilibrium and non-equilibrium conditions. Dilatometry. Heat treatment of steels. Surface hardening treatments. Microstructure and properties of ordinary cast irons, including grey, white, mottled, malleable and ductile irons.

4.433C Physical Metallurgy 2C S1 L2 T1

Prerequisite: 4.412A.

Theory of plasticity of metals. Introduction to dislocation theory and its application to mechanical properties of alloys. Strengthening mechanisms, creep, fracture, grain size dependence of strength. Introduction to generation of deformation and recrystallization textures. Measurements of age-hardening, activation energy of strain ageing.

4.434 Physical Metallurgy 3C S2 L2 T1

Prerequisite: 7.735.

Structure and properties. Application of the chemistry of the defect solid state to materials preparation and reactivity. Non stoichiometry and stoichiometry dependent physical and chemical properties of metal compounds. Structure and properties of ionic and metallic melts.

4.443 Physical Metallurgy 2D S2 L2 T2

Prerequisite: 4.432.

Diffusion in the solid state, Kirkendall effect, mechanisms. Fick's laws, solutions. Grain boundary, surface and dislocation pipe diffusion. Precipitation, nucleation and growth of isolated precipitates. Co-operative precipitation, pearlite, discontinuous precipitation. Proposed laws governing growth rates, maximum velocity, maximum rate of entropy production. Hardenability. Effect of alloying elements on pearlite growth

rates. Grossman and Jominy tests, calculation of depth of hardening. Development of stresses during quenching, retained stress, distortion, quench cracking.

4.444 Advanced Crystallography of Phase Transformations **S1 or S2 L1**

Co- or prerequisite: 4.414.

Advanced crystallography of phase transformations. Martensite crystallographic theory applied to ferrous martenites, generalization of lattice invariant shear, dilatation. Application of coincident site theory. O lattice theory to generalized phase boundary structure. Crystallography of Widmanstatten precipitates.

4.453 Physical Metallurgy 2E **S2 L1 T1**

Prerequisite: 4.432.

Alloy steels. Ternary equilibria involving iron and carbon. Metallography and properties of alloys steels. Effect of alloying elements on austenite formation and decomposition under equilibrium and non-equilibrium conditions. Heat treatment of alloy steels. Metallography and properties of alloy cast irons.

4.494 High Temperature Techniques **S1 or S2 L1**

Experimental methods for the determination of thermophysical and thermochemical properties at elevated temperatures.

4.613A Metallurgical Engineering 2A **S1 L2 T1**

Prerequisite: 4.722.

Transport processes. Application of transport principles to primary and secondary metallurgical practice. Course examples are drawn from metallurgical engineering practice in the broadest sense. Heat losses from BOF vessels and ladies. Slab cooling in hot strip mills. Interaction of free and submerged gas jets with melts. Accretion stability, back wall and tuyere erosion. Continuous casting. Solidification in metal and sand moulds. Solute transference between liquid metals and slags. Vacuum and magnesium desulphurization of steel melts. Lead softening. Cementation. Role of line and point defects on reactivity.

4.614 Metallurgical Engineering 3A **S1 L1 T1**

Prerequisite: 4.613A.

Kinetics and mass transfer in metallurgical processes. Kinetics of interphase transfer in metallurgical systems. Single particle, fluid solid reactions, topochemical reactions, reactions of porous solids. Application to reduction of iron oxides. Reaction between liquid metals and gases, reactions involving drops and bubbles. Reaction between liquid metals and slags, mass transfer at bubble stirred interfaces. Application to metal refining proces sess. Vacuum degassing and refining processes.

4.623B Metallurgical Engineering 2B **S2 L3 T0.5**

Prerequisite: 2.102A.

Electrometallurgical engineering. Thermodynamics, kinetics and electrochemistry of aqueous solutions, potential-pH diagrams and other stability diagrams. Application to hydrometallurgy, corrosion, corrosion prevention and electrodeposition and electropolishing. Contacting of metallurgical phases, batch and continuous contacting. Application to design of leaching systems and reduction of metal oxides. Electrochemical corrosion, types of corrosion, influence of alloying and heat treatment, influence of stress. Corrosion prevention, cathodic protection, passivation and inhibitors, selection of materials, designing against corrosion. Electrodeposition, growth morphology, electropolishing.

4.624B Metallurgical Engineering 3B **S1 L3**

Prerequisite: 4.732.

Mechanical and thermal processing. Mechanisms of deformation. Origin of rolling and annealing textures. Inhomogeneities of deformation. Texture control and controlled rolling. Application to transformer steel, HSLA steel, deep drawing steel, tungsten filaments. Superplasticity, creep, deformation maps. Sheet metal forming. Industrial operations of cutting, piercing, blanking, folding, bending, stretching, flow turning, deep drawing. Materials requirements for dies and sheet. Assessment of formability. Forming limit diagrams.

4.633 Metallurgical Engineering 2C **F L2 T1**

Prerequisites: 10.001 or 10.011.

Mathematical methods. 1. 10.301 Statistics SA see Engineering Handbook 2. Numerical methods. Finite difference and finite element techniques and their application to metallurgical phenomena involving diffusional transport, elasticity and plasticity.

4.634 Metallurgical Engineering 3C **S1 L2.5 T0.5**

Prerequisite: 4.453.

Advanced materials. Interrelationship between the structure and properties of metallic and non-metallic magnetic materials. Domain magnetism. Magnetic anisotropy and control of magnetic properties by modification of microstructure. Magnetically soft and hard magnetic materials. Metallic glasses. Microstructure and properties of high temperature alloys, iron-base alloys, nickel-iron alloys, nickel-base, cobalt-base and chromium-base alloys. Strengthening mechanisms. Creep, oxidation and hot corrosion. Coatings and protection. Process metallurgy and applications of high temperature alloys. Fibre composites, Fibre and matrix materials, fabrication. Design with fibre composites. Mechanical properties and environmental effects, corrosion, fatigue, creep and damage tolerance. Mechanisms of sintering in metals. Techniques of powder metallurgy; compaction, powder characteristics. Sintering in presence of liquid phase, cementation, cermets. Preparation of super-alloys.

4.642 Metallurgical Engineering 1D **S2 L1 T1**

Prerequisite: 4.732.

Metal forming. Introduction to metal forming operations. Factors affecting deformation and workability. Processes of forging, rolling, extrusion, and wire drawing. Die materials and geometry. Deformation parameters and processing defects.

4.643 Metallurgical Engineering 2D **S2 L2 T1**

Prerequisites: 4.412A, 4.732.

Fracture mechanisms. Classification of macroscopic and microscopic fracture mechanisms in metals. Initiation and

propagation of ductile, brittle, fatigue, creep, stress-corrosion and corrosion-fatigue fracture. Effect of metallurgical defects and design deficiencies on origin and cause of fracture. Analysis of various models of fracture using metallographic and scanning transmission electron fractographic techniques. Studies of case histories of engineering service failures.

4.644 Metallurgical Engineering 3D **S2 L2 T2**

Prerequisite: 4.453.

Welding engineering. Welding metallurgy, welding of structural steels, Q and T steels, stainless steels. Welding of aluminium alloys. Welding codes and standards. Welding processes, SMAW, GMAW, FCAW, SAW. Resistance welding, robotic welding. Electron-beam welding, laser welding. Non-destructive testing X-ray and gamma radiography, ultrasonic and eddy current testing.

4.654 Metallurgical Engineering 3E **S2 L1 T3**

Prerequisites: 4.633, 4.643.

Engineering design. Engineering design codes of practice, experimental and theoretical stress analysis and fracture mechanics. Design codes and statutory regulations with emphasis on selection of materials for service conditions. Design approaches to fatigue and brittle fracture are treated in terms of contemporary rules for approaches to fatigue and dynamic loading and low temperature service. Stress analysis component is presented in terms of both experimental techniques and numerical analysis using finite element computer programs. Emphasis in laboratory classwork is on electrical resistance strain gauge techniques but other techniques are also applied. Quantitative design against fracture in terms of linear elastic fracture mechanics and elastic plastic fracture mechanics using COD and J integral approaches is presented with reference to case studies.

4.664 Surface Treatments and Wear **S2 L1 T1**

Prerequisite: 4.623B.

Coatings for corrosion prevention, engineering and decorative purposes. Specifications for coating systems. Electrochemical and other metallic coatings. Non-metallic coatings. Selection, testing and evaluation of coatings. Classification of wear modes. Mechanisms of adhesive and abrasive wear. Selection, testing and evaluation of materials for wear mitigation. Wear-resistant materials, wrought and cast steels, cast iron, hard-facing and non-metallic materials.

4.674 Mathematical Plasticity **S2 L1**

Prerequisite: 4.633.

Mathematical approaches to macroscopic plastic deformation; slip line field analysis, upper and lower bound techniques, finite element techniques. Application to estimation of loads and stresses developed during industrial deformation processes: rolling, drawing, bending.

4.684 Transport Phenomena in Metallurgical Processes **S1 or S2 L1**

Co- or prerequisite: 4.614.

Control of many metallurgical processes and design of suitable plant depend on an appreciation of factors affecting rate of reaction. In many cases, especialy when conditions are far from equilibrium, transport of heat and or mass is rate limiting.

Deals with application of transport processes fluidised flow, heat and mass transfer to a number of typical processes. Illustration from: iron-making, steelmaking, combustion, fluidized bed processing, leaching, solvent extraction, vacuum processing.

4.704 Design With Brittle Materials **S1 or S2 L1 T1**

Pre-requisites 4.732 or 8.6110

Materials with stiffness and resistance to wear, chemical attack and high temperature. Effects of composition and ceramic micro-structure on mechanical properties. Strength and fracture theories; brittle fracture. Effect of time under loan. Design principles; effect of thermomechanical stress. Design for loaded components. Selection of materials. Inspection and non-destructive testing and evaluation. Standards.

4.712 Materials Engineering 1A **S1 L1 T2.5**
Unit 1. 3220 Introduction to Fluid Flow **S1 L1 T1**

Prerequisites: 1.001, 10.001

Fundamental concepts of Fluids. Simplification of the Navier-Stokes Equation: Fluid Statics, continuity. Bernoulli's equation, momentum and energy equations. Flow in closed conduits, including laminar and turbulent flow and losses due to friction. Measurement in Fluid Mechanics; viscosity, pressure, velocity, flowrate.

Unit 2. 4712A Fluid Flow in Materials Processing **S1 T1.5**

Prerequisties: 3220

Application of the principles of fluid flow in the production and application of ceramic and metallic materials. Subject examples are drawn from ceramic and metallurgical engineering practice in the broadest sense.

4.713 X-Ray Diffraction and Electron Microscopy **S1 L2 T2**

Prerequisite: 4.412A or 4.212

X-ray diffraction, electron optics, and analysis. Production, absorption and diffraction of X-rays. Powder and single crystal X-ray methods. Stereographic projections and crystal geometry. Applications of diffraction methods to solid solutions and solubility limit, thermal analysis, stress measurement, chemical analysis. X-ray fluourescence spectroscopy and analysis, on-stream analysis. Electron optics and analysis, transmission and scanning electron microscopy. Energy-loss spectrometers, microanalysis.

4.722 Materials Engineering 1B
Unit 1. 3.222 Heat Transfer and Temperature Measurement **S1 L1 TI**

The subject will deal with conduction, convection and radiation. Conduction will cover Fourier's Law and the thermal resistance concept. Convection will deal with passage of fluid over a surface and the importance of the Reynolds number in calculating the convection heat transfer coefficient. Radiation will deal with blackbody radiation and Stefan's Law. Applications to industrial heat transfer equipment will be discussed.

Temperature measurement devices and circuits. Pyrometry.

Unit 2. 4722A Heat Flow in Materials Processing S1 T1.5

Prerequisite: 3.222.

Application of the principles of heat transfer in the production and application of ceramic and metallic materials. Subject examples are drawn from ceramic and metallurgical engineering practice in the broadest sense.

4.732 Mechanical Properties of Materials S1 L2 T2

Prerequisite: 5.0011. Co-requisite: 4.412A.

Mechanical properties of solids. Nature and significance of mechanical properties. Mechanical testing; the tension test, hardness testing and impact testing. Stress-strain-time relationships. Analysis of stress and strain, stress and strain transformation relationships, Mohr's circle, elastic stress-strain relationships, application to various types of loading and metal working processes. Failure and yeilding criteria. Influence of stress state, temperature, strain rate and environment on mechanical behaviour.

4.742 Physics of Materials S2 L2 T1

Pre-requisite: 1.001 or 1.011.

Interatomic bonding in solid materials. Types of interatomic bonds, metallic, covalent, ionic. Introductory quantum mechanics in one dimension, free electron theory, effects of periodic potential, density of states curves. Effect of electron to atom ratio on conductivity and crystal structure; semiconductors; instrinsic, extrinstic. Exchange energy; ferromagnetism, antiferromagnetism. Elementary perturbation theory, covalent bond; crystal structures, properties. Ionic bond, crystal structures, force models, properties.

4.752 Thermodynamics of Materials 1 S2 L2 T1

Prerequisite: 2.102A

Fundamental principles of the thermodynamics of closed and open systems. Phase equilibria, the stability and composition of coexisting phases. Chemical potential, fugacities and activities of gases and gas mixtures. The thermodynamics of nucleation and growth of percipitates and spinodal decomposition. Order-disorder in phases. Tabular, analytic and diagrammatic representation of thermo-dynamic properties. Mass and energy balances. Application of thermodynamics to materials properties and preparation.

4.753 Thermodynamics of Materials 2 S1 L2 T1

Prerequisite: 4.752

Thermodynamics functions of mixing, excess and integral mixing functions. Thermodynamic stability and models of solutions, standard states. Long-range order in solutions, interstitial solution. Calculation of phase diagrams. Thermodynamics of interfaces and surfaces. Statistical thermodynamics of solutions. Thermodynamics of irreversible processes. Computer programs for calculation of thermodynamic functions of mixing. Experimental methods in thermodynamics. Application of thermodynamics in material behaviour and reactivity and in industry.

4.762 Materials and Design 1 S1 L1 T1

An appreciation of the relationships between the properties of materials, component design, manufacture and product performace. Materials selection as an integral part of successful design. Long term potential for materials improvement and substitution. Plant visits to selected materials processing plants.

4.694 Air Pollution control in the Metallurgical Industry S1 or S2 L0.5 T0.5

Case studies of emission survey, measurements and compliance program planning in the primary and secondary metallurgical industries.

4.823 Numerical Methods F L1 T0.5

Prerequisite: 10.031.

Consists of Unit 2 – Numerical Methods of 4.633 Metallurgical Engineering 2C.

4.913 Materials Science F L2

1. The properties of crystalline solids. Defect structure of crystals. Influence of defects on the behaviour of crystals. The properties of metals and metallic alloys in terms of modern theories. The development of alloys for specific engineering applications. The elastic and plastic properties of solids. The mechanisms of fracture in crystalline solids. Ductile and brittle fracture. Creep. Fatigue. Design of materials. **2.** *Metallic corrosion. Polymer materials:* The structure and properties of polymers. Mechanisms for the modification of properties. *Ceramic materials:* The structure and properties of ceramics. Similarities and differences with other crystalline solids. Ceramic-metal composites.

4.934 Design with Advanced Materials S2 L4 T2

The development, application and design with advanced materials of relevance to the chemical process industries. Studies of case histories of engineering service failures.

4.942 Materials for Mining Engineers F L2

Solidification of metals, structure and defects in castings and welds. Phase equilibrium and strengthening mechanisms in alloys – application to engineering materials, including ferrous and non-ferrous alloys. Non-equilibrium structures, heat treatment and modification of structures and properties. Elastic and plastic deformation. Mechanical properties of solids and their significance. Mechanical testing– tension, hardness, impact. Stress-strain-time relationships and the influence of stress state, temperature, strain rate and environment. Corrosion. Fracture and fatigue. Use of hardfacing and carbides in minimising wear of mining machinery.

4.964 Materials Science and Engineering for Electrical Engineers S2 L3 T1

Prerequisite: 1.982 Solid State Physics.

Metallic, ceramic, organic, polymeric and composite materials and their technology for electrical engineering applications. Structures and structure property relations, phase equilibria and their effect on mechanical, electrical, magnetic, thermal and chemical properties. The shaping, treating and joining of materials. Aqueous and gaseous corrosion. Metallic glasses, superconductors, fast ion conductors. The role of materials science in the development of electrical energy systems.

Graduate Study

For Information Key refer to page 10.

4.201G Graduate Materials Seminar **F L1 T1**

Instruction in written or oral presentation of technical and scientific material at an advanced level which involves a presentation by the candidate of a lecture on a selected topic.

4.211G Metallurgical Practice **S1 or S2**

Studies relating to one or more specialised areas such as founding, welding, corrosion.

4.221G Advanced Metallurgical Techniques **S1 or S2**

Lectures and laboratory work in such areas as metallography, electron microscopy, stress analysis, fracture mechanics, mechanical testing and electrochemical techniques.

4.231G Advanced Theoretical Metallurgy **S1 or S2**

Topics drawn from physical, chemical and mechanical metallurgy.

4.241G Graduate Materials Project **F6**

An experimental, technical investigation or design project, including a written thesis.

4.251G Advanced Materials Technology **S1 or S2**

Principles of materials selection, selection of materials based on engineering design criteria, materials, specifications and principles and methods of non-destructive testing.

School of Mines

School of Mines

Head of School
Professor G. J. S. Govett

Administrative Assistant
Miss L. A. Bruce

The School of Mines, which was formed in 1986, consists of three Departments corresponding to the three main professions on which the mining and minerals industry of Australia depends. These are the Departments of Applied Geology; Mining Engineering; Mineral Processing and Extractive Metallurgy.

Prior to the formation of the School of Mines, Applied Geology and Mining Engineering were separate Schools and Mineral Processing and Extractive Metallurgy (sometimes referred to as Mineral Engineering) was spread among several other Schools in the Faculty. Bringing the three together into the School of Mines is an important development in mining industry education in Australia.

Geologists, Mining Engineers and Mineral Engineers work closely together in the mining industry. The Geologist is responsible for discovering new mineral resources and for defining the size, value and condition of the deposit. The Mining Engineer decides if the deposit is worth mining, designs the mine and thereafter manages it throughout its life. The Mineral Engineer deals with these resources after they have been mined, and designs and manages the large plants needed to turn the crude ore into metal or the raw coal into saleable fuel.

Each is an expert in her or his own field, but each also needs to have a good appreciation of the work of the other two. Professional roles in the mining industry are not always clear cut and it is a distinct advantage for geologists, mining engineers and mineral engineers to study and interact together while at University, in preparation for their necessarily close involvement with each other during their professional careers.

Separate degree courses are available in each of the Departments as described below. Students enrol in the course of their own choice and many activities are departmentally centred, but others are School-based to provide a corporate identity with the mining and allied industries.

Department of Applied Geology

Head of Department
Professor J. Roberts

Geology is 'the science of the earth', and as such covers a broad spectrum of knowledge on the constitution and evolution of our planet. Applied geology involves a specific interest in the use of earth science for the benefit of humanity, including, for example, the search for and evaluation of metallic ore-bodies and accumulations of fossil fuels, or the application of geological knowledge to a range of engineering and environmental problems.

Department of Mineral Processing and Extractive Metallurgy

Head of Department
Dr J. D. Navratil

Mineral Engineering comprises those professional activities required for the extraction of valuable components from mined ore, and their conversion into refined metals and similar products used in the manufacturing industries. Graduates from the Mineral Engineering degree course are capable of

the professional activities of research and development, design and commissioning of processes and plants, and operation and supervision of production plants in the mineral industry.

The mineral industry is diverse in scope, scale and location. It produces refined metals, construction materials, coal and coke, and a wide variety of other products such as chemicals, ceramics, abrasives and paints. Every mineral deposit has some unique characteristics that influence the extraction processes. Also each deposit is limited in quantity, consequently new ones must be continually investigated and developed. There is, therefore, a progressive challenge to mineral engineers to improve extraction methods and develop new techniques.

Department of Mining Engineering

Head of Department
Professor F. F. Roxborough

Administrative Assistant
Ms. S. Howard

Mining Engineering is concerned with the design, development and management of mines for the extraction of the earth's mineral and energy resources. Mining production whether underground, at the surface, offshore or on the sea floor is a technically advanced engineering activity and the mining engineering course caters for the present day and future requirements of the industry. The mining engineer is a front line executive in control of all phases of a mining project from evaluation of a coal or an ore deposit, the planning and development of its extraction, its processing on site, the safe disposal of waste products and the restoration of the environment during and after mining.

Most mining engineers are trained for careers in mine production and management and their engineering and managerial roles necessitate liaison with a range of experts, from those engaged in exploration geology, to those in end-product development and marketing. The mining engineering course involves a strong grounding in basic sciences, engineering principles and management as a foundation to training for the production and mine management functions. The course also provides a good appreciation of the science of geology, the technology of mineral processing and the economics of resources so that the mining engineer can effectively work in any section of the mining industry from evaluation of ore reserves to marketing and finance.

The mining engineer's training has an appeal to many other industries in that it combines excellence in a broad range of disciplines from science and engineering to economics of management of human resources. With such a background, mining engineers can easily adapt to work in almost any industry either on graduation or at a later stage in their career.

After graduation, mining engineers who choose to develop careers in production management, will be required to gain further practical experience before obtaining a Mine Managers Certificate of Competency, in either Coal or Metalliferous Mining. These statutory certificates of competency are issued by the State Department of Industrial Relations, which in the case of New South Wales coal mining comes under the Coal Mines Regulation Act No. 67, 1982, and for metalliferous mining under the Mines Inspection Act No. 75, 1901, as amended.Arrangements have been made with the Universities of Newcastle and Tasmania for students who have completed a specified program at these institutions to be admitted with advanced standing to Year 3 of the Mining Engineering degree course at the University of New South Wales.

General Education Electives

For details of changes in the General Education requirements see Faculty Information

Staff

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Administrative Assistant
Lynne Anne Bruce

Department of Applied Geology

Professor and Head of Department
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Greg McNally, BSc *Syd.*, BA *N.E.*, MAppSc *N.S.W.*
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Project Scientist
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Peter Richard Atherden, BSc *N.S.W.*, MSc *Macq.*
Mark Francis Reddy, BSc *N.S.W.*

Department of Mineral Processing and Extractive Metallurgy

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Department of Mining Engineering

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Administrative Assistant
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Professional Officers
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Joseph Arthur Shonhardt, BScTech MSc *N.S.W.*

Key Centre for Mines (Incorporates the University of New South Wales and the University of Wollongong)

Director
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Administrative Assistant
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Centre for Groundwater Management and Hydrogeology (in association with the Faculty of Engineering)

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Deputy Director
Colin Raymond Dudgeon, BE ME PhD *N.S.W.*

Senior Staff Member
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Richard Ian Acworth, BSc *Leeds*, MSc PhD *Birm.*, FGS

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Research Assistant
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Professional Officers
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Administrative Assistant
Beverley Ann Collin

Centre for Waste Management (in association with the Faculty of Engineering)

Director
Eric Matthew Claus, BSc *Loyola Marymount*, MSc *Utah State*, MIE Aust

Deputy Director
Michael John Knight, BSc PhD *Melb.*, FGS, MIE Aust

Course Outlines

Undergraduate Study

Department of Applied Geology

The degree course in Applied Geology is of four years' duration and leads to a BSc degree at Pass or Honours level. It provides a comprehensive education in all aspects of earth science, with emphasis on the skills and applications required for professional practice of geology in the mineral industry, construction and development, or related areas. Graduates are prepared by the course to enter any branch of the geological profession, and to change their area of employment as different opportunities arise.

No previous knowledge of geology is required to enter this course but a sound background in mathematics together with one or more other science subjects is essential. Students will take programs designed to bring them up to a satisfactory standard of physics and chemistry in year 1. Students who have reached a satisfactory standard in HSC geology may be offered an alternative program in Year 1.

A three-year full-time course in Geology, and courses that combine a single major in Geology with Physics, Chemistry, Mathematics, or Botany and Zoology, and courses that combine Geology with Geophysics and Geography are available to students in the Faculty of Science. Provision is also made for part-time study in the first year of Geology within that Faculty. Selected students in the Faculty of Science may study for an Honours degree in Geology.Master of Applied Science degree courses in Engineering Geology, Hydrogeology, Environmental Geology, Mineral Exploration, Exploration Geochemistry and Exploration Geophysics are offered on a part-time or a full-time basis. The courses are designed to provide specialized training in practical applications to these fields.

General Education Electives

For details of changes in the General Education requirements refer to the table earlier in this chapter.

3000
Applied Geology – Full-time

Bachelor of Science
BSc

Year 1		Hours per week S1	S2
1.001	Physics 1	6	6
OR			
1.021	Introductory Physics	6	6
2.121	Chemistry 1A*	6	0
2.131	Chemistry 1B	0	6
10.001	Mathematics 1 *or*		
10.021B	General Mathematics 1B *and*	6	0
10.021C	General Mathematics 1C	0	6
25.110	Geological Processes**	6	0
25.120	Geological Environments**	0	6
		24	24

*Students without the specified prerequisite for 2.121 will be required to take either a Chemistry Bridging Course or 2.111, Introductory Chemistry before enrolling in this subject.

**Up to 2 days of field tutorials in 25.110, Geological Processes and up to 4 days in 25.120, Geological Environments are essential parts of these subjects. Attendance is compulsory.

Year 2			
25.211	Earth Materials 1**	6	0
25.212	Earth Environments 1**	6	0
25.221	Earth Materials 2***	0	6
25.223	Earth Physics*	0	6
25.2261	Mathematical Geology 1	0	3
	General Education Elective	2	2
		14	17

*Field work of up to 2 days is a compulsory part of the subject.
**Field work of up to 5 days is a compulsory part of the subject.
***Field work of up to 4 days is a compulsory part of the subject.

Students take Ancillary Subjects equivalent to 2 units from Table 1 of the Combined Sciences Handbook.

Year 3			
25.311	Earth Materials 3	6	0
25.321	Earth Materials 4*	0	6
25.312	Earth Environments 2**	6	0
25.333	Exploration Geophysics	3	2
25.3162	Mathematical Geology 2	3	0
25.314	Mineral and EnergyResources 1***	6	0
25.324	Mineral and Energy Resources 2*	0	6
25.325	Engineering and Environmental Geology***	0	6
25.3281	Exploration Geochemistry	0	2
25.3271	Structural Geology*	0	2
	General Education Elective	2	2
		26	26

*Field work of up to 4 days is a compulsory part of the subject.
**Field work of up to 7 days is a compulsory part of the subject.
***Field work of up to 3 days is a compulsory part of the subject.

Year 4		S1	S2
25.411	Advanced Geological Techniques*	6	
25.412	Professional Practice**	6	
25.413	Special Topics in Applied Geology**	12	
25.420	Field Project		24
		24	24

* Field work of up to 7 days is a compulsory part of this subject.
** Formal classes are scheduled for 13 weeks only to accommodate the field tutorial component of 25.411.

Recommended Programs in subject 25.413 Special Topics in Applied Geology:

		Hours per week (13 weeks)
a)	**Mineral Exploration and Mining Geology†**	
	Principles of Mining *or*	
	Mines Development	2
	Mine Economics	4
	Mineral Process Engineering or	
	Sampling and Analytical Methods	2
	Exploration Geology	2
Total		10
b)	**Sedimentary Basin Studies**	
	Seismic Stratigraphy	2
	Advanced Sedimentology	4
	Advanced Coal Geology	2
	Advanced Petroleum Geology	2
Total		10
c)	**Geophysics*†**	
	Gravity and Magnetic Methods	2
	Seismic Methods	2
	Electrical Interpretation	2
	Regional Geophysics	2
	Geophysical Interpretation	2
Total		10
d)	**Engineering Geology***	
	Engineering Geology	4
	Geomechanics	2
	Hydrogeology	2
	Environmental Geology	2
Total		10

Plus one additional two hour subject from either the above list or a list of other topics, subject to the approval of the Head of Department.

* An additional two hour subject may be prescribed by the program authority.
†Fieldwork of up to three days is a compulsory part of this program.

Department of Mineral Processing and Extractive Metallurgy

The Department offers an undergraduate course of four years duration leading to the award of a BE degree at pass or honours level. This course meets the formal requirements for admission to the professional mining and metallurgical institutions.

A double degree in Chemical Engineering and Mineral Engineering, Bachelor of Engineering Bachelor of Science degree is available. Students may be awarded honours BE BSc double degree for distinguished performance over five years of study. Refer to School of Chemical Engineering.

The Mineral Engineering course is based on a broad spectrum of mathematics, physics, chemistry, geology, mineralogy and chemical engineering, and specializes in mineral processing, extractive metallurgy and process plant design.

A Master of Applied Science degree course in Mineral Engineering is also offered.

3126
Mineral Engineering – Full-time Course

Bachelor of Engineering
BE

Year 1		Hours per week S1	S2
1.001	Physics 1	6	6
2.121	Chemistry 1A and	6	0
2.131	Chemistry 1B	0	6
5.0011	Engineering Mechanics 1	4	0
5.0012	Introduction to Engineering Design and Materials	2	0
5.0302	Engineering Drawing and Descriptive Geometry	0	4
7.610	Introduction to Mining and Mineral Engineering	0	2
10.011	Higher Mathematics 1 *or*		
10.001	Mathematics 1	6	6
		24	24
Year 2			
2.102A	Physical Chemistry	6	0
7.621	Mineral Engineering Science 1	0	3
7.622	Mineral Engineering 1	3	3
37.623	Mineral Engineering Laboratory 1	0	3
10.031	Mathematics	2	2
10.301	Statistics SA	2	2
25.520	Geology for Mining Engineers 1	2	2
48.021	Chemical Engineering 1A		
	Unit 1 Heat Transfer 1	0	2
	Unit 2 Computations	1	1
	Unit 3 Dimensions and Dimensional Analysis	1	0
48.301	Fuel Engineering for Mining Engineers	3	3
	General Education Subject	2	2
		22	23
Year 3			
4.972	Materials for Mining Engineers	2	2
6.854	Electrical Power Engineering	0	3
7.113	Mining Methods	2	2
7.631	Mineral Engineering Science 2	5	0
7.632	Mineral Engineering 2	3	3
7.633	Mineral Engineering Laboratory 2	3	3
10.032	Mathematics	2	2
25.523	Mineralogy	2	2
48.031	Chemical Engineering 2A		
	Unit 1 Mass Transfer Theory	2	0
	Unit 2 Heat Transfer 2 Theory	1	0
48.136	Reactor Design	1	2
48.163	Instrumentation and Process Control 1	0	3
	General Education Subject	2	2
		25	24

Year 4		Hours per week S1	S2
7.214	Mine Economics and Planning	4	4
7.642	Mineral Engineering 3	6	6
7.643	Mineral Engineering Projects and Laboratory	6	9
48.041	Chemical Engineering 3A		
	Unit 2 Simultaneous Heat and Mass Transfer	1	0
	Unit 4 Transport Phenomena	1	0
48.042	Chemical Engineering 3B		
	Unit 2 Optimization	1	0
	Professional Electives*	3	3
	General Education	2	2
		24	24

*Professional Electives: Appropriate subjects to the total of six session hours may be nominated. A list of some such subjects is available from the Head of School.

3129
Chemical Engineering Mineral Engineering – Full – time Course

Bachelor of Engineering/Bachelor of Science BE/BSc

Refer to School of Chemical Engineering and Industrial Chemistry section.

Department of Mining Engineering

The Department offers a 4 year full-time course in Mining Engineering leading to the award of the degree of Bachelor of Engineering at Pass or Honours level, and a graduate course requiring one year of full-time or two years of part-time study leading to the award of the Graduate Diploma GradDip in Mining and Mineral Engineering.

3140
Mining Engineering – Full-time Course

Bachelor of Engineering BE

Year 1 of the course is similar to as that for several other Engineering courses and Year 2 includes those subjects of common relevance to the Engineering disciplines. Year 3 is largely devoted to basic mining subjects and Year 4 provides advanced instruction in subjects essential to all mining engineers. In addition, the fourth year offers a wide range of elective subjects, allowing students, if they so wish, to concentrate their studies on a particular sector of the industry, such as coal mining or metalliferous mining. An important fourth year requirement is for students to undertake personal research or a study project in mining or minerals engineering on which they are required to submit a thesis for examination.

For the award of Honours at the conclusion of the full-time course, students will need to have distinguished themselves in the formal work, in other assignments as directed by the Head of School, and in the final year project.

In the undergraduate course it is compulsory for students to gain practical experience in the mining industry during successive long recesses. The minimum requirement is 100 days which must be completed before graduation. The School assists students in securing suitable vacation employment. Students are required to submit for assessment an industrial training report on the vacation and other relevant experience acquired.

Year 1		Hours per week S1	S2
1.001	Physics 1	6	6
2.951	Chemistry 1 ME	6	0
5.0011	Engineering Mechanics 1	4	0
5.0721	Computing	0	3
7.011	Stress Analysis in Mining 1	0	3
7.021	Mining, Minerals and the Environment*	0	3
7.031	Descriptive Engineering	2	0
7.041	Technical Communication	0	3
10.001	Mathematics 1	6	6
		24	24

*Visits to mines and related undertakings are a requirement of this subject.

Year 2			
1.9222	Electronics	3	0
4.942	Materials for Mining Engineers	3	3
6.854	Electrical Power Engineering	0	3
7.012	Stress Analysis in Mining 2	3	0
7.132	Fluid Mechanics and Thermodynamics	2	2
7.142	Mine Development*	2	0
7.172	Microcomputers Mining	2	0
10.022	Engineering Mathematics 2	4	4
10.301	Statistics SA	2	2
25.520	Geology for Mining Engineers**	2	2
29.441	Surveying for Engineers	0	6
29.491	Survey Camp	0	0
	General Education Subject	2	2
		25	24

*Visits to mines and related undertakings are a requirement of this subject.
**Includes two compulsory field tutorials.

Year 3			
7.113	Mining Methods	2	2
7.1231	Geomechanics A	3	0
7.1232	Geomechanics B	0	2
7.133	Mine Transport	0	3
7.153	Power Supply in Mines	2	0
7.163	Excavation Engineering	2	2
7.173	Computer Applications in Mining	1	1
7.183	Mine Ventilation and Drainage	2	2
7.213	Mine Surveying	2	0
7.223	Mine Feasibility Studies	0	1
7.433	Mining Laboratory	2	2
7.7342	Minerals Engineering Processes	3	3
25.530	Geology for Mining Engineers 2*	4	4
	General Education Subject	2	2
		25	24

*A geology field excursion is held in Session 2.

Year 4		**Hours per week** S1	S2
7.114	Geotechnical Engineering	2	2
7.174	Mining Legislation	0	2
7.214	Mine Economics and Planning	4	2
7.224	Operational Management	2	2
7.304	Mine Safety Engineering	2	2
7.414	Minerals Industry Project	5	5
7.424	Industrial and Research Seminars	1	1
	General Education Subject	2	2
together with an approved group of three advanced subjects selected from the following			
7.104	Underground Coal Mining*	2	2
7.144	Surface and Offshore Mining	2	2
7.184	Underground Metalliferous Mining*	2	2
7.194	Tunnel Engineering and Shaft Sinking	2	2
7.744	Mineral Process Technology	2	2
		24	24

†Approval for a group of subjects must be obtained from the Head of School and must include at least one of the subjects marked*. An elective subject of special interest to a particular student but not on the above list may be taken, with the approval of the Head of Department.

Graduate Study

Department of Applied Geology

8020
Engineering Geology-Hydrogeology -Environmental Geology Course

Master of Applied Science
MAppSc

The course consists of a Project (Group A) and from six to nine subjects are core subjects of the course. The total credit point requirement of the course is 36, of which the project could account for 9, 12 or 18 credit points. The 9 and 12 credit point project is aimed at those students who prefer a higher content of teaching in their MAppSc course, or who find that their interests are not fully covered within the core subjects and a single optional subject.

The five core subjects are all taught in the first session. Up to three additional subjects, completed by full-time attendance during the second session, or part-time, or as an external student, may be credited towards the course, with a consequent reduction in the project requirements. The project normally consists of field and laboratory work, and is related to the student's major interest. Students must consult the Course Director for approval of the project.

Group A		**Hours per week** S1	S2
25.729G	Project (Engineering Geology Graduate Course)	0	9
25.728G	Project (Engineering Geology Graduate Course)	0	12
25.703G	Project (Engineering Geology Graduate Course)	0	18

Group B		**Hours per week**	
The core subjects comprise			
8.788G	Site Investigation	3	0
25.726G	Geological Engineering	3	0
25.727G	Fundamentals of Geomechanics	3	0
25.704G	Environmental Geology	3	0
25.702G	Hydrogeology	3	0
The optional subjects would normally be chosen from			
25.705G	Engineering Geophysics	3	
25.707G	Geopollution Management	3	
25.816G	Geological Remote Sensing	3	
7.941G	Advanced Rock Mechanics	3 or X	
8.790G	Stability of Slopes		3 or X
8.880G	Groundwater Modelling	3	
8.777G	Numerical Methods in Geomechanics		3 or X

An additional requirement for the award of the MAppSc Engineering Geology will be the satisfactory completion of laboratory and field practical sessions, attendance on field excursions, and combinations to tutorials and seminars. These exercises will be considered part of the core component, but may not be included within the formal content of any individual subject.

8091
Mineral Exploration Graduate Course

Master of Applied Science
MAppSc

The course is designed to give broad training in techniques of modern mineral exploration to geologists and mining engineers. Practical aspects are emphasized and the field-laboratory project is oriented to current problems of mineral exploration. The duration of the course is one academic year of full-time study; the course is, however, divided into three units to facilitate part-time study. All students must complete Units A, B and C. Formal course work Units A and B accounts for 20-22 hours per week during Session 1. Some students depending upon their qualifications may be required to take a Special Project, 25.000G, either as a preor co-requisite. The courses within the three units may be varied at the discretion of the Head of the Department to suit the requirements of individual students.

Unit A (Weeks 1-7 Session 1)

25.800G Seminar
25.801G Geology in Exploration 1
25.802G General Introduction to Exploration Geophysics
25.803G Introduction to Exploration Geochemistry
28.804G Introduction to Data Processing and Interpretation
25.805G Resource Economics 1
and *either*
25.807G Exploration Geophysics
or
25.808G Exploration Project
7.013* Principles of Mining
and
7.044* Mining Economics
Seven days of field tutorials are an integral part of Unit A.

*These are one session subjects, ie weeks 1-14.

Unit B (Weeks 8 -14 Session 1)

25.811G Advanced Geology in Exploration
25.815G Resource Economics 2
25.816G Remote Sensing
25.817G Mining Law and Exploration Management
25.840G Seminar
7.001G Exploration Drilling
and *either*
7.013* Principles of Mining
and
7.044* Mining Economics
or
25.818G Exploration Project

*These are one session subjects, ie weeks 1-14.

Unit C (Session 2)

25.819G Field – Laboratory Project

8092
Exploration Geophysics Graduate Course

Master of Applied Science
MAppSc

This is a specialized course in the techniques of exploration geophysics relevant to the current needs of the exploration industry. Practical applications are emphasized, and the field-laboratory project is designed to investigate aspects of specific exploration problems.

The duration of the course is one academic year of full-time study; the course is, however, divided into three units to facilitate part-time study. All students must complete units A, B and C. Formal course work Units A and B accounts for 20-22 hours per week during Session 1. Some students depending upon their qualifications may be required to take a Special Project, 25.000G, either as a preor co-requisite. The courses within the three units may be varied at the discretion of the Head of the Department to suit the requirements of individual students.

Unit A (Weeks 1-7 Session 1)

25.800G Seminar
25.801G Geology in Exploration 1
25.802G General Introduction to Exploration Geophysics
25.803G Introduction to Exploration Geochemistry
25.804G Introduction to Data Processing and Interpretation
25.805G Resource Economics 1
25.807G Exploration Geophysics

Seven days field tutorials are an integral part of Unit A.

Unit B (Weeks 8-14 Session 1)

25.831G Geological Interpretation
25.832G Advanced Exploration Geophysics
25.840G Seminar

Unit C (Session 2)

25.839G Field – Laboratory Project

8093
Exploration Geochemistry Graduate Course

Master of Applied Science
MAppSc

This is a specialist course in the techniques of exploration geochemistry covering general principles, specific field applications, laboratory techniques, and data display and interpretation. Practical applications are emphasized and the field-laboratory project is designed to investigate aspects of mineral exploration problems.The duration of the course is one academic year of full-time study; the course is, however, divided into three units to facilitate part-time study. All students must complete units A, B and C. Formal course work Units A and B accounts for 20-22 hours per week during Session 1. Some students depending upon their qualifications may be required to take a Special Project, 25.000G, either as a preor co-requisite. The courses within the three units may be varied at the discretion of the Head of the Department to suit the requirements of individual students.

Unit A (Weeks 1-7 Session 1)

25.800G Seminar
25.801G Geology in Exploration 1
25.802G General Introduction to Exploration Geophysics
25.803G Introduction to Exploration Geochemistry
25.804G Introduction to Data Processing and Interpretation
25.805G Resource Economics 1
and *either*
7.013* Principles of Mining
and
7.044* Mining Economics
or
25.808 Exploration Project
Seven days field tutorials are an integral part of Unit A.

*These are one session subjects, ie weeks 1-14.

Unit B (Weeks 8-14 Session 1)

25.831G Geological Interpretation
25.832G Advanced Exploration Geophysics
25.840G Seminar

Unit C (Session 2)

25.829G Field – Laboratory Project

Refer to Graduate Study section in the School of Geography for the following graduate courses:

5025 Graduate Diploma in Arid Land Management
8025 Master of Applied Science in Arid Land Management
- Hydrogeology
- Terrain Management

5026 Graduate Diploma in Remote Sensing
8026 Master of Applied Science in Remote Sensing
8045 Master of Environmental Studies

Centre for Groundwater Management and Hydrogeology

The Centre for Groundwater Management and Hydrogeology was established in 1987 as a Federal National Centre. It is a joint enterprise of the faculties of Applied Science and Engineering with general aims to research groundwater problems of strategic national importance and to co-ordinate and develop postgraduate courses, continuing education programs and to liaise with industry. An M AppSc degree in Hydrogeology and Groundwater Management is also offered.

8021
Hydrogeology and Groundwater Management Graduate Course

Master of Applied Science
MAppSc

Core Subjects		Credits	Session
25.702G	Hydrogeology	3	1
8.880G	Groundwater Modelling	3	1
7.937G	Hydrogeochemistry	3	1
8.875G	Hydrological Processes	3	1

Co-requisite Subject as required for 25.721G and 7.937G (satisfactory level required to be achieved)

25.717G Computing for Groundwater Specialists

Options

25.707GGeopollution Management
25.716GGroundwater Geophysics
25.718GRemote Sensing of Groundwater Resources
8.843GGroundwater Hydraulics
8.847GWater Resources Policy*
8.849GIrrigation*
8.850GDrainage of Agricultural land*

Project

25.719GGroundwater Research Project (C18)
25.720GGroundwater Project (C12)

*Existing subject not offered each year

Centre for Waste Management

The Centre for Waste Management is a joint enterprise of the Faculties of Applied Science and Engineering, that co-ordinates and develops teaching and research in the multidisciplinary area of waste management. Waste management is concerned with the study of treating, controlling and disposing of industrial and domestic wastes as applied to the analysis of waste disposal technologies. Particular emphasis is placed on the safe treatment, disposal and resource recovery of solid and liquid wastes.

8085
Waste Management Graduate Course

Master of Applied Science
MAppSc

Candidates are required to complete a course totalling at least 36 credits, made up of compulsory subjects, elective subjects and a project or a Research Project. The degree may be obtained internally on a full-time (normally 2 sessions of 18 credits) or parttime normally 4 sessions of 9 credits basis. An external course program is also offered (normally over 4 sessions). Selection of subjects for formal course must be approved by Director. A candidate must normally complete 18 credits of core subjects.

Core Subjects		Credits	Session
8.872G	Management of Wastes	3	2
8.873G	Waste and Wastewater Analysis and Environmental Requirements	3	1
8.874G	Waste Management Science	3	1
25.715G	Sources of Waste and Landfill Disposal	3	1
48.067G	Treatment, Disposal and Resource Recovery of Solid and Liquid Wastes	3	2
48.388GX	Unit Operations in Wastewater Sludge and Solids Management	3	1

Elective Subjects

7.152G Mining Conservation
7.535X Mine Fill Technology
48.391GXAtmospheric Pollution Control Theory
48.392GXAtmospheric Pollution Control Practical Aspects
8.857G Sewage Treatment and Disposal
8.870G Hydraulics and Design of Water and Wastewater Treatment Plants
25.702G Hydrogeology
25.707G Geopollution Management
25.704G Environmental Geology
46.203G Medical Aspects
46.204G Legislative Aspects
46.512G Project in Waste Management
46.513G Research project in Waste Management
47.481G Management of Dangerous Materials
47.120G Human Behaviour and Safety Science
48.063G Industrial Water and Wastewater Engineering

5070
Waste Management Graduate Diploma Course

Graduate Diploma
GradDip

Candidates are required to complete a course totalling at least 30 credits made up of compulsory subjects, elective subjects and a 3 credit report. The diploma may be obtained full-time normally (2 sessions of 15 credits) or part-time 4 sessions basis. An external course program is also offered (normally over 4 sessions).

Selection of subjects for formal course work must be approved by the Director. A candidate must normally complete 18 credits of core subjects.

Core Subjects		Credits	Session
8.872G	Management of Wastes	3	2
8.873G	Waste and Wastewater Analysis and Environmental Requirements	3	1
8.874G	Waste Management Science	3	1
25.715G	Sources of Waste and Landfill Disposal	3	1

48.067G	Treatment, Disposal and Resource Recovery of Solid and Liquid Wastes	3	2
48.388G	Unit Operations in Wastewater Sludge and Solids Management	3	1

Elective Subjects

7.152G Mining Conservation
7.535X Mine Fill Technology
48.391GX Atmospheric Pollution Control Theory
48.392GX Atmospheric Pollution Control Practical Aspects
8.857G Sewage Treatment and Disposal
8.870G Hydraulics and Design of Water and Wastewater Treatment Plants
25.702G Hydrogeology
25.707G Geopollution Management
25.704G Environmental Geology
46.203G Medical Aspects
46.204G Legislative Aspects
6.511G Report in Waste Management
47.481G Management of Dangerous Materials
47.120G Human Behaviour and Safety Science
48.063G Industrial Water and Wastewater Engineering

Department of Mineral Processing and Extractive Metallurgy

8055
Mineral Engineering Graduate Course

Master of Applied Science
MAppSc

The course is under revision and will not be offered until 1991.

Department of Mining Engineering

8056
Mining Geomechanics Graduate Course Part-time (External)

Master of Applied Science
MAppSc

The course is offered to enable graduate mining engineers, geologists and civil engineers stationed in remote locations to carry out advanced theoretical and practical studies in geomechanics applicable to mining operations. Most of the work is completed by correspondence, with the exception of short annual residential schools of two weeks duration at the Kensington campus.

Enquiries from graduates living in the Sydney metropolitan area, as well as from graduates in other disciplines, are welcomed. In the latter case it may be necessary to include supporting subjects at undergraduate level within the Masters' program as approved by the Head of Department, up to a maximum of 25 per cent of the total program. It may also be necessary in some circumstances to take some prerequisite or co-requisite back ground undergraduate subjects, as directed by the Head of Department.

The program consists of formal study equivalent to six hours of lectures per week, for three years on a part-time external basis. One third of total program consists of a project on an approved topic covering a field or laboratory investigation of a mining geomechanics problem.

Six of the subjects, in addition to the project, form a compulsory core strand. These are augmented by a range of elective, optional subjects. Two options may be selected for study, subject to the approval of the Head of School and availability of the topics.

Assessment is by formal examination at appropriate country centres where necessary and by assignment work.

Year 1		**Hours per week** S1	S2
25.727G	Fundamentals of Geomechanics	3	0
7.515X	Rock Mechanics Measurements	3	0
25.726G	Geological Engineering	3	0
One optional subject			
Year 2			
7.941X	Advanced Rock Mechanics	3	0
7.405X	Numerical Methods in Geomechanics	3	0
7.415X	Stability of Slopes	0	3
One optional subject			
Year 3			
7.455X	Mining Geomechanics Project	6	6

Optional Subjects may be chosen from
25.702G Hydrogeology
7.535X Mine Fill Technology
7.545X Advanced Rock Cutting Technology
7.555X Blasting Technology

5040
Mining and Mineral Engineering Graduate Diploma Course

Graduate Diploma
GradDip

The Graduate Diploma course in Mining and Mineral Engineering is designed to provide professional training for graduates in Science, Applied Science or Engineering who wish to specialize in the fields of mining and mineral beneficiation. The course is concerned primarily with instruction in the scientific and engineering principles associated with the mining and beneficiation of minerals and coal.

The Graduate Diploma in Mining and Mineral Engineering (GradDip) will be awarded on the successful completion of one year full-time or two years part-time study. The course is a blend of lecture and laboratory work and allows the choice

of elective specialization in either mining engineering or mineral processing and coal preparation.

It should be noted that some degree of specialization will be possible in the laboratory investigations.When appropriate, certain sections of the course may be offered as a unit over a short period of time to permit mineral industry personnel to attend the advanced course in a particular area of that discipline.

Fulltime Program		**Hours per week** S1	S2
7.013	Principles of Mining	2	0
7.234	Mineral Economics	1	1
7.111G	Mining Engineering	3	3
7.311G	Mineral Beneficiation	0	3
7.714	Mineralogical Assessment	1	0
7.7341	Mineral Process Engineering	2	0
7.122G	Mining Engineering Technology	3	3
or			
7.322G	Mineral Beneficiation Technology	3	3
7.132G	Mining Engineering Laboratory and Project *or*		
7.332G	Mineral Engineering Laboratory	3	3
		15	13
Year 1 - Part-time			
7.013	Principles of Mining	2	0
7.234	Mining Economics	1	1
7.111G	Mining Engineering	3	3
7.311G	Mineral Beneficiation	0	3
7.714	Mineralogical Assessment	1	0
7.7341	Mineral Process Engineering	2	0
		9	7
Year 2 - Part-time			
7.122G	Mineral Engineering Technology	3	3
	or		
7.322G	Mineral Beneficiation Technology	3	3
7.132G	Mining Engineering Laboratory and Project or	3	3
7.332G	Mineral Engineering Laboratory	3	3
		6	6

When appropriate, up to 3 hours per week may be selected from approved courses available within this Department or offered by other Schools within the University.

Key Centre for Mines

The Key Centre for Mines is a joint initiative of the Universities of New South Wales and Wollongong, with seed funding from the Department of Employment, Education and Training. The purpose of the Key Centre for Mines is to provide a full range of educational and research services to the Minerals Industries.

Particular emphasis is being placed on continuing education, distance learning and industry based research and development.

The industry sector being addressed by the Key Centre for Mines covers the exploration, extraction, and primary processing of mineral resources.

Courses to be offered will be defined in 1990, for further information please contact the Key Centre for Mines.

Subject Descriptions

Undergraduate Study

Departments of Mining Engineering and Mineral Processing and Extractive Metallurgy

Mining Engineering and Mineral Processing and Extractive Metallurgy are Departments within the School of Mines.

7.011 Stress Analysis in Mining 1 **S2 L1 T2**

Concepts of stress and strain. Mohr's circle diagrams. Introduction to elastic theory. Simple beam and column theory. Introduction to computer methods of stress analysis in mining.

7.012 Stress Analysis in Mining 2 **S1 L1 T2**

Prerequisite: 7.011

Statics in mining systems. Bending moments, shear force and torsion. Combined stresses, calculation of principal stresses and strains. Brittle behaviour and anistropy. Time-dependent properties and creep. Computer methods of stress analysis.

7.013 Principles of Mining **S1 L2**

Mining Engineering terminology and definitions. Drilling techniques for production blasting and exploration. Explosives and rock fragmentation processes. Mine development, access to mineral deposits and their exploitation. Surface and underground techniques. Methods of working coal and metalliferous deposits. Methods of ground support. Offshore mining; the ventilation and drainage of mines; mine transport and materials handling. Mine safety engineering.

7.021 Mining, Minerals and Environment **S2 L2 T1**

Mineral deposits – metallic, non-metallic and fuels. Elements of prospecting and exploration. Basic mining techniques – mine development, mineral extraction and abandonment of mines. Mining services. Unit operations of mineral processing and extractive metallurgy. The engineer and society. Professional ethics. Community relationships. Alternative land uses. Disposal of mine waste and its commercial exploitation. Mine lease rehabilitation and restoration. Pollution monitoring and control. Environmental impact statements. Legislative controls on mining and on mineral exports.

7.031 Descriptive Engineering **S1 L1 T1**

Aspects of engineering technology required for a full understanding of the mining engineering course. Internal combustion and compression ignition engines, portable diesel power. Gearboxes, automatic transmissions. Flexible couplings, bearings, gear trains, belt drives, hydrokinetic and hydrostatic drives. Hydraulic circuits. Glands, seals, stuffing boxes. Rotary pumps and reciprocating pumps. Compressed air generation and reticulation. Track-laying vehicles. Braking systems – drum, disc and wet plate. Boilers and power generation. Electrical control and drive systems for mining machinery. Basic ergonomics for machine controls.

7.041 Technical Communication **S2 L1 T2**

Introduction to engineering drawing – Australian standards, first and third angle projections, isometric drawing. Engineering sketches, presentation of oral and written data, engineering graphics. Meetings and staff training. Report writing - analysis of experimental data and presentation of graphs and figures.

7.044 Mining Economics **S1 L2 T2**

Aspects of micro- and macro-economics. Theory and practice of resource sampling. Valuation of mineral properties and mining projects including reserve calculation by traditional and geostatistical methods. Geological reserves and mining reserves. Interaction of grade, tonnage, mining recovery and mining method. Financing of mining ventures. Types of mining companies – private, public, no-liability. State ownership and participation. Investment decision analysis – cash flow models, sensitivity analysis. Marketing of mineral commodities.

7.104 Underground Coal Mining **F L1 T1**

Prerequisites: 7.113, and 7.114, 7.1231, 7.1183.

Effect of surface improvements and structural geology on mine layout. Influence of coal seam properties on choice of extraction height and working section. Coal properties related to machine extraction. Pillar and coalface layouts to optimise strata control. Face and roadway support systems. Mechanised extraction: cutting machines, their stability and steering, armoured face conveyors and stage loaders, coal clearance systems, coal bunkerage. Mechanisation problems in thin, thick, steep and faulted seams. Multi-seam layouts. Limitations on face advance rate. Logistics of high-speed extraction — supplies, manpower, rapid transfer of face equipment. Packing and stowing. Hydraulic mining. Supervision and performance criteria.

7.113 Mining Methods **F L2**

Prerequisite: 7.142.

Technical and environmental considerations for mining by surface or underground methods. Permanent mining facilities and mine development. *Metalliferous deposits:* underground and surface mining. Sublevel open stoping, sublevel caving, cut and fill stoping, other underground mining methods. Pillar recovery. *Coal and lignite deposits:* occurrence in Australia. Surface mining methods – considerations of terrain, mining of single, multiple, thin, thick and steeply inclined seams. Underground mining methods – use of panels, pillared, shortwall and longwall mining of thin, thick, multiple and steeply inclined seams. Abandonment of mines.

7.114 Geotechnical Engineering **F L1 T1**

Prerequisites: 7.1231, 7.1232.

Stresses around mine openings: magnitude and distribution, determination by analytical methods, analogue and mathematical modelling, in situ measurements. Energy changes caused by excavations. Initiation and propagation of

failure in rock structures. Stability of excavations: natural and artificial supports, permanent and temporary supports. Design of support systems. Stability of rock slopes. Ground control measurements. Rockbursts. Outbursts in coal. Mining subsidence, nature effects, prediction and control.

7.1231 Geomechanics A **S1 L1.5 T1.5**

Prerequisite: 10.001. Co-requisite: 7.433.

Rock mass, rock material and discontinuities. Geomechanical properties of discontinuities – orientation, spacing, persistence, roughness, apertures and filling. Rock mass classification. Rock strength and deformability, concepts and definitions, common laboratory strength tests, measurement of deformability by static tests, dynamic measurements, influence of time on rock deformation. Strength criteria for isotropic and anisotropic rock material, shear behaviour of discontinuities, behaviour of rock masses containing discontinuities. Pre-mining state of stress and its measurement.

7.1232 Geomechanics B **S2 L1 T1**

Prerequisite: 10.001. Co-requisite: 7.433.

Soil description and classification, engineering behaviour of soils, basic definitions in soil mechanics, effective stress concept, shear strength of soils, soil permeability, flow of water in soils, consolidation, stresses in soil from external loading, design of shallow foundations, compaction, compaction control, pavement and haul-road design, lateral earth pressures, soil slope stability, expansive and dispersive soils, filter design.

7.132 Fluid Mechanics and Thermodynamics **F L1 T1**

Prerequisites: 1.001, 5.0011, 7.011, 10.001. Co-requisite: 10.022.

Fluid properties, fluid statics, fluid flow – laminar and turbulent. Continuity equation, energy equation, momentum equation. Flow measurement. Pumps and pump characteristics. Energy losses in pipelines and open channels. Boundary layer theory. Dimensional analysis. Thermodynamic systems - states, processes and properties. Energy of a system, first and second laws of thermodynamics. Reversibility, ideal gas laws, cycles for heat engines, heat pumps, compressors and refrigerators, psychrometrics.

7.133 Mine Transport **S2 L2 T1**

Transport requirements for minerals, waste, supplies and people. Mine winding systems for shafts and drifts. The mechanics of hoisting. Mine ropes and chains. Winding cycle diagrams and calculations. Surface and underground haulage arrangements. Secondary transport systems. Rope haulage, aerial reopeways, monorails, belt conveyors, locomotive haulage. Track mounted, crawler and trackless methods. Elements of soil vehicle mechanics applied to mining equipment. Primary systems. Chain, screw and bucket conveyors and elevators. Shaker and vibratory conveyors. Hydraulic and pneumatic transport methods. Chutes and bunkers. Design of transport systems.

7.142 Mine Development **S1 L2**

Prerequisite: 7.021.

Infrastructure requirements for mines and mining communities. Prospecting, exploration, mine feasibility studies, statutory requirements. Surface requirements and layout for winding, ventilation, drainage, mine services, administration, welfare. Mine working drawings. Provision of primary underground access by shaft, drive, drift, decline and incline, adit, raise, winze. Development through water-bearing and unconsolidated ground. Explosives applied in mine development. Development by tunnelling machine. Equipping shafts. Ground support during development. Emergency egress requirements. Development of surface metalliferous and coal mines. Spoil and waste disposal, land restoration and other environmental considerations. Preparation of Environmental Impact Statements.

7.144 Surface and Offshore Mining **F L1 T1**

Prerequisite: 7.113.

Surface mining of tabular and other deposits, general methods, current trends. Planning and design of surface mines; reserves, scale of operatio9ns, surface facilities. Stripping ratio, pit limit determination by manual and computer-based methods, phase plans, operating layouts, scheduling. Mining systems: equipment selection, type, capacity and fleet size, operational costs, maintenance. Slope stability: pit walls, spoil piles, ground water control. Surface rehabilitation. Stream and offshort dredging for metals, minerals, gemstones and construction materials. Evaluation of marine deposits. Dredge design and operation. Beach sand mining. Deep sea mining. International agreements and law. Project.

7.153 Power Supply in Mines **S1 L1 T1**

Prerequisite: 1.9222, 6.854, 7.031, 7.132.

Electric power distribution, mine cables, switchgear. Flameproofing and intrinsic safety, fault protection. Oil hydraulic power. Fluid characteristics. Components and circuits. Pumps, motors, valves. Speed and torque control. Compressed air: generation, distribution, applications and equipment, compressors. Control theory, automatic control in mining.

7.163 Excavation Engineering

Rock drilling and boring. Percussive, rotrary, hybrid and exotic methods. Drilling patterns for shafts, headings, faces and benches. Classificatio9n of chemical explosives and their application. Detonation. Misfire procedures. Alternative explosive agents. Special blasting techniques including presplitting, profiling, trenching, casting and demolition. Environmental considerations, handling and storage of explosives, vibrations. Nuclear blasting. Rock fragmentation by machine. Principles of rock cutting mechanics. Drag picks and free rolling cutters. Hydraulic mining. Water jet cutting. Thermal, electrical, ballistic and other novel fragmentation techniques. Rock cutting tool materials. Effect of tool metallurgy on ear and fracture resistance. Methods of assessment rock cuttability. The design of cutting arrays for machine mining.

7.172 Microcomputers in Mining **S1 L1 T1**

Types of microcomputers, components, operating systems. Spread sheets, data bases and word processors. Software applicable to mining. Use of microcomputers for control, minitoring and data acquisition.

7.173 Computer Applications in Mining **F L1**

Prerequisite: 7.172.

Simulation of mining problems. Application of selected programs to exploration, operations, economics and design.

7.174 Mining Legislation **S2 L2**

An appreciation of the laws relating to mining practice and to safety and health in mines.

7.183 Mine Ventilation and Drainage **F L2 T1**

Prerequisites: 7.132, 7.142. Co-requisite: 7.433.

Mine ventilation – practice in mines, forces causing airflow, resistance of workings and distribution of mine air, network analysis, fans and their operation, auxiliary ventilation calculations, economic size of airways. Ventilation surveys. Mine gases – hazards, accurrence, detection, monitoring and control. Airborne dust - physiological effects, sampling, measurement and analysis, sources and control. Mine climate – physiological effects, air cooling power, factors affectring mine climate and control. Ventilation planning – airflow requirements based on gaseous, airborne dust and heat pollutants.

Mine drainage – engineering hydrology, sources of mine water, forecasting water inflows, drainage and dewatering, pumps and pumping.

7.184 Underground Metalliferous Mining **F L1 T1**

Prerequistes: 7.113.

Production, development and resource scheduling. Main development, slope development. Cyclic and continuous production systems – slope, haulage, hoisting; use of stockpiles and multi-face production systems. Optimum ore fragmentation, material flow in passes. Pillar recovery. Optimum fill selection. Preparation and placement of mine fills. Bulkhead design, fill dewatering. Ground support during stoping. Practice in Australasia. Mine design project.

7.194 Tunnel Engineering and Shaft Sinking **F L1 T1**

Not available to students who have completed 7.164.

Scope for tunnels. Site investigation. Primary excavation in soft and hard ground. Drilling and blasting. Tunnelling shields, full face boring, partial face machines. Debris disposal. Temporary and permanent support. Ground stability. Sub-aqueous tunnels. Cut and cover tunnels, immersed tubes. Compressed air working. Environmental considerations. Tunnel services, ventilation, drainage and lighting for road and all-rail tunnels. Shaft sinking in different ground conditions. Ground treatment before excavation. Shaft lining.

7.213 Mine Surveying **S1 L1 T1**

Prerequisite: 29.441

Map projections and the Integrated Survey Grid. Statutory and other requirements relating to mine surveys and plans. Codes of practice. Limits of error. Dip, fault and other three-dimensional problems. Borehold surveys. Correlation of mine surveys with the Integrated Survey Grid. Correlation of underground and surface surveys. Shaft plumbing. Gyrotheodolite. Shaft depth and verticality surveys. Subsidence surveys. Specialised equipment and techniques.

7.214 Mine Economics and Planning **S1 L2 T2 S2 L1 T1**

Prerequisite: 7.113, 7.223.

Resource sampling, reserve calculations by traditional methods and by geostatistics, feasibility studies including calculation of capital costs and operating costs, company taxation. Feasibility study project. Project financing – equity, debt, leasing, non-recourse financing, joint ventures. Company types and structures, capitalisation, documents of incorporation and of annual reports. Commodity marketing, metal exchanges, producer pricing, price forecasting. Mining law, mineral ownership, federal and state responsibilities, royalties. Projectr control, contracts, insurance. Operating cost systems, discounted cash flow techniques appllied to mine expansion and system modification. Replacement of mine plant.

7.223 Mine Feasibility Studies **S2 L1**

Elements of mineral project cash flow. Application of numerical discounted cash flow techniques to economic analysis of mineral projects. Parameter sensitivity calculations.

7.224 Operational Management **F1 L1 T1**

Approaches to management study: managerial functions, objectives and decision making, organisation concepts, elementary industrial phsychology, work measurement and appraisal, industrial relations, communication, negotiations, recruitment, selection and training of personnel. Operations research, control networks, decision analysis, linear programming, queueing theory, simulation, purchasing and stores policy, management accounting and budget controls, reliability engineering, maintenance procedures, personnel and materials management.

7.234 Mineral Economics **F L1**

Business cycles. Theory of wages. Types of mine, contracts. London metal exchange. The economics of processing after the mine lease. National stockpiles. Depletion of world resources. Prediction techniques for supply and demand. Type of company, statutory duties of directors.

7.304 Mine Safety Engineering **F L1 T1**

Safety precautions against outbursts. Methane drainage. Fires and explosions in coal and metalliferous mines, explosible dust. Spontaneous combustion. Water hazards in mines and precautions against inundation. Mine rescue and recovery. Noise measurement, hearing hazards and control. Mine lighting. Poisons and general toxic hazards. Radiation hazards. Loss control, accidents, accident investigations, safety programs. Safety and health legislation.

7.414 Minerals Industry Project **F T5**

Candidates are required to submit a disseration or thesis on a mining, minerals engineering or other topic approved by the Head of Department. The work may take the form of an engineering analysis, experimental investigation, theoretical study or design project. Candidates may be required to present themselves for oral examination on the subject of their submission.

7.424 Industrial and Research Seminars **F L1**

The program includes two types of seminar. One deals with research work being undertaken or recently completed by members of the School of Mines. The other involves engineers and scientists from industry, other University schools and

research establishments discussing projects of special or topical interest in mining and allied fields.

7.433 Mining Laboratory **F L1**

The program includes two types of seminar. One deals with research work being undertaken or recently completed by members of the School of Mines. The other involves engineers and scientists from industry, other University schools and research establishments discussing projects of special or topical interest in mining and allied fields.

7.433 Mining Laboratory **F T2**

Co-requisites: 7.1231, 7.1232.

A program of laboratory experiments for Year 3 students requiring the submission of appropriate laboratory reports related to the syllabus areas of the the co-requisite subjects.

7.610 Introduction to Mining and Mineral Engineering **S1 L2**

Mineral deposits, metallic, non-metallic and fuels. Elements of prospecting and exploration. Basic mining techniques. Mining phases: development, exploitation, and withdrawal. Mining and the environment. Mining services. Relevance of basic science and engineering subjects to mining design and operations. The unit operations of mineral processing and extractive metallurgy, related to end use of product and its market value. Safe disposal of waste material.

7.621 Mineral Engineering Science 1 **S2 L2 T1**

Application of the principles of stoichiometry and thermodynamics to mineral processing and extractive metallurgy. Review of the laws of thermodynamics, material and energy accounting, the thermodynamic data sources, chemical and phase equilibria in pyrometallurgical systems, computer methods, theory of metal solutions, slags, fused salts and mattres. Application to combustion of fuels, roasting, chlorination, reductgion of oxides, smelting of sulphides and refining of metals.

7.622 Mineral Engineering 1 **F3**

Unit 1 Physical Operations in Mineral Processing

Basic theory and applications to unit design of the physical operations in mineral beneficiation, breakage and comminution, screening, classification, flotation, gravity concentration, minor separation processes and de-watering. Integration of equipment into complete flowsheets, case studies of operating plants to illustrate the factors that influence the flowsheet design.

Unit 2 Process Design for Mineral Extraction

Mineral extraction processes in terms of mechanisms and achievments. Ovberall extraction schemes. Quantitative analysis and computation in the solution of mineral engineering problems involving fluid flow, heat transfer, statistics, and mineralogy. End uses of minerals, the technical aspects of the market requirements and how these influence mineral processing and extractive metallurgy.

7.623 Mineral Engineering Laboratory 1 **S2 T3**

Laboratory exercises relevant to both mineral and metallurgical processing covering: experimental design, the gathering and interpretation of data used for the assessment of ores and minerals in order to determine the processes most suitable for their beneficiation and subsequent refinement or utilization.

7.631 Mineral Engineering Science 2 **S1 L5**

Unit 1 Physical and Chemical Characterisation of Mineral Particles

Physico-chemical and electrical characteristics of surfaces. Surface phenomena in flotation. Fluid particle dynamics and the characteristics of ores and ore pulps in relation to the handling of these materials. Fine particle statistics in mineral beneficiation.

Unit 2 Aqueous Thermodynamics and Hydrometallugical Processes

Application of principles of aqueous thermodynamics, electro-chemistry, chemical and electrochemical kinetics, to hydrometallugical processes: leaching of minerals and concentrates, solution purification, precipitation, and other separation processes, ion-exchange and liquid-liquid extraction.

Unit 3 Elements of Geomechanics

Elements of geomechanics in relation to the classification, testing, handling and disposal or rocks and soils.

7.632 Mineral Engineering 2 **F L3**

Unit 1 Plant Performance

Plant performance monitoring and the analysis, computation and reporting of operating data. Analysis and evaluation of mineral processing operations and extractive processes.

Unit 1 Process Design 1

Integrated design of mineral processing and extraction circuits. The application of reaction engineering principles to the design and evaluation of mineral and metallurgical reactors and processes with consideration of unsteady state processes. Identification of the information required to select and design processes, dealing with deficiencies in information. Development of communication skills through the collection and presentation of technical information.

7.633 Mineral Engineering Laboratory 2 **F T3**

Exercises in mineral processing and extractive metallurgy designed to develop investigational skills for obtaining quantitative relations for process phenomena, testing the performance of a machine or reactor, simulating a process by a computer program, instrumental analysis, quantitative measurements of the properties of minerals and particles, solutions and gases. Collection and interpretation of data from operating plants. Development of proficiency in technical report writing, and communication.

7.642 Mineral Engineering 3 **F L3 T3**

Unit 1 Control and Simulation

Problems in the automatic control and on-line analysis of mineral and metallurgical processes.

Unit 2 Process Design 2

Methodologies and mineral engineering investigations, including statistical design of testwork, development of

quantitative empirical relationships, sensitivity analysis, and development of theoretical relationships. Development of a systematic approach to technical decision-making, with industrial case studies.

Unit 3 Environmental Engineering

Origin and control of environmental hazards in mineral engineering. Disposal of waste materials.

7.643 Mineral Engineering Projects and Laboratory **S1 T6 S2 T9**

One major investigation based on a selected problem in mineral engineering. A second problem in process selection and design based on quantitative data for various options. A third project may be included as an exercise in selection and evaluation of information from the literature for a specific case study Seminars.

7.714 Mineralogical Assessment **S1 L1**

Assessment of the physical and chemical properties of economic minerals. Significance of the textures of minerals on the selection of mineral beneficiation processes. Destructive and non-destructive testing of bore cores. Factors influencing effective comminution and liberation.

7.725 Chemical and Extractive Metallurgy 1 **S2 L2 T1**

Metallurgical thermodynamics and kinetics. Review of the First Law of Thermodynamics, Thermochemistry, and material balance calculations. Review of the Second Law, free energy function, statistical interpretation of entropy, and Third Law. Phase equilibria in a one component system. Reactions involving gases, and gases with pure condensed phases. Graphical representation of equilibria. Ellingham diagrams and Kellog predominance area diagrams. Tabulation of thermodynamic data and sources of data. Introduction to heterogeneous kinetics, reactions of a solid particle with a gas.

7.734 Mineral Process Engineering **S1 L2 T1**

7.7341 Mineral Process Engineering **S1 L2**

The necessity for minerals beneficiation. Mineralogical assessment. Comminution: fracture, liberation, size-criteria, energy-size relationships. Crushing, grinding and attrition. Screening and classification, cyclones. Concentration processes, density, electrical, magnetic and other physical methods. Interfacial phenomena. Surfactants. Flotation. Liquid-solid separation: flocculation, thickening, agglomeration, filtration. Materials balances.

7.7342 Minerals Engineering Processes F L1 T2

Beneficiation requirements. Scope of mineral processing. Sampling and mineralogical assessment. Comminution, fracture, liberation, size criteria, energy-size relationships. Crushing and grinding. Screening and classifying. Fluid dynamics of suspensions. Attrition. Concentration processes: density, electrical, magnetic and other physical methods. Cyanidation, amalgamation, leaching, solvent extraction and ion exchange. Interfacial phenomena. Surfactants. Flotation. Liquid-solid separation: flocculation, thickening, agglomeration, filtration. Drying. Materials balances.

7.735 Chemical and Extractive Metallurgy 2 **S1 L2 T1.5**

Metallurgical thermodynamics. Thermodynamic behavious of solutions, activity of a component in solution, Gibbs-Duhem equation, free energy of solution, properties of ideal and non-ideal solutions, integration of Gibbs-Duhem equation and relationship to activity determinations, regular solutions and a quasi chemical model of solutions. Free energy-composition and phase diagrams of binary systems, alternative standard states, relationship among phase diagrams, free energy and activities. Thermodynamics of interfaces. Equilibrium between phases of variable composition, Gibbs phase rule. Solutions containing several solutes. Estimation of activities in ternary systems. Galvanic cells. Structure and thermodynamic properties of slags.

7.744 Mineral Process Technology **F L1 T1**

Physics and chemistry of surfaces. Measurement of surface properties. On-stream and laboratory analysis and measurements. Laboratory and pilot testing. Flowsheet design. Equipment selection. Plant layout. Monitoring and control systems. Process evaluation. Storage and blending. Materials handling. Waste disposal and pollution control. Waste treatment. Process simulation. Marketing.

7.7451 Advances in Pyrometallurgy **S1 or S2 L2**

Advances in pyrometallurgy relasted to extraction and refining processes used for recovery of ferrous and non-ferrous metals.

7.7452 Advances in Hydrometallurgy **S1 or S2 L1 T1**

A critical analysis of: recent industrial and research developments in extraction metallurgy: major problems that are the subjects of current researchb and development in extractive metallurgy; the variety of methods available for research and development.

7.746 Mineral Process Chemistry

Sources of equilibrium stability data, methods of presenting in graphic forms thermochemical data for application to interpreting the chemical reactions and mechanisms of aqueous process. Overall schemes of metal extraction. Analysis and resolution in the processing and metalliferous raw material. Effects of minor components on overall scheme and efficts of mineralogy on process performance. Analysis of testwork methods. Process chemistry of the smelting and refining of ferrous, non-ferrous and recycled materials. Fundamental principles of metal extraction and plant practice. Analysis of recent research and industrial development in hydrometallurgy. Thermodynamic and kinetic considerations in electrometallurgy. Electrochemical reactor and cell designs. Electrochemistry in industrial processes.

7.748 Technical Decision Making **S1 or S2 L1 T1**

A systematic approach to technical decision-making involving problem analysis, identification of options, data collection, selection of criteria, application of criteria and implementation. Case studies in decision-making based on specific, topical projects in industry.

Department of Applied Geology

Field tutorials are an essential part of these subjects and are held during weekends and/or recesses. Dates and costs are available during the first week of the subject. Attendance is compulsory.

25.110 Geological Processes **S1 L2 T4**

Stream 1

Constitution of the Earth: The Earth and the Solar System. The interior of the Earth: the crust and its chemical composition, gravity and isostasy. Minerals and rocks, economic mineral deposits. *Earth Processes.* The origin of igneous rocks, plutonism and volcanism. The geological cycle. Weathering processes, soil formation and landforms. The origin of sedimentary rocks, transportation, deposition, lithification. Arid, glacial and periglacial processes. Geological time. Metamorphism and metamorphic rocks. Structural geology, classification and origin of faults and folds. Quaternary stratigraphic sequences, neotectonics. *Field work* of up to two days is a compulsory part of the subject.

OR

Stream 2

Available only with permission of the Head of School.

A program of projects and independent study of selected aspects of geology. Assessment includes practical and theory examinations.

25.120 Geological Environments **S2 L2 T4**

Prerequisites:

	HSC Exam Score Range Required
2 unit Mathematics* *or*	55-100
3 unit Mathematics *or*	1-50
5 uniy Mathematics	1-100
and	
2 unit Science (Physics) *or*	53-100
2 unit Science (Chemistry) *or*	53-100
2 unit Science (Geology) *or*	53-100
2 unit Science (Biology) *or*	53-100
4 unit Science	1-50
3 unit Science	90-150
and	
25.110.	

**This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics (Mathematics in Society).*

Earth Environments. Introductory palaeontology, including the evolution of life, invertebrates amd vertebrates. Principles of stratigraphy. The stratigraphy of New South Wales: Broken Hill, Lachlan, Orogen, New England Fold Belt and Sydney Basin. Introductory stratigraphy of Australia from the Precambrian to the Recent. The mineralogical study of rocks, techniques and significance of mineralogy. Structural geology, stereographic and statistical treatment of structural data. *Earth Dynamics.* The evolution of ocean basins, sea-floor spreading and sea-level changes. Climates of the past. Geophysical methods of exploration; seismology and earthquake prediction. Plate tectonics and continental drift. *Field work* of up to four days is a compulsory part of the subject.

25.211 Earth Materials 1 **S1 L2 T4**

Prerequisite: 25.120.

Mineralogy. Principles of optical crystallography and the use of the polarizing microscope. Chemical and physical properties of rock forming minerals. Mineral identification. *Igneous Petrology.* Occurrence., classification and origin of igneous rocks. Fractional crystalization and differentiation. Partial melting. Simple binary melting diagrams. Igneous petrololgy relating to plate tectonics. *Practical.* Macroscopic and microscopic examination of rock forming and ore minerals and igneous rocks in the field and the laboratory. *Field work* of five days is a compulsory part of the subject.

25.212 Earth Environments 1 **S1 L3 T3**

Prerequisite: 25.120

Sedimentology. Flow regimes and bedding forms, sedimentary structures. Modern and ancient sedimentary environments of deposition: alluvial, nearshore, shelf and deep sea, in both terrigenous clastic and carbonate/evaporite domains. The facies concept: lateral and vertical relationships between depositional environments and associated lithofacies within developing sediment wedges. *Palaeontology.* Morphology and stratigraphic distribution of invertebrates, including Foraminifera, Brachopoda, Mollusca, Arthropoda, Protochordata and Echinodermata. Introductory paleobotany, Biogeography. Trace fossils. Reef building organisms and the evolution of reefs. Field work of up to five days is a compulsory part of the subject.

25.221 Earth Materials 2 **S2 L3 T3**

Prerequisite: 25.211

Sedimentary Petrology. The influence of transportation, deposition and diagenesis on the composition, texture and structure of detrital sedimentary rocks. The non-classic sedimentary rocks including phosphates, evaporites; ferruginous and silceous deposits. *Metamorphic Petrology.* Origin and classification of metamorphic rocks as an aid in understanding common mineral assemblages. Petrogrpahic studies of common metamorphic rocks. Field studies. *Structural Geology.* Origin, classification and description of structural elements and analysis of simple fracture systems. Tectonics and tectonic analysis. *Field work* of up to four days in a compulsory part of the subject.

25.223 Earth Physics **S2 L2 T4**

Prerequisite: 25.110.

Global Geophysics. Principles of gravity, geomagnetism, palaeomagnetism, geothermy and seismology and their relation to shape, internal constitution, dynamic processes and major tectonic features of the earth. *Photogeology.* The use of air photos for geological mapping and geomorphological evaluation of land. Techniques and principles of photo-interpretation and multi-band photography. Photo-interpretation of folds, faults, joints, bedding, limestone, intrusive igneous volcanic rocks, alluvial fans, terraces, slopes, landslides, coastal and tropical landforms. Relationships between geology, drainage, soil and vegetation, orebody

expression gossans, colouration halos. An introduction to remote sensing. *Geological Surveying.* Levels, tachometers and theodolites. Field techniques. Precision of angular measurements. Stadia surveying. Levelling. Field computations. Closed and open traverses. Coordinates and their computation. *Field work* of two days is a compulsory part of the subject.

25.2261 Mathematical Geology 1 **S2 L2 T1**

Prerequisite: 25.120.

Geological Statistics. Measurement scales in geology. Probability distributions and their properties; sampling and test of significance. Application of these techniques using geological data. *Geological Computing:* FORTRAN programming; test editing; control language for VAX and CYBER.

25.311 Earth Materials 3 **S1 L2 T4**

Prerequistie: 25.221.

Mineralogy. Principles of X-ray powder diffractometry and the use of X-ray powder cameras and diffractometers. Elementary stereology. Laboratory methods of mineral separtation. Mineral characterization. *Geochemistry.* Accuracy, precision and quality of geochemical data. Graphical display of analyses. Norms. The distribution of elements in terrestrial rocks. Nature and origin of meteorites and tektites. *Aqueous Geochemistry.* Redox potentials in nature. Oxidation/reduction and sediment formation. Solubilities, metal transport and ore deposition. The growth of minerals from solution and the development of mineral textures. Particular aqueous geochemical systems.

25.312 Earth Environments 2 **S1 L3 T3**

Prerequisite: 25.212 (note: it is desirable that students taking this unit have also taken 25.223).

Stratigraphy. Stratigraphic classification. Biological and physical methods of correlation. Introduction to radiogenic methods of age determination: 14C, K/Ar, Rb/Sr, Nd/Sm, U/Th/Pb and fission track methods. Definition of international stratigraphic boundaries, stratotypes and reference points. Types of sedimentary basins and continental margins. The development of the Precambrian craton of Australia. The geological evolution of eastern Australia, particularly the late Paleozoic and Mesozoic history of the Tasman Mobile Belt. Intracratonic basins of western and southern Australia and the effects of the dispersal of Gondwanaland. Geological evolution of the northern margin of the Australian plate, particularly the Mesozoic to Recent of Papua-New Guinea. *Palaeontology.* Theories of biologic classification. Processes and theories of evolution. The origin and early history of life. Functional morphology. Practical application of palaeontology. *Field Mapping.* Geological report writing and cartography. *Field work* of up to seven days is a compulsory part of the subject.

25.314 Mineral and Energy Resources 1 **S1 L3 T3**

Co-requisite: 25.221 or 25.311.

Metallic Resources: Classification and origin of the ore deposits, geochemical processes, research methods. Orthomagmatic, hydrothermal, porphyry, volcanic-sedimentary, Mississippi Valley type, chromium, iron, managanese ores, residual and mechanical ores. Introduction to mineral exploration. Laboratory study of hand specimens, thin sections and polished sections of various ore types; study of selected mining areas representing various types; study of selected mining areas representing various genetic types of ore. *Economic Mineralogy.* Nature of reflected light. Ore textures and their interpretation. Phase relations and paragenesis of ore minerals. Practical work in optical properties of ore minerals, hardness and reflectivity measurements: study of selected ores and ore minerals under the microscope including textural studies. *Field work* of up to three days is a compulsory part of the subject.

25.3162 Mathematical Geology 2 **S1 L2 T1**

Prerequisite: 25.2261.

Application of the mathematical techniques listed below to geological data processing and analysis. Analysis of variance. Introduction to matrix algebra. Regression analysis, trend surface analysis; time series analysis; Markov chain analysis. Introduction to nonparametric statistics. Introduction to multivariate statistics. *Practical work* based on the use of SPSS, BMDP and other library programs.

25.321 Earth Materials 4 **S2 L3 T3**

Prerequisite: 25.221.

Clay Mineralogy: The structure and properties of the clay mineral groups including the kaolinites, illites, smectites, chlorites, mixed layered and fibrous clay minerals. Techniques for the identification of the clay inerals. Clay-water systems and ion exchange. Chemical weathering and the origin of the clay minerals. Industrial uses of clays and bauxite. *Advanced Igneous Petrology.* Origin of silicate liquids. High pressure and low pressure fractionation. Liquids and fluids. Nature of the Upper Mantle. The use of trace elements and isotopes as petrogenetic indicators. Practical petrography and literature studies of igneous suites. Field study. *Advanced Metamorphic Petrology.* Facies series. Metamorphic reactions. Isograds. Mineral assemblages as geobarometers and geothermometers. Fluids in metamorphosism. Fabric. Relationships of deformations and recrystallization. Metamorphic petrology of Australia. Practical macroscopic and microscopic study of metamorphic rocks. *Field work* of up to six days is a compulsory part of the subject.

25.324 Mineral and Energy Resources 2 **S2 L3 T3**

Prerequisite: 25.212 or 25.5212.

Coal Geology. Nature and properties of coal. Methods of testing and analysis. Introduction to coal petrology. Origin of coal seams and coal-bearing sequences. Coalfield exploration and coal mining geology. Geological factors in coal preparation and use. Geology of oil shale. *Petroleum Geology.* Geological factors critical to the occurrence of oil and natural gas. Geochemistry of hydrocarbons and formation fluids; techniques of petroleum exploration. Assessment and development of reserves. Typical petroleum occurrences in Australia and overseas. *Non-metallic Minerals.* Occurrences and economic use of non-metallic and industrial minerals including limestone, silica, asbestos and construction materials. *Sedimentary Basin Analysis.* Techniques of analysis and data presentation using information from outcrops, boreholes (including geophysical logs) and seismic sections. Construction and interpretation of structural isopachous and lithofacies maps. Seismic stratigraphy. Styles of semimentation within and structural development of basins in

different tectonic regimes. Evolution of sedimentary basins. *Field work* of four days is a compulsory part of the subject.

25.325 Engineering and Environmental Geology **S2 L4 T2**

Environmental Geology: Hydrodynamics of pollutants and water quality principles. Domestic, industrial and radioactive waste disposal, deep well injections. Geological hazards and urban planning. Environmental impacts of dams, mineral exploration, mining and impact statement techniques. Water resources lay and pollution. Land use conflicts. *Hydrogeology.* The hydrological cycle; confined and unconfined groundwater. Hydrological characteristics of rocks and their measurement. Pump tests. Aquifer boundaries. Exploration for groundwater development and monitoring of groundwater resources. Groundwater flow tests. Case studies from the Great Artesian Basin and the Murrumbidgee area. *Geomechanics.* Rock and soil masses and their engineering behaviour. Influence of composition and fabric. Discontinuities in rocks and soils and their analysis for engineering purposes. Mechanical properties and their measurement. Stress-strain theory. *Coastal Geology.* Properties of sedimentary populations. Sampling practice and analysis of measured data. Geological implications of sedmient parameters. Coastal environmental assessment. Shoreline processes. Geological evolution of the inner continental shelf. *Field work* of up to three days is a compulsory part of the subject.

25.3271 Structural Geology **S2 L1 T1**

Prerequesite: 25.221.

Advanced Structural Geology. Analysis of structural elements at the microscopic, mesoscopic and macroscopic scales. Detailed studies of the analysis of metamorphic terrains. eg Coorna Complex, Broken Hill. *Field work* of up to four days is a compulsory part of the subject.

25.3281 Exploration Geochemistry **S2 L1 T1**

Prerequisites: 25.311 and 25.314

Principles and techniques of soil drainage and rock geochemistry as applied to mineral exploration.

25.333 Exploration Geophysics **S1 L3 and S2 L1 T1**

Prerequisite: 25.120.

Physical properties of rocks and soils. Introduction to seismic, gravity, magnetic, electrical, electromagnetic and radiometric methods of geophysical exploration. Application of these methods in the search for mineral deposits, petroleum, coal and groundwater and in civil and mining engineering projects. Interpretation of geophysical data. *Field work* of up to three days is a compulsory part of the subject.

25.411 Advanced Geological Techniques **S1 L T6**

Geochemical Techniques. Sampling strategy and methodology; preparation of samples for analysis. Modern destructive and non-destructive methods of rock and mineral analysis including spectrophotometry, AAS, ICP, DCP, XRF and electron probe microanalysis.

Geological Data Processing. Application of probability graphs to exploration data. Processing and interpretation of geological data using selected univariate and multivariate statistics; typical case studies in mathematical geology exemplifying these techniques. Practical work based on microcomputer operating systems, word processing, statistical and graphical packages.

Remote Sensing. Principles of various remote sensing techniques including landsat and side-looking airborne radar. Techniques of image enhancement and digital processing. Applications of remote sensing in lithological mapping and tectonic analysis. Integration of remotely sensed data with conventional data sources. Practical work with the interactive computer on image analysis with particular reference to student field study areas.

Field Work: A compulsory tutorial of up to seven days duration providing training in advanced mapping techniques and in the integrated use of multiple sources of field data.

25.412 Professional Practice **S1 L3 T3**

Prerequisites: 25.314, 25.324.

Project Management: Organization and costing of geological field programs; land tenure, exploration and mining titles; design of drilling, sampling and analysis programs; integration of geophysical methods; use of geological database and modelling systems; estimation of resources and reserves; reporting requirements, liability and ethics in geological practice.

Research and Communication: Literature search and bibliographic indexes; preparation of theses, reports and scientific papers; preparation of maps and other illustrations; presentation of technical material in verbal form; job applications and interview requirements.

Social Issues and the Applied Sciences The subject covers social issues arising from future technological developments and the role that a professional applied scientist can play in influencing future directions. It will be taught by a combination of group activity, case studies and projects and seminars from visiting speakers, some of whom will be from disciplines other than the applied sciences.

Topics to be covered will include: the rights and obligations of consumers and manufacturers with specific applications from the food industry. Issues associated with the restructuring of industries, public transport, port facilities etc. Government protection of manufacturing industries such as automobiles, clothing and chemicals and the impact of this on relationships with our trading partners. The resolution of conflicts of interest over landuse in national parks, wilderness and recreational areas and urban areas. Energy policies and their global implications. The impact of mining on society and the environment. The effects on society of the introduction of new technologies such as home based computer terminals and new materials such as semiconductors. The influence of cartels and the political importance of strategic materials.

25.413 Special Topics in Applied Geology **S1 L, T12**

Instruction by lectures, tutorials and assignments in advanced aspects of a chosen area of geological specialisation. Programs are offered in a number of specialised fields including Mineral Exploration and Mining Geology, Sedimentary Basin Studies, Geophysics and Engineering Geology. Details of these programs are available from the Head, Department of Applied Geology. The special Topics program would normally be related to the topic of the chosen

Field Project and is designed to be a preparation for a future career. Variation from the standard programs is allowed subject to approval from the Head of Department.

25.420 Field Project **S2**

A major field-laboratory project, which generally includes geological mapping, on some aspect of mineral or sedimentary basin resources, engineering or environmental geology or resource geophysics.

25.510 Geology for Geomorphologists and Pedologists **S1 L1 T1 S2 L2 T2**

Prerequisites: 25.211, 25.221.

Clay Mineralogy. The structure and the properties of the clay groups, including the kaolinites, illities, smectites, chlorites, mixed layered and fibrous clay minerals. Techniques for the identification of the clay minerals. Clay-water systems and ion exchange. Chemical weathering and the origin of the clay minerals. Industrial uses of clays and bauxite. *Sedimentology.* Properties of sedimentary populations. Sampling practices. Measurement of grain size, grain shape and packing; analyses of measured data. Geological significance of sediment parameters. *Coastal Geology.* The shoreline processes. Littoral and longshore drifts and net sand movement. Coastal engineering works. The estuarine environment; sedimentation, chemical and biological processes, investigation techniques.

25.511 Surficial Materials and Processes

Prerequisite: 25.211.

Clay Mineralogy. The structure and properties of the clay minerals groups including the kaolinities, illites, smecites, cholorites, mixed layered and fibrous clay minerals. Clay-water systems and ion exchange. Chemical weathering and the origin of the clay minerals. Industrial uses of clays and bauxite. *Sedimentary Petrology.* The influence and transportation, deposition and diagenisis on the composition, texture and structure of detrital sedimentary rocks. The non-clastic sedimentary rocks including phosphates, evaporites, ferruginous and silceous deposits. *Hydrology.* The hydrological cycle; confined and unconfined groundwater. Hydrological characteristics of rocks and their measurement. Pump tests. Aquifer boundaries. Exploration for groundwater development and monitoring of groundwater resourves. Groundwater flow tests. Case studies from the Great Artesian Basin and the Murrumbidgee area.

25.5122 Geology for Civil Engineers **S1 L2 T1**

An introduction to mineralogy, petrology, structural geology, stratigraphy and geomorphology. Weathering of rocks and development of soils. The role of the geologist in civil engineering.

25.520 Geology for Mining Engineers 1 **F L1 T1**

Outline of the main brances of geology and their application to Mining Engineering. Introduction to geomorphological processes and resulting landforms. Fundamentals of the atomic structure of minerals including major rockforming minerals and ore minerals, their crystal symmetry, their physical and chemical properties. *Igneous Rocks,* formation, texture, composition and classification of the more important igneous rocks. *Sedimentary Rocks,* processes of formation depositional environment, composition and classification. *Metamorphic Rocks,* metamorphic processes and metamorphic structures, classification and description of metamorphic rocks. Physical properties of rocks including porosity, permeability and capillarity. Weathering processes of rocks and minerals. Deformation of rocks and the resulting effects such as folds, faults, joints and foliation. An introduction to modern theories of tectonism. Integration of geological observations. *Practical Work.* Laboratory work consists of exercises related to the Lecture course: geological mapping includi ng structure contour problems. Study of minerals and rocks in hand specimens. *Field Tutorials.* Two field tutorials are conducted at which attendance is compulsory. Satisfactory reports must be submitted. Note: Total hours: 56. The subject is divided equally between lectures and laboratory work. Field Tutorial hours are additional.

25.5212 Sedimentology **S1 L1 T1**

Prerequisite: 25.120. Excluded: 25.212.

As for *Sedimentology* in 25.212 Earth Environments 1. Available only to Course 3145.

25.523 Mineralogy **F L1 T1**

Crystallography, crystalline state and crystal growth of minerals. Fundamentals of the atomic structure of minerals, with examples of Bravais lattices and introduction to space lattice group theory. Physical properties of crystals, cleavage, gliding, secondary twinning, elasticity. Elements of crystal optics in polarized light. Classification, descriptive mineralogy and occurrence of primary and secondary minerals with special emphasis on economic mineral deposits, their mode of formation, parageneses, textures and intergrowths. Elements of fuel geology, construction and refractory materials. *Laboratory: Crystallography* – Examination of crystals and crystal models for symmetry. Stereographic projection of crystals. *Optical Mineralogy* – Examination of minerals and rocks in transmitted and incident light using the polarizing microscope. Determination of refractive indices of crystal fragments by the immersion method. *Descriptive and Determinative Mineralogy* – Macroscopic examination of common minerals with emphasis on economic minerals. Study of texture and intergrowths of common mineral parageneses including the principal rock types in which they occur.

25.530 Geology for Mining Engineers 2 **F L2 T2**

Palaeontology and Stratigraphy: principles of stratigraphy; the use of fossils in stratigraphic correlation and bore logging. *Structural Geology:* elements of structural geology: stereographic projection and fracture analysis applied to mining operations. *Geology of Fuels:* origin and properties of coal, oil, oil shale and natural gas; stratigraphic and structural considerations in exploration and development of coal and petroleum deposits. *Hydrogeology:* principles of hydrogeology: principles of hydrogeology; transmission of ground water in rocks and soils applied to mining operations. *Ore Deposits:* mineralogy of industrially important metallic and non-metallic minerals; theories of ore formation including secondary enrichment processes. *Exploration Procedures:* theories and application of exploration techniques in mineral and coalfield exploration including geological and geophysical methods. *Field Tutorial:* a geology field excursion is held at the end of Session 1, attendance is compulsory.

25.5331 Physical Geology for Petroleum Engineers 1 **S1 L1 T2**

Introduction to earth science, the constitution of the earth, rock composition, rock types and processes of formation and deformation, organic evolution, geological time, fluids in rocks, presentation of geological data.

25.5332 Physical Geology for Petroleum Engineers 2 **S2 L1 T2**

Sedimentary petrology, sedimentary environments and facies, facies analysis, origins and formation of petroleum, exploration techniques, petroleum in Australia.

25.5302 Structural Geology for Petroleum Engineers **S2 L1 T2**

Prerequisite: 25.301.

Origin and properties of both regional and local geological structures and petroleum traps. Delineation of structures and petroleum traps by geophysical methods.

25.5311 Aqueous Geochemistry **S1**

Prerequisite: 25.221.

As for *Aqueous Geochemistry* in 25.311 Earth Materials 3. Available only to Course 3145. Note: Tutorials comprise 10 hours total in Session 1 only.

25.5312 Geological Field Mapping **S1 L2**

Prerequisite: 25.5312. Excluded: 25.312.

As for *Field Mapping* in 25.312 Earth Environments 2. Available only to Course 3145.

25.5313 Stratigraphy **S1 L2**

Prerequisite: 25.5212. Excluded: 25.312 Earth Environment 2. 25.5212. Excluded 25.312.

As for *Stratigraphy*, in 25.312 Earth Environments 2.

25.542 Mining Geology Project **S2**

Note: Comprises 18 hours total in Session 2.

25.9311 Gravity and Magnetic Methods **S1 L2 T1**

Prerequisites: 1.001 and 10.001. It is desirable that students taking this unit have a background to geology.

Fundamental principles. Field procedures and instruments. Reduction of field data. Regionals and residuals. Effects of sources of simple geometrical shapes and generalized two and three-dimensional distributions. Applications. Field work of one day is a compulsory part of the subject.

25.9312 Seismic Methods **S1 L2 T1**

Prerequisites: 1.001 and 10.001 It is desirable that students taking this unit have a background in geology.

Seismic waves. Physical/engineering properties of geological materials. Ray theory is seismic refraction and reflection methods. Instrumentation. Data acquisition and processing. Depth and velocity analysis. Geophysical and geological interpretation. Case history studies. *Field work* of one day is a compulsory part of the subject.

25.9313 Electrical Methods **S1 L2 T1**

Prerequisites: 1.001 and 10.001. It is desirable that students taking this unit have a background in geology.

Introductory theory and field practice of resistivity, self-potential, induced polarization and airborne and ground electromagnetic methods. Geological interpretation of field data. Geophysical logging. Field work of one day is a compulsory part of the subject.

25.9315 Regional Geophysics **S1 T15**

Qualitative and quantitative appraisal of geophysical data for a selected area.

Servicing Subjects

These are subjects taught within courses offered by other faculties.

For further information regarding the following subjects see the Combined Sciences Handbook.

25.435 Geology Honours

25.621 Marine Geology 1 **F L1 T2**

Prerequisites: 25.601 or both 25.110 and 25.120.

Sedimentology. Flow regimes and bedding forms, sedimentary structures. Modern and ancient sedimentary environments of deposition, alluvial, nearshore, shelf and deep sea, in both terrigenous clastic and carbonate/evaporite domains. The facies concept: lateral and vertical relationships between depositional environments and associated lithofacies within developing sediment wedges. *Global Geophysics.* Principles of gravity, geo-magnetism, palaeomagnetism, geothermy and seismology and their relation to shape, internal constitution, dynamic processes and major tectonic features of the earth. *Mineralogy and Petrology.* Igneous and sedimentary rock types of the ocean floor and their significance.

Field work of five days is a compulsory part of the subject.

25.622 Hydrological and Coastal Surveying **F L1 T2**

Prerequisites: Nil.

General principles of surveying, Optical and electronic methods of distance and elevation measuring. Coastal position fixing. Coordinates systems and their application to coastal mapping. Map projections. Long and short term monitoring of coastal changes. Tides, their measurement and determination of tidal planes. Soundings and bathymetric surveys. Shallow water investigations for seabed and bedrock morphologies. Through its intensive practical approach, the course is designed to give to each student an understanding of coastal surveying applicable to a large variety of small scale investigations, from beach monitoring to estuarine detail bathymetry.

25.631 Marine Geology 2 **F L1 T2**

Prerequisite: 25.621.

Clay Mineralogy. Structure and properties of the clay mineral groups including the kaolinites, illites, smectites, chlorites, mixed layered and fibrous clay minerals. Techniques for identification of the clay minerals. Clay-water systems and ion exchange. Chemical weathering and the origin of the clay minerals. *Sedimentary Basin Analysis:* Techniques of analysis and data presentation using information from outcrops,

boreholes (including wireline logs) and seismic sections. Construction and interpretation of structural, isopachous and lithofacies maps. Seismic stratigraphy. Styles of sedimentation within the structuring of basins in tensional, compressive and strik-slip tectonic regimes. Basin evolution. *Stratigraphy.* Ocean basin stratigraphy and the environmental and chronological utility of the principal groups of index fossils. Stratigraphical history and correlation of sedimentary rocks in the deep ocean basins and on continental shelves. Changes of sea level. The Quaternary history of the oceans. Reefs and carbonate sedimentation. Deep sea consolidated sediments. Field work not esceeding two days is a compulsory part of the subject.

25.632 Estuarine Ecology **F L1 T2**

Prerequisite: Nil.

The physical nature of the estuarine environment: its characteristic topography, chemistry and layering of water masses; tidal behaviour. Characteristic sediments, stratigraphy of sediment bodies and distribution patterns of sediments and microfossils in estuaries. Inorganic and microbial diagenesis of estuarine sediments. Procedures for mapping, sampling and sample analysis. Mineral morphology. Statistical treatment of results. Field work of four days is a compulsory part of the subject.

25.6341 Marine Mineral Deposits and Oceanic Minerals **S1 L1 T2**

Oceanic minerals and mineral deposits: Resources important to human civilization of a biological, fluid and mineral nature. Mining of ocean resources. Geological aspects of waste disposal and engineering works in the ocean. Tidal energy.

25.6342 Exploration and Seismic Methods **S2 L2 T1**

Geophysics of ocean basins and off-shore areas and the techniques of their study. Seismic refraction, reflection and computational methods, instrumentation of seismic and acoustic sources, recording systems and signal processing. Geological and physical interpretation of results. Practical work on instrumentation, recording and interpretation of field data.

25.9314 Geological Applications **S1 L1 T1**

Prerequisite: 25.120.

A subject of ten weeks' duration. *Structural Geology:* Elements of structural geology, sterographic projection and fracture analysis. *Geology of Fuels:* Origin of coal, oil and natural gas; stratigraphic and structural consideration of oil and coalfields. *Hydrogeology:* Principles of hydrogeology; transmission of groundwater in rocks and soils. *Field work* of one day is a compulsory part of the subject.

25.9321 Geophysical and Geological Applications **S2 L1 T2**

Prerequisite: 25.120. Excluded: 25.6342.

Geological interpretation of Geophysical data. Seismic stratigraphy. Coal-seam geometry from high resolution seismic and in-seam data. *Geology of Ore Deposits.* Mineralogy of industrially important metallic and non-metallic minerals. Theories of ore formation including secondary enrichment processes. Available only in program 2503.

Graduate Study

Departments of Mining Engineering and Mineral Processing and Extractive Metallurgy

Mining Engineering and Mineral Processing and Extractive Metallurgy are Departments within the School of Mines.

Generally these subjects are of three hours' duration per week or multiples of that time.

7.001G Exploration Drilling

Drilling equipment and technology. Deep boring. Selection of drilling methods, drill hole surveys. Development and exploitation of mineral resources. Exercises on mine planning.

7.111F Mining Engineering

1. Surveying methods to quantify mineral resources. Mine development. Explosives. Shaft sinking, tunnelling, excavation methods. **2.** Advanced mining systems, parameters for applicability and efficiency of mining methods, waste disposal. Non-entry methods, in situ mining. Off-shore mining methods. Rock mechanics, mechanical behaviour of rocks. The Mining Acts.

7.122G Mining Engineering Technology

1. Mine ventilation contaminants, toxicity of mineral particles and gases, thermodynamics of mine air, network analyses, air conditioning in mines. Mine safety, health, hygiene, noise. **2.** Mine lighting, electrical power distribution, generation and reticulation of compressed air. Materials handling. Surface and underground haulage systems, design criteria. Mine drainage. Standards specifications. **3.** Feasibility studies. Mine design and layout, separation of functions for maximum efficiency; application of analogue and digital computers. Production control, grade control, administration. Resources allocation, finance, labour, equipment. Size and scope of mining company operations. **4.** Mine support. Mining methods employing fill, fill compressibility. Rock and cemented rock fill. Placement of mixed fills. **5.** Rock mechanics. Stress and strain analysis. The mechanics of strata movement and the distribution of pressure around mine workings. Ground control and methods of support in the workings and the waste. Design of mining excavations. Slope stability. **6.** Subsidence phenomena associated with mine workings. Methods of working and design of structures to minimize damage.

7.132G Mining Engineering Laboratory

A selection of advanced laboratory investigations in sampling and valuation, mine support, temporary or long term; mine design and plant related to extraction and servicing functions; rock properties; programming of mining methods and transport; non-entry mining; petroleum engineering; gasification; solvent processes.

7.151G Ground Control and Excavation Engineering

1. Natural state of stress in rock masses. Effects of geological structures on the stability of mine working. Stresses and rock movements induced by mining operations. Design of mining systems and layout of workings based upon rock mechanics and functional considerations. **2.** Principles and design of support systems. Inter-relation of temporary, stabilizing and long term support. Support of permanent mining and civil engineering openings. Control of ground in the vicinity of production excavations. **3.** Design and construction aspects of open pit slopes and tailing dams. **4.** Rock-breaking and drilling methods, penetrability and workability of rocks; fracturing. Nature, occurrence and prediction of rockbursts. Mechanics of crack propagation and subsidence.

7.152G Mining Conservation

The reclamation of excavated land; integration with operational stages of mining. Mining cycles of alluvial, strip, and open cuts, land clearing, stabilizing the mined area, socio-economic aspects of mining, rehabilitation costs, government regulations. Examination and evaluation of a current operation.

7.153G Environmental Conditions in Mines

The energy equation applied to ventilation, sources of heat in mines, geothermal gradients, thermodynamics, pressure-volume diagrams. Practical aspects of high air temperatures and the control of atmospheric conditions in deep underground mines. Fan design, installation and testing. Psychrometry, ventilation planning. Computer applications. Selected laboratory experiments and network designs.

7.154G Rock Excavation and Transportation

Rock fragmentation drilling, blasting large rounds. Loading techniques, shovels, draglines, bucket wheel excavators, dredges, front-end loaders, tractor scrapers. Operating factors, selection procedures, cost estimating. Materials handling, continuous, semi -continuous, batch systems, cost analysis.

7.311G Mineral Beneficiation

Prerequisite: 7.7341 or equivalent

Processing economics: mineral processing and its integration with mining, metallurgical and chemical operations. Principles of raosting, leaching, electrolysis, cementation, solvent extraction and ion exchange. Particle mechanics: size, shape, surface area, size distribution functions. Relative and bulk densities. Theory of fracture mechanisms, comminution, energy requirements. Processes of agglomeration. Physical separation methods, electronic sorting, electrostatic and magnetic separation.

7.322G Mineral Beneficiation Technology

Prerequisite: 7.311G or equivalent.

1. Fluid mechanics of mineral pulps, free, hindered and zone settling, thickening, classification, hydrocyclones, dewatering, filtration. Gravity concentration jigging, sink and float, flowing film fluidized beds. **2.** Interfacial phenomena, the structure of solid-water, air-water, solid-air and oil-water interfaces. Experimental techniques, applicable to the study of these interfaces. Electrokinetic theory, electrical double layer interaction. Adsorption mechanisms. Collectors, activators, depressants, modifiers, frothers, flocculants. **3.** Sulphide mineral flotation, xanthate chemistry, oxide mineral

flotation, salt mineral flotation. Coal preparation, coal constitution, bore core evaluation, selective preparation, blending for utilization. **4.** Process design. Feasibility studies, extraction processes and environmental conditions. Selection and location of equipment, fluid-solids flow, design of auxiliary units, development and presentation of flow-sheets. Sampling and experimental techniques, batch, continuous and pilot plant testing. Scale up. Product disposal. Principles of chemical analysis, instrumentation, measurement of variables in mineral processing, controllers, use of computers. Technical management.

7.332G Mineral Engineering Laboratory

Prerequisite: 7.311G or equivalent.

Laboratory investigations may be selected from the following according to availability and specialization: metalliferous ore concentration; coal preparation; beneficiation of non-metallics; processing of mineral fluids.

7.351G Mineral Beneficiation

Prerequisite: 7.7342 or 7.311G or their equivalent.

Process design based upon mineral properties; extraction processes and environmental conditions. Selection of technology to be adopted. Basis of feasibility studies. Special considerations for coal preparation and treatment of industrial minerals. Flowsheet planning, solid and fluid flows, auxiliary units, materials handling, product disposal. Experimental techniques used in testing. Scale up procedures. Plant control, automation, use of computers. Management of mineral processing operations.

7.361G Minerals Engineering 1 **S1 L3 T4**

1. Principles of mineral deposition. Constitution of coal. Fuel technology. Coke making. Principles of extractive metallurgy. Beneficiation and utilization of industrial minerals. Materials balances. **2.** Fluid dynamics of mineral pulps. Rheology of fluids and particulate suspensions. Dynamics of particle and bubble motion and collision. Flow through porous media. Fluidized beds. Flow in pipes, open channels and thin films. **3.** Materials handling: Flow characteristics of granular materials. Belt and mechanical conveyors. Stockpiles, bins and hoppers. Blending. Feeders. Distributors. Slurry pumps. Solids pipelines. Sampling theory and practice. **4.** Particle statistics: Concepts of particle size. Size analysis methods. Size distribution functions. Specific surface. Shape factors. Number-, Surfaceand Volume mean sizes. **5.** Interfacial phenomena: Free surface energy. Surface tension. Three phase contact. Electrokinetic theory. Double layer interaction. Chemical and physical adsorption. Experimental techniques. Foams.

7.362G Minerals Engineering 2 **S1 L4 T4**

1. *Comminution.* Fracture. Liberation. Energy-size relationships. Grindability. Conventional comminution equipment. Feed and product characteristics. Open and closed circuit operation. Vibratory and fluid energy mills. **2.** *Screening and classification.* Screening as a process of chance. Screen loading. Factors affecting screen capacities. Types of screen. Probability screens. Optical imaging. Hydraulic, mechanical and cyclone classifiers. **3.** *Physical concentration processes.* Gravity concentration. Jigs, heavy media and flowing films. Electronic and optical sorting. Electrical and magnetic separators. **4.** *Chemical concentration processes.* Leaching. Solvent extraction and ion exchange. Cementation. Cyanidation and amalgamation. **5.** *Flotation.* Collectors, activators, depressants, modifiers, frothers. Conventional and novel cells. Flotation kinetics. Entrainment. Soluble salt flotation. Reverse flotation. Agglomeration and carrier flotation. Selective flocculation and agglomeration. **6.** *Liquid-solid separation and product disposal.* Flocculation. Thickening. Filtration. Drainage. Dewatering by screens and cyclones. Centrifuging. Dryers. Tailings dams. Tailing utilization including mine fill, reclamation. Pollution control.

7.363G Minerals Engineering Laboratory **S1 T3**

A series of laboratory investigations relating to material covered in subjects 7.361G and 7.362G.

7.364G Minerals Engineering 3 **S2 L4 T4**

1. *Process analysis and simulation.* partition and efficiency curves. Washability curves. The Mayer curve. Computer models of comminution, sizing and concentration processes. Laboratory and pilot scale testing. Scale up procedures. **2.** *Process design.* Process appraisal, selection of technology based upon mineral properties, extraction processes, energy requirements and environmental conditions. Feasibility studies. Special considerations for coal preparation and treatment of industrial minerals. Process flowsheet planning, equipment selection and details of solid and fluid flows. Engineering flowsheets showing details of major and auxiliary units, materials handling, product disposal, water and electricity, distribution and equipment control. **3.** *Instrumentation and control.* Principles of chemical analysis. Laboratory and *in situ* instrumental analysis. Flow and density gauges. Level detectors. Belt weighers. Controllers and control strategies. Automation. **4.** *Plant design.* Factors influencing selection of site. Plant and site layout. Preparation of technical and commercial specifications and tender documents. Construction scheduling. Environmental aspects. Noise control. Safety. **5.** *Management.* Personnel selection and training. Trade Union organization. Communications and consultation. Management structure and organization. Marketing. Contracts and smelter schedules. Maintenance planning. Accounting and budget control. Purchasing and stores policies.

7.365G Minerals Engineering Project **S2 T10**

Laboratory work to evaluate information necessary for the design of a process for the beneficiation of ore from a metalliferous deposit, preparation of coal or treatment of industrial minerals. Candidate's report to include a process flowsheet, an equipment and materials flowsheet and a plant design layout.

7.442G Mineral Industry Analysis **S2 L2**

Aspects of micro- and macro-economics. Type of companies, private, public, no-liability, State ownership and participation. Financing of mining ventures. Contracts and project assessment. Obsolescence and replacement. Operations research control networks, decision analysis, linear programming, queueing theory, simulation, improvization. Grade control, estimation of cut-off grades. Includes

advanced work in the technical and economic analysis of mining or mineral operators. Cases are selected for examination and analysis; critical review.

7.405X Numerical Methods in Geomechanics S1 3

Boundary Value Problems: Equivalent continuum, equilibrium in terms of stresses, boundary conditions, displacement and strain, constitutive relations of elasticity, differential equations. Finite Elements: Approximate solution and variational principle, stiffness matrix and equivalent nodal force vector, finite elements, assembly and solution of the global system, isoparametric and infinite elements, pre and postprocessing, elastoplasticity, groundwater flow, modelling strategy, programming considerations. Geotechnical applications. Boundary Elements: Basic singular solution, indirect method, direct method, isoparametric and infinite elements, construction and solution of system of equations, programming considerations, geotechnical applications.

7.415X Stability of Slopes S2 3

Data collection for pit slope design, statistics of defects in rock masses: Length, orientation, spacing, roughness, planar and two wedge failure modes. Tetrahedral wedges, Bishop, Morgenstern-Price and other methods. Physical admissibility. Toppling and other modes of ailure, probabalistic slope analysis, effect of presistence, bench and overall slope design. Slope support; cable botls, anchors and other methods, drainage for improvement of stability. Dams and tailings disposal. Slope monitoring. Continuum and joint seepage of water.

7.455X Mining Geomechanics Project F 6

Individual project on an investigation related to an actual mining geomechanics problem, the topic to be chosen after consultation with a staff member. A report is required.

7.515X Rock Mechanics Measurements S1 3

Field measurement of rock mass properties. Controlled postfailure strength and deformation properties of rock. Data collection and analysis. *In situ* stress measurement. Prediction of premining rock stresses. Monitoring rock movement and stress change in underground and surface rock excavations. Seismic techniques in rock mechanics.

7.525X Strata Control Engineering S2 3

Dislocations, stress changes and energy changes in the rock mass around underground excavations. Design of self-supporting, artificially supported and caved underground excavations. Introduction to boundary element methods of stress analysis. Prediction and control of rockbursts and instantaneous outbursts in coal. Analogue modelling of pillar mining. Rock mechanics of longwalls.

7.535X Mine Fill Technology S2 3

Fill properties and their assessment. Fill preparation, placement and dewatering. Field sampling and in situ testing. Mining methods employing fill. Pozzolanic fills. Dry fills and rock fills. Economic aspects of fill practice. Soil and rock mechanics aspects. Environmental aspects. Specific fill practice in mining coal and uranium.

7.545X Advanced Rock Cutting Technology S2 3

Mechanics of rock cutting by picks, discs, toothed roller cutters and button cutters. Machine applications. Tool materials and wear. Selection of cutting systems. Rock cuttability assessment. Rock cutting machine design for coal and competent rock. Case studies.

7.555X Blasting Technology S2 3

Historical development of commercial explosives. Description of various explosives and their compositions. Explosive properties. Initiation of explosives. Delay systems in firing. Explosive accessories. Handling explosives on site. Safety in firing blasts and precautions against extraneous electricity. Procedure in misfires. Rock blasting without drilling holes. Acquisition, storage and transport of explosives. Underwater blasting. Underwater vibrations from blasting. VCR blasting.

7.565X Rock Slope Stability F 2

Economic aspects in the design of rock slopes in open cut mines. Failure of rock slopes and controlling factors. Stability of temporary rock slopes. Probabilistic analysis.

7.575X Subsidence Engineering F 2

Trough subsidence resulting from the extraction of bedded mineral deposits. Parameters influencing subsidence. Subsidencerelated phenomena causing damage to structures at or below the surface. Measurement and empirical prediction. Theories and modelling of subsidence. Control of subsidence.

7.917G Fire and Explosion S1 or S2 L2

Chemistry and physics of combustion reactions; types of flames; deflagration and detonation; ignition; fire point; flammable limits. Industrial fuel-fired appliances; fire risks in buildings; fire fighting equipment; flame proofing; fire and explosive risks in chemical process industries; case studies. Use of appropriate standards and legislation. Fire research; insurance.

7.936G Equilibrium Concepts in Water Systems

The application and limitations of chemical thermodynamics in water systems. Aqueous inorganic process systems including water treatment and minerals processing. The effects and control of pollution. Thermodynamic diagrams such as InE pH, potential pH, temperature pH and concentration pH are developed as an aid to assessing system energetics. Sources and estimation of thermodynamic data. Kinetics and mechanism in relation to aqueous system energetics. Analysis of kinetic data.

7.937G Hydrogeochemistry S1 L1.5 T1.5 C3

Chemical composition of natural and contaminated groundwater, inorganic and organic chemical principles. Application of chemical thermodynamics in groundwater systems; data sources. Development of Eh pH, activity and other diagrams to assess system stabilities and mineral dissolution and precipitation. Non-equilibrium approaches. Chemical classification of groundwaters and hydrochemical facies in aquifers. Geochemical evolution of groundwater along flow paths in a variety of porous and fractured rocks for saturated and unsaturated zones. Application of stable and

radioactive isotopes. Computer models to evaluate chemical patterns. Case studies of significant groundwater basins; Great Artesian Basin. Interactions of solid, liquid and gaseous phases. Salt sieving and brine development. Chemical and microbiological reactions in and near boreholes and relevance to borehole performance deterioration, rehabilitation. Chemical dispersion theories for contaminants, hydrochemical modelling for inorganic and organic contaminant plumes. Practical field insitu chemical parameter measurement, sampling, laboratory analysis, laboratory and field experiments for determination of hydrochemical parameters, adsorption, desorption, Kd, dispersivity.

7.941X Advanced Rock Mechanics **S1 3**

Field measurement of rock mass properties. Controlled post-failure strength and deformation proerties of rock. Data collection and analysis of rock mass and support response. In situ stress measurement. Prediction of pre and post-mining rock stresses and deformations. Monitoring rock movement and stress change in underground and surface rock excavations. Seismic techniques in rock mechanics. Dislocations, stress changes and energy changes in the rock mass around underground excavations.

Department of Applied Geology

25.702G Hydrogeology **S1 L1.5 T1.5 C3**

Surface and sub-surface methods of geological and geophysical investigation; ground water exploration of confined and unconfined aquifiers. Geological and hydraulic characteristics of rocks; aquifer boundaries, groundwater storage and quality. Hydraulics of wells. Hydrogeological systems analysis, including computer methods, mapping techniques and groundwater resources evaluation. Hydrogeology of arid and semi-arid zones. Case history studies of groundwater fields.

25.703G Project (Engineering Geology Graduate Course) **S2 C18**

The project is a research investigation consisting of field and laboratory work in any of the disciplines. Engineering Geology, Hydrogeology, Environmental Geology.

25.704G Environmental Geology **S1 L1.5 T1.5 C3**

Geological hazards: seismic risk, landslides, subsidence, floods, erosion, volcanic eruptions, discrete and continuous hazards, event return time. Geological resources and their management: types of resources, use and potential environmental conflict, resource economics and policy formulation. Waste disposal and the mineral industry, reclamation and rehabilitation of land used for extractive purposes. Swamp drainage. Geology and urban planning: map preparation, multiple land use principle, aesthetic criteria for landscape evaluation. Environmental impact of dams, roads, explorative and extractive stages of mining, impact statement techniques, case studies. Communication of geological information to technical and non-technical people. Geological legislation for water resources and waste disposal.

25.705G Engineering Geophysics **S1 L2 T1 C3**

Shallow seismic refraction: elastic theory, sources and equipment. Determination of fracture index, rippability. Applications to damsites, highways, depth of weathering, material quality. Seismic reflection. Sparker and boomer profiling, side scan sonar with application to coastal harbours, sewer outfalls. Electrical methods, direct current geoelectric theory, resistivity sounding and profiling with applications to determination to bedrock depth, location of water table, clay filled dykes, shear zones. Magnetic, electro-magnetic and gravity methods as applied to engineering problems. Geophysical well logging: resistivity, self-potential, gamma ray and sonic logs applied to determination of rock properties and location of clay-filled joints. Field tutorials: Short field tutorials are included.

25.707G Geopollution Management **S1 L1 T1 C3**

Material properties and hydrodynamic factors influencing surface and subsurface flow of pollutants in rocks and soils. Water quality and the problems of standards. Risk analysis in relation to water quality, contaminant sources and safety. Use of field instruments for quality determination. Geological and technological factors in waste disposal for minimal environmental impact; domestic and industrial wastes, deep well injection. Salinity management, salt evaporative basin groundwater relations. Management of radioactive wastes, waste disposal problems in limestone areas. Behaviour over time of wastes disposed in rocks and soils. Case studies of aquifer contamination and practical measures for preventing pollution. Groundwater treatment technology. Rational planning of waste disposal and water resources for industrial and domestic use.

25.707X Geopollution Management **S1 L1 T1 C3**

Material properties and hydrodynamic factors influencing surface and subsurface flow of pollutants in rocks and soils. Dispersion theory and modelling for pollutants in aquifers. Water quality and the problems of standards. Use of field instruments for quality determination. Geological and technological factors in waste disposal: domestic and industrial wastes, including the Rocky Mountain Arsenal Well case study, deep well injection methods. Management of radioactive wastes, waste disposal problems in limestone areas. Case studies of aquifer pollution and practical measures for preventing pollution. Rational planning of water resources for industrial and domestic use.

25.715G Sources of Waste and Landfill Disposal **S1, C3 L2 T1;**
25.715X **S1, X C3**

Sources of solid and liquid wastes, design and operation of landfills, processes within landfills, re-use and planning of sites, transport of waste.

25.716G Groundwater Geophysics **S1 L1.5 T1.5 C3**

Fundamentals and theory of the gravity, magnetic, electrical, electro magnetic and seismic geophysical methods. Relationships between geophysical and hydrogeological properties of earth materials. An introduction to geophysical well logging. Applications of geophysics to regional and detailed groundwater exploration and development, including surface and airborne techniques. In particular: location of water table, stratigraphic detail, determination of bedrock depth,

water quality, porosity and pollution plumes, salinity mapping, saltwater-fresh water interface, fracture and cavity detection.

25.717G Computing for Groundwater Specialists **S1 L1.5 T1.5 C0**

Introduction to FORTRAN programming, mainframe, microcomputer operation systems, databases, spreadsheets, statistical and graphical packages with applications relating to groundwater processes.

25.718G Remote Sensing of Groundwater Resources **S3 L1.5 T1.5 C3**

The physics of various remote sensing techniques; interpretation of conventional aerial photography in exploration; Infra-red remote sensing techniques; side-looking airborne radar; theory and applications of Landsat imagery; enhancement techniques for satellite imagery; interpretation of Landsat photographic products and application to several case history areas. Integration of remote sensing information with the overall database as applied to exploration. Remote sensing for hydrogeological mapping, recognition of aquifers and recharge, discharge zones, salinity mapping. Application of Landsat. TM. SPOT, RADAR and integrated information systems.

25.719G Groundwater Research Project **S2 C18**

Research investigation consisting of one or more of; modelling, laboratory experiments, field work related to hydrogeology and groundwater management.

25.720G Groundwater Project **S2 C12**

Study of similar content to 25.719G but at a smaller scale.

25.726G Geological Engineering **S1 L1.5 T1.5 C3**

Geomechanical properties of intact rock. Geomechanical properties of discontinuities and rock masses. Weathering processes and geotechnical consequences. Engineering classidicaiton of rock masses. Excavation - rippability, mechanical excavation of tunnels, surface and tunnel blasting. Rock support for shallow underground structures. Dam engineering, dam size geology, embankment zoning, foundation treatment and grouting, materials selection and specificaiton, dispersive soils and filter design. Foundations on rock, buildings, temporary supprt of open excavations.

25.727G Fundamentals of Geomechanics **S1 L1.5 T1.5 C3**

Engineering mechanics, limit equilibrium, equilibrium of multiple-bodies, stress and strain in two and three dimensions, equations of equilibrium and compatibility. Isotropic and anisotropic elasticity, plastic and viscous yield criteria and potential surfaces. Stereographic projection methods for rock mechanics. Geomechanical properties and classification of soils and rocks. Laboratory and field testing techniques for soils and rocks. Deformability and strength properties of rocks and shear strength of rock discontinuities. Stresses about rock openings and beneath point loads. Stress measurement in rocks.

25.800G Seminar **S1* T2**

A weekly seminar to present and discuss student papers on exploration topics: speakers from industry are invited to attend and present papers from time to time.

25.801G Geology in Exploration 1 **S1* L4**

The development of conceptual models in mineral exploration and formulation of exploration programs. Consideration of significant guides to ore including structure, lithology, alteration and gossans.

25.802G General Introduction to Exploration Geophysics **S1* L3**

A basic introduction to the theory and practice of exploration geophysics, including treatment of applications and limitations of the main methods of seismic, electric, electro-magnetic, gravity, magnetic and radiometric methods to geological problems in hydrocarbon, coal, ground water, mineral and engineering exploration. Treatment includes fundamental aspects of the method and case histories illustrating applications areas. Field tutorial survey camp: An integrated, geological, geophysical and geochemical field tutorial survey camp of seven days' duration is an integral part of this subject.

25.803G Introduction to Exploration Geochemistry **S1* L3**

Basic principles of exploration geochemistry and the role of exploration geochemistry in the generalized exploration sequence. Principles and problems of anomaly recognition. Examples of main applications.

25.804G Introduction to Data Processing and Interpretation **S1* L3**

FORTRAN and computer programming; use of terminal facilities. Basic data storage and retrieval. Simple interpretative procedures for exploration data.

25.805G Resource Economics 1 **S1* L1**

Interdependence of political, economic and technical factors in mineral resource supplies. Examination of the main factors in reserves and resources estimation.

25.807G Exploration Geophysics **S1* L6**

An introduction to the theory and practice of all geophysical methods in exploration for energy, minerals, groundwater and engineering applications. These will include seismic reflections, seismic refraction, electrical, electro-magnetic, magnetic, gravity and radiometric methods of exploration, including the planning and conduct of field surveys for general and particular applications, and the theory and practice of the interpretation of geophysical results in terms of geological problems, conditions and occurrences.

25.808G Exploration Project **S1* T6**

Interpretation of exploration case-history data designed to familiarize students with the type of information normally required by exploration companies.

25.811G Advanced Geology in Exploration **S1† L4**

Definition of the geological environment and search techniques for major categories of mineral deposits including porphyry coppers, carbonateand shale-hosted lead-zinc ores, volcanogenic massive sulphide ores, vein and sandstone uranium. Geological aspects of reserve estimation. Exploration case histories.

25.815G Resource Economics 2 **S1† L2**

Distribution, production, consumption and trade in minerals. Supply adequacy and resource assessments and projected requirements. Review of the Australian minerals industry in a global context.

25.816G Geological Remote Sensing **S1† L4**

The physics of various remote sensing techniques; interpretation of conventional aerial photography in exploration; Infra-red remote sensing techniques; side looking airborne radar; theory and applications of Landsat imagery; enhancement techniques for satellite imagery; interpretation of Landsat photographic products and application to several case history areas. Integration of remote sensing information with the overall data base as applied to exploration.

25.817G Mining Law and Exploration Management **S1† L1**

Mining law in Australia with special reference to land tenure and lease acquisition; organization and management of exploration programs.

25.818G Exploration Project **S1† T6**

Design and costing of exploration program by students. This may be based on simulated conditions or actual situations.

25.819G Field-Laboratory Project **S2**

An individual exploration project that requires the student to acquire field and laboratory data on geological, geochemical and geophysical aspects of an actual exploration problem. As far as possible the project should be designed in consultation with the exploration industry. A report is required.

25.821G Geology in Exploration 2 **S1† L2**

Specialized search techniques for selected types of metallic ores, with appropriate case histories.

25.823G Advanced Exploration Geochemistry **S1† L2 T6**

Detailed consideration of the main techniques with emphasis on soil, drainage and rock surveys. All applications and problems will be examined on the basis of case-histories of actual surveys. Special consideration is given to problems of applications under Australian conditions.

25.824G Advanced Data Processing and Interpretation **S1† L2 T2**

Advanced concepts of data storage and retrieval; problems of display of geochemical data; multi-variate statistical data interpretation. Students are encouraged to supply their own data sets for processing.

25.827G Laboratory Methods **S1† L1 T3**

Instruction in the main techniques o sample preparation and instrumental analysis appropriate to exploration geochemistry. Practical experience with AAS and XRF. Students are encouraged to supply their own samples.

25.828G Exploration Project **S1† T6**

Interpretation of exploration data from geochemical surveys; this may be based on data from actual surveys, or data generated by the students themselves.

25.829G Field-Laboratory Project **S2**

An individual research project designed to contribute to the solution of a practical exploration problem; as far as possible the project should be chosen in consultation with the exploration industry to ensure relevancy to current exploration problems. In general the project involves collection of field data and samples, chemical analysis of samples, and interpretation of the results. A report is required.

25.831G Geological Interpretation **S1† T2**

The geological interpretation of geophysical data and geophysical models in seismic, electrical, electromagnetic, gravity and magnetic methods, including selected case studies from petroleum, coal, mineral and engineering exploration.

25.832G Advanced Exploration Geophysics **S1† L16**

An extension and advanced treatment of the subject matter in 25.807G, in the theory and practice of field and interpretational procedures in all methods and aspects of exploration geophysics, including instrumentation, manual and electronic data processing and interpretation. Specific application areas for prominent geophysical exploration techniques in the solution of relevant geological problems are treated in detail in both field and theoretical aspects of the methods.

25.839G Field-Laboratory Project **S2**

Exploration geophysical project on one or more topics of relevance in energy, water, mineral or engineering exploration. Includes tutorial sessions and seminars on relevant topics of geophysical geological geochemical exploration.

25.840G Seminar **S1† T2**

A weekly joint seminar of Mineral Exploration, Exploration Geochemistry, and Exploration Geophysics students who present papers on aspects of their own particular specialization. Outside speakers from industry and government organizations are invited to participate in the seminars from time to time.

25.915G Project in Hydrogeology

Small project involving the analysis of hydrogeological data from Fowlers Gap.

25.916G Research Project in Hydrogeology

Research project on some aspect of the hydrogeology of an arid region.

**Equivalent contact hours, but also including fieldwork out of session.
*Weeks 1-7 only.
†Weeks 8-14 only.

Servicing Subject Descriptions

Servicing Subject Descriptions

Undergraduate Study

Physics

Physics Level I Units

1.001 Physics **1F L3 T3**

Prerequisites:

	HSC Exam Score Range Required
2 unit Mathematics or*	*67-100*
3 unit Mathematics or	*1-50*
4 unit Mathematics	*1-100 or*
and	
	(for 1.001 only) 10.021B
2 unit Science (Physics) or	*57-100*
2 unit Science (Chemistry) or	*60-100*
3 unit Science or	
4 unit Science or	*31-100*
1.021	

Co-requisite: 10.021C or 10.001 or 10.011.

*This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics (Mathematics in Society).

Aims and nature of physics and the study of motion of particles under the influence of mechanical, electrical, magnetic and gravitational forces. Concepts of force, inertial mass, energy, momentum, charge, potential, fields. Application of the conservation principles to solution of problems involving charge, energy and momentum. Electrical circuit theory, application of Kirchoff's laws to AC and DC circuits. Uniform circular motion, Kepler's laws and rotational mechanics. Properties of matter: solids, liquids, gases. The wave theories of physics, transfer of energy by waves, properties of waves. Application of wave theories to optical and acoustical phenomena such as interference, diffraction and polarization.

1.021 Introductory Physics 1 (For Health and Life Scientists) **F L3 T3**

Prerequisites: None. Co-requisites: 10.021A and 10.021B, 10.021B and 10.021C, or 10.001 or 10.011.

Principally for students majoring in the life and health sciences disciplines. Topics at an introductory level.The methods of physics, describing motion, the dynamics of a particle, conservation of energy, kinetic theory of gases, properties of liquids, vibrations and waves, electricity and conduction in solids, ions and ionic conduction, magnetism and electromagnetic induction, alternating current, atomic nature of matter, X-rays, the nucleus and radio-activity, geometrical optics, optical instruments, wave optics, microscopes and their uses.

Physics Level II Units

1.002 Mechanics, Waves and Optics **S1 L3 T1**

Prerequisites: 1.001 or 1.011, 10.001 or 10.011. Co-requisite: 10.2111. Excluded 1.992, 10.4111, 10.4211.

Harmonic motion, systems of particles, central force problems, Lagrange's equations, coupled oscillations, travelling waves, pulses, energy and momentum transfer, polarization, birefringence, interference, thin films, gratings, lasers, holography, fibre optics, Faraday effect, photoelasticity.

1.012 Electromagnetism and Thermal Physics S2 L3 T1

Prerequisites: 1.001 or 1.011, 10.001 or 10.011. Co-requisite: 10.2111. Excluded 1.972, 1.992.

Electric field strength and potential, Gauss' law, Poisson's and Laplace's equations, capacitance, dielectrics and polarization, magnetism, electro-magnetic induction, Maxwell's equations, electromagnetic waves. Laws of thermodynamics, kinetic theory, microscopic processes, entropy, solid state defects, Helmholtz and Gibbs functions, Maxwell's relations, phase diagrams, chemical and electrochemical potential.

1.022 Modern Physics FL0.5 T0.5

Prerequisites: 1.001 or 1.011, 10.001 or 10.011. Co-requisite: 10.2112. Excluded 1.9322, 1.982.

Special theory of relativity: time dilation, length contraction, simultaneity, Lorentz transformations, energy and mass. Photon properties, de Broglie relations, Uncertainty principle, operators in quantum mechanics, postulates of quantum mechanics, potential wells, steps and barriers, harmonic oscillator, H atom, angular momentum, magnetic moment, electron spin, nuclear spin. Atomic and molecular spectra, lasers, quantum statistics, free electron model of a metal, band theory; nuclear size, density, mass; nuclear models, fission and fusion, nuclear forces.

1.032 Laboratory F T3

Prerequisites: 1.001 or 1.011, 10.001.

Excluded 1.9222.

Alternating current circuits, complex impedance, resonance, mutual inductance, introductory electronics, diode and characteristics and circuits, power supplies, transistor characteristics, single stage and coupled amplifiers, experiments using AC circuits. Experimental investigations in a choice of areas including radioactivity, spectroscopy, properties of materials, Hall effect, nuclear magnetic resonance, photography, vacuum systems.

1.062 Computer Applications in Experimental Science 2 S1 L2 T3

Prerequisite: 1.061 Excluded 1.042.

Interface between computer and experiment, programmed and interrupt interaction, direct and dual port memory access concepts, hardware, software and timing restraints. Real-world variables, transducers and conversion to binary representation, converters and counters, signals and noise. Data collection, reduction and storage as digital matrices. Numerical modelling, analysis and elementary control of a system.

1.9222 Electronics S1 L1 T2

Prerequisites: 1.001 or 1.002 or 1.021. Excluded 1.032.

The application of electronics to other disciplines. Includes: principles of circuit theory and analogue computing; amplifiers, their specification and application, transducers; electronic instrumentation; industrial data acquisition.

1.9322 Introduction to Solids S2 L2 T1

Prerequisites: 1.001 or 1.011 or 1.021. Excluded 1.022, 4.402, 4.412.

Introductory quantum mechanics and atomic physics; crystal structure; point and line defects, introductory band theory; conductors, semi-conductor and insulators; energy level diagrams.

Physics Level III Units

1.023 Statistical Mechanics and Solid State Physics S1 L3 T1

Prerequisites: 1.012, 1.022, 10.2112.

Canonical distribution, paramagnetism, Einstein solid, ideal gas, equipartition, grand canonical ensemble, chemical potential, phase equilibria, Fermi and Bose statistics, Bose condensation, blackbody radiation. Crystal structure, bonding, lattice dynamics, phonons, free-electron models of metals, band theory, point defects, dislocations.

1.0343 Advanced Optics S2 L1.5 T0.5

Co-requisite: 1.002.

Fresnel and Fraunhofer diffraction, Fourier transforms, filtering, coherence length and time, stellar interferometers, laser theory, non-linear optics.

1.0533 Experimental Physics B1 S1 T4

Prerequisite: 1.032.

Selected experiments and projects. Advanced experimental techniques and open ended projects in the areas covered in 1.043 Experimental Physics A together with projects involving electron and nuclear magnetic resonances, low temperature physics and super-conductivity. Fourier optics, holography.

1.0543 Experimental Physics B2 S2 T4

Prerequisite: 1.032.

As for 1.0533 Experimental Physics B1.

1.1433 Biophysics S1 L2 T1

Prerequisites: 1.012, 1.022.

Thermodynamics in biology, electrochemical potentials, Donnan equilibrium, irreversible processes, diffusion and applications to biological systems. Membrane potentials. Nernst potential, Goldman and Nernst-Planck equation, generalized approach. Active transport. Membrane structure. The nerve impulse, activation and inactivation, Hogkin and Huxley equations. Muscle, contractive process, thermodynamics. Ecological ensemble theory, global thermodynamics interaction of species, ecological associations.

1.1533 Biophysical Techniques S2 L2 T1

Prerequisites: 1.012, 1.022, 1.032.

Theory and application of physical techniques of relevance to the study of biological systems. Techniques considered may include optical and electron microscopy X-ray and neutron diffraction, magnetic resonance, lasers, light scattering, calorimetry, fluorescence, electrochemical techniques and electrophysiological methods and dielectric measurements.

1.3033 Mechanical Properties of Materials S1 L1.5 T0.5

Co-requisite: 1.023. Excluded 4.403.

Properties of materials in relation to their structure: atomic and molecular structure of solids; elasticity, inelasticity, long-range

rubber elasticity, viscoelasticity; plasticity; brittle fracture; viscosity and surface tension of liquids; adhesion; friction and lubrication.

1.713 Advanced Laser and Optical Applications **F L1.5 T0.5**

Co-requisite: 1.002. See also Table 1.

Laser operation, characteristics, theory, design of such types as gas, ion, molecular, excimer and dye lasers. Filter design, multiple beam interference, etalon use, dielectric mirror design. Modulators, theory and application, electro and acousto optic phenomena. Detectors, types, basic theory and design. Solid state and vacuum tube systems. Non-linear optics, theory and applications. A design study and case history of a typical optical system. Materials processing fundamentals. Laser safety.

1.9422 Introduction to Physics of Measurement **S1 L1 T1**

Prerequisites: 1.001 or 1.011. Excluded 1.042.

Resolution: accuracy and sensitivity of instruments, errors of observation; experimental design; transducers; thermometry; electrical noise; servo systems, mechanical design of apparatus; optical instruments optical fibres; photometry; calorimetry; analogue to digital conversion and digital instruments; measurement of very large and very small quantities.

Chemistry

2.103B Organic Chemistry **S1 L3 T3**

Prerequisite: 2.102B. Excluded 2.003B.

Heterocyclic Chemistry: synthesis and reactions of the following heteroaromatic systems; pyridine, quinoline, isoquinoline, pyrimidine, pyrrole, furan, thiophen, indole, imidazole; exampoles of naturally occuring alkaloids where relevant. Alicyclic Chemistry: stereochemistry of acyclic systems; classical and nonclassical strain in cyclic systems; stereochemistry and conformation of monocylic and polycyclic compounds; synthesis, reactions and rearrangement of monocyclic compounds including stereochemical selectivity; transannular reactions in mediam rings; synthesis and reactions of fused and bridged polycyclic systems; examples of steroids and terpenes where relevant. Structure Determination: application of spectroscopic methods eg nuclear magnetic resonance, mass spectroscopy to determination of organic structures.

2.003J Fundamentals of Biological and Agricultural Chemistry **S1 L2 T4**

Prerequisites: 2.121 and 2.131, or 2.141. Excluded 2.013L, 41.101.

Aspects of the chemical and physical properties of materials important in biological systems. Methods of separation, of purification and estimation, and correlations of structure with reactivity. Methods of separation and identification, such as gel permeation, discussed as appropriate to each topic. Significance of isomerism in biological systems, optical and geometrical, absolute configuration. Amino acids, peptides and introduction to protein structure. Relevant properties, acid base properties, pK values, zwitterion, isoelectric points. Simple peptide synthesis. Treatment of carbohydrates, establishment of structures, reactivity. Chemistry of monosaccharides, disaccharides and polysaccharides. Methods of analysis, chemical and physiochemical. Fats, correlation of properties with saturated and unsaturated fatty acid composition. Structural chemistry of fatty acids. Reaction of unsaturated fatty acids, urea complexes. Detergents. Trace elements in biological systems. Chemistry of common heterocyclic systems with emphasis on molecules of biological importance.

2.030 Organic Chemistry **S1 L2 T4**

Prerequisite: 2.102B.

The spectroscopic identification of organic compounds, free radical chemistry and electro-organic processes, various aspects of the organic industrial processes such as industrial synthesis based on petrochemicals, and organometallic reactions of industrial interest. Selected topics from the dyestuff, pharmaceutical and agricultural industries discussing syntheses and reactions including degradation.

2.043B Food Chemistry **S1 L2 T4**

Treatment of the following aspects of food chemistry.

Water: The concept of free and bound wsater, mechanisms of water binding in foods, measurement of free, bound and total water. *Proteins:* Chemical properties of different protein types in foods, rheological properties, chemical and thermal coagulation, chemical modification of proteins, methods of analysis: kjedahl, chlorimetric, NIR. *Carbohydrates:* Structures and reactions of sugars, starch, cellulose, pentosans. Vegetable gums, pectins. Caramelisation reactions. Analytical methods. Maillard reaction. *Minerals in foods:* Presence and chemical importance of minerals in foods. Effects of minerals on food properties. (Ca^{2}+, Fe^{2}+, Mg^{2}+ *inter alia*), electrochemistry. *Vitamins:* Structure, chemical reactions and sources of common vitamins C, B1. B2, B6, Niacin, B12, A, D, Folate. Analytical methods. *Food flavour chemistry:* Chemistry of essential oils and volatile food flavour components. Techniques of food flavour research. *Pigments:* Chemical structure of natural and synthetic pigments in plant and animal foods. Mechanisms of pigment breakdown, effects of oxidation and pH.

2.0433 Instrumental Methods of Food Analysis **S2 L1 T2**

Treatment of theory and practice of modern instrumental methods of analysis, with srrong emphasis on the analysis of food constituents. Methods studied include the following: *Spectrophotometry*: Ultra-violet. Visible. Infra-red. Near infra-red. Fluorimetry. Nuclear magnetic resonance. Mass spectroscopy – also coupled with gas chromatography. Atomic Absorption. Inductive coupled plasma. *Other techniques:* Gas liquid chromatography. High pressure liquid chromatography. Electrophoresis. Selective ion electrodes. Differential scanning colorimetry. Surface colour measurements.

2.043L Chemistry and Enzymology of Foods **F L2 T4**

Prerequsite: 2.102B. Excluded 2.003J, 2.043L.

The chemistry of food constituents at an advanced level and the relationship between the chemistry and enzymology associated with the origin and handling of foodstuffs. Treatment of the stability of constituents, changes in colour and texture occurring during processing and storage.

Methods of assessment, chemical and physical. General classification of constituents, role of free and combined water. Fixed oils and fats, rancidity of enzymic and autoxidative origin, antioxidants natural and synthetic theories on mechanisms of action, carbohydrates, reactivity, role in brewing processes, carbohydrate polymers, starch structure, enzymic susceptibility and mode of action, estimations, enzymic degradation and enzymic browning, reactions and stability of natural pigments, vitamins, preservatives.

2.102A Physical Chemistry **S1 or S2 L3 T3**

Prerequisites: 2.121 and 2.131, or 2.141, and 10.011 or 10.001 or 10.021B and 10.021C. Excluded 2.002A.

Thermodynamics: first, second and third laws of thermodynamics; statistical mechanical treatment of thermodynamic properties; applications of thermodynamics: chemical equilibria, phase equilibria, solutions of nonelectrolytes and electrolytes, electrochemical cells. Kinetics: order and molecularity; effect of temperature on reaction rates: elementary reaction rate theory. Surface chemistry and colloids: adsorption, properties of dispersions; macromolecules and association colloids.

2.102B Organic Chemistry **F or S2 L3 T3**

Prerequisite: 2.131 or 2.141. Excluded 2.002B

Discussion of the major types of organic reaction mechanisms eg addition, substitution, elimination, free-radical, molecular rearrangement within context of important functional groups eg aliphatic hydrocarbons, monocyclic aromatic hydrocarbons, halides, organometallic compounds, alcohols, phenols, aldehydes, ketones, ethers, carboxylic acids and their derivatives, nitro compounds, amines and sulfonic acids. Introduction to application of spectroscopic methods to structure determination.

2.102C Inorganic Chemistry and Structure **S1 or S2 L3 T3**

Prerequisites: 2.121 and 2.131, or 2.141. Excluded 2.042C.

Fundamentals of spectroscopy as experimental basis for theories of electronic structures of atoms and molecules. Concepts and consequences of quantum theory. Molecular orbitals. Ligand ield theory, magnetochemistry. Geometrical structure and chemical bonding, molecular and non-molecular structures, molecular symmetry, ionic covalent and metallic bonds. Occurrence, preparation, properties and reactions of compounds of the p-block elements, of transition metals and of post-transition metals. Principles of co-ordination chemistry. Thermodynamics applied to inorganic systems in solid and solution phases.

2.102D Chemical and Spectroscopic Analysis **S1 or S2 L3 T3**

Prerequisites: 2.121 and 2.131, or 2.141; and 10.011 or 10.001 or 10.021B and 10.021C. Excluded 2.002D and 2.003H.

General procedures in analytical science, accuracy, propagation of errors, precision. Analytical reaction chemistry, titrimetric, and gravimetric, analysis. Solvent extraction. Electroanalytical methods. Chromatography. Instrumental aspects of all major spectroscopic methods. Optical spectroscopy, nuclear magnetic and electron spin resonances, mass spectrometry. Sample handling.

2.102E Organic and Inorganic Chemistry for Chemical Engineers **S1 L4**

Prerequisites: 2.121 and 2.131 or 2.141

Discussion of selected types of organic reactions eg addition, substitution, elimination, free radical, rearrangement to provide a broad cover of the chemistry of aliphatic hydrocarbons, halides, alcohols, ethers and amines. Addition reaction of aldehydes and ketones. Substitution reactions of acid derivatives. Chemistry of benzene and its derivatives with a brief extension to include naphthalene chemistry. Survey of geometrical structures, energetics, bonding, reactions and reactivity, spectroscopic and magnetic properties of representative inorganic compounds, including selected main group compounds, compounds of selected transition metals and rare earth elements, and coordination complexes. Applications of inorganic chemistry.

2.111 Introductory Chemistry **S1 L2 T4**

Prerequisite: Nil.

Note: Students who have passed 2.121 or 2.131 may not enrol in 2.111 or 2.141. Students meeting the 2.121 or 2.141 prerequisite are not permitted to enrol in 2.111 without the permission of the Head of the School of Chemistry. Students who enrol in 2.111 must pass 2.111 before they can proceed to 2.121 or 2.131 or 2.141.

Classification of matter and the language of chemistry. The gas laws and the ideal gas equation, gas mixtures and partial pressure. The structure of atoms, cations and anions, chemical bonding, properties of ionic and covalent compounds. The periodic classification of elements, oxides, hydrides, halides and selected elements. Acids, bases, salts, neutralization. Stoichiometry, the mole concept. Electron transfer reactions. Qualitative treatment of reversibility and chemical equilibrium, the pH scale. Introduction to the diversity of carbon compounds.

2.121 Chemistry 1A **S1 or S2 L2 T4**

Prerequisites:

	HSC Exam Score Range Required
2 unit Mathematics or*	*67.100*
3 unit Mathematics or	*1-50*
4 unit Mathematics	*1.100*
and	
2 unit Science (Physics) or	*53.100*
2 unit Science (Chemistry) or	*53.100*
4 unit Science or	*1-50*
3 unit Science or	*90-150*
2.111	

*This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics (Mathematics in Society)

.Stoichiometry and solution stoichiometry. Properties of gases; kinetic molecular theory. Thermochemistry. Atomic structure, electron configurations and the periodic table. Types of chemical bonds, electronegativity, molecular geometry. Periodicity of physical and chemical properties of common representative elements and compounds. Liquids and solids, changes of state, phase diagrams. Types of solids. Solutions and their properties. Colloids. Facts and theories about reaction kinetics.

Note: Students who have passed 2.121 or 2.131 may not enrol in 2.111 or 2.141. Students meeting the 2.121 or 2.141 prerequisite are not permitted to enrol in 2.111 without the permission of the Head of the School of Chemistry. Students who enrol in 2.111 must pass 2.111 before they can proceed to 2.121 or 2.131 or 2.141.

2.123E Environmental Chemistry **S2 L3 T3**

Prerequisites: 2.102A and 2.102D. Excluded 2.043A.

Physico-chemical aspects of the environment. Factors affecting the chemistry of rivers, estuaries, oceans, surface and sub-surface water. Photolysis reactions in the atmosphere, primary and secondary pollutants. Distribution of elements, nutrient elements, carbon and oxygen in ecological systems chemical models of these cycles. Analysis of naturally occurring species and pollutants. Requirements, validation and performance monitoring of standard analytical procedures.

2.131 Chemistry 1B **S1 or S2 L2 T4**

Prerequisite: 2.121.

Chemical equilibrium, equilibrium constants, quantitative calculations applied to acid-base and solubility equilibria; buffers, titrations, chemical analysis. Oxidation and reduction reactions, electrode potentials. Chemical thermodynamics, entropy, free energy. Chemistry of carbon compounds, stereoisomerism; alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids and derivatives, amines.

Note: Students who have passed 2.111 may be permitted to enrol in 2.131 on application to the Head of the School of Chemistry.

2.141 Chemistry 1M **F L2 T4**

Prerequisites:	*HSC Exam Score Range Required*
*2 unit Mathematics**	*67-100*
3 unit Mathematics	*1-50*
4 unit Mathematics	*1-100*
and	
2 unit Science Chemistry or	*60-100*
4 unit Science or	*1-50*
3 unit Science	*90-150*
or	
2.111	

*This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics Mathematics in Society.

Note: As for **Note** 2.121 Chemistry 1A.

The syllabus is an integrated one of 2.121 and 2.131 see above. Students majoring in Chemistry may take 2.141 in lieu of 2.121 and 2.131.

2.951 Chemistry 1ME **S1 L3 T3**

Prerequisite: As for 2.121.

A treatment of chemistry which illustrates the application of the principles of chemistry to problems of concern to mechanical engineers. Topics: chemistry of materials, thermochemistry, chemical kinetics and equilibrium, radioactivity and nuclear power, electrochemistry and corrosion of metals. Introduction to organic chemistry, structure and properties of polymers, fuels and lubricants. Surface chemistry.

Mechanical and Industrial Engineering

5.0011 Engineering Mechanics 1 **S1 or S2 L2 T2**

Prerequisite:	*HSC Exam Score Range Required*
Either	
2 unit Science Physics or	*53-100*
4 unit Science multistrand	*1-50*
or	
2 unit Industrial Arts or	*53-100*
3 unit Industrial Arts	*1-50*

Excluded 5.010, 5.0101, 5.0201.

Note: Students who wish to enrol in this subject in courses other than the full-time courses in Aeronautical Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering and Naval Architecture can make up for the lack of the prerequisite by work taken in Physics in the first half of the first year.

Equilibrium. Friction. Systems of multiforce members, co-planar and three-dimensional. Mass centre; centroid. Fluid statics. Plane particle kinematics: rectilinear, curvilinear and relative motion. Plane particle kinetics: equations of motion; work, power, energy; impulse, momentum, impact.

5.0012 Introductory Engineering and Materials Science **Design**

Excluded 5.0016, 5.010.

Introduction to engineering design: Engineering method, problem identification, creative thinking, mathematical modelling; computer-aided design; materials and processes; communication of ideas; the place of engineering in society

Introduction to materials science: Structure and properties of main types of engineering materials, with emphasis on the way in which properties may be controlled by controlling structure.

5.0300 Graphical Analysis and Communications **S2 L1 T2**

Excluded 5.0016, 5.030, 5.0302.

Descriptive geometry as the basis of analysis and synthesis of spatial relationships: points, lines, plans, solids, intersections. Orthographic and other projection systems. Engineering drawing as a means of definition and communication, selection of views, construction of drawings, conventions, dimensions and tolerancing. Introduction to computer-based drafting systems.

5.0302 Engineering Drawing and Descriptive Geometry **S1 or S2 L1 T3**

Excluded 5.0016, 5.030.

Graphic communication. First and third angle orthographic projection and isometric projection. Descriptive geometry fundamentals and their application to engineering problems with special emphasis on visualization of problems and development of methods for their solution. Australian standard engineering drawing practice. Applications involving detail and assembly drawings, functional dimensioning and tolerancing.

5.0305 Manufacturing Technology **S2 L0.5 T3**

Prerequisites: 5.0011, 5.0012. Co-requisite: 5.421. Excluded 5.030.

Description of the processes classified as: forming from liquid or solid, material removal, material joining. Elementary mechanics of forming and cutting processes. Analysis of the primary functions of machine tool structures and their operation. Relationship between product design and manufacture processes. Elementary functional analysis of product designs, including linear loop equations, limits and fits, dimensional accuracy of processes and alternate design and manufacturing strategies.

5.122 Mechanical Engineering Design **2F L1 T2**

Prerequisites: 5.010, 5.030. Co-requisites: 5.0201, 5.061, 5.422, 5.620, 5.626.

Design of basic engineering elements and simple systems. Selection and specification of materials and manufacturing processes for engineering items. Communication by means of engineering drawings including tolerances of manufacturing information for simple structures and assemblies. Application of standards and trade literature to design. Simple design-and-make project to meet a published specification and to demonstrate the product's performance.

5.3021 Engineering Mechanics 2A **S1 or S2 L2 T1**

Prerequisites: 1.001 or 1.951, 5.0201 or 5.0011, 10.001 or 10.011. Excluded 5.300.

Kinetics of system of particles, plane steady mass flow. Plane kinematics and kinematics of rigid bodies, mass moment of inertia, differential equations of motion, work, energy, impulse and momentum. One degree of freedom vibrations, free, forced, undamped, damped, transmissibility.

5.3022 Engineering Mechanics 2B **S1 or S2 L/T2**

Prerequisites: 1.001 or 1.951, 5.3021, 10.001 or 10.0011.

Transverse vibrations of beams. Whirling of shafts. Motion relative to a rotating and moving frame. Virtual work for static and dynamic systems. Kinematics and kinetics of simple mechanisms.

5.5010 Computing 1M **S2 L/T3**

Excluded: 5.0721.

Introduction: history, applications, hardware, software, a model of a computer system, editors, operating systems. Program design and development: programming style, syntax charts, errors and debugging. Data: data types, declarations, input/output, file control.. Programming constructs: arithmetic expressions, assignment, relational and logical expressions, selection, iteration, intrinsic functions, statement functions, subprograms, common, communication. Applications using existing programs; sorting, word processing, graphics and plotting, simultaneous linear alegbraic equations.

5.620 Fluid Mechanics 1 **F L1 T1**

Prerequisites: 1.001 or 1.951, 5.010, 10.001 or 10.011. Co-requisite: 5.300. Excluded 5.622.

Units. Fluid properties; fluid statics. Flow fields; unsteady and compressible flow. Bernoulli's equation. Momentum equations. Ideal flow. Flow measurement. Dimensional analysis: similitude; dimensionless numbers; methods of analysis. Steady one dimensional flow in ducts: laminar and turbulent; pressure loss; friction factor; losses in bends and fittings. Elementary boundary layer flow; skin friction and drag. Pumps and turbines.

5.626 Thermodynamics 1 **F L1 T1**

Prerequisites: 1.001 or 1.951, 5.010, 10.001 or 10.011. Excluded 5.622.

Work, energy, power. Units. Systems, states and processes. Control mass and volume. Fluid properties: extensive; intensive. Equation of state. Tables of properties. First law of thermodynamics. Non-flow processes: reversible; irreversible. Flow processes: energy equation; enthalpy. Ideal processes and cycles. Reversibility. The second law of thermodynamics. Entropy. Isentropic processes. Cycles for engines and heat pumps. Energy conversion efficiency. Reciprocating pumps; compressors; engines. Energy analysis; P-V diagrams.

Electrical Engineering and Computer Science

6.611 Computing 1 **S1 or S2 L3 T3**

Prerequisite: As for 10.001. Co-requisite: 10.001 or 10.001 or 10.011. Excluded 6.600, 6.620.

Introduction to programming: design and correctness of algorithms and data structures; programming in a high-level algorithmic language which provides simple, high level program control and data structuring facilities. Problem solving: basic ideas of problem solving; introduction to abstract structures used for computing solutions to problems. Introduction to propositional logic, computing machinery, computer arithmetic, artificial intelligence, and operating systems.

6.621 Computing 2A **S1 or S2 L3 T2**

Prerequisites: 6.611, 10.001 or 10.011. Excluded 6.620, 6.021D.

For those students who intend to take further subjects in computer science. Expansion and development of material introduced in 6.611 Computing 1. Systematic program development: introduction to programming language semantics, reasoning about programs, program derivation, abstract programs, realization of abstract programs conversion from abstract to concrete. Practice in programming in a high-level programming language. Data-structures: arrays, lists, sets, trees; recursive programming. Introduction to computer organization: a simple machine architecture. Introduction to operating systems.

6.854 Electrical Power Engineering **S2 L1 T2**

Prerequisite: 1.001 or equivalent 1.9222 or 6.851 for students in Course 3140.

Extensive introduction to the theory and application of heavy current electrical engineering. Commences with the requisite circuit theory and then proceeds to consideration of the distribution of electrical power and the characteristics and selection of electrical machinery. DC power supplies, three-phase AC supply, voltage regulation, transformers, AC and DC machines and their rating; a project illustrating the application of electrical engineering to various aspects of industry. Consists of one 2hour tutorial or laboratory sessions per week each commencing with a structured mini-lecture. Detailed lecture notes are provided.

6.856 Electronics for Measurement and Control **S1 L2 T1**

The use of electronics in mechanical systems and the processing of signals by analog and digital techniques. Revision of basic circuit theory, operational amplifier circuits, feedback and filtering. Digital logic using integrated circuits. Noise. Techniques for A D and D A conversion, measurement system interfacing to microprocessors.

Civil Engineering

8.1130 Engineering Drawing **S1 L1 T2**

Fundamental concepts of descriptive geometry, orthographic drawing, first and third angle drawing, isometric and perspective drawing, Australian standard engineering and drawing practice, application of descriptive geometry to common problems in civil engineering, graphic communications, introduction to computer graphics.

8.6110 Structures **S1 L1 T2**

Theory of structures: Moduli of elasticity, simple stress and strain. Compound bars, temperature stresses. Thin shells. Stress at a point. Strain at a point. Principal stresses and strains. Relationship between load, shear force and bending moment. Moments of inertia, principal moments of inertia. Stresses due to axial force, bending moment, shear force, and torsion. Differential equations of simple beam theory. Deflection of beams. Statically indeterminate beams. Strain energy. Deflections at a single load. Shock loads. Theory of centrally loaded column and eccentrically loaded columns.

8.6130 Properties of Materials **F L1 T1**

Mechanical behaviour of materials. Response to static loading in tension, compression, shear and bending. Use of static test data in analysis and design; variability of material properties; factors of safety. Hardness tests. Creep in solid materials. Response to dynamic loading; fatigue; impact. Deterioration of engineering materials. Rheological classification of materials.

Mathematics

10.001 Mathematics 1 **F L4 T2**

Prerequisite:	*HSC Exam Score Range Required*
2 unit Mathematics or*	*67-100*
3 unit Mathematics or	*1-50*
4 unit Mathematics	*1-100*
or	
10.021B.	

Excluded 10.011, 10.021B, 10.021C.

*This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics (Mathematics in Society).

Calculus, analysis, analytic geometry, linear algebra, an introduction to abstract algebra, elementary computing.

10.011 Higher Mathematics 1 **F L4 T2**

Prerequisite:	*HSC Exam Score Range Required*
3 unit Mathematics	*120-150*
or	
4 unit Mathematics	*1-100*

Excluded 10.001, 10.021B, 10.021C.

Calculus, analysis, analytic geometry, linear algebra, an introduction to abstract algebra, elementary computing.

10.021B General Mathematics 1B **S1 L4 T2**

Prerequisite:	*HSC Exam Score Range Required*
2 unit Mathematics or*	*60-100*
3 unit Mathematics or	*1-50*
4 unit Mathematics	*1-100*
or	
10.021A	

Excluded 10.011, 10.001.

*This refers to the 2 Unit Mathematics subject which is related to the 3 Unit Mathematics subject. It does not refer to the subject 2 Unit Mathematics (Mathematics in Society)

Functions (and their inverses), limits, asymptotes, continuity; differentiation and applications; integration, the definite integral and applications; inverse trigonometric functions; the logarithmic and exponential functions and applications; sequences and series; mathematical induction; the binomial theorem and applications; introduction to probability theory; introduction to 3-dimensional geometry; introduction to linear algebra.

10.021C General Mathematics 1C **S2 L4 T2**

Prerequisite: 10.021B.

Excluded 10.001, 10.011.

Techniques for integration, improper integrals; Taylor's theorem; first order differential equations and applications; introduction to multivariable calculus; conics; finite sets; probability; vectors, matrices and linear equations.

10.022 Engineering Mathematics 2 **F L2 T2**

Prerequisite: 10.001.

Differential equations, use of Laplace transforms, solutions by series; partial differential equations and thier solution for selected physical problems, use of Fourier series; introduction to numerical methods; matrices and their application to theory of linear equations, eigenvalues and their numerical evaluation; vector algebra and solid geometry; multiple integrals; introduction to vector field theory.

10.031 Mathematics **F L1 T1**

Prerequisite: 10.001 or 10.011 or 10.021C (CR).

Note A: A unit, together with 10.032, which is available to Faculty of Science students as one of a sequence of two units constituting a terminating service course in mathematics. As such it is mutually exclusive to any other Level II or Level III unit in Pure and or Applied Mathematics and or Theoretical Mechanics except that 10.412A may be taken with 10.031 and 10.032.

Note B: Mathematics 10.031 is included for students desiring to attempt only one Level II Mathematics unit. If other Level II

units in Pure Mathematics or Applied Mathematics are taken, 10.031 *Mathematics will not be counted.

Differential equations, use of Laplace transforms, solutions by series; partial differential equations and their solution for selected physical problems, use of Fourier series; multiple integrals, matrices and their application to theory of linear equations, eigenvalues; introduction to numerical methods.

10.032 Mathematics **F L1 T1**

Prerequisite: 10.031.

Note A: As for Note A in 10.031 Mathematics.

Note B: Mathematics 10.032 is included for students desiring to attempt only one Level III Mathematics unit. If other Level III units in Pure Mathematics, Applied Mathematics or Theoretical Mechanics are taken. 10.032 Mathematics will not be counted.Vector calculus; special functions; convolution theorem and applications; complex variable theory; Fourier integrals; Laplace transforms with application to ordinary and partial differential equations.

10.1113 Pure Mathematics 2 – Multivariable Calculus **S1 or S2 L1.5 T1**

Prerequisite: 10.001 or 10.011. Excluded 10.1213.

Multiple integrals, partial differentiation. Analysis of real valued functions of one and several variables.

10.2111 Applied Mathematics 2 – Vector Calculus **S1 or S2 L1.5 T0.5**

Prerequisite: 10.001. Excluded 10.2211.

Properties of vectors and vector fields; divergence, gradient, curl of a vector; line, surface, and volume integrals. Gauss' and Stokes' theorems. Curvilinear co-ordinates.

10.2112 Applied Mathematics 2 – Mathematical Methods for Differential Equations **S1 or S2 L1.5 T0.5**

Prerequisite: 10.001. Excluded 10.2212.

Mathematical methods for ordinary and partial differential equations. Series solutions, numerical methods, separation of variables. Fourier series. Besser functions.

10.301 Statistics SA **F L1 T**

Prerequisite: 10.001 or 10.021C. Excluded 10.331, 10.311A, 10.311B, 10.321A, 10.321B, 45.101.

Probability, random variables, independence, binomial, Poisson and normal distributions, transformations to normality, estimation of mean and variance, confidence intervals, tests of hypotheses, contingency tables, two sample tests of location, simple and multiple linear regression, analysis of variance for simple models.

Accounting

14.501 Accounting and Financial Management 1A **S1 or S2 L2 T2**

Prerequisite: Nil.

The basic concepts of financial model building and information systems, including the double-entry recording system, the accounting cycle, income measurement and financial reporting, and an introduction to basic elements of auditing.

14.511 Accounting and Financial Management 1B **S1 or S2 L2 T2**

Prerequisite: 14.501.

Development of basic concepts introduced in 14.501 Accounting and Financial Management 1A, including corporate reporting, business finance, system design, elementary computer applications.

14.522 Accounting and Financial Management 2A **S1 or S2 L2 T2**

Prerequisites: 14.511 plus

	HSC minimum mark required
2 unit Mathematics or	*60*
2 unit	*60*
3 unit Mathematics	*3 unit or*
3 unit	*1*
4 unit Mathematics	*4 unit*

The design, production and use of accounting and other quantitative information in the planning and control of organizations, with particular reference to manufacturing activities.

14.542 Accounting and Financial Management 2B **S2 L2 T2**

Prerequisite: 14.511 plus HSC results as for 14.522.

Critical examination of concepts and problems in income measurement, asset valuation and financial reporting for various forms of business undertaking with particular reference to corporate organizations, including associated aspects of auditing and taxation and methods of accounting for changing prices.

98.613 Business Finance 2A **S1 or S2 LT3**

Prerequisite: 14.511, 15.101E and 15.102E.

The essential aspects of financial decision-making in business including: factors influencing capital expenditure decisions; alternative approaches to valuation; factors affecting the formulation of the capital structure; influence of the capital market environment.

14.606 Management Information Systems Design **S2 L2 T1**

Prerequisite: 14.602. Excluded 14.603.

Organizational impact, information systems design methodologies, requirements elicitation, logical and physical design, implementation procedures, principles of data

management, data analysis, telecommunications networks, systems design in a distributed environment, commercial programming practice, systems development case studies using spreadsheet, file management and word processing software.

19.602 Computer Information Systems 1S1 or S2 L2 T1

Prerequisite: 15.411 or 15.401 or approved studies in computer science.

Information systems and the organization, architecture of typical commercial application systems, the systems lifecycle, the systems analysis design task, tools and techniques of the systems analyst, documentation techniques, internal controls and interfacing with the edp auditor, file design concepts, logic and computer hardware, commercial computer programming.

99.774 Legal Environment of Commerce **S1 or S2 L2 T1**

Prerequisite:	*HSC minimum mark required*
2 unit English General or	*60*
2 unit English or	*53*
3 unit English	*1*

The Australian legal system and areas of substantive law relevant to commerce including contract, business organization, employment, commercial arbitration, advertising, trade regulation, civil compensation, discrimination.

99.776 Legal Regulation of Commerce S1 or S2 L2 T1

Prerequisite: 14.774.

The regulation of restrictive trade practices and sales promotion. The legal framework of marketing strategy with special reference to anti-competitive practices including collusive activity, exclusive dealing, price discrimination, resale price maintenance, mergers and monopolization and consumer protection law including misleading and deceptive advertising and other unfair practices. Consumer credit; product liability; protection of intellectual property.

Commerce and Economics

15.101E Microeconomics 1 **S1 or S2 L2 T1**

Prerequisite:	*HSC minimum mark required*
2 unit English General or	*60*
2 unit English or	*53*
3 unit English	*1*

Economics as a social science, the central role of scarcity and opportunity cost. Australian industrial structure. Efficiency concepts. Relative prices and their change through time. Demand, revenue and elasticity. Theory of exchange. Property rights, externalities and distortions. Gains from specialization and international trade. Marginal productivity, input demand. The price taking firm, profit maximization in short and long run. Taxation, protection, stabilization of markets. Imperfect markets, competition policy. Investment decisions and economic growth.

15.102E Macroeconomics 1 **S1 or S2 L2 T1.5**

Prerequisite: 15.101E.

The economics of output, employment and inflation, including social accounting, consumption and investment functions, the Keynesian goods market model, supply and demand for money, interactions between the goods and money markets in equilibrium and disequilibrium situations, inflation and the balance of payments.

15.201E Microeconomics 2 **S1 L2 T2**

For students first enrolling in 1989 –
Commerce prerequisite: 15.102E
Arts Applied Science Sciences prerequisites: 15.102E, 15.103M.
Co-requisite: 15.203M.
Excluded 15.221E, 15.203E.

For students who first enrolled before 1989 –
Commerce prerequisite: 15.011.
Applied Science Sciences prerequisites: 15.011 plus 15.401 or 15.411 or 10.001 or 10.011.
Arts prerequisite: 15.011. Co-requisites: 15.401 or 15.411 or 10.001 or 10.011.
Excluded 15.012, 15.072.

Consumer behaviour. Theory of the firm, production theory. Competition, monopoly, oligopoly. Factor markets. General equilibrium analysis: efficiency and equity, welfare maximisation, gains from trade. Externalities, market distortions. Intertemporal economics, investment criteria.

15.202E Macroeconomics 2 **S2 L2 T2**

Commerce prerequisite: 15.102E.
Arts Applied Science Sciences prerequisites: 15.201E and 15.203M.
Excluded 15.204E, 15.222E

For students who first enrolled before 1989 –
Commerce prerequisite: 15.011.
Art Applied Science Sciences prerequisites: 15.002 plus 15.401 or 15.411 or 10.001 or 10.011.
Co-requisite 15.421.
Excluded 15.052, 15.062.

Extensions to the Keynesian model of income determination. Consumption and investment theories. Money demand and supply. Balance of payments and exchange rate analysis. Inflation and unemployment. Introduction to dynamic analysis. Labour markets. Growth and cycles.

15.203E Applied Microeconomics **SS L2 T1.5**

Commerce prerequisite: 15.102E.
Arts Applied Science Sciences prerequisites: 15.102E and 15.103M or 15.104M.
Excluded 15.201E, 15.221E.

For students who first enrolled before 1989 –
Commerce Arts Applied Science Sciences prerequisite: 15.011.
Excluded 15.012 and 15.002.

Structural change in the Australian economy. The effect of different market structures on firms and consumer welfare. The consequences of markets failure and the effects of government regulation. Investment decisions in the public and private sectors, including the estimation of future benefits, revenues and costs, the measurement of consumer and producer surplus. The economics of non-renewable and other resources.

Australia's international trade and investment and the effects of restrictions on international trade and investment.

15.204E Applied Macroeconomics **SS L2 T1.5**

Commerce prerequisite: 15.102E.
Arts Applied Science Sciences prerequisite: 15.102E and 15.103M or 15.104M.
Excluded 15.202E, 15.222E.

For students who first enrolled before 1989 –
Commerce Arts Applied Science Sciences prerequisite: 15.011. Excluded 15.052 and 15.042.

Economic growth and fluctuations in Australia. Inflation, unemployment and balance of payments issues. Fiscal, monetary, exchange rate and incomes policies. Changes in the structure of the Australian financial ystem and its links with the international monetary system. Effects of restrictions on capital markets.

15.205E Marxian Political Economy **S1 or S2 L2 T1**

Prerequisite: 15.102E.

For students who first enrolled before 1989 –
Commerce Arts Applied Science prerequisite: 15.011.

Varieties of political economy. Marx and the classics, the Marxian system. Marxian economics since Marx, Marx and socialist planning, Marxian analysis of current economic problems.

15.207E Natural and Environmental Resources Economics **S1 or S2 L2 T1**

Prerequisites: 15.201E or 15.221E or 15.203E.

For students who first enrolled before 1989 –
Prerequisite: 15.002 or 15.012 or 15.072.

Classification of renewable and non-renewable resources: reserves, resources and resource base; the concept and measurement of resource scarcity, costs, prices and rents; exhaustion of resources, ore quality, exploration, availability of substitutes; uncertanty of discovery, technical progress, market imperfections; renewable resources, sustainable yield concepts. Policy issues, with particular reference to Australia's role in the international economy.

15.241E Economics of Developing Countries **S1 L2 T1**

For students who first enrolled before 1989 –
Commerce Arts Applied Science prerequisite: 15.072 or 15103 or 15.113.

Aspects of economic development in the less developed countries. Characteristics of these countries and the policies available to them, simplified models of under-development, phenomenon of structural change in the development process, role of industrialization in promoting structural change, international relationships of developing countries and strategies of development based on industry or agriculture.

15.243E Public Finance **S1 or S2 L2 T1**

For students who first enrolled before 1989 –
Commerce Applied Science prerequisite: 15.002 or 15.012 or 15.072.
Arts prerequisites: 15.002 or 15.012 or 15.072 plus 15.421 or 15.403.

General aspects of public sector expenditure and its financing with special reference to Australia: role of government in the economy; principles and types of public expenditure; tax sharing and revenue systems; economic and welfare aspects of different types of taxes and social services systems; inflation and tax indexation; loan finance and the public debt; fiscal policy, the Budget and the economy.

15.247E Public Sector Economics **S1 or S2 L2 T1**

For students who first enrolled before 1989 –
Commerce Arts prerequisite: 15.002 or 15.012 or 15.072.
Applied Science prerequisite: 15.002 or 15.012 or 15.072 with the approval of the Head of the Department of Economics.

The theory of public economic activity in the short-run and the long-run. Government objectives and the social welfare function. Equity and efficiency in revenue raising. The theory of public sector pricing and its applications. Techniques of investment appraisal, cost-benefit analysis and related issues. The application of cost-benefit analysis to transport, urban and other problems.

15.201H Management and Business **S1 L2 T1**

Prerequisite: 15.102E. Excluded: 15.902.

Origins, evolution and attributes of modern business enterprise in Australia, Europe, America and Japan; strategy, structure and corporate performance; the economics of organization and the organization of work; theory and analysis of multinationals; integration, diversification and the marketing function; managerial hierachies; decision management and decision control; entrepreneurship; public policy, social responsibility and the external business environment.

15.208E Industry Economics and Australian Industrial Policy **S1 or S2 L2 T1**

Prerequisite: 15.201E or 15.221E or 15.203E.

For students who first enrolled before 1989 –
Commerce Applied Science prerequisite: 15.002 or 15.012 or 15.072.
Arts prerequisites: 15.403 or 15.421 plus 15.072 or 15.012 or 15.002.

Structure of industry; inter-relationships between the role of the business firm and industrial structure; multinational corporations; factors affecting size-structure and performance such as economies of scale; barriers to entry, vertical integration, diversification and mergers, patents, the development and transmission of technology; industrial policy in Australia with special reference to competition policy; foreign investment and mergers, and some specific industry policies eg on motor vehicles, electronics, steel, petroleum.

15.211E Managerial Economics **S1 L2 T1**

Prerequisites: 15.101E and 15.102E.

The application of economic concepts and analysis to managerial decision making. The relevance of opportunity cost and marginal analysis. Introduction to linear programming as a tool for managerial decision making. Production and cost analysis and measurement, with applied examples. Market and demand analysis and forecasting with applied examples. Problems of price setting. The role of non-price competition, such as advertising. The cost of capital and capital budgeting. An introduction to risk.

15.301E Microeconomics 3 **S1 L2 T2**

Prerequisites: 15.201E, 15.202E and 15.203M.
Exclusion: 15.321E.

For students who first enrolled before 1989 –
Commerce prerequisite: 15.002 or 15.012.
Arts Applied Science Sciences prerequisite: 15.002 or 15.012.
Co-requisite: 15.412.
Excluded 15.153.

Input-output analysis, applications to Australia. General equilibrium analysis: industry protection and taxation. Income distribution. Market failure, property rights and public goods. Introduction to analysis of uncertainty. Deregulation of industry. Public enterprise pricing and investment.

15.302E Macroeconomics 3 **S2 L2 T2**

For students first enrolling in 1989 –
Prerequisites: 15.201E, 15.202E and 15, 203M.
Excluded 15.322E

For students who first enrolled before 1989 –
Commerce prerequisite: 15.042 or 15.052.
Arts Applied Science Sciences prerequisite: 15.042 or 15.052.
Co-requisite: 15.412.
Excluded 15.013.

Macroeconomic theory and policy including an introduction to the theory of economic policy, the structure and dynamic characteristics of macro-models, fiscal policy, monetary theory and policy, inflation and unemployment. Rational expectations Macroeconomic policy in Australia.

15.501 Introduction to Industrial Relations **S2 L2 T1**

For students enrolled in Faculties other than Commerce and Arts. Designed to provide a practical introduction to important industrial relations concepts, issues and procedures. Includes: the origins, evolution and operation of the Australian system of industrial relations; the structure and role of trade unions and employer bodies; the function of industrial tribunals such as the Australian Conciliation and Arbitration Commission and the NSW Industrial Commission; wages structure and determination; employment, unemployment and retraining; the nature and causes of strikes and other forms of industrial conflict; the processes and procedures for conflict resolution.

Where appropriate to class composition, particular attention is paid to individual industries.

For further information regarding the following subject see the Faculty of Arts Handbook.

30.511 Industrial Relations 1A **S1 or S2 L2 T1.5**
Commerce Arts prerequisite:

	HSC minimum mark required
2 unit English General or	*60*
2 unit English or	*53*
3 unit English	*1*

Multi-disciplinary introduction to a range of important concepts and issues in industrial relations. Political, social, economic, legal, historical and psychological aspects of the evolution and operation of modern employer employee relations with material drawn from both Australian and overseas experience. The nature and implications of: strikes, lockouts and other forms of industrial conflict and alienation; the structure and policies of State and Federal trade unions, the State labor councils and such peak organizations as the Australian Council of Trade Unions; the employer industrial relations function and the structure and policies of employer associations; processes of work rule determination, such as collective bargaining, mediation, conciliation and compulsory arbitration; labour movements; and the role of the various arbitration tribunals and government instrumentalities with respect to industrial relations.

Biological Science

17.031 Biology A **S1 L2 T4**

Prerequisite:	*HSC Exam Score Range Required*
2 unit Science (Physics) or	*53-100*
2 unit Science (Chemistry) or	*53-100*
2 unit Science (Geology) or	*53--100*
2 unit Science Biology or	*53--100*
3 unit Science or	*90-150*
4 unit Science	*1-50*

Basic cell structure; membranes, organelles, prokaryotic and eukaryotic cells; cellular locomotion; basic biological molecules; enzymes; structure and metabolic roles, cellular compartmentalization and enzyme function; diffusion, osmosis and active transport; theory of inheritance, linkage, mutation, information transfer and protein synthesis.

Requirements for Practical Work Equipment required for practical work is set out in the *Course Guide*, available during enrolment time at the First Year Registration Centre Physics Building. Students must purchase this prior to the first week of session.

17.041 Biology B **S2 L2 T4**

Prerequisite: 17.031. Excluded. 17.021.

The evolution, diversity and behaviour of living things and the ways in which they have adapted to varying environments. Emphasis on the structure and function of flowering plants and vertebrate animals, and their roles in Australian ecosystems. The theory covered in lectures and tutorials is illustrated by observation and experiment in laboratory classes.

Botany

17.702 Flowering Plants **S1 L2 T4**

Prerequisites: 17.031 and 17.041.

This covers basic aspects of plant biology and provides practical skills required in level III units. It is essential for students intending to specialise in the plant sciences. The course follows the development of plants from seedling stage to maturity, examining the structural and environmental controls, and the close relationship between structure and function in major plant systems. The following topics are dealt with in detail: the properties of plant cells and their walls in relation to growth; differentiation and how cells are organised into different tissues; transport systems and the movement of

water and photosynthetic products; seed structure, the physiology of germination and its regulation by internal and external factors; primary and secondary growth and its regulation by plant hormones; shoot systems; leaf development; aborescence; adaptation to particular environments; root systems; mineral acquisition and water uptake; root growth and development; interactions of roots with microorganisms and the impact of symbiotic asssociations such as mycorrhizas on root structure and physiology; evolution of the land plants; the significance of having an enclosed carpel and the evolution of the gynoecium. Practical works provides basic skillsin plant anatomy and light microscopy; an introduction to the character states of flowering plant families in the Sydney region; how to use a key to identify a plant; growth and mineral nutrition, including collection of numerical data and a statistical approach to data handling; inoculation of plants with microorganisms; an integrated approach to salt secretion in mangroves.

17.703 Plant Taxonomy and Systematics S1 L2 T4

Prerequisite: 17.702.

The assessment, analysis and presentation of data for classifying organisms both at the specific and supra-specific level.

17.712 Biometry S1 L2 T4

Prerequisites: 17.031, 17.041. Excluded 10.311A, 10.321A, 10.331.

Statistical methods and their application to biological data, including introduction to probability; the binomial, Poisson, normal distributions; student's t,(^{2}+ and variance ratio tests of significance based on the above distributions, the analysis of variance of orthogonal and some non-orthogonal designs; linear regression and correlation. Non-linear and multiple regression. Introductory factorial analysis. Introduction to experimental design. Non-parametric statistics, including tests based on (^{2}, the Kruskal-Wallis test, Fisher's exact probability test and rank correlation methods. Introduction to programming in BASIC.

17.713 Environmental Botany S1 L2 T4

Prerequisites: 17.031 and 17.041.

The soil and atmospheric environments in which plants live and a study of the interaction of plants with their environment. Energy and mass transfer.

17.722 Biology of Invertebrates S2 L2 T4

Prerequisites: 17.031, 17.041.

A comparative study of morphology, taxonomy and functional biology of invertebrate animals. Emphasis is placed on the major groups (Anthropods and Molluscs) and on marine forms. Practical classes and a compulsory field camp illustrate the lecture material.

The morphology and systematics of the major Phyla of invertebrate animals will be considered on a group by group basis, beginning with relatively simple animals and moving to the more complex. Within this framework the following will be considered: **1.** functional biology including physiology, feeding mechanisms, reproduction and mode of life (free-living, sessile and parastic); **2.** the effect of increasing the body size and complexity of physiological function (internal transport systems, excretion, gas exchange and coordination); **3.** detailed coverage of the invertebrate component of zooplankton; **4.** evolutionary relationships between Phyla – the Phyla covered will include Porifera, Cnidaria and Ctenophora, Platyhelminthes, Nemertina, Nematoda, Annelida, Arthropoda, Onychophora, Sipuncula, Bryozoa, Mollusca, Echinodermata, Hemichordata, Chaetognatha and non-vertebrate Chordata.

17.723 Plant Community Ecology S2 L2 T4

Prerequisites: 17.702 and 17.012 or 27.111.

Recognition and delimitation of plant communities. Ecology of selected Australian vegetation types. Use of numerical methods and application of community concepts to palaeoecology. Field work is an integral part of this course.

Zoology

17.732 Vertebrate Zoology S1 L3 T4

Prerequisites: 17.031 and 17.021, or 17.041.

A comparative study of the Chordata, with particular reference to the vertebrates, including morphology, systematics, evolution and natural history, with reference to selected aspects of physiology and reproduction. Practical work to supplement the lecture course. Field excursions as arranged.

17.783 Animal Behaviour S2 L2 T4

Prerequisites: 17.712, and 17.722 or 17.732

An introduction to Ethology, the biological study of behaviour. Physiological, ecological, developmental and evolutionary aspects of behaviour are examined as important elements in the analysis of behaviour, particularly social behaviour. Both field and laboratory work are included.

17.773 Evolution and Popular Genetics S1 L2 T3

Prerequisites: 17.031, 17.041.

Current evolutionary theory, emphasizing the population level. Ecological genetics, speciation, evolution of social behaviour, molecular evolution and general evolutionary genetics. Some background in genetics is desirable.

17.733 Population and Community Ecology S2 L3 T3

Prerequisites: 17.041 and 10.001 or 10.011 or both 10.021B and 10.021C.

Examination of the dynamics of one, two or more interacting populations. Systems analysis and simulation in ecology. Theoretical and mathematical analysis of the dynamics and stability of ecosystems. Topics in the optimal management of renewable resources. Unifying concepts in ecology.

17.813 Vertebrate Zoogeography and Evolution S2 L2 T4

Prerequisite: 17.732.

A geographic approach to the current distribution, abundance and types of vertebrate species in the Australian region. Particular emphasis is placed on the basic principles of speciation, the history of the Australian continent, vertebrate adaptations and changes in the distribution and abundance

of the Australian vertebrate fauna under the influence of humans. Field excursions as arranged.

17.8232 Economic Zoology **S1 L1 T2**

Prerequisite: 17.722

A study of the biology, ecology and control of vertebrate and invertebrate animals which harm humans and their possessions. Human and domestic animal parasitology, pests on plants, diseases caused or spread by animals, chemicals, biological and physical control, and side effects.

Industrial Engineering

Industrial Engineering is a Department within the School of Mechanical and Industrial Engineering.

18.121 Production Management **F L2 T1**

Prerequisites: 10.031, 10.331.

Engineering economy: Economic objectives of the firm. Economic measure of performance: net present value, annual equivalent value and the DCF rate of return including the incremental rate of return and their application in the selection and replacement of processes and equipment. *The use of human and physical resources:* Methods engineering, ergonomics, motion and time study, financial incentives, applications to machine controlled processes, work sampling and data collection. Plant location, factory layout. *Production and quality control:* Control of jobbing, repetitive batch and continuous production. Manufacturing organizations, functions, inter-relationships and information flow. Sampling techniques in quality control, control charts. *Introduction to inventory control:* Analysis of some engineering planning decisions. *Introduction to operational research:* The formation and optimization of mathematical models of industrial processes. The development of decision rules. Some techniques of operational research and applications, eg mathematical programming, queueing theory, inventory models, simulation.

18.1211 Production Management A **S1 L3**

Prerequisites: 10.031, 10.331 or 10.021B, 10.021 C, 13.200.

Use of human and physical resources: Methods engineering, ergonomics, motion and time study, financial incentives, applications to machine controlled processes, work sampling and data collection. Plant location, factory layout. *Production and quality control:* Control of jobbing, repetitive batch and continuous production. Manufacturing organisations, functions, interrelationships and information flow. Sampling techniques in quality control, control charts. *Introduction to inventory control:* Analysis of some engineering planning decisions.

18.1212 Production Management B **S2 L3**

Prerequisites: 18.1211.

Engineering economy: Economic objectives of the firm. Economic measure of performance: net present value, annual equivalent value and the DCF rate of return including the incremental rate of return and their application in the selection and replacement of processes and equipment. *Introduction to operational research:* Formation and optimization of mathematical models of industrial processes. Development of decision rules. Some techniques of operational research and applications, eg mathematical programming, queueing theory, inventory models, simulation.

18.131 Operations Research

Introduction to operational research: The formation and optimization of mathematical models of industrial processes. The development of decision rules. Some techniques of operational research and applications, eg mathematical programming, queueing theory, inventory models, simulation.

18.551 Operations Research **F L2 T1**

Prerequisites: 5.0721, 10.351. Excluded: 6.646.

The formulating and optimization of mathematical models. The development of decision rules. Some techniques of operations research such as mathematical programming, queueing theory, inventory models, replacement and reliability models; simulation. These techniques applied to situations drawn from industrial fields, eg production planning and inventory control. Practical problems of data collection, problem formulation and analysis.

Information Systems

19.603 Computer Information System 2 **S2 L2 T1**

Prerequisite: 19.602. Excluded: 19.606

System analysis and design: requirements analysis and specification, logical and physical design of business systems, specification and updating of files, man-machine dialogue procedures. Comparison of design methodologies top-down and evolutionary.

Marketing

28.012 Marketing Systems **S1 L2 T2**

Prerequisite: Nil.

Conceptual introduction of marketing from the systems viewpoint. Evolution and characteristics of marketing systems, buyer behaviour, marketing channel flows (equalizing supply and demand, communication, ownership, finance, physical distribution), marketing activities in the firm (planning and marketing program, co-ordination and control of marketing activities, problem solving, product planning, promotion and pricing, physical distribution management), resources allocation by competition, the expanding role of government, social performance of marketing and social efficiency of marketing.

28.052 Marketing Research **S2 L2 T2**

Prerequisite: 15.421

Sources and types of marketing information. Design, conduct, analysis and reporting of market surveys and experiments. Technique of statistical inference.

28.073 Stategic Marketing **S1 L2 T2**

Prerequisites: 28.012 and 28.052.

Conceptual framework relevant to the practice of marketing management for the further development of an integrative understanding of the market function. Important extensions and limitations of customer orientation and the emergence of a braoder concept of marketing; stages of development of a marketing operation, the central role of innovation in opportunity management and the concept of control; importance of product life cycle concept to the formulation of marketing strategy; relationships between corporate and marketing strategy; marketing strategy, future analysis and scenario construction.

28.083 Managerial Marketing **S2 L2 T2**

Prerequisite: 28.073.

Application of theoretical marketing concepts developed in 'Strategic Marketing' and quantitative techniques developed in 'Marketing Models'. Based on the planning, implementation and appraisal of a major field study.

Surveying

29.441 Surveying for Engineers **S2 L2 T2.5**

Principles of surveying; co-ordinate systems, levelling, linear and angular measurement. Traversing, tacheometry and electronic distance measurement. Areas and volumes. Horizontal and vertical curves. Control, underground and construction surveys. Outline of photogrammetry.

29.491 Survey Camp

A one-week field camp for students studying 29.441 Surveying for Engineers.

Town Planning

Core Subject

36.411 Town Planning **S1 L2 T1**

Architecture prerequisite: 11.4308 and 100 credit points.

Introduction to the purpose, scope and application of planning. The urban planning process. Objectives and means of planning cities. Levels of planning and types of palns; state environmental policies, regional environmental plans, local environmental plans. Problems in planning: equitable distribution of resources. Environment and environmental impact statements. Planning law and administration. Future of cities.

Landscape Architecture

Students should contact the Head of School before enrolling in any of the following subjects.

37.1616 Land Systems **S2 L1 T1**

Prerequisite: 37.5505.

An investigation of resources and their management in relation to a range of land use types with an emphasis on an ecological appraoch. Management of both natural and cultural landscapes within the context of marine, coastal, estuarine and terrestial environments. Studies of specific examples and the effects of human impacts. Methods of conservation and rehabilitation considered. Field excursions.

37.9105 Landscape Planning 1 **S1 L2 T2**

Prerequisite: 37.1504.

Basic methods and techniques of resource data collection, analysis and valuation. History of landscape planning in Australia and overseas with reference to pioneering case studies. Projects include the use of maps, air photos and simple computer programs.

37.9206 Landscape Planning 2 **S2 L2 T2**

Prerequisite: 37.9105.

Classification of planning methods. Study of complex methods and techniques used in recent landscape planning models. Development of land use suitability models for recreation, residential, industrial, commercial, grazing, agriculture, forestry and conservation. Projects include the use of remote sensing techniques and advanced computer programs.

Biochemistry

41.101 Biochemistry **F L2.5 T3.5**

Prerequisites: 17.041, 2.121 and 2.131, or 2.141. Excluded 2.003J.

The chemical properties of amino acids, peptides and proteins, carbohydrates, nucleic acids and lipids and the biological roles of these compounds. The nature and function of enzymes. The intermediary metabolism of carbohydrates, lipids and nitrogenous compounds. The relationship between structure and function of enzymes, other proteins, hormones and biological membranes, metabolic networks and control mechanisms. The molecular mechanism of gene expression and protein synthesis. Photosynthesis. Practical work to amplify the lectures.

Biotechnology

Biotechnology is a Department within the School of Applied Bioscience.

42.102A Biotechnology A **S1 L2 T4**

Prerequisites: 41.101 and or 44.121 (Pass Conceded) PC or (Pass Terminating) PT awarded prior to Session 2, 1983, is not acceptable.

The basic principles involved in the operation of microbial processes on an industrial scale. Includes: the selection, maintenance and improvement of microorganisms; the influence of physical and chemical factors on the microbial environment; the control of environmental factors; the effects of operational patterns on batch and continuous flow cultivation; aeration and agitation; scale-up of microbial processes; air and media sterilization; the harvesting, purification and standardization of products; the principles involved in microbial processes for chemical, pharmaceutical and food production, microbial waste treatment and environmental control. The laboratory component includes manipulation of micro-organisms, laboratory-scale fermenter operation, microbial enzyme isolation, visits to industrial fermentation plants and industrial seminars.

42.102B Biotechnology B **S2 L2 T4**

Prerequisite: 42.102A (Pass Conceded) PC or (Pass Terminating) PT awarded prior to Session 2, 1983, is not acceptable.

Application of principles of biotechnology to the analysis and design of microbial processes of industrial relevance (antibiotics, microbial enzymes, single cell protein from carbohydrates and hydrocarbons, fermented foods and beverages, amino acids and vitamins, microbial polysaccharides, activated sludge and photosynthetic processes for waste treatment, microbial leaching of low-grade minerals). Emphasis on quantitative approach; mass and heat balance calculations, kinetic and thermodynamic analysis, detailed equipment design and specification, process design and layout, process simulation, plant location, application of optimization techniques. The economics of microbial processes are considered and comparison made with alternative modes of production or treatment. The economics of agroindustry in Australia using microbial processes. Marketing of fermentation products, clinical trials required, legal constraints, patent rights. Technical and economic feasibility studies, and a design project.

42.102C Microbial Genetics **S1 L2 T4**

Prerequisites: 41.101 or 44.101. Excluded 43.102.

A detailed study of the mutational basis of microbial variation. Mutagens: mechanisms of mutagenesis; induction, enrichment, isolation and characterization of mutants; mechanisms of repair of mutational damage. Systems of gene transfer and recombination in fungi, bacteria and bacterial viruses; the use of these systems in constructing genetic maps, and as tools for probing aspects of microbial physiology and biochemistry. Genetic control of gene expression; the operon concept and its application to specific regulatory systems. Genetic code, collinearity between a gene and its product, genes within genes, suppression of mutations. Restriction and modification of DNA; genetic engineering – its implications and prospects. Genetics of nitrogen fixation.

42.114 Fermentation Processes

Factors governing the use of microorganisms in industrial processes, including the selection, maintenance and improvement of microorganisms, the control of environmental factors, batch and continuous flow operational patterns, product recovery, process optimization and waste disposal. Demonstrations of the operation and control of fermenter systems and of microbial process simulation.

42.103 Biotechnology (Honours)

Advanced formal training in selected areas of biotechnology and participation in one of the school's research projects.

Microbiology

44.101 Introductory Microbiology **S1 L2 T4**

Prerequisites: 17.031 and 17.041.

The general nature, occurrence and importance of microorganisms. A systematic review of the major groups of microorganisms; the eucaryotic protista micro-algae, protozoa and fungi; procaryotic protista blue-green alfae, higher" bacteria, typical unicellular bacteria and small bacteria-like forms; plant, animal and bacterial viruses. The relationship between microorganisms and their environment, ecological considerations. Interactions between microorganisms and higher organisms.

44.121 Microbiology 1 **S2 L2 T4**

Prerequisites: 44.101 and 41.101 or 2.003J.

The balanced structure of this unit makes it suitable for students majoring in microbiology and also for students who wish to enlarge their knowledge and skills in microbiology beyond those obtained in 44.101 Introductory Microbiology or equivalent units at other institutions.The classification and function of bacteria. Differentation of major families and genera of bacteria. Measurement models and theory of microbial growth. Comparative aspects of microbial growth. Bacterial nutrition and biosynthetic pathways. Microbial survival. Theory and practice of sterilization. Introduction to applied aspects of microbiology especially medical microbiology and the role of bacteria in ecosystems.

44.141 Microbiology **S1 L4 T4**

This course is solely for students enrolled in the Food Technology BSc courses 3060 and 3070 in the Faculty of Applied Science.

Political Science

54.1003 Australian Political Institutions **S1 3CCH C6**

J. Paul

Excluded 54.1001, 54.1002 and 54.1006.

The nature and history of Australian political institutions in depth. The Australian constitution and federal structure and the

role of the High Court in helping determine the nature of the power relationships in Australian politics. The political parties, their history, successes and failures, strengths and weaknesses both in and out of government. The formal institutions of government: parliament, cabinet, the bureaucracy and both Labor and Liberal prime ministers. Elections and voting in Australia and pressure groups.

54.1004 Government in the Modern World **S2 3CCH C6**

A. Chan, A.C. Palfreeman

Excluded 54.1001.

The development, nature and forms of government in the modern world. Particular attention is paid to the major conceptual tools of political analysis with emphasis on a comparative approach to the study of government and case studies drawn from Australia and the industrialized and developing areas. An underlying theme is the management of conflict and the establishment of order in the various systems examined.

54.1005 A History of Political Thought **S2 3CCH C6**

C. Condren

Excluded 54.1001.

An introduction to Western political theory through the study of four major texts taken from three distinctly different political civilisations. Each text is studied against its social and intellectual background and in the context of the political crises to which it was addressed. The main themes of the lectures concern the relationship between political theory and practice and that between language and political awareness.The texts are Plato, The Republic; Machiavelli, The Prince and Discourses; Hobbes, Leviathan; Locke, The Second Treatise of Government.

54.1006 The Australian Political System **S1 3CCH C6**

R. Lucy

Excluded 54.1001, 54.1002, 54.1003.

Basic concepts in political science such as power, influence and authority. Models of the Australian political system. The subsequent examination of the Australian political system is designed to illustrate these concepts and to test these models. The Australian political system is understood as the formal governmental institutions, political parties, and political culture. Australian political issues are studied to illustrate the Australian political culture.

54.1007 The Politics of Development **S2 3CCH C6**

R. Lim

Excluded 54.1001.

The history of Australia's relations with Asia. Australia's place in the postwar network of US alliances and the impact of this on relations with regional countries, especially China. The development of ASEAN and Australia's relations with it, with particular emphasis on Indonesia. The economic relationship with Japan and China and proposals for an Asian Pacific community. The debate about aid policy.

54.1008 Politics of Soviet-Type Systems **S1 3CCH C6**

S. Fortescue

Excluded 54.1001.

Examines political concepts and phenomena in Soviet-type systems, with the emphasis on Eastern Europe. Includes legitimacy and authority, economic reform and political pluralism, the party in communist systems, political participation, and others. The approach is strongly comparative, with an effort being made to discern and explain differences within the Eastern bloc, and between that bloc and the Western and developing worlds.

54.2008 Public Policy Making **S2 3CCH C6**

E. Thompson

Prerequisite: 12 Level 1 credit points in Political Science.

The problems of administering government and the problems of decision making. Models of decision-making are discussed, as are problems in implementation. Areas of public policy in Australia, such as poverty and education.

Graduate Study

Chemistry

2.251G Toxicology, Occupational and Public Health **F L1 T3**

Important classes of toxic materials found in the environment; treatment of pesticide residues, industrial chemicals of various types, toxic gases, mould metabilites and bacterial toxins occurring in food, carcinogenic substances, toxic metals, etc. Effects of these substances on living organisms, particularly man. Practical work: pesticide residue analysis, blood and urine analysis, gas sampling and analysis, trace metal determination and experiements on the animal metabolism of toxic substances.

2.271G Chemistry and Analysis of Foods **F L1 T1**

Illustrates the bases and application of analytical techniques as applied to foods. Emphasis is placed on the design of methods, on the preparation of material for instrumental anaylsis and on the interpretation of data. Includes: proteins and flesh foods, carbohydrates and saccharine foods, fats and oils, dairy and fermentation products, vitamins, food additives preservatives and colouring matters, pesticide residues, metal contaminants food microscopy.

Electrical Engineering and Computer Science

6.070G Digital Image Processing Systems **C3**

Excluded 6.476G.

The fundamentals of digital image processing with topics selected from the following: Visual perception and the image model, transforms, enhancement, sharpening and smoothing, restoration, encoding, segmentation, reconstruction and images from projections and lomography, satellite imaging and imaging in remote sensing; image processing hardware and systems; picture processing; measurement and inspection.

97.580G Image Analysis in Remote Sensing **C3**

Prerequisite: 10.361 or equivalent.

Techniques for extracting information from remotely sensed data with particular emphasis on satellite imagery. Topics taken from: nature and characteristics of earth resources and related satellites; satellite sensors and data formats; image enhancement techniques; image classification methods, including clustering, classification and feature selection; image classification methodologies; new horizons in remote sensing image analysis.

97.581G Microwave Remote Sensing **C3**

Use of passive and active radar microwave techniques in remote sensing of earth resources. Topics include: real and synthetic aperture radar systems; passive microwave radiometry; energy-surface interactions; interpretation of microwave image data: applications in agriculture, geology, oceanography and hydrology; issues in signal and image processing; characteristics of airborne and spaceborne microwave sensors.

Civil Engineering

8.402G Transport, Environment, Community **F C6**

Effect of transport on public health, environment and communities. Analysis of unwanted effects of transport activity: accidents, noise, pollution, intrusion; causation, measurement, preventative and remedial action. Community reaction to transport activity; government, bureaucracy and public involvement in transport policy and environment impact statements.

8.403G Theory of Land Use Transport Interaction **S1 C3**

Theoretical aspects of land use transport planning. Basic concepts, data collection methods, systems models and equation of state function behavioural, optimizing. Introduction to land use-transport modelling land use, generation, distribution, modal assignment, network assignment, evaluation. Planning methodologies short-, medium-, long-term; action planning, strategic planning; local, urban, regional national.

8.413G Transport Economics **S2 C3**

Cost and price analysis for each of the transport modes road, rail, air and sea. Welfare analysis and taxation theory with respect to transport. Economics of location, economics of land use models; regional trade model.

8.701G Economic Decision Making in Civil Engineering **SS C3**

Review of practical engineering decision-making problems and relevant techniques. Engineering economics, benefit cost analysis, consideration of inflation and taxation in investment decisions, bidding, decision theory, microeconomic theory, objectives and criteria, multiple objective planning.

8.703G Optimization Techniques in Civil Engineering **SS C3**

Search, linear programming, non-linear programming, geometric programming, calculus of variations, maximum principle, applications.

8.776G Rock Mechanics **SS C3**

Description of rock mass and discontinuities, strength and failure criteria, classification systems. Data collection and presentation. Initial stresses and their measurements, methods of stress analysis, stresses around underground openings. Selection of design of tunnel support systems, steel sets, rock bolts and shotcrete. Design of large underground openings. Excavation. Methods of prediction. Blasting.

8.777G Numerical Methods in Geomechanics **SS C3**

Fundamentals of finite element and boundary element methods; application to practical geotechnical design and case studies; deformation and flow problems; linear and

non-linear analysis; application to underground opening, stability of slopes, foundations, mining excavation; seepage and consolidation soil-structure interaction problems; earth pressures, retaining walls and buried pipes, thermal stress analysis.

8.833G Free Surface Flow **SS C3**

Theory of waterflow in open channels. Application of theory to design of hydraulic structures, spillways, control gates, energy dissipators, channel transitions. Use of hydraulic models.

8.842G Groundwater Hydrology **SS C3**

Confined and unconfined aquifers, analogue and digital models of aquifer systems, water movement in the unsaturated zone, recharge, groundwater quality, sea water intrusion.

8.843G Groundwater Hydraulics **SS C3**

Mechanics of flow in saturated porous materials, steady and unsteady flow to wells, leaky aquifers, partial penetration, multiple aquifer boundaries, delayed yield from storage, regional studies.

8.847G Water Resources Policy **SS C3**

Resource economics, water supply, water demand, multiple objective planning, multiple purpose projects, water law, water administration, case studies.

8.848G Water Resource System Design **SS C3**

Principles of the optimal design and operation of multiple purpose, multiple component, water resource system; evaluation of cost and benefits in complex and simple systems.

8.849G Irrigation **SS C3**

Soils, soil-water relationships, plants, climate, crop requirements; water budgets, sources, quality, measurement; irrigation efficiency. Design of irrigation systems, appurtenant works, distribution.

8.857G Sewage Treatment and Disposal **SS C3**

8.857X Sewage Treatment and Disposal **X S2 C3**

Application of processes and process variations used to improve the quality of sewage effluent, and the disposal of the effluent. Re-use of effluents where applicable. Sludge treatment and disposal.

8.870G Hydraulics and Design of Water and Wastewater Treatment Plants **S2 C3**

Co-requisites: 8.856G, 8.857G.

Application of hydraulic principles to flows within treatment plants. Selection and integration of unit processes required for water and wastewater treatment, plant layout, plant design including hydraulic profiles, the influence of flow and load variability, instrumentation and control strategies.

8.872G Management of Wastes **S2 L2 T1 C3**

8.872X Management of Wastes **X S1 C3**

Management and control strategies in waste management, legal requirements, local and overseas legislation, case studies of waste management.

8.873G Waste and Wastewater Analysis and Environmental Requirements **S1 L1 T1 C3**

8.873X Waste and Wastewater Analysis and Environmental Requirements **X S1 C3**

Principles of analytical methods used in chemical analysis of wastes and wastewaters, sampling schemes, statistical evaluation of data, environmental requirements to prevent pollution.

8.874G Waste Management Science **S1 L2 T1 C3**

8.874X Waste Management Science **X S1 C3**

Aspects of chemistry, biology and geology relevant to waste management, equilibrium and kinetic approaches, cell structure and metabolisms, formation and classification of rocks and soils. 8.850GDrainage of Agricultural LandSSC3

Characteristics of drainage systems, steady and unsteady state drainage formulae, conformal transformation solutions, soil characteristics field measurement of hydraulic conductivity and soil water pressure, significance of unsaturated zone, practical aspects.

8.857G Sewage Treatment and Disposal **SS C3**

8.857X Sewage Treatment and Disposal **X S2 C3**

Application of processes and process variations used to improve the quality of sewage effluent, and the disposal of the effluent. Re-use of effluents where applicable. Sludge treatment and disposal.

8.860G Investigation of Groundwater Resources 1 **SS C3**

Occurrence and extraction of groundwater, investigation and drilling methods, systems approach, optimization techniques, conjunctive use studies, quality of groundwater.

8.861G Investigation of Groundwater Resources 2 **SS C3**

Geophysical methods, remote sensing, photo-interpretation, aridenvironment studies, analog models, case studies.

8.864G Arid Zone Hydrology **S1 L1 T1 C3**

Co-requisites: 8.837G, 8.838G.

Arid zone rainfall characteristics, data collection and instrumentation, runoff processes, infiltration, transmission loss, recharge processes, flood characteristics and design; water yield, storage of water; evaporation and evaporation suppression; sediment transport and measurements.

8.865G Arid Zone Water Resources Management **SS L1 T1 C3**

Water as a resource: demand for and supply of water; works and management to match demand with supply. Special features of the arid zone climate, water uses, quantification of demand quantities and qualities; measurement of flow rate, volume, quality. Engineering works: design, construction, operation and maintenance of work, including excavation tanks, dams, pipelines, pumps, windmills, engines and

motors, troughs; costs; reliability; energy sources for pumping. Special practices: water spreading, irrigation including trickle irrigation; evaporation reduction, desalination.

8.870G Hydraulics and Design of Water and Wastewater Treatment Plants **S2 C3**

Co-requisites: 8.856G, 8.857G.

Application of hydraulic principles to flows within treatment plants. Selection and integration of unit processes required for water and wastewater treatment, plant layout, plant design including hydraulic profiles, the influence of flow and load variability, instrumentation and control strategies.

8.872G Management of Wastes **S1 L2 T1 C3**

8.872X Management of Wastes **X S1 C3**

Management and control strategies in waste management, legal requirements, local and overseas legislation, case studies of waste management.

8.873G Waste and Wastewater Analysis and Environmental Requirements **S1 L1 T1 C3**

8.873X Waste and Wastewater Analysis and Environmental Requirements **X S1 C3**

Principles of analytical methods used in chemical analysis of wastes and wastewaters, sampling schemes, statistical evaluation of data, environmental requirements to prevent pollution.

8.874G Waste Management Science **S1 L2 T1 C3**

8.874X Waste Management Science **X S1 C3**

Aspects of chemistry, biology and geology relevant to waste management, equilibrium and kinetic approaches, cell structure and metabolisms, formation and classification of rocks and soils.

8.875G Hydrological Processes **S1 L2 T1 C3**

Measurements and variations of meteorological processes. Conditions for precipitation. Definition, forms, types and measurement of precipitation.The evaporation process. Plant water dynamics. Methods of estimating evaporation and transpiration at different space and time scales. Management of evaporation and transpiration.The interception process. Significance in the water cycle and in the rainfall runoff process. Measurement and estimation of interception. Factors affecting infiltration. Description and importance of the process. Introduction to unsaturated flow theory. Philip, Green and Ampt, and Horton equations. Ponding and nonponding infiltration. Effect of macropores, soil horizons etc.General description of the runoff process. Horton runoff, saturated surface flow, throughflow, partial area runoff, variable source areas, occurrence of different processes. Effects of depression storage, topography and subsurface features such as macropores and soil horizons on the nature of processes and their space-time distribution. Catchment storage, channel transmission losses.Groundwater recharge by percolation through vadose zone and by transmission loss from streams. Artificial recharge. Groundwater discharge through stream base flow and transpiration of phreatophytes.Effects of land use on precipitation, interception, infiltration, evapotranspiration. Resulting effects on yield, flood runoff, water quality, surface salting and sediment production.

8.877G Flood Design 1 **SS C3**

Introduction to flood estimation, frequency analysis of hydrological data, design rainfall data, hydrograph analysis, storm rainfallrunoff relations, design flood estimation for small to medium sized catchments including the rational method, introduction to urban drainage design.

8.878G Flood Design 2 **SS C3**

Introductory flood routing, loss rates, linear and nonlinear response, unit hydrographs, runoff routing, choice of method of flood estimation, urban drainage design.

8.879G Flood Design 3 **SS C3**

Flood frequency analysis, river flood routing, catchment characteristics, estimation of extreme floods, synthetic unit hydrographs, design hydrograph methods, application of runoff routing models.

8.880G Groundwater Modelling **S1 L1 T1 C3**

Types of groundwater models and their physical bases for porous and fractured rock aquifers. Modelling low permeability materials. Analogue, analytical and numerical model forms. Finite difference and finite element approaches to model development. Spreadsheet applications for groundwater modelling, boundary conditions, matrix structure, inverse methods for parameter estimation. Stochastic modelling and characterization of variability Modelling multiphase, immiscible fluids, and regional groundwater flow. Applications of modelling to borefield management, saltwater intrusion, mine dewatering, geotechnical problems; settlement, slope stabilization. Use of standard model computer codes.

Surveying

29.101G Aspects of Electromagnetic Distance Measurement **SS L2 T1 C3**

New developments in electronic distance measurements including multiple wavelength systems, interferometers, optical transponders. Component properties of instrumental errors. Techniques of instrumental calibration and establishment of calibration facilities. High precision measurement techniques.

29.102G Characteristics of Optical Surveying Instrumentation **SS L2 T1 C3**

Sources of error in modern optical surveying instruments. Methods of testing and calibration. Observational techniques for reducing effects of errors. Developments in circle reading and level sensing systems. Design of instrument testing facilities.

29.103G Precise Engineering Surveys **SS L2 T1 C3**

Techniques and instrumentation for precise surveys. Applications in industry and engineering; deformation and settlement surveys, surveys for large constructions, optical tooling, special measurement problems.

29.106G Special Topic in Surveying A **C3**

A special subject to be lectured on by visiting professors or other visiting staff.

29.107G Special Topic in Surveying B **C3**

A special subject taken by an individual student or a small group of students by private study in conjunction with tutorial sessions with the members of staff in charge of the subject.

29.151G Adjustment of Control Surveys **SS L2 T1 C3**

Choice and analysis of adjustment models in geodetic triangulation and control surveys. Detection of outliers. Design optimization and analysis of survey control networks. Methods of carrying out very large continental adjustments.

29.210G Satellite Surveying **SS L2 T1 C3**

Concepts of satellite surveying: nomenclature, TRANSIT system, GPS for point and relative positioning, vertical control. Surveying with GPS: planning a survey, field and office procedures, case studies. Considerations for high-precision applications: aspects of satellite geodesy, modelling the observable, dual frequency observations, orbit determination, short-arc techniques.

29.211G Introduction to Geodesy **S1 L2 T1 C3**

Geodesy in the service of mankind. The earth's gravity field. The earth's motion in space. Co-ordinate and time systems used in geodesy. Horizontal and vertical control networks. Earth Satellite motion. Principles of satellite positioning. Gravimetric geodesy. Space geodetic methods. Variations of geodetic positions with time.

29.212G Doppler Positioning **SS L2 T1 C3**

Description of the TRANSIT system of satellites. Principle of Doppler measurements. Geodetic position from Doppler. Doppler satellite receivers, computation of point position and translocation using on-board software. Broadcast and precise ephemerides. Mainframe software and multi-station computation. Interpretation of results.

29.213G Physical Metereology **S2 L2 T1 C3**

Electromagnetic wave propagation, geometrical optics approximation, emission and transfer of radiation. Structure of the earth's atmospheric envelope, surface layer and boundary layer metereology, structure of the ionosphere, atmospheric turbulence, meteorological measurements. Interaction and propagation of electromagnetic radiation. Refraction, scattering, absorption, dispersion, reflection. Description, models and solutions of geodetic refraction effects. Atmospheric effects on remote sensing visible, infrared and microwaves. Remote sensing of atmospheric parameters.

29.530G Analytical Photogrammetry **SS L2 T1 C3**

Fundamental relationships, image and object space. Interior orientation, deviations from collinearity, use of reseau. General orientation of one and two images by collinearity and coplanarity conditions. Calibration of metric and non-metric cameras. Principles of analytical plotters, software design. Special applications of photogrammetry.

29.531G Photogrammetric Block Adjustment **SS L2 T1 C3**

Review of strip triangulation. Simultaneous block adjustments with independent models and bundles. Additional parameters.

Solution of large systems of symmetric strongly diagonal linear equations. Computer programs. Control requirements and auxiliary control.

29.532G Computer-Assisted Mapping **SS L2 T1**

Introduction to principles of computer-assisted mapping. Sources of data, ground survey maps, images. Collection and editing of feature coded digital terrain data, points, lines and areas. Digital elevation models, acquisition and interpolation, breaklines, contouring. Accuracy of heights from digital elevation models. Design of mapping programs based on computer-assisted techniques.

29.600G Principles of Remote Sensing **S1 L2 T1 C3**

History and development. Definition and physics of basic electromagnetic radiation quantities. Basic-energy matter relationship. Spectral signatures of surfaces. Atmospheric considerations and the reduction of atmospheric effects. Sensor concepts including film and electro-optical sensors. An introduction to data processing and enhancement, including image interpretation procedures.

29.602G Remote Sensing Procedures **S2 L2 T1 C3**

Review of atmospheric correction procedures and application to multi-temporal Landsat MSS data. Review of image registration, enhancement and classification procedures with particular reference to multi-source remote sensing data sets. Analysis of techniques over a varied land use area. Land use change project and analysis using multi-source and multi-temporal remotely sensed imagery, including Landsat MSS, TM, SPOT and SAR.

29.603G Statutory Controls of Land Development **SS L2 T1 C3**

Detailed examination of the subdivision and development process in N.S.W., with particular emphasis on the statutory procedures and controls at the local government level. The Local Government Appeals Tribunal and its major relevant decisions. Local Government and land development law. Case studies in land development.

29.604G Land Information Systems **SS L2 T1 C3**

Land information as maps and records. Methods of data collection. Integrated surveys and coordinate systems. Legal boundaries. Land tenure. Identifiers. Computerization of land information. Data input methods. Data storage methods. Data processing and manipulation, including management, searching, existing data base languages, and interactive data editing. Data output, including computer graphics, line printer maps, and digital plotters. Application of Anc-Info LIS software.

29.605G Ground Investigations for Remote Sensing **S1 L2 T1 C3**

The spectral, temporal and spatial characteristics of various surfaces, and the available sensors to effect maximum

differentiation. Ground and image comparisons. Instruments available for field measurements. Field investigation procedures including positioning and sampling considerations.

29.608G Cadastral Systems **SS L2 T1 C3**

The cadastral concept. Cadastral surveying and mapping, land registration, valuation of land, land tenure and land administration. Cadastres and land information systems L.I.S.. Strategies for improving cadastral systems. Cadastral systems in developing countries; legal, technical, administrative, economic and social issues.

29.909G Project **C9**

29.918G Project Report **C18**

29.936G Thesis **C36**

Industrial Relations and Organizational Behaviour

30.935G Organization Behaviour **S1 L3**

Relationships between individuals and organizations. Individual behaviour personality, perception, motivation, learning, performance. Organizations as settings for individual behaviour types of organization, work organizations. Interaction, groups and work groups. Organizational influences on work behaviour: structural factors and the design of work; reward systems; organizational cultures and social influences. The development of individual-organization relationships: participation, socialization, careers; conflict, stress and adaptation; organizational effectiveness.

30.958G Organizational Communications **S2 L3**

Prerequisite: 30.935G or equivalent.

Communication is both an end and a means to an end for members of complex organizations. As an end, the patterned inputting, processing and outputting of information is the network of interdependent relationships that we come to call an organization. Thus communication is organizing. As a means to an end, communication suggests the ways that govern the interaction of organizational members exchanging messages in service of such outcomes as decision making, innovation, etc.

Organizational communication therefore is the study of the flow of messages in an information network as well as the uses made of those messages by network participants for the overall attainment of organizational goals.

30.960G Technological Change and Organizational Participation **S1 L3**

Prerequisite: 30.942G or 14.956G or their equivalent.

The complex relationships between technological change and organizational participation in societies using advanced technology, with particular reference to Australia, California, Japan, Germany and the Nordic nations. Key issues include: the relationship between technological change and sociotechnical systems, skill formation, organizational learning, industrial relations, humanization of work, organizational equity, participation, and power.

Town Planning

Graduate Study

36.945G The Organization of Town Planning

Aims, means and consequences of town planning in Australia. Aims of planning: organization of the environment in respect of space and time, interrelationship of functions, equity of resource distribution, human satisfaction, the nature of the planning approach. Means of planning: overview of the planning process, laws related to planning, planning assessment procedures, environmental management at different levels, decision-making processesfinanciers', firms' and private decisions, changes in public values, public participation, political and economic constraints. Consequences of planning: illustrative case studies, evaluation of planning methodology and procedures.

Graduate School of the Built Environment

39.908G Community Noise Control **S1 L1 T1 C2**

Introduction; sound and sound propagation, sound power, sound pressure, decibels; sound perception, psychoacoustics loudness, annoyance, phons and dBA; hearing conservation; acoustic measuring and analysing instruments sound level meters, filters, analysers, recorders; sound sources; community noise assessment; the NSW Noise Control Act; practical exercises in sound recording, analysis and assessment; noise control source noise reduction, use of barriers, enclosures, distance, sound absorbing materials; sound transmission through building elements; noise components of environmental impact statements.

Librarianship

55.815G Economics of Information Systems **S1**

Use of surveys, user studies and market research to determine demand. Costing, financial planning, control and forecasting. Cost-benefit analysis. Economics of networks. Economic implications of new technologies.

55.817G Information Storage and Retrieval Systems **F**

Role of thesauri and other indexing language structures. Automated thesaurus design and maintenance. Automatic indexing and classification systems. Concept co-ordination, use of Boolean operators and search strategy design.

Systems analysis, design and costing. Design of user and interactive cueing tutorials. Choice criteria for on-line and batch systems. Testing, analysis and evaluation of systems. Advanced technologies for information storage and retrieval.

55.823G Files and Database Systems **S1**

File structures, database management systems and file interrogation systems in a text processing or bibliographical environment. Topics: relations, their mapping and normalization; access methods; data organization; independence, integrity and security; CODASYL databases, relational databases and query languages.

Graduate Study

Conditions for the Award of Higher Degrees

First Degrees

Rules, regulations and conditions for the award of first degrees are set out in the appropriate Faculty Handbooks.
For the list of undergraduate courses and degrees offered see Faculty (Undergraduate Study) in the Calendar.

Higher Degrees

The following is the list of higher degrees and graduate diplomas of the University, together with Higher Degrees the publication in which the conditions for the award appear.
For the list of graduate degrees by research and course work, arranged in faculty order, see Table of Courses (by faculty): Graduate Study in the Calendar.

For the statements Preparation and Submission of Project Reports and Theses for Higher Degrees *and* Policy with respect to the Use of Higher Degree Theses see later in this section.

Higher Degrees

Title	Abbreviation	Calendar/Handbook
Doctor of Science	DSc	Calendar
Doctor of Letters	DLitt	Calendar
Doctor of Laws	LLD	Calendar
Doctor of Medicine	MD	Calendar Medicine
Doctor of Philosophy	PhD	Calendar and all handbooks
Master of Applied Science	MAppSc	Applied Science
Master of Architectural Design	MArchDes	Architecture
Master of Architecture	MArch	Architecture
Master of Archives Administration	MArchivAdmin	Professional Studies
Master of Arts	MA	Arts University College
Master of Biomedical Engineering	MBiomedE	Engineering
Master of Building	MBuild	Architecture
Master of the Built Environment	MBEnv	Architecture

Higher Degrees (continued)

Title	Abbreviation	Calender/Handbook
Master of the Built Environment (Building Conservation)	MBEnv	Architecture
Master of Business Administration	MBA	AGSM
Master of Chemistry	MChem	Sciences*
Master of Cognitive Science	MCogSc	Arts
Master of Commerce (Honours)	MCom(Hons)	Commerce
Master of Commerce	MCom	Commerce
Master of Community Health	MCH	Medicine
Master of Construction Management	MConstMgt	Architecture
Master of Education	MEd	Professional Studies
Master of Educational Administration	MEdAdmin	Professional Studies
Master of Engineering	ME	Applied Science Engineering University College
Master of Engineering *without supervision*	ME	Applied Science Engineering
Master of Engineering Science	MEngSc	Engineering Applied Science University College
Master of Environmental Studies	MEnvStudies	Applied Science
Master of Health Administration	MHA	Professional Studies
Master of Health Personnel Education	MHPEd	Medicine
Master of Health Planning	MHP	Professional Studies
Master of Industrial Design	MID	Architecture
Master of Landscape Architecture	MLArch	Architecture
Master of Landscape Planning	MLP	Architecture
Master of Laws	LLM	Law
Master of Librarianship	MLib	Professional Studies
Master of Management Economics	MMgtEc	University College
Master of Mathematics	MMath	Sciences*
Master of Music	MMus	Arts
Master of Nursing Administration	MNA	Professional Studies
Master of Optometry	MOptom	Sciences*
Master of Paediatrics	MPaed	Medicine
Master of Physics	MPhysics	Sciences*
Master of Project Management	MPM	Architecture
Master of Public Health	MPH	Medicine Professional Studies
Master of Psychology (Applied)	MPsychol	Sciences §
Master of Psychology (Clinical)	MPsychol	Science§
Master of Psychotherapy	MPsychotherapy	Medicine
Master of Safety Science	MSafetySc	Engineering
Master of Science	MSc	Applied Science Architecture Engineering Medicine Sciences*§ University College
Master of Science *without supervision*	MSc	Applied Science Architecture

Title	Abbreviation	Calender/Handbook
Master of Science *without supervision* (continued)	MSc	Engineering Medicine Sciences*§ University College
Master of Science (Acoustics)	MSc(Acoustics)	Architecture
Master of Science (Industrial Design)	MSc(IndDes)	Architecture
Master of Science and Society	MScSoc	Arts
Master of Social Work	MSW	Professional Studies
Master of Statistics	MStats	Sciences*
Master of Surgery	MS	Medicine
Master of Surveying	MSurv	Engineering
Master of Surveying *without supervision*	MSurv	Engineering
Master of Surveying Science	MSurvSc	Engineering
Master of Town Planning	MTP	Architecture
Master of Welfare Policy	MWP	Professional Studies
Graduate Diploma	GradDip	Applied Science Architecture Engineering Sciences*§
	DipPaed	Medicine
	DipEd	Professional Studies
	DipIM-ArchivAdmin DipIM-Lib	
	DipFDA	Sciences*

*Faculty of Science.
§Faculty of Biological and Behavioural Sciences.

Higher Degrees (continued)

Graduate Diploma

Higher Degrees

Doctor of Philosophy (PhD) (under review)

1. The degree of Doctor of Philosophy may be awarded by the Council on the recommendation of the Higher Degree Committee of the appropriate faculty or board (hereinafter referred to as the Committee) to a candidate who has made an original and significant contribution to knowledge.

Qualifications

2. (1) A candidate for the degree shall have been awarded an appropriate degree of Bachelor with Honours from the University of New South Wales or a qualification considered equivalent from another university or tertiary institution at a level acceptable to the Committee

(2) In exceptional cases an applicant who submits evidence of such other academic and professional qualifications as may be approved by the Committee may be permitted to enrol for the degree.

(3) If the Committee is not satisfied with the qualifications submitted by an applicant the Committee may require the applicant to undergo such assessment or carry out such work as the Committee may prescribe, before permitting enrolment as a candidate for the degree.

Enrolment and Progression

3. (1) An application to enrol as a candidate for the degree shall be made on the prescribed form which shall be lodged with the Academic Registrar at least one calendar month before the commencement of the session in which enrolment is to begin.

(2) In every case, before permitting a candidate to enrol, the head of the school* in which the candidate intends to enrol shall be satisfied that adequate supervision and facilities are available.

(3) An approved candidate shall be enrolled in one of the following categories:

(a) full-time attendance at the University;

(b) part-time attendance at the University.

(4) A full-time candidate shall be fully engaged in advanced study and research except that the candidate may undertake not more than five hours per week or a total of 240 hours per year on work which is not related to the advanced study and research.

(5) Before permitting a part-time candidate to enrol, the Committee shall be satisfied that the candidate can devote at least 20 hours each week to advanced study and research for the degree which (subject to (8)) shall include regular attendance at the school* on an average of at least one day per week for 48 weeks each year.

(6) A candidate shall be required to undertake an original investigation on an approved topic. The candidate may also be required to undergo such assessment and perform such other work as may be prescribed by the Committee.

(7) The work shall be carried out under the direction of a supervisor appointed from the full-time academic members of the University staff

(8) The work, other than field work, shall be carried out in a school of the University except that the Committee:

(a) may permit a candidate to spend not more than eighteen months of the program in advanced study and research at another institution provided the work can be supervised in a manner satisfactory to the Committee;

(b) may permit a candidate to conduct the work at other places where special facilities not possessed by the University may be available provided the direction of the work remains wholly under the control of the supervisor;

(c) may permit a full-time candidate, who has been enrolled as a full-time candidate for at least six academic sessions, who has completed the research work and who is writing the thesis, to transfer to part-time candidature provided the candidate devotes at least 20 hours each week to work for the degree and maintains adequate contact with the supervisor.

(9) The progress of a candidate shall be reviewed annually by the Committee following a report by the candidate, the supervisor and the head of the school* in which the candidate is enrolled and as a result of such review the Committee may cancel enrolment or take such other action as it considers appropriate.

(10) No candidate shall be awarded the degree until the lapse of six academic sessions from the date of enrolment in the case of a full-time candidate or eight academic sessions in the case of a part-time candidate. In the case of a candidate who has had previous research experience the committee may approve remission of up to two sessions for a full-time candidate and four sessions for a part-time candidate.

(11) A full-time candidate for the degree shall present for examination not later than ten academic sessions from the date of enrolment. A part-time candidate for the degree shall present for examination not later than twelve academic sessions from the date of enrolment. In special cases an extension of these times may be granted by the Committee.

Thesis

4. (1) On completing the program of study a candidate shall submit a thesis embodying the results of the investigation.

(2) The candidate shall give in writing to the Academic Registrar two months notice of intention to submit the thesis.

(3) The thesis shall comply with the following requirements.:

(a) it must be an original and significant contribution to knowledge of the subject;

(b) the greater proportion of the work described must have been completed subsequent to enrolment for the degree;

(c) it must be written in English except that a candidate in the Faculty of Arts may be required by the Committee to write a thesis in an appropriate foreign language;

(d) it must reach a satisfactory standard of expression and presentation;

(e) it must consist of an account of the candidate's own research but in special cases work done conjointly with other persons may be accepted provided the Committee is satisfied about the extent of the candidate's part in the joint research.

(4) The candidate may not submit as the main content of the thesis any work or material which has previously been submitted for a university degree or other similar award but may submit any work previously published whether or not such work is related to the thesis.

(5) Four copies of the thesis shall be presented in a form which complies with the requirements of the University for the preparation and submission of theses for higher degrees.

* Or department where a department is not within a school, or schools or departments where the research is being undetaken in more than one school or department.

(6) It shall be understood that the University retains the four copies of the thesis submitted for examination and is free to allow the thesis to be consulted or borrowed. Subject to the provisions of the Copyright Act, 1968, the University may issue the thesis in whole or in part, in photostat or microfilm or other copying medium.

Examination

5. (1) There shall be not fewer than three examiners of the thesis, appointed by the Academic Board on the recommendation of the Committee, at least two of whom shall be external to the University.

(2) At the conclusion of the examination each examiner shall submit to the Committee a concise report on the thesis and shall recommend to the Committee that:

(a) the candidate be awarded the degree without further examination; or

(b) the candidate be awarded the degree without further examination subject to minor corrections as listed being made to the satisfaction of the head of the school*; or

(c) the candidate be awarded the degree subject to a further examination on questions posed in the report, performance in this further examination being to the satisfaction of the Committee; or

(d) the candidate be not awarded the degree but be permitted to resubmit the thesis in a revised form after a further period of study and/or research; or

(e) the candidate be not awarded the degree and be not permitted to resubmit the thesis.

(3) If the performance at the further examination recommended under (2)(c) above is not to the satisfaction of the Committee, the Committee may permit the candidate to re-present the same thesis and submit to further examination as determined by the Committee within a period specified by it but not exceeding eighteen months.

(4) The Committee shall, after consideration of the examiners' reports and the results of any further examination, recommend whether or not the candidate may be awarded the degree. If it is decided that the candidate be not awarded the degree the Committee shall determine whether or not the candidate be permitted to resubmit the thesis after a further period of study and/or research.

Fees

6. A candidate shall pay such fees as may be determined from time to time by the Council.

Master of Applied Science (MAppSc) and Master of Environmental Studies (MEnvStudies)

1. The degree of Master of Applied Science or Master of Environmental Studies by formal course work may be awarded by the Council to a candidate who has satisfactorily complete a program of advanced study.

Qualifications

2. (1) A candidate of the degree shall:

(a) have been awarded an appropriate degree of Bachelor of four full-time years duration (or the part-time equivalent) from the University of New South Wales or a qualification considered equivalent from another university or tertiary institution at a level acceptable to the Higher Degree Committee of the Faculty of Applied Science (hereinafter referred to as the Committee), or

(b)(i) have been awarded an appropriate degree of Bachelor of three-full-time years duration (or the part-time equivalent) from the University of New South Wales or a qualification considered equivalent from another university or tertiary institution at a level acceptable to the Committee and

(ii) have undertaken appropriate postgraduate studies of the full-time year's duration (or the part-time equivalent) at the University of New South Wales or studies considered equivalent from another university or tertiary institution at a level acceptable to the Committee.

(2) An applicant who submits evidence of such other academic or professional attainments as may be approved by the Committee may be permitted to enrol for the degree.

(3) If the Committee is not satisfied with the qualifications submitted by an applicant the Committee may require the applicant to undergo such assessment or carry out such work as the Committee may prescribe, before permitting enrolment.

Enrolment and Progression

3. (1) An application to enrol as a candidate for the degree shall be made on the prescribed form which shall be lodged with the Academic Registrar at least two calendar months before the commencement of the session in which enrolment is to begin.

*Or department where a department is not within a school, or schools or departments where the research is being undetaken in more than one school or department.

(2) A candidate for the degree shall be required to undertake such formal subjects including the submission of a report on a project, and pass such assessment as prescribed. The project shall be under the supervision of an academic staff member and shall be assessed by two examiners (for a major project).

(3) The progress of a candidate shall be reviewed at least once a year by the Committee and as a result of its review the Committee may cancel enrolment or take such other action as it considers appropriate.

(4) No candidate shall be awarded the degree until the lapse of two academic sessions from the date of enrolment in the case of a full-time candidate and four sessions in the case of a part-time candidate. The maximum period of candidature shall be four academic sessions from the date of enrolment for a full-time candidate, eight sessions for a part-time candidate, and ten sessions for an external candidate. In special cases an extension of these times may be granted by the Committee.

Fees

4. A candidate shall pay such fees as may be determined from time to time by the Council.

Master of Engineering (ME) and Master of Science (MSc)

1. The degree of Master of Engineering or Master of Science by research may be awarded by the Council on the recommendation of the Higher Degree Committee of the appropriate faculty (hereinafter referred to as the Committee) to a candidate who as demonstrated ability to undertake research by the submission of a thesis embodying the results of an original investigation.

Qualifications

2. (1) A candidate for the degree shall have been awarded an appropriate degree of Bachelor from the University of New South Wales or a qualification considered equivalent from another university or tertiary institution at a level acceptable to the Committee.

(2) An applicant who submits evidence of such other academic or professional attainments as may be approved by the Committee may be permitted to enrol for the degree.

(3) When the Committee is not satisfied with the qualifications submitted by an applicant the Committee may require the applicant, before being permitted to enrol, to undergo such examination or carry out such work as the Committee may prescribe.

Enrolment and Progression

3. (1) An application to enrol as a candidate for the degree shall be made on the prescribed form which shall be lodged with the Academic Registrar at least one calendar month before the commencement of the session in which enrolment is to begin.

(2) In every case, before permitting a candidate to enrol, the head of the school (or department) in which the candidate intends to enrol shall be satisfied that adequate supervision and facilities are available.

(3) An approved candidate shall be enrolled in one of the following categories:

(a) full-time attendance at the University;

(b) part-time attendance at the University;

(c) external - not in regular attendance at the University and using research facilities external to the University

(4) A candidate shall be required to undertake an original investigation on an approved topic. The candidate may also be required to undergo such examination and perform such other work as may be prescribed by the Committee.

(5) The work shall be carried out under the direction of a supervisor appointed from the full-time members of the University staff.

(6) The progress of a candidate shall be reviewed annually by the Committee following a report by the candidate, the supervisor and the head of the school (or department) in which the candidate is enrolled and as a result of such review the Committee may cancel enrolment or take such other action as it considers appropriate.

(7) No candidate shall be granted the degree until the lapse of three academic sessions in the case of a full-time candidate or four academic sessions in the case of a part-time or external candidate from the date of enrolment. In the case of a candidate who has been awarded the degree of Bachelor with Honours or who has had previous research experience the Committee may approve remission of up to one session for a full-time candidate and two sessions for a part-time or external candidate.

(8) A full-time candidate for the degree shall present for examination not later than six academic sessions from the date of enrolment. A part-time or external candidate for the degree shall present for examination not later than ten academic sessions from the date of enrolment. In special cases an extension of these times may be granted by the Committee.

Thesis

4. (1) On completing the program of study a candidate shall submit a thesis embodying the results of the original investigation.

(2) The candidate shall give in writing two months notice of intention to submit the thesis.

(3) The thesis shall present an account of the candidate's own research. In special cases work done conjointly with other persons may be accepted, provided the Committee is satisfied about the extent of the candidate's part in the joint research.

(4) The candidate may also submit any work previously published whether or not such work is related to the thesis.

(5) Three copies of the thesis shall be presented in a form which complies with the requirements of the University for the preparation and submission of higher degree theses.

(6) It shall be understood that the University retains the three copies of the thesis submitted for examination and is free to allow the thesis to be consulted or borrowed. Subject to the provisions of the Copyright Act, 1968, the University may issue the thesis in whole or in part, in photostat or microfilm or other copying medium.

Examination

5. (1) There shall be not fewer than two examiners of the thesis, appointed by the Academic Board on the recommendation of the Committee, at least one of whom shall be external to the University unless the Committee is satisfied that this not practicable.

(2) At the conclusion of the examination each examiner shall submit to the Committee a concise report on the merits of the thesis and shall recommend to the Committee that:

(a) the candidate be awarded the degree without further examination; or

(b) the candidate be awarded the degree without further examination subject to minor corrections as listed being made to the satisfaction of the head of the school (or department); or

(c) the candidate be awarded the degree subject to a further examination on questions posed in the report, performance in this further examination being to the satisfaction of the Committee; or

(d) the candidate be not awarded the degree but be permitted to resubmit the thesis in a revised form after a further period of study and/or research; or

(e) the candidate be not awarded the degree and be not permitted to resubmit the thesis.

(3) If the performance at the further examination recommended under (2)(c) above is not to the satisfaction of the Committee, the Committee may permit the candidate to re-present the same thesis and submit to a further oral, practical or written examination within a period specified by it but not exceeding eighteen months.

(4) The Committee shall, after consideration of the examiners' reports and the reports of any oral or written or practical examination, recommend whether or not the candidate may be awarded the degree. If it is decided that the candidate be not awarded the degree the Committee shall determine whether or not the candidate may resubmit the thesis after a further period of study and/or research.

Fees

6. A candidate shall pay such fees as may be determined from time to time by the Council.

Master of Engineering (ME), Master of Science (MSc) and Master of Surveying (MSurv) *without supervision*

1. The degree of Master of Engineering or Master of Science or Master of Surveying without supervision may be awarded by the Council on the recommendation of the Higher Degree Committee of the appropriate faculty (hereinafter referred to as the Committee) to a candidate who has demonstrated ability to undertake research by the submission of a thesis embodying the results of an original investigation.

Qualifications

2. A candidate for the degree shall have been awarded an appropriate degree of Bachelor from the University of New South Wales with at least three years relevant standing in the case of Honours graduates and four years relevant standing in the case of Pass graduates, and at a level acceptable to the Committee.

Enrolment and Progression

3. An application to enrol as a candidate for the degree without supervision shall be made on the prescribed form which shall be lodged with the Academic Registrar not less than six months before the intended date of submission of the thesis. A graduate who intends to apply in this way should in his or her own interest, seek at an early stage the advice of the appropriate head of school (or department) with regard to the adequacy of the subject matter and its presentation for the degree. A synopsis of the work should be available.

Thesis

4. (a) A candidate shall submit a thesis embodying the results of the investigation.

(2) The candidate shall give in writing to the Academic Registrar two months notice of intention to submit the thesis.

(3) The thesis shall present an account of the candidate's own research. In special cases work done conjointly with other persons may be accepted, provided the Committee is satisfied about the extent of the candidate's part in the joint research.

(4) The candidate may also submit any work previously published whether or not such work is related to the thesis.

(5) Three copies of the thesis shall be presented in a form which complies with the requirements of the University for the preparation and submission of theses for higher degrees.

(6) It shall be understood that the University retains the three copies of the thesis submitted for examination and is free to allow the thesis to be consulted or borrowed. Subject to the provisions of the Copyright Act, 1968, the University may issue the thesis in whole or in part, in photostat or microfilm or other copying medium.

Examination

5. (1) There shall be not fewer than two examiners of the thesis, appointed by the Academic Board on the recommendation of the Committee, at least one of whom shall be external to the University unless the Committee is satisfied that this is not practicable.

(2) Before the thesis is submitted to the examiners the head of the school (or department) in which the candidate is enrolled shall certify that it is *prima facie* worthy of examination.

(3) At the conclusion of the examination each examiner shall submit to the Committee a concise report on the thesis and shall recommend to the Committee that:

(a) the candidate be awarded the degree without further examination; or

(b) the candidate be awarded the degree without further examination subject to minor corrections as listed being made to the satisfaction of the head of the school (or department); or

(c) the candidate be awarded the degree subject to a further examination on questions posed in the report, performance in this further examination being to the satisfaction of the Committee; or

(d) the candidate be not awarded the degree but be permitted to resubmit the thesis in a revised form after a further period of study and/or research; or

(e) the candidate be not awarded the degree and be not permitted to resubmit the thesis.

(4) If the performance at the further examination recommended under (3)(c) above is not to the satisfaction of the Committee, the Committee may permit the candidate to re-present the same thesis and submit to further examination as determined by the Committee within a period specified by it but not exceeding eighteen months.

(5) The Committee shall, after consideration of the examiners' reports and the results of any further examination, recommend whether or not the candidate may be awarded the degree. If it is decided that the candidate be not awarded the degree the Committee shall determine whether or not the candidate may resubmit the thesis after a further period of study and/or research.

Fees

6. A candidate shall pay such fees as may be determined from time to time by the Council.

Master of Environmental Studies (MEnvStudies)

See Master of Applied Science above.

Master of Science (MSc)

See Master of Engineering above.

Master of Science (MSc) without supervision

See Master of Engineering without supervision above.

Graduate Diploma

Graduate Diploma (GradDip) Qualifications

1. A Graduate Diploma may be awarded by the Council to a candidate who has satisfactorily completed a program of advanced study.

2. (1) A candidate for the diploma shall have been awarded an appropriate degree of Bachelor from the University of New South Wales or a qualification considered equivalent from another university or tertiary institution at a level acceptable to the Higher Degree Committee of the appropriate faculty (hereinafter referred to as the Committee).

(2) An applicant who submits evidence of such other academic or professional attainments as may be approved by the Committee may be permitted to enrol for the diploma.

(3) If the Committee is not satisfied with the qualifications submitted by an applicant the Committee may require the applicant to undergo such assessment or carry out such work as the Committee may prescribed, before permitting enrolment.

3. (1) An application to enrol as a candidate for the diploma shall be made on the prescribed form which shall be lodged with the Academic Registrar at least two calendar months before the commencement of the session in which enrolment is to begin. **Enrolment and Progression**

(2) A candidate for the diploma shall be required to undertake such formal subjects and pass such assessment as prescribed.

(3) The progress of a candidate shall be reviewed at least once annually by the Committee and as a result of its review the Committee may cancel enrolment or take such other action as it considers appropriate.

(4) No candidate shall be awarded the diploma until the lapse of two academic sessions from the date of enrolment in the case of a full-time candidate or four sessions in the case of a part-time candidate. The maximum period of candidature shall be four academic sessions from the date of enrolment for a full-time candidate and six sessions for a part-time candidate. In special cases an extension of these times may be granted by the Committee.

4. A candidate shall pay such fees as may be determined from time to time by the Council. **Fees**

Scholarships and Prizes

The scholarships and prizes listed below are available to students whose courses are listed in this handbook. Each faculty handbook contains in its Scholarships and Prizes section the scholarships and prizes available with that faculty. The General Information section of the Calendar contains a comprehensive list of scholarships and prizes offered throughout the University.

Scholarships

Undergraduate Scholarships

Listed below is an outline only of a number of scholarships available to students. Full information may be obtained from Room G20, located on the Ground Floor of the Chancellery.

Unless otherwise indicated in footnotes, applications for the following scholarships should be made to the Academic Registrar by 14 January each year. Please note that not all of these awards are available every year.

Donor	Value	Year/s of Tenure	Conditions
General			
Bursary Endowment Board*	$200 pa	Minimum period of approved degree/ combined degree course	Merit in HSC and total family income not exceeding $6000
Sam Cracknell Memorial	Up to $3000 pa payable in fortnightly instalments	1 year	Prior completion of at least 2 years of a degree or diploma course and enrolment in a full-time course during the year of application; academic merit; participation in sport both directly and administratively; and financial need.

Undergraduate Scholarships (continued)

Donor	Value	Year/s of Tenure	Conditions
General (continued)			
Girls Realm Guild	Up to $1500 pa	1 year renewable for the duration of the course subject to satisfactory progress and continued demonstration of need	Available only to female students under 35 years of age who are permanent residents of Australia enrolling in any year of a full-time undergraduate course on the basis of academic merit and financial need.
W.S. and L.B. Robinson**	Up to $4200 pa	1 year renewable for the duration of the course subject to satisfactory progress	Available only to students who have completed their schooling in Broken Hill or whose parents reside in Broken Hill; for a course related to the mining industry. Includes courses in mining engineering, geology, electrical and mechanical engineering, metallurgical process engineering, chemical engineering and science.
Universities Credit Union	$500 pa	1 year with the possibility of renewal	Prior completion of at least 1 year of any undergraduate degree course. Eligibility limited to members of the Universities Credit Union Ltd of more than one year's standing or members of the family of such members.
Alumni Association	Up to $1500 pa	1 year with the possibility of renewal	Available to students enrolled in any year of a full-time course. Candidates must be the children of Alumni of the University of NSW and may be either permanent residents of Australia or overseas students.

*Apply to The Secretary, Bursary Endowment Board, PO Box 460, North Sydney 2060, immediately after sitting for HSC.
**Applications close 30 September each year.

Applied Science

Applied Bioscience

Food Science and Technology

Coca-Cola Export Corporation	Up to $1500 pa	1 year renewable for the duration of the course subject to satisfactory progress	Permanent residence in Australia. Not more than 22 years of age on 1 December preceding the year in which the award commences and eligibility for admission to Year 1 of the full-time degree course in Food Technology.
George Weston Foods Ltd	Up to $4000 over 4 years		
CAFTA-New South Wales	$600 pa	1 year renewable	Permanent residence in Australia. Eligible for admission to Year 2, 3 or 4 of course three available.

Chemical Engineering and Industrial Chemistry

Bridge Oil Ltd	Up to $5000 pa	1 year renewable for the duration of the course subject to satisfactory progress	Permanent residence in Australia living in Queensland and must have completed the first two years of any accredited engineering program in that state

Undergraduate Schoplarships (continued)

Donor	Value	Year/s of Tenure	Conditions
Applied Science (continued)			
Dow Chemical Australia	Up to $1000 pa	1 year renewable for the duration of the course subject to satisfactory progress	Permanent residence in Australia and eligibility for admission to Year 2 of the fulltime degree course in Chemical Engineering
Shell Refining Australia Pty Ltd	Up to $1500 pa		Eligibility for admission to Year 2 of the full-time degree course in Chemical Engineering
Society of Petroleum Engineers Pty Ltd	Up to $2500		Permanent residence in Australia living in specified state and must have completed the first two years of any accredited engineering program in that state
Fibre Science and Technology			
Textile Technology			
Australian Wool Corporation	Up to $2500	1 year renewable for the duration of the course, subject to satisfactory progress	Permanent residence in Australia and eligibility for admission to the full-time degree course in Textile Technology
Bonds Industries Ltd	$2477 pa		
Bradmill Textiles Ltd	Up to $3000 pa		
Bruck Australia Limited	$3821 or $2477 pa		
Fibremakers Division of ICI Australia Operations Pty Ltd	$3821 or $2477 pa		
Textile Council of Australia	$3821 or $2477 pa		
Webco	$500 pa		
Wool and Animal Science			
Merck, Sharp and Dohme	Up to $1000 pa	1 year renewable for the duration of the course, subject to satisfactory progress	Eligibility for admission to the full-time degree course in Wool and Pastoral Sciences
Australian Wool Corporation	Up to $2500 pa		
Dalgety Farmers Bicentennial	Up to $2500		
Materials Science and Engineering			
Materials			
Australian Ceramic Society	Up to $300 pa	1 year renewable for the duration of the course, subject to satisfactory progress	Permanent residence in Australia and eligibility for admission to Year 1 or Year 2 of the full-time degree course in Ceramic Engineering.
The Brick Manufacturer's Association of New South Wales	Up to $2,500 pa		
Caroma Industries Ltd	Up to $1000 pa		
Fowlerware	Up to $500 pa		
Monier Limited	Up to $1000 pa		
Plessey Australia Pty Ltd	Up to $1000 pa		
The Thomson Family	Up to $1000 pa		
Zacuba Pty Ltd	Up to $1500 pa		

Undergraduate Schoplarships (continued)

Donor	Value	Year/s of Tenure	Conditions
Applied Science (continued)			
Metallurgy			
Sir Rupert Myers Industrial Sponsors Program	Up to $1500 pa	1 year renewable for the duration of the course subject to satisfactory progress	Open to students whose parents are permanent residents of Australia or who are themselves permanent residents and who are eligible for admission to Year 1 or Year 2 of the full-time degree course in Metallurgy or Metallurgical Engineering
Comalco Research Award in Metallury	Up to $1500		Eligibility for admission to Year 1 of the full-time degree course in Metallurgy or Metallurgical Process Engineering
Mines			
Applied Geology			
Renison Goldfields Consolidated	$5000 pa	1 year	Permanent residence in Australia and enrolled in Year 4 of the Applied Geology course, or equivalent Science and Mathematics (honours) course
BP Coal Australia	Up to $500 pa	1 year renewable for the duration of the course, subject to satisfactory progress	Permanent residence in Australia and enrolled in Year 4 of the Applied Geology or Mining Geology degree course or equivalent program in the sciences
Mining Engineering			
Stan Sawyer Memorial Scholarship to Coal Mining Students	Up to $200 pa	1 year renewable for the duration of the course, subject to satisfactory progress	Eligibility for admission to Year 3 or Year 4 of the full-time degree course in Mining Engineering
School of Mines			
The Charles Warman Scholarship	$4000 pa	1 year	Permanent residence in Australia and enrolled in any year of the full-time degree course in Mineral Engineering
Joint Coal Board Scholarship	$500	1 year	Enrolled in Year 4 of Geology, Mineral Engineering or Mining Engineering course. Selection is based on academic merit.

The UNSW Co-op Program

The University of New South Wales has industry-linked education scholarship programs to the value of $8000 per annum in the following areas: Business Information Technology, Chemical Engineering, Civil Engineering, Electrical and Computer Engineering, Industrial Chemistry, Mechanical and Industrial Engineering, Mining, Mineral Engineering and Applied Geology. Further information can be obtained by writing to The Co-ordinator, UNSW Co-op Programs Industry-Linked Education Office, C/- Vice-Chancellors Division.

Graduate Scholarships

Application forms and further information are available from the Student Centre, located on the Ground Floor of the Chancellery unless an alternative contact address is provided. Information is also available on additional scholarships which may become available from time to time, mainly from funds provided by organizations sponsoring research projects.

The following publications may also be of assistance: **1.** *Awards for Postgraduate Study in Australia and Awards for Postgraduate Study Overseas,* published by the Graduate Careers Council of Australia. PO Box 28, Parkville, Victoria 3052;* **2.** *Study Abroad,* published by UNESCO;* **3.** *Scholarships Guide for Commonwealth Postgraduate Students, published by the Association of Commonwealth Universities.**

Details of overseas awards and exchanges administered by the Department of Employment, Education and Training can be obtained from: Awards and Exchanges Section, Department of Employment, Education and Training, PO Box 826, Woden, ACT 2606.

*Available for reference in the University Library.

Donor	Value	Year/s of Tenure	Conditions
General			
University Postgraduate Research Scholarships	Living allowance of $9000 pa. Other allowances may also be paid.	1-2 years for a Masters and 3-4 years for a PhD degree	Applicants must be honours graduates or equivalent. Applications to Dean of relevant Faculty.
Commonwealth Postgraduate Research Awards	$12,734 to $16,433		Applicants must be honours graduates or equivalent or scholars who will graduate with honours in current academic year, and who are domiciled in Australia. Applications to Academic Registrar by 31 October.
Commonwealth Postgraduate Course Awards	Living allowance of $10,415 pa. Other allowances may also be paid.	1-2 years; minimum duration of course	Applicants must be graduates or scholars who will graduate in current academic year, and who have not previously held a Commonwealth Post-graduate Award. Applicants must be domiciled in Australia. Preference is given to applicants with employment experience. Applications to Academic Registrar by 30 September.
Australian American Educational Foundation Fulbright Award	Travel expenses and $A2000 as establishment allowance.	1 year, renewable	Applicants must be graduates who are domiciled in Australia and wish to undertake research or study for a higher degree in America. Applications close 30 September with The Secretary, DEET, AAEF Travel Grants, PO Box 826, Woden ACT 2606.
Australian Federation of University Women	Amount varies, depending on award	Up to 1 year	Applicants must be female graduates who are members of the Australian Federation of University Women
Commonwealth Scholarship and Fellowship Plan	Varies for each country. Generally covers travel, living, tuition fees, books and equipment, approved medical expenses. Marriage allowance may be payable.	Usually 2 years, sometimes 3	Applicants must be graduates who are Australian citizens and who are not older than 35 years of age. Tenable in Commonwealth countries other than Australia. Applications close with Academic Registrar in September or October each year.
The English-Speaking Union (NSW Branch)	$5000	1 year	Applicants must be residents of NSW or ACT. Awarded to young graduates to further their studies outside Australia. Applications close mid-April with The Secretary, Ground Floor, Sydney School of Arts, 275c Pitt Street, Sydney NSW 2000.

Graduate Scholarships (continued)

Donor	Value	Year/s of Tenure	Conditions
General (continued)			
Frank Knox Memorial Fellowships tenable at Harvard University	Stipend of $US7000 pa plus tuition fees	1, sometimes 2 years	Applicants must be British subjects and Australian citizens, who are graduates or near graduates of an Australian university. Applications close with the Academic Registrar mid October.
Robert Gordon Menzies Scholarship to Harvard	Up to $US 15,000	1 year	Tenable at Harvard University. Applicants must be Australian citizens and graduates of an Australian tertiary institution. Applications close 31 December with the Registrar, A.N.U., GPO Box 4, Canberra ACT 2601
Gowrie Scholarship Trust Fund	$4000 pa. Under special circumstances this may be increased	2 years	Applicants must be members of the Forces or children of members of the Forces who were on active service during the 1939-45 War. Applications close with the Academic Registrar by 31 October.
Harkness Fellowships of the Commonwealth Fund of New York	Living and travel allowances, tuition and research expenses, health insurance, book and equipment and other allowances for travel and study in the USA	12 to 21 months	Candidates must be Australian citizens and **1.** Either members of the Commonwealth or a State Public Service or semi-government Authority. **2.** Either staff or graduate students at an Australian university. **3.** Individuals recommended for nomination by the Local Correspondents. The candidate will usually have an honours degree or equivalent, or an outstanding record of achievement, and be not more than 36 years of age. Applications close 29 August with the Academic Registrar. Forms available from Mr J Larkin, Bureau of Agriculture and Resource Economics, GPO Box 1563, Canberra ACT 2601.
The Packer, Shell and Barclays Scholarships to Cambridge University	Living and travel allowances, tuition expenses.	1-3 years	Applicants must be Australian citizens who are honours graduates or equivalent, and under 26 years of age. Applications close 15 October with The Secretary, Cambridge Commonwealth Trust, PO Box 252, Cambridge CB2 ITZ, England.
The Rhodes Scholarship to Oxford University	Approximately £4,200 stg pa	2 years, may be extended for a third year.	Unmarried Australian citizens aged between 19 and 25 who have an honours degree or equivalent. Applications close in August each year with The Secretary, University of Sydney, NSW 2006.
Applied Science			
Pig Research Council Study/Training Awards			Applications close 19 September with the Department of Primary Industry, Canberra ACT 2600.
Australian Wool corporation Postgraduate Scholarships	$21,362 (taxable)	1 year subject to satisfactory progress. Renewable annually; maximum tenure of 2 years for a Masters candidate or 3 to 4 years for a PhD degree.	Tenable in Australian tertiary institutions or overseas in exceptional circumstances. Enquiries to the School of Fibre Science and Technology.

Graduate Scholarships (continued)

Donor	Value	Year/s of Tenure	Conditions
Applied Science (continued)			
Australian Metal and Live-stock Research and Development Corporation	$8,882 pa	1-3 years varies with course	Awarded for graduate study of the industry leading to the award of a diploma, or Masters or PhD degree. Tenable in Australia or overseas. Applications close 31 July with the AMLR&D Corporation, PO Box A498, Sydney South NSW 2000.
Water Industry Research Award	$17,764 pa	2-4 years	Applications close with the Academic Registrar 10 January.

Prizes

Undergraduate University Prizes

The following table summarizes the undergraduate prizes awarded by the University. Prizes which are not specific to any School are listed under General. All other prizes are listed under the Schools in which they are awarded.

Information regarding the establishment of new prizes may be obtained from the Examinations Section located on the Ground Floor or the Chancellery.

Donor/Name of Prize	Value $	Awarded for
General		
The Sydney Technical College Union Award	$400.00 and Bronze Medal	Leadership in student affairs combined with marked academic proficiency by a graduand.
The University of New South Wales Alumni Association Prize	Statuette	Achievement for community benefit by a student in the final or graduating year.
School of Applied Bioscience – Department of Food Science and Technology		
The Cottee's Foods Prize	$120.00	The best performance in 49.142 Food Leglislation in the Bachelor of Science in Food Technology course.
The Wilfred B.S. Bishop Prize	$75.00	The best overall performance in the Bachelor of Science Degree in Food Technology course by a student who has made a significant contribution to staff and student activities.
School of Applied Bioscience – Department of Biotechnology		
The Burns Philp Food Prize	$175.00	The best performance in 42.101 Introduction to Biotechnology in the Bachelor of Science course
The Burns Philp Food Prize	$175.00	The best performance in one of the Level 3 Biotechnology subjects 42.102A Biotechnology A 42.102B Biotechnology B 42.102C Microbial Genetics by a student in the Bachelor of Science course
The Burns Philp Food Prize	$175.00	The best overall performance in the Bachelor of Science (Biotechnology) Honours course
The Nestle Australia Pty Limited Prize	$200.00	The best performance in 49.140 Project in the Bachelor of Science in Food Technology course
School of Chemical Engineering and Industrial Chemistry		
The AGL Sydney Limited Prize	$200.00	The best performance in a subject selected by the Head of School
The Australian Corrosion Association (NSW Branch) Award	$150.00 and one years membership of the Association	The best performance in 48.121 Corrosion in the Chemical Industry
The Australian Institute of Energy Prize	$50.00	The best performance in a subject selected by the Head of School
The Australian Paper Manufacturers Ltd Prize	$150.00	The best performance in 48.163 Instrumentation and Process Control in the Chemical Engineering course
The Australian Paper Manufacturers Ltd Prize	$150.00	The best performance in 48.163 Instrumentation and Process Control in the Industrial Chemistry course

Undergraduate University Prizes (continued)

Donor/Name of Prize	Value $	Awarded for
School of Chemical Engineering and Industrial Chemistry (continued)		
The CSR Limited Prize	$100.00	The best performance in a subject selected by the Head of School
The Chemical Technology Society Annual Award	$50.00	The best performance by an undergraduate in Years 1 and 2 or stages 1 to 4 of the Bachelor of Science (Industrial Chemistry) course.
The Esso Australia Ltd Prize	$200.00	The best performance in Year 2 of Chemical Engineering
The Fuel Technology Staff Prize	$200.00	The best performance in a subject selected by the Head of School
The Institution of Chemical Engineers Prize	$100.00 and Medal	The best thesis by a student in the final year of the Bachelor of Engineering course in Chemical Engineering
The Shell Prize	$100.00	The best performance by a student in Year 2 or equivalent part-time stage of the Chemical Engineering or Industrial Chemistry courses including sporting and student activities.
The Shell Prize	$100.00	The best performance by a student in Year 3 or equivalent part-time stage of the Chemical Engineering or Industrial Chemistry courses including sporting and student activities
The Shell Prize	$100.00	The best performance by a student in Year 4 or equivalent part-time stage of the Chemical Engineering or Industrial Chemistry courses including sporting and student activities.
The Shell Prize	$100.00	For a student who has, in the opinion of the Head of School, performed some meritorious activity of note either inside or outside the University.
The Shell Prize	$200.00	The best performance in a subject selected by the Head of School
The Simon-Carves Australia Prize	$100.00	The best performance in 48.135 Thermodynamics
The Stauffer Australia Limited Prize	$100.00	The best performance in a subject selected by the Head of School
The Western Mining Corporation Ltd Prize	$150.00	The best performance in 48.036 Chemical Engineering Laboratory 1
The Western Mining Corporation Ltd Prize	$150.00	The best performance in 48.044 Chemical Engineering Laboratory 2
School of Fibre Science and Technology – Department of Textile Technology		
The J.B. Speakman Prize	$50.00	The best undergraduate thesis in the final year of the Bachelor of Science course in Textile Technology
The R.J. Webster Prize	$250.00	The best performance throughout the Bachelor of Science course in Textile Technology
The Textile Institute Prize	Two years free membership of the Textile Institute	The best performance in 13.113 Textile Technology 3 by a student in the Bachelor of Science course in Textile Technology

Undergraduate University Prizes (continued)

Donor/Name of Prize	Value $	Awarded for
School of Fibre Science and Technology – Department of Wool and Animal Science		
The Bayer Animal Health Prize	$120.00	The best performance in Years 2 and Year 3 of a Degree course in Wool Science
The C.R. Luckock Prize	$Book or $60.00 voucher drawn on Uni.Co-op Bookshop	The best performance in Meat Science in the Department of Wool and Pastoral Sciences
The National Farmers' Federation Prize	$150.00	Excellent academic attainment by a graduating student in the Bachelor of Science in Wool and Pastoral Sciences
The Parkes Wool Promotion Committee Prize	A shield held in the Department of Wool Science on which the name of the successful student is engraved each year	The best performance in Practical Wool Studies in the Department of Wool and Pastoral Sciences
The P.R. McMahon Memorial Prize	$100.00	Excellence in Wool Science in the Bachelor of Science course in Wool and Pastoral Sciences
School of Geography		
The Jack Mabbutt Medal	Medal	The best performance in the Year 4 Project in Applied Geography by a student in the Bachelor of Science (Applied Science) course
The Jack Mabbutt Prize	$150.00	Best performance by a Year 3 student proceeding to Honours in Geography
School of Materials Science and Engineering		
The Alcan Australia Ltd Prize	$200.00	The best performance in a subject selected by the Head of School
The Austral Crane Prize	$150.00	The best performance in a subject selected by the Head of School
The Australasian Corrosion Association (NSW) Prize	$150.00	The best performance in 4.623B Metallurgical Engineering 2B by a student in the Bachelor of Metallurgical Engineering course
The Australian Welding Institute Prize	Books to the value of $30.00	The best performance in a subject selected by the Head of School
The Australian Ceramic Society Prize	$100.00	The highest overall course aggregate by a student completing the final year of the degree of Bachelor of Engineering in Ceramic Engineering
The Broken Hill Propietory Company Prize	$150.00	The best performance in a subject selected by the Head of School
The Hugh Muir Prize	$275.00	The best performance by a student in the final year seminar class, who in the opinion of the Head of School has contributed most to the coprorate life of the School of Materials Science and Engineering
The Institute of Metals and Materials Australasia Prize	$100.00 and one years member ship of the Institute	The best performance in a subject selected by the Head of School
the Max Hatherly Prize	$275.00	The best performance in the final year practical examination or for an outstanding performance in Metallography

Undergraduate University Prizes (continued)

Donor/Name of Prize	Value $	Awarded for
School of Materials Science and Engineering (continued)		
The Western Mining Corporation Ltd Prize	$150.00	The best overall performance in Year 3 full-time (or its part-time equivalent) by a student in the Engineering or Bachelor of Science (Technology) courses in Materials Science and Engineering
The Western Mining Corporation Ltd Prize	$150.00	The best overall performance in Year 4 full-time (or its part-time equivalent) in the Bachelor of Engineering (Metallurgical Process Engineering) or Bachelor of Science (Technology) courses in Materials Science and Engineering
The Z.C. Mines Prize	$200.00	The best performance in a subject selected by the Head of School
School of Mines		
The Joint Coal Board Prize	$200.00	The best performance in Year 2 of the Bachelor of Engineering Course in Mining Engineering
The Joint Coal Board Prize	$200.00	The best performance in Year 3 of the Bachelor of Engineering course in Mining Engineering
The Joint Coal Board Prize	$300.00	The best overall performance in the Bachelor of Engineering course in Mining Engineering
The Western Mining Corporation Ltd Melbourne Prize	$200.00	The best overall performance by a student in the Bachelor of Engineering course in Mining Engineering
The Western Mining Corporation Ltd Perth Prize	$150.00	The best overall performance by a student in the final year of the Bachelor of Engineering course in Mining Engineering
The Western Mining Corporation Ltd Perth Prize	$150.00	The best overall performance by a student in Year 3 of the Bachelor of Engineering course in Mining Engineering
School of Mines – Department of Applied Geology		
The Crae Mapping Prize in Applied Geology	$250.00	The best performance in 25.312 Earth Environments 2 - Geological Field Mapping Tutorial by a student in the Bachelor of Science course
The F.C. Loughnan Prize For First Year Geology	$100.00	The best performance in year 1 of the Geology component of the Bachelor of Science Course.
The F.C. Loughnan Prize in Applied Geology	$340.00	The best performance in Year 3 of the Geology component of the Bachelor of Science course.

Graduate University Prizes

The following table summarizes the graduate prizes awarded by the University.

Donor/name of Prize	Value $	Awarded for
School of Applied Bioscience – Department of Biotechnology		
The Burns Philp Food Prize	$175.00	The best overall performance in the Master of Applied Science (Biotechnology) course
School of Chemical Engineering and Industrial Chemistry		
The Clean Air Society of Australia and New Zealand Prize in Atmospheric Pollution Control	$100.00	The Highest aggregate in 48.391G Atmospheric Pollution Control and 48.392G Practical Aspects of Pollution Measurement and Control in a postgraduate course in the School of Chemical Engineering and Industrial Chemistry
School of Fibre Science and Technology – Department of Textile Technology		
The Malcolm Chaikin Prize	$200.00 and Bronze Medal	The most outstanding Ph.D thesis in the Department of Textile Technology
School of Mines – Department Of Applied Geology		
The Laric V. Hawkins Prize		The best written account of research work in the area of Geophysics in a postgraduate degree or diploma course

Student's Timetable

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
9-10										
10-11										
11-12										
12-1										
1-2										
2-3										
3-4										
4-5										
5-6										
6-7										
7-8										
8-9										

Student's Timetable

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
9-10										
10-11										
11-12										
12-1										
1-2										
2-3										
3-4										
4-5										
5-6										
6-7										
7-8										
8-9										

Student's Timetable

Time	Monday		Tuesday		Wednesday		Thursday		Friday	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
9-10										
10-11										
11-12										
12-1										
1-2										
2-3										
3-4										
4-5										
5-6										
6-7										
7-8										
8-9										

The University of New South Wales Kensington Campus

Theatres

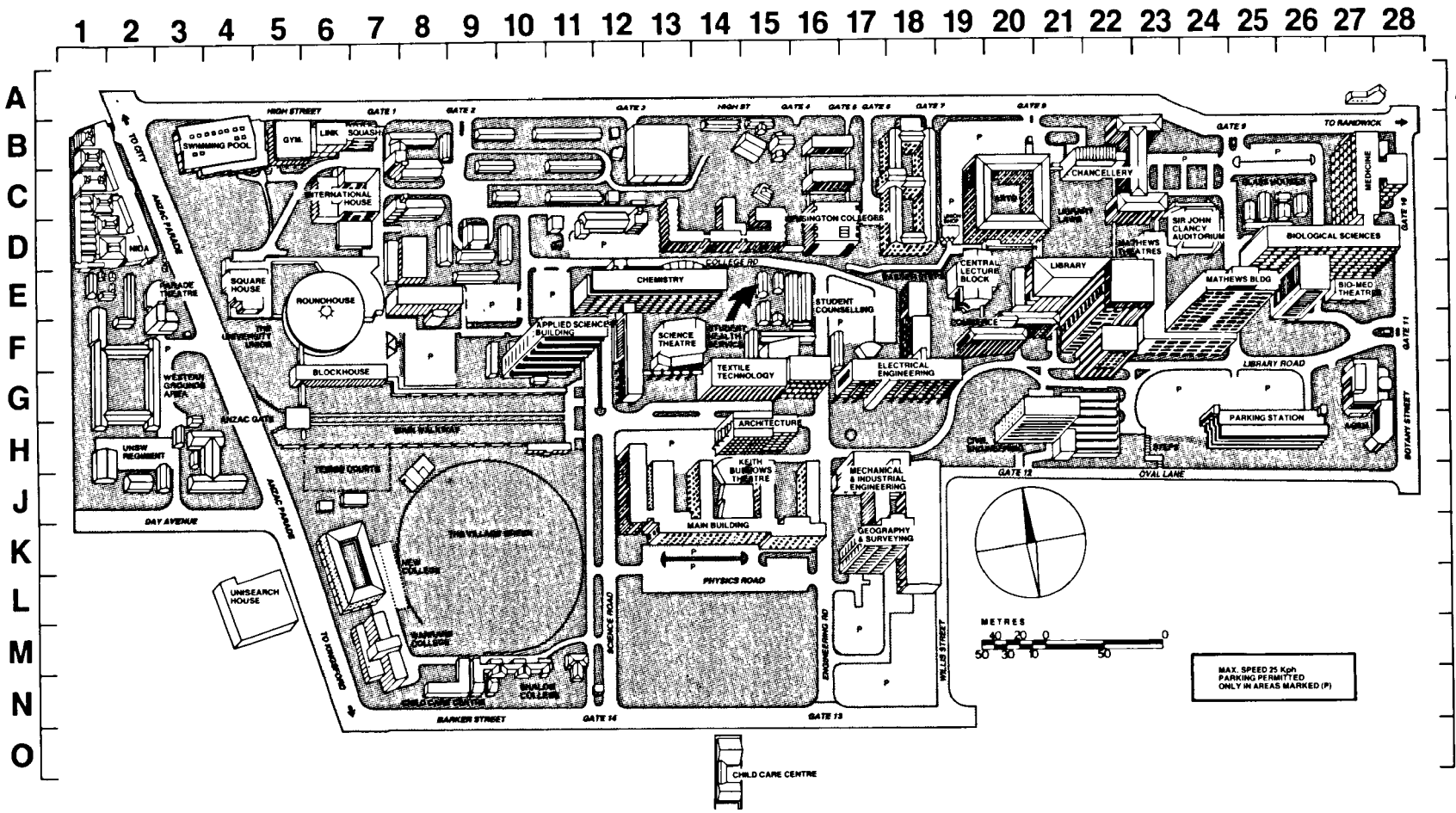
Biomedical Theatres **E27**
Central Lecture Block **E19**
Classroom Block (Western Grounds) **H3**
Rex Vowels Theatre **F17**
Keith Burrows Theatre **J14**
Main Building (Physics) Theatrette **K14**
Mathews Theatres **D23**
Parade Theatre **E3**
Science Theatre **F13**
Sir John Clancy Auditorium **C24**

Buildings

Affiliated Residential Colleges
New (Anglican) **L6**
Shalom (Jewish) **N9**
Warrane **M7**
Applied Science **F10**
Architecture **H14**
Arts (Morven Brown) **C20**
Banks **F22**
Barker Street Gatehouse **N11**
Basser College **C18**
Biological Sciences **D26**
Central Store **B13**
Chancellery **C22**
Chemistry
Dalton **F12**
Robert Heffron **E12**
Civil Engineering **H20**
Commerce and Economics (John Goodsell) **F20**
Dalton (Chemistry) **F12**
Electrical Engineering **G17**
Geography and Surveying **K17**
Goldstein College **D16**
Golf House **A27**
Gymnasium **B5**
House at Pooh Corner **N8**
International House **C6**
Io Myers Studio **D9**
John Goodsell (Commerce and Economics) **F20**
Kanga's House **O14**
Kensington Colleges **C17** (Office)
Basser **C18**
Goldstein **D16**
Philip Baxter **D14**
Link **B6**
Maintenance Workshop **B13**
Materials Science and Engineering **E8**
Mathews **F23**
Mechanical and Industrial Engineering **J17**
Medicine (Administration) **B27**
Menzies Library **E21**
Morven Brown (Arts) **C20**
New College (Anglican) **L6**
Newton **J12**
NIDA **D2**
Parking Station **H25**
Philip Baxter College **D14**
Robert Heffron (Chemistry) **E12**
Sam Cracknell Pavilion **H8**
Shalom College (Jewish) **N9**
Sir Robert Webster (Textile Technology) **G14**
Squash Courts **B7**
Swimming Pool **B4**
Unisearch House **L5**
University Regiment **J2**
University Union (Roundhouse) – Stage I **E6**
University Union (Blockhouse) – Stage II **G6**
University Union (Squarehouse) – Stage III **E4**
Wallace Wurth School of Medicine **C27**
Warrane College **M7**

General

Academic Staff Office **C22**
Accounting **F20**
Admissions **C22**
Adviser for Prospective Students **F15**
Anatomy **C27**
Applied Economic Research **G14**
Applied Geology **F10**
Applied Science (Faculty Office) **F10**
Architecture (including Faculty Office) **H14**
Arts (Faculty Office) **C20**
Audio Visual Unit **F20**
Australian Graduate School of Management **G27**
Banking and Finance **F20**
Biochemistry **D26**
Biological and Behavioural Sciences (Faculty Office) **D26**
Biomedical Engineering **A28**
Biomedical Library **F23**
Biotechnology **D26**
Bookshop **G17**
Building **H14**
Careers and Employment **F15**
Cashier's Office **C22**
Chaplains **E15**
Chemical Engineering and Industrial Chemistry **F10**
Chemistry **E12**
Child Care Centres **N8, O14**
Civil Engineering **H20**
Commerce and Economics (Faculty Office) **F20**
Community Medicine **D26**
Computing Services Department **F21, D26**
Continuing Education Support Unit **F23**
Counselling and Careers Service **F15**
Economics **F20**
Education **G2**
Education Testing Centre **E15**
Electrical Engineering and Computer Science **G17**
Energy Research, Development and Information Centre **F10**
Engineering (Faculty Office) **K17**
English **C20**
Ethics Committees Secretariat **B8**
Examinations **C22**
Fees Office **C22**
Food Science and Technology **F10**
French **C20**
General Staff Office **C22**
Geography **K17**
German Studies **C20**
Graduate Office and Alumni Centre **E4**
Graduate School of the Built Environment **H14**
Groundwater Management and Hydrogeology **F10**
Health Administration **C22**
History **C20**
Industrial Arts **H14**
Industrial Relations and Organizational Behaviour **F20**
Information Systems **F20**
Kanga's House **O14**
Kindergarten (House at Pooh Corner) **N8**
Landscape Architecture **K15**
Law (Faculty Office) **F21**
Law Library **F21**
Legal Studies and Taxation **F20**
Liberal and General Studies **C20**
Librarianship **F23**
Library **E21**
Lost Property **C22**
Marine Science **D26**
Marketing **F20**
Materials Science and Engineering **E8**
Mathematics **F23**
Mechanical and Industrial Engineering **J17**
Medical Education **C27**
Medicine (Faculty Office) **B27**
Microbiology **D26**
Mineral Processing and Extractive Metallurgy **E8**
Mining Engineering **K15**
Music **B11**
National Institute of Dramatic Art **D2**
Off-campus Housing **C22**
Optometry **J12**
Pathology **C27**
Patrol and Cleaning Services **C22**
Petroleum Engineering **D12**
Philosophy **C20**
Physics **K15**
Physiology and Pharmacology **C27**
Political Science **C20**
Printing Unit **C22**
Psychology **F23**
Public Affairs Unit **C22**
Publications Section **C22**
Remote Sensing **K17**
Russian Studies **C20**
Safety Science **J17**
Science and Mathematics Course Office **D26**
Science and Technology Studies **C20**
Social Work **G2**
Sociology **C20**
Spanish and Latin American Studies **C20**
Sport and Recreation Centre **B6**
Student Health **E15**
Student Records **C22**
Students' Union **E4** and **C21**
Surveying **K17**
Tertiary Education Research Centre **E15**
Textile Technology **G14**
Theatre Studies **B10**
Town Planning **K15**
Union Shop (Upper Campus) **D19**
University Archives **E21**
University Press **A28**
University Union (Blockhouse) **G6**
Waste Management **H20**
WHO Regional Training Centre **C27**
Wool and Animal Science **B8**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A B C D E F G H J K L M N O
HIGH STREET
GATE 1
GATE 2
GATE 3
GATE 4
GATE 5
GATE 6
GATE 7
GATE 8
GATE 9
TO RANDWICK
TO CITY
ANZAC PARADE
SWIMMING POOL
GYM
LINK
SQUASH
INTERNATIONAL HOUSE
NIDA
SQUARE HOUSE
ROUNDHOUSE
PARADE THEATRE
THE UNIVERSITY UNION
WESTERN GROUNDS AREA
BLOCKHOUSE
ANZAC GATE
UNSW REGIMENT
DAY AVENUE
TENNIS COURTS
UNISEARCH HOUSE
TO KINGSFORD
THE VILLAGE GREEN
NEW COLLEGE
BARKER COLLEGE
CHILD CARE CENTRE
BARKER STREET
GATE 14
SCIENCE ROAD
CHEMISTRY
COLLEGE RD
APPLIED SCIENCE BUILDING
SCIENCE THEATRE
STUDENT HEALTH SERVICE
STUDENT COUNSELLING
TEXTILE TECHNOLOGY
ELECTRICAL ENGINEERING
ARCHITECTURE
KEITH BURROWS THEATRE
MAIN BUILDING
PHYSICS ROAD
MECHANICAL & INDUSTRIAL ENGINEERING
GEOGRAPHY & SURVEYING
ENGINEERING RD
WILLIS STREET
GATE 13
KENSINGTON COLLEGES
CHANCELLERY
MATHEWS THEATRES
SIR JOHN CLANCY AUDITORIUM
BIOLOGICAL SCIENCES
MEDICINE
GATE 10
CENTRAL LECTURE BLOCK
LIBRARY
MATHEWS BLDG
BIO-MED THEATRE
GATE 11
LIBRARY ROAD
PARKING STATION
STEPS
GATE 12
OVAL LANE
BOTANY STREET
METRES
40 30 20 10 0
50 30 10 50
MAX. SPEED 25 Kph
PARKING PERMITTED
ONLY IN AREAS MARKED (P)
CHILD CARE CENTRE

This Handbook has been specifically designed as a source of reference for you and will prove useful for consultation throughout the year.

For fuller details about the University – its organization, staff membership, description of disciplines, scholarships, prizes, and so on, you should consult the Calendar.

The Calendar and Handbooks also contain a summary list of higher degrees as well as the conditions for their award applicable to each volume.

For detailed information about courses, subjects and requirements of a particular faculty you should consult the relevant Faculty Handbook.

Separate Handbooks are published for the Faculties of Applied Science, Architecture, Arts, Commerce and Economics, Engineering, Law, Medicine, Professional Studies, Science (including Biological and Behavioural Sciences and the Board of Studies in Science and Mathematics), and the Australian Graduate School of Management (AGSM).

The Calendar and Handbooks, which vary in cost, are available from the Cashier's Office.