Chemical and Biomolecular Engineering

Department of Chemical and Biomolecular Engineering

Following the introduction of the chemical engineering degree in 1952, graduates from the Department of Chemical and Biomolecular Engineering have been readily accepted into industry, both in Australia and worldwide. Graduate Chemical and Biomolecular Engineering starting salaries are higher than for any other engineering discipline.

Chemical and Biomolecular Engineering is concerned with developing and analysing process systems, which are strongly dependent upon chemistry and involve physical changes. Our graduates find employment in the biochemical industry, the food industry, the minerals industry, the metallurgical industry and the pharmaceutical industry, as well as in the traditional chemical industry. Chemical and Biomolecular Engineers are well suited for environment-related engineering positions given their strong background in process systems and in chemical and biological processes in particular.

Chemistry and mathematics are taken through the first two years of the course. In Semester 2 of first year, a major chemical and biomolecular engineering subject is taken. Students may also take a Semester 1 unit, Introduction to Chemical Engineering, which provides a comprehensive introduction to the discipline, its role in the modern world and the challenges that lie ahead.

In second year, students are introduced to further specific chemical engineering subjects that build on the first-year core subject. These in turn are built on in subsequent years and culminate in final year design and research projects, which bring together all that the student has learnt in the preceding years. Provision is also made for students to broaden their education by taking a number of elective subjects during their course.

Department of Chemical and Biomolecular Engineering: undergraduate degree structures

Bachelor of Engineering (Chemical) (BE)

The recommended or standard course structures are listed below. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied. Where the courses include elective subjects these should be chosen so that timetable clashes are avoided. In particular, students in combined degrees should plan their courses so that the subjects chosen in the other faculty do not clash with those recommended for the engineering component.

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.5)*	12.5
610-141	Chemistry A *(p.2)*	12.5
or		
610-121	Chemistry A (Advanced Studies Program) *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
Elective		12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
610-142	Chemistry B *(p.2)*	12.5
or		
610-122	Chemistry B (Advanced Studies Program) *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
Elective		12.5

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
411-202	Process Engineering 1 *(p.5)*	12.5
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
431-202	Engineering Analysis B *(p.12)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5

Third year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
411-339	Process Engineering 2 *(p.7)*	12.5
411-391	Bionanoengineering *(p.8)*	12.5

Fourth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
411-445	Process Engineering 3 *(p.9)*	12.5
Semester 2		
411-446	Research Project *(p.9)*	18.75
411-447	Design Project *(p.9)*	18.75
411-448	Biochemical/Environmental Engineering 2 *(p.9)*	12.5
or		
411-449	Materials and Recycling *(p.10)*	12.5

Bachelor of Engineering (Chemical and Biomolecular) (BE)

The recommended or standard course structure for the first three years only of the Bachelor of Engineering (Chemical and Biomolecular) is listed below. The structure for fourth year will be in the 2008 *Handbook*. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware, however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied.

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.5)*	12.5
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
650-141	Biology of Cells and Organisms *(p.1)*	12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
610-142	Chemistry B *(p.2)*	12.5
or		
610-122	Chemistry B (Advanced Studies Program) *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
650-142	Genetics & The Evolution of Life *(p.1)*	12.5

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
411-254	Biomolecular Process Principles *(p.6)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
431-202	Engineering Analysis B *(p.12)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
411-255	Metabolic Engineering *(p.6)*	12.5

Third year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5

Third year		Points
411-343	Chemical Engineering Management *(p.7)*	12.5
411-392	Fermentation Process Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
411-339	Process Engineering 2 *(p.7)*	12.5
411-391	Bionanoengineering *(p.8)*	12.5

Bachelor of Engineering (Engineering Management) (Chemical)

The recommended or standard course structure for the first three years only of the Bachelor of Engineering (Engineering Management) (Chemical) is listed below. The fourth year structure will be in the 2008 *Handbook*. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware, however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied.

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.5)*	12.5
610-141	Chemistry A *(p.2)*	12.5
or		
610-121	Chemistry A (Advanced Studies Program) *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
325-101	Managing People and Organisations *(p.1)*	12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
610-142	Chemistry B *(p.2)*	12.5
or		
610-122	Chemistry B (Advanced Studies Program) *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
Commerce subject as required		12.5

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
421-258	Engineering Business Management *(p.10)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
431-202	Engineering Analysis B *(p.12)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5

Third year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
411-391	Bionanoengineering *(p.8)*	12.5
Commerce subject as required		12.5

Bachelor of Arts/Bachelor of Engineering (BA/BE)

The recommended or standard course structures are listed below. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied. Where the courses include elective subjects, these should be chosen so that timetable clashes are avoided. In particular, students in combined degrees should plan their courses so that the subjects chosen in the other faculty do not clash with those recommended for the engineering component.

Students who intend to overlap second and later year subjects should consult with a course adviser to ensure all core engineering requirements are met.

Note: Chemical Engineering subjects: 411-202 Process Engineering 1, 411-391 Bionanoengineering, 411-339 Process Engineering 2, 411-445 Process Engineering 3, 411-448 Biochemical/Environmental Engineering 2, 411-449 Materials and Recycling are not taken by students enrolled in BE combined with Arts, Commerce or Law.

First year		Points
Semester 1		
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
Arts subjects as required		25
Semester 2		
610-142	Chemistry B *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
Arts subjects as required		25

Second year		Points
Semester 1		
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
Arts subjects as required		25
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
431-202	Engineering Analysis B *(p.12)*	12.5
Arts subjects as required		25

Third year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
Arts subjects as required		37.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
Arts subject as required		12.5

Fourth year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
Arts subjects as required		25

Fifth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
Arts subject as required		12.5
Semester 2		
411-446	Research Project *(p.9)*	18.75
411-447	Design Project *(p.9)*	18.75
Arts subject as required		12.5

Bachelor of Engineering/Bachelor of Commerce (BE/BCom)

The recommended or standard course structures are listed below. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied. Where the courses include elective subjects these should be chosen so that timetable clashes are avoided. In particular, students in combined degrees should plan their courses so that the subjects chosen in the other faculty do not clash with those recommended for the engineering component.

Students who intend to overlap second- and later-year subjects should consult with a course adviser to ensure all core engineering requirements are met.

Note: Chemical Engineering subjects: 411-202 Process Engineering 1, 411-391 Bionanoengineering, 411-339 Process Engineering 2, 411-445 Process Engineering 3, 411-448 Biochemical/Environmental Engineering 2, 411-449 Materials and Recycling are not taken by students enrolled in BE combined with Arts, Commerce and Law.

First year		Points
Semester 1		
316-102	Introductory Microeconomics *(p.1)*	12.5
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
Commerce subject as required		12.5
Semester 2		
316-101	Introductory Macroeconomics *(p.1)*	12.5
316-130	Quantitative Methods 1 *(p.1)*	12.5
610-142	Chemistry B *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5

Second year		Points
Semester 1		
316-205	Introductory Econometrics *(p.1)*	12.5
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
Commerce subject as required		12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
431-202	Engineering Analysis B *(p.12)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
325-201	Organisational Behaviour *(p.1)*	12.5

Third year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
Commerce subjects as required		37.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
Commerce subjects as required		25

Fourth year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
Commerce subjects as required		25

Fifth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
Commerce subject as required		12.5
Semester 2		
411-446	Research Project *(p.9)*	18.75
411-447	Design Project *(p.9)*	18.75
Commerce subject as required		12.5

Bachelor of Laws/Bachelor of Engineering (Chemical) (LLB/BE)

The recommended or standard course structures are listed below. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied. Where the courses include elective subjects these should be chosen so that timetable clashes are avoided. In particular, students in combined degrees should plan their courses so that the subjects chosen in the other faculty do not clash with those recommended for the engineering component.

Students taking combined degree courses and who intend to overlap second- and later-year subjects, should consult with a course adviser to ensure all core engineering requirements are met. Students must ensure they complete 300 points of law subjects overall, including the core subjects listed below and at least 12.5 points of legal theory.

Note: Chemical Engineering subjects: 411-202 Processing Engineering 1, 411-391 Bionanoengineering, 411-339 Process Engineering 2, 411-445 Process Engineering 3, 411-448 Biochemical/Environmental Engineering 2, 411-449 Materials and Recycling are not taken by students enrolled in BE combined with Arts, Commerce and Law.

First year		Points
Semester 1		
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
730-112	Principles of Public Law *(p.1)*	12.5
730-111	Legal Method and Reasoning *(p.1)*	12.5
Semester 2		
610-142	Chemistry B *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
730-114	Torts *(p.1)*	12.5
730-113	Dispute Resolution *(p.1)*	12.5

Second year		Points
Semester 1		
431-201	Engineering Analysis A *(p.11)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
730-213	Obligations *(p.2)*	12.5
730-212	Legal Theory *(p.2)*	12.5
Semester 2		
431-202	Engineering Analysis B *(p.12)*	12.5
411-102	Chemical Process Analysis *(p.5)*	12.5
730-215	Contracts *(p.2)*	12.5
730-214	Constitutional Law *(p.2)*	12.5

Third year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
730-365	Administrative Law *(p.3)*	12.5
730-366	Property *(p.3)*	12.5
Law subject as required		12.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
730-367	Trusts *(p.3)*	12.5
730-368	Criminal Law and Procedure *(p.4)*	12.5

Fourth year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
730-453	Remedies *(p.4)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5

Fifth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
730-456	Corporations Law *(p.9)*	12.5
Semester 2		
411-446	Research Project *(p.9)*	18.75
411-447	Design Project *(p.9)*	18.75
730-454	Legal Ethics *(p.4)*	12.5

Sixth year	Points
Law subjects as required to ensure 300 points of law subjects completed	100

Bachelor of Engineering/Bachelor of Science (BE/BSc)

The following programs are samples only. The first-year program should fulfil the prerequisites for both BE and BSc studies. For example, those students intending to pursue a major in life sciences should complete the 100-level subjects specified in the life sciences package *First-year packages (p.10)*.

Usually the 200-level BE requirements are taken over two years, in the second and third year of the combined program. The order in which the units are taken may be altered to accommodate timetable arrangements.

The recommended or standard course structures are listed below. When setting the timetable every effort will be made to avoid clashes between the times of classes associated with these sets of subjects. Students should be aware however, that if it proves to be impossible to achieve a timetable without clashes in these sets of subjects, the Faculty reserves the right to modify course structures in order to eliminate the conflicts. Students will be advised during the enrolment period of the semester if the recommended courses need to be varied. Where the courses include elective subjects these should be chosen so that timetable clashes are avoided. In particular, students in combined degrees should plan their courses so that the subjects chosen in the other faculty do not clash with those recommended for the engineering component.

Students taking combined degree courses and who intend to overlap second- and later-year subjects, should consult with a course adviser to ensure all core engineering requirements are met.

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.5)*[1]	12.5
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
Science subject as required		12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
610-142	Chemistry B *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
Science subject as required		12.5

1. Elective or science subject.

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
620-142	Mathematics B *(p.5)*	12.5
or		
620-122	Mathematics B (Advanced) *(p.4)*	12.5
Science subject as required		12.5
Semester 2		
620-232	Mathematical Methods *(p.7)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
Science subjects as required		25

Note: Students intending to take Faculty of Engineering mathematics subjects at the 200-level instead of Faculty of Science mathematics subjects must seek course advice from the Department of Chemical and Biomolecular Engineering.

Third year		Points
Semester 1		
620-231	Vector Analysis *(p.7)*	12.5
Science subjects as required		37.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
Science subjects as required		25

Fourth year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-343	Chemical Engineering Management *(p.7)*	12.5
411-393	Bioprocess Engineering *(p.8)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
411-339	Process Engineering 2 *(p.7)*	12.5
411-391	Bionanoengineering *(p.8)*	12.5

Fifth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
411-445	Process Engineering 3 *(p.9)*	12.5
Semester 2		
411-446	Research Project *(p.9)*	18.75
411-447	Design Project *(p.9)*	18.75
411-448	Biochemical/Environmental Engineering 2 *(p.9)*	12.5
or		
411-449	Materials and Recycling *(p.10)*	12.5

Biochemical Engineering stream

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.5)*	12.5
650-141	Biology of Cells and Organisms *(p.1)*	12.5
610-141	Chemistry A *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
Semester 2		
411-102	Chemical Process Analysis *(p.5)*	12.5
650-142	Genetics & The Evolution of Life *(p.1)*	12.5
610-142	Chemistry B *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.5)*	12.5
620-142	Mathematics B *(p.5)*	12.5
or		
620-122	Mathematics B (Advanced) *(p.4)*	12.5
521-211	Biochemistry & Molecular Biology Part A *(p.2)*	12.5
526-201	Principles of Microbiology & Immunology *(p.1)*	12.5
Semester 2		
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
620-232	Mathematical Methods *(p.7)*	12.5
521-212	Biochemistry & Molecular Biology Part B *(p.2)*	12.5
526-221	Practical Microbiology *(p.2)*	12.5

Third year		Points
Semester 1		
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
620-231	Vector Analysis *(p.7)*	12.5
526-301	Microbial Cells and Genomes *(p.2)*	12.5
526-321	Molecular Microbiology Techniques *(p.3)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.5)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.6)*	12.5
526-302	Microbial Biotechnology *(p.2)*	12.5
526-327	Projects: Microbiology *(p.4)*	12.5

Fourth year		Points
Semester 1		
411-303	Reactor Engineering *(p.6)*	12.5
411-330	Biochemical Engineering Mini-Project *(p.6)*	6.25
411-331	Heat and Mass Transport Processes 1 *(p.6)*	12.5
411-335	Biochemical/Environmental Engineering 1B *(p.7)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.7)*	12.5
411-337	Practical and Computer Laboratory *(p.7)*	12.5
411-339	Process Engineering 2 *(p.7)*	12.5
411-391	Bionanoengineering *(p.8)*	12.5

Fifth year		Points
Semester 1		
411-432	Particle Mechanics and Processing *(p.8)*	12.5
411-441	Heat and Mass Transport Processes 2 *(p.8)*	12.5
411-442	Process Equipment Design *(p.9)*	12.5
411-445	Process Engineering 3 *(p.9)*	12.5
Semester 2		
411-447	Design Project *(p.9)*	18.75

Fifth year		Points
411-448	Biochemical/Environmental Engineering 2 *(p.9)*	12.5
411-450	Biochemical Engineering Research Project *(p.10)*	18.75

Subject descriptions

316-101 Introductory Macroeconomics

See full subject details on page 1.

316-102 Introductory Microeconomics

See full subject details on page 1.

316-130 Quantitative Methods 1

See full subject details on page 1.

316-205 Introductory Econometrics

See full subject details on page 1.

325-101 Managing People and Organisations

See full subject details on page 1.

411-101 Introduction to Chemical Engineering

Credit points: 12.5

Coordinator: Dr R Dagastine

Contact: A total of 48 hours *(Semester 1)*.

Description: The objective of this unit is to provide a comprehensive introduction to the discipline of chemical engineering, its role in the modern world, the challenges that lie ahead and the tools available to the chemical engineer.

This subject comprises lectures, tutorial sessions and plant visits covering the following areas: the origins of chemical engineering and its historical development; basic chemical engineering concepts and principles and their role in the development of integrated chemical processes; the traditional chemical engineering industries: oil refining, petrochemicals, heavy chemicals; the expanding involvement of chemical engineers in the biochemical, food, mineral, electronics and environmental fields; and factors influencing the design and operation of process plants: safety, risk and hazards; costs and profitability; environmental considerations; and community interactions.

Instruction will also be provided in basic computing skills, effective communication and information retrieval.

Assessment: One written 3-hour end-of-semester examination (40%); two 4000-word plant visit reports (30% each) due two weeks after the corresponding plant visits. An overall mark of 50% and a mark of 30% or more in each component of assessment are needed to pass the subject.

411-102 Chemical Process Analysis

Credit points: 12.5

Coordinator: Assoc Prof D Shallcross

Contact: Thirty-two hours of lectures, 11 hours of tutorials and 5 hours of laboratories and workshops *(Semester 2, repeat Summer)*.

Description: This subject is an introduction to chemical engineering flowsheet calculations, including material and energy balances, unit systems, and real gas and vapour behaviour predictions. Topics include systems of units and unit conversion; concept of conservation of mass is developed as the basis for determining mass flows in chemical processing systems; material balances around single process units, and groups of units, involving simple systems and recycle streams, and non-reacting and reacting systems; component, elemental balances; gases, liquids and vapours, ideal and real gas behaviour, use of compressibility factor and generalised compressibility factor charts, vapour pressure estimation, humidity; and concept of conservation of energy is developed as the basis for determining energy flows in and around chemical processing systems, evaluation of enthalpy changes with and without phase change, simplified energy balances for batch, steady-state and adiabatic-systems, estimation of heats of reaction, combustion, solution and dilution, energy balances in reacting systems, simultaneous material and energy-balances.

Assessment: One written 1.5 hour mid-semester examination (20%), one written assisgment of no more than 1000 words (10%), due week 4 summer semester, week 9 semester 2; and one written 2-hour end-of-semester examination (70%).

411-201 Introduction to Transport Processes

Credit points: 12.5

Coordinator: Assoc Prof N Pamment

Prerequisites: 620-141 Mathematics A and 620-143 Applied Mathematics or equivalent

Contact: Forty-eight hours *(Semester 1, repeat Summer)*.

Description: The objectives of this subject are to understand the fundamental concepts of momentum, heat and mass transfer and to be able to apply this knowledge to the solution of problems in process engineering.

Momentum transport: Newton's law of viscosity, viscosity of gases and liquids, shear stress and momentum flux, shell momentum balances in laminar flow; Reynolds number; and boundary layer theory.

Heat Transport: Conduction; Fourier's law, thermal conductivities of gases, liquids and solids; steady state conduction through planar and cylindrical resistances; resistances in series; conduction with a heat source; shell thermal energy balances; calculation of temperature profiles in conductors; convection, concept of thermal boundary layer, definition and evaluation of heat transfer coefficients; Nusselt and Prandtl numbers; combined conduction and convection; overall heat transfer coefficients; heat exchangers, cocurrent and counter-current flow, energy balance and rate equations for simple double pipe heat exchangers.

Mass Transport: Molecular diffusion, eddy diffusion, bulk flow; definitions of concentrations, average velocities and fluxes; Fick's first law; diffusivities of gases and liquids; application to binary mixtures; equimolal counterdiffusion and diffusion through a stationary component; and two-phase mass transfer; concept of mass transfer boundary layer, Schmidt number, individual film and overall mass transfer coefficients.

Assessment: One written 3-hour end-of-semester examination (100%).

411-202 Process Engineering 1

Credit points: 12.5

Coordinator: Dr G Qiao

Prerequisites: 411-102 Chemical Process Analysis and 411-201 Introduction to Transport Processes are either prerequisites or corequisites.

Contact: Twelve hours of lectures and 36 hours of problem-solving classes *(Semester 1)*.

Description: The objectives of this subject are to introduce the design of chemical processes including the different types of flowsheets used to represent process plants, measurements and instrumentation used in process plants; and to provide training in process optimisation and solution of ill-defined process problems.

This subject will comprise lectures and problem-solving classes, covering the following areas: methods of design of chemical processes; types of flowsheets used to represent chemical process plants and their generation using HYSYS or equivalent software; process control methods; and types of measurement and instrumentation used for measurement of temperature, pressure, flow and level in the chemical process industries. Assignments will draw on material from other chemical engineering subjects and utilise computer software packages as required. Typical topics include material and energy balance calculations, optimal solution of process equations and simple economic analysis of a process plant.

Assessment: Ten assignments (eight worth 8% each and two worth 18% each) spread across the semester. Nine assignments involve written reports of up to 1500 words, mostly prepared during weekly problem classes; one assignment involves a 5-minute oral multimedia presentation delivered during the second half of the semester.

411-203 Fluid Mechanics

Credit points: 12.5

Coordinator: Assoc Prof M Davidson

Corequisites: 431-202 Engineering Analysis B or 620-232 Mathematical Methods

Contact: Thirty-two hours of lectures, 12 hours of tutorials and 4 hours of laboratory work *(Semester 2)*.

Description: The content of this subject is as follows: manometry; derivation of the continuity equation, mechanical energy balance; friction losses in a straight pipe, fanning friction factor, treatment of roughness, valves and fittings; simple network problems; principles of open channel flow; compressible flow - thermodynamic preliminaries, propagation of a pressure wave, isothermal and adiabatic flow equations in a pipe, choked flow; pumps - pump characteristics, centrifugal pumps, derivation of theoretical head; head losses leading to the actual pump head curve, calculating system head, determining the operating point of a pumping system, throttling for flow control, cavitation and NPSH, introduction to positive displacement pumps; stirred tanks - radial, axial and tangential flow; types of agitators, vortex elimination, the standard tank configuration, power number and power curve, dynamic and geometric similarity in scale-up; multi-dimensional fluid flow - Newtonian and non-Newtonian fluids, momentum flux, development of multi-dimensional equations of continuity and for momentum transfer, application to tube flow, Couette flow, Stokes flow etc., solutions for creeping flow, turbulence, universal velocity profile.

Assessment: One written 3-hour end-of-semester examination (90%); two laboratory reports (10%) of up to 2000 words or 3-5 pages each, not including

diagrams, graphs and raw data, each due two weeks after the corresponding laboratory session.

411-204 Chemical Engineering Thermodynamics

Credit points: 12.5

Coordinator: Dr L Yeow

Prerequisites: 610-141 and 610-142 Chemistry and 100-level Mathematics.

Contact: Forty-eight hours *(Semester 2).*

Description: Review of the First Law and the Second Law of Thermodynamics, definition of terms associated with these laws, primary thermodynamic functions (P, V, T, U and S) and the Maxwell relations, auxiliary thermodynamic functions (H, G and A), P-V-T diagrams of pure substances, ideal gas and departure from ideality, equations of state. Calculations of thermodynamic properties and thermodynamic charts, application of thermodynamics to flow processes, vapour and gas power cycles, compressors and turbines, refrigeration and gas liquefaction.

Partial molar quantities, chemical potential and activity coefficient. Gas mixtures and liquid mixtures, dilute solution. Solubility of a gas in a liquid and a solid in a liquid. The phase rule, phase equilibria in one component systems, two component systems.

Chemical reaction equilibria, stoichiometric number, reaction coordinate. Effect of temperature and pressures on equilibrium constant, evaluation of equilibrium constant, relationship between equilibrium constant and composition. Graphical representation of standard free energy change. Ellingham diagrams. The oxides of carbon. Non-standard conditions. Graphical representation of heterogeneous equilibria. Metal-sulphur-oxygen systems. Processing alternatives.

Assessment: One written 3-hour end-of-semester examination (100%).

411-217 Chemical Engineering Research Elective 2

Credit points: 12.5

Coordinator: Prof P J Scales

Prerequisites: Usually core chemical engineering 100-level subjects. Students must obtain permission to undertake this subject prior to enrolling, through a member of the department who is willing to supervise them.

Contact: Forty-eight hours by arrangement with the supervisor *(Semester 1, repeat 2).*

Description: The content of this subject is dependent on the interests and expertise of the student. The subject functions to provide students with the opportunity to do supervised research on a topic not normally treated in the undergraduate curriculum. The student should gain skills in independent research and acquire the ability to apply engineering and scientific analysis to a piece of scientific work of particular personal and intellectual interest.

Assessment: One written report of up to 5000 words (not including appendices, diagrams, tables, computations and computer output) due at the end of semester; to pass the subject, the project work on which the report is based must be of a satisfactory standard.

411-254 Biomolecular Process Principles

Credit points: 12.5

Coordinator: Mr G Martin

Prerequisites: 610-141 Chemistry A; 610-142 Chemistry B; 650-141 Biology of Cells and Organisms.

Contact: 34 hours of lectures, 6 hours of tutorials and 10 hours of practical work *(Semester 1).*

Description: Definition and scope of biomolecular and bioprocess engineering. Survey of industrial applications. The role of the biomolecular engineer. Anatomy of some typical industrial processes: brewing, vaccine production, biological C, N and P removal, artificial skin productin, self-assembled biosensors. Role of microbial, plant and animal cells in bioprocessing. Microorganisms, structure and function. Survey of relevant microbial groups. Microbiological methods. Microbial applications in process engineering. Bioproducts from plant cells. Structure and function of plant cells. Plant tissue culture methods. Human and animal cells and culture methods. Application to tissue engineering. Structure, function and properties of biological marcromolecules. Carbohydrates. Proteins. Lipids. Nucleic acids. Stability and physical properties of biomacromolecules.

Practical work (microbiology laboratory)

Assessment: One written 3-hour end-of-semester examination (90%); practical work assignments not exceeding a combined total of 1000 words (10%).

411-255 Metabolic Engineering

Credit points: 12.5

Coordinator: Dr S Gras

Prerequisites: 411-254 Biomolecular Process Principles.

Contact: 34 hours of lectures, 6 hours of tutorials and 8 hours of practical work *(Semester 2).*

Description: Metabolism in microbial, plant and animal cells. Control of metabolism and its application to bioprocessing and bioproduct process development. Pathways of catabolism and anabolism in heterotrophs. Photosynthesis. Chemoautotrophs and their role in biological waste treatment. Genetic control of metabolism. Genetic manipulation by mutation and recombinant DNA techniques. Case studies in the development of bioprocesses employing recombinant microorganisms. Control at the enzyme level. Enzyme inhibition kinetics. Immobilised enzymes, mass transfer and kinetic effects. Protein and enzyme engineering. Metabolic engineering.

Practical work (enzyme kinetics)

Assessment: One written 3-hour end-of-semester examination (90%); practical work assignments not exceeding a combined total of 2000 words (10%).

411-303 Reactor Engineering

Credit points: 12.5

Coordinator: Dr G Qiao

Prerequisites: 610-141 and 610-142 Chemistry.

Semester: Semester 1

Description: Basic concepts, ideal reactors, interpreting batch reactor data - no volume change, batch reactor data - complex reactions, batch reactor data - variable volume and differential method. Ideal reactor performance - batch reactor, ideal reactor performance - mixed flow reactor, ideal reactor - plug flow reactor, ideal reactor - performance comparison. Multiple reactors - mexed and plug flow reactors of identical size, multiple reactors - reactors of varying sizes, recycle plug flow reactor. Temperature effects - non-adiabatic operation, temperature effects - adiabatic operation, temperature instability. Non-ideal flow in reactors: residence time distributions, tracer tests, conversion in non-ideal reactors. Rate controlling mechanisms: film resistance control, chemical reaction control, surface and pore diffusion control, ash layer diffusion, shrinking core mechanisms, effectiveness factors and the Thiele modulus. Kinetic regimes for fluid-fluid and gas-fluid reactions.

Assessment: One written 3-hour end-of-semestser examination (80%); a written 2-hour mid-semester test or a reactor design assignment (20%). An overall mark of 50% and a mark of 40% or more in the end of semester examination are needed to pass the subject.

411-317 Chemical Engineering Research Elective 3

Credit points: 12.5

Coordinator: Prof P J Scales

Prerequisites: Usually core chemical engineering 200-level subjects. Students must obtain permission to undertake this subject prior to enrolling, through a member of the department who is willing to supervise them.

Contact: Forty-eight hours by arrangement with the supervisor *(Semester 1, repeat 2).*

Description: The content of this subject is dependent on the interests and expertise of the student. The subject functions to provide students with the opportunity to do supervised research on a topic not normally treated in the undergraduate curriculum. The student should gain skills in independent research and acquire the ability to apply engineering and scientific analysis to a piece of scientific work of particular personal and intellectual interest.

Assessment: One written report of up to 5000 words (not including appendices, diagrams, tables, computations and computer output) due at the end of semester; to pass the subject, the project work on which the report is based must be of a satisfactory standard.

411-330 Biochemical Engineering Mini-Project

Credit points: 6.25

Coordinator: Assoc Prof N B Pamment

Contact: Twenty-four hours *(Semester 1, repeat 2).*

Description: Students will undertake a short investigative project in biochemical engineering, either individually or as members of a team. The project may entail a critical literature review or, more usually, an experimental project with one of the department's research groups. Students undertaking the project will develop their investigative and research skills as well as their skills in report writing.

Assessment: One written report of up to 2000 words (not including appendices, diagrams, tables, computations and computer output) due at the end of semester; to pass the subject, the project work on which the report is based must be of a satisfactory standard.

411-331 Heat and Mass Transport Processes 1

Credit points: 12.5

Coordinator: Dr S Kentish

Prerequisites: 411-102 Chemical Process Analysis, 411-201 Introduction to Transport Processes, 411-203 Fluid Mechanics, 411-204 Chemical Engineering Thermodynamics and 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B), or equivalent, 610-211 Light, Matter and Chemical Change.

Contact: Forty-eight hours *(Semester 1).*

Description: Students successfully completing this subject will be able to apply the principles of heat transfer to convective heat transfer problems, heat exchanger and evaporator designs, and to analyse and design equilibrium stage and continuous contactor separation operations including simple distillation, gas absorption and liquid extraction.

Heat Transport Processes Convection: use of heat transfer correlations to predict coefficients; concept of an overall heat transfer coefficient, fouling factors; determination of the area required for a given heat duty. Use of simulation packages such as HYSYS and ASPEN. Free convection: discussion and application of Grashof Number and other dimensionless groups. Heat exchanger design. Basics of condensation and boiling. Evaporation: various evaporator types and their advantages and disadvantages (forced circulation, film types); multiple and single effects; backward and forward feed; boiling point elevation; mechanical recompression; evaporator energy balances.

Mass Transport Processes: Unsteady state mass transfer and Fick's Second Law; prediction of diffusivity; dimensional analysis and equations of change for mass transfer. Definition of separation processes, separating agents, separation factors, equilibrium and rate type processes, equilibrium stage, non-equilibrium performance. Equilibrium stage processes - Distillation: single-stage separations, equilibrium flash, differential distillation; multistage separations, operating lines, reflux; binary distillation, varying reflux ratio, minimum reflux, total reflux, optimum reflux, feed plate location, side streams, open steam; tray efficiency via overall and Murphree efficiencies. Use of simulation packages such as DISTIL- Gas absorption: basic mass transfer mechanism; material balances, co-current and countercurrent flow, limiting L/G ratio; multistage absorption and the absorption factor method; continuous contact, transfer units, height of a transfer unit, calculation of number of transfer units. Humidification and cooling tower height calculation.Liquid Extraction: applications of liquid extraction, liquid-liquid equilibria; single-stage extraction, choice of solvent/feed ratio; multistage cross-current extraction; continuous counter-current multistage extraction. Continuous contact operations.

Assessment: One written 3-hour end-of-semester examination (70%); a 90-minute written class test one third of the way through the semester (20%); and an assignment expected to take about 10 hours due two thirds of the way through the semester (10%). An overall mark of 50% and a mark of 40% or more in the end of semester examination are needed to pass the subject.

411-335 Biochemical/Environmental Engineering 1B

Credit points: 6.25

Coordinator: Assoc Prof N Pamment

Corequisites: 411-334 Biochemical/Environmental Engineering 1A or equivalent science subject

Contact: Twenty-four hours *(Semester 1).*

Description: Students successfully completing the course should have developed an understanding of the kinetics of enzyme and microbial processes and the factors affecting the design and operation of fermentation equipment.

Content: Enzymic processes. Michaelis-Menten approach. Kinetics of enzyme inhibition. Immobilised enzymes. Batch microbial growth and product formation. Continuous culture. Microbial growth kinetics. Application of Monod model to batch and chemostat culture. Kinetics of product formation. Maintenance energy and endogenous respiration. Design of fermentation processes. Medium formulation and inoculum preparation. Industrial sterilisation processes. Calculation of sterility level. HTST sterilisation. Design of continuous sterilisers. Air sterilisation. Vessel design for aseptic operation. Fermenter design configurations. Aeration of ermenters. Oxygen requirements of microorganisms. Mixing in fermenters. Biochemical separation processes.

Assessment: One written 2-hour end-of-semester examination (100%).

411-336 Process Dynamics and Control

Credit points: 12.5

Coordinator: Dr L Yeow

Prerequisites: 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B) or equivalent.

Contact: Forty-eight hours *(Semester 2).*

Description: Students successfully completing the subject should understand the factors influencing the dynamic response of chemical processes and be able to analyse and implement process control strategies.

Content: Process Dynamics: Examples of controlled and manipulated variables and control schemes in chemical plants. Time domain, Laplace and frequency domain analyses of process dynamics modelled by linear ordinary differential equations. Transfer functions, amplitude ratio and phase angle, Bode plots. Modelling of complex chemical plants by a series of first, second order and dead time processes. Process identification by step response and frequency response, pulse testing. Step response vector and dynamic matrix.

Process Control: Transfer function of PID controller, closed loop transfer function. Effects of varying proportional gain, derivative and integral times. Effects of measurement lag. Routh stability analysis, Bode stability criterion, gain and phase margins, Ziegler-Nichols tuning. Cascade control and improvements arising from cascade control. Dead time compensation and other and model-based process control. Feedforward compensation, steady-state and lead-lag feedforward. Interactions in multiple-input multiple-out processes, Bristol relative gain array, decoupling. Introduction to dynamic matrix control. Computer-based process control, sampling interval, Shannon sampling theorem and computer implementation of process control.

Assessment: One written 3-hour end-of-semester examination (100%).

411-337 Practical and Computer Laboratory

Credit points: 12.5

Coordinator: Dr V Tirtaatmadja

Prerequisites: 411-201 Introduction to Transport Processes, 411-203 Fluid Mechanics and 411-331 Heat and Mass Transport Processes 1, 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B or equivalent).

Contact: Thirty hours of practical work and 18 hours of lectures/tutorials *(Semester 2).*

Description: Students successfully completing the course should have acquired skills in the methods of experimental investigation, including the operation of a range of scientific apparatus and engineering equipment, as well as in the analysis of data and the reporting of findings. They will also have acquired basic skills in computer-aided design (CAD).

Content: Experimental work illustrating the principles of fluid mechanics, particle mechanics, heat and mass transfer, reaction kinetics, and process control and signal analysis. The use of computer-aided design packages such as *HYSYS* for flow sheet development, material and energy balance calculations, unit operations, engineering drawings, equipment design and process design and optimisation. Use of computer-based physical property data and estimation packages.

Assessment: 8 short reports/assignments (of up to 1000 words each) and 3 long reports (of up to 4000 words each, not including diagrams, graphs and raw data) (based on laboratory work) (85%) and 2 short reports (of up to 1500 words each) (based on computing work) (15%); submission dates are spread across the semester. Students must submit all assignments in order to pass the subject.

411-339 Process Engineering 2

Credit points: 12.5

Coordinator: Assoc Prof D Shallcross

Prerequisites: 411-102 Chemical Process Analysis, 411-201 Introduction to Transport Processes, 411-203 Fluid Mechanics, 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B) or equivalent.

Contact: Forty-eight hours comprising 12 hours of lectures and 36 hours of problem solving classes *(Semester 2).*

Description: Material taught in other chemical engineering subjects will be reinforced by a series of assignments in which ill-defined and open-ended engineering problems will be tackled. Students successfully completing the subject will have developed enhanced engineering problem-solving skills. They will also have developed an appreciation for the legal and social framework within which engineers must practise.

Content: Practice in the development and application of selection criteria for making appropriate engineering decisions. Creating and analysing processing systems which economically transform raw material, energy and know-how into useful products. Safety, sustainable development and ethics.

Assessment: Ten equally-weighted assignments spread across the semester. Each assignment involves a written report of up to 1000 words in length.

411-343 Chemical Engineering Management

Credit points: 12.5

Coordinator: Mr M Parkinson

Contact: Forty-eight hours *(Semester 1).*

Description: Objectives: Students successfully completing this unit should develop an appreciation of the management of safety, project development and the profitability analysis of projects, sustainable development, and other managerial issues affecting the engineer.

Content: Safety management including Hazard Analysis (Hazan) and Hazard and Operability (Hazop) studies. Project development including the stages of a project, how to carry out a feasibility study, estimation of capital and operat-

ing costs, profitability analysis of projects including comparison of alternative investment options, and simple accounting. Sustainable Development; professional ethics; the legal, environment and responsibilities of the engineer; management of innovation and intellectual property; project management and project planning networks; industrial relations; diverse management issues.

Assessment: An assignment not exceeding a total of 3000 words plus accompanying tables and calculations (20%) and a final examination of three hours (80%).

411-391 Bionanoengineering

Credit points: 12.5

Coordinator: Prof P Scales

Prerequisites: 411-203 Fluid Mechanics, 431-202 Engineering Analysis B or equivalent, 610-211 Light, Matter and Chemical Change

Contact: 34 hours lectures, 6 hours tutorials, 8 hours practical demonstrations *(Semester 2).*

Description: Nanotechnology and bionanotechnology, history and definition, fine particle fluids, coloidal dispersions and emulsions. The role of surfaces in processing and materials manufacture. Coagulation, electrokinetics, nano-particle dispersion and stability criterion. Inter-particle forces and parameters that influence flow and gelation properties. The role of molecular additives in controlling inter-particle forces and stability. Nano-particle characterisation using light scattering. Solution properties of polymers, macromolecules, self assembly surfactants, lipids, proteins and polysaccharides. The role of self assembly in the formation of structured nano and biomaterials. Cell assembly and molecular components. Nano-particle formation through precipitation. Surface layer structure, functionionalisation and biocompatibility of nano-particles for pharmaceutical, drug delivery biossay, biosensor and immunology applications. Safety and ethical issues in bionanotechnology.

Assessment: One written 3-hour end-of-semester examination (80%); one assignment of up to 4000 words (not including appendices and diagrams and tables) due in the second half of the semester (20%).

411-392 Fermentation Process Engineering

Note: Students may only gain credit for 411-392 Fermentation Process Engineering or 411-393 Bioprocess Engineering.

Credit points: 12.5

Coordinator: Prof P Scales

Prerequisites: 411-254 Biomolecular Process Principles and 411-255 Metabolic Engineering

Corequisites: 411-303 Reactor Engineering

Contact: Thirty-four hours of lectures, 6 hours of practice class assignments and 8 hours of practical work *(Semester 1).*

Description: Batch and continuous culture. Kinetics of microbial growth and product formation. Sterilisation and aseptic equipment design. Factors affecting the selection of media for industrial fermentations. Design of stirred-tank, airlift and other fermenters. Special requirements of plant and animal cell culture. Design for oxygen transfer and mixing. Materials selection. Fermenter scale-up. Fermentation process monitoring and control. Downstream separation technologies. Ethical, legal and regulatory issues in fermentation process engineering. Practice classes on the solution of open-ended problems in fermentation process design. Practical work (fermentations and downstream separation techniques).

The objectives are to acquaint students with procedures for the design and control of industrial scale fermentation processes, to provide them with experience in the solution of open-ended design problems in fermentation process engineering, and to allow them to acquire practical skills in the conduct of fermentations and associated downstream separation processes.

Assessment: An examination of three hours contributing 70% to the assessment, practice class assignments totalling not more than 2000 words contributing 20% to the assessment, and practical work reports totalling not more than 1000 words contributing 10% to the assessment.

411-393 Bioprocess Engineering

Note: Students may only gain credit for one of 411-393 Bioprocess Engineering or 411-392 Fermentation Process Engineering.

Credit points: 12.5

Coordinator: Assoc Prof N Pamment

Pre or Corequisites: 411-303 Reactor Engineering

Contact: Thirty-eight hours of lectures, 6 hours of tutorials and 4 hours of practical work *(Semester 1).*

Description: Structure and function of biological macromolecules; biochemical pathways; genetics and cellular control processes; cell structure and function; microbial diversity and survey of microbial groups methods for characterisation, cultivation and enumeration of microorganisms; and survey of applications in biochemical and environmental engineering.

Enzymic process. Michaelis-Menten approach. Kinetics of enzyme inhibition. Immobilised enzymes. Batch microbial growth and product formation. Continuous culture. Microbial growth kinetics. Application of Monod model to batch and chemostat culture. Kinetics of product formation. Maintenance energy and endogenous respiration. Design of fermentation processes. Medium formulation and inoculum preparation. Industrial sterilisation processes. Calculation of sterility level. HTST sterilisation. Design of continuous sterilisers. Air sterilisation. Vessel design for aseptic operation. Fermenter design configurations. Aeration of fermenters. Oxygen requirements of microorganisms. Mixing in fermenters. Biochemical separation processes.

Practical work (Microbiology laboratory).

The objectives are to introduce students to the biological and kinetic concepts underlying bioprocesses engineering and to acquaint them with procedures for the design and control of industrial scale fermentation and biological waste treatment processes.

Assessment: One three hour examination at the end of semester1 contributing 90% to the assessment and practical work assignments not exceeding a total of 1000 words contributing 10% to the assessment.

411-417 Chemical Engineering Research Elective 4

Credit points: 12.5

Coordinator: Prof P J Scales

Prerequisites: Usually core chemical engineering 300-level subjects. Students must obtain permission to undertake this subject prior to enrolling, through a member of the department who is willing to supervise them.

Contact: 48 hours by arrangement with the supervisor *(Semester 1, repeat 2).*

Description: The content of this subject is dependent on the interests and expertise of the student. The subject functions to provide students with the opportunity to do supervised research on a topic not normally treated in the undergraduate curriculum. The student should gain skills in independent research and acquire the ability to apply engineering and scientific analysis to a piece of scientific work of particular personal and intellectual interest.

Assessment: One written report of up to 7000 words (not including appendices, diagrams, tables, computations and computer output) due at the end of semester; to pass the subject, the project work on which the report is based must be of a satisfactory standard.

411-432 Particle Mechanics and Processing

Credit points: 12.5

Coordinator: Prof P J Scales

Prerequisites: 411-203 Fluid Mechanics and 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis) or equivalent.

Contact: Forty-eight hours *(Semester 1).*

Description: Upon completion of this unit, students will have an appreciation of the flow behaviour of particulate materials and the design of unit operations associated with particulate slurries in a range of unit operations common to the materials, food, water, pharmaceuticals and minerals processing industries. They will be familiar with the unit operations in comminution and particle liberation, particle separation, hopper flow, solid-liquid separation and fluidisation and flow through packed beds.

Content: Particle size and measurement of particle size, shape factors, differential and cumulative distributions, mean size, median size and surface area. Generalised description of separation and classification efficiency based on particle size and density, composition and magnetic susceptibility. Hydrocyclones, screens and data reconciliation for particulate separators, including the two product formula. Comminution, Bond work index, matrix description of size reduction and milling circuit simulation, comminution circuits and liberation of particles from composite particles. Flow properties of solids, design of bins and hoppers, mass and channel flow. Solid-liquid separation including flocculation processes, gravity sedimentation, clarification, thickening and pressure filtration. Motion of particles in fluids, fluidisation, minimum fluidisation velocity and bed expansion, flow of fluids through granular beds.

Assessment: One written 3-hour end-of-semester examination (80%); a written 1-hour mid-semester test (20%).

411-441 Heat and Mass Transport Processes 2

Credit points: 12.5

Coordinator: Dr R Dagastine

Prerequisites: 411-331 Heat and Mass Transport Processes 1.

Contact: Forty-eight hours *(Semester 1).*

Description: Students successfully completing this subject will be able to apply the principles of heat transfer to conduction and radiation heat transfer problems and to analyse and design separation operations including adsorption and ion exchange, multicomponent distillation, simultaneous mass and heat transfer, membrane separation processes and mass transfer with chemical reaction.

Content: Heat transport processes radiation: basic principles of radiation; shape factors (viewfactors); radiation between grey surfaces in the network approach; applications of networks for various situations. Conduction: Fourier's Law of heat conduction; multi-dimensional heat transfer equations; steady-state heat conduction and the Laplace equation; steady-state conduction with distributed heat source and the Poisson equation; simplified equation for steady-state heat conduction; fins; transient heat conduction and the diffusion equation; examples of simple solution of transient heat conduction; brief introduction to numerical methods for heat conduction problems. Mass transport processes: Multicomponent distillation, including short cut and rigorous techniques for the prediction of column performance. Solvent extraction, including the effect of axial dispersion. Adsorption and ion exchange - types of absorbents, fixed bed adsorber models, isothermal equilibrium and non-equilibrium design and operation. Mass transfer with chemical reaction, homogeneous and heterogeneous reactions, and application to equipment performance and design. Application of simultaneous heat and mass transfer to separation processes. Membrane separation processes and separation processes used in biotechnology.

Assessment: One written 3-hour end-of-semester examination (70%); a written 1-hour mid-semester test (15%); five problem sheets distributed across the semester (15%). An overall mark of 50% and a mark of 40% or more in the end of semester examination are needed to pass the subject.

411-442 Process Equipment Design

Credit points: 12.5

Coordinator: Assoc Prof G Franks

Prerequisites: 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B) or equivalent, 411-203 Fluid Mechanics

Corequisites: 411-441 Heat and Mass Transport Processes 2

Contact: Forty-eight hours *(Semester 1).*

Description: Students completing this course should have acquired an understanding of engineering mechanics, the behavior of different materials, the mechanical aspects of the design and operation of process equipment, including safety considerations.

Content: Elements of statics; forces, moments, equilibrium of rigid bodies, application to simple structures. Properties of materials for chemical engineering plant and equipment; ferrous and non-ferrous metals, polymers, composites, ceramics. Strength of materials; selection of materials. Response of materials to steady and dynamic loading; thermal expansion, thermal shock. Beams, bending moments, stresses and deflections. Application to the design of chemical equipment. Design of fluid storage and transfer equipment; pressure and non-pressure vessels, pumps and compressors, nozzles, piping, valves. Disassembly, inspection, and assembly of equipment. Design of other operational units commonly used in chemical plants; solid handling devices, fluid processing units. Hydraulic aspects of plate distillation column, packed columns, fluidised beds, demisters and decanters. Safety and integrity of equipment; safe working stress; corrosion of metallic components. Design standards and codes of practice. Plant layout; equipment, piping and site layouts. Documentation.

Assessment: One written 3-hour end-of-semester examination (60%); one assignment of up to 5000 words (not including appendices and diagrams and tables) due in the middle of the semester (20%). Students must pass both components of assessment in order to pass the subject.

411-445 Process Engineering 3

Credit points: 12.5

Coordinator: Assoc Prof D E Dunstan

Prerequisites: 411-331 Heat and Mass Transport Processes 1, 411-303 Reactor Engineering (prior to 2005 411-433), 411-335 Biochemical/Environmental Engineering 1B, 411-336 Process Dynamics and Control and 411-337 Practical and Computer Laboratory.

Corequisites: 411-441 Heat and Mass Transport Processes 2, 411-442 Process Equipment Design.

Contact: Forty-eight hours comprising 12 hours of lectures and 36 hours of problem-solving classes *(Semester 1).*

Description: Students completing this subject will develop experience in critical thinking by tackling ill-defined engineering tasks as well as organising and prioritising tasks to meet deadlines will be developed. Their written communication skills will be enhanced. They will have an appreciation of the documents used in the design of process plants and their awareness will be strengthened of the resources available for use in the design of chemical plants. Their understanding of the issues relating to project and contract management will be deepened.

Content: Practice in conducting chemical plant feasibility and design studies through a series of assignments in the following areas: process plant economic analysis, sensitivity of economics to external influences, consideration of political, environmental and other effects on project viability. Integrated process design of chemical plants including the necessary documentation and the consideration of control strategy for safe operation. Discussion of the various tools and resources available for design of chemical plants. Issues relating to project and contract management.

Assessment: Twelve variously weighted written assignments spread across the semester; many are completed within the subject's weekly 3-hour class sessions.

411-446 Research Project

Availability: As a special arrangement, Research Project may be undertaken in Summer Semester and/or Semester 1 with the approval of the Head of Department.

Credit points: 18.75

Coordinator: Dr G Qiao

Prerequisites: 411-432 Particle Mechanics and Processing (prior to 2005 411-332), 411-303 Reactor Engineering (prior to 2005 411-433), 411-335 Biochemical/Environmental Engineering 1B, 411-336 Process Dynamics and Control, 411-337 Practical and Computer Laboratory, 411-441 Heat and Mass Transport Processes 2.

Contact: Seventy-two hours *(Semester 1, repeat 2, Summer).*

Description: Students successfully completing this unit should be able to plan and conduct an independent research project on process engineering.

Candidates will undertake as individuals or as a member of a team a designated investigative project which could involve a critical literature review, experimental research and/or development, theoretical modelling, process simulation and/or the solution of an industrial problem. Rigorous planning and scheduling of the project, time management, written and verbal technical communication, interpretation of results and team work will be required.

Assessment: A written report of up to 4000 words, not including appendices, diagrams, tables, computations and computer output, due towards the end of semester (50%); an oral presentation during the end of semester examination period (25%); an assessment of the quality of the student's research work (25%).

411-447 Design Project

Credit points: 18.75

Coordinator: Dr S Kentish & Mr B Hooper

Prerequisites: 411-432 Particle Mechanics and Processing (prior to 2005 411-332), 411-303 Reactor Engineering (prior to 2005 411-433), 411-335 Biochemical/Environmental Engineering 1B, 411-336 Process Dynamics and Control, 411-337 Practical Work and Computer Laboratory, 411-441 Heat and Mass Transport Processes 2, 411-442 Process Equipment Design and 411-343 Chemical Engineering Management.

Contact: Seventy-two hours *(Semester 2).*

Description: Students successfully completing the course will learn the skills necessary to complete a chemical engineering feasibility study and to carry out the integrated process and equipment design for an industrial chemical process. They will be presented with an initially poorly-defined task for which much of the design data is not available. In completing the design they will apply most of the skills learned earlier in their course and will learn to function as part of a team and to manage their time effectively.

This unit requires the students to undertake a major design task utilising the knowledge gained throughout the chemical engineering course. This comprises the following tasks: design of a process to meet a specified requirement; feasibility study of alternative processes which meet the specification; determination of sequence for investigation of a chemical manufacturing project and preparation of a report; consideration of environmental impacts and sustainability issues; preparation of flowsheets; confirmation of effects of market forecasts; economic evaluation; preparation of estimates for the minimisation of capital and production costs; specification of equipment; selection of construction materials; and specification of instrumentation location, staff and labour requirements and safety precautions. The HYSYS simulation package will be utilised where appropriate. There will also be a series of lectures on various aspects of design.

Assessment: Three written reports of up to 200 pages in total and with no more than 100 pages of supporting material (appendices, diagrams, tables, computations and computer output). The first report is due one third of the way through the semester (15%), the second report is due two thirds of the way through the semester (30%) and the final report (55%) is due at the end of the semester. The first two reports include team-based tasks and peer assessments by team members will be included in the final mark.

411-448 Biochemical/Environmental Engineering 2

Credit points: 12.5

Coordinator: Dr M Connor

Prerequisites: 411-335 Biochemical/Environmental Engineering 1B or 421-210 Environmental Engineering Basics (students who have completed 421-

210 but not 411-355 are advised to undertake some preliminary reading in basic microbiology prior to commencing the subject).

Contact: 48 hours *(Semester 2).*

Description: Students successfully completing this subject should have a broad understanding of the nature of waste streams, the principles underlying their treatment, and the important processes used to treat a variety of domestic, industrial and agricultural wastes. In addition they will have gained an understanding of the more important physical, chemical and biological techniques used in the process design of a variety of waste treatment systems. They will also have gained practical experience in the operation of a bench scale activated sludge unit and the common assay procedures used to evaluate its performance.

Contents: The characteristics of liquid and solid wastes and the objectives of waste treatment; important waste assay procedures; primary, secondary and tertiary wastewater treatment processes; physical and chemical treatment processes for both liquid and solid wastes; biological waste treatment and the role of various microbial groups: anaerobic, facultative, aerobic and aerated lagoons and factors affecting their design; activated sludge and related processes; adherent growth processes and associated design considerations; biological and physico-chemical removal of nitrogen and phosphorus; anaerobic processes and their use in liquid and solid waste treatment; treatment and disposal of biosolids; recycling and reuse of wastes; life cycle analysis, sustainability and cleaner production.

Assessment: One written 3-hour end-of-semester examination (70%); a written 1-hour mid-semester test (15%); a 2000-word practical report due two weeks after the second of two laboratory sessions (15%). An overall mark of 50% and a mark of 40% or more in the end of semester examination are needed to pass the subject.

411-449 Materials and Recycling

Credit points: 12.5

Coordinator: Prof M Reuter and Assoc Prof G Franks

Prerequisites: 411-432 Particle Mechanics and Processing (prior to 2005 411-332), 411-303 Reactor Engineering (prior to 2005 411-433), 411-204 Chemical Engineering Thermodynamics.

Contact: Thirty-two hours of lectures, sixteen hours of tutorials and computer laboratory *(Semester 2).*

Description: Students successfully completing this unit should understand the complex interaction of processes within the material cycle i.e. starting with consumer products, primary material production, material properties and ending with recycled material, waste and environmental issues. This will be based on material science principles, thermodynamics, kinetics (etc.) as well as system engineering and optimization. The students will understand the relationships between materials composition, processing, microstructure and properties.

Content: Industrial Ecology, materials in consumer products, survey of the relationship between metals and non-metals production and the industrial cycle of materials and recycling. Application of fundamental principles to simulate material systems. Advanced aspects of physico-chemical principles of oxide and sulphide processing, to produce metals and ceramic products from ores as well as a recycled materials and consumer products. The systems approach to recycling of products, process sustainability and environmental considerations. The relationship between product sophistication, material properties, separation efficiency and recycling. Case studies, such as the optimization of a material flow system by the use of optimization procedures, thermodynamics, physical separation principles, will be part of the course. Also included are a review of interatomic bonding, material atomic structure, phase diagrams and equilibria, and material mechanical, electrical and magnetic properties. Finally the process of developing material selection criteria and selecting materials for particular applictions will be presented.

Assessment: One written 3-hour end-of-semester examination (80%); a written 1-hour mid-semester test (20%).

411-450 Biochemical Engineering Research Project

Credit points: 18.75

Coordinator: Dr Greg Qiao

Contact: Seventy-two hours in semester 2 *(Semester 1, repeat 2).*

Description: Candidates will undertake as individuals or as a member of a team a designated investigative project in biochemical engineering. The project could involve a critical literature review, experimental research and/or development, theoretical modelling, process simulation and/or the solution of an industrial problem.

Assessment: A written report of up to 4000 words, not including appendices, diagrams, tables, computations and computer output, due towards the end of semester (50%); an oral presentation during the end of semester examination period (25%); an assessment of the quality of the student's research work (25%).

431-201 Engineering Analysis A

See full subject details on page 11.

431-202 Engineering Analysis B

See full subject details on page 12.

610-141 Chemistry A

See full subject details on page 2.

610-142 Chemistry B

See full subject details on page 2.

610-211 Light, Matter & Chemical Change B

See full subject details on page 3.

610-221 Organic & Bio-organic Chemistry

See full subject details on page 4.

620-121 Mathematics A (Advanced)

See full subject details on page 4.

620-122 Mathematics B (Advanced)

See full subject details on page 4.

620-123 Applied Mathematics (Advanced)

See full subject details on page 4.

620-141 Mathematics A

See full subject details on page 5.

620-142 Mathematics B

See full subject details on page 5.

620-143 Applied Mathematics

See full subject details on page 5.

620-231 Vector Analysis

See full subject details on page 7.

620-232 Mathematical Methods

See full subject details on page 7.

640-121 Physics A (Adv)

See full subject details on page 2.

640-122 Physics B (Adv)

See full subject details on page 2.

640-141 Physics A

See full subject details on page 2.

640-142 Physics B

See full subject details on page 3.

650-141 Biology of Cells and Organisms

See full subject details on page 1.

650-142 Genetics & The Evolution of Life

See full subject details on page 1.