Chemical engineering

Department of Chemical Engineering

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

Chemical 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 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 engineering subject is taken. Students may also take a new 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 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.4)*	12.5
610-141	Chemistry *(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.4)*	12.5
610-142	Chemistry *(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.4)*	12.5
411-202	Process Engineering 1 *(p.4)*	12.5
431-201	Engineering Analysis A *(p.9)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
431-202	Engineering Analysis B *(p.9)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5

Third year		Points
Semester 1		
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5
411-334	Biochemical/Environmental Engineering 1A *(p.6)*	6.25
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5
411-337	Practical and Computer Laboratory *(p.6)*	12.5
411-338	Product Engineering *(p.6)*	12.5
411-339	Process Engineering 2 *(p.6)*	12.5

Fourth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-443	Chemical Engineering Management *(p.8)*	12.5
411-445	Process Engineering 3 *(p.8)*	12.5
Semester 2		
411-446	Research Project *(p.8)*	18.75
411-447	Design Project *(p.8)*	18.75
411-448	Biochemical/Environmental Engineering 2 *(p.8)*	12.5
or		
411-449	Minerals Engineering *(p.9)*	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.

First year		Points
Semester 1		
610-141	Chemistry *(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 *(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.9)*	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.4)*	12.5
431-202	Engineering Analysis B *(p.9)*	12.5
Arts subject as required		25

Third year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.4)*	12.5
Arts subjects as required		37.5
Semester 2		
411-203	Fluid Mechanics *(p.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
Arts subjects as required		12.5

Fourth year		Points
Semester 1		
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5
411-334	Biochemical/Environmental Engineering 1A *(p.6)*	6.25
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5

Fourth year		Points
411-337	Practical and Computer Laboratory *(p.6)*	12.5
Arts subjects as required		25

Fifth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-443	Chemical Engineering Management *(p.8)*	12.5
Arts subject as required		12.5
Semester 2		
411-446	Research Project *(p.8)*	18.75
411-447	Design Project *(p.8)*	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.

First year		Points
Semester 1		
316-102	Introductory Microeconomics *(p.1)*	12.5
610-141	Chemistry *(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 *(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.9)*	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.4)*	12.5
431-202	Engineering Analysis B *(p.9)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5
Commerce subject as required		12.5

Third year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.4)*	12.5
Commerce subjects as required		37.5
Semester 2		
411-203	Fluid Mechanics *(p.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
Commerce subjects as required		25

Fourth year		Points
Semester 1		
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5
411-334	Biochemical/Environmental Engineering 1A *(p.6)*	6.25
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5
411-337	Practical and Computer Laboratory *(p.6)*	12.5
Commerce subjects as required		25

Fifth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-443	Chemical Engineering Management *(p.8)*	12.5
Commerce subject as required		12.5
Semester 2		
411-446	Research Project *(p.8)*	18.75
411-447	Design Project *(p.8)*	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.

First year		Points
Year long		
730-104	Torts and the Process Of Law *(p.1)*	25
Semester 1		
610-141	Chemistry *(p.2)*	12.5
620-121	Mathematics A (Advanced) *(p.4)*	12.5
or		
620-141	Mathematics A *(p.5)*	12.5
730-105	History and Philosophy of Law I *(p.1)*	12.5
Semester 2		
610-142	Chemistry *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5
730-115	History and Philosophy of Law II *(p.1)*	12.5

Second year		Points
Year long		
730-202	Contracts *(p.1)*	25
730-260	Criminal Law and Procedure *(p.1)*	25
Semester 1		
431-201	Engineering Analysis A *(p.9)*	12.5
610-221	Organic & Bio-organic Chemistry *(p.4)*	12.5
Semester 2		
431-202	Engineering Analysis B *(p.9)*	12.5
411-102	Chemical Process Analysis *(p.4)*	12.5

Third year		Points
Year long		
730-301	Constitutional and Adminstrative Law *(p.2)*	25
730-304	Property *(p.2)*	25
Semester 1		
411-201	Introduction to Transport Processes *(p.4)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
610-211	Light, Matter & Chemical Change B *(p.3)*	12.5

Fourth year		Points
Semester 1		
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5
411-334	Biochemical/Environmental Engineering 1A *(p.6)*	6.25
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5
411-337	Practical and Computer Laboratory *(p.6)*	12.5
730-462	Equity and Trusts *(p.2)*	12.5
Law subjects as approved		12.5

Fifth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-443	Chemical Engineering Management *(p.8)*	12.5
Law subject as required		12.5
Semester 2		
411-446	Research Project *(p.8)*	18.75
411-447	Design Project *(p.8)*	18.75
Law subject as required		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.8)*

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.4)*[1]	12.5
610-141	Chemistry *(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.4)*	12.5
610-142	Chemistry *(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.4)*	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 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.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
Science subjects as required		25

Fourth year		Points
Semester 1		
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5
411-334	Biochemical/Environmental Engineering 1A *(p.6)*	6.25
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
411-343	Chemical Engineering Management *(p.7)*	12.5
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5
411-337	Practical and Computer Laboratory *(p.6)*	12.5
411-338	Product Engineering *(p.6)*	12.5
411-339	Process Engineering 2 *(p.6)*	12.5

Fifth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-443	Chemical Engineering Management *(p.8)*	12.5
411-445	Process Engineering 3 *(p.8)*	12.5
Semester 2		
411-446	Research Project *(p.8)*	18.75
411-447	Design Project *(p.8)*	18.75
411-448	Biochemical/Environmental Engineering 2 *(p.8)*	12.5
or		
411-449	Minerals Engineering *(p.9)*	12.5

Biochemical Engineering stream

First year		Points
Semester 1		
411-101	Introduction to Chemical Engineering *(p.4)*[1]	12.5
600-141	Biology of Cells and Organisms *(p.1)*	12.5
610-141	Chemistry *(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.4)*	12.5
600-142	Genetics & The Evolution of Life *(p.1)*	12.5
610-142	Chemistry *(p.2)*	12.5
620-123	Applied Mathematics (Advanced) *(p.4)*	12.5
or		
620-143	Applied Mathematics *(p.5)*	12.5

1. Or science subject

Second year		Points
Semester 1		
411-201	Introduction to Transport Processes *(p.4)*	12.5
620-142	Mathematics B *(p.5)*	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.1)*	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	Biotechnology 1:Microbial Genes & Cells *(p.2)*	12.5
526-321	Molecular Microbiology Techniques *(p.3)*	12.5
Semester 2		
411-203	Fluid Mechanics *(p.4)*	12.5
411-204	Chemical Engineering Thermodynamics *(p.5)*	12.5
526-302	Biotechnology 2: Processes & Innovations *(p.2)*	12.5
526-326	Projects: Immunology / Biotechnology *(p.4)*	12.5

Fourth year		Points
Semester 1		
411-330	Biochemical Engineering Mini-project *(p.5)*	6.25
411-331	Heat and Mass Transport Processes 1 *(p.5)*	12.5
411-332	Particle Mechanics and Processing *(p.5)*	12.5

Fourth year		Points
411-343	Chemical Engineering Management *(p.7)*	12.5
411-335	Biochemical/Environmental Engineering 1B *(p.6)*	6.25
Semester 2		
411-336	Process Dynamics and Control *(p.6)*	12.5
411-337	Practical and Computer Laboratory *(p.6)*	12.5
411-338	Product Engineering *(p.6)*	12.5
411-339	Process Engineering 2 *(p.6)*	12.5

Fifth year		Points
Semester 1		
411-441	Heat and Mass Transport Processes 2 *(p.7)*	12.5
411-442	Process Equipment Design *(p.7)*	12.5
411-433	Reactor Engineering *(p.7)*	12.5
411-445	Process Engineering 3 *(p.8)*	12.5
Semester 2		
411-447	Design Project *(p.8)*	18.75
411-448	Biochemical/Environmental Engineering 2 *(p.8)*	12.5
411-450	Biochemical Engineering Research Project *(p.9)*	18.75

Subject descriptions

145-126 Effective Communication for Engineering

See full subject details on page 1.

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.

411-101 Introduction to Chemical Engineering

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M Connor & Assoc Prof P J Scales

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: Up to four written assignments, of around 2000 words in length and one examination not exceeding three hours. Students will be notified of the weighting of assessment components at the beginning of the semester.

411-102 Chemical Process Analysis

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof D Shallcross

Contact: 36 hours of lectures and 12 hours of tutorials *(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 examination not exceeding three hours.

411-201 Introduction to Transport Processes

Credit points: 12.5 **HECS-band:** 2

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.

Content: 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 examination not exceeding three hours.

411-202 Process Engineering 1

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr A O'Connor

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: Up to 12 written assignments, each being no longer than the equivalent of 1500 words.

411-203 Fluid Mechanics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M Davidson & Assoc Prof P J Scales

Prerequisites: 411-201 Introduction to Transport Processes.

Corequisites: 431-202 Engineering Analysis B

Contact: Thirty hours of lectures, 14 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 examination not exceeding three hours (85% of total mark), plus three laboratory assignments (15% of total mark).

411-204 Chemical Engineering Thermodynamics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr Y Leong 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 3-hour examination at the end of semester.

411-217 Chemical Engineering Research Elective 2

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M A Connor & Assoc 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, Summer).*

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: A written report not exceeding 5000 words. Project work must be completed satisfactorily to pass the subject.

411-317 Chemical Engineering Research Elective 3

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M A Connor & Assoc 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: 48 hours by arrangement with the supervisor *(Semester 1, repeat 2, Summer).*

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: A written report not exceeding 5000 words. Project work must be completed satisfactorily to pass the subject.

411-330 Biochemical Engineering Mini-project

Credit points: 6.25 **HECS-band:** 2

Coordinator: Assoc Prof N B Pamment

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

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: A written report of approximately 2000 words (excluding appendices)

411-331 Heat and Mass Transport Processes 1

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr S Kentish & Assoc Prof P J Scales

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. 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; apparent and actual heat transfer coefficients; thermal and mechanical recompression; evaporator energy balances.

Mass Transport Processes: Definition of separation processes, separating agents, separation factors, equilibrium and rate type processes, equilibrium stage, non-equilibrium performance. Unsteady state mass transfer and Fick's Second Law; prediction of diffusivity; dimensional analysis and equations of change for mass transfer. 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. 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 - 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.

Assessment: A 3-hour written examination at the end of semester contributing at least 80% of the final mark and class test(s) during the semester contributing up to 20% of the final mark.

411-332 Particle Mechanics and Processing

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof P J Scales & Dr M A Connor

Prerequisites: 411-203 Fluid Mechanics 1 and 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B) 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 and minerals processing industries. They will be familiar with the unit operations of comminution and particle liberation, particle separation, hopper flow, solid-liquid separation, 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, 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 minerals 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 class test during the semester contributing 20% to the final mark as well as an examination not exceeding three hours contributing 80% of the final mark.

411-334 Biochemical/Environmental Engineering 1A

Credit points: 6.25 **HECS-band:** 2

Coordinator: Assoc Prof N Pamment

Prerequisites: 610-141 Chemistry and 610-142 Chemistry or equivalent

Corequisites: 411-335 Biochemical/Environmental Engineering 1B

Contact: Twenty-four hours including six hours of practical work *(Semester 1).*

Description: The objectives of this subject are to acquaint the student with basic microbiological and biochemical concepts essential to the understanding of biochemical engineering and environmental engineering processes, including 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.

Assessment: An examination of not more than three hours contributing 90% to the final assessment and practical reports not exceeding 1000 words contributing 10% to the final assessment

411-335 Biochemical/Environmental Engineering 1B

Credit points: 6.25 **HECS-band:** 2

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 fermenters. Oxygen requirements of microorganisms. Mixing in fermenters. Biochemical separation processes.

Assessment: An examination of not more than three hours.

411-336 Process Dynamics and Control

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr L Yeow & Assoc Prof P J Scales

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: An examination not exceeding three hours.

411-337 Practical and Computer Laboratory

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof P J Scales & Dr M A Connor

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-nine hours of practical work and 9 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 *ChemCAD* and *AutoCAD* 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: Practical work reports not exceeding a total of 6000 words contributing 80% to the final assessment, and assignments in computer-aided design not exceeding a total of 1500 words, contributing 20% to the final assessment.

411-338 Product Engineering

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof P J Scales

Prerequisites: 411-203 Fluid Mechanics, 431-202 Engineering Analysis B (prior to 2001, 421-205 Engineering Analysis B) or equivalent, 610-211 Light, Matter and Chemical Change (prior to 2001, 610-211 Physical Chemistry IIB).

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

Description: Upon completion of this unit, students should have an appreciation of the flow behaviour of particulate materials and the influence of surface chemistry, additives and processing history on the behaviour of fine solid and liquid particle slurries. They will be familiar with the application of these concepts to the formulation of products and processes in the minerals, ceramics, pigment, food and pharmaceuticals industries. These concepts will be extended to the manufacture and characteristics of ceramic, cemented and geopolymerised materials and a range of plastic and filled plastic materials.

Content: The role of surfaces in processing and materials manufacture. Fine particle fluids, colloidal dispersions and emulsions. Coagulation and stability criterion. Inter-particle forces and the influence on slurry flow properties. The role of molecular additives in food, minerals and soil science. Measurement of slurry viscosity and dispersion characterisation including electrokinetics, light scattering and spectroscopy. Ultra-small particle characterisation and the role of excited state properties and the significance in photo-degradation of materials. Solution properties of macromolecules and the application to non-cross linked gels, viscosity control, thickening and flocculation. Micelle formation from surfactants and application to cleaning, solubilisation and particle manufacture. Precipitation, crystallisation and production of fine particulate materials. Structure-function and mechanical property relationships for plastic and coatings. Classification of plastics including thermo-flocculation sets and thermo-plastics. The role of fine filler materials in properties and durability of plastics and coatings. Melt processing and curing.The role of particles in ceramic properties. Mechanical versus green-body property inter-relationships. Cementation and geopolymerisation reactions.

Assessment: One class test during the semester contributing 20% to the final mark, as well as an examination not exceeding three hours at the end of the semester, contributing 80% of the final mark.

411-339 Process Engineering 2

Credit points: 12.5 **HECS-band:** 2

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. Practice in application of computer design packages to perform chemical process design calculations. General, contract, corporate, environmental and intellectual property law.

Assessment: Assignments not exceeding a total of 80 pages of computations, diagrams and written work.

411-343 Chemical Engineering Management

Credit points: 12.5 **HECS-band:** 2

Coordinator: Mr Barry Hooper, Mr Mike Parkinson

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

Description: Objectives: Students successfully completing this unit should develop an appreciation of the management of safety, the environmental and economic basis of the chemical industry, ethics, and other managerial issues affecting the engineer.

Content: Hazard identification and hazard and operability studies. Risk assessment. Hazard management. Ethics and professionalism. The legal environment and responsibilities of the engineer. Behaviour of people in organisations. Communication in business. Motivation of staff. Starting a company. Management of innovation. Estimation of capital and manufacturing costs. Economic and profitability analysis of projects. Alternative investments. Risk and uncertainty. Basic accounting. Project planning networks. Project management. Diverse management issues.

Assessment: Assignments not exceeding a total of 8000 words contributing 40% to the final mark, and an examination of three hours contributing 60% of the final mark.

411-401 Separation Processes 2

Credit points: 6.25 **HECS-band:** 2

Coordinator: Prof G Stevens & Assoc Prof P J Scales

Prerequisites: Satisfactory completion of: 411-301 Chemical Engineering Thermodynamics, 411-302 Transport Phenomena 2, 411-303 Fluids/Solids Processing, 411-306 Separation Processes 1, 421-303 Mathematics for Engineers 3.1,

Contact: Thirty-six hours *(Semester 1).*

Description: The objectives of this subject are to gain an overview of the types of separation processes available and be familiar with the concepts of adsorption and ion exchange, multicomponent distillation, simultaneous mass and heat transfer, membrane separation processes and mass transfer with chemical reaction.

Topics covered include: 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 adsorbants, fixed bed adsorber models, isothermal equilibrium design, granule model, non-equilibrium operation; mass transfer with chemical reaction, homogeneous and heterogeneous reactions, application to equipment performance and design; application of simultaneous heat and mass transfer to separation processes; and membrane separation processes and separation processes used in biotechnology

Assessment: One examination not exceeding three hours.

411-403 Reactor Engineering 2

Credit points: 6.25 **HECS-band:** 2

Coordinator: Dr G Qiao & Assoc Prof P J Scales

Prerequisites: 610-033 Chemistry (Chemical Engineering), 421-303 Maths for Engineers Unit 3.1, 411-301 Chemical Engineering Thermodynamics, 411-302 Transport Phenomena 2, 411-303 Fluids/Solids Processing, 411-305 Heat Transfer 1, 411-306 Separation Processes 1 and 411-206 Reactor Engineering 1

Contact: Thirty-six hours *(Semester 1).*

Description: The aim of this subject is the analysis, design, scale-up and modelling of chemical reactors processing heterogeneous phases. The topics to be covered are non-ideal flow in reactors: residence time distributions, tracer tests, dispersion model, tank-in-series model, multi-parameter models, fluidised bed reactors, conversion in non-ideal reactors, micromixing and macromixing, early and late mixing of fluids; generalised description of rate controlling mechanisms in heterogeneous reacting systems: film resistance control, chemical reaction control, surface and pore diffusion control, ash layer diffusion, shrinking core mechanisms, effectiveness factors and the Thiele modulus, identification of rate controlling mechanisms through experiments and modelling, determination of kinetic parameters; design of heterogeneous reactors incorporating non-ideal flow and distributed rate constants; kinetic regimes for fluid-fluid and gas-fluid reactions; and design of catalytic reactors, staged adiabatic packed bed catalytic reactors, deactivation and regeneration of catalysts.

Assessment: One class test during semester contributing 20% to the final mark, as well as an examination not exceeding three hours contributing 80% to the final mark.

411-417 Chemical Engineering Research Elective 4

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M A Connor

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, Summer).*

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: A written report not exceeding 7000 words. Project work must be completed satisfactorily to pass the subject.

411-433 Reactor Engineering

Note: This subject is not offered in 2003.

Credit points: 12.5 **HECS-band:** 2

Prerequisites: 610-141 and 610-142 Chemistry

Semester: Not Offered

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. Mulitiple reactors - mixed and plug flow reactors of identical size, mulitple 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, dispersion model, tanks-in-series model, multi-parameter models, conversion in non-ideal reactors, micromixing and macromixing. 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. Design of catalytic reactors, staged adiabatic packed bed catalytic reactors, deactivation and regeneration of catalysts.

411-441 Heat and Mass Transport Processes 2

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof G Stevens & Assoc Prof P J Scales

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 examination not exceeding three hours at the end of semester.

411-442 Process Equipment Design

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr Andrew Kyllo

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. Columns and compression members. 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: An assignment of not more than 5000 words contributing 30% to the final assessment and an examination of not more than three hours at the end of the semester contributing 70% to the final assessment. Students must pass both components of assessment in order to pass the subject.

411-443 Chemical Engineering Management

Credit points: 12.5 **HECS-band:** 2

Coordinator: Mr Barry Hooper, Mr Mike Parkinson

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

Description: Students successfully completing this unit should develop an appreciation of the management of safety, the environmental and economic basis of the chemical industry, ethics, and other managerial issues affecting the engineer.

Content: Hazard identification and hazard and operability studies. Risk assessment. Hazard management. Ethics and professionalism. The legal environment and responsibilities of the engineer. Behaviour of people in organisations. Communication in business. Motivation of staff. Starting a company. Management of innovation. Estimation of capital and manufacturing costs. Economic and profitability analysis of projects. Alternative investments. Risk and uncertainty. Basic accounting. Project planning networks. Project management. Diverse management issues.

Assessment: Assignments not exceeding a total of 8000 words contributing 40% to the final mark, and an examination of three hours contributing 60% of the final mark.

411-445 Process Engineering 3

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof D E Dunstan

Prerequisites: 411-331 Heat and Mass Transport Processes 1, 411-333 Thermodynamics and Reactor Engineering 2, 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 tackling ill-defined engineering tasks as well as organising and prioritising tasks to meet deadlines. 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: Assignments not exceeding 100 pages of computations, diagrams and written work.

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 **HECS-band:** 2

Coordinator: Assoc Prof N B Pamment

Prerequisites: 411-332 Particle Mechanics and Processing, 411-333 Thermodynamics and Reactor Engineering 2, 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.

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 approximately 3000 words (excluding appendices) contributing 50% to the total assessment, along with an oral presentation (25%) and an assessment of the quality of the research work (25%).

411-447 Design Project

Credit points: 18.75 **HECS-band:** 2

Coordinator: Dr S Kentish & Assoc Prof P J Scales

Prerequisites: 411-332 Particle Mechanics and Processing, 411-333 Thermodynamics and Reactor Engineering 2, 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 411-443 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; preparation of flowsheets; confirmation of effects of market forecasts; economic evaluation; preparation of estimates for the minimisation of capital and production costs; and specification of equipment; selection of construction materials; and specification of instrumentation location, staff and labour requirements and safety precautions. There will be a series of lectures on various aspects of design.

Assessment: A technical report of up to 150 pages, including appendices.

411-448 Biochemical/Environmental Engineering 2

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M Connor & Assoc Prof P J Scales

Prerequisites: 411-335 Biochemical/Environmental Engineering 1B

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 3-hour examination at the end of the semester (70%), mid-term test (20%) and one practical report of no more than 2000 words (10%)

411-449 Minerals Engineering

Credit points: 12.5 **HECS-band:** 2

Coordinator: Assoc Prof N Gray

Prerequisites: 411-332 Particle Mechanics and Processing, 411-333 Thermodynamics and Reactor Engineering 2

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

Description: Students successfully completing this unit should understand the nature and variety of the processes involved in the mineral processing industry and be able to apply thermodynamics, rate phenomena and reactor engineering principles to the analysis, design and simulation of metallurgical processes.

Content: Survey of metallurgical processes and unit operations, metallurgical terminology and calculations. Process mineralogy, mineral liberation, froth flotation, hydrometallurgical processing, mineral processing circuit design, coal preparation. Advanced aspects of physico-chemical principles of oxide and sulphide smelting. Properties of slags and important phase diagrams. Physico-chemical principles of metal refining and application. Bath smelting. Environmental control. Mathematical and physical modelling of metallurgical processes. Simulation of pyrometallurgical processes such as reduction of oxides, roasting of sulphides, hydrometallurgical processes, bath smelting and heat flow in metal treatment processes.

Assessment: One class test during the semester contributing 20% to the final mark and an examination not exceeding three hours at the end of Semester 2 contributing 80% to the final mark.

411-450 Biochemical Engineering Research Project

Credit points: 18.75 **HECS-band:** 2

Coordinator: Assoc Prof N B Pamment

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

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 approximately 3000 words (excluding appendices) contributing 50% to the total assessment, along with an oral presentation (25%) and an assessment of the quality of the research work (25%)

431-201 Engineering Analysis A

See full subject details on page 9.

431-202 Engineering Analysis B

See full subject details on page 9.

600-141 Biology of Cells and Organisms

See full subject details on page 1.

600-142 Genetics & The Evolution of Life

See full subject details on page 1.

610-141 Chemistry

See full subject details on page 2.

610-142 Chemistry

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

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620-231 Vector Analysis

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620-232 Mathematical Methods

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640-121 Physics A (Adv)

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640-141 Physics A

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730-104 Torts and the Process Of Law

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730-105 History and Philosophy of Law I

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