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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Department of Chemical and Process Engineering

STUDENT HANDBOOK

2005

Department of Chemical and Process Engineering
University of Canterbury
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Help Directory

All the staff of the Department are very willing to give advice on any general or specific matter relating to University study. There are some functions for which specific staff member should be consulted.

Prospective students:	Head of Department	
Intermediate:	see Dr Pat Jordan	
Enrolments or change of course:	1st Pro	see Dr Pat Jordan
	2nd Pro	see Mr Ian Gilmour
	3rd Pro	see Dr Chris Williamson
Practical Work Advisor:	Mr Ian Gilmour	
Use of computers:	Mr Tony Allen	
Safety Officer:	Mr David Brown	
Students with disabilities:	Head of Department	
International students:	Associate Professor Shusheng Pang	

Additional Departmental information is available on the Web:
http://www.cape.canterbury.ac.nz

1. Head of Department's Message

I would like to offer my personal welcome to you and to introduce this Student Handbook for the Department of Chemical and Process Engineering. I hope that you will find the information contained in the handbook useful and that it gives you some insight into being a member of the Department here at Canterbury. As a department of the University of Canterbury, one of the foremost universities in New Zealand and in the Southern Hemisphere, we are fortunate to be able to attract some of the very best and most able individuals from within New Zealand and overseas who participate in the activities of the Department at every level. Our distinguished alumni who hold or have held some of the most prestigious positions in the process industries and other sectors both in New Zealand and abroad are testimony to our internationally accredited excellence in teaching and research. We aim to pursue our teaching and research activities to the highest international standards.

Chemical and Process Engineering is one of the major four engineering disciplines and may be defined as "The design, implementation and control of operations involving the large scale handling, conversion and purification of solids, liquids and gases for the economic manufacture of useful, marketable products". One of the major themes of Chemical and Process Engineering for the new millennium is "sustainability" and as such we are tailoring our courses and research programmes with this in mind.

Another major theme for the 21st century is Biotechnology and we are currently developing a new stream entitled Bioprocess Engineering, with the planned introduction of a suite of new courses at the 300 and 400 levels over the period 2005-06 specifically on that theme. Certainly we would expect that some of our current students would have the opportunity to participate in some of those courses.

In terms of employment and student interest Chemical and Process Engineering is currently buoyant within New Zealand and the indicators of this are:

- Strong demand for graduates in New Zealand and internationally.
- The continuing strength and importance of the process industries in "added value" industries such as manufactured wood products, processed food and food derivatives, beverages, specialty chemicals and biotechnology products.
- The starting salaries of new chemical engineering graduates are among the highest of all graduates.

We have three primary goals as a Department:

1. To develop engineering graduates of the highest international calibre with an ability to design, operate and manage processes and who can provide leadership in the process industries and their constituent organisations in New Zealand and worldwide. The application of the highest international standards of education and training is essential given the extremely rigorous health, safety, and environmental requirements of our employer industries, and the very high value of the capital assets used by those industries.
2. Fulfill at all times the minimum requirements for undergraduate course accreditation by the Institution of Professional Engineers, of New Zealand, and the Institution of Chemical Engineers, London. In the latter case, the full MEng level of international accreditation, we currently hold.
3. To foster, promote and resource research of the highest scientific quality, set in a context of medium or long term application in the chemical and process industries and which provides a stimulating and innovative environment for post-graduates. Attraction of high quality graduate students and growth of our research teams is a key goal.

Whether you are a prospective undergraduate student for a BE degree, a prospective post-graduate student for either the ME degree programme or a PhD degree programme, a current student, a potential industrial collaborator or sponsor of our research, if you wish to discuss the activities of the department or if you have any questions, I invite you to contact me at your earliest convenience.

Peter Gostomski

2. Chemical and Process Engineering

2.1 What is Chemical and Process Engineering?

For a hundred years, Chemical and Process Engineers have been at the forefront of those industries making everyday chemical and related products for use in all sectors of the economy. Nowadays they also work in areas such as oil refining, petrochemicals, fertilisers, pulp and paper, metals industries, dairy, meat and other food processing, general manufacturing, electricity, waste treatment, environmental control, marketing, consulting and teaching.

Chemical and Process Engineers design and operate processes that convert raw materials into useful products. For example:

- Trees into paper and board
- Polymers into paint
- Milk into cheese, yogurt or casein
- Fresh produce into preserved or processed foods
- Effluent into pure water
- Crude oil into petrol and diesel
- Iron ore into steel
- Biological products such as pharmaceuticals

They are also involved in minimising the emission of undesirable byproducts, by improving the operating efficiency of processes and by intercepting and cleaning pollutants from waste streams that go to air, water and soil. A number of Chemical Engineers work in medical fields, such as in the design of artificial kidneys and in the production of pharmaceuticals.

2.2 Who can become a Chemical and Process Engineer

The basic requirement is to be a person who enjoys a challenge and wants to make a contribution to society through applications of the principles of chemistry, physics, and biological sciences.

To obtain entrance to any university degree in engineering, a good school background in Physics, Mathematics and Chemistry to Year 13 level is required. Biology is also increasingly useful.

Women students typically account for 30-50% of our undergraduate classes in chemical and process engineering, and many women are enjoying fulfilling careers in this field.

2.3 What do Chemical and Process Engineers do?

Most Chemical and Process Engineers are employed by companies who process New Zealand's raw materials into useful products. Employers include manufacturers of pulp and paper, dairy products, fertilizer, methanol, petrol and metals. Many graduates progress to become managers and consultants. After graduating B.E. (Chem), about three years of professional experience under the supervision of a member of the Institution of Professional Engineers New Zealand (IPENZ) or the Institution of Chemical Engineers UK (IChemE) is required for full professional status to be achieved.

2.3.1 Career Paths

Our graduates interact with many other people to do the following:

- ***design*** plant for material processing
- supervise ***construction*** of plant
- ***commission*** new plant (make it work)
- supervise ***operation*** of plant
- ***troubleshoot*** an ***optimise*** existing plant (make it work better)
- ***research/develop*** new processes and products.
- ***marketing*** of processes, technology and products.

Your job could be in a specific industry such as the dairy industry, or fertilisers, or pulp and paper, or may be in general consulting/construction firms.

Firms that have frequently employed our graduates include:

- Fonterra
- Tasman Pulp and Paper Company Ltd
- Natural Gas Corporation
- Petrochem Corporation
- NZ Aluminium Smelters Ltd.
- Kingston Morrison (design and environmental consulting)
- Carter Holt Harvey Ltd
- Beca Simon
- BP Oil

3. Entry Requirements for an Honours Degree in Chemical and Process Engineering

3.1 The Engineering Degree

The basic engineering degree is the Bachelor of Engineering (Honours) (B.E.(Hons) degree. This normally takes a minimum of four years study – an "Intermediate" year and three "Professional" years.

3.2 Entry to the University

From 2005 onwards, the University of Canterbury will be using NCEA credits as an indicator for entrance. The minimum standard will be 42 credits at level 3 NCEA (14 credits in each of 2 approved subjects and a further 14 credits from no more than 2 additional domains or approved subjects). Students will also be required to meet the minimum literacy (4 credits in both reading and writing at level 2) and numeracy (14 credits at level 1) standards. *For up- to- date information on entry criteria please look at the College of Engineering website www.engf.canterbury.ac.nz or contact the College of Engineering Office, University of Canterbury, Private Bag 4800, Christchurch. ph: 03 364 2608.*

3.3 The Intermediate Year

The first year at University for students interested in Chemical and Process Engineering will normally be the Engineering Intermediate year. The Engineering Intermediate year includes a mixture of university level maths, physics and chemistry. In addition, there are courses in engineering mechanics and modelling and an optional course giving an overview of the different engineering disciplines. A student must pass the Engineering Intermediate year before officially gaining entrance to the School of Engineering and proceeding on with studies in Chemical and Process Engineering. The details of the Engineering Intermediate requirements and course content are detailed in the University Calendar and the Enrolment Handbook.

3.3.1 The Intermediate Year at Canterbury

The direct route to the Chemical and Process Engineering course is through the Engineering Intermediate Examination. This normally requires the student to pass courses in the core subjects of Mathematics (12 points), Physics (6 points) and Chemistry (6 point minimum but 12 points recommended), plus other courses from a range which includes Introduction to Engineering, Modelling and Computation, and Biology to a total of 42 points.

Students who have completed a health sciences intermediate with good grades may apply for entry to the first professional year.

Required courses for intermediate year:

Mathematics:	MATH104	Mathematics 1A	
or	MATH105	Mathematics 1B	[12 points]
or	MATH106	Mathematics 1C	[6 points]
and	MATH107	Mathematics 1D)	[6 points]
Physics:	PHYS112	Waves, Thermodynamics and Materials	[6 points]
or	PHYS113	Waves, Thermodynamics and Materials	
Chemistry:	CHEM113	Engineering Chemistry	[6 points]

Note: The Department recommend that candidates with an interest in Chemical and Process Engineering include three of BIOL111 Cellular Biology and Biochemistry, CHEM112 General Chemistry B, ENGR110 Introduction to Engineering, MATH 171 Mathematical Modelling and Computation.

4. Chemical Engineering Undergraduate Course

4.1 The B.E.(Hons) Chemical and Process Course Structure

Any queries on the undergraduate course should be made to the appropriate Director of Studies, who may, if necessary, refer the student to the Head of Department.

The structure of the B.E.(Hons) course is quite different to that of many other degree courses at Canterbury, such as the B.A. and the B.Sc degrees, which require one to accumulate the requisite number of points at various levels of study. Engineering degrees are not counted in points; instead students are required to pass each of the three professional years as a whole.

What happens if you fail one or more courses?

Generally, if students fail a course or courses in a professional year then they are required to repeat the course or courses in a subsequent year.

Strictly speaking, a student must complete a professional year before beginning on courses of a succeeding professional year. However, normally the Department would allow students to take some courses from the subsequent professional year in addition to the course(s) being repeated. Nevertheless, because many courses follow on from one professional year to the next, and because of the problem of lecture clashes between courses in the different professional years, there will be limitations on the courses students can take in the subsequent year. In addition, it is normal to limit the total course weighting for a repeating student to less than 1.00 (a full professional year is equivalent to a course weight of 1.00). In most cases this will extend the period of time required to complete the degree; generally at least an extra year will be needed. A student's course in any particular year must be approved by the Department; students cannot simply take whatever courses they wish.

Students who fail a course or courses in the First Professional year will receive a Departmental warning letter which will list the courses to be completed in the next year of study. If a student fails a course for the second time, their academic record will be reviewed by the Faculty of Engineering and they may be excluded from the Faculty.

Students with only one failed course may be considered for the award of a pass in the examination as a whole (PEAW). To be considered for a PEAW, you must have, in the opinion of the Department, a good chance of completing the subsequent professional year without further failure. Current practice is that students with a D grade in the failed course and a grade point average (GPA) in excess of a C+ are considered for the award of PEAW. Students who have failed more than one course or who have an E grade in the failed course will not be considered for a PEAW.
Note that the award of a pass in the examination as a whole is exceptional and students should neither expect nor rely on one being granted.

What about eligibility for Honours?

For students to receive a B.E.(Hons) degree they must normally meet the following minimum criteria:

Complete the three Professional years in no more than four years of study, or if an entrant to Second Professional must complete the Second and Third Professional years in no more than three years of study, and have a weighted grade point average (GPA) greater than a C+.

The procedure to calculate the weighted GPA for the award of honours is based on the principles:

- 20% weighting for 2nd Pro courses and 80% weighting for 3rd Pro courses;
- in calculating the GPA for the Second (or Third) Professional year, all grades obtained in Second (or Third) Professional courses (including fail grades and those obtained in external courses which are necessary for the degree) are used;

Students who do not meet these criteria, but have passed all courses and completed all other requirements for a B.E.(Hons) degree, may be awarded a Bachelor of Engineering degree without Honours.

4.2 First Professional Year

In the First Professional year, all students study engineering mathematics, chemistry and the fundamentals of chemical engineering. These involve application of the primary sciences, especially physics and chemistry, to understanding the ways in which energy and materials interact, to enable raw materials to be transformed into useful products. Material delivered through lectures is reinforced in laboratory, tutorial, and design classes.

First Professional Examination

(1)	EMTH 210	Engineering Mathematics 2
(2)	EMTH 271	Mathematical Modelling and Computation 2
(3)	ENCH 202	Engineering Materials 1 (Chemical)
(4)	ENCH 241	Engineering Chemistry 2
(5)	ENCH 250	Chemical Process Technology
(6)	ENCH 252	Thermodynamics 1
(7)	ENCH 253	Heat and Mass Transfer
(8)	ENCH 254	Fluid Mechanics 1
(9)	ENCH 263	Process Engineering Design 1
(10)	ENCH 271	Chemical Engineering Laboratories 1

4.3 Second Professional Year

The courses in the Second Professional year show more relevance to the process industries and chemical engineering applications. There is a range of interesting courses that cover the theory and practice of chemical engineering in the process industries. There are nine core topics and one elective, which allows students to begin a branch of specialisation that can be continued and consolidated in the subsequent and final year. For example, students may choose to specialise in environmental engineering, wood process engineering, bioprocess engineering or automatic control in the process industries by selection of the relevant topics in the Second and Third Professional years.

Topics covered are: engineering computation and process modelling, chemical reaction engineering, thermodynamics, heat transfer theory and operations, heat exchanger design and pinch analysis, fluid and particle mechanics, solid and fluid handling, distillation, humidification and drying operations, column operations, membrane separations, materials of construction, optimisation of systems, design of experiments, process design of equipment, problem solving skills, column operations, wood process science and industrial safety.

Second Professional Examination

(1) ENCH 350 Process Systems Engineering (two course weight)
(2) ENCH 351 Chemical Reaction Engineering
(3) ENCH 352 Thermodynamics 2
(4) ENCH 353 Heat Transfer Operations
(5) ENCH 354 Fluid Mechanics 2
(6) ENCH 355 Particle Technology
(7) ENCH 360 Chemical Engineering Separations (two course weight)
(8) ENCH 363 Process Engineering Design 2
(9) ENCH 371 Chemical Engineering Laboratories 2
(10) ONE of the courses (a) to (h) listed below:
    (a) ENCH 321 Industrial Pollution Control
    (b) ENCH 322 Energy Resource Management
    (c) ENCH 323 Special topic
    (d) ENCH 327 Wood Process Science (Chemical)
    (e) ENCH 357 Special Topic
    (f) ENCH 358 Advanced Chemical Engineering Materials
    (g) ENCH 359 Chemical Engineering Mathematics
    (h) ENCH 380 Bioprocess Engineering

4.4 Third Professional Year

In the Third Professional year there are four compulsory courses that are essential background knowledge for any chemical engineer as well as providing a valuable educational experience. There is a Process Engineering Design course in which students, working in groups, are required to design and economically evaluate a complete process, giving them an experience that is as close as possible to the job they would be doing if they worked in a chemical engineering design office. The Design Project which forms the major part of this course is one of the main culminating features of the entire degree course and gives the student the opportunity to bring together many of the individual subject skills in the detailed design of a real process. Example processes include the production of skimmed milk powder, protein concentrate and liqueurs from milk, magnesium from seawater and urea from coal gasified underground. There are two associated courses, one on Process Management that concentrates on the background economic concepts needed for process evaluation, and one on Process Control so students know how to keep their processes operating consistently to make products of the right quality. The final compulsory course is a Research Project where students have to work independently to make progress in solving a real research problem.

There are also a number of optional courses and students choose four of these. They can make their choices to give their degree a biological emphasis by studying Engineering

Microbiology or Process Biotechnology, enhance their process design knowledge by studying extra Process Control or Thermodynamics or take other subjects of interest including Industrial Pollution Control, Engineering Systems, Wood Process Science or Engineered Wood Products. Students can also take the option of replacing one of their optional courses with any six point course from another faculty if they would like an experience outside the normal courses taken for engineering and science.

Third Professional Examination

(1) ENCH 450 Process Control
(2) ENCH 460 Process Management
(3) ENCH 463 Process Engineering Design 3 (two course weight)
(4) ENCH 471 Research/Management Project
(5) FOUR of the courses (a) to (n) listed below
- (a) ENCH 415 Engineering Microbiology
- (b) ENCH 421 Industrial Pollution Control
- (c) ENCH 422 Energy Resource Management
- (d) ENCH 427 Wood Process Science (Chemical)
- (e) ENCH 429 Engineered Wood Products
- (f) ENCH 451 Advanced Process Control
- (g) ENCH 452 Thermodynamics 3
- (h) ENCH 454 Process Biotechnology
- (i) ENCH 455 Engineering Systems
- (j) ENCH 457 Special Topic
- (k) ENCH 458 Advanced Chemical Engineering Materials
- (l) ENCH 459 Chemical Engineering Mathematics
- (m) ENCH 480 Industrial Process Engineering
- (n) ENCH 481 Bioprocess Engineering 2

Subject to the approval of the Head of Department a candidate may offer in place of *one* of the courses under (5) above one of the courses listed below:
- (a) ENCH 441 Engineering Chemistry 3A
- (b) ENCH 442 Engineering Chemistry 3B
- (c) ENCH 443 Engineering Chemistry 3C
- (d) ENCH 444 Engineering Chemistry 3D
- (e) ENCH 445 Engineering Chemistry 3E
- (f) ENCH 446 Engineering Chemistry 3F

or any other set of degree courses which, in total, is equivalent to at least 6 points, provided that the candidate satisfies the necessary prerequisites for each course concerned and that none of the courses have been credited towards a degree course.

A candidate's choice of courses shall be approved by the Head of Department.

NOTES:
(1) Not all courses 5(a) to (n) will necessarily be available in any one year and prospective candidates should consult the Head of Department concerning the courses to be taught.
(2) ENCH 415, ENCH 421, ENCH 422, ENCH 427, ENCH 458 and ENCH 459 are restricted against, respectively, ENCH 315, ENCH 321, ENCH 322, ENCH 327, ENCH 358 and ENCH 359.

5. COURSE DESCRIPTIONS

5.1 First Professional Year Courses

EMTH 210 ENGINEERING MATHEMATICS 2 — Math Dept

This course focuses on the mathematics used in various branches of Engineering. It covers a selection of topics in multivariable calculus, ordinary differential equations, and linear algebra. These topics include Fourier series, eigenvalues and eigenvectors, Laplace transforms and double integrals.

EMTH 271 MATHEMATICAL MODELLING & COMPUTATION 2
Math Dept/ K Morison

The course is one of numerical methods, Matlab programming and modelling.

Prescription: Use of the package MATLAB including matrix algebra, user-defined functions, surface plotting. Numerical methods including solutions of systems of linear equations, solution of ordinary differential equations and systems of equations, approximation techniques. Modelling projects. Engineering applications using spreadsheets.

ENCH 202 ENGINEERING MATERIALS 1 (CHEMICAL) — M Kral

The course is taught by the Department of Mechanical Engineering, dealing with all materials classes (metals, ceramics, polymers, composites and electronic materials). The course covers atomic/crystal structure, thermodynamics and kinetics, mechanical properties of materials, principles of materials selection, processing, environmental interactions (corrosion) and failure mechanisms.

Prescription: Metallurgy, polymers, corrosion, strength of materials.

ENCH 241 ENGINEERING CHEMISTRY 2 — P Steel (CHEM)

This course includes topics in chemistry selectively taken from a number of 200 level chemistry papers. Topics include: Physical (chemical kinetics, surfaces and catalysts); Analytical (principles and applications of chromatographic separation techniques); Organic (a dedicated 200 level organic chemistry course based on the reactions of organic molecules of interest to industrial chemists and chemical engineers). Biochemistry is now a significant part of the course.

There are a number of labs which are a compulsory part of this course.

Prescription: Organic, inorganic, analytical and physical chemistry.

ENCH 250 CHEMICAL PROCESS TECHNOLOGY — **I A Gilmour**, C J Williamson, P A Gostomski

This course is in three parts.

- Stoichiometry, Material and Energy Balances, Flow Sheeting. The theory and practice of solving material and energy balances for systems with and without chemical reaction. Material and energy balances on combustion processes.
- Process Safety. Industrial Safety including Hazard Analysis and industrial case studies.
- Works Visits. Visits to some local industrial sites, to help relate the theory to the real world of chemical engineering.

Prescription: Stoichiometry of chemical processes, process safety

ENCH 252 THERMODYNAMICS 1 — **C J Williamson**

An introduction to fundamental thermodynamics. The course is in two halves. The first deals with introductory ideas and the First Law of Thermodynamics, applied to closed and open systems. The second half deals with the Second Law and some of its applications, including property prediction.

Prescription: An introduction to chemical and process thermodynamics.

ENCH 253 HEAT AND MASS TRANSFER — **P J Jordan**/K H Chu

The course is in two parts. Heat Transfer deals with mechanisms of heat transfer, conductive heat transfer at steady state; convective heat transfer, Newton's Law for unsteady state heating and cooling, and or introduction to heat exchangers.

Mass Transfer includes consideration of molecular diffusion and eddy diffusion processes, and of the basic mass transfer relationships governing flux, diffusivity, and concentration gradients. The concept of mass transfer coefficients is introduced and the inter-relationships between film mass transfer coefficients and overall mass transfer coefficients are analysed. An overview of mass transfer operations in Chemical and Process Engineering is also included.

Prescription: An introduction to heat-transfer and mass-transfer operations.

ENCH 254 FLUID MECHANICS 1 — **K R Morison**

Fluid Mechanics deals with properties of fluids, pressure in static systems, buoyancy, dynamic systems, energy, Bernoulli's equation, flow meters, friction, pipe flow, pumping, compressible flow and other topics. It also includes a section on units of measure and dimensional analysis.

Prescription: Units, dimensional analysis and fluid mechanics

ENCH 263 PROCESS ENGINEERING DESIGN 1 **J Pearse**
KRM/IAG

Basic sketching and drawing of engineering components, engineering drawing using both manual and CAD techniques, introduction to engineering design and familiarisation with engineering hardware. Electrical motors and circuits.

Prescription: Drawing, anatomy of engineering, electric motors and circuits

ENCH 271 CHEMICAL ENGINEERING LABORATORIES 1
K H Chu/Ian Gilmour

A series of laboratory classes to illustrate aspects of chemical engineering taught in ENCH 250, ENCH 252, ENCH 253, ENCH 254 and to learn important aspects of engineering report preparation.

There are a total of eight experiments distributed through the year. A formal report is required for each experiment, except the first, usually due one week after the date of the experiment. A sample calculation, and in some cases a line diagram of the apparatus, is required as preparation before most experiments. There are 14 formal lectures supporting the individual laboratories, report writing and proper measurement techniques.

Prescription: Measurement, errors, laboratory experiments and reports, spreadsheet calculation

5.2 Second Professional Year Courses

ENCH 350 PROCESS SYSTEMS ENGINEERING	P J Jordan K R Morison

This course is in 5 parts:

- * Engineering Computation covers engineering computational tools such as advanced Excel, Matlab, Simulink and a revision of Visual Basic.
- * Optimisation gives an introduction to optimisation methods including Excel's Solver.
- * Process Modelling covers development of mathematical models of processes.
- * Process Dynamics involves mathematical modelling, revision of Laplace transforms, process dynamic elements and linearisation, state space methods.
- * The section on the Numerical Solution of Algebraic and Differential Systems covers methods for numerical solution of algebraic equations and ordinary differential equations.

Prescription: Process dynamics, optimization, matlab, effective computation, differential equations and linear systems.

ENCH 351 CHEMICAL REACTION ENGINEERING	K R Morison K H Chu

This course is in two sections: The first teaches a series of introductory lectures dealing with the process context of chemical reactors such as biological treatment, fermentation, petro-chemicals, combustion, inorganic chemical production, batch and continuous reactors together with definition of nomenclature and terms. The course provides some revision and extensions on chemical reaction kinetics including definitions of necessary basic rate expressions, their determination and interpretation. The course deals with the design and sizing of individual reactor types, the principle types including batch reactors, plug flow reactors, and continuous tank

The second section presents lectures which build upon on the concepts for chemical reactor design with some treatment of biochemical reactors and fermenters. Consideration will also be given to mixing and non-ideal flow in reactors and the methodology for residence time distribution measurements and their interpretation summarised. The final section of the course deals with heat effects in chemical reactors and explains concepts including optimum temperature profile.

Prescription: Chemical reaction engineering, process modelling.

ENCH 352 THERMODYNAMICS 2	K N Marsh

Review of fundamentals, phase diagrams, non-ideal gases and equations of state. Thermodynamic relationships, residual properties, correlations. Solution thermodynamics, partial and excess properties. Activity coefficient models and mixture equations of state. Introduction to thermodynamic models in simulation packages. Liquid-vapour, liquid-liquid, vapour-liquid-liquid and solid-liquid equilibria.

Prescription: Further topics in chemical and process thermodynamics.

ENCH 353 HEAT TRANSFER OPERATIONS — **P J Jordan**, I A Gilmour

This course is split into two sections: The first section of 12 lectures is on heat transfer. Conduction covers practical analytical and numerical solutions for unsteady state conduction in one and more dimensions, and heat transfer from finned surfaces. Radiation covers classical radiation theory, emissivity and the greenhouse effect, radiation shape factors, the electrical analogy and multi-surface radiation interchange.

The second section of 12 lectures covers; types of heat exchangers, thermal design and sizing of shell and tube exchangers and plate heat exchangers, optimisation for performance, sizing of evaporators, pinch analysis for energy targeting and design of heat exchanger networks.

Prescription: Heat transfer, heat exchanger design, evaporators.

ENCH 354 FLUID MECHANICS 2 — **J Abrahamson**, P J Jordan, S S Pang

This 24 lecture course brings together a number of different aspects of fluid mechanics that are relevant to chemical engineering. It includes advanced fluid mechanics (momentum, continuity, Navier Stokes and CFD), non-Newtonian flow (constitutive equations, capillary flow, pressure drop prediction, viscosity measurement), and solid/liquid flow, gas/liquid flow and mixing of liquids, mixer design and selection.

Prescription: Momentum, CFD, mixing, non-Newtonian, gas-liquid, solid-liquid flow.

ENCH 355 PARTICLE TECHNOLOGY — **J Abrahamson**, K H Chu

Topics covered are useful for understanding and design of many particle handling and processing operations. It covers particle fundamentals, particle/fluid interaction, flow through beds of particles, solid/fluid materials handling, hopper design, bulk powder properties, classifiers, fluidisation, filtration, sedimentation, pneumatic conveying.

Prescription: Flow and processing of particulate solids, atomization, flow with two phases.

ENCH 360 CHEMICAL ENGINEERING SEPARATIONS — **I A Gilmour**, SS Pang, , K H Chu

This is a full year double weight course which deals with process operations involving separations. Operations considered include: distillation, humidification, drying, liquid-liquid extraction, gas absorption and membrane separations. Basic principles of distillation and absorption are described and the design methods for simple stage-wise and continuous contact equipment are discussed. The basic relationships governing heat and mass transfer processes during cooling of liquids by evaporation and drying of moist solids are considered. The principle of liquid-liquid extraction is described and elementary concepts concerned with totally miscible systems and partially miscible systems and the simple design methods for stage-wise processes are summarised. There will also be an 8 lecture section dealing with the important area of membrane separation processes. This will include consideration of operations such as ultra-filtration, reverse osmosis, micro-filtration and dialysis.

Prescription: Mass transfer, stage processes, distillation and column design, liquid extraction, psychometrics, drying, membranes, batch processes, other separations, selecting separation processes.

ENCH 363 PROCESS ENGINEERING DESIGN 2 — I A Gilmour

P A Gostomski, C J Williamson

This course is taught in four parts:

* a 9 lecture block on Process Diagnostics which is designed to develop confidence and skills in solving engineering problems. Some problem solving strategies are covered with their application to set problems.
* a 7 lecture block on Material and Energy balances, covering degrees of freedom analysis with practice at solving problems on reactive systems.
* an 8 lecture block on industrial safety. This will include risk reduction techniques for design including inherent safety philosophy. Also risk assessment techniques such as Dow Fire & Explosion Index will be covered.
* introduction of a computer aided design package based on HYSYS in 4 lab sessions. This is used as material for one of the design projects.

Two design projects are included.

1) A simple multi-unit design using HYSYS in Semester 1.
2) Design of process plant relating to unit operations within chemical and process industries, or equivalent, in Semesters 1 and 2. Past projects have been in the form of a team competition based on the design and construction of a chemically powered model car. Cars competed for performance locally and the winner qualified for a Grand Final event called Chem-E-Car held at the annual CHEMECA Conference in Australasia.

Prescription: Mass energy balances, problem solving, pinch, safety. Two projects, unit and multi unit operations.

ENCH 371 CHEMICAL ENG. LABORATORIES 2 — J Abrahamson

A series of laboratory classes/experiments with equipment at a small pilot plant scale, to illustrate aspects of material taught in ENCH 350, ENCH 351, ENCH 352, ENCH 353, ENCH 354, ENCH 355, ENCH 359 and ENCH 361. A basic introduction to experimental design and analysis is also given.

A total of 6 experiments must be completed. One topic is compulsory and a further 5 experiments out of a possible 15 are completed throughout the first three terms. A report (either short, rapidly executed industrial, poster, improvement with oral or formal presentation) is written/given for each experiment, usually due one week after the date of the experiment. The major final report is due early in the 4th term. A sample calculation, in most cases a line diagram of the apparatus, and in some cases a proposal, are required as preparation before experiments. 5 lectures are given in *statistical design of experiments*.

Prescription: Laboratory and pilot-plant experiments.

5.3 Courses offered at either Second or Third Professional Year

The courses listed in this section may be taken during either the second or third professional year.

ENCH 321/421/ENCI 484 INDUSTRIAL POLLUTION CONTROL
J Abrahamson/I Mason

Management concerns: characterisation of wastes, waste surveys, pollution prevention. Waste effects: toxicity, fate and transport of pollutants.
Waste water treatment options: equalisation, neutralisation, solids separation.
Air pollution options and their control – gaseous pollutants and particulates. The course has a case-study emphasis, leading directly into the group assignments and field trip.

Prescription: Industrial pollution control, waste effects, pollution prevention.

ENCH 322/422 ENERGY RESOURCE MANAGEMENT I A Gilmour
W B Earl/C JWilliamson

Topics include:

* New Zealand energy resources covering flows and sources.
* Combined heat and power systems.
* Pinch analysis and Process Integration principles for the efficient use of energy, covering; basic theory of energy targeting, heat exchanger network analysis, designing for maximum energy recovery, finding the best network designs and integrations with thermal operations by economic analysis.
* Petrochemical Refining
* Renewable energy forms including biomass, wind, solar, photovoltaic cells and fuel cells.

Prescription: Energy resources, their efficient use and integration in the process industries.

ENCH 327/427 WOOD PROCESS SCIENCE (CHEMICAL) Not Offered in 2005
J C F Walker

This course is taught by Professor John Walker (School of Forestry). The first part of this course focuses on the science of wood material such as the anatomy, chemistry and physics of wood. This is followed by a review of forestry practice and its effects on wood quality. Then selected features of solid wood processing and wood-based panel products are examined. The reasons for processing material in a particular way are also looked into.

Prescription: Wood anatomy, physics and chemistry. Conversion of wood.

ENCH 357 Special Topic (ENGINEERED WOOD PRODUCTS)
Equivalent to ENCH 429 in 2005
S Pang

ENCH 358/458 ADVANCED CHEMICAL ENGINEERING MATERIALS
J Abrahamson
SS Pang/K N Marsh

This course is about the new class of materials known as *nanomaterials* (with fine structure on the scale of nanometres (10^{-9} m)). These materials are revolutionizing many areas of technology, from electronics to energy storage to drug delivery in the human body. The course will explain the emerging value of *nanotechnology* (the production and use of nanomaterials) for the process engineer, and how it is enabling many innovative processes. Application areas covered include nanotubes, membranes, fuel cells and batteries, micromachines, sensors including biosensors, and composite construction materials. The course is balanced with lectures on the background necessary to understand the special properties of nanomaterials (nanomicroscopy, interfaces, polymer chemistry, biological cell structure, micelles, and molecular simulation).

Prescription: Polymers, ceramics, corrosion and electrochemical processes

ENCH 359/459 CHEMICAL ENG MATHEMATICS Not Offered 2005

ENCH 380 BIOPROCESS ENGINEERING L Greenfield (SoBs)

This course is an introduction to microbiology. Structure and attributes of bacteria, fungi and viruses. Introduction to biochemistry of microbial cells, Study of enzymes. Applied use of enzymes. Genetic engineering. Production of recombinant proteins. Recombinant microbes for industrial applications. Beneficial and detrimental effects of microbial growth. Industrial uses of microorganisms.

Prescription: To give an appreciation of the diverse world of micro-organisms, their activity and uses to which they are put.

5.4 Third Professional Year Courses

ENCH415	**ENGINEERING MICROBIOLOGY**	**L Greenfield**

Introduction to microbiology. Structure and attributes of bacteria, fungi and viruses. Introduction to biochemistry of microbial cells, Study of enzymes. Applied use of enzymes. Genetic engineering. Production of recombinant proteins. Recombinant microbes for industrial applications. Beneficial and detrimental effects of microbial growth. Industrial uses of microorganisms.

Prescription: An introduction to the nature, growth and ecology of micro-organisms. Environmental and industrial microbiology.

ENCH 429	**ENGINEERED WOOD PRODUCTS**	**S Pang**

The technology of composites. Product and process requirements in terms of wood chemistry and structure, wood requirements and preparations, resin technology, panel performance requirements and test procedures. Environmental impacts of products and processes. Overview of wood combustion and the pulp and paper industry.

ENCH 441 (CHEM 321/361)
ENCH 442 (CHEM 322/362)
ENCH 443 (CHEM 323)
ENCH 444 (CHEM 324)
ENCH 445 (CHEM 325/BIOCHEM 302)
ENCH 446 (CHEM 363)

The above courses are available as outside options for Third Professional year students under clause 20(5). Please contact the Department of Chemistry for further information.

ENCH 450	**PROCESS CONTROL**	**C J Williamson**

Topics include: Motivation for feedback control including financial and safety considerations. An overview of the different control modes such as feedback, feedforward, on/off and emergency control. Significant detail on structure, tuning and modifications to the main feedback control algorithm - Proportional, Integral, Derivative control (PID). The advantages and disadvantages of feedforward and cascade control will be covered. The simulation package Simulink (part of Matlab) will be used extensively.

Prescription: An introduction to process control technology.

ENCH 451	ADVANCED PROCESS CONTROL	Not offered 2005

ENCH 452	THERMODYNAMICS 3	K N Marsh

Review of fundamentals; solution equilibria, equations of state and activity coefficient models, comparisons and applications. Predictions using *UNIFAC*. Liquid-liquid-vapour equilibria, Solid-vapour equilibria, gas solubility and adsorption. Application and use of *HYSYS*. Data sources, electronic data bases, prediction methods for thermophysical properties. Application of molecular thermodynamics, statistical mechanics and quantum mechanical calculation to understanding and predicting fluid properties.

Prescription: Advanced topics in chemical and process thermodynamics.

ENCH 454	PROCESS BIOTECHNOLOGY	**P Gostomski**/ K H Chu

There are two components to the course.

- *Industrial Biotechnology Operations*
- *Downstream Separation Processes*

Prescription: Applied biochemistry and microbiology, biochemical reaction engineering

ENCH 455	ENGINEERING SYSTEMS	E Dalziell (Civil)

A General Systems approach to analysis and modelling of complex systems and processes in nature, technology and society. The aim is to enable students to adopt a critical and creative response to complex system problems ranging from hard technical systems to softer systems relating to the interface between technology and its social and physical environment.

ENCH 457/ENME 448	Special Topic: Introduction to CFD	**P Jordan**, J Abrahamson

This course aims to provide an understanding of the theoretical background of CFD and an introduction to its practical application including selection of appropriate models and numerical methods and assessment of the quality of the results. This is done through lectures, case studies and assignments including practical exercises using a commercial package

ENCH 459	CHEMICAL ENG MATHEMATICS	Not offered 2005

ENCH 460 PROCESS MANAGEMENT S S Pang/N J Peet

This course has three parts: Technological economics, Project Management and Operations Research.

Technological Economics: information requirements for project analysis, capital and operating cost estimation and investment appraisal using discounted cash flow methods. Wider issues covered include economics and everyday experience, national accounts, environmental, resource and ecological economics.

Project Management: project organisation, definition, strategy, project objective and time planning, critical path, process plant contracts and model forms.

Operations Research: Linear programming concepts, its jargon and techniques to find solutions to objectives. Simplex, revised simplex, sensitivity analysis, symmetric duals, transportation and assignment techniques. Use of EXCEL Solver for such problems with problems arising there from. Application of probability theories to replacement, maintenance and reliability in processing industry is also introduced.

Prescription: Process economics and other economic topics; operations research principles and practice and process project management.

ENCH 463 PROCESS ENGINEERING DESIGN 3 C J Williamson

This course contains some lectures and design projects: The lecture topics are:

- Process flow diagrams (PFDs) and piping and instrumentation diagrams (PIDs).
- Hierarchical strategy for process design following J M Douglas.
- Control system synthesis and control loop specification.
- Process Safety

Prescription: Process systems, computer-aided process design, project management and process plant design projects.

ENCH 471 RESEARCH PROJECT

This course consists of a research project which will be different for each student. Students will select preferences for topics at the end of the second professional year and topics will be allocated during the summer vacation.

6. Other Requirements for B.E.(Hons) Degree

In addition to the academic requirements discussed above there are certain other requirements for the BE(Hons) degree.

6.1 First Aid Training

At some stage before you graduate you are required to present to the College of Engineering Office a valid First Aid Certificate, taught by a University approved organisation. Courses in First Aid are arranged through the College of Engineering Office, who also have details of which certificates are approved.

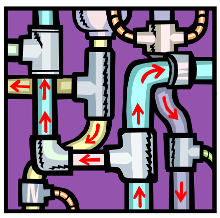
6.2 Workshop Training

In order to become familiar with workshop processes, methods, the use of hand tools, welding, lathes and other machine tools, you are required to undertake workshop training. Workshops totaling approximately 36 hours, are run in-house by the Department during the term breaks . A timetable will be circulated at the start of the academic year and you can book a slot of your choice through the departmental office. You will be invoiced $275 when you commence the workshop training.

You should have completed workshop training before enrolling for any subject of your Second Professional year.

Exemptions will be given to students who have completed an appropriate indentured apprenticeship, or have completed appropriate work for a NZ Certificate of Engineering.

You must apply in writing to Dr Peter Gostomski for an exemption.



6.3 Practical Work Training

Experience gained while working in industry during the summer vacations is a requirement of the BE degree and is an important aspect of the degree programme. You will experience engineering practice and management in two or three jobs, beginning with work in a mechanical workshop and finishing by tackling a professional project. A total of 120 days is required, with at least 40 of those days in a mechanical workshop. Approval is required for these jobs and the College of Engineering Office has details of the requirements.

Students may be given partial or total exemption from Practical Work Training if they have completed an appropriate indentured apprenticeship or appropriate work for a NZ Certificate of Engineering. You must apply in writing to the College of Engineering Practical Work Co-ordinator, Mrs Cheryl McNickel, for an exemption. Further information on Practical Work can be obtained from the Department Practical Work Advisor, Mr Ian Gilmour in the first instance.

6.4 Practical Work Reports

You must submit two work reports on periods of practical work completed. These reports are ***confidential*** between the student and the College of Engineering.

The report should not be disclosed to any other party. The College of Engineering Office has details of the requirements for the work reports.

Employers complete a report form for each student and each period of work. These reports detail the dates of employment, the hours worked, the type of work performed, and comments on student behaviour, attendance and performance. Unsatisfactory reports are discussed with the employer and the student, and may result in the work not being credited for the Degree.

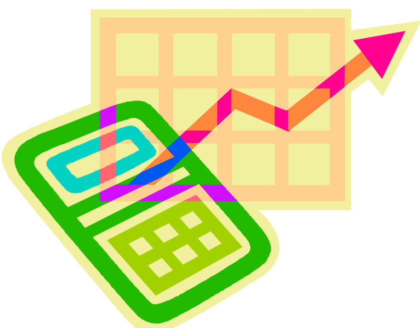
6.5 Calculators and Computers for use in Engineering

All students are expected own a scientific calculator.
Campus computers offers good advice if you wish to purchase a computer : http://shop.it.canterbury.ac.nz/int/

Please note:

Chem Eng Undergrad Computer Lab

No food or drink may be taken into the lab, except for sipper bottles



7. Postgraduate Study

7.1 Where to from here?

The Department has a strong reputation in postgraduate study programmes. Postgraduate study is an opportunity to obtain an in-depth knowledge of an academic discipline. Able undergraduate students are encouraged to keep in mind the possibility of continuing their studies to complete either a Master of Engineering (ME) or a Doctor of Philosophy (PhD) degree. We invite you to discuss with the staff, as early as possible, your continuing academic career either in this department or elsewhere.

The Department has a variety of **postgraduate programmes.**

7.2 M.E.

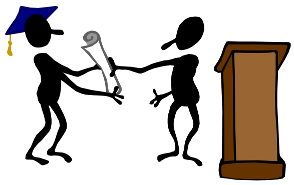
Students who have completed the Honours year may elect to continue for a minimum of one additional year to complete a Masters degree. The degree involves a course of study including postgraduate courses and a research project. Supervision of the thesis is undertaken by a staff member with expertise in the student's area of interest. The programme can be tailored to suit your requirements. Options range from a minimum of two postgraduate courses with more emphasis on the thesis to six courses and a research project.

Students in the Masters programmes can expect to be challenged and to learn a great deal in a very short time. These programmes differ from the BE. First, the focus is on the process of creating knowledge rather than simply acquiring or applying it. Masters students are expected to add to the knowledge base in their subject areas. Second, students are expected to take responsibility for their own learning by seeking out additional sources of information, working independently and with peers. Postgraduate courses, offering in-depth studies of selected topics, will be taught by both the permanent staff and visiting Erskine Fellows who are recognised experts in their subject areas.

M.E. theses recently completed (or in progress)

Chalermot, Warawan	Measuring VOCs in Christchurch ambient air: using SIFT-MS technique
Hinton, Adam	Resin woodfibre wall interactions
Holmes, David	Bacterial cellulose
Narayan Ramanath, D	Computational fluid dynamics modelling
Querrioux, Thomas	Carbon nanotube continuous production
Tandon, Gaurav	Experimental determination of minimum wetting rates in a falling film evaporator
Cussins, Melanie	Clean distributed hydrogen production
Nagata, Yuko	Leachate treatment by direct osmosis

7.3 Ph.D.



The Ph.D comprises a minimum of two years of study and research, with the results presented as a thesis. The Ph.D differs from a Masters in that the research should result in a significant original contribution to knowledge. A candidate will also be expected to undertake postgraduate courses. A Ph.D is essential for those wishing to continue with an academic or research career.

Ph.D theses recently completed (or in progress)

Chapman, Kelvin	A study of two aspects of medium density fibre board manufacture
Hii, Michael	Kiwifruit flower pollination - wind pollination efficiencies and sprayer jet applications
Quispe-Chavez, Nohemi	Conceptual methodology for the design of dairy processes
Ranasinghe, Milinda	Modelling the mass and energy balance in a compost biofilter
Savage, Matthew	Integrated treatment processes for primary wool scouring effluent
Hunter, Tristan	Dynamics and control of multistage membrane plants
Zhang, Zheng	Identification and Evaluation of Improved Drying Methods of New Zealand Beeches by Means of an Energy-efficient Kiln Process."
Gupta, Arun	Pressing of MDF
Herritsch, Alfred	Drying stress and warp in kiln drying of timber
Hughes, Thomas	The effect of natural gas clathrate hydrate structure on calorimetric properties and dissociation time
Kandil, Mohamed	Thermodynamic and transport properties of mixtures of refrigerants with compatible lubricants
Kibar, Derya	Photo catalytic degradation in a novel reactor design for wastewater treatment applications
McMurdy, Murray	Efficient kiln drying of quality softwood
Miladinovic, Natalija	Biological interactions during ion exchange
Shastry, Rahul	Continuous production of carbon nanotubes by an arc discharge in a reactor and its application as filed emission devices
Stevenson, John	Study and development of a digitally based optimal state space/fuzzy logic control system for Department's existing glass distillation column
Vasudevamurthy, Madhu	Novel compatible solutes of enzyme and protein stabilisation

Professor Shusheng Pang is the Director of Postgraduate Studies

8. Research Interests of Staff

Dr John Abrahamson, M.E., Ph.D., C. Eng., M.I. Chem.E., FRSNZ
Particle collection; bin design; cyclones; particle measurement and sampling; caking of solids; snow; oscillating flows; carbon; ball lightning; nanotubes and particles.

Dr Khim Chu, B.E. (Hons), Ph.D. (National University of Singapore)
Bioseparations; large-scale chromatography; adsorption technology; wastewater treatment; process modelling.

Mr Ian A Gilmour, M.E., C.Eng., M.I.Chem.E.
Fuel technology; renewable energy; integration of heat and power industry, utilisation of wood and biomass residues as sources of chemicals; clean technologies, computer modelling of pulp and paper processes.

Dr Peter A Gostomski, B.S.(Penn State), M.S., Ph.D.(RPI).
Bioprocess engineering; air pollution control technology; process control.

Dr Pat J Jordan, B.E. (Hons), Ph.D.
Computational fluid dynamics; wood technology; heat transfer; supercritical fluid extraction (especially lipids); process modelling

Professor Ken N Marsh, B.Sc.(Hons)(Melb), M.Sc., Ph.D.(New Eng.).
Thermodynamic properties of fluids and fluid mixtures; measurement of vapour-liquid equilibria; heat pumps and properties of refrigerants; use of ionic liquids as replacement for volatile organic solvents; physical property prediction methods.

Dr Ken R Morison, B.E.(Hons), D.I.C., Ph.D. (Lond.).
Fluid mechanics; non-newtonian fluids; viscosity measurement; process measurement and control; process modelling and simulation, dairy process engineering; Visual Basic/Excel/Word.

Associate Professor Shusheng Pang, B.E, M.E, Ph.D
Director of Wood Technology Research Centre
Heat and mass transfer, separation processes, mathematical modeling, process and equipment design, wood thermodynamics and properties, drying fundamentals and technologies, wood products and processing, MDF processing

Dr Chris J Williamson, B.E. (Hons), Ph.D., C. Eng., M.I. Chem.E.
Process design; simulation and control; artificial intelligence applications in chemical engineering (especially artificial neural networks and expert systems); thermodynamics.

Associate Professor W Brian Earl, B.E. (Hons), B.Sc.(N.Z), Ph.D. C. Eng., F.I.Chem.E., F.NZIC, F.IPENZ. (Retired)
Process design (especially computer aided); dynamic process modelling; alternative vehicle fuels; electrochemical engineering (corrosion, aluminium batteries), separation processes.

Dr N John Peet, B.Sc.(Hons)(Edin.), Ph.D., C.Eng., F.I.Chem.E, F.NZIC., F.IPENZ. (Retired)
Energy analysis, energy policy studies; air pollution; environmental systems dynamics; sustainability; ecological economics; sustainability of complex systems.

9. Some other information

9.1 Where Staff Are Located

Chemical and Process Engineering academic and secretarial staff occupy levels 4 and 5 of the S R Siemon building on the corner of Creyke and Forestry Roads. The Mechanical Workshop is situated on the ground floor of the H D Denham building and the Electrical Workshop is on level 2 of the same building. There is a photoboard with a photo of all staff and their room numbers in the foyer on the ground floor of the S R Siemon building. All rooms are numbered and most have the staff member's name on the door.

9.2 Lecture Times and Punctuality

All morning lectures start promptly on the hour, and finish at 10 to, ie., 8.00 -8.50 am
Laboratories/Lectures in the afternoon start at 10 past the hour, i.e., 1:10 -2.00pm

Please note the 20 minute morning tea break in Engineering has ceased to exist from 2005. There is still a lunch break from 12.50pm to 1.10pm

Please arrive punctually for lectures and laboratories. Late arrivals distract students and lecturers and may result in exclusion from the lecture or laboratory.

9.3 Other Sources of Information

Department Health & Lab Safety Manual
Department Postgraduate Handbook
Faculty of Engineering Postgraduate Handbook
University of Canterbury Student Guide
University of Canterbury Enrolment Handbook
University of Canterbury Calendar

9.4 Endnote

This book has been written in good faith with the intention of giving useful information and insights to students. It is not an official statement of University policy. In all cases the University Calendar should be referred to for precise statements of the University regulations. Naturally, even the departmental policies stated may have to be modified as circumstances change.