School of Chemical and Biomolecular Engineering

Unit of Study Descriptions

ENGG 5001 Professional Development

This unit of study is compulsory for all Postgraduate Coursework students enrolled in the Faculty of Engineering and Information Technologies.

6 credit points

Semester 1 / 2

Classes: lectures, tutorials and workshops (2 hours per week)

Assessment: Essay, presentation, participation in group project, project report.

Objectives:

To provide:

- an introduction to the various elements of engineering practice
- an understanding of the role of the engineer in industry
- basic knowledge of the law of contracts and legal responsibility
- teamwork and leadership skills
- an understanding of professional responsibilities of engineers
- competence in verbal communication and presentations
- competence in reading and writing reports
- an understanding of ethical considerations.

Outcomes:

Students will have a working competence in the various elements of engineering practice, and enhanced communication skills that will assist them in their other technical courses.

Syllabus Summary:

- Some Heroic Engineers
- The various roles of engineers
- Professional and legal responsibilities
- Teamwork
- Leadership
- Creativity
- Effective verbal communication
- Effective written communication
- Ethical issues
- Engineering case studies – successes and disasters
- Management of risk

CHNG 5002 Environmental Decision Making (Wastewater Treatment Technologies)

6 credit points

Semester 2

Assessment:

Evaluation of this course will be on the basis of 2 assignments (40%), one run in the third quarter and one in the fourth, two quizzes (40%) and attendance of two field trips (20%). The assignments will consist of a combination of group and individual work, and will require interim hand-ins and a final hand in on which assessment will be based. Attendance at lectures and tutorial hand-ins are prerequisites to successful completion

Aims and Objectives

- To gain an operational and legal context for waste and specifically wastewater generation and treatment.
- To develop an awareness and comprehensive understanding of technologies (physical, chemical and biological) which may be used as effective treatments for liquid and some solid waste streams, based on process principles.
- To explore issues pertaining to management of environmental hazards in the process industry

Syllabus Summary

- An operational paradigm for the process industries
- Why waste is inevitable
- A regulatory framework
- Hazard rating of process wastes
- Physical treatment technologies
- Chemical treatment technologies
- Biological treatment technologies
- Waste containment practices

Recommended Readings

- Standard handbook of hazardous waste treatment and disposal, Harry M. Freeman, editor. New York:McGraw-Hill, c1998. 2nd ed
- Industrial water pollution control, W. Wesley Eckenfelder, McGraw Hill

CHNG 5003 Green Engineering

6 credit points

Semester 2

Assessment: 5 case studies worth 20% each

Contact hours: 1 x 1 hour lecture, 2 x 1 hr self directed group learning sessions, 1 x 3 hour laboratory session

Aims and Objectives:

Green engineering, eco-technology and sustainable technology are all interchangeable terms for the design of products and processes that maximise resource and energy efficiency, minimise (or preferably eliminate) waste and cause no harm to the environment. In modern society, engineers equipped with the skills to develop sustainable technologies are tremendously valuable. This course will examine cutting edge examples of sustainable technologies across a broad range of applications relevant to chemical engineering.

Syllabus summary:

Case studies and applications include:

- A brief introduction to the modern chemical engineer and her fields of practice.
- Introduction to sustainable technology design, eco-technology and green engineering.
- A review of sustainability models and practice.
- Zero emission process design
- Natural capital
- Case study 1 – Carbon sequestration
- Case study 2 – Phytomining - mining gold with plants
- Case study 3 – Making paper from agricultural wastes
- Case study 4 – Zero emission brewing
- Case study 5 – Biomimicry

Note: Other topics may be substituted in the case studies as appropriate

CHNG 5004 Particles and Surfaces

6 credit points.

Semester: 2

Contact Hours: Lectures (2 hours per week), tutorials (2 hours per week), practicals (10 hours in the session).

Objectives:

Solid-solid and solid-liquid interactions are an important aspect in mineral processing. The aim of any mineral processing operation is the efficient extraction of the valuable metals or minerals (concentrate) from the waste materials in the ore (gangue). The goal of this course is to understand the various key steps and the corresponding principles required to achieve metal extraction from the ores. In achieving this, the course will include elucidation of the principles in size reduction or comminution of the ore in liberating the valuable minerals, and the examination of the microscopic details of solid-liquid, solid-gas andsolid-solid interactions in mineral processing and their roles in macroscopic phenomena such as adhesion, wetting, adsorption, and mineral reactions such as reduction roasting and leaching. The general understanding of these factors will allow manipulation and improvement of performance in mineral beneficiation, dewatering of mineral slurries and extractive metallurgy.

Syllabus summary:

- Liberation: the release of valuable minerals from associated gangue using comminution strategies (size reduction), control through particle size analysis and understanding of mineralogy and grain sizes.
- Separation/Beneficiation: separation of “concentrates” and “gangue using the differences in mineral properties including density, magnetic susceptibility, electrical conductivity, surface chemistry (hydrophobicity/hydrophilicity).
- Dewatering: sedimentation, flocculation and coagulation, filtration and thermal drying.
- Hydrometallurgy/Pyrometallurgy: chemical thermodynamic modeling of aqueous and solid systems, mineral stability.
- Metal Recovery: precipitation, electrowinning, electrorefining, adsorption and solvent extraction.
- Tailings Disposal: management of solid and liquid effluents
- Applications: Design and analysis of comminution circuits. Development of strategies for the processing of complex ores and waste products. Disposal of heavy metal residues and the impact on the environment.

CHNG5601 Membrane Science

6 credit points.

Semester: 1

Prerequisite: N/A

Assessment: Examination

- To give students a background in the physics of cell membranes.
- For students to understand the electro diffusion of materials through membranes.
- To provide the students with a good background in the electrical properties of cell membranes
- For student to gain an understanding of the process of excitation in nerve and muscle.

Expected outcomes:

Students will be able to:

- Understand the physical and physico-chemical basis of processes in cell membranes.
- Understand the ubiquitous ion channel basis of nerve excitation and transport in cells.
- Be able to assess the physico-chemical basis of new developments in biotechnology, bionic devices and pharmacological areas and contribute to those developments.
- Understand the use of electroporation techniques for genetic engineering and animal cloning.

Syllabus summary:

Self-assembly, molecular structure and function of cellular membranes. Ion partitioning and electrical properties. Fixed charge membranes, Electrodiffusion, Nernst potentials, osmotic relations, chemio-osmotic hypothesis. Ion channels and other protein nanomachines.

Nerve excitation, the Hodgkin-Huxley equations. Excitation in cardiac and other tissues. Membrane stability, electrical breakdown in cell membranes. Biotechnology applications including electroporation techniques for genetic engineering and animal cloning.

References:

R. K. Hobbie Intermediate Physics for Medicine and Biology, John WileyH. G. L. Coster Thermodynamics of Life Processes, UNSPress (Library reference only)B. Nölting Methods in Modern Biophysics, SpringerW. Ho and K. K. Sirkar Membrane Handbook Part VIII Microfiltration. Chapman Hall Plus Recommended as required within the course.

CHNG5602 Cellular Biophysics

6 credit points.

Semester 1

Assessment: Examination Objectives

- To give students a good background in the physics of biological processes.
- For students to understand differences between thermodynamically closed and open systems and its relevance to cells and other biological systems.
- To provide an introduction to the thermodynamics of irreversible and evolutionary processes of relevance to biology.
- To introduce students to the statistical mechanics of self assembly and equilibrium structures and its relevance to biology at the molecular level.

Expected outcomes:

Students will be able to:

- To deduce basic physical aspects of biological processes in different contexts.
- Analyse transport (mass transfer) in biological systems and the bioenergetics of such processes.
- Understand and appreciate the rapidly advancing new developments in molecular biology and biotechnology.

Syllabus summary:

Review of thermodynamics, open and closed systems, entropy production. Thermodynamics of non-equilibrium processes. Energy transformation, active transport. The Donnan equilibrium, dielectric exclusion and ion partitioning. The evolution of open thermodynamic systems. Application of Statistical-Mechanics to self-assembly of molecular structures, applications of biological interest.

References:

R. K. Hobbie Intermediate Physics for Medicine and Biology, John Wiley H. G. L. Coster Thermodynamics of Life Processes, UNSPress (Library reference only) B. Nölting Methods in Modern Biophysics, Springer Plus Recommended as required within the course.

CHNG5603 Analysis, Modelling and Control of Bio-Physical Systems

6 credit points.

Semester 1

Assessment: Project work and assignments.

Objectives:

- To give students an understanding of the use of (computer-based) statistical techniques in extracting information from experimental data obtained from biophysical systems.
- To acquaint students with the issues and techniques to be considered when mathematically modelling bio-physical systems.
- To familiarise students with the issues and techniques to be considered when developing a monitoring and/or control scheme for bio-physical systems.

Expected outcomes:

Students will be able to:

- Choose the appropriate statistical technique(s) to employ when faced with the task of analysing experimental data, and use the relevant techniques(s) within a computer-based environment (such as Excel, Matlab or SSSP).
- Appreciate what the most appropriate modelling option is in a given situation (ie empirical (data-based) modelling; parameter estimation within a given model form; first-principles modelling).
- Design a monitoring/control scheme based on the key dynamic features of the process.

Syllabus summary:

Review of statistical distributions; tests based on z, t and F variables; calculation of confidence intervals; hypothesis testing; linear, multi-linear and nonlinear regression; analysis of variance; principal component analysis; use of computer-based statistical tools. Data-based modelling techniques (ie time series analysis; neural networks; genetic programming); parameter estimation and uncertainty analysis; first-principles modelling based on the underlying physico-chemical mechanisms; use of computer-based modelling

tools. Dynamic response of bio-physical process; inferred or estimated variables; control system design and implementation; introduction to model-based control; use of computer-based control system design and analysis tools.

References:

Recommended as required within the course.

CHNG5604 Membrane Science Laboratory

6 credit points.

Semester 2

Assessment: Laboratory exercises

Objectives:

- To allow students to explore experimentally the theoretical concepts learned in the other modules.
- To gain practical insights into electrodiffusion and other mass transport processes through membranes.
- To give students an understanding of the construction and functional properties of synthetic separation membranes.

- To explore experimentally the various factors affecting the performance of synthetic separation membranes.

Expected outcomes:

Students will be able to:

- An enhanced appreciation of the science and technology of membranes.
- Apply concepts learned in the theoretical courses to practical problems.
- Develop membrane-based devices for water purification or waste water management.
- Be in a position to assess and correct problems encountered in membrane based processes.

Syllabus summary:

The course is comprised of a series of some 20 integrated, in depth, laboratory based exercises and analytical problems. Topics include:

Construction and structure of synthetic membranes. Reverse osmosis, nanoflitration and microfiltration membranes. Flux measurements, pore characteristics. Ion exchange membranes. Electrodiffison, membrane potentials, Goldman equation, streaming potentials. Electrodialysis.

References:

R. K. Hobbie Intermediate Physics for Medicine and Biology, John Wiley

H.G. L. Coster and T. C. Chilcott Fundamentals of Membrane Science – Laboratory Notes to be made available to students B. Nölting Methods in Modern Biophysics, Springer W. Ho and K. K. Sirkar Membrane Handbook Part VIII Microfiltration. Chapman Hall Plus recommended as required within the course.

CHNG5605 Bio-Products: From Laboratory to Marketplace

6 credit points.

Semester 2

Assessment: Project work.

Objectives:

To give students an appreciation of the various stages involved in successfully taking a bio-product from the laboratory into the marketplace.

For students to understand that for any given bio-product there are invariably a number of production paths, each of which has its advantages and disadvantages.

To show students the steps involved in preparing a business plan for a given bio-product that takes due account of both technical and financial considerations.

Expected outcomes:

Students will be able to:

- Develop alternative production paths for a given bio-product and rank these on the basis of a combination of technical and (first-pass) costing considerations.
- Further develop the more attractive production path(s) and appreciate the role that commercial flowsheeting software can play at this stage.
- Develop a complete business plan for the chosen production path for a specified bio-product.

Syllabus summary:

Bio-product manufacture (including separation and purification); product specifications; the role of regulatory authorities; scaling-up the process; economic criteria for ranking alternatives; use of flowsheeting software (eg Aspen Plus). Market identification; selling your idea to the Board; cost estimation; determining the 'optimal' size plant; quantifying and coping with technical and market uncertainty; development of a business plan. For a specified bio-product, each student would be expected to work towards the development of a business plan that could be used to successfully 'launch' a new manufacturing process.

Referencs:

Recommended as required within the course.

Projects and Seminars

Theses Projects (a written report on a specific topic to be undertaken only under the guidance of an academic supervisor):

CHNG 5901 PROJECT PART A (Semester 1)

6 credit points

CHNG 5902 PROJECT PART B (Semester 2)

6 credit points

CHNG 5904 SEMINAR 1

2 credit points

CHNG 5905 SEMINAR 2

2 credit points

CHNG 5906 EXTENDED & ENHANCED PROJECT

12 credit points

CHNG 5907 EXTENDED & ENHANCED PROJECT

24 credit points

Session: 1 or 2

Assessment: Assessment of Thesis

Objectives

To complete a research project and successfully analyse a problem, devise appropriate experiments, analyse the results and produce a well-argued thesis.

Expected outcomes:

Students will be able to:

- Develop research skills and to cope with ambiguity
- Select appropriate engineering principles to solve an open-ended problem
- Understand that engineering is practised in non-ideal, poorly defined situations. A good engineer is able to successfully solve problems in these situations.

Syllabus summary:

In order to enrol in a project, students must first of all secure an academic supervisor in an area that they are interested in. The topic of your project must be determined in discussion with the supervisor.