The University of Sydney
School of Chemical and Biomolecular Engineering

Units of Study – Standard Bachelor Degree Programs

CHNG1006 Professional Communication for Engineers

Credit points: 2 **Teacher/Coordinator:** Dr Marjorie Valix **Session:** Semester 2 **Classes:** 2 hours of lectures/tutorials per week for 1 semester. **Corequisites:** CHNG1103 **Assessment:** Tutorials and assignments (pass/fail course): participation (attendance and contribution) 10%; individual written exercises 4 x 10%; individual written assignment 50% **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Note: Students who fail a diagnostic skills test will be asked to enrol in this unit of study.

Aim: To improve students' written communication for academic and professional purposes. This course will specifically develop skills in the construction, cohesion, style and grammar of key written genres such as short answer responses and reports; to develop critical and analytical approaches to processing information; to support written assessment tasks within the discipline. Syllabus summary: This course will address the need for engineers to have adequate literacy skills. The course will cover aspects of information retrieval and processing, construction and development of an answer, control of academic writing, grammatical correctness and quality of presentation. There will be a focus on improving the structure, academic style and grammatical correctness of students' writing. Outcome: At the end of this unit of study students should be able to demonstrate improved skills in: writing appropriately for audience, purpose and situation; understanding basic sentence and paragraph structure; critically evaluating information; logical reasoning in writing.

CHNG1103 Material & Energy Transformations Intro

Credit points: 6 **Teacher/Coordinator:** Dr Marjorie Valix **Session:** Semester 2 **Classes:** 4 hours of lectures/tutorials per week for one semester. **Assumed knowledge:** Mathematics Extension 1; 2 unit Physics; 2 unit Chemistry. **Assessment:** Continuous assessment by assignments 50%; final examination 50%. **Practical field work:** Occasional field trips to industrial sites. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This unit of study replaces CHNG1101, CHNG1102, CHNG1001, CHNG1201.

This unit of study is an introduction to chemical engineering processes and calculations. Syllabus summary: Material transformations related topics will include unit systems and unit conversion; properties of fluids; mass balance calculations on flow systems; equilibrium compositions of reacting systems; vapour pressure and humidity. Energy related topics will include first law of thermodynamics applied to flow systems; thermodynamic properties such as enthalpy, internal energy, heat capacities; calculations for ideal gas and liquid gas systems and thermochemistry.

Objectives: Students should develop an understanding of and competence in the formulation and solution of material and energy balance problems in engineering; develop competence in using basic flowsheet analysis and appropriate computational tools; improve their group work and problem solving skills; gain an ability to extract a simplified version of a problem from a complex situation. Outcomes: By the end of the unit of study, students will be able to set up and calculate energy and material balances for a variety of commonly encountered engineering scenarios; appreciate key aspects of processes carried out in today's chemical and process industries; work as an effective member of an engineering team; be able to outline a logical approach for solving a variety of complex engineering problems.

CHNG2801 Conservation and Transport Processes

Credit points: 6 **Teacher/Coordinator:** A/Prof Fariba Dehghani **Session:** Semester 1 **Classes:** 2 lectures per week for 1 semester, 1 hour tutorial per week for 1 semester and projects and self assisted learning (4 hours per week for 1 semester). **Prerequisites:** All core 1st year engineering units of study. **Assumed knowledge:** Calculus Computations (Matlab, Excel) Mass and Energy Balances **Assessment:** Competency based assessment, assessment weighting:| Tutorials (20%) Quizzes (30%) Final examination and/or individual projects (30%) Group work and presentations (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day By the end of this unit of study, students should be proficient at applying the basic principles of mass, energy and momentum balances to solve engineering problems involving simple fluid flow, heat and mass transfer. Further, students will be able to perform simple dimensional analysis and to see the utility of this general approach in engineering: for example in friction factors, heat and mass-transfer correlations. Students will also develop skills in the basic design of different types of chemical reactors, given the corresponding chemical rate law. The focus of this unit of study is to provide the key concepts and principles as tools through keynote lectures, with supporting tutorials and laboratory sessions giving valuable hands-on experience. Guidance will be provided to students to seek additional detailed information for specific applications in their projects. This unit of study runs concurrently with another enabling technology unit of study CHNG2802. These two units together will provide students with the tools and know-how to tackle the real-life engineering problems encountered in the concurrent project-based unit of study, CHNG2803. This integrated course structure is designed to help students become familiar with the multi-disciplinary nature of chemical engineering today.

CHNG2802 Applied Maths for Chemical Engineers

Credit points: 6 **Session:** Semester 1 **Classes:** Lectures (2 hours per week for 1 semester), tutorials (2 hours per week for 1 semester). **Prerequisites:** All core 1st year engineering units of study. **Corequisites:** CHNG 2803 (Analysis Practice 1) CHNG 2801 (Conservation and Transport Processes) CHEM 2404 (Forensic and Environmental Chemistry) **Assumed knowledge:** Enrolment in this unit of study assumes that all core science and engineering UoS in first-year have been successfully completed. **Assessment:** Competency based assessment, assessment weighting: Tutorials (20%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

This unit of study consists of two main strands : statistical analysis of data and numerical (computer based) methods for solution of equation sets. By the end of the statistical analysis strand, students should be proficient at applying the basic principles of statistical analysis, and appreciate how they can be applied to a variety of engineering applications. The following statistical tools are studied: normal distribution, the test statistic z, confidence intervals for the population mean, t-distribution, hypothesis testing, data fitting, uncertainty analysis, propagation of random errors and analysis of variance. The numerical methods strand will see students become proficient at: solution of single and multivariable algebraic equations; solution of nonlinear differential equations; use of Excel and Matlab for data manipulation and equation solving; use of commercial flowsheeting software (Hysys) for solving engineering problems. This unit of study runs concurrently with another enabling technology unit of study, CHNG2801. These two units together will provide students with the tools and know-how to tackle the real-life engineering problems encountered in the concurrent project-based unit of study, CHNG2803. This integrated course structure is designed to help students become familiar with the multi-disciplinary nature of chemical engineering today.

CHNG2803 Energy and Fluid Systems Practice

Credit points: 6 **Teacher/Coordinator:** Dr Howard See **Session:** Semester 1 **Classes:** Projects and self assisted learning (8 hours per week) **Prerequisites:** All core engineering 1st year units of study. **Corequisites:** CHNG 2801 (Conservation and Transport Processes) CHNG 2802 (Applied Mathematics for Chemical Engineers) CHEM 2404 (Forensic and Environmental Chemistry) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative and quantitative information **Assessment:** Projects (50%); Final examinations (50%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

This unit of study is centred around three real-life engineering projects which cover traditional and non-traditional domains of chemical engineering, and span the energy, chemical processing and bio-medical sectors. By the end of this unit, students will be proficient in analysing complex fluid and energy networks and decomposing them into their essential component parts. Students will understand the functionality of each of these key components, and will be able to characterise the performance of the engineering network in terms of both component and system-wide variables. Students will also be able to take this information and explore the optimum operating conditions for the network. This unit of study runs concurrently with two enabling technology units of study, CHNG2801 and CHNG2802. These two units will provide students with the tools and know-how to tackle the real-life engineering problems encountered in CHNG2803. This integrated course structure is designed to help students become familiar with the multi-disciplinary nature of chemical engineering today.

CHNG2804 Chemical & Biological Systems Behaviour

Credit points: 6 **Teacher/Coordinator:** Dr Vincent Gomes **Session:** Semester 2 **Classes:** Lectures (1 hour per week for 1 semester), tutorials (2 hours per week for 1 semester). Projects and self assisted learning (4 hours per week for 1 semester). **Prerequisites:** All core 1st year engineering units of study. **Corequisites:** CHNG 2805 (Industrial Systems and Sustainability) CHNG 2806 (Analysis Practice 2 - Treatment, Purification and Recovery Systems) CHEM 2403 (Chemistry of Biological Molecules) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. **Assessment:** Competency based assessment; assessment weighting: Tutorials (10%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (30%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Aims and Objectives: Chemical Engineering requires an understanding of material and energy transformations and how these are driven by molecular interactions. The rate of such transformations is dependent on driving forces and resistances, and these need to be defined in terms of fundamental physical and chemical properties of systems. This course seeks to provide students with a sound basis of the thermodynamics of chemical and biological systems, and how these, in turn, define limits of behaviour for such real systems. The thermodynamic basis for rate processes is explored, and the role of energy transfer processes in these highlighted, along with criteria for equilibrium and stability. Emphasis is placed on the prediction of physical properties of chemical and biological systems in terms of state variables. The course delivery mechanism is problem-based, and examples from thermal, chemical and biological processes will be considered, covering molecular to macro-systems scale. The course builds naturally from the second year first semester course in conservation and transport processes, and prepares students fundamentally for the third year course in design of chemical and biological processes, which deals fundamentally with reaction / separation systems, and considers phase and chemical equilibria. By the end of this unit of study a student should be competent in the following: Understanding the thermodynamic basis of rate processes; Predicting equilibrium and stability of chemical and biological systems from thermodynamic information; Predicting physical properties of such systems in terms of state variables; Using thermodynamic property information to analyse energy and material transfer processes in real systems.

CHNG2805 Industrial Systems and Sustainability

Credit points: 6 **Session:** Semester 2 **Classes:** Lectures (2 hour per week for 1 semester), tutorials (2 hours per week for 1 semester). Projects and self assisted learning (4 hours per week for 1 semester). **Prerequisites:** All core 1st year engineering units of study. **Corequisites:** CHNG 2804 (Chemical and Biological Systems Behaviour) CHNG 2806 (Analysis Practice 2 - Treatment, Purification & Recovery Systems) CHEM 2403 (Chemistry of Biological Molecules) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative

information **Assessment:** Competency based assessment; assessment weighting: Tutorials and Group Presentations(10%), Tests (30%), Projects (60%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Aims and Objectives: To develop an awareness of the various concepts which underpin Sustainable Development, including technical and economic efficiency, stewardship of the bio-physical environment, and social acceptability. To examine the material economy from the perspective of open and closed thermodynamic systems, and the implications of this for resource consumption and waste generation To explore governing frameworks for Sustainability, and engagement of chemical engineers with these. To explore tools and approaches for quantifying industry's environmental performance and how this can be examined within a Sustainability framework. To consider process design and operation, and product design, from a Sustainability perspective, how these can be informed by Green Engineering principles, and to suggest how this combination of perspectives could lead to a re-defined industry sector. By the end of this UoS a student should be competent in: Understanding the thermodynamic basis of the material economy in terms of resource consumption and waste generation; Understanding the philosophical, social and political bases for sustainability, in addition to the technical, economic and environmental ones; Understanding the role of technology in promoting sustainability; Understanding corporate responsibilities with respect to sustainability; Quantifying the environmental performance of industry (with specific reference to the resource and processing sectors) using appropriate tools; Interrogating governing frameworks for sustainability to support actions within industry; Understanding the trade-offs in decisions which impact on sustainability; Being effective communicators of sustainability arguments to all stakeholders, and interpreters of social and environmental concerns in ways which can help shape industry practice.

CHNG2806 Materials Purification and Recovery

Credit points: 6 **Teacher/Coordinator:** Dr Marjorie Valix **Session:** Semester 2 **Classes:** Projects and self assisted learning (8 hours per week for 1 semester.) **Prerequisites:** All core 1st year engineering units of study. **Corequisites:** CHNG2804 (Chemical and Biological Systems Behaviour) CHNG2805 (Industrial Systems and Sustainability) CHEM2403 (Chemistry of Biological Molecules) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative and quantitative information **Assessment:** Projects (50%); Final Examination (50%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Aims and Objectives: To recognise that chemical engineers are involved in creation of products and processes, in manipulating complex systems, and in managing technical operations. To develop an appreciation of the practical application of concepts and tools to real design problems in the process, product and service sectors in which chemical engineers are engaged. To consider this through three project-driven case studies covering a range of integrated analysis scenarios, from the domain of energy and fluid systems. This course is a concurrent requirement for the

concept and enabling technology courses running in parallel in the same semester By the end of this UoS a student should be proficient in the characterisation of process systems in which there is simultaneous transport of mass and energy, and optimise such systems around product quality objectives; characterisation of wastes and by-products in terms of their subsequent processing potential; understand biological processes to a level of being able to exploit them as reactive systems for product recovery; understand the tools of process analysis pertinent to such systems and to suggest design improvements to the component parts of such systems as part of process improvement. The three projects offered in this course module cover traditional and non-traditional domains of chemical engineering, and cover chemical and bio-chemical processing.

CHNG3041 Exchange Program 3A

Credit points: 24 **Session:** Semester 1,Semester 2 **Prerequisites:** Completion of all Year 1 and 2 core units of study in Chemical Engineering, and at least 96 credit points towards the degree. Approval of the Heads of School of Chemical and Biomolecular Engineering at the University of Sydney and the host institution is required. **Assessment:** Individual approved subjects at the host institution are assessed according to their standard procedures and a grade of "R" satisfied requirements is recorded on their academic transcript from this institution. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Year 3 elective unit of study for the degree in Chemical Engineering. Objectives/Outcomes: The objective of this (single semester) Exchange Program is to provide students with the opportunity to live and learn in a foreign culture while completing the academic and professional requirements of the University of Sydney degree program. Upon completion of the full year-long exchange (i.e. both CHNG3041 and CHNG3042), students will have completed work at least equivalent to Year 3 in the Chemical Engineering degree, including in particular all Year 3 core units of study.

CHNG3042 Exchange Program 3B

Credit points: 24 **Session:** Semester 1,Semester 2 **Prerequisites:** Completion of all Year 1 and 2 core units of study in Chemical Engineering, and at least 96 credit points towards the degree. Approval of the Heads of School of Chemical and Biomolecular Engineering at the University of Sydney and the host institution is required. **Assessment:** Individual approved subjects at the host institution are assessed according to their standard procedures and a grade of "R" satisfied requirements is recorded on their academic transcript from this institution. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Year 3 elective unit of study for the degree in Chemical Engineering.Objectives/Outcomes The objective of this (single semester) Exchange Program is to provide students with the opportunity to live and learn in a foreign culture while completing the academic and professional requirements of the University of Sydney degree program. Upon completion of the full year-long exchange (ie both CHNG3041 and CHNG3042), students will have completed work at least equivalent to Year 3 in the Chemical Engineering degree, including in particular all Year 3 core units of study.

CHNG3801 Process Design

Credit points: 6 **Session:** Semester 1 **Classes:** Lectures (2 hours per week for 1 semester), tutorials (2 hours per week for 1 semester). **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior chemistry; ENGG1800; CHNG1103; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG 3803 (Design Practice 1 - Chemical & Biological Processes) CHNG 3802 (Operation, Analysis and Improvement of Industrial Systems) **Assumed knowledge:** Enrolment in this unit of study assumes that all (six) core chemical engineering UoS in second year have been successfully completed. **Assessment:** Competency based assessment; assessment weighting: Tutorials (20%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the final-year with its emphasis on detailed design work, thesis based research and advanced engineering options.

This unit of study consists of three strands: reaction engineering; vapour-liquid equilibrium and distillation; heat transfer. The central aim is to show how these unit operations interact in the design and operation of process equipment. The reaction engineering strand covers the following: development of appropriate kinetic rate laws; use of rate laws in designing continuous stirred tank, plug-flow and packed-bed reactors. The second strand focuses on the following: numerical methods for predicting vapour-liquid equilibrium; binary and multi-component distillation; deviations from ideal behaviour. The heat transfer strand covers the following issues: forced and natural convective heat transfer; shell and tube heat exchangers; heat transfer with phase change; radiative heat transfer. The various strands make extensive use of computer software: Excel and Matlab for data manipulation and equation solving; commercial flowsheeting software (Hysys) for solving engineering design problems. This unit of study runs concurrently with another enabling technology unit of study CHNG3802. These two units together provide students with the tools and know-how to tackle real-life engineering problems encountered in the concurrent project-based unit of study, CHNG3803. This integrated course structure is designed to help students become familiar with the multi-disciplinary nature of chemical engineering today.

CHNG3802 Operating/Improving Industrial Systems

Credit points: 6 **Session:** Semester 1 **Classes:** Lectures (2 hours per week for 1 semester), tutorials (2 hours per week for 1 semester). **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG 3801 (Process Design) CHNG 3803 (Design Practice 1 - Chemical & Biological Processes) **Assumed knowledge:** Enrolment in this unit of study assumes that all (six) core chemical engineering UoS in second year have been successfully completed. **Assessment:** Competency based assessment; assessment weighting: Tutorials (10%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (30%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the final-year with its emphasis on detailed design work, thesis based research and advanced engineering options.

Aims and Objectives: All industrial processes require some process monitoring and control for satisfactory operation. The performance of a process may be improved via the implementation of some level of optimisation. This unit of study commences with a component on process data management before moving on to empirical modelling and data reconciliation techniques. The second component will concentrate on the role of process control covering: the development of linear models, control system analysis, the design and performance of feedback control systems, advanced control systems and the use of control related software. The final component will focus on process optimisation of batch and continuous processes. This UoS demonstrates that: process control and optimisation are integral concepts for any modern plant; a unified approach allows a diversity of application fields to be readily handled via a consistent approach from data analysis, though process control to process optimisation. The UoS will allow each student to achieve and demonstrate competency through a range of individual and group-based activities. By the end of this UoS a student should achieve competence in the following: process data management skills relevant to engineering (statistical analysis, data-based modelling and data reconciliation techniques); appreciation of the role of process control in modern manufacturing; designing an appropriate feedback control system and analysing its performance for a range of process applications using both traditional and software-based techniques; appreciation of the limitations of feedback control and be able to design a range of common enhancements; appreciation of the role of process optimisation in modern manufacturing; use of both traditional and software-based techniques to design optimisation schemes for a range of process applications and analyse the performance of such schemes; appreciate the limitations that exist whenever mathematical models are used as the basis for process control and/or optimisation; appreciate the 'vertical integration' that exists from modelling, through control, to optimisation.

CHNG3803 Chemical/Biological Process Design

Credit points: 6 **Teacher/Coordinator:** Dr Vincent Gomes **Session:** Semester 1 **Classes:** Projects and self assisted learning (8 hours per week.) **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG 3801 (Process Design) CHNG 3802 (Operation, Analysis and Improvement of Industrial Systems) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative and quantitative information **Assessment:** Projects (50%); Final Examination (50%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the fourth year.

Aims and Objectives: To recognise that chemical engineers are involved in the creation of products and processes, in manipulating complex systems, and in managing technical operations; To develop an appreciation of the practical application of concepts and tools to real design

problems in the process, product and service sectors in which chemical engineers are engaged; To consider this through three project-driven case studies covering a range of design scenarios, from the domain of chemical and biological processes. This course is a concurrent requirement for the concept and enabling technology courses running in parallel in the same semester. By the end of this unit of study a student should be proficient in: Developing a design strategy for integrated production of a liquid chemical product from a variety of raw materials, to specified purity, using a mix of chemical and biological synthesis techniques- and demonstrating this in project mode; Applying design and analysis tools for control and optimisation of the above process- and demonstrating this in project mode; Developing a strategy for chemical or biological product design, with a focus on characterisation of physical properties and functionality- and demonstrating this in project mode. These three projects address the fundamentals of design of continuous processes, and the challenges inherent in them regarding their operation and optimisation.

CHNG3804 Biochemical Engineering

Credit points: 6 **Teacher/Coordinator:** A/Prof Fariba Dehghani **Session:** Semester 2 **Classes:** 1 x 1 hour lecture per week for 1 semester, 2 x 1 hr self directed group learning sessions per week for 1 semester. **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802, CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Assumed knowledge:** Enrolment in this unit of study assumes that all (six) core chemical engineering UoS in second year have been successfully completed. **Assessment:** Tutorials (10%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (30%). **Practical field work:** 1 x 3 hour laboratory session per week for 1 semester. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is a third year elective in chemical engineering. The concepts and enabling technologies taught in this course are relevant to the real world practice of chemical engineering across a range of industries. Students with an interest in bio-engineering will find the background provided by this UoS particularly useful in their fourth year research thesis.

Biochemical engineering is increasingly playing an important role in technology to modern society. The engineers with knowledge of various aspects of biochemical processes are tremendously valuable. The course will examine cutting edge examples of biochemical technologies across a broad range of applications relevant to chemical engineering. The specific objectives of this course are to understand the history and scope of the biotechnology industry; examine the role of biochemical engineering in the industrial application of biotechnology and its development. We will provide an understanding of the major fundamental aspects of biochemical engineering and implementing the knowledge acquired to some selected industrial applications. At the completion of this unit of study students should have developed an appreciation of the underlying principles of biochemical engineering and the ability to apply these skills to new and novel situations. The students will be able to critically analyse different types of biochemical engineering processes and to improve these processes consistent with the principles of biochemical engineering. Students are encouraged to engage in an interactive environment for exchange of information and develop problem-solving skills for successfully handling challenging engineering situations. This course will be assessed by quizzes, assignments and exams.

CHNG3805 Product Formulation and Design

Credit points: 6 **Teacher/Coordinator:** Dr Andrew Harris **Session:** Semester 2 **Classes:** lectures (2 hours per week for 1 semester), tutorials (1 hour per week for 1 semester) and projects and self assisted learning (4 hours per week for 1 semester) **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG 3806 (Management of Industrial Systems) CHNG 3807 (Design Practice 2 - Products and Value Chains) **Assumed knowledge:** Mass and Energy Balances Conservation and Transport Phenomena Applied Mathematics (for Chemical Engineering) Process Design Concepts Process Control and Optimisation Concepts **Assessment:** Competency based assessment; assessment weighting: Tutorials (20%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the final-year with its emphasis on detailed design work, thesis based research and advanced engineering options.

Product design is one of the new frontiers of chemical and biomolecular engineering. Many products emerge from their processing not as a continuous stream, but as discrete entities. There are many examples of discrete systems in chemical and biomolecular engineering; these include particulate systems (e.g. powders or solid particles in fluids), as well as polymeric and biological systems (e.g. emulsions and cells, respectively). This UoS is an introduction to the basic concepts in discrete systems necessary for a chemical engineer to be able to formulate and design discrete products with desired properties. In essence it is a course on product formulation and design. The UoS will provide students with a working knowledge of the types of discrete systems available, the ways in which particulate systems can be characterized and their applications in industry. These aspects will form the foundation for an introduction to the common techniques used to model discrete systems. By the end of the UoS students should be proficient at understanding the types of discrete systems available, and the techniques used to characterise particulate systems, understanding the basic principles of particle-fluid systems, applying these principles and solving simple problems in product design and particulate engineering.

CHNG3806 Management of Industrial Systems

Credit points: 6 **Teacher/Coordinator:** Mr Donald White **Session:** Semester 2 **Classes:** Lectures (2 hours per week for 1 semester), tutorials (2 hours per week for 1 semester). Projects and self assisted learning (4 hours per week for 1 semester). **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG3805 (Product Formulation and Design) CHNG3807 (Design Practice 2 - Products and Value Chains) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative

information **Assessment:** Competency based assessment; assessment weighting: Tutorials (10%), Quizzes (30%), Final examination and/or individual projects (30%), Group work and presentations (30%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the fourth year.

Aims and Objectives: To develop an appreciation of management practice in process-led and product-driven industries; considering project management, economic evaluation of processes, risk assessment and decision making with multiple objectives and uncertainty; to develop the requisite tools to support above; to consider approaches to innovation and entrepreneurship; to consider all this in the context of different scales of operation - from single process, to business unit, to enterprise, and across supply and value chains; to support this analysis through real-problem case studies and projects. By the end of this UoS a student should be competent in: developing project work plans in conjunction with project management schedules; performing economic evaluations of projects, plans and processes; performing qualitative risk assessments of projects, plans and processes; exploring optimisation of complex processes under risk and uncertainty, covering unit operations, business units, enterprises and value chains.

CHNG3807 Products and Value Chains

Credit points: 6 **Teacher/Coordinator:** Dr Andrew Harris **Session:** Semester 2 **Classes:** Projects and self assisted learning (8 hours per week for 1 semester.) **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Corequisites:** CHNG3805 (Product Formulation and Design) CHNG3806 (Management of Industrial Systems) **Assumed knowledge:** Ability to conduct mass and energy balances, and the integration of these concepts to solve real chemical engineering problems Ability to understand basic principles of physical chemistry, physics and mechanics Ability to use mathematics of calculus (including vector calculus) and linear algebra, and carry out computations with MATLAB and MS EXCEL. Ability to read widely outside of the technical literature, and to synthesise arguments based on such literature Ability to write coherent reports and essays based on qualitative and quantitative information **Assessment:** Projects (50%); Final examinations (50%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: This UoS is part of an integrated third-year program in chemical engineering. Completion of this body of work is required before a student will be permitted to move into the fourth year.

This UoS is designed to give students experience at solving complex, interesting, real world engineering problems, by applying theoretical and experimental principles learnt during their studies. During the UoS students will be required to work on three project-driven case studies covering a range of design scenarios, from the domain of particulate products, entrepreneurial ventures (business 'start ups'), ethics and product value chains. This UoS is a concurrent requirement for the concept and enabling technology courses running in parallel in the same semester. By the end of the UoS students should be proficient at developing a strategy for taking a product development idea from concept to commercial artefact - with a comprehensive appreciation of economic arguments, underlying uncertainties (and how to mitigate these), and consideration of trade-offs inherent in this development. They should also be able to apply design

and analysis tools for the synthesis of particulate products leading to the manufacture of a preferred product at pilot scale and be able to develop a strategy for the design and analysis of extended business enterprises. A key aspect of the UoS is that students demonstrate these outcomes in project mode. The three projects in the UoS address "issues of scale" of chemical and biomolecular engineering, from molecular to macro-systems levels.

CHNG3808 Polymer Engineering

Credit points: 6 **Teacher/Coordinator:** A/Professor Vincent Gomes, Department of Chemical Engineering, Room 452, 9351 4868, vgomes@chem.eng.usyd.edu.au **Session:** Semester 1 **Classes:** Lectures (2 hours per week for 1 semester), tutorials and laboratory sessions (2 hours per week for 1 semester). **Prerequisites:** 12 credit points of junior Mathematics; 12 credit points of junior Chemistry; CHNG1103; ENGG1800; CHNG2801; CHNG2802; CHNG2803; CHNG2804; CHNG2805; CHNG2806 **Assumed knowledge:** Completion of CHNG3801; CHNG3802; CHNG3803 and currently enrolled in CHNG3805, CHNG3806, CHNG3807. **Assessment:** Tutorials (10%), Quizzes (30%), Final examination and/or individual projects (35%), Group work and presentations (25%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Polymers are ubiquitous and a significant number of scientists and engineers are employed by the Polymer Industry. This Unit of Study will facilitate engagement with a broad spectrum of engineering knowledge base that range from polymer synthesis to design of polymer products to developing sustainable technology in polymer synthesis and applications. The industrial applications range from biomedical to electronics and semiconductors to nanotechnology, in addition to usual consumer products. Technical knowledge relating to polymer chemistry, mathematics, fluid and solid mechanics, heat transfer, mass transfer and reaction engineering will be applied for the planned outcomes of this course. The specific objectives are: To analyse molecular structures and their relations with material properties; To investigate the variety of thermal and thermo-mechanical properties relevant for probing polymer structure as well as understanding material behaviour in the context of applications; To engage with rheological characterization of polymers to probe polymer structural as well as to understand material behaviour in the context of applications; To understand the principles of polymer synthesis and to design polymerization reactors for producing polymer resins; To understand the principles of polymer processing in order to design polymeric products for consumer and specialty applications; To critically analyze production of polymeric goods from the sustainability point of view; To engage with examples of cutting-edge engineering product and process designs and applications that encompass biomedical, nanotechnology, electronics and other emerging technologies. At the completion of this Unit of Study students should have developed: An appreciation of the underlying principles of polymer engineering; The ability to apply these skills to new and novel situations; The ability to critically analyse the methods of manufacture of different products and processes and to improve these processes; The development of an integrated suite of problem-solving skills needed to successfully handle new engineering applications; An ability to independently research and be critical of the findings; An ability to analyze experimental data; An ability to carry out process and product design through critical thinking; Interpersonal, group and teamwork skills including the ability to communicate clearly and concisely; Professionalism in terms of taking responsibility for the results of their calculations and recommendations; Lifetime or self-directed learning skills including the ability to critically assess one's own performance in a constructive manner.

CHNG4001 Practical Experience

Teacher/Coordinator: Dr Marjorie Valix **Session:** Semester 1,Semester 2 **Classes:** There are no formal classes. Students are required to obtain a minimum of 10 weeks practical work experience before entering their 4th Year. **Assumed knowledge:** Advisory prerequisite: 28 credit points of 3rd year units **Assessment:** By submission of a report of approximately 2500 words on the industrial experience undertaken. The report will cover the nature of the industry, the company's organisational relationships both internally and externally and a technical section devoted to the work performed by the student. The report is to be submitted before the end of the first week of the 4th academic year. **Practical field work:** A minimum of 10 weeks work experience in a Chemical Engineering related industry. **Campus:** Camperdown/Darlington **Mode of delivery:** Professional Practice

Fourth year core unit of study for the degree in Chemical Engineering. Objectives/Outcomes To obtain first-hand experience of the way chemical engineering skills are employed in an industrial context. Syllabus Summary Each student is required to work as an employee of an approved organisation and to submit a report on that work. The employment undertaken must be relevant to Chemical Engineering and should be discussed, before acceptance, with a member of the Department of Chemical Engineering. While the responsibility for obtaining satisfactory employment rests with the student, the Department, through the Chemical Engineering Foundation, and the Careers and Appointments Service will assist wherever possible.

CHNG4003 Advances in Chemical Engineering A

Credit points: 4 **Session:** Semester 1,Semester 2 **Classes:** Two (1hr) lectures plus one (1 hr) tutorial per week for one semester. **Assumed knowledge:** Knowledge of modern chemical engineering principles and practice. **Assessment:** Depending on the project, an assortment of: Case Study reports; oral presentations; assignments; projects; quizzes; final examination **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Fourth year elective unit of study for the degree in Chemical Engineering. Objectives/Outcomes: The objective of this unit of study is to provide students with exposure to the latest developments in research and technology. Syllabus: This unit will discuss the impact of current research and new technology on the profession of chemical engineering. It will address the changes that are taking place in industrial processes as a result of these new technologies. The syllabus details will change from time to time as specialist lecturers become available.

CHNG4006 Professional Option

Credit points: 2 **Session:** Semester 1,Semester 2 **Classes:** There are no formal classes for this course. **Assumed knowledge:** advisory prerequisite: Passed at least 144 credit points. **Assessment:** Written report or oral presentation or poster presentation. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Note: Student must be in the final semester of their degree program.

Fourth year elective unit of study for the degree in Chemical Engineering. Objectives/Outcomes: The objective of this course is to provide students with experience in how to prepare and present a technical report. Syllabus This course requires a student to carry out an assignment related to the profession of chemical engineering - this will normally consist of a discussion of the design or operation of an industrial process. The discussion will be presented in the form of a written report, as a seminar, or both.

CHNG4041 Exchange Program 4A

Credit points: 24 **Session:** Semester 1,Semester 2 **Prerequisites:** Completion of all Year 1, 2 and 3 core units of study in Chemical Engineering, and at least 144 credit points towards the degree. Approval of the Heads of School of Chemical and Biomolecular Engineering at the University of Sydney and at the participating exchange institution. **Assessment:** Students spend either one academic year or semester at the host institution where they take a normal load. Their specific course choices are approved by the Heads of Department of the two institutions. Individual approved subjects at the host institution are assessed according to their standard procedures and a grade of "R" satisfied requirements will be recorded on their academic transcript from this institution. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Year 4 elective unit of study for the degree in Chemical Engineering. Objectives/Outcomes The objective of this (single semester) Exchange Program is to provide students with the opportunity to live and learn in a foreign culture while completing the academic and professional requirements of the University of Sydney degree program. Upon completion of the full year-long exchange (ie both CHNG4041 and CHNG4042), students will have completed work at least equivalent to Year 4 in the Chemical Engineering degree, including in particular the Year 4 core units of study, and will have fulfilled all the requirements of their degree from the University of Sydney.

CHNG4042 Exchange Program 4B

Credit points: 24 **Session:** Semester 1,Semester 2 **Prerequisites:** Completion of all Year 1, 2 and 3 core units of study in Chemical Engineering, and at least 144 credit points towards the degree. Approval of the Heads of School of Chemical and Biomolecular Engineering at the University of Sydney and at the participating exchange institution. **Assessment:** Students spend either one academic year or semester at the host institution where they take a normal load. Their specific course choices are approved by the Heads of Department of the two institutions. Individual approved subjects at the host institution are assessed according to their standard procedures and a grade of "R" (satisfied requirements) is recorded on their academic transcript at this institution. **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Year 4 elective unit of study for the degree in Chemical Engineering. Objectives/Outcomes The objective of this (single semester) Exchange Program is to provide students with the opportunity to live and learn in a foreign culture while completing the academic and professional requirements of the University of Sydney degree program. Upon completion of the full year-long exchange (ie both CHNG4041 and CHNG4042), students will have completed work at least equivalent to Year 4 in

the Chemical Engineering degree, including in particular the Year 4 core units of study, and will have fulfilled all the requirements of their degree from the University of Sydney.

CHNG4203 Major Industrial Project

Credit points: 24 **Session:** Semester 1 **Classes:** Student spends six months at an industrial placement working on a Chemical Engineering project. **Prerequisites:** Passed at least 144 credit points. Students wishing to do this unit of study are required to discuss the matter with the Head of School prior to enrolment. **Assessment:** Thesis; case study reports; oral presentations; poster presentation. **Campus:** Camperdown/Darlington **Mode of delivery:** Professional Practice

Note: Department permission required for enrolment

This unit of study will give students a rich experience in carrying out a major project within an industrial environment, and in preparing and presenting detailed technical reports (both oral and written) on their work. The project is carried out under joint University/industry supervision and extends over several months, with the student essentially being engaged fulltime on the project at the industrial site. Previous students have been placed with industries in areas including the mining industry, oil and gas processing, plastic and paint manufacture, food production, manufacturing and so on. Students will learn from this experience the following essential engineering skills : how to examine published and experimental data, set objectives, organise a program of work, and analyse results and evaluate these in relation to existing knowledge. Presentation skills will also be developed, which are highly relevant to many branches of engineering activity.

CHNG4801 Chemical Engineering Thesis A

Credit points: 6 **Teacher/Coordinator:** Dr Andrew Harris **Session:** Semester 1,Semester 2 **Classes:** Students are expected to take the initiative when pursuing their research projects. The supervisor will be available for discussion - typically 1 hour per week. **Prerequisites:** CHNG3801 Process Design CHNG3802 Operation, Analysis and Improvement of Industrial Systems CHNG3803 Design Practice 1 - Chemical & Biological Processes CHNG3805 Product Formulation and Design CHNG3806 Management of Industrial Systems CHNG3807 Design Practice 2 - Products and Value Chains **Prohibitions:** CHNG4002 Thesis **Assumed knowledge:** Enrolment in this unit of study assumes that all (six) core chemical engineering UoS in third year have been successfully completed. **Assessment:** Oral Presentation (15%), Progress Report (including literature review) (15%), Thesis (60%), Poster (10%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

The ability to plan, systematically conduct and report on a major research project is an important skill for professional engineers. This unit of study builds on technical competencies introduced in previous years, as well as making use of the report writing and communications skills the students have developed. The research activity is spread over two units (Chemical Engineering Thesis A and B) run in first and second semester. In this unit of study, students are required to plan and begin work on a major research project, which is very often some aspect of a staff member's research interests. Some of the projects will be experimental in nature, while others may involve computer-based simulation, design or literature surveys. In this unit, students will learn how to

examine published and experimental data, set objectives, organize a program of work and devise an experimental or developmental program. The progress at the end of Thesis A will be evaluated based on a seminar presentation and a progress report. The skills acquired will be invaluable to students undertaking engineering work.

CHNG4802 Chemical Engineering Design A

Credit points: 6 **Teacher/Coordinator:** Mr Don White **Session:** Semester 1 **Classes:** Lectures (2 hours per week for 1 semester), tutorials (2 hours per week for 1 semester), group work (2 hours per week for 1 semester). **Prerequisites:** CHNG3801 Process Design CHNG3802 Operation, Analysis and Improvement of Industrial Systems CHNG3803 Design Practice 1 - Chemical & Biological Processes CHNG3805 Product Formulation and Design CHNG3806 Management of Industrial Systems CHNG3807 Design Practice 2 - Products and Value Chains **Prohibitions:** CHNG4201 Chemical Engineering Design 1 **Assumed knowledge:** Enrolment in this unit of study assumes that all (six) core chemical engineering UoS in third year have been successfully completed. **Assessment:** Final examination and/or individual projects (30%), Group work and presentations (50%), Quizzes and tutorials (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Note: This UoS is part of an integrated (two semester) fourth year program in chemical engineering design whose overarching aim is to complete the 'vertical integration' of knowledge - one of the pillars on which this degree program is based.

Aims and Objectives: In the overall design process, chemical engineers must clearly understand the (often complex) interactions and trade-offs that occur between technical, economic, social and environmental considerations. This units of study builds on concepts in each of these areas introduced in previous years but with an emphasis on their successful integration within a comprehensive design activity. This design activity is spread over two unit of study (Chemical Engineering Design A and B) run in first and second semester. The primary aim in the first unit of study is to consider the technical issues -with an emphasis on creating and evaluating a range of alternative options that exist at both the unit operation and complete flowsheet levels. The primary emphasis in the subsequent unit of study is on evaluating how non-technical considerations affect the final process design and its operation. By the end of this unit of study a student should be able to develop a wide range of alternative conceptual designs for a given product specification and market analysis, have an appreciation of how to evaluate process alternatives at the conceptual level with a view to creating a 'short-list' worthy of more detailed technical investigation, be familiar with the use of process flowsheeting software to compare alternative designs , appreciate the fact that technical considerations are only one component in an overall successful design project and be able to clearly present the results from both individual and group work in oral/written formats.

CHNG4805 Chemical Engineering Thesis B

Credit points: 6 **Teacher/Coordinator:** Dr Andrew Harris **Session:** Semester 1,Semester 2 **Classes:** Students are expected to take the initiative when pursuing their research projects. The supervisor will be available for discussion - typically 1 hour per week. **Prerequisites:** CHNG 4801 Chemical Engineering Thesis A **Assumed knowledge:** Enrolment in this unit of study assumes that Chemical Engineering Thesis A and all (six) core chemical engineering

UoS in third year have been successfully completed. **Assessment:** Progress Report (15%), Thesis (60%), Oral presentation (15%), Poster (10%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Note: This UoS is part of an integrated (two semester) fourth year program involving a chemical engineering research project and thesis. It has the overarching aim of completing the 'vertical integration' of knowledge - one of the pillars on which this degree program is based. Students who have successfully completed CHNG4203 Major Industrial Project may apply for exemption from this unit of study and replace it with an advanced level chemical engineering elective unit of study.

The ability to plan, systematically conduct and report on a major research project is an important skill for professional engineers. This unit of study builds on technical competencies introduced in previous years, as well as making use of the report writing and communications skills the students have developed. The research activity is spread over two units (Chemical Engineering Thesis A and B) run in first and second semester. In this unit of study, the primary emphasis is on the execution of a comprehensive and systemic series of investigations, and the reporting of the study in a major thesis document and an oral presentation. Students will acquire skills in developing a plan for a series of studies to illuminate an area of research, in evaluating alternatives at the conceptual level with a view to creating a 'short-list' worthy of more detailed technical investigation, and in searching the literature for guidance of the studies. Further, communication skills will be developed, such as the ability to clearly present the background and results in a written format and in an oral presentation to a general engineering audience.

CHNG4806 Chemical Engineering Design B

Credit points: 6 **Teacher/Coordinator:** Mr Don White **Session:** Semester 2 **Classes:** Lectures (Average 1-2 hours per week for 1 semester), group work (6 hours per week for 1 semester). **Prerequisites:** CHNG4802 Chemical Engineering Design A or CHNG4203 MIPPS **Prohibitions:** CHNG4202 Chemical Engineering Design 2 **Assumed knowledge:** Enrolment in this unit of study assumes that all core chemical engineering UoS in third-year have been successfully completed, as well as the related first semester UoS Chemical Engineering Design A. **Assessment:** Group work contribution, Group Report and presentations (80%), Individual projects (20%) **Campus:** Camperdown/Darlington **Mode of delivery:** Normal (lecture/lab/tutorial) Day

Note: Department permission required for enrolment

Note: This UoS is part of an integrated (two semester) fourth year program in chemical engineering design whose overarching aim is to complete the 'vertical integration' of knowledge - one of the pillars on which this degree program is based.

Aims and Objectives: In the overall design process, chemical engineers must clearly understand the (often complex) interactions and trade-offs that occur between technical, economic, social and environmental considerations. This unit of study builds on concepts in each of these areas introduced in previous years but with an emphasis on their successful integration within a comprehensive design activity. This design activity is spread over two unit of study (Chemical Engineering Design A or MIPPS run in first semester and Design B in second semester. The primary emphasis in this semester is on evaluating the interactions between the technical and non-

technical considerations, and how they affect the final process design and its operation. By the end of this unit of study a student should be able to develop a wide range of alternative conceptual designs for a given product specification and market analysis, have an appreciation of how to evaluate process alternatives at the conceptual level with a view to creating a 'short-list' worthy of more detailed technical investigation, be familiar with the use of process flowsheeting software to compare alternative designs , appreciate the fact that technical considerations are only one component in an overall successful design project and be able to clearly present the results from both individual and group work in oral/written formats.