The descriptions of undergraduate modules offered by the Department of Chemical and Biomolecular Engineering are given below. For brevity, the workload is displayed in an A-B-C-D-E format where A represents the number of lecture hours per week, B the number of tutorial hours per week, C the number of laboratory hours per week, D the number of project/assignment hours per week and E the number of hours per week for preparatory work.

CN1101A Chemical Engineering Principles and Practices
Modular Credits: 4
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides an experiential exposure to chemical engineering concepts through a series of hands-on experimental laboratories. Simple yet visually engaging demonstrations will bring these concepts to life, and act as a preview and bridge to the core modules in the undergraduate curriculum, while highlighting their practical relevance. The students will prepare for each session by compulsory pre-laboratory readings on theoretical background and laboratory procedures. In the laboratory, they will learn to carry out measurement, data collection, analysis, modelling, interpretation and presentation. The laboratory sessions will be blended with real engineering applications of industrial and societal relevance to Singapore.

CN2102 Chemical Engineering Principles and Practices II
Modular Credits: 4
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module is the second part of a two-part module designed to provide first year Chemical and Biomolecular Engineering students with an experiential exposure to the foundational concepts of Biomolecular/Biochemical/Bioprocess Engineering, including mass and energy balances, biosafety and sterile handling, bioreaction kinetics, bioreactor design, downstream processing and purification, etc., through a series of hands-on experimental laboratories. In the laboratory, they will learn to carry out measurement, data collection, analysis, interpretation and presentation. The laboratory sessions will be blended with real engineering applications of industrial and societal relevance to Singapore.

CN2101 Material and Energy Balances
Modular Credits: 3
Workload: 2-0.5-0-0-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with basic concepts of material and energy balances in chemical engineering processes. It also gives a comprehensive introduction to different analytical and problem-solving methods. In particular, steady state material and energy balances, including recycles, phase changes and reactions, simultaneous material and energy balances and unsteady state balances are covered in this module. All fundamental concepts are illustrated by using relevant process examples. This module is targeted at level one engineering or science students.

CN2116 Chemical Kinetics and Reactor Design
Modular Credits: 4
Workload: 3-1-0-3-3
Co-requisite(s): CN2125
Preclusion(s): Nil
Cross-listing(s): Nil
The module begins with a revision of chemical kinetics and thermodynamics emphasizing on the different definitions of reaction rates, rate expressions, and simple and complex reactions. The design equations for ideal reactors are then introduced followed by the general methods of analysis of rate data. Reactor sequencing, yield versus productivity considerations in multiple reactions, and non-

isothermal operations round up the first half of the course. More advanced topics such as residence time distributions in reactors, kinetics of catalytic reactions and catalyst deactivation, coupling of chemical reactions with transport processes, form the bulk of the second half of the course.

CN2121 Chemical Engineering Thermodynamics
Modular Credits: 4
Workload: 3-1-0-0.5-6.5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with an understanding of the basic laws and concepts of thermodynamics for analysing chemical engineering problems. The basic definition, applications and limitations of chemical engineering thermodynamics are first introduced followed by a review of basic laws, properties and concepts of thermodynamics. The application of basic concepts of energy conversion is extended to refrigeration and liquefaction processes. The development and discussion of thermodynamic property relations for systems of constant and variable compositions are covered in detail. The developed property relationships together with the basic laws are then applied to the analysis of the various equilibrium problems in chemical engineering such as vapour-liquid, vapour-liquid-liquid, liquid-liquid, solid-liquid and chemical reaction equilibria. This module is targeted at level 2 chemical engineering students.

CN2122A Fluid Mechanics
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): MA1511, MA1512, H2 Physics (or PC1221 Fundamentals of Physics I or equivalent)
Preclusion(s): Nil
Cross-listing(s): Nil
This module considers the classification of fluids and their properties, followed by the analysis of static fluid. The integral and differential forms of the fundamental equations – Continuity, Momentum and Energy equations are then studied. The concept of momentum transfer by the shear stress is introduced in this course. Dimensional analysis and model theory are studied. The concept about boundary layer theory, flow with pressure gradient, viscous flow and turbulence are also described. Practical aspect involves the consideration of flows in closed conduits. At the end of the course, basic concepts regarding fluid machinery is also covered.

CN2125 Heat and Mass Transfer
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Co-requisite(s): CN2122A
Preclusion(s): Nil
Cross-listing(s): Nil
This course considers three modes of heat transfer, namely, conduction, convection, and radiation. For heat conduction, both steady and unsteady states are examined. These are followed by analyses of convective heat transfer and heat transfer with phase change, and subsequently radiative heat transfer. Heat exchangers and their design are discussed. Steady and unsteady state molecular diffusion is studied, while convective mass transfer is analyzed using exact and approximate integral analysis. Finally, analogies between mass, heat and momentum transfer are discussed leading to the concept of transport phenomena.

CN3101A Chemical Engineering Process Lab
Modular Credits: 4
Workload: 0-0-5-1-4
Prerequisite(s): CN2116, CN2121, CN2122A, CN2125, CN3124A
Preclusion(s): CN3101, CN3102
Co-requisite(s): CN3121, CN3132

Cross-listing(s): Nil
Students will learn how to perform laboratory-scale experiments in a small team. This practical module strengthens their technical writing and oral presentation, and problem-solving skills. Experiments in this module are related to chemical engineering thermodynamics, fluid mechanics, heat and mass transfer, reaction engineering, process dynamics and control, mass transfer and separation processes. Moreover, students will learn how to use safety equipment to handle hazardous waste following safety protocols. They will also learn assembly/disassembly of equipment, fault diagnosis, operation of thermocouples and flow meters, instrumental analysis, data logging and processing, operation of process plant items, error analysis and data validation.

CN3101 Chemical Engineering Laboratory I
Modular Credits: 4
Workload: 0-0-5-1-4
Prerequisite(s): CN2116, CN2121, CN2122A, CN2125
Preclusion(s): Nil
Cross-listing(s): Nil
Students learn how to perform laboratory-scale experiments in a small team. They also learn communication skills through report writing and oral presentations. Experiments in this module are related to chemical engineering thermodynamics, fluid mechanics, heat and mass transfer and reaction engineering. Moreover, students learn how to use safety equipment to handle hazardous waste following safety protocols. They also learn assembly/disassembly of equipment, fault diagnosis, operation of thermocouples and flow meters, instrumental analysis, data logging and processing, operation of process plant items, error analysis and data validation. Students will perform 8 experiments (5 hours each) during the semester.

CN3124A Fluid-Particle Systems
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Co-requisite(s): CN2122A
Preclusion(s): Nil
Cross-listing(s): Nil
This module introduces various multiphase processes that are important to Chemical Engineering applications. These include sedimentation, flow through packed beds, filtration, fluidisation, pneumatic transport and cyclone separation. The concepts of single particle terminal velocity and hindered settling velocity in multiple particle systems are introduced and applied to engineering designs of continuous settling systems. Principles of flow through packed beds are discussed and applied towards engineering designs of filtration and fluidized bed systems. Pressure drop calculations for pneumatic transport systems and engineering design calculations for gas cyclone systems are discussed. The module concludes with the study of crystallisation, colloids and nanoparticles.

CN3121 Process Dynamics and Control
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): MA1511, MA1512, MA1513
Preclusion(s): Nil
Cross-listing(s): Nil
This module presents the full complement of fundamental principles with clear application to heat exchangers, reactors, separation processes and storage systems. It incorporates introductory concepts, dynamic modelling, feedback control concepts and design methods, control hardware, and advanced control strategies including feed-forward, cascade and model-based control. SIMULINK will be introduced and used to simulate and examine the effectiveness of various control strategies. The module also incorporates case studies that prepare the students to design control systems for a realistic-sized plant. This module is targeted at chemical engineering students who already have a basic knowledge of chemical engineering processes.

CN3132 Separation Processes
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): CN2101, CN2121, CN2125
Preclusion(s): Nil
Cross-listing(s): Nil
In this module, equilibrium stage and rate-based design concepts in separation processes are introduced. Starting from simple single stage, binary separation, the theoretical treatment is extended to multi-component, multi-stage processes. After brief introduction to inter-phase mass transfer, basic concepts in rate-based design for the more important separation processes such as absorption and distillation are illustrated. The rate-based design concept is then extended to operations involving simultaneous heat and mass transfer such as in cooling tower and drying processes. The process design principles are illustrated with distillation, absorption, extraction, adsorption, cooling tower and drying processes.

CN3135 Process Safety, Health & Environment
Modular Credits: 3
Workload: 2-1-0-2-2.5
Prerequisite(s): CN2121, CN2122A
Preclusion(s): Nil
Cross-listing(s): Nil
This module aims to provide fundamental concepts and methods for the design and operation of safe plants. The students will gain a thorough understanding of chemical process hazards, their identification, their potential effects on safety, health, and the environment, and methods of assessment and control. Emphasis is placed on the integrated management of safety, health, and environmental sustainability.

CN3421A Process Modelling and Numerical Simulation
Modular Credits: 3
Workload: 2-1-0-2-2.5
Prerequisite(s): MA1511, MA1512, MA1513
Co-requisite(s): CN2116
Preclusion(s): Nil
Cross-listing(s): Nil
This module introduces model formulation and MATLAB programming specially for chemical engineering students. This course covers the formulation of process models and necessary numerical techniques for solving the model equations arising in thermodynamics, fluid mechanics, heat and mass transfer, reaction engineering, transport phenomena, and process systems engineering. The numerical techniques include methods for solving systems of linear and non-linear algebraic equations and systems of linear and non-linear ordinary and partial differential equations. Direct and iterative techniques, numerical differentiation and integration, linear regression, error propagation, convergence and stability analysis will also be taught in the context of chemical engineering problems. Students will learn using various tools (Excel spreadsheet and MATLAB) for solving different numerical problems. This module is targeted at level 3 chemical and environmental engineering students.

CN4118 B. Eng. Dissertation
Modular Credits: 8
Workload: 0-1-12-0-7
Prerequisite(s): CN3101, CN3121, CN3132, CN3135, CN3421A
Preclusion(s): Nil
Cross-listing(s): Nil
The project aims to provide students with training for scientific or technical research. The module involves an assignment of a research project, equipment training and safety education. Students need to spend at least one full day per week on the project under the guidance of the project supervisor and co-supervisor. A thesis is required at the end of the semester, including literature survey, materials and method, results and discussion, and suggestions for further study. A poster presentation is also required. This module is targeted at all level 4 chemical engineering students.

CN4122 Process Synthesis and Simulation
Modular Credits: 3
Workload: 2-2-0-1.5-2
Pre-requisites: CN2116, CN2121, CN2122A, CN3132
Co-requisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module aims to provide fundamentals and methods of process synthesis and simulation, which are required for design of chemical processes/plants. Students learn a heuristic method for process development, simulation strategies, main steps in process design and rigorous process simulation using a commercial simulator through both lectures and many hands-on exercises. They will also learn detailed mechanical design of process equipment, cost estimation and profitability analysis of chemical processes.

CN4123R Final Year Design Project
Modular Credits: 6
Workload: 0.5-1-0-8.5-5
Pre-requisites: CN3135, CN4122, EG2401A
Co-requisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
In this capstone design project, students execute a group project to design a chemical production facility. They solve a practical design problem in the same way as might be expected in an industrial situation. Students develop and evaluate process flowsheet alternatives via rigorous simulation, perform preliminary sizing, analyze safety and hazards, and estimate costs and profitability. Further, they learn how to solve open-ended problems by making critical design decisions with sound scientific justification and giving due consideration to cost and safety. Project coordinators act as facilitators, and students work almost independently on the project and exercise their creativity.

CN4201R Petroleum Refining
Modular Credits: 4
Workload: 3-1-0-0-6
Prerequisite(s): CN2116, CN3132
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides working knowledge of a refinery set-up, major process & treatment units, critical energy, safety design and off-site requirements. Starting from crude oil assay and refinery products quality requirements, the course covers distillation, catalytic reforming, visbreaker, hydrocracker and other process units. Energy and utility requirements, storage concepts along with hydrogen systems, COGEN options and Linear Program Applications are introduced. The final topic is on building the process flow diagram for a well-integrated oil refinery and product blending. The commercial aspects of refining and profitability models are discussed. A refinery visit provides students with invaluable insight.

CN4203R Polymer Engineering
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
The course introduces students to the principles of producing a polymer product starting from polymer synthesis to the final engineering design and production. It starts with an introduction to polymer chemistry of various synthesis methods and strategies. This is followed by the analysis and characterization of polymers using the physics of polymers. Finally, techniques for producing or synthesizing polymers will be learnt. The various processing methods such as extrusion, injection modelling, blow molding and film blowing for polymers so produced are discussed. Detailed

mathematical analyses of some process operations based on momentum, heat and mass transfer approaches are carried out.

CN4205R Pinch Analysis and Process Integration
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): CN2125, CN3421A
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with a working knowledge of selected techniques and software in pinch analysis and process integration as well as their application to chemical processes. The first part of the module covers pinch analysis for heat integration, including data extraction and energy targeting, heat exchanger network design, integration of utilities, heat and power systems, and distillation columns. Application of pinch analysis to maximization of water re-use is also discussed. Another topic is data reconciliation and gross error detection, and their applications. This module is targeted at senior chemical engineering students.

CN4207R Business Skills for Oil & Petrochemical Industry
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module will allow students to gain vital business related skills and knowledge of this complex and volatile industry. It will provide a broad overview of the markets and functional skill sets required to succeed in this fast paced industry.

CN4211R Petrochemicals and Processing Technologies
Modular Credits: 4
Workload: 2.5-0.5-0-1-6
Prerequisite(s): CN2121, CN2116
Preclusion(s): Nil
Cross-listing(s): Nil
The course provides an overview of the petrochemical industry, with a focus on the Singapore industry. The following processes are discussed: Refining, Steam Reforming, Steam Cracking, Ammonia and Methanol production, Polymerisation processes, important heterogeneous and homogeneous catalytic processes. To provide an in-depth understanding, fundamental aspects of the processes, i.e., catalysis, kinetics, thermodynamics and reactor design will be highlighted.

CN4215R Food Technology and Engineering
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): CN2125, CN3132
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with the necessary background for food processing in the context of chemical engineering operations. The module combines food science and engineering operations as an integrated food-engineering course. It starts with food science topics such as food chemistry, microbiology and nutrition. It then focuses on the applications of various chemical engineering operations (refrigeration, freezing, evaporation, drying, thermal sterilisation) to food processing. The course also covers other relevant topics such as food rheology and packaging of food products. This module is targeted at level 4 chemical engineering students.

CN4216R Electronic Materials Science
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with a fundamental knowledge of electronic materials produced or processed in various industries. It imparts a basic understanding in electrical, optical, and magnetic properties of electronic materials in relation to their importance in the optoelectronic/semiconductor industry and their technological applications such as wafer devices, solid-state fuel cells, lithium secondary batteries, light-emitting diodes and solid-state lasers. In particular, semi-conductors, electronic ceramics, conducting polymers and optical and magnetic materials will be introduced. This module is targeted at level 4 engineering students.

CN4217R Processing of Microelectronic Materials
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with an overview of semi-conductor processing with an emphasis on the role of chemical engineering principles. An overall view of manufacturing in the semi-conductor industry and the role of chemical engineers are given. The physical and material aspects of solid-state devices are introduced with a view towards understanding their functions. The next part takes the students through the various processing events, starting with silicon wafer manufacture and continuing with diffusion, CVD, photo-lithography, etching and metallisation. Chemical engineering principles are highlighted in each section. The module concludes with a description of process integration for device manufacture and a brief discussion about electronic packaging. This module is targeted at level 4 chemical engineering students.

CN4218 Particle Technology Fundamentals and Applications
Modular Credits: 4
Workload: 2.5-1-0-1.5-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with both basic concepts and applications for the synthesis and handling of particulate materials, covering various topics such as colloids and fine particles, pharmaceutical particle synthesis and processing, dynamics of particulate systems, fluidization, pneumatic conveying and standpipe, electrostatics for particle processing, particulate flow metering and tomography, discreate element method and continuum modeling. Particulate solids are characterised in terms of size, size distribution, measurement and analysis and processing such as comminution and mixing. The pharmaceutical, biomedical and energy applications of particle technology will be covered at the end of the module.

CN4221R Control of Industrial Processes
Modular Credits: 4
Workload: 2.5-1-0-3.5-3
Prerequisite(s): CN3121, CN4122
Preclusion(s): Nil
Cross-listing(s): Nil
This module will give students sound knowledge and appreciation of the development of plant-wide control (PWC) systems for chemical processes. The course will cover the systematic design of a regulatory control system with the aid of heuristics and computer-aided simulation tools. Students will be introduced to dynamic (real-time) simulation of chemical processes. Active learning techniques will be employed throughout. As part of the assessment, students will get to work hands-on with a project to design and simulate PWC systems for a chemical plant. Students are also assessed by means of a

class test, and small individual assignments.

CN4223R Microelectronic Thin Films
Modular Credits: 4
Workload: 3-1-0-0-6
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with a working knowledge of thin film technology as it is applied in the microelectronics industry. The emphasis is on the role of chemical and engineering science in materials processing. The module commences with an introduction to basic concepts in the kinetic theory of gases, thin film formation, vacuum technology and surface preparation. The next section covers a variety of thin film deposition techniques – physical as well as chemical. Thin film processing and patterning is the next subject of discussion. In particular, process operations relevant to semi-conductor device manufacture are covered. Diagnostics and characterisation of thin films is also presented with a view to familiarise students in state-of-the-art methodologies. The last part is devoted to an intensive study of thin film phenomena from a materials perspective. This module is targeted at level 4 chemical engineering students.

CN4227R Advanced Process Control
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): CN3121
Preclusion(s): Nil
Cross-listing(s): Nil
The first topic discusses the effect of model/plant mismatch on the closed-loop system, followed by the robust controller design method with the aim to maintain stability or/and achieve performance in the presence of the modelling error. As most chemical processes are multivariable in nature, the design issues related to multi-loop (or decentralised) and decoupling controllers are discussed in the next topics. For digital computer control topics, the materials taught parallel those covered in CN3121. The last topic focuses on a powerful and modern control technique known as model predictive control that has received wide-spread use in the refining and chemical process industries.

CN4233R Good Manufacturing Practices in Pharmaceutical Industry
Modular Credits: 4
Workload: 3-1-0-3-3
Prerequisite(s): CN2102, CN3132
Preclusion(s): Nil
Cross-listing(s): Nil
This course covers important topics pertaining to regulatory and quality issues associated with pharmaceutical production. The two main components of the module are: regulatory aspects of pharmaceutical manufacture and analytical techniques for quality control. The concept of good manufacturing practices (GMP) and its components including standard operating procedures, documentation, validation, organization and personnel, premises, equipment, production and quality control are covered in the first half of the module. The second part of the module introduces the students to the various analytical techniques employed in pharmaceutical industry to assess drug's quality.

CN4238R Chemical & Biochemical Process Modelling
Modular Credits: 4
Workload: 2-1-0-6-1
Prerequisite(s): Nil
Co-requisite(s): CN3421A
Preclusion(s): Nil
Cross-listing(s): Nil
In this module, the students will consolidate their accumulated knowledge of fundamental modelling principles and analytical/numerical solution techniques by applying them to a wide variety of large-scale,

steady as well as dynamic, chemical, physicochemical, and biochemical systems of industrial importance. The module will emphasise the full range of modelling and simulation techniques including first-principle model development, model analysis and validation, and model prediction and applications. The students will demonstrate their acquired skills by solving one or more sufficiently complex problems of their own choice in a term project to gain hands-on experience.

CN4240R Unit Operations and Processes for Effluent Treatment
Modular Credits: 4
Workload: 2.5-1-0-1.5-5
Prerequisite(s): CN2116
Preclusion(s): Nil
Cross-listing(s): Nil
This module provides students with a working knowledge of unit operations and processes for the control of industrial effluent from the chemical process industries. The module begins with an overview of the characteristics of effluent from the chemical plant operations, and its impact on the environment. Concepts of environmental sustainability and green processing particularly pertinent to the chemical industry will be covered, including techniques for waste minimisation and pollution prevention. Finally, applications of processes (physical, chemical and biological) for the treatment of effluent from plant facilities will be presented. Case studies from various industries will also be presented. This module is targeted at level 4 chemical engineering students.

CN4241R Engineering Principles for Drug Delivery
Modular Credits: 4
Workload: 3-1-0-1-5
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module teaches students how to apply engineering principles to solve problems in drug delivery and applying them to the design of advanced drug delivery devices. Students are taught the application of engineering principles in the design of drug delivery devices for human health care. Basic concepts and principles in system physiology, pharmacokinetics and pharmacodynamics are introduced. Mechanisms and mathematical models of drug absorption, distribution, metabolism, and excretion are discussed. Various drug delivery devices are analysed. Lipid based and polymer based drug delivery systems are used for a sample case study.

CN4245R Data Based Process Characterisation
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): CN3121
Preclusion(s): Nil
Cross-listing(s): Nil
This course aims to provide students with the design and analysis skills necessary to generate and exploit data for a wide variety of tasks that include process monitoring, process modelling, control, optimisation and new product design. Topics covered will include multivariate statistics, system identification and design of experiments. Theory and applications will be equally emphasised. The students will gain an appreciation for the possibilities and limitations of various data based modelling techniques and also the confidence to apply these methods in practical situations. They will be able to make judicious choices of methods and design variables for real-world applications.

CN4246R Chemical and Bio-Catalysis
Modular Credits: 4
Workload: 2.5-1-0-3-3.5
Prerequisite(s): CN2116
Preclusion(s): Nil
Cross-listing(s): Nil
Students will learn the concepts of homogeneous and heterogeneous catalysis with increasing

complexities, starting from those involving polymeric phases, enzyme pockets, up to those involving zeolite cages and complex oxide surfaces. To achieve these, students will learn catalytic cycles, catalyst structures, catalytic material synthesis and characterisation methods, reaction mechanisms, kinetics, transport phenomena (such as diffusion, mass transfer and heat transfer), and reaction engineering. Many reactions and catalysts of industrial importance will be emphasised throughout the module to illustrate these principles. The students will then learn how to apply their accumulated knowledge of these principles to the design of novel catalysts.

CN4247R Enzyme Technology
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): CN2116
Preclusion(s): Nil
Cross-listing(s): Nil
This module will start with a general introduction about enzyme, enzymatic transformation, and enzymatic process. It will be followed by various components in the development of the enzymatic process: enzyme classes and enzymatic reactions; enzyme discovery and high-throughput screening and detection methods; enzyme purification, characterisation, structure, function, and selectivity; protein engineering; cell engineering; biotransformation with isolated enzymes and microbial cells; reaction engineering; enzyme in organic solvent, two-liquid phase system, and enzyme stabilisation; cofactor regeneration; and product recovery. Finally, the students will learn process economics and industrial examples on the enzymatic production of fine chemicals.

CN4248 Sustainable Process Development
Modular Credits: 4
Workload: 2-1-0-2-5
Prerequisite(s): CN2116, CN3132
Preclusion(s): Nil
Cross-listing(s): Nil
In this module, the concepts of sustainability and sustainable development and their engineering and social relevance in the development of chemical processes and products are introduced. The principles of green chemistry are presented. Clean energy and energy sustainability issues are objectively analyzed. This is followed by a detailed discussion on the developments in scientific methodologies for the sustainable engineering design of processes. Concepts of product stewardship and product design are also introduced. The methodologies and concepts are enumerated with relevant case studies. The students demonstrate their understanding through continual assessment tests and written reports, and oral presentations on open-ended projects.

CN4249 Engineering Design in Molecular Biotechnology
Modular Credits: 4
Workload: 2.5-0.5-2-3-4
Prerequisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
In this module, basic principles of molecular biotechnology will be introduced. Design process based on engineering principles will also be introduced. Subsequently the module will apply the concepts and tools of molecular biotechnology to design useful methods and processes in biotechnology. Representative examples of molecular biotechnology applications such as molecular diagnostics, therapeutics, and their impact on human health will also be covered.

CN4250 Chemical Product Design
Modular Credits: 4
Workload: 2.5-1-0-3.5-3
Prerequisite(s): CN2116, CN3132, CN3135
Co-requisite(s): EG2401A
Preclusion(s): Nil

Cross-listing(s): Nil
Many chemical companies are moving towards higher-value-added specialty chemical products from commodities. This module prepares students with the expertise of (higher-value-added) chemical product design for such companies. It covers the basic methodology with illustrative examples from many areas such as active ingredients and personal-care products. The module involves active-learning lectures and student teaching (with feedback from the lecturer and peers) so that students will gain competence of thinking divergently and critically, and confidently solving open-ended problems through group discussion.

CN4251 Troubleshooting with Case Studies for Process Engineers
Modular Credits: 4
Workload: 2-1-0-2-5
Prerequisite(s): CN2116, CN2121, CN2125, CN3132
Co-requisite(s): Nil
Preclusion(s): Nil
Cross-listing(s): Nil
This module aims to produce chemical engineers who can contribute and increase the effectiveness of problem solving in the Chemical Process Industries. It introduces robust heuristics and a systematic approach to problem solving, which combines critical and creative thinking with technical knowledge. The skill development is delivered through the presentation of various problem-solving strategies and techniques, and by applying them to real case studies from a few diverse process industries.

CN4291 Selected Topics in Chemical Engineering
Modular Credits: 4
Workload: 3-1-0-2-4
Prerequisite(s): CN2116, CN3132, CN3135, CN3421A
Preclusion(s): Nil
Cross-listing(s): Nil
This elective module aims to provide in-depth knowledge in the selected topics of interest to chemical engineers. The topics will be chosen according to the availability of expertise (e.g., visiting staff, researchers in research institutes and engineers from industry), and will be advanced, based on industry practice and new developments.