B.Eng. (Chemical and Biomolecular Engineering)

Description of courses

**Year 1 courses**

**MH1810 Mathematics 1 (3 AU)**

In this course, the basic concepts of limits, differentiation, and integration are introduced. Applications of differential and integral calculus are included. In addition, the course also covers topics on complex numbers, vectors, and matrices to prepare students for other courses in Year 1.

**Topics include:** Complex numbers, vectors and matrices, limits and continuity of functions, derivatives, applications of derivatives, integration, integration methods, applications of integration.

**CH1102 Introduction to Chemical Engineering to New Era (1 AU)**

1. Basis in chemical engineering curriculum
2. Traditional industries for chemical engineers
3. Roles of chemical engineers in traditional industries
4. Emerging industries for chemical engineers
5. Roles of chemical engineers in emerging industries
6. Communication skills, ethics and career path of chemical engineers.

**CH1104 Materials & Energy Balances (4 AU)**

This subject focuses on the material and energy balances in chemical processes and lays the foundation in other chemical engineering subjects such as thermodynamics, unit operations, reaction kinetics, etc. It introduces the engineering approach to problem solving: Breaking a process down into its components, establishing the relations between known and unknown process variables, assembling the information needed to solve for the unknowns, and finally obtaining the solution using appropriate computational methods.

**CH1105 Materials Science (3 AU)**

Materials Science is an interdisciplinary field where the properties of materials are related to their structures at the atomic, microscopic and macroscopic levels. Understanding this relationship helps students to achieve the required combination of properties in a given material for specific functionalities and therefore applications. This is an introductory course where basic scientific concepts are evolved from fundamental physics and chemistry to the roles of atomic and micro/macroscopic structures on the properties of different types of materials. Important topics on functional properties such as metallic, semiconducting, optical, magnetic, thermal and mechanical properties are covered in greater detail. This course also includes the use of materials in Chemical and Biomolecular Engineering.

**CH1117 Engineering Mathematics (4 AU)**


**CH1131 Bimolecular Engineering (4 AU)**

The course will cover the basic and functional aspects of cellular systems. Analysis of components and their functionality in cellular systems is included in this course. Students will also be exposed to aspects of biotechnology, genetic and metabolic engineering which play an increasingly important role in the new era of chemical engineering.
CH2102 Organic Chemistry & Spectrophotometry (4 AU)

This course aims to teach students organic chemistry at the intermediate level. The course focuses primarily on all the basic reactions of organic functional groups, and teaches students stereochemistry and spectroscopy of organic structures.

CH1108 Thermodynamics (4 AU)

[Prerequisite: CH1104]

This course introduces the different energy forms, thermodynamic properties, and their relationships in terms of concepts and applications in close and open systems. Homo-and heterogeneous phases are also considered with single or multiple component systems. In particular, the laws of thermodynamics are applied to solve abstract and real-life problems.

CH1801 Chemical & Biomolecular Engineering Laboratory 1 (1 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to chemical engineering, physical and analytical chemistry, biomolecular engineering, materials science.

The experiments include: (a) Titration of polyproptic acid, (b) Solubility product, (c) Introduction to MATLAB, (d) Intro to Excel.

*The experiments listed are subject to change per AY.*

CH1802 Chemical & Biomolecular Engineering Laboratory 2 (1 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to chemical engineering, physical and analytical chemistry, biomolecular engineering, materials science.

The experiments include: (a) Size exclusion, (b) Plasmid isolation, (c) Iodine thiosulfation, (d) Tensile testing.

*The experiments listed are subject to change per AY.*

HW0188 Engineering Communication I (2 AU)

This course covers basic academic literacy skills as well as written and oral communication skills for the field of engineering.

GC0001 Introduction to Sustainability- Multidisciplinary Approaches & Solution (1 AU)

This course is an introduction to sustainability presented in six modules by six different disciplines, as represented by NTU's schools and centres. 1. The ecological basis of the natural environment from a regional and planetary perspective. 2. Key requirements and constraints for social development and survival, including energy, water, and the built environment. 3. The intersection of economic markets and financial systems, both from the perspective of driving growth and consumption, as well as playing a role as incentives for positive change. 4. The political economy framework of global and regional sustainability challenges. 5. The interaction and connectedness between the various single disciplines and themes.

ML0001 Absolute Basics for Career (1 AU)

In today's competitive world, it is essential that students learn the crucial career skills early to ensure a competitive edge sharpened with a heightened sense of workplace values and ethics. This course takes students through a journey of career discovery, understanding and polishing of oneself which will then be translated into job application tools such as resumes and interview skills. All students will have the opportunity to undergo a robust Career Assessment Tool, which assesses their career options and career self and helps them chart a career action plan. They will also learn how to identify and articulate the concept of personal branding.
and applying that to resumes and interviews and online social media. Students will also be exposed to the basics of grooming to ensure that they are aware of the importance of first impressions in all situations.

**Year 2 courses**

**CH2103 Fluid Systems (4 AU)**

[Prerequisite: CH1104 and CH1117]

This course introduces fluid behaviours in various systems relevant to industrial practice. Mass, energy and momentum balances related to fluid flows. Fluid flow in pipes. Dimensional analysis, Pump and compressors. Differential equations of fluid mechanics.

**CH2104 Heat & Mass Transfer in Chemical & Biological Systems (4 AU)**

[Prerequisite: CH1104, CH1108, CH1117, CH2103 and MH1810]

The course aims to enable students to understand the meaning of the terminology and physical principles of heat and mass transfer. Students are taught to compute heat transfer rate and/or temperature distribution for processes involving heat and mass transfer, when requisite conditions are given. They are taught to develop representative models of real processes and system (e.g. heat exchanger, cooling tower) and to draw conclusion from analysis.

**CH2106 Introduction to Multidisciplinary Engineering (2AU)**


**CH2107 Computational Methods in Chemical Engineering (3 AU)**

[Prerequisite: CH1117]

Introduction to solving mathematical problems via numerical methods. Introduction to computation algorithms and application of the programming packages. Matrix algebra, linear algebraic equations, eigenvalues and eigenvectors, non-linear polynomial equations, function approximation, numerical integration and differentiation, ordinary differential equations, and partial differential equations.

**CH2109 Decision Tools for Business & Engineering (3 AU)**

Making difficult choices in business, manufacturing, finance and engineering domains require mathematical knowledge like statistics, optimization, probability, control and modeling. The course emphasizes applying these mathematical tools to solve engineering/business problems though case study.

**CH2140 Chemical Engineering Unit Operations I (4 AU)**

[Prerequisite: CH1104, CH1108 and CH3103]

This course will introduce the principles of separation processes. Particular emphasis will be placed on how thermodynamics and kinetics affect separation processes and how to exploit differences in physical properties to separate constituents of a mixture. The course will focus mainly on classical equilibrium staged separations such as distillation, gas-liquid absorption and liquid-liquid extraction. Introduction will be provided to more advanced processes such as membranes and adsorption.
CH3102 Chemical Reaction Engineering (4 AU)

[Prerequisite: CH1104 and MH1810]


CH3103 Chemical Thermodynamics (3 AU)

[Prerequisite: CH1108]

This course introduces thermodynamics at a more advanced level. Application of basic thermodynamic relations to the analysis of refrigeration and liquefaction. Concepts of residual properties and excess properties and their applications in system involving real gases, gaseous mixtures and non-ideal solutions. Development of property relations involving fugacity, fugacity coefficient and activity coefficient. Applications of laws and relations of thermodynamics for the analysis of physical and chemical reaction processes.

CH2801 Chemical & Biomolecular Engineering Laboratory 3 (2 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to chemical and biomolecular engineering.

The experiments include: (a) Organic synthesis, (b) Organic (UV), (c) Organic (NMR, FTIR), (d) Gene transformation, (e) Vapor compression cycle, (f) Impact of jet/viscosity.

*The experiments listed are subject to change per AY.*

CH2802 Chemical & Biomolecular Engineering Laboratory 4 (2 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to chemical and biomolecular engineering.

The experiments include: (a) Friction loss in pipes, (b) Centrifugal pumps, (c) Counterflow heat, (d) Forced convection heat transfer, (e) Natural convection & radiation, (f) Determination of gas & liquid, (g) Partial molar volume.

*The experiments listed are subject to change per AY.*

HW0288 Engineering Communication II (2 AU)

This course will improve the writing skills of students with particular reference to the Final Year Project (FYP) report, and their communication skills in professional settings.

HY0001 Ethics and Moral Reasoning (1 AU)

HY0001 will introduce students to three major ethical theories' utilitarianism, Kant's deontology, and virtue ethics. Then, four weeks will be devoted to teaching the ethical principles underlying academic integrity, research ethics, and intellectual property. Finally, students will discuss issues related to the ethics of environmental sustainability and conservation. All the while, students will be challenged apply the ethical theories learned to concrete moral problems, including world poverty, corporate accountability and whistleblowing, and workplace discrimination.
Year 3 courses

CH3101 Process Control & Dynamics (4 AU)

[Prerequisite: CH1104, CH2104, CH1108, CH3102 and MH1810]

This course introduces the basics of process dynamics and control. Development of linear dynamic models using conservation laws and experimental data. Analysis of dynamic response of process systems modelled using transfer functions. Open and closed-loop stability analysis. Design and analysis of proportional-integral-derivative (PID) controllers. Design of advanced controllers like feedforward and cascade controllers.

CH3141 Advanced Unit Operations (3 AU)

This course is designed for students with an engineering background to learn the particle processings and separation techniques used for pharmaceutical and biological industries. The course emphasizes the fundamental chemical engineering principles encountered in gas-solid/liquid-solid systems. The objective of the course is to provide students with a comprehensive and concise overview of different separation processes available for system involving solids and to develop independent problem solving abilities.

CH3802 Chemical & Biomolecular Engineering Laboratory 5 (3 AU)

Laboratory experiments and projects to provide practical application and understanding of theories relating to chemical and biomolecular engineering.

The experiments include: (a) Chem absorption in a packed bed, (b) Continuous distillation, (c) Process control, (d) Fluidization, (e) C*/Tubular flow reactor, (f) Cooling tower.

*The experiments listed are subject to change per AY.*

CH4101 Chemical, Biological & Plant Safety (2 AU)

This course aims to teach students about chemical, biological and plant safety at advanced level; and to understand and application of fundamental tools used to design, manage, operate safety and quantify risks in chemical and biological plants.

CH0491 Engineers & Society (3 AU)

The course comprises 4 main topics: Evolution of Modern Singapore; Technology & Society: Ethics and Professionalism and The Environment. The students are made aware of ‘Current Issues’ at the time of their study.

HW0310 Professional Communication (2 AU)

[AY1617 will be the final year that it will be offered for AY13 matriculated students or earlier]

This course aims to equip students with the oral and written communication skills essential for functioning effectively in the workplace. Teaching and learning is conducted in the context of a globalised and constantly changing work environment with emphasis placed on flexibility and persuasiveness in communication. The focus is on written as well as oral professional communication.
Year 4 courses

CH3104 Biochemical Engineering (3 AU)

[Prerequisite: CH1104, CH1131, CH2104, CH2105 and CH3102]


CH4801 Final Year Design Project (8 AU)

This is the capstone course which utilizes the fundamentals of chemical engineering (material balances, energy balances, transport phenomena, thermodynamics, kinetics, separations, unit operations, and safety) in the design and operation of chemical plants. This course will enable students to undertake and manage projects as a team to its successful completion and to write good technical reports.

CBE electives (all 3AUs unless otherwise stated)

CH4102 Special Topics in Pharmaceutical Manufacturing

The aim of this course is to introduce students to the regulation processes in pharmaceutical manufacturing; and to expose students to the technology transfer of pharmaceutical manufacturing.

CH4105 Food Engineering

The topics that will be covered in this course include: Properties of food and processing, separation and concentration of food components, size reduction, heat processing, food biotechnology.

CH4106 Formulation of Active Pharmaceutical Ingredients Dosage Forms

The objective of the course is to give an insight in drug formulation and the setting of quality specifications. Thus, the course is devoted to the objectives involved in bringing an active pharmaceutical ingredient into an effective and safe dosage form.

CH4213 Pharmokinetics and Bio-pharmaceutics


CH4303 Bioseparations

Bioseparation techniques that have been developed over the past couple decades to separate biological mechanistic analysis of key phenomena at the microscopic scale in bioseparation, will be emphasized, purification of biomolecules ranging from recombinant proteins to gene therapy products, with footnotes detailing economics of the products. Among the topics to be discussed are sedimentation, centrifugation, filtration, membrane separations, precipitation, crystallization, extraction, and the principles and scale-up of liquid chromatography.
CH4304 Synthetic Biology

Fundamentals of synthetic biology, molecular biology and genetic engineering; functional genomics; computational and metabolic modelling; synthetic genetic circuits; genetic networks; potential applications in biotechnology.

CH4305 Special Topics in Biotechnology


CH4306 Bioanalytical Techniques

The objective of this course is to provide a forum for advanced student discussion on the development, application and utility of modern analytical and bioanalytical methods and techniques used in research. A secondary purpose is to discuss the generation, application and meaning of data in addressing complex questions and problems in biochemical engineering, cell biology, molecular biology and biochemistry.

CH4308 Therapeutic Engineering

The learning objective is to obtain fundamentals of engineered therapeutics. It covers: Basic cell and structural biology; Basic histology; Tissues and Organs; Cell culture; Transport phenomenon; Biomaterials; Tissue engineering scaffolds; Cell-biomaterials interactions; and Tissue engineering case studies.

CH4103 Chemistry of Heterocyclic Compounds

The objective of the course is to give students an insight into heterocyclic chemistry and the use of different classes of these compounds in active pharmaceutical ingredients. Heterocyclic compounds are of prime importance in the chemical industry, and heterocyclic chemistry is therefore a fundamental topic in the undergraduate courses. The emphasis of this course is on synthetic aspects, and it covers the essential details and basic principles with reference to all the important classes of heterocyclic compounds. It is the study of Heterocyclic organic compounds including their methods of synthesis, reactions and their mechanisms. Three-four- five- and six- membered heterocyclic compounds with one heteroatom as well as five- and six- membered with two or three heteroatoms, particularly those containing nitrogen will be taught. The course includes the synthesis of some naturally occurring heterocyclic compounds.

CH4220 Special Topics in Industrial Chemistry & Green Processing

This course covers special topics of current interest in the area of industrial chemistry and green processing, which include: Industrial chemistry, food chemistry and processing, food additives, flavour and fragrances, chemical processes, environmental friendly processes.

CH4222 Industrial Chemical Processes


CH4223 Petroleum Refining

The objective of this course is to introduce CBE students to the hydrocarbon/refining/petrochemical industry. By the end of the course, students should understand and be able to describe the standard processes. They should be able to apply concepts and perform simple calculations. They will be made aware of renewable technologies and have knowledge of environmental issues. They will be able to appreciate the current challenges the industry faces.
CH4250 Special Topics in Polymers for Nanotechnology

This course aims to provide an overview on the types of polymeric systems that are relevant to the emerging field of nanotechnology. Most of the materials covered are at the cutting edge of emerging technology that utilise polymers for applications in Nanotechnology.

CH4405 Catalysis and Surface Science


CH4702 Independent Research Project I

[This is only offered to CBE students who are in their final year and ABP students who are in their 3rd year.]

Independent research project in a topic related to Chemical and Biomolecular Engineering.

CH4703 Independent Research Project II

[This is only offered to CBE students who are in their final year and ABP students who are in their 3rd year and they must have cleared CH4702.]

Independent research project in a topic related to Chemical and Biomolecular Engineering. Students who have cleared CH4702 can take up CH4703.