

## **B.Eng. (Chemical and Biomolecular Engineering)** **Description of courses**

### **Year 1 courses**

#### **CH1101 Mathematics 1 (3 AU)**

Complex numbers. Vectors and matrices. Limits and continuity of functions. Derivatives. Applications of derivatives. Integration. Integration methods. Applications of integration.

#### **CH1104 Materials & Energy Balances (3 AU)**

This course introduces material and energy balance concepts, calculations and problem solving skills. Material balance for single and multi-component systems. Energy balance on non-reactive/reactive/transient processes. Computer-aided mass & energy balance calculations.

#### **CH1105 Materials Science (3 AU)**

Introduction and significance of materials science. Bonding between atoms. Building blocks of materials. Crystal defects and diffusion. Structural properties of materials. Functional properties of materials. Phases and microstructures. Applications to chemical and biomolecular engineering.

#### **CH1106 Mathematics for Engineers A (3 AU)**

Modeling chemical and biomedical engineering systems. First order differential equations. Second order differential equations. Laplace transforms. Linear algebra. Eigenvalues and eigenvectors. Systems of first order differential equations.

#### **CH1107 Mathematics for Engineers B (3 AU)**

Partial differentiation. Multiple integrals. Vector algebra and vector calculus. Fourier series, integrals, and transforms. Partial differential equations.

#### **CH1111 Introduction to Programming (1 AU)**

A self-learning course to introduce students to programming. Arithmetic operations. Logical operators and functions. Graphics. Arrays and matrices. Input and output. Modular and structured programming.

#### **CH1120 Physical Chemistry (2 AU)**

Non-flow system. System and surrounding. Temperature. Equilibrium and non-equilibrium states. First law. Second law. Entropy. Chemical reaction thermodynamics. Equilibrium constant.

#### **CH1131 Biomolecular Engineering I (3 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 introduces organic chemistry and spectroscopy at a more intermediate level. Study main organic reactions. Mechanism of organic transformations. Spectroscopy of organic compounds.

#### **CH2108 Thermodynamics (3 AU)**

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.

#### **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.

#### **HW0110 Effective Communication (2 AU)**

The communication process. Intrapersonal and interpersonal communication. Oral and written communication.

## Year 2 courses

### **CH2103 Fluid Systems (4 AU)**

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)**

This course introduces fundamentals of heat and mass transfer. Heat transfer by conduction, convection and radiation. Mass transfer mechanisms. Convective mass transfer. Interface mass transfer.

### **CH2105 Biomolecular Engineering II (3 AU)**

The course will cover the basic and functional aspects of biochemical reactions in the cellular systems. Analysis of components and their functionality in cellular systems is included in this course. Students will also be exposed to aspects of biochemical engineering, and metabolic engineering which play an increasingly important role in the new era of chemical engineering.

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

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.

### **CH2140 Principles of Separation Processes (4 AU)**

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)**

This course introduces chemical reaction engineering concepts and theories at a fundamental level. Reaction rates and batch reactor. Continuous isothermal reactors. Nonisothermal reactors. Multiple steady states and transients. Mass transfer and catalytic reactor. Residence time distribution and non-ideal flow reactor.

### **CH3103 Chemical Thermodynamics (3 AU)**

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.

### **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.

### **HW0210 Technical Communication (2 AU)**

Principles of technical communication. Conveying technical information in writing and orally. Types of technical reports. Technical writing style.

### **Year 3 courses**

#### **CH3101 Chemical & Biomedical Process Control & Dynamics (4 AU)**

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.

#### **CH3004 Biochemical Engineering (4 AU)**

Principles of Genetically Engineered Organisms. Genetic Molecular Biology Techniques. Enzyme Kinetics and Protein Engineering. Kinetics of Microbial Growth. Batch and Continuous Fermentation.

#### **CH3141 Particle Technology and Separation Processes (3 AU)**

This course introduces general principles of separation processes and their applications, including recovery of products from pharma- & bio- processes. Particulate technology. Filtration. Crystallization. Drying.

#### **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.

#### **CH4901 Engineers & Society (3 AU)**

Evolution of modern Singapore. Technology and society. Ethics and professionalism. The environment.

#### **HW0310 Professional Communication (2 AU)**

Interpersonal communication in professional settings. Intercultural communication. Negotiating skills. Job search skills. Professional oral presentations. Working effectively in a team.

## **Year 4 courses**

### **CH4101 Chemical, Biological & Plant Safety (2 AU)**

Toxicology. Industrial hygiene & hazards identification. Fire, explosion, and prevention. Reliefs. Risk assessment, HAZOP analysis and accident investigation. Case histories. Sustainability.

### **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.

### **CH4903 Environmental Sustainability (3 AU)**

Environmental problems, their causes, and sustainability. Food and soil resources. Water resources. Nonrenewable energy resources. Energy efficiency and renewable energy. Air pollution. Climate change and ozone loss. Water pollution. Solid and hazardous waste.