MSc in Chemical Engineering Course

Core		
Course Code	**Course title**	**Academic Unit (AU)**
CH6230	Advanced Reaction Engineering	3
CH6240	Advanced Chemical Engineering Thermodynamics	3
CH6250	Advanced Mathematical Methods for Chemical Engineering	3
CH6265	Industrial case studies	3

Elective		
Course Code	**Course title**	**Academic Unit (AU)**
CH6310	Chemical Process Simulation and Technoeconomic Analysis	3
CH6270	Sustainable Pharmaceutical Technology	3
CH6280	Pharmaceutical Formulations	3
CH6241	Catalyst Design and Development	3
CH6260	Advanced Process Control	3
CH6300	MSc Research	6
CH6209	Decision Tools for Engineering Businesses	3
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CM6861	Advanced Topics in Environmental Sciences and Sustainable Development	3
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CH6400	Electrochemistry and electrocatalysis	3
CH6410	Nanocatalysis	3
CH6490	Process Design, Optimization and Supply Chain	3

CH6230 - Advanced Reaction Engineering

The objective of this course is to impart and to continue the rigorous study of reaction engineering. In this course, particular emphasis will be given to chemical kinetics and transport phenomena, review of elements of reaction kinetics, rate processes in heterogeneous reacting systems, design of fluidfluid and fluid-solid reactors, scale-up stability of chemical reactors and residence time analysis of heterogeneous chemical reactors.

CH6240 – Advanced Chemical Engineering Thermodynamics

This course aims to teach chemical thermodynamics at an advanced level, including thermodynamics concepts and principles in relation to open flow systems, ideal and non-ideal gas and liquid mixtures, and to apply them on chemical engineering processes, in particular, thermal power cycles, liquefaction, phase equilibria and chemical equilibria. You will also learn practical skills such as numerically constructing thermodynamic equilibria, phase diagrams and other types of diagrams, e.g. Pourbaix diagram and Ellingham diagram.

CH6250 – Advanced Mathematics Methods for Chemical Engineering

This course is to introduce the concept of Data Analytics to solve problems encountered in engineering and non-engineering fields. You will be able to use numerical approaches learnt in this course to gain understanding, optimize and make decision from data.
Upon successful completion of this course, you will be able to:
1. Develop and use numerical algorithms to solve integration and differential equations.

2. Data analytics and its applications, aided by computer software.

3. Apply machine learning to regression and classification problems.

4. Apply neural network to both numerical modelling and machine learning.

CH6265 Industrial Case Studies

The objective of this course is to provide exposures to real life industry problems that are encountered in chemical, pharmaceutical, semiconductor and other manufacturing sectors. You will be working in groups to tackle the problems as case studies. Key topics include:

1. Root cause analysis
2. Chemical industry
3. Pharmaceutical industry
4. Semiconductor industry

CH6260 Advanced Process Control

The objective of this subject is to provide the students with the principles and understanding of modelling and control of physiological and biomedical systems and methods for the analysis and design of these systems with applications.

CH6270 Sustainable Pharmaceutical Technology

This course aims to equip you with the latest research and development strategies to enhance the environmental sustainability of manufacturing of pharmaceuticals, including small-molecule active pharmaceutical ingredients and drug biologics (e.g., peptides, proteins). This course covers sustainability enhancement strategies in drug solubility enhancement, environmental footprints reduction, continuous manufacturing platform, and lifecycle analysis. This course will enable you to apply and implement the different approaches available for sustainability enhancement in the pharmaceutical industry.

CH6280 Pharmaceutical Formulations

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.

Course content:

1. Principles of Dosage form Design and Development
2. Solid Dosage Forms and Modified-Release Drug Delivery Systems
3. Semi-Solid and Transdermal Systems
4. Pharmaceutical Inserts
5. Liquid Dosage Forms
6. Sterile Dosage Forms and Delivery Systems

CH6241 Catalyst Design and Development

This course aims to introduce basic concepts in catalysis and the representative catalytic reactions to the engineering students. The design and development of catalysts in the laboratory and industry are focused. Various types of catalysis such as homogeneous and heterogeneous catalysts, enzymes, polymers, shall be covered. The reaction mechanisms shall be discussed, this module will enable students to define and comprehend principle and practical uses of catalysts.

CH6300 MSc Research

This independent research study course gives students experience in planning and executing the early stages of a potential research career. Students will have to actively engage and arrange for a faculty member to host them for a research project. Each student will individually work on a project over the duration of two semesters. The assessments will include a project proposal due at the early stages of the academic year and a final report due at the end of the year. The assessments are letter-graded, but there is no final examination.

CH6310 Chemical Process Simulation and Techno-Economic Analysis

This course is intended for those of you who are new to process design or those who need to refresh and deepen your knowledge about process design and simulation. In this course, you will learn to effectively synthesize a process flow diagram by applying and integrating various chemical engineering principles and implementing techno-economic evaluation method with the aid of process simulation software, such as Aspen Plus and/or HYSYS.

CH6209 Engineering Business Decision Tools

In this course, students will learn and understand engineering business structure and economics, and hence identify and apply the important and common decision tools for engineering business, such as chemical manufacturing. At the end of the course, you will be able to understand basic economics and engineering business structure to identify and apply the appropriate decision tools for engineering business.

CH6202 Project Management for Engineers

This course aims to introduce basic concepts in project management to the engineering students. This equips the engineers to improve their employability in the industry and helps in their career growth. Some of the key concepts such as project integration, scope management, project planning, project budget & cost management, project risks and opportunities, communication and conflict management shall be covered. This module will enable students to define and plan a project with proper understanding of engineers' role.

CH6320 Industrial Safety and Operational Excellence

Process safety and operational excellence are essential aspects of chemical manufacturing. This course will serve prepare graduates for challenges in the chemical process industry. This course will cover three aspects, viz. (1) introduction to process engineering in chemical process industry, (2) industrial safety and hygiene control for chemical and biological plants and (3) quality control and quality assurance of the chemical process industry. This course will teach the basic concepts, common tools and case studies in oil & gas, refineries, chemical, pharmaceutical and semiconductor industries.

BG6011 Microfluidics and Lab-On-Chip for Chemical & Biomedical Applications

This course will cover fundamentals of microfluidic and Lab-On-Chip technology, including the basic fluid mechanics theory, microfabrication for microfluidics, microfluidic flow control and system development. Function of microfluidics components, such as valves, pumps and mixers will be explained in detail. Applications of microfluidics and Lab-On-Chip will be highlighted by introducing the microfluidic components for life sciences, chemistry, point-of-care diagnostics, Organ-on-Chip and so on. Through assignment, students will have the chance to research a particular type of microfluidic technology and its utility for specific applications.

BG6013 Data Analytics for Biomedical Applications

This course will cover the following:

1. Introduction to data science and its applications in real-world problems
2. Data Exploration, Data Cleaning and Pre-Processing
3. Introduction of Statistic in Data Analysis
4. Data Mining
5. Machine learning in data science
6. Basic Python Programming
7. Data science using Python in Jupyter notebook
8. Machine Learning Approach #1: Linear Regression
9. Machine Learning Approach #2: Classification
10. Machine Learning Approach #3: Clustering
11. Machine Learning Approach #4: Anomaly Detection
12. Application of algorithms from the above four approaches on real data using python in Jupyter notebook
13. Visualization
14. Data analytics on real data from biomedical applications using Python in Jupyter notebook

CM6861 Advanced Topics in Environmental Sciences and Sustainable Development

This course is an inter-disciplinary and broad survey of topics related to industrial and environmental chemistry within Singapore and around the world. The topics are intended to bring greater awareness to practical applications of chemistry beyond the traditional molecular chemistry curriculum. The course will give overview of industrial and environmental chemistry, with a focus on industries relevant to Singapore's current and future chemical industry.

CM6862 Advanced Analytical & Manufacturing Techniques in Pharmaceutical Industry

This course is intended to equip graduate students with the awareness and knowledge of the overall analytical and manufacturing techniques in both the drug discovery and development, and the pharmaceutical industries. Besides the overall drug discovery and development process, other topics include analytical techniques (high performance liquid chromatography, liquid chromatograph mass spectroscopy, gas chromatography, manufacturing & controls (CMC, continuous flow chemistry and manufacturing techniques like biocatalysis and additive manufacturing.

CH6400 – Electrochemistry and Electrocatalysis

This course aims to provide you with a deep understanding of electrochemistry and electrocatalysis, equipping you with the knowledge and skills to tackle complex challenges in energy conversion and storage. It is designed for students with a background in chemistry, physics, or engineering who are interested in exploring the intersection of these fields. By taking this course, you will gain valuable insights and hands-on experience that are essential for careers in net zero emissions, renewable and sustainable energy, environmental technology, and advanced materials research, as well as for further academic pursuits in related disciplines.

CH6410 – Nanocatalysis

In the nanocatalysis course, you will explore the fundamental principles and innovative applications of nanocatalysts in various chemical processes. This course is designed for graduate students in the fields of chemistry, materials science, and engineering, who are eager to expand their expertise in catalysis at the nanoscale. By participating in this course, you will gain valuable insights and hands-on experience that will not only enhance your research capabilities but also prepare you for exciting career opportunities in academia, industry, and cutting-edge research environments where nanocatalysis plays a crucial role in sustainable development and advanced technology.

CH6490 – Process Design, Optimization and Supply Chain

This course will provide students with a deep understanding of the principles and practices involved in the Process Design and Supply Chain. Students will learn to apply engineering principles, operations research, and supply chain management strategies to design, optimize, and manage processes in a way that maximizes productivity, reduces costs, and ensures sustainability.
The following topics will be covered in the course

1. **Overview of Process Design**
   This aims to develop simulation skills to consider complex process design in the context of safety, cost, and sustainable process plant development. It equips with a systematic design methodology to design key unit operations (i.e. reactor, separator, and heat exchanger) in a chemical plant, with an emphasis on the conceptual issues that are fundamental to the process creation.
2. **Supply Chain and Logistics**
   Supply chains are global in nature comprising of complex interactions and flows between tens, even hundreds and thousands of companies and facilities geographically distributed across regions and countries. There are mainly three types of flow in any Supply Chain which is material flow, information flow, and finance flow. Supply chain networks are studied and Strategic, tactical, and Operational decisions that optimizes supply chain performance are explored.
3. **Process Optimization**
   Linear, Mixed-Integer Linear and nonlinear programming is studied. Process simulation and modeling tools (e.g., Aspen HYSYS, MATLAB, GAMS) are explored and several Case studies on process optimization are discussed.