

## Module Description

### Technical Modules

#### 1. Applied Homogeneous & Heterogeneous Catalysis

The goal of these modules is to provide insight into the industrially very important field of catalysis. Both homogeneous and heterogeneous catalyses will be described and important applications will be exemplarily described. An understanding of the principles of catalysis and the demands on efficient catalysts will be provided. The principles of establishing catalytic mechanisms will be outlined. Upon completion of the modules, students will be able to understand the principle of catalysis and the demands on efficient catalysts.

#### 2. Electrochemistry & New Materials for Lithium/Sodium-based Energy Storage Systems

This course would consist of 3 major parts. Firstly, it will introduce students to a different class of energy storage systems - supercapacitors and hybrid capacitors. The underlying mechanism of energy storage in these devices will also be presented. The students will be able to appreciate how supercapacitors bridge the gap between batteries and capacitors. Research developments based on lithium ion supercapacitors will also be presented. Secondly, novel battery systems beyond lithium ion would be detailed along with challenges and latest research trends in these systems (e.g. aqueous lithium ion/sodium ion/lithium-air/lithium-sulphur batteries). Finally, students will be exposed to the profound impact of nanomaterials on research in energy storage with a focus on lithium and sodium ion based systems.

#### 3. The Development of Batteries

In this short and intensive course, students will learn the fundamentals of electrochemistry, the basic components of a battery and the principles governing its operation. Students will also become familiar with the materials used in modern lithium-ion batteries and their respective operational characteristics. In addition, they will appreciate the factors that affect battery performance and the mechanisms responsible for performance degradation. Lastly, students will get an overview of the latest development in battery research.

#### 4. Ionic Liquids: Solvent or Catalyst

Ionic liquids have developed from laboratory curiosities to highly-tuned molecules. Although used in early stages as solvents, these "solvents" have improved selectivity, conversion and product separation in catalytic or stoichiometric reactions. Thus, significant efforts are undertaken to understand these non-conventional solvents. The lecture will elaborate on the unique chemical and physical properties of ionic liquids; synthesis and purification steps are also discussed. The students will get an overview of this class of substances and a detailed insight on how they are tailored to suit the application at hand.

#### 5. Green Chemistry

This module will introduce the concept of green and sustainable chemistry to students. This will allow students to think about chemistry from a different perspective by creating alternative, safe technologies to pollutions.

#### 6. Polymeric Membrane and Its Application: From a Chemistry Perspective

Polymeric membranes are used to separate a desired product from liquid and gaseous mixture in chemical and pharmaceutical industries. There are diverse approaches to create the "best" membrane for a particular application and this course will explore the fundamentals behind each approach from a chemistry perspective. At the end of the course, the students will be able to apply these principles to theoretically design a membrane for a particular separation of concern.

## 7. Biochemistry for Industrial Chemists

This module will cover a range of applications of biochemical systems (microorganisms and their associated processes) to the commercial transformation of diverse raw materials into finished products upon applying chemical processes. This session will give an introduction to topics such as growth and product formation in biocatalysis, characteristics of large-scale fermentations, energy production (ethanol, biogas etc.) and conversion of sunlight into biomass (bioreactors and biophotolysis). Production of biomolecules such as insulin and antibiotics is also a major component discussed in this session. The session will end with an introduction to biochemical basis of waste management and pollution control.

## 8. Biomedical Chemistry

This module focuses primarily on chemistry at the interface to biology, with applications within the pharmaceutical and biomedical fields, where the traditional boundaries between pharmacology, chemistry and biology tend to merge. The session will provide a survey of the drug design, discovery and development processes utilized by academic and industrial biomedical chemists using rational approaches to drug design and development from a biological, organic chemistry and mechanistic standpoint.

### **Soft-skill Modules**

#### 1. Career Essentials

With rising competition in the recruitment market, there is an increasing need for applicants to differentiate themselves when faced with global competition for highly sought-after jobs. The module will equip students the knowledge and skills that will help them with their career planning and job search strategies. Topics covered include personal branding and networking skills, resume and cover letter writing and interview skills.

#### 2. International Management & Business Negotiation Focusing on the Cultural Influence

Business is basically about customers, followed by profit and then own company resilience. This course will highlight customer management from two perspectives, i.e. to manage customer expectations in international business and to maintain customer relationships through negotiation tactics from different cultural perspectives.

#### 3. Managing Research Projects

The module will cover the following subjects: Starting a research project, Project management, Literature review, Data analysis, Writing and Publishing a paper. Upon completion of the module, the students will have the adequate skills and training for writing and management of project proposals and are able to understand the tools and techniques for the successful operation of international projects.