iTeach – Chemical Engineering Learning Outcomes

Section 1

Underpinning Mathematics and Science

- Have a knowledge and understanding of mathematics necessary to support applications of key engineering principles.
- Have a knowledge and understanding of basic mathematical models relevant to chemical engineering.
- Have a knowledge and understanding of scientific principles, namely the relevant aspects of physics, chemistry, biochemistry, biology and materials science.

Section 2

Core Chemical Engineering

Fundamentals

- Understand the principles of mass and energy balances
- Understand the thermodynamic and transport properties of fluids, solids and multiphase systems
- Understand the principles of momentum, heat and mass transfer, and be able to apply them to problems involving flowing fluids and multiple phases
- Be able to apply thermodynamic analysis to processes with heat and work transfer
- Understand the principles of equilibrium and chemical thermodynamics, and be able to apply them to phase behaviour, and to systems with chemical reaction
- Understand the principles of chemical reaction engineering

Mathematical Modelling and Quantitative Methods

- Be familiar with, and able to apply, a range of appropriate tools such as dimensional analysis and mathematical modelling
- Understand the role of empirical correlation and other approximate methods
- Be competent in the use of numerical and computer methods. (The emphasis is on the use of software in solving chemical engineering problems)

Process and Product Technology

- Understand and be able to apply methods to analyse the characteristics and performance of a range of typical mixing, separation, and similar processing steps for fluids, particulates and multi-phases
- Understand the principles on which processing equipment operates, and be able to apply methods to determine equipment size and performance of common items such as reactors, exchangers and columns
- Understand and be able to estimate the effect of processing steps upon the state of the material being processed, and on the end product in terms of its composition, morphology and functionality

Systems

- Understand the principles of batch and continuous operation and criteria for process selection
- Understand the inter-dependence of elements of a complex system and be able to synthesise such systems by integrating process steps into a sequence and applying analysis techniques such as balances (mass, energy) and pinch
- Understand system dynamics, be able to predict the response to changes in a dynamic system, and be able to design and determine the characteristics and performance of measurement and control functions

Safety

- Understand the inherent nature of safety and loss prevention, and the principal hazard sources in chemical and related processes – including flammability, explosivity, toxicity (including biological hazards)
- Understand the principles of risk assessment and of safety management, and be able to apply techniques for the assessment and abatement of process and product hazards
- Understand methods of identifying process hazards (e.g. HAZOP), and of assessing environmental impact
- Be aware of specialist aspects of safety and environmental issues, such as noise, hazardous area classification, relief and blowdown, fault tree analysis
- Understand the legislative framework and how it is applied to the management of safety, health and environment in industry, from the perspectives of operators, designers, constructors and in offices

Sustainability, Economics, Ethics

- Understand the principles of sustainability (environmental, social and economic) and be able to apply techniques for analysing, throughout the lifecycle, the interaction of process, product and plant with the environment

- Understand and be able to apply the main methods of minimizing the environmental impact on air, water, land, and integrated eco-systems, including waste minimization at source and ‘end-of-pipe’ methods
- Be able to apply the principles of process, plant and project economics
- Understand the need for high ethical and professional standards and understand how they are applied to issues facing engineers

Section 3
Engineering Practice and Design

Engineering Practice

- Understand and be able to use relevant materials, equipment, tools, processes, or products.
- Have a knowledge and understanding of workshop and laboratory practice.
- Be able to undertake well-planned experimental work and to interpret, analyse and report on experimental data.
- Be able to find and apply, with judgement, information from technical literature and other sources.
- Be aware of the importance of codes of practice and industry standards and have some experience in applying them.
- Be aware of quality assurance issues and their application to continuous improvement.
- Be aware of the range of applications of chemical engineering and the roles of chemical engineers.
- Be aware of the concept and implications of ‘professional’ (chartered) engineers and the role of Professional Engineering Institutions.

Engineering Design

- Understand the importance of identifying the objectives and context of the design in terms of: the business requirements; the technical requirements; sustainable development; safety, health and environmental issues; appreciation of public perception and concerns.
- Understand that design is an open-ended process, lacking a predetermined solution, which requires: synthesis, innovation and creativity; choices on the basis of incomplete and contradictory information; decision making; working with constraints and multiple objectives; justification of the choices and decisions taken.
- Be able to deploy chemical engineering knowledge using rigorous calculation and results analysis to arrive at and verify the realism of the chosen design.
- Be able to take a systems approach to design appreciating: complexity; interaction; integration.
- Be able to work in a team and understand and manage the processes of: peer challenge; planning, prioritising and organising team activity; the discipline of mutual dependency

- Be able to communicate effectively to: acquire input information; present the outcomes of the design clearly, concisely and with the appropriate amount of detail, including flowsheets and stream data; explain and defend chosen design options and decisions taken.

Section 4
Advanced level

Depth

Masters degree programmes that provide students with a deeper penetration of knowledge and understanding than has previously been acquired from a first exposure to a topic earlier in the degree programme, taught to Bachelor level standard. Such advanced programmes must therefore have clearly distinguishable prerequisites of taught study from earlier in the curriculum plan. (Where long programme/modules exist due allowance will be made to address this principle concept).

Engineering practice and design

- Understand the limitations of current practice.
- Be aware of research and developments in relevant technologies and their potential impact on current practice.
- Have undertaken research and/or development project work that provides opportunities for: application of research methods; originality and experience in dealing with uncertainty and new concepts and/or applications.
- Have communicated the outcomes of the project work in a professional manner that may include: thesis; publication; poster; presentation.
- Have a comprehensive understanding of design processes and methodologies and an ability to apply and adapt them in unfamiliar situations.
- Have the ability to generate an innovative design for processes, systems and products to fulfil new needs.

Breadth

Masters degree programmes that expose students to topics additional to those that would normally be considered as core chemical engineering but that are valuable to further developing their chemical engineering formation.

Section 5

Embedded Learning

General Transferable Skills

- Have developed a wide range of problem-solving skills
- Have developed a range of effective communication skills including written reports and presentations
- Recognise the importance of working effectively with others and have acquired a range of experience in achieving this
- Recognise the importance of leadership skills and have had some opportunity to acquire these
- Be effective users of IT
- Recognise the importance of project planning and time management and have acquired a range of experience in achieving these
- Be aware of the benefits of continuing professional development and of personal development planning