MCAST

Malta College of Arts, Science & Technology

MQF Level 6

AS6-01-19

MCAST Bachelor of Science (Honours) in Chemical Technology

Course Specification

Course Description

This degree is geared towards those students who envisage a career in applied chemical sciences and related industries. The programme will offer an opportunity for students to gain a foundation in the core chemistry concepts and the manufacture of chemical products, such as pharmaceuticals, polymers, foods, beverages and petrochemicals. The knowledge, skills and competences attained give the individuals an opportunity to succeed in employment in a wide range of manufacturing and processing industries, consulting firms, government, research and educational institutions.

The course will expose students to the development and design of chemical processes at different scales and creates a bridge between science and manufacturing, by applying the principles of chemistry and engineering to solve problems involving the production or use of chemicals. The programme also provides opportunities for learners to focus on the development of higher level skills in a scientific and technological context, providing learners to develop a range of skills and attributes essential for successful performance in professional working life.

Within this degree students will be required to choose one minor stream of 5 units (amounting to 30 ECTS) from the following 4 options: Chemical Engineering; Human Sciences; Computer Engineering; Organizational Decision Making.

Programme Learning Outcomes

At the end of the programme the learner will be able to:

1. Understand theoretical aspects of fundamental and specialized chemistry subjects and apply the acquired knowledge to solve complex problems encountered in the chemical industry.

2. Understand the processes involved in the research and development of chemical manufacturing activities.

3. Understand the operation and maintenance of industrial chemical plants and appreciate the need of health and safety and environmental considerations.

4. Know how to manage a quality system and understand the typical duties of laboratory managers in different types of laboratory.

Entry Requirements

MCAST Advanced Diploma in Applied Science
or
2 A-Level Passes and 2 I-Level Passes
Compulsory A-Level: Chemistry
Preferred A or I-Level: Biology, Physics, Mathematics (Pure or Applied)

Key Units

A key unit is a unit which is considered fundamental to a specific course. According to the University College Regulations, a student shall not be allowed to progress from one year to the next if such student fails in a key unit

Unit Title	ECTS
Chemical Laboratory Techniques	12
Introduction to Chemical Engineering	6
Quality Assurance and Quality Control	6
Research Methods within a Research Project	12

Current Approved Programme Structure

Unit Title	ECTS
Inorganic Chemistry	6
Organic Chemistry	6
Physical Chemistry	6
Chemical Laboratory Techniques	12
Analysis of Scientific Data and Information	6
Introduction to Chemical Engineering	6
Principles of Spectroscopy and Chromatography	6
Analytical Chemistry	6
Environmental Chemical Analysis	6
Industrial Chemistry	6
Medicinal Chemistry	6
Environmental Monitoring and Analysis	6
Quality Assurance and Quality Control	6
Laboratory Management	6
Research Methods within a Research Project	12
Work Based Experience	6
Chemical Reaction Engineering	6
Chemical Engineering Thermodynamics	6
Fundamentals of Engineering and Process Engineering	6
Mechanical Operations	6
Process Modelling and Computing	6
Separation Processes	6
Transport Phenomena	6
Dissertation	12
Entrepreneurship	6
English	6
Critical Thinking	6
Total ECVET/ECTS	**180**

Inorganic Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

The unit will allow the learner to obtain a sound foundation of inorganic chemistry. Inorganic chemistry is the study of the properties and behaviour of the elements and their compounds.

This unit provides the learner with the knowledge of the periodic classification of the elements in terms of the behaviour of the elements themselves and that of their compounds. It will give the learner knowledge about the periodic trends of the elements and will enable the learner to predict the properties of elements based on their position within the periodic table.

It also introduces the learner to the quantum mechanical model for the arrangement of electrons in the atoms. It also provides an inside depth into the bonding of atoms and molecular orbital theory. It will enable the learner to apply these models in order to predict the shape and properties of molecules and compounds.

This unit is relevant to learners wishing to further their knowledge of chemistry in order to have a sound theoretical basis for the understanding of the properties of compounds and material chemistry.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Use quantum mechanics to explain the electronic arrangement in atoms.*
2. *Apply the concepts of bonding to explain the properties of compounds.*
3. *Describe and explain the periodic classification of elements*
4. *Explain the properties of elements, and their compounds, in terms of their electronic configuration.*

Organic Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

This is a knowledge and skills-based unit that will allow learners to demonstrate that they have a proper understanding of basic organic compounds: their basic chemical structure, their properties and reactions, and their reaction mechanisms.

By expanding on the knowledge attained from other chemistry units and by introducing new concepts related the field of organic chemistry, this unit is meant to serve as a sound introduction to organic chemistry. In particular, the unit delves further into the specific organic chemistry reaction mechanisms which have not been covered in other units. In essence, this unit will be developing the students' knowledge of organic chemistry by reviewing basic and new material.

By placing an emphasis on the industrial importance of such reactions and processes, this information will allow the learners to further appreciate the wide variety of organic compounds and their use within society.

Based on theoretical and practical work, both as part of formal and summative assessment, learners will be able to complete coursework and examinations for this unit.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe the structure and bonding of organic compounds.*
2. *Describe the terminology used in organic reaction mechanisms.*
3. *Describe the reactions of hydrocarbons.*
4. *Describe the reactions of mono-functional group compounds.*

Physical Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

The unit will allow the learner to obtain a sound foundation of physical chemistry. It provides a concise coverage of a wide range of essential topics in physical chemistry and this will give the learner valuable insight into in the various processes that physical chemistry entails.

This unit is relevant to learners wishing to further their knowledge of chemistry in order to have a sound theoretical basis for laboratory analysis. It will enable the learner to understand the chemistry of bonding, energetics, kinetics and equilibria. This unit involves several mathematical calculations and it is important that the learner has a proper basis of mathematics, especially algebra and solving equations.

The learner will make use of mathematical models to describe and predict physical phenomena such as enthalpies of reaction and rates of reactions. At the end of this unit, the learner will understand the driving force behind chemical reactions that take place around us

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe properties of atoms, understand gas laws and thermodynamics.*
2. *Describe and apply the concepts of chemical energetics.*
3. *Describe and apply the concepts of chemical kinetics.*
4. *Describe and apply the concepts of chemical, ionic, redox equilibria.*

Chemical Laboratory Techniques

Unit level (MQF): 5

Credits: 12

Unit Description

This Unit is designed to develop learners in a range of laboratory skills that extends from MQF/EQF Level 4 Chemical Laboratory Techniques. Learners will further synthesize organic and inorganic compounds using a range of techniques which are important in the new drug development. The products will be separated, identified and the purities are determined using spectroscopic and chromatographic techniques. Thorough risk assessments will be carried out for all practical work and the results acquired will be analyzed and presented in the form of a scientific report.

In a world of increasing Health and Safety regulations, it has become mandatory for Science Laboratory workers to follow the most stringent procedures for handling normal and hazardous substances and dispose them appropriately. Learners will gain autonomy to analyses experimental procedures, research hazards and risks involved using Material Safety Data Sheet (MSDS) and completing Control of Substance Hazardous to Health (COSHH) forms and risk assessments.

Learners will study the *mechanism* of a chemical reaction to understand the sequence of events that take place as reactant molecules are converted into products. This allows the simplification of complex chemical reactions into elementary processes. Practical work should enhance learners' knowledge and understanding by following the predicted reaction pathways. Where an unexpected observation is made, students will have the opportunity to evaluate the reasons for the cause of the failure. The products can be identified using spectroscopic and chromatographic methods following the synthesis as well as titrimetric analysis for determining concentrations and purities. Learners will acquire presentation skills throughout this Unit by writing laboratory reports using Scientific Journal format as well as making presentation using Power Points and posters.

On completion of the Unit learners will gain competence in many aspects of synthetic and instrumental chemistry commonly used in the research laboratory environment.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Synthesize substances using a range of techniques.*
2. *Perform qualitative and quantitative analysis using spectroscopic techniques.*
3. *Perform qualitative and quantitative analysis using chromatography.*
4. *Perform quantitative analysis using titrimetric techniques.*

Analysis of Scientific Data and Information

Unit level (MQF): 5

Credits: 6

Unit Description

This is a skills and knowledge based unit that will allow learners to demonstrate that they have a proper understanding of the analysis of scientific information and data. Learners will initially familiarise themselves the various ways in which data and information can be presented in the scientific field. Emphasis will be placed on the ways of how data can be presented and illustrated, in both tabular and graphical forms. This will be followed by emphasis on the processes of data processing, with a brief overview of numerical analysis of data. These skills are of vital importance in many chemical experiments that require rigorous manipulation of data.

The Unit will also introduce learners to the many statistical data analysis methods commonly employed. Descriptive statistics and other simple statistical tools will be covered, as well as methods of data distribution. In addition, this unit will allow learners to familiarise with statistical tests, which are of paramount importance in the scientific field. In order to allow them to fully grasp the content of these data processing tools, learners will practice these analytical techniques firsthand. Lastly, learners will be providing important insight into the presence and existence of errors in the analysis process. This is a vital component of the unit, especially when discussing how analysis conclusions should be framed.

Learners will be able to complete two separate assessments and employ most of these tools and techniques listed in the course description below.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Present information and data to scientific standards.*
2. *Process data using numerical analysis.*
3. *Process data using statistics.*
4. *Examine the limitations in concluding results.*

Introduction to Chemical Engineering

Unit level (MQF): 5

Credits: 6

Unit Description

This unit will introduce the learner to the field of chemical engineering. A broad definition of chemical engineering and its benefits to society will be provided through an overview of the fundamental concepts. All aspects of physical, chemical and biochemical processes as found in traditional chemical engineering will be covered. Learners will be able to develop a basic understanding of the major topics in chemical engineering upon introduction to unit operations and unit processes. They will learn the principles of momentum, heat and mass transfer under unit operations as well as chemical reaction engineering, chemical kinetics and chemical process modelling under unit processes. It is important that relevant calculations in each topic are adequately covered under both contact and hands on learning hours.

The learner will also be introduced to and develop an understanding of modern chemical engineering fields such as fuel cell technology, industrial ecology, new techniques and materials including nanotechnology and polymers respectively. This is an important aspect of the unit because of the ever expanding nature of chemical engineering into relatively new fields in science and engineering. The topics covered in the unit need not go into great depth; learners will have a new learning objective for each topic covered. Emphasis will be placed on relating the unit sub-topics to real world situations to give the learner an appreciation of chemical engineering principles in practice; the aim is to give learners an application-oriented knowledge.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain fundamental aspects of chemical engineering and related ethical responsibility.*
2. *Explain the relevant physical and chemical processes and principles of chemical engineering.*
3. *Apply chemical engineering principles to solve problems.*
4. *Identify unit operations and apply useful mathematical methods and models essential for chemical engineering.*

Principles of Spectroscopy and Chromatography

Unit level (MQF): 5

Credits: 6

Unit Description

The objectives of this unit are: to provide an overview of analytical techniques (atomic and molecular spectroscopic techniques) appropriate for the modern chemical analysis; to develop the use of spectroscopy in chemical analysis; to develop the use of gas and High Performance Liquid Chromatography as a separation and analytical techniques; to discuss how combination of techniques are required in building up strategies for the analysis of compounds; and to develop a basic understanding of analytical validation.

In the spectroscopy part of the course, the students will learn about the electromagnetic spectrum, the relationship between the frequency/wavelength and energy, the dual nature of electromagnetic radiation; interaction between electromagnetic radiation and matter resulting in the electronic transitions, in atoms and molecules, from the ground state to higher energy (absorption) levels and back to lower energy levels (emission). Students will learn about the underlying theory and the instrumentation involved in: Atomic absorption and emission spectroscopies; Visible and Ultraviolet absorption and emission spectroscopies; Infrared spectroscopy; Nuclear Magnetic Resonance (NMR) spectroscopy and Mass spectroscopy.

In the chromatography part of the unit, the students will learn about the factors that determine the respective molecules' elution time along the chromatographic plate or from a chromatographic column, namely mass, boiling point, and chemical interactions {related to the functional groups present} of the eluting molecules.

The students will learn about the constituent parts of the instruments and their purpose; how a sample is prepared prior to being inserted into the instruments; how the prepared sample is actually inserted into the instruments, and what physically and chemically happens to the sample constituents during the analysis process inside the instruments. The ultimate aim is for students to learn how to perform analysis and interpret correctly the results given by the instruments.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the fundamental theory of spectroscopy.*
2. *Apply the fundamental theory towards the various spectroscopic techniques.*
3. *Explain the fundamental theory of chromatography.*
4. *Apply the fundamental theory towards the various chromatographic and combined techniques (e.g. Gas Chromatography and Mass Spectroscopy.)*

Analytical Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

This unit will enable the learner to discuss analytical chemistry and define its major strands of quantitative and qualitative analysis. He/she would be able to define titrimetric and gravimetric analysis as purely quantitative techniques while chromatography and spectroscopy as being suitable to addressing both qualitative and quantitative objectives. The learner shall recognise what data is to be collected from which technique, how to process data, present data and how results are to be interpreted. In relation to data processing, the learner shall be able to demonstrate what errors are to be considered, calculated and thus used for result evaluation. The learner shall attain the ability to compare between accuracy and precision of methods and explain the necessity of attaining both qualities in a method. S/he shall also be able to describe what system is to be utilised for the calibration of methods and equipment in the principle methods of analysis.

All parts of the unit shall focus on the provision of a sound insight into the chemical basis of the principles of the various analysis techniques such that the learner is able to justify the use of one technique over the other. Subsequently, upon unit completion, the learner shall be able to address a task for analysis, explain which techniques that would be required to generate the required results, devise a method outline and ensure validation.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Recognise the importance of the analytical process and select appropriate separation techniques.*
2. *Operate titrimetric and gravimetric analysis to quantify analyse content.*
3. *Apply analytical spectroscopy for qualitative analysis including structure elucidation.*
4. *Demonstrate ability to interpret data obtained from analyses.*

Environmental Chemical Analysis

Unit level (MQF): 5

Credits: 6

Unit Description

This is a skills and knowledge based unit that will allow learners to demonstrate that they have a proper understanding of environmental chemical analysis, starting from underpinning principles of pollutant chemicals in the environment, to sampling and testing techniques, and environmental modelling regimes. Students will familiarise themselves with the distribution of various chemical species in the environment, with particular reference to their sources and the various types of biological and chemical transformations which they undergo once released into the environment. This information will allow the learners to better grasp the techniques and methods of how environmental chemical analysis is employed for tackling various chemical pollutants.

The Unit is meant to serve as a proper introduction to pollution from an environmental chemistry perspective. While some of the concepts may have been covered in other units, this module strictly takes a chemical route to environmental pollution. On completion of the Unit, learners will be able to differentiate between pollution effects of different chemical species, with a proper understanding of their sources and various transformations once present in the environment. In addition, learners will also be introduced to methods by which chemical analysis is undertaken directly at the sampling site and in the laboratory. An introduction to the use of environmental models is also included in this unit, so that learners can grasp the notions of using models to predict potential environmental issues prior to them occurring.

Learners will be able to complete laboratory experiment write-ups and examinations for this unit after following the content described below. Lectures will be complemented by experimental work in the laboratory which will allow learners to visualise concepts which have been covered during lectures.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe chemical principles in an environmental context.*
2. *Demonstrate how chemical analysis is used in environmental monitoring.*
3. *Perform quantitative environmental analysis.*
4. *Examine the applications of environmental modelling.*

Industrial Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

By the end of the unit the learner would have been given a broad overview of the chemical industry. The unit aims to bridge the gap between academia and the processes industry. For this reason, this unit may be classified as interdisciplinary with respect to the skills required, as the learner is expected to seek knowledge in other subjects such as physics, engineering, health and safety and economics to fully appreciate the complexity of chemical processes.

Learners will be given an overview of the global chemical industry, its financial and socio-economical value and also an insight into the global players in the sector. Learners will be provided with taxonomy to aid in the classification of chemicals and their processes, along with the fundamental tools, utilised by engineers, to help in the understanding of plant designs. The unit will also provide the learner with the opportunity to familiarise him/herself with tools used specifically in chemical engineering, such as mass and energy balance, fluid dynamics and mass transfer.

Practice in the subject could be attained through a 'plant design project' where the learner could be given the opportunity to work within a group to design a specific chemical process. The idea of assessing through a design project presents the learner with a real-life brief and the design team is to simulate a chemical plant in accordance to the specifications. The knowledge, competences and skills attained throughout the academic year will help the learner evaluate the brief in a constructive manner and evaluate all scenarios before proposing the best solution to the customer. This level 5 unit aims to gear learners with the fundamental tools used in the chemical industry to be proficient in understanding any process plant, should the learner visit or work in one.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Categorise different industrial chemical processes.*
2. *Construct a process flow diagram for a specific chemical process.*
3. *Evaluate physio-chemical parameters involved in chemical processes.*
4. *Identify different unit operations.*

Medicinal Chemistry

Unit level (MQF): 5

Credits: 6

Unit Description

Learners will discover how to apply chemical and scientific principles to the process of drug discovery, drug action, drug design and drug manufacturing. Through this unit candidates will understand that the action of drugs depends on concepts such as hydrophilicity and hydrophobicity, hydrogen bonding, polarity, ionization, electronegativity, acid-base properties, pH, pKa, stereochemistry, kinetics, molecular size and other physico-chemical properties.

Drug action at receptors and enzymes will be studied. Using the appropriate chemical principles learners will consider the pharmacokinetic and pharmacodynamic properties of drug molecules.

Structure-activity relationships will be explored. Students will look into examples of natural sources of drug molecules and learn about the variety of modern drug discovery techniques.

The understanding of the principles of medicinal chemistry will be consolidated through the use of case-studies on the development of actual drugs and through practical sessions examining the physico-chemical properties of drug substances.

Learners will appreciate the process of drug development from laboratory to manufacture to patient, with a look at the EU directives, regulations and guidelines on new drug applications, clinical trials and drug manufacturing. Chemical and toxicological principles will be applied to the process of cleaning of manufacturing equipment, with an introduction to the use of toxicity, potency, dose and other concepts in calculations to determine acceptable carry-over limits from one product to another. Learners will also learn about how the expiry dates of medicines can be determined using chemical concepts.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the action of drugs at enzymes and receptors and the relationship between drug structure and chemical properties and drug action.*

2. *Explain the factors that affect a drug's absorption, distribution, metabolism and excretion.*
3. *Describe the drug discovery and manufacturing process, including examples of natural sources of drug molecules.*
4. *Appreciate the role of biologically active molecules in biochemical systems and aspects of drug safety.*

Environmental Monitoring and Analysis

Unit level (MQF): **5**

Credits: **6**

Unit Description

This is a skills and knowledge based unit that will allow learners to demonstrate that they have a proper understanding of environmental monitoring and analysis. Learners will familiarise themselves with the methods in which pollutants are transferred between systems in the environment, these being either biotic or abiotic. Anthropogenic sources of these pollutants will also be covered, providing a detailed scrutiny of various anthropogenic activities that release different chemical pollutants in different environmental systems. In this context, numerous examples from the Maltese Islands will also be included, in order to allow students to better visualise and familiarise with the concepts at hand.

The Unit is meant to provide a holistic insight into environmental monitoring and analysis, by firstly allowing learners to understand how the pollutants arrive, change and impact the environment, and how their different chemical qualities allow for their analytical study. Learners will also be exposed to sampling protocols inherent to environmental monitoring and analysis, followed by a review of the methods of how analytes are processed after being sampled. This module will be concluded by including a section on Maximum Permitted Levels of these analytes, which is of prominent importance when dealing with chemical species that are very persistent.

Learners will be able to complete an analytical experiment report, may be engaged in completing a research proposal and class presentation for this unit after following the content described below. The research proposal is meant to allow learners to interpret the contents of this module in a critical way, and applying this knowledge on a case study of their choice.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe how biogeochemical cycles result in the transfer of substances between components of ecosystems.*
2. *Examine the sources and effects of environmental pollutants.*
3. *Apply sampling methods appropriate to an analyte.*
4. *Determine the concentration of analytes in samples.*

Quality Assurance and Quality Control

Unit level (MQF): **5**

Credits: **6**

Unit Description

Laboratories exist for a number of reasons ranging from supporting manufacturing processes and providing contractual services through to areas such as high performance forensic and research analytical services. The credibility of test results from an Analytical Laboratory is fundamental to its reputation and sustainability. This unit provides Learners with the opportunity to understand the related concepts and issues. The critical roles of Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS) accreditation are covered.

For those who may be unfamiliar with the difference between the principles of Quality Control and Quality Assurance the terms will be defined at the outset. Where possible, field trips to a variety of different specialized Laboratories settings may be used to help bring the subject to life, stimulate student discussion and embed the learning.

In essence, the unit covers the validity of analytical results, the power and use of internal and external Quality Control processes, the power and use of Quality Assurance processes and the value of Laboratory accreditation to specific related industry standards.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the validity of analytical results in a quality framework.*
2. *Use Quality Control methods in Laboratory analysis.*
3. *Use Quality Assurance methods in a Laboratory setting.*
4. *Explain the benefits of Laboratory accreditation.*

Laboratory Management

Unit level (MQF): 5

Credits: 6

Unit Description

This unit provides learners with an excellent insight into the critical role and responsibilities of management within laboratory. It will also benefit those currently in other laboratory leadership roles as well as those interested in this career path. Laboratory managers, supervisors and team leaders play a pivotal role in the success of the laboratory.

The unit considers different laboratory types, including Process Control, Contract Analysis, Project Support, Educational and Research and Development laboratory types. It covers the specific responsibilities including organisational design, Health and Safety, legislation, regulations, Laboratory design, standards, stock control, purchasing, Quality Management System design, policies, Standard Operating Procedures (SOP) structure, accreditation, qualifications and training.

There is a wide variety of laboratory types and settings in existence which understandably impact the shape and content of laboratory management roles. There are also however many common concepts and themes (covered in this unit) that when professionally implemented add value in any laboratory setting.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Define the responsibilities of laboratory managers.*
2. *Determine the Health and Safety compliance needs in the laboratory.*
3. *Determine aspects of organization of laboratories.*
4. *Determine and understand features of laboratory quality management systems.*

Research Methods within a Research Project

Unit level (MQF): **5**

Credits: **12**

Unit Description

This unit will cover aspects of research methods used in degree research. The aim is to introduce students to research and develop their understanding and skills in both quantitative and qualitative research methods. Students in this module will be introduced to the research process and apply different methodologies, data collecting tools and conceptual frameworks.

In this study-unit students will cover how to methodologically adopt the appropriate research design to specific research questions using experimental, quasi-experimental, descriptive and epidemiological methods. Qualitative data collection designs to be introduced include archival studies, interviews and case studies. The syllabus also covers the challenges of various data collection techniques as well as the measurement issues of questionnaire development, reliability and validity of data, issues of sampling and of sampling size.

The quantitative part of the unit will address research questions in terms of statistical concepts. The aim is to have students confident with using descriptive statistics, estimation and confidence intervals and inferential statistical tests such as chi-square, t-tests and ANOVAS for both parametric and non-parametric data. Skills in using statistical software such as SPSS will also be developed.

Following completion of this unit, students should be familiar with all parts of the research process including funding application, ethics and publication. Tools will be provided for the student to individually formulate a research question, a sound proposal and carry out a pilot research project which can then be developed into a full research project at level 6.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Identify and describe the main stages of the research process.*
2. *Select the appropriate research design for a particular research question.*
3. *Apply and understand issues of reliability, validity, bias and sampling.*
4. *Demonstrate skills using qualitative methodologies.*

5. *Demonstrate skills using quantitative methodologies.*
6. *Demonstrate and respect the ethical issues and responsibilities required in research.*

Work-based Experience

Unit level (MQF): 5

Credits: 6

Unit Description

This skills-based unit will allow learners to demonstrate that they have the necessary skills to be able to work in a chosen science industry. Students will be able to identify a suitable placement for themselves, make effective contact with potential employers and produce proposals for meaningful work that benefits both the learner and the employer. They will familiarise themselves with the work practices and tasks expected of them during the placement and negotiate their role in the organisation for the duration of their placement.

Students will also be able to fully understand the implications of working within time, budgetary and legislative constraints. Amongst the skills developed are: effective time management (planning and organising on a daily basis and on a longer term project), and working independently and within teams. As regards legislative constraints, students will have the opportunity to familiarize themselves with the regulatory mechanisms and industry standards in place in order to work effectively and safely with the organisation. By the end of the unit, students would have developed a reflective practice and understanding of how to improve their efficiency in the workplace.

On a different note, this Unit will also provide the learner with the ability to use instruments and apparatus in an environment relevant to their chosen field of scientific work.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Negotiate industry experience.*
2. *Identify the specific requirements of the placement.*
3. *Undertake work experience as identified.*
4. *Monitor and evaluate own performance and learning.*

Chemical Reaction Engineering

Unit level (MQF): 6

Credits: 6

Unit Description

This unit addresses the major steps at the heart of most chemical processes, i.e. chemical reactor design.

The unit reviews the fundamental concepts of thermodynamics and kinetics relevant to chemical reactors design and the different types of reactors that are likely to be encountered in the course of designing a chemical process. The learners are then introduced to the techniques required to carry out mass and energy balances for reactors other than ideal ones.

The subject of catalysis is covered in depth and topics such as mechanisms and kinetics of catalytic reactions, catalysts classification, formulation, preparation, structure, surface area, pore size distribution, adsorption, mass and heat transfer in catalytic reactors, resistances, diffusion, pore models, effectiveness factor, catalyst deactivation and regeneration are discussed. Both heterogeneous and homogeneous catalysis will be covered.

Mass transfer with chemical reaction in multiphase systems will provide the introduction to the discussion of the design of fixed-bed catalytic reactors and transport reactors as well as other types of multiphase reactors.

The stoichiometry and kinetics of reaction in biological systems will be covered and the students will be taught the design procedures for biochemical reactors.

Special attention will be paid to non-ideality in chemical reactors with mathematical treatment of residence time distribution in real reactors.

The module emphasise the importance of safety in reactor design and discusses the relevant inherently safe design issues as well as the dangers of fire, explosion and accidental release of material.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand homogeneous reactions in ideal reactors.*
2. *Understand non-ideal flow in reactors.*
3. *Understand reactions catalysed by solids.*

Chemical Engineering Thermodynamics

Unit level (MQF): 6

Credits: 6

Unit Description

Through this unit, the learner will learn how to apply the principles of classical thermodynamics to chemical engineering problems. He will learn about the application of First and Second Laws of Thermodynamics including thermodynamic cycles, closed and open systems. The unit aims to establish the general thermodynamic principles and key relations that are essential to description of material and energy transfer processes that occur in typical chemical plant equipment.

The application of basics of classical thermodynamics to transient open and closed systems, criteria of stability and equilibria will also be covered including phase and chemical equilibria of multicomponent systems. The principle elements include the adaptation of the laws of thermodynamics to depiction of various flow processes, the mathematical description of phase and chemical reaction equilibria and illustration of their application. Applications are emphasized through extensive problem work relating to practical cases.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Apply the first and second law of thermodynamics in an engineering context.*
2. *Apply equations of state and fundamental thermodynamic relationships in an engineering context.*
3. *Understand fundamental phase equilibria laws in an engineering context.*
4. *Apply fundamental laws of chemical reaction equilibria in an engineering context.*

Fundamentals of Engineering and Process Engineering

Unit level (MQF): 6

Credits: 6

Unit Description

Chemical engineers are concerned primarily with process engineering involving the conversion of raw materials into valuable products. The products can include pharmaceuticals, specialized plastics, petrochemicals, materials for biomedical applications, and energy. The learner of the unit will cover these processes, which usually start out at a small laboratory scale and later developed for production at a large chemical plant scale.

The unit discusses material and energy streams in the process covering raw materials and their preparation, outlining the different operations involved, the separation of products and treatment of unreacted feed and by-products.

The learner will be acquainted with the graphical symbols used for equipment, piping and instrumentation diagrams. The equipment that forms the building blocks of any process will be introduced. This will cover process equipment such as stirred tank reactors, separators, heat exchangers, pumps, compressors and electric motors. The unit also covers the material used for chemical equipment and the learners will be taught how to protect it from corrosion and maintaining it.

Reactors for chemical transformation of gases, liquids and solids will be covered. Other process related equipment such as electrical, mechanical and civil engineering elements will be presented.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand elementary equipment used in chemical production.*
2. *Understand material used for chemical production.*
3. *Understand the role of other engineering fields in the chemical industry.*
4. *Understand the principles of unit operations in chemical industry.*

Mechanical Operations

Unit level (MQF): 6

Credits: 6

Unit Description

This unit introduces the learner to the principles and practices involved in contacting, conveying, separating and storing single and multiphase systems. It includes the flow of incompressible fluids in conduits and past immersed bodies, as well as the transportation, metering, and mixing of fluids. Unit operations involved in the contacting and physical separation of phases, such as fluidisation, sedimentation and centrifugation, evaporation and membrane separation are also studied.

This unit also provides a thorough introduction to particle technology. The unit begins with understanding particle characterisation, the fluid mechanics of single and multi-particle systems and particulate fluidisation. The physics underlying powder flow will be covered to enable introductory hopper design. Common powder processing operations will be studied, selected from powder mixing/segregation, sedimentation, dewatering and size enlargement.

After completing this unit, the student will be able to understand particle characterisation techniques and how the motion and fluid mechanics of a single particle and multi-particle assemblies are affected by particle properties. The student will be able to select a suitable particle characterisation method; manipulate particle size distribution data; model particle flow in fluids and fluidized beds; and be able to use particle properties to design a suitable powder hopper to ensure powder flow. Finally, the student will understand the underlying principles of several powder processing operations, be able to design the key parameters for that unit operation and develop an appreciation for the complexities of powder handling and processing.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand solids characterisation, handling and particle size reduction in an engineering context.*

2. *Understand the principles of communition and different types of equipment for size reduction.*
3. *Understand engineering aspects of sedimentation, fluidisation and filtration processes.*
4. *Understand mixing processes.*

Process Modelling and Computing

Unit level (MQF): 6

Credits: 6

Unit Description

This unit introduces learner to modern computational and mathematical techniques for solving problems in chemical engineering. Leaners will be able to apply computational techniques to solve a wide range of numerical problems arising in Chemical Engineering. Learners will learn theory, algorithms, implementation, and analysis of output for numerical.

The aim of this unit is to teach learners how to apply computational methodologies to solve chemical engineering problems when no closed-form, analytical solution exists. Achievement of this aim requires learning the basics of structured programming as well as learning how to combine engineering knowledge, judgment, and intuition to develop reasonable approximations through the engineering modelling process. Because mathematical judgment and approximations are involved, the material in this unit will be somewhat more open-ended than the material covered in other unit. Emphasis will be placed on understanding the basic concepts behind the various numerical methods studied and implementing basic numerical methods.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Differentiate and integrate numerically.*
2. *Solve an equation/-s with one or more variables.*
3. *Apply approximation theory in a chemical engineering context.*
4. *Solve ordinary and partial differential equations in a chemical engineering context.*

Separation Processes

Unit level (MQF): 6

Credits: 6

Unit Description

This unit provides a focus on the separation processes that are part of the core knowledge and problem solving skills basis for chemical engineering unit operations. Each of these separation processes will be examined in detail and their application in a range of industries including oil and gas, pharmaceutical, food and environmental remediation.

This unit provides the learner with the fundamentals governing a range of separation processes such as absorption, distillation, humidification, leaching, liquid extraction and adsorption. The learner will apply the knowledge to the design and evaluation of these separation processes.

The overall aim is to provide a deep understanding of the general fundamentals such as mass and energy balances, phase equilibria and transport kinetics, and of how these principles are applied in design of separation processes in the process industry and in clean technology. The learners will get insight into the considerations that have to be balanced in finding a suitable solution to a specific separation problem. The aim is that the learner will also reach understanding of how this knowledge can be applied to separations in other situations, in particular in environmental systems.

The unit comprises fundamentals, basic requirements, and design principles for separation processes. Detailed descriptions and analyses of common unit operations are given. The fundamental mechanisms of phase equilibria and mass and/or heat transport and how the mathematical description of these mechanisms can be used in the design are also treated, as well as matters concerning the practical design of apparatus.

The unit also includes more empirical design methods, primarily for stage apparatus and continuous apparatus for common unit operations. The unit includes design of separation processes for process industry and for clean technology, as well as the

application of the methods to other systems - in particular environmental systems. The course has particular emphasis on energy efficiency and the environment.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand separation by phase addition or creation.*
2. *Understand separations by barrier and solid agents.*
3. *Understand separations that involve a solid phase.*

Transport Phenomena

Unit level (MQF): 6

Credits: 6

Unit Description

Transport Phenomena is the subject which deals with the movement of different physical quantities such as momentum, energy and mass in any chemical process and combines the basic principles (conservation laws) and laws of various types of transport.

This unit provides learners with the fundamentals to solve problems involving transports of momentum, energy and mass in chemical systems using a unified approach. Although all these fields are developed separately throughout the history of science and technology, the learner will study these transport phenomena together due to following reasons:

- These transport phenomena occur frequently and most of the time simultaneously in industrial problems.
- All type of transport phenomena can be explained by similar transport and conversion laws. Physical properties which are used to describe transport laws like kinematic viscosity, thermal diffusivity or mass diffusivity play similar role.
- The mathematical requirements for solving problems related to transport phenomena are more or less similar.

This unit will also acquaint the learner with important topics in advanced transport phenomena (momentum, heat and mass transport). Topics include laminar and turbulent flow, thermal conductivity and the energy equation, molecular mass transport and diffusion with heterogeneous and homogeneous chemical reactions. Focus will be to develop physical understanding of principles discussed and with emphasis on chemical engineering applications. In addition to the text, the learner will be exposed to classic and current literature in the field.

The main objective of this unit is to give basic knowledge of transport phenomena one by one. The basic laws of transport phenomena like the Newton's law of viscosity or the Fourier's law of heat conduction or the Fick's law of diffusion are taken up at appropriate places. Basic axioms of conservations namely conservation of momentum, energy and mass are used for deriving simple shell balances and then the basic equations of transport phenomena are derived. Since this is a unit meant for

undergraduate students, solutions of some simple engineering problems which can be solved analytically are studied.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand momentum transport.*
2. *Understand energy transport.*
3. *Understand the mass transport.*