

**MODULAR PROGRAMME IN SCIENCE & TECHNOLOGY STUDIES
DIPLOMA CYCLE SYLLABUS**

Core Modules in Year 1

Module Title	Introduction to Learning
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

This course is designed to develop the time management, study and writing skills needed by students working towards third level qualifications. Additionally, students will begin to develop the skills needed to interact effectively in a blended learning environment.

- To introduce students to the learning environment and make them comfortable and confident in their studies
- To introduce students to various learning resources and familiarise them with their use
- To enable students to learn, revise and research effectively
- To enable students to communicate effectively through verbal and written means

Syllabus

- The blended learning environment
- Time management
- Study skills
- Essay writing
- Technical report writing
- Oral presentation
- Exam preparation

Module Title	Maths I
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

- Acquaint students with the fundamentals of differential and integral calculus, linear algebra and their applications
- Equip the students with the fundamental mathematical tools and logical processes for a modern working environment

Syllabus

Calculus 1

- Functions and graphs: informal limits
- Calculation of limits, introduction to continuity, limits as x tends to infinity, and asymptotes
- Differentiation by rule: the Chain Rule
- Review of trigonometry: Limits and differentiation of trigonometric functions
- Indefinite integration: integration by substitution
- Functions and graphs; informal limits
- Graphs, tangents, maxima and minima, concavity
- Word problems, related rates
- Integration by parts: introduction to $\log x$ and e^x , logarithmic differentiation, differentiation of a^x etc.
- Inverse trigonometric functions: partial fractions, trigonometric substitutions
- Definite integrals, areas between curves: introduction to the Fundamental Theorem of the Calculus
- Implicit differentiation; first order differential equations: separable and linear equations

Algebra 1

- Introduction to 2 by 2 matrices and determinants
- Transpose, adjoint and inverse
- Characteristic equation, eigenvalues and eigenvectors
- Applications: geometry, linear transformations, and linear equations
- The Principle of Induction

Module Title	Physics I
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

This module provides students with fundamental skills in measurement and analysis of experimental data and the link between experiment and theory. The aim of the module is to introduce key physics principles in fields such as kinematics, fluids, wave motion and sound, work and energy. The main objectives are developing a conceptual understanding of physics principles and a good problem solving technique.

Syllabus

- Units of measurement. Basic Units. Dimensions of physical quantities. SI Units. Derived SI units. Use of dimensions to check formulae. Conversion factors. Significant figures.

- Error and precision in experimental data. Human error. Instrumental limitations. Statistical fluctuations. Poisson distribution. Control and elimination of extraneous influences. Disturbances caused by observation.
- Vector and scalar quantities. Graphical resolution of vector quantities.
- Speed, velocity, and acceleration. Uniformly-accelerated motion.
- Newton's laws of motion. The concept of force. Normal, friction, elastic, tension, and gravitational forces. Circular motion and centripetal force.
- Work and energy. Conservation of mechanical energy.
- Collisions in one dimension.
- Equilibrium of rigid bodies. Principle of moments. Simple machines.
- Simple harmonic motion.
- Fluids and pressure. Archimedes' Principle.
- Scales of temperature. Heat energy. Calorimetry. Transfer of heat energy.
- Gases – Ideal Gas Law. Thermodynamics and heat engines.
- Wave motion and sound. Doppler effect. Decibel scale.
- Principle of superposition. Standing waves on strings and in pipes.

Module Title	Chemistry
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

The module will introduce the basic concepts of molecular science and use them to discuss the behaviour of atoms and molecules in qualitative and quantitative terms. It will provide the framework for an understanding of the molecular basis of many technologically important processes.

Learning Outcomes:

- An understanding of the basic structure and properties of atoms and molecules
- An appreciation of the molecular basis of many macroscopic properties and events
- An understanding the structure of gases, solids and liquids
- The ability to carry out basic calculations relating to the mole concept and chemical thermodynamics
- An understanding of the role of Chemistry in the environment and in many technological processes

Syllabus

- Atomic structure and properties
- Chemical bonding: intramolecular and intermolecular
- The molecular structure of gases solids, and liquids
- The structure of metals

- The three dimensional structure of molecules
- The mole concept and chemical arithmetic
- Basic chemical thermodynamics
- Chemical reactions and time: basic concepts of chemical kinetics
- Organic chemistry and the petrochemical industry
- A consideration of case studies relating to environmental issues and industrial processes

Module Title	Biology & Biotechnology I
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Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

This course aims to introduce some of the fundamental scientific concepts of biology and underpinning biotechnology.

Learning outcomes:

- An awareness of the various forms of life
- A knowledge and understanding of the basic anatomical and physiological characteristics of organisms
- An understanding of some of the interactions which can occur (i) between organisms and (ii) between organisms and their environment
- An introduction to the personal, social, political, economic, technological and environmental implications of biology

Syllabus

Diversity, form, function, and ecology of organisms; Macromolecules, DNA and the genetic code; Prokaryotic and Eukaryotic cell division and growth; How cells harvest energy; Replication and transcription; Translation and regulation of gene expression; Microbes and the environment; Introduction to biotechnology; Applications of biotechnology.

Module Title	Introduction to Operations Engineering
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Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

- To gain an appreciation of the strategic importance of operations and how Operations can provide a competitive advantage in the marketplace
- To understand the relationship between Operations and other business functions

- To develop a working knowledge of the concepts and methods related to designing and managing Operations
- To gain an understanding of how Operating Systems are interrelated
- To organise activities in Operations Systems effectively
- To calculate the Manufacturing Lead Time, Production Capacity, Utilisation, Work-in-Progress and Efficiency for various manufacturing processes
- To gain an understanding of layout decision making in Operations Management and to analyse the flow of work, material, people and information through a system.

Syllabus

- History of development of Engineering Systems
- Trends in Modern Manufacturing
- Product Life Cycles
- Product and Service Design Process
- Process Types and Factory Layouts
- Introduction to Ergonomics
- Key Performances Indicators-Manufacturing Lead Time
- Production Capacity
- Utilisation and Availability
- Work-in-Progress
- Production Planning and Control
- Technology and Automation
- e-Business

Practical Work: Students are assigned to groups who are required to submit an assignment and report on new product development. This exercise entails the use of spreadsheets to calculate costs/benefits and write a report. The practical work accounts for 25% of total marks.

Guided tours to firms are arranged for the students on this course to familiarise them with the industrial environment. Students submit a brief report on the guest firm, its production layout and the role of industrial engineering within the firm.

Module Title	Introduction to Management
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

This course covers the concepts, theories and techniques on which management is based. It aims to:

- Provide students with a comprehensive understanding of the key concepts and principles of management
- Examine how management principles are applied in a range of business contexts

Syllabus

Foundations of Management, External Environment and Corporate Culture, Managing in a Global Environment, Organisational Goal Setting and Planning, Strategy Formulation and Implementation, Managerial Decision Making, Fundamental of Organising, Organisational Structure, Managing Change, Human Resource Management, Leadership and Motivation, Management Control Systems, Teamwork, Business Ethics.

Module Title	Information Technology
Year of Delivery	1
Module Type	Core
Requisite Modules	None

Learning Objectives

Upon completion of this module, the student should be able to:

- Describe the functions of the various hardware components normally found in their computers
- Identify the various types of computer software; the operating system and application packages
- Describe the workings of the Internet and WWW
- Write reports in Word
- Conduct spreadsheet analysis using Excel
- Make presentations using PowerPoint
- Work on projects independently and with teams

Syllabus

- Introduction to computer hardware, components, software, operating systems, networks, the Internet and WWW
- Introduction to computer applications such as MS Office

Core Modules in Year 2

Module Title	Maths II
Year of Delivery	2
Module Type	Core
Requisite Modules	Maths I is a prerequisite

Learning Objectives

- Acquaint students with the fundamentals of differential and integral calculus, linear algebra and their applications
- Equip the students with the fundamental mathematical tools and logical processes for a modern working environment

Syllabus

Calculus 2

- Inequalities: inequalities involving absolute values
- Definition of a limit (using *epsilon* and *delta*), limits of sums and constant multiples
- Continuity and differentiability: differentiation from first principles
- Tangents to a graph, Newton's Method
- The Mean Value Theorem: application to increasing and decreasing functions, l'Hopital's Rule
- Graphs, maxima and minima, concavity: word problems, related rates
- Riemann sums, the trapezoidal rule: the Fundamental Theorem of Calculus
- The logarithmic function as an integral, and its properties: the exponential function
- Definite integrals, areas between curves
- Indefinite integration: reduction formulae
- Reduction formulae, partial fractions, inverse trigonometric functions, etc.
- Implicit differentiation; first order differential equations: separable and linear equations.

Algebra 2

- Complex numbers: de Moivre's Theorem, applications to trigonometry and roots of unity, solution of equations
- Introduction to 3 by 3 matrices and determinants
- Transpose, adjoint and inverse
- Application to linear equations
- Markov processes: transition matrices, steady states, recurrence relations

Module Title	Physics II
Year of Delivery	2
Module Type	Core
Requisite Modules	Physics I is a prerequisite

Learning Objectives

The aim of this module is to build on the knowledge acquired in Physics I and to introduce new concepts such as light, nuclear physics, electric forces and electric fields, magnetic forces and magnetic fields. The objective of this module is to provide a balance of quantitative reasoning, conceptual understanding and enhancement of problem solving skills in a systematic manner.

Syllabus

- Practical measurements. The value of repeated measurements. Estimation of the mean value. Distribution about the mean value. Recognition of systematic errors. Combination of random and systematic errors. Combining errors on sums and products of variables.
- Interpretation of experimental data. Use of graphical presentation. Guidelines on effective plotting of data. Linear regression – slope and intercept. Use of curve-fitting software. Least squares fit. Data handling using excel spreadsheets.
- Planning of experimental work. Maintaining a laboratory notebook. Designing experiments to measure specific variables. Interpreting the data. Writing laboratory reports.
- Electric charge. Electric forces and fields. Electrostatics.
- Electric potential. Charge storage in capacitors.
- Electric Currents – Ohm’s Law. Resistance and resistivity. Resistors in series and in parallel. Batteries and cells. Internal resistance. Kirchhoff’s rules. Electrical safety.
- Magnetic forces and magnetic fields. Principle of the motor.
- Electromagnetic induction. Electric generator. Transformers.
- Elementary alternating current circuits.
- Semiconductor devices – diodes, transistors, solar cells.
- Electromagnetic waves and the EM spectrum. Light as an EM wave.
- Polarization of light waves.
- Reflection of light waves. Mirrors – plane, concave, convex. Image formation.
- Optical Interference – Young’s slits. Thin film interference.
- Diffraction at a single slit. Diffraction gratings.
- Photoelectric Effect. Generation of X-rays – characteristic spectra.
- Nuclear structure and radioactivity. Radioactive decay series.
- Application of alpha, beta, gamma radiation and radioactive isotopes.

Module Title	Statistics
Year of Delivery	2
Module Type	Core
Requisite Modules	Maths I is a prerequisite

Learning Objectives

This module provides a basic introduction to the ideas of probability and statistics, and how probability can be applied in a number of contexts including statistical inference.

Syllabus

- Graphical and numerical summaries of data.
- Basic counting.

- Notions of probability - sample spaces, events, combination of events, conditional probability and independence, Bayes Theorem.
- Discrete random variables, their probability distributions and moments.
- Continuous random variables, with emphasis on normally distributed variables.
- Sampling distributions of means and proportions.
- The Central Limit Theorem.
- Basic ideas in interval estimation and hypothesis testing.
- Some common statistical inference procedures.
- Enumerative data analysis.
- Correlation and simple linear regression.

Module Title	Introduction to Environmental Science
Year of Delivery	2
Module Type	Core
Requisite Modules	None

Learning Objectives

The main aim of this course is to provide an introduction to the scientific concepts underlying environmental issues and to aspects of human behaviour that will play a key role in solving current environmental problems.

Syllabus

- **Resource Use and Management**
Principles of resource management; fundamentals of energy, fossil fuels and nuclear energy; water, mineral and biological resources; land resources and management
- **Environmental Degradation**
Principles of pollution control; water & air pollution; municipal solid waste and hazardous waste
- **Environmental Issues and Solutions**
Environmental law in Ireland and the EU; statutory agencies with environmental responsibilities; environmental impact assessment; environmental economics

Module Title	Operations Engineering
Year of Delivery	2
Module Type	Core
Requisite Modules	Introduction to Operations Engineering is a prerequisite

Learning Objectives

- To understand the role and challenges facing an operations manager in a dynamic business environment

- To understand the importance of the people, process and technology relationship in operations
- To understand the impact and implications of operations oriented problems
- To be capable of generating and prioritising alternative solutions for real life operations problems
- To be capable of applying operations tools to industrial problems
- To be familiar with information technology solutions to operations problems

Syllabus

- Introduction to Operations Engineering
- Operations Strategy
- Introduction to Quality Planning and Control
- Product and Service Design
- Process and Technology
- Facility Layout and Line Balancing
- Human Resources
- Supply Chain Management
- Forecasting
- Capacity Planning and Aggregate Production Planning
- Inventory Management
- Scheduling
- Introduction to Just in Time & Lean Systems
- Introduction to Project Planning and Control
- Enterprise Resource Planning

Module Title	Organisational Behaviour
Year of Delivery	2
Module Type	Core
Requisite Modules	Introduction to Management is a prerequisite

Learning Objectives

The objective of this course is to provide students with the theoretical background in the behavioral sciences that will facilitate a deeper understanding of people in organizations.

Syllabus

The course will cover the following indicative topics: perception, attribution, personality, communication, motivation, stress, leadership, power, group functioning, organizational structure and change.

Module Title	In-Company Project
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Year of Delivery	2, 3 and 4
Module Type	Core
Requisite Modules	None

Learning Objectives

- To provide students with the opportunity to generate ideas and solve problems in an industrial setting
- To allow students practice some of the skills and techniques developed in other course modules

Syllabus

Selection of suitable project, User requirements definition and Problem Statement, Diary of Events, Project Planning and Scheduling, Project Execution, User Acceptance Analysis, Project Report.

Optional Science Modules in Years 1 and 2

Module Title	Science, Technology & Society
Year of Delivery	1 and 2
Module Type	Optional Science Stream and Optional Technology Stream
Requisite Modules	None

Learning Objectives

- To introduce students to the nature, functioning and evolution of manufacturing, communications, information and emergent technologies
- To enable candidates to assess the impact of science and technology on society, and society on scientific progress and technological change
- To understand the national and regional impact of innovation
- To enable students in science and engineering to reflect critically and consider the impact and implications of their work for society

Syllabus

This module explores key ethical, social and policy issues in the relationships between science, technology and society. Central questions addressed relate to the determinants of technological progress, the impacts of science on social outcomes, and the implications for public policy formation of 'knowledge based societies'. Particular emphasis is devoted to the concepts of national and regional innovation systems, and the linkages between actors in such systems, such as enterprises, third level institutions, and public funding agencies.

Module Title	Database Applications
Year of Delivery	1 and 2
Module Type	Optional Science Stream and Optional Technology Stream
Requisite Modules	Information Technology is a prerequisite

Learning Objectives

Upon completion of this module, the student will:

- Understand database concepts and general DBMS applicability and use
- Be competent in the practical use of MS Access
- Appreciate the role of databases in industrial information systems

Syllabus

- Introduction to Database concepts; tables, relationships, keys
- Data modelling
- Tools; MS Access, SQL, Visual Basic
- Applications development and industrial case study

Module Title	Molecular Medicine I
Year of Delivery	1 and 2
Module Type	Optional Science Stream
Requisite Modules	Biology & Biotechnology I is a prerequisite

Learning Objectives

- An understanding of the molecules implicated in the development of diseases
- Comprehension of the basic principles behind the development of gene therapies
- An appreciation of ethical issues

Syllabus

The molecular mechanisms underlying diseases including SCID, cancer, Multiple Sclerosis, Alzheimers Disease, arthritis, spinal cord injury will be described. In addition, strategies based on the application of regenerative techniques like gene and stem cell therapy to the alleviation of different diseases, will be outlined. Potential ethical and technical issues will be addressed.

Module Title	Analytical Chemistry
Year of Delivery	1 and 2
Module Type	Optional Science Stream
Requisite Modules	Chemistry is a prerequisite

Learning Objectives

The module will explain the importance of analytical chemistry in all areas of human activity and provide an understanding of the most important analytical techniques currently being used.

Learning Outcomes:

- An awareness of the importance of Analytical Chemistry to all aspects of human activity
- An understanding of the basic techniques and instruments used in Analytical Chemistry and of the problems they are used to solve.

Syllabus

- Analytical Chemistry: basic concepts including sampling methods
- Spectroscopy: infrared and ultraviolet spectroscopy, mass spectrometry, other relevant techniques
- Separation techniques: gas chromatography (GC), high performance liquid chromatography (HPLC) and thin-layer chromatography (TLC)
- Atomic Absorption Spectrometry
- Electrochemistry

Module Title	Environmental Chemistry
Year of Delivery	1 and 2
Module Type	Optional Science Stream
Requisite Modules	Chemistry is a prerequisite

Learning Objectives

The module will provide an understanding of the chemical principles underpinning environmental chemistry with particular reference to the chemistry of the atmosphere and the technologies involved in water treatment.

Learning Outcomes

- An understanding of the basic concepts of Environmental Chemistry
- An understanding of the basic technologies involved in water pollution and treatment
- An appreciation of the chemistry of the atmosphere and of atmospheric pollution: this will include a discussion of the chemical principles involved in issues such as global warming and the ozone layer problem

Syllabus

- Environmental Chemistry: basic principles
- Atmospheric Chemistry
- Water pollution and water treatment
- Ecotoxicology

Module Title	Biology & Biotechnology II
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Year of Delivery	1 and 2
Module Type	Optional Science Stream
Requisite Modules	Biology & Biotechnology I is a prerequisite

Learning Objectives

This module builds on the material covered in Biology and Biotechnology I and introduces the modern Biotechnology sector. At the conclusion of the course students should be in a position to:

- Recognise the foundations of modern biotechnology and the methods underpinning the sector
- Develop an appreciation of recombinant DNA technology and the principals that form the basis for this technology
- Describe the common methods and applications of biotechnology with regard to microorganisms, plants and animals
- Describe the common methods and applications of biotechnology with regard to medicine and human genome project
- Acknowledge the ethical implications of biotechnology

Syllabus

Laboratory techniques for biotechnology; Fermentation technology; Recombinant proteins; transgenic animals; antibodies; genetic vaccines; Advances in drug discovery and delivery; Soil, waste and wastewater management; Control of pest and disease causing populations; Introduction to the ethical challenges of biotechnology.

Optional Technology Modules in Years 1 and 2

Module Title	Science, Technology & Society
Year of Delivery	1 and 2
Module Type	Optional Science Stream and Optional Technology Stream
Requisite Modules	None

Learning Objectives

- To introduce students to the nature, functioning and evolution of manufacturing, communications, information and emergent technologies
- To enable candidates to assess the impact of science and technology on society, and society on scientific progress and technological change
- To understand the national and regional impact of innovation
- To enable students in science and engineering to reflect critically and consider the impact and implications of their work for society

Syllabus

This module explores key ethical, social and policy issues in the relationships between science, technology and society. Central questions addressed relate to the determinants of technological progress, the impacts of science on social outcomes, and the implications for public policy formation of 'knowledge based societies'. Particular emphasis is devoted to the concepts of national and regional innovation systems, and the linkages between actors in such systems, such as enterprises, third level institutions, and public funding agencies.

Module Title	Database Applications
Year of Delivery	1 and 2
Module Type	Optional Science Stream and Optional Technology Stream
Requisite Modules	Information Technology is a prerequisite

Learning Objectives

Upon completion of this module, the student will:

- Understand database concepts and general DBMS applicability and use
- Be competent in the practical use of MS Access
- Appreciate the role of databases in industrial information systems

Syllabus

- Introduction to Database concepts; tables, relationships, keys
- Data modelling
- Tools; MS Access, SQL, Visual Basic
- Applications development and industrial case study

Module Title	Design of Engineering Systems
Year of Delivery	1 and 2
Module Type	Optional Technology Stream
Requisite Modules	Introduction to Operations Engineering is a prerequisite

Learning Objectives

This module aims to provide:

- A solid grounding in transferable skills such as oral and visual skills, team-working, the ability to 'learn how to learn', and the ability to synthesise and apply acquired knowledge to the solution of problems
- An appreciation of system design problems and to gain an understanding of the design specification phase
- An understanding of proposed alternative solutions to design problems and to contribute to the choices as to the preferred solution
- The ability to work effectively in teams and the capacity to undertake lifelong learning

- An appreciation of ethical standards in engineering particularly in regard to people and the environment

Syllabus

- Design and the design process
- System/Product Life Cycle
- Assessment of requirements
- Problem formulation
- Design specification
- Embodiment design
- Modelling
- Design evaluation
- Detail design
- Documentation
- Implementation/Production
- Environmentally Sound Disposal/Minimisation
- Design for Environment
- Design for Health and Safety
- Regulatory Environment

Module Title	Introduction to Management Science
Year of Delivery	2
Module Type	Optional Technology Stream
Requisite Modules	Introduction to Operations Engineering, Operations Engineering, Maths 1, Maths 2 and Statistics are prerequisites

Learning Objectives

- Understand and appreciate the role of management science techniques in solving real life engineering and business problems
- Adopt a scientific approach/philosophy to analyzing real life engineering management problems and generate optimal solutions
- Have a sound base in the fundamentals of quantitative management science techniques and be able to apply these techniques in solving problems

Syllabus

- Mathematical modelling approach to managerial decision making
- Linear programming
- Sensitivity Analysis
- Transportation
- Transshipment

- Assignment
- Network Flow Models
- Multi-criteria Decision Making
- Decision Analysis
- Case studies

Module Title	CAD Modelling
Year of Delivery	1 and 2
Module Type	Optional Technology Stream
Requisite Modules	None

Learning Objectives

By the end of the module students will be able to:

- Demonstrate a good working knowledge of 2D CAD and apply this to communicating design solutions and engineering detailing
- Effectively communicate design information through 2D CAD models

Syllabus

Contemporary CADD software with particular reference to Autocad; hardware, software and operating systems; the Autocad drawing environment: absolute and relative coordinates, units and limits; CAD tools and drawing setup; the UCS; basic and advanced drawing and editing commands; introduction to layers; using blocks, attributes and symbol libraries; communicating engineering and design details; dimensioning and dimensioning styles; toleranced dimensioning; sectional views and hatching; text; introduction to Paper Space; basic customisation techniques; isometric drawing. CAD construction techniques; plotting; using AutoLISP routines from the Internet. DWF drawings; Introduction to 3D functions.

Module Title	Introduction to Quality Management
Year of Delivery	2
Module Type	Optional Technology Stream
Requisite Modules	Introduction to Operations Engineering, Statistics and Operations Engineering are prerequisites

Learning Objectives

- Appreciate the difference between QC, QA and TQM
- Understand the role of, and how to develop a QMS
- Become aware of regulatory issues and QMS accreditation
- Appreciate the importance of quality in the supply chain
- Be familiar with commonly employed data collection and quality improvement tools
- Appreciate the concept of variability and the role of Statistical Methods

Syllabus

- History of Quality Management
- Quality Control / Assurance
- Total Quality Management
- Quality Management Systems, documentation, audits, standards (ISO9000:2000)
- Quality in the Supply Chain
- Quality Problem Solving tools
- Natural variation in products and processes
- Overview of statistical techniques for Product and Process Control