University College Dublin
An Coláiste Ollscoile Baile Átha Cliath

National University of Ireland, Dublin
Ollscoil na hÉireann, Baile Átha Cliath

Engineering

Session 2005/06

From September 2005 all first year courses are modularised. Further information is available at www.ucd.ie/horizons

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Degrees in Engineering

The University may grant the following degrees to students who, under conditions laid down in the statutes and regulations, have completed approved courses of study, and have passed the prescribed examinations of the University, and fulfilled all other prescribed conditions.

- Bachelor of Engineering (BE)
- Bachelor of Science (BSc)
- Master of Engineering Science (MEngSc)
- Master of Engineering (ME)
- Master of Engineering Design (MED)
- Master of Industrial Engineering (MIE)
- Master of Science (MSc)
- Doctor of Philosophy (PhD)

There are seven programme options leading to the award of the BE Degree:

- Agricultural and Food Engineering (not open to new entrants)
- Biosystems Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Electronic Engineering
- Mechanical Engineering

The approved courses of study in each degree programme must be pursued during at least twelve terms.

The degree of Bachelor of Science is awarded in respect of the Three-year undergraduate programme

- Structural Engineering with Architecture

Most graduates of this programme will go on to take the two-year Masters course in Structural Engineering with Architecture.

Full details of all Engineering disciplines and programmes are available online at www.ucd.ie/engineer. Please submit any enquiries to eng.arch@ucd.ie.

Degree of Bachelor of Engineering (BE)

General Regulations

Electronic Engineering and Electrical Engineering

Students in *Electronic or Electrical Engineering* will be required, on entering the Fourth Year of the degree programme, to choose either Electronic Engineering or Electrical Engineering.

Language Requirement

Students who entered any of the Engineering degree programmes prior to 2004 shall be required to pass an examination in a language approved by the Programme Board. Such students will not be conferred with the BE Degree until they have satisfied this language requirement. Language courses are offered to such students at different levels; the language skills of individual students determine the level at which a course is taken.

Students who entered any of the Engineering degree programmes in 2004 are required to reach a defined level of attainment in a third language, approved by the Programme Board, in order to be eligible for the award of the BE degree. Students entering with a Grade C3 at Higher Level in the Leaving Certificate examination of the Republic of Ireland, or its equivalent in an approved language will be deemed to meet the language requirement.

Examination Regulations

The University Examinations for the Degree of Bachelor of Engineering are:

1.. The Second University Examination;
2.The Third University Examination;
3.The BE Degree Examination.

For eligibility for admission to each of the examinations, the prescribed course of study for that examination must have been attended satisfactorily.

The Second University Examination may be taken not earlier than the end of the sixth term after matriculation. The Third University Examination may be taken not earlier than the end of the ninth term after matriculation. The Examination for the Degree of Bachelor of Engineering may be taken not earlier than the end of the twelfth term.

Honours may be awarded at each examination under the rules specified in the "Marks and Standards" document of the University.

The attention of students is directed to the following: Credit for a course, Pass or Honours, requires satisfactory attendance and performance of all work prescribed during the Year.

Regulations governing all examinations are contained in Marks and Standards. Students should consult this publication, available at www.ucd.ie/exams.

Time Limit for Passing Examinations

Attention is drawn to the following University Regulations:

1) No student will be allowed to present himself/herself for any examination in the University prior to the completion of the preceding examination.

   a) a) Students must complete the Second University Examination within two academic years from the date of passing the First University Examination.

   b) Students must complete the Third University Examination within two academic years from the date of passing the Second University Examination.

   c) Students failing to pass any of these examinations within the specified interval will be ineligible to proceed in their degree programme. Exceptions may be granted by the Engineering Programme Board only for very serious reasons.

   d) Following a change in the syllabus of a Subject, or the deletion of a Subject, examination papers based on the old syllabus will be provided for at most one year.

Syllabus of Courses for Degree of Bachelor of Engineering

Engineering (undenominated entry)

Agricultural and Food Engineering

Second Year (Old Curriculum)

Course Code	*Course Title*	*ECTS Credits*
AFEN 2001	Food Science	10
AFEN 2002	Literature Research Project	
MEEN 2003	Thermodynamics	2
MEEN 2001	Applied Dynamics	4
MEEN 2002	Mechanics of Materials	4
MEEN 2008	Mechanics of Fluids	2
EEEN 2036	Electrical Engineering	
EEEN 2035	Electronic Engineering	5
CVEN 2001	Introduction to Biosystems	2
MATH 2600	Mathematics	8
COMP 2605	Computer Science	3
AFEN 2020	Literature Research Project and Course Work	20
	Total	60

Third Year

Course Code	*Course Title*	*ECTS Credits*
AFEN 3002	Power and Machinery I	8
AFEN 3001	Process Engineering Principles	8
MEEN 3001	Thermodynamics	5
AFEN 3003	Structural and Soil Engineering	7
EEEN 3025	Electronic Engineering	4
MEEN 3006	Computer Methods in Engineering	2
MAPH 3034	Engineering Computation	2
MATH 3601	Mathematics (Module A)	
MATH 3602	Mathematics (Module B)	2
ANSC 3600	Crop Husbandry and Animal Husbandry	4
AFEN 3021	Design Project	18
AFEN 3022	Year's Work	
	Total	60

Fourth Year

Course Code	*Course Title*	*ECTS Credits*
AFEN 4003	Food Process Engineering	8
AFEN 4004	Food Manufacturing Systems	6
AFEN 4001	Sustainable Buildings for Biological Systems	8
AFEN 4002	Bioenvironmental Engineering	8
AFEN 4005	Power and Machinery II	8
AFEN 4007	Major Project	16
Two elective units:		
BMGT 4001	Management and its Environment (1 unit)*	3
AERD 4600	Farm Management (1 unit)	3
ELEN 4005	Renewable Energy Systems (1 unit)	3
AFEN 4006	Surveying (1 unit)	3
AFEN 4010	Forest Engineering (1 unit)	3
MATH 4601/2	Mathematics A or B (1 unit)	3
PEP 4030	Environmental Policy and Management (1 unit)	3
MEEN 4004	Managing Manufacturing Enterprise (1 unit)	3
	Total	60

Second Year

Food Science **AFEN 2001**

Food Biochemistry

Fundamentals of food biochemistry as applied to food and nutrition with emphasis on the biochemistry of carbohydrates, proteins, fats, enzymes and vitamins.

Food Microbiology

Basic food microbiology, mould, yeasts, bacteria; contamination, preservation and spoilage of selected foods.

Food Physics

Rheological and thermal properties of foods. Measurement of colour of foods. Mass transfer in foods.

Literature Research Project **AFEN 2002**

Students will be required to carry out a comprehensive literature survey in a selected aspect of agricultural and food engineering. An oral progress presentation and comprehensive final report will be required.

* These subjects have a laboratory or other practical component in addition to the lecture course.

Thermodynamics **MEEN 2003**

(For Agricultural and Food and Mechanical Engineering students)

First Law of Thermodynamics; Control system analysis; control volume analysis; steady-state, steady-flow energy equation. Second Law of Thermodynamics; Work and heat; quality of energy; reversible and irreversible processes; Carnot cycle; absolute temperature scale; definition of entropy; Clausius inequality; derivation of T-ds relations. Analysis of thermodynamic cycles; Rankine, Vapour Compression, Brayton-Joule, Otto, Diesel Cycles.

Applied Dynamics **MEEN 2001**

(For Biosystems, Electronic & Electrical and Mechanical Engineering Students)

Three-dimensional force systems: resultants and equilibrium. Topics in friction. Particle kinematics. Plane kinematics of rigid bodies. Plane kinetics of rigid bodies: direct methods ; impulse and momentum; work and energy. Vibration, free and forced. Central force motion.

Mechanics of Materials **MEEN 2002**

(For Agricultural & Food, Chemical and Mechanical Engineering students)

One dimensional stress and strain. Biaxial stress. Principal stresses and strains in 2-D. Hookes Law. Strain gauges. Thin-walled pressure vessels. Torsion of circular shafts. Bending stresses and deflections. Buckling of slender bars.

Mechanics of Fluids **MEEN 2008**

A continuation course on fluid flow from a physical viewpoint.

Review of fluid properties. Fluid statics. Kinematics of fluid flow. Continuity equation. Stream function – Two-dimensional-incompressible. Rotational and irrotational motion. Circulation. Equations of irrotational motion. Dynamics of fluids. Force, energy and momentum. Effects of pressure, weight, viscosity, turbulence and compressibility. Dynamic similitude. Boundary layers, surface drag, form drag. Turbo-machinery.

Electrical Engineering **EEEN 2036**

(For Agricultural & Food and Mechanical Engineering students)

Review of DC analysis, superposition, Thevenin's Theorem. Transient analysis: RL, RC, LC, RLC circuits. AC concepts: phasors, complex impedance, combining impedances, AC superposition. Frequency response of 1st and 2nd order circuits. RLC circuits. DC bridges and measurement. AC power.

Electronic Engineering **EEEN 2035**

(For Agricultural and Food and Mechanical Engineering students)

PN junction: Diode, LED. Rectification. Power supply design. FET and MOSFET as circuit elements (switch, amplifier). BJT transistor. Simple amplifiers: operating point and bias. AC equivalent circuits.

Introduction to Biosystems **CVEN 2001**

(For Agricultural and Food, Chemical and Civil Engineering students)

Definitive properties and levels of organisation of living systems. Chemical composition of living systems. Cell metabolism. Origin of life-metabolic evolution. Diversity of life forms. Animal and plant tissues and organs. Physiological systems. Protists. Nutrient requirements of organisms. Populations, communities and ecosystems. Biogeochemical cycles. Emergence of man. Impact of man on the biosphere. Social implications of recent advances in biology.

Mathematics **MATH 2600**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Computer Science **COMP 2605**

Software engineering: Requirements analysis, formal and semi-formal specification, top-down structured programming, abstract data types, modularity, validation and verification. Software systems: Assemblers, compilers, high-level languages, operating systems.

Programming problems related to the course material will be assigned.

Literature Research Project and Course Work **AFEN 2020**

The Year's Work consists of assignments in the following areas:

Computer Applications (Introduction to PCs, word processing, spreadsheet analysis, databases, presentation graphics, 2D and 3D computer aided drafting)
Electrical and Electronic Engineering
Engineering Technology
Food Science
Literature Research (AFEN 2002)

Third Year

Power and Machinery I **AFEN 3002**

Philosophy and practice of design. Materials. Geometric tolerances. Physical, chemical and biochemical characteristics of biological materials including grass, cereals, potatoes, vegetables, fruit, timber and peat. The design of machine components including bearings, shafting, springs and gears. Stress analysis and design for fatigue. Computer-based systems design. Finite element analysis. Computer aided design. International standards.

Engines and fuels. Energy resources. Energy conversion systems. Thermodynamic limits to engine performance. Electric motors. Heat exchangers. Engine testing. Biofuels. Mechanical and fluid power transmission systems, including gearboxes, clutches, torque converters and electronic control systems. Hydraulic power systems.

Process Engineering Principles **AFEN 3001**

Basic modes of heat transfer. Steady state conduction. Unsteady state conduction. Free and forced convection. Finned surfaces. Heat exchangers. Radiation. Heat transfer with phase change. Process laboratory practicals. Computer applications.

Mass balances. Mass transfer. Principles and applications of separation processes including: distillation, leaching, filtration, membrane processes, protein fractionation, centrifugation, reactor design. Process laboratory practicals. Computer applications.

Thermodynamics **MEEN 3001**

(For Agricultural & Food and Mechanical Engineering students).
Entropy, reversibility and availability. Second Law efficiency.

Rankine, Re-Heat & Regenerative cycles. Brayton-Joule gas turbine cycle. Combined steam & gas turbine cycles. Combined heat & power systems.

Mixtures of gases. Psychrometry. Air Conditioning.

Fuels & Combustion. First Law for reacting systems.

Compressible internal flow: Ideal gas relationships, Mach number and speed of sound. Isentropic flow in converging diverging nozzles. Non-isentropic flow: Fanno and Rayleigh flow, shock waves.

Structural and Soil Engineering **AFEN 3003**

Soil classification. Phase relations. Failure theory. Retaining walls. Slope stability. Foundation pressures. Consolidation and compaction.

Structural analysis. Estimation of loading on structures including wind load. Steel, reinforced concrete and wood as structural materials. Design for bending, shear, deflection, compression and buckling in basic structural elements including beams, slabs, walls, columns, trusses and simple frames.

Electronic Engineering **EEEN 3025**

(For Agricultural & Food and Mechanical Engineering students)

Amplifiers: Frequency response. The operational amplifier: ideal properties, standard circuit configurations, non-ideal behaviour.

Transducers: brief overview and examples.

Filters: Passive, active, implementations using op-amps.

Data acquisition: sensor impedance; noise types, sources & precautions; signal conditioning; filtering; differential/single inputs; AtoD conversion.

Digital electronics: Gates, transistor implementation. Fundamentals of digital logic, Boolean algebra, Karnaugh maps. Combinational digital logic building blocks, half adder, full adder. Sequential digital logic: JK flip-flop, D and T flip-flops, and memory.

Computer Methods in Engineering **MEEN 3006**

(For Agricultural & Food and Mechanical Engineering students)

Statistical methods: interpretation of experimental data, curve fitting, statistical analysis, validation of models. Introduction to finite element analysis. Introduction to rapid application development languages.

Engineering Computation **MAPH 3034**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Mathematics **MATH 3600**

Mathematics [Module A: LT-FS-CV] (1 unit)* **MATH 3601**

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equations, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat), engineering applications.

Introduction to theory of functions of a complex variable (CV). Cauchy-Riemann equations. Harmonic functions. Conformal mappings. Cauchy integral formulae.

Mathematics [Module B: Integral Calculus] (1 unit)* **MATH 3602**
Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stokes' theorem. Applications.

Crop Husbandry and Animal Husbandry **ANSC 3600**
Climate and soils. Principles of tillage and grass production. Conservation and utilisation of farm foods. Principles of feeding, breeding and management of farm animals. Animals in disease. Animal behaviour; shelter needs of the animal. Interdependence of livestock and crops.

Design Project AFEN 3021
Students will carry out a design project involving the design of a machine, machine element, item of equipment, building or system associated with a selected aspect of agricultural and food engineering.

Year's Work **AFEN 3022**
The year's work consists of projects in the following areas:

Computer Methods in Engineering
Process Engineering (Laboratory)
Electrical/Electronic Engineering (Laboratory)
Mechanics and Thermodynamics (Laboratory)
Structural and Soil Engineering (Design and Laboratory)
Design Project

Fourth Year

Food Process Engineering **AFEN 4003**
Pasteurisation, UHT and aseptic processing, microwave and dielectric heating, crystallisation, freezing, homogenisation, emulsification, sensors for food process automation. Computer applications. Laboratory process practicals.

Drying theory and applications, including water binding mechanisms, high and low temperature drying, constant and falling rate periods, industrial applications with reference to foods, feed, peat and timber. Other unit operations connected with the drying process, such as evaporation, extrusion, packaging and storage. Simulation of the drying process, computer applications laboratory. Laboratory process practicals.

Food Manufacturing Systems **AFEN 4004**
Quality systems standards. Food legislation. Process plant layout. Principles of cleaning, hygienic design.

Food refrigeration: refrigeration cycles, equipment, thermal properties, cooling and freezing processes, mathematical modelling, IT, chilled and frozen foods.

* 1 unit = 24 lecture hours.

Sustainable Buildings for Biological Systems **AFEN 4001**

Planning and environmental legislation. Building design for higher biological organisms. Structural materials. Low emission buildings. Environmental control systems. Atmospheric emissions abatement. Biofilters. Atmospheric dispersion modelling. Landscaping.

Bioenvironmental Engineering **AFEN 4002**

Legislation, waste and waste-water treatment, solid waste, atmospheric emissions, noise, IPC licensing, environmental management and auditing. Land as a waste treatment and disposal medium, hydrology, treatment processes in the soil, design.

Power and Machinery II **AFEN 4005**

Precision Agriculture

The "cycle" of precision agriculture; spatial inventories and issues of error in spatial data; global positioning systems (GPS); yield mapping; sensors and Time delay modelling; sensing systems; remote sensing and NIR sensors; and variable rate technology.

Control

Modelling dynamic systems, system response, feedback control. Instrumentation, measurement of pressure, flow and temperature, compact data loggers. Programmable logic controller (PLC) technology.

Major Project **AFEN 4007**

Students will carry out a comprehensive project involving experimentation, systems analysis and/or design in an approved topic in agricultural and food engineering. The project will include:

(i) A survey of the literature;
(ii) Oral progress report (seminar style);
(iii) The presentation of a comprehensive report.

In addition to the above, a total of two units* of the following course/s must be studied:

Management and its Environment **(1 unit)** **BMGT 4001**

The Irish economy, its institutions and international relationships. The firm and its environment. Organisational objectives and corporate behaviour. Economic concepts. Market structure and the competitive process. Demand analysis. Forms of organisation, private and public bodies. Management, its nature and functions – planning, organising, directing, controlling. Financial management. Presentation and analysis of financial statements. Forecasting. Working capital. Capital budgeting. Financial institutions. Marketing management. Market research. Product life cycle. Product mix. Marketing mix. Operations management. Concept of a system. System design, planning and control. Personnel management. Industrial relations. Trade unions. Collective bargaining.

* 1 unit = 24 lecture hours.

Farm Management **(1 unit)** **AERD 4600**
Objectives and goals of the farm manager, farm management functions and organisation, farm family life cycle. Farm accounting definitions and analysis techniques, capital budgeting and investment appraisal, partial budgeting and whole farm planning and budgeting; enterprise budgets, direct payments, REPS and other State supports. Farm management controls, computerisation and IT; alternative enterprises, farm labour and risk analysis, part-time farming. Farm security and safety, management for quality production at farm level.

Renewable Energy Systems **(1 unit)** **ELEN 4005**
Aspects of renewable energy systems (e.g. windpower, hydropower, wavepower, photovoltaic conversion, direct solar heating, biomass, hydrogen as an energy vector, introduction to economic analysis).

Surveying **(1 unit)** **AFEN 4006**
Chain surveying; surveys of small areas and buildings; survey instruments and their use in plane surveying; ordnance survey maps; triangulation, calculation and adjustment of traverses; circular curves. Contouring and topographic surveying; tacheometry. Electronic distance measurement. Areas and volumes. Aerial surveying and associated area mensuration.

Forest Engineering **(1 unit)** **AFEN 4010**
Forest machinery design, selection and operation. Timber transport. Environmental impact. Central tyre inflation (CTI) and telemetric control systems.

Mathematics **(1 unit)** **MATH 4601**
A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Mathematics **(1 unit)** **MATH 4602**
A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Environmental Policy and Management **(1 unit)** **PEP 4030**
This will provide an overview of analytical techniques applied in management and policy analysis in regard to key environmental challenges, including climate change, acidification, water, air, waste. Sectoral issues in agriculture, industry (IPC licensing), transport and energy will be addressed. Students will acquire some insights as to the key issues, and an analytical framework with which to address them. Lectures will be complemented as appropriate by the views of key leaders in environmental policy and management in Ireland.

Managing Manufacturing Enterprise **(1 unit)** **MEEN 4004**
For course description, see under 'Mechanical Engineering', page 66.

Biosystems Engineering

Second Year

Course Code	*Course Title*	*ECTS Credits*
BSEN 2001	Biophysics	4
BSEN 2002	Applied Biochemistry	4
INDM 2601	Microbiology	4
AFEN 2002	Literature Research Project	
MEEN 2003	Thermodynamics	3
MEEN 2028	Mechanics of Materials	4
MEEN 2008	Mechanics of Fluids	3
⎧EEEN 2036	Electrical Engineering	4
⎩EEEN 2035	Electronic Engineering	⎫
CVEN 2001	Introduction to Biosystems	4 ⎭
MATH 2600	Mathematics	10
COMP 2605	Computer Science	4
AFEN 2020	Literature Research Project and Course Work	16
	Total	60

Third Year

Course Code	*Course Title*	*ECTS Credits***
BSEN 3007	Biosystems Engineering	4
MEEN 3001	Thermodynamics	4
MEEN 3006	Computer Methods in Engineering	3
MAPH 3034	Engineering Computation	3
MATH 3600	Mathematics	5
ANSC 3600	Crop Husbandry and Animal Husbandry	4
⎧AFEN 3021	Design Project	⎫
⎩BSEN 3008	Year's Work	18 ⎭
Ten Units from the following :		
BSEN 3001	Process Development (2 units)	3
BSEN 3002	Structural Engineering (2 units)	3
AFEN 3002	Power and Machinery (4 units)	6
BSEN 3003	Product Development (2 units)	3
CVEN 3001	Hydraulics (4 units)	6
BSEN 3004	Soil Engineering (4 units)	3
EEEN 3027	Electrical Engineering (2 units)	3
	Total	60

Fourth Year

Course Code	*Course Title*	*ECTS Credits*
BSEN 4001	Biosystems Modelling	8
AFEN 4007	Major Project	18
Seventeen Units from the following :		
BSEN 4002	Process Engineering (4 units)	8
BSEN 4003	Refrigeration (2 units)	4
BSEN 4004	Process Automation (2 units)	4
BSEN 4005	Control (2 units)	4
AFEN 4001	Sustainable Buildings for Biological Systems (4 units)	8
AFEN 4002	Bioenvironmental Engineering (4 units)	8
CVEN 4012	Design of Water Control Systems (2 units)	4
BSEN 4006	Waste Management (4 units)	8
AFEN 4006	Surveying (1 unit)	4
BSEN 4007	Precision Agriculture (2 units)	4
BSEN 4008	Mechanisation (2 units)	4
AFEN 4010	Forest Engineering (2 units)	4
BMGT 4001	Management and its Environment (2 units)	3
MATH 4601	Mathematics (1 unit)	3
MATH 4602	Mathematics (1 unit)	3
PEP 4030	Environmental Policy and Management (1 unit)	3
MEEN 4004	Managing Manufacturing Enterprise (1 unit)	3
FOR 3610	Remote Sensing and GIS (2 units)	4
BSEN 4009	Engineering Properties of Biomaterials (2 units)	4
ELEN 4005	Renewable Energy Systems (1 unit)	3
AERD 4600	Farm Management (1 unit)	3
	Total	60

Second Year

Literature Research Project **AFEN 2002**

Students will be required to carry out a comprehensive literature survey in a selected aspect of agricultural and food engineering. An oral progress presentation and comprehensive final report will be required.

Biophysics **BSEN 2001**

Rheological and thermal properties of biological materials. Measurement of colour of biological materials. Mass transfer in biological materials.

Applied Biochemistry **BSEN 2002**

Fundamentals of biochemistry as applied to biological materials with emphasis on the biochemistry of carbohydrates, proteins, fats, enzymes and vitamins.

Microbiology **INDM 2601**

Basic microbiology, mould, yeasts, bacteria, contamination, preservation and spoilage of selected biological materials.

Thermodynamics **MEEN 2003**

(For Biosystems and Mechanical Engineering students)

First Law of Thermodynamics; Control system analysis; control volume analysis; steady-state, steady-flow energy equation. Second Law of Thermodynamics; Work and heat; quality of energy; reversible and irreversible processes; Carnot cycle; absolute temperature scale; definition of entropy; Clausius inequality; derivation of T-ds relations. Analysis of thermodynamic cycles; Rankine, Vapour Compression, Brayton-Joule, Otto, Diesel Cycles.

Mechanics of Materials **MEEN 2028**

(For Biosystems, Chemical and Mechanical Engineering students)

One dimensional stress and strain. Biaxial stress. Principal stresses and strains in 2-D. Hookes Law. Strain gauges. Thin-walled pressure vessels. Torsion of circular shafts. Bending stresses and deflections. Buckling of slender bars.

Mechanics of Fluids **MEEN 2008**

A continuation course on fluid flow from a physical viewpoint.

Review of fluid properties. Fluid statics. Kinematics of fluid flow. Continuity equation. Stream function – Two-dimensional-incompressible. Rotational and irrotational motion. Circulation. Equations of irrotational motion. Dynamics of fluids. Force, energy and momentum. Effects of pressure, weight, viscosity, turbulence and compressibility. Dynamic similitude. Boundary layers, surface drag, form drag. Turbo-machinery.

Electrical Engineering **EEEN 2036**

(For Biosystems and Mechanical Engineering students)

Review of DC analysis, superposition, Thevenin's Theorem. Transient analysis: RL, RC, LC, RLC circuits. AC concepts: phasors, complex impedance, combining impedances, AC superposition. Frequency response of 1st and 2nd order circuits. RLC circuits. DC bridges and measurement. AC power.

Electronic Engineering **EEEN 2035**

(For Biosystems and Mechanical Engineering students)

PN junction: Diode, LED. Rectification. Power supply design. FET and MOSFET as circuit elements (switch, amplifier). BJT transistor. Simple amplifiers: operating point and bias. AC equivalent circuits.

Introduction to Biosystems **CVEN 2001**

(For Biosystems, Chemical and Civil Engineering students)

Definitive properties and levels of organisation of living systems. Chemical composition of living systems. Cell metabolism. Origin of life-metabolic evolution. Diversity of life forms. Animal and plant tissues and organs. Physiological systems. Protists. Nutrient requirements of organisms. Populations, communities and ecosystems. Biogeochemical cycles. Emergence of man. Impact of man on the biosphere. Social implications of recent advances in biology.

Mathematics **MATH 2600**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Computer Science **COMP 2605**

Software engineering: Requirements analysis, formal and semi-formal specification, top-down structured programming, abstract data types, modularity, validation and verification. Software systems: Assemblers, compilers, high-level languages, operating systems.

Programming problems related to the course material will be assigned.

Literature Research Project and Course Work **AFEN 2020**

The Year's Work consists of assignments in the following areas:

Computer Applications (Introduction to PCs, word processing, spreadsheet analysis, databases, presentation graphics, 2D and 3D computer aided drafting) Electrical and Electronic Engineering, Engineering Technology, Biophysics/Applied Biochemistry, Literature Research (AFEN 2002)

Third Year

Biosystems Engineering **BSEN 3007**

Modes of heat transfer in biological materials. Heat exchangers. Mass balances, mass transfer. Separation processes including: distillation, filtration, membrane processes,

centrifugation, chromatography. Reactor design, Psychrometrics in biological systems. Process laboratory.

Thermodynamics **MEEN 3001**

(For Biosystems and Mechanical Engineering students).
Entropy, reversibility and availability. Second Law efficiency.

Rankine, Re-Heat & Regenerative cycles. Brayton-Joule gas turbine cycle. Combined steam & gas turbine cycles. Combined heat & power systems.

Mixtures of gases. Psychrometry. Air Conditioning.

Fuels & Combustion. First Law for reacting systems.

Compressible internal flow: Ideal gas relationships, Mach number and speed of sound. Isentropic flow in converging diverging nozzles. Non-isentropic flow: Fanno and Rayleigh flow, shock waves.

Computer Methods in Engineering **MEEN 3006**

(For Biosystems and Mechanical Engineering students)
Statistical methods: interpretation of experimental data, curve fitting, statistical analysis, validation of models. Introduction to finite element analysis. Introduction to rapid application development languages.

Engineering Computation **MAPH 3034**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Mathematics **MATH 3600**

Mathematics [Module A: LT-FS-CV] (1 unit)* ***MATH 3601***

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equations, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat), engineering applications.

Mathematics [Module B: Integral Calculus] (1 unit)* ***MATH 3602***

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stokes' theorem. Applications.

* 1 unit = 24 lecture hours.

Crop Husbandry and Animal Husbandry **ANSC 3600**

Climate and soils. Principles of tillage and grass production. Conservation and utilisation of farm foods. Principles of feeding, breeding and management of farm animals. Animals in disease. Animal behaviour; shelter needs of the animal. Interdependence of livestock and crops.

Design Project AFEN 3021

Students will carry out a design project involving the design of a process, building, system or item of equipment associated with a selected aspect of biosystems engineering.

Year's Work **BSEN 3008**

The year's work consists of assignments in the following areas:

Computer Methods in Engineering
Biosystems Engineering (Laboratory)
Thermodynamics (Laboratory)
Structural and Soil Engineering (Design and Laboratory)
Design Project

Elective Subjects:

Ten Units of the following to be chosen from permitted combinations with the approval of the Head ofSubject:

Process Development **(2 units)** **BSEN 3001**

Quality systems standards. Legislation. Process plant layout. Principles of cleaning, hygienic design.

Structural Engineering **(2 units)** **BSEN 3002**

Structural analysis. Estimation of loading on structures including wind load. Steel, reinforced concrete and wood as structural materials. Design for bending, shear, deflection, compression and buckling in basic structural elements including beams, slabs, walls, columns, trusses and simple frames.

Power and Machinery I **(4 units)** **AFEN 3002**

Philosophy and practice of design. Materials. Geometric tolerances. Physical, chemical and biochemical characteristics of biological materials including grass, cereals, potatoes, vegetables, fruit, timber and peat. The design of machine components including bearings, shafting, springs and gears. Stress analysis and design for fatigue. Computer-based systems design. Finite element analysis. Computer aided design. International standards.

Engines and fuels. Energy resources. Energy conversion systems. Thermodynamic limits to engine performance. Electric motors. Heat exchangers. Engine testing. Biofuels. Mechanical and fluid power transmission systems, including gearboxes, clutches, torque converters and electronic control systems. Hydraulic power systems.

Product Development **(2 units)** **BSEN 3003**

Product development incorporating sensory analysis, colour measurement, principal components analysis, statistical analysis, new products, shelf life analysis.

Hydraulics **(4 units)** **CVEN 3001**

Calculation and design for pressure conduits and open channels. Hydraulics of pressure conduits, flow in pipe networks, unsteady flow in pipes. Hydraulic machines including pumps and turbines. Non-uniform flow in open channels; critical depth and hydraulic jump; control sections and transitions in open channels. Groundwater hydraulics of wells, drains and ditches. Elementary physical hydrology: The hydrological cycle and water balances; precipitation; evaporation and transpiration; infiltration and percolation; groundwater storage and outflow; surface runoff.

A course of laboratory experiments illustrating the principles of flow in pressure conduits and open channels. Problems related to the subject matter of the lectures.

Soil Engineering (4 units) **BSEN 3004**

Soil classification. Phase relations. Failure theory. Retaining walls. Slope stability. Foundation pressures. Consolidation and compaction.

Electrical Engineering **(2 units)** **EEEN 3027**

Power and power factor correction: Three phase systems. Power measurement in 3-phase systems.

Safety. Earthing. Fuses. Circuit breakers. Residual current devices. Insulation.

Magnetic devices: B-H curve for iron. Magnetic circuits.

DC machines: machine models, series, shunt and compound connected, speed control, torque speed characteristics, starting.

Single Phase Transformer: Ideal transformer. Approximate equivalent circuit. Open and short circuit.

Induction Machines: Three phase winding and rotating magnetic field, slip, equivalent circuit model, torque and mechanical power, open and short circuit tests, speed control theory and practice.

Fourth Year

Biosystems Modelling **BSEN 4001**

Numerical and computer modelling of biological engineering processes including the drying of solid and liquid biomaterials. Numerical modelling systems using finite element and finite difference methods including practical examples as well as analytical solutions.

Major Project **AFEN 4007**

Students will carry out a comprehensive project involving experimentation, systems analysis and/or design in an approved topic in agricultural and food engineering. The project will include:

(i) A survey of the literature;
(ii) Oral progress report (seminar style);
(iii) The presentation of a comprehensive report.

In addition to the above, a total of two units* of the following course/s must be studied:

Elective subjects

Seventeen units of the following to be chosen from permitted combinations (e.g. Food and Process Engineering, Environmental Engineering or Mechanisation Systems) with the approval of the Head of Subject.

Process Engineering **(4 units)** **BSEN 3002**

Unit process, hear and mass transfer systems in bioprocessing including pasteurisation, sterilisation, dehydration, freezing, fermentation, crystallisation, extrusion, emulsification, microwave and dielectric heating. Physical, chemical and microbiological changes in biological materials. Packaging and storage.

Refrigeration **(2 units)** **BSEN 4003**

Refrigeration cycles, equipment, thermal properties, cooling and freezing processes, mathematical modelling, chilled and frozen materials of biological origin.

Process Automation **(2 units)** **BSEN 4004**

On-line measurement systems for biological materials including optical (NIR, MIR, visible), rheological, ultrasonic and hot wire sensors, Process automation

Control **(2 units)** **BSEN 4005**

Modelling dynamic systems, system response, feedback control. Instrumentation, measurement of pressure, flow and temperature, compact data loggers. Programmable logic controller (PLC) technology.

Sustainable Buildings for Biological Systems **AFEN 4001**

Siting of agricultural buildings and food facilities. Internal layout. Internal environment control systems. Crop storage. Reinforced concrete. Structural steel. Computer applications.

Animal production buildings. Food facilities. Milking parlour design. Agricultural building services. Management and disposal of animal manures. Technologically advanced methods of manure management. Rural roads. Computer applications.

* 1 unit = 24 lecture hours.

Bioenvironmental Engineering **AFEN 4002**
Legislation, waste and waste-water treatment, solid waste, atmospheric emissions, noise, IPC licensing, environmental management and auditing. Land as a waste treatment and disposal medium, hydrology, treatment processes in the soil, design.

Design of Water Control Systems **(2 units)** **CVEN 4012**
Elements of applied hydrology. Water quantity requirements for domestic and industrial uses. Water sources and their development. Quality of natural waters. Quality standards for potable and industrial water supplies. Water purification processes. Water distribution. Design of sewer systems. Purification of domestic and industrial wastes. Control of water pollution. Atmospheric pollution. Refuse disposal.

Waste Management **(4 units)** **BSEN 4006**
Sources of organic wastes: collection, storage and treatment systems; nutrient management planning; best available techniques; environmental management systems; REPS planning; concrete technology; systems analysis; solutions and costs; legislation.

Surveying **(1 unit)** **AFEN 4006**
Chain surveying; surveys of small areas and buildings; survey instruments and their use in plane surveying; ordnance survey maps; triangulation, calculation and adjustment of traverses; circular curves. Contouring and topographic surveying; tacheometry. Electronic distance measurement. Areas and volumes. Aerial surveying and associated area mensuration.

Precision Agriculture **(2 units)** **BSEN 4007**
Global Positioning Systems (GPS), Geographic Information Systems (GIS), sensors, yield maps, variable rate technology, satellite imagery, decision support, soil and environmental properties.

Mechanisation (2 units) **BSEN 4008**
Agricultural machinery, system selection and operation: including tractors, tillage, seeding and planting; fertiliser application; spraying, crop harvesting.

Management and its Environment **(1 unit)** **BMGT 4001**
The Irish economy, its institutions and international relationships. The firm and its environment. Organisational objectives and corporate behaviour. Economic concepts. Market structure and the competitive process. Demand analysis. Forms of organisation, private and public bodies. Management, its nature and functions – planning, organising, directing, controlling. Financial management. Presentation and analysis of financial statements. Forecasting. Working capital. Capital budgeting. Financial institutions. Marketing management. Market research. Product life cycle. Product mix. Marketing mix. Operations management. Concept of a system. System design, planning and control. Personnel management. Industrial relations. Trade unions. Collective bargaining.

Mathematics **(1 unit)** **MATH 4601**
A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Mathematics (1 unit) MATH 4602
A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Environmental Policy and Management (1 unit) PEP 4030
This will provide an overview of analytical techniques applied in management and policy analysis in regard to key environmental challenges, including climate change, acidification, water, air, waste. Sectoral issues in agriculture, industry (IPC licensing), transport and energy will be addressed. Students will acquire some insights as to the key issues, and an analytical framework with which to address them. Lectures will be complemented as appropriate by the views of key leaders in environmental policy and management in Ireland.

Managing Manufacturing Enterprise (1 unit) MEEN 4004
For course description, see under 'Mechanical Engineering', page 66.

Remote Sensing and GIS (2 Units) FOR 3610
Fundamental concepts of remote sensing and Geographic Information Systems (GIS). Digital interpretation of OS raster maps and orthophotos. Development of hands-on GIS computer skills of point, line and polygon theme and attribute table creation within ArcView 3.1. GIS skills of joining dbf databases to theme attribute tables. Building GIS queries. Integration of vector, raster and attribute GIS databases. Specification of GIS database structure. Digital area and perimeter estimation.

Application of remote sensing and GIS in forest, agricultural and environmental resource inventory. Applications of GIS skills in forest inventory, the Rural Environmental Protection Scheme (REPS) and spatial resource inventory and design. Development and group presentation of individual GIS projects in ArcView.

Engineering properties of Biomaterials (2 Units) BSEN 4009
Engineering properties of biological materials with particular emphasis on materials of plant and animal origin as pertaining to biosystems engineering.

Renewable Energy Systems (1 unit) ELEN 4005
Aspects of renewable energy systems (e.g. windpower, hydropower, wavepower, photovoltaic conversion, direct solar heating, biomass, hydrogen as an energy vector, introduction to economic analysis).

Farm Management (1 unit) AERD 4600
Objectives and goals of the farm manager, farm management functions and organisation, farm family life cycle. Farm accounting definitions and analysis techniques, capital budgeting and investment appraisal, partial budgeting and whole farm planning and budgeting; enterprise budgets, direct payments, REPS and other State supports. Farm management controls, computerisation and IT; alternative enterprises, farm labour and risk analysis, part-time farming. Farm security and safety, management for quality production at farm level.

Chemical Engineering

Second Year

Course Code	*Course Title*	*ECTS Credits*
CHEN 2001	Chemical Engineering Measurement*	3
CHEN 2006	Chemical Engineering Process Principles II*	3
CHEN 2007	Chemical Thermodynamics and Kinetics*	5
CHEN 2008	Chemistry	5
MEEN 2008	Mechanics of Fluids	3
MEEN 2002	Mechanics of Materials	5
CHEN 2005	Biotechnology I	3
MATH 2604	Mathematics	11
EXPH 2607	Experimental Physics*	5
CHEN 2010	Computers in Chemical Engineering I*	4
CHEN 2012	Year's Work*	13
	Total	60

Third Year

Note: Third year students should note that in the assessment for the BE Degree the performance of candidates at both the Third and Final Examinations is taken into account in the following manner: An adjusted overall percentage mark will be computed by adding 30% of the percentage mark obtained at the first sitting of the Third Examination to 70% of the percentage mark obtained in the Final Examination. Ranking of students and the award of Honours in the BE Degree will be based on such adjusted overall percentage mark.

Course Code	*Course Title*	*ECTS Credits*
CHEN 3010	Unit Operations I*	5
CHEN 3002	Heat Transfer I and Mass Transfer*	4
CHEN 3003	Fluid Flow I	3
CHEN 3011	Chemical Engineering Design and Engineering Materials	4
EEEN 3027	Electrical Engineering	3
CHEN 3009	Applied Chemistry	5
CHEN 3008	Biotechnology II*	3
CHEN 3006	Chemical Engineering Thermodynamics*	5
MATH 3615	Pure and Applied Mathematics	8
MAPH 3014	Engineering Computation	3
CHEN 3012	Computers in Chemical Engineering II*	4
CHEN 3021	Year's Work*	13
	Total	60

Fourth Year

Course Code	*Course Title*	*ECTS Credits*
CHEN 4001	Unit Operations II*	7
CHEN4002	Reactor Design and Automatic Control*	7
CHEN 4003	Heat Transfer II and Fluid Flow II	7
CHEN 4004	Process Design	4
BMGT 4001	Management and its Environment	3
CHEN 4005	Chemical and Biochemical Engineering Processes*	4
CHEN 4009	Environmental Studies	4
CHEN 4007	Design Project*	12
CHEN 4008	Research Project*	12
	Total	60

Second Year

Chemical Engineering Measurement **CHEN 2001**

Principles of engineering measurement and experimentation; report-writing; data presentation and analysis; temperature measurement; pressure measurement; laminar and turbulent pipe flow; flow measurement; principles of fluid rheology; rotational

* Subject has associated coursework

viscometers; tank-tube viscometer; basic particle size analysis; introduction to centrifugal pumps; basic engineering statistics; histograms; probability density function; basics of probability; probability density functions; normal and lognormal distributions; confidence intervals on the mean and variance; hypothesis testing ;t-test, chi-squared test, f-test, p-values; one-way ANOVA.

Chemical Thermodynamics and Kinetics **CHEN 2007**

Thermodynamics: Introduction. The first law, stoichiometry and enthalpy balance problems. The second law, reversibility and irreversibility, the Carnot cycle, Clausius' theorem, entropy, entropy calculations. The Gibbs and Helmholtz functions. Equilibrium criteria. The fundamental property relations for a homogeneous fluid of constant composition. Maxwell's relations. The third law. The thermodynamics of open systems. Gas, steam and refrigeration cycles.

Chemical Kinetics: The rate equation. Analysis of kinetic data. The Arrhenius equation. Elementary and complex reactions. Batch and flow reactors. Physical and chemical adsorption. Adsorption isotherms. Measurement of surface area and pore size distribution. L-H and H-W models.

Chemistry **CHEN 2008**

Introduction to industrial and applied chemistry. Unit processes in organic synthesis and industrial applications. Laboratory work relating to the content of lecture courses.

Computers in Chemical Engineering I **CHEN 2010**

An applied programming course to introduce computer based problem-solving techniques. Students are expected to complete a number (6 to 8) of assignments covering a range of problems drawn from different areas of chemical engineering and which use selected numerical methods in their solution. Both Matlab® and Excel are used extensively throughout the course.

Mechanics of Fluids **MEEN 2008**

A continuation course on fluid flow from a physical viewpoint. Review of fluid properties. Fluid statics. Kinematics of fluid flow. Continuity equation. Stream function – two-dimensional-incompressible. Rotational and irrotational motion. Circulation. Equations of irrotational motion. Dynamics of fluids. Force, energy and momentum. Effects of pressure, weight, viscosity, turbulence and compressibility. Dynamic similitude. Boundary layers, surface drag, form drag. Turbo-machinery.

Biotechnology I CHEN 2005

Relevance of biochemistry, industrial microbiology and biotechnology to chemical engineering; biological catalysis; enzymes; protein structure and function; sugars and polysaccharides; macromolecules; DNA double helix; transcription and translation; the genetic code; control of expression; energy coupling; ATP; glycolysis; TCA cycle; electron transport; aerobic and anaerobic metabolism; higher organisms and cellular differentiation; microbial cells; microbial nutrition; microbial metabolism; microbial growth; microbial genetics; asepsis; applications.

Mechanics of Materials **MEEN 2002**

One-dimensional stress and strain. Biaxial stress. Principal stresses and strains in 2-D. Hookes Law. Strain gauges. Thin-walled pressure vessels. Torsion of circular shafts. Bending stresses and deflections. Buckling of slender bars.

Mathematics **MATH 2604**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Experimental Physics **EXPH 2607**

Two lectures a week during Michaelmas, Hilary and Trinity terms.
Thermal radiation, theory and application. Photons. Light as waves and particles. Quantisation of energy and momentum in atoms. Demonstration of quantised energy levels. Wavelike properties of particles. Wave mechanics and the Schrodinger equation. Time independent wave equation and applications. The one electron atom. Radiation and energy transitions. Atoms in magnetic fields. Anomalous Zeeman effect. Electron spin. Many electron atoms. Pauli exclusion principle. Emission and absorption. Introduction to statistical mechanics, microstates and macrostates. Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions. Applications to solids. Laser cooling of atoms and ions, Bose-Einstein condensation. Low-dimensional structures: quantum wells, wires and dots. Periodic structures. Lasers: Einstein coefficients, population inversion, feedback and cavity design. Diode lasers, quantum well and quantum cascade lasers. Magnetism, ferromagnetism, domains and boundaries, hysteresis, new magnetic materials. Laboratory: Four Laboratory experiments involving measurements of the physical quantities discussed in the course of lectures.

Year's Work **CHEN 2012**

Chemical Engineering Graphics: A practical introduction to computer-based drafting. Flow sheets in standard format and graphical presentations relevant to chemical engineering.

Chemical Engineering Laboratory I: A course of laboratory experiments and computing sessions designed to illustrate fundamental principles of chemical engineering, measurement and Chemistry. Experiments are undertaken in heat and mass transfer, fluidflow, liquid pumping, rheological characterisation and particle size distribution analysis. Chemical analysis – Volumetric and gravimetric methods. Electrochemistry – Conductance behaviour of electrolytes, the Nernst equation, potentiometric methods. Surface chemistry – Adsorption from solution, surface tension, ion exchange. Chemical kinetics – Reaction order, the Arrhenius equation. Instrumental analytical techniques – The use of conductance bridges, pH meters, potentiometers, ion activity meters, gas chromatography and atomic adsorption spectrophotometry.

Chemical Engineering Process Principles II **CHEN 2006**

Introduction to Transport Phenomena in Chemical Engineering Processes.

Third Year

Unit Operations ICHEN 3010

Momentum Transfer Operations**:** Fluid flow through packed beds, filtration, particle movement through a fluid, free and hindered setting, sedimentation, dust collection, air pollution control theory and technology.

Heat Transfer Operations: Humidification, operations, psychometric chart, humidity measurement, solids drying, rotary dryers, evaporation.

Heat Transfer I and Mass Transfer **CHEN 3002**

Heat Transfer I: Modes of heat transfer. Steady state conduction. Unsteady state conduction. Free and forced convection. Design of heat exchangers. Introduction to: boiling; condensation.

Mass Transfer: Molecular diffusion in gases and liquids. Diffusivity. Diffusion in turbulent flow. Analogies between heat, mass and momentum transfer. Interphase mass transfer. Mass transfer coefficients. Various theories of interphase mass transfer. Eddy diffusion. Diffusion in solids. Applications to chemical and biochemical engineering problems.

Fluid Flow I **CHEN 3003**

Flow measurement, pressure drop in heat exchanges and packed beds. Drag coefficients and particle trajectories. Two-phase pipe flow. Non-Newtonian fluids and power law flow. The classification and characteristics of pumps, fans and compressors. Agitator power requirements.

Chemical Engineering Design & Engineering Materials **CHEN 3011**

Chemical Engineering Design: Principles for safe design and operation of chemical process equipment.

Chemical Engineering Thermodynamics **CHEN 3006**

Introduction to the thermodynamics of multi-component systems. Molar and partial molar quantities. Experimental measurement of partial molar volume and partial molar enthalpy. Partial molar free energy. The Gibbs-Duhem equation. Phase equilibrium and reaction equilibrium criteria. The ideal gas mixture. The ideal solution. Fugacity, fugacity coefficient correlations. The Lewis and Randall rule. Excess properties, activity coefficients. The phase rule; phase behaviour in vapour-liquid, liquid-liquid and solid-liquid systems – the use of activity coefficient correlations and equations of state. Chemical reaction equilibria; equilibrium constants, the van't Hoff equation. Reactions in homogeneous and heterogeneous systems.

Computers in Chemical Engineering II **CHEN 3012**

An applied programming course to introduce computer based problem-solving techniques. Students are expected to complete a number (6 to 8) of assignments covering a range of problems drawn from different areas of chemical engineering and which use selected numerical methods in their solution. Both Matlab® and Excel are used extensively throughout the course.

Biotechnology II CHEN 3008

Properties and function of DNA; DNA polymerase; gene cloning; gene libraries; analytical techniques; vectors and hosts; choice of a vector; drug resistance genes; the lac operon; gene sequencing; overexpression systems; promotors; eukaryotic and prokaryotic genes; post-translational modification; codon usage; protein engineering; methods of selecting for mutant overwild-type; monitoring protein production; solubilisation and refolding; protein recovery; biospecific methods; PCR; introduction to ethics and patenting in Biotechnology; basic bioreactor technology; monitoring and control; stoichiometry of bioreactions; heat generation and mass transfer in bioreactors; shear effects in fermentation systems.

Applied Chemistry **CHEN 3009**

Study of selected topics in industrial and applied Chemistry.

Electrical Engineering **EEEN 3027**

DC circuit analysis. AC circuit analysis. Energy power, reactive power, phasor analysis applied to single phase circuits. Power factor correction. Series resonance. Operational amplifier and applications. Elementary active and passive filters. Phasor analysis of three phase circuits. Power measurement in three phase circuits. Magnetic circuits. Operating principle of the single phase transformer. Equivalent circuit of the transformer. Rotating fields in three phase machines. Operating principle of the three phase induction machine. Development of the equivalent circuit of the three phase induction machine. Starting and speed control of induction motors. Electrical safety. Protection. Codes of Practice. Electrical safety in potentially flammable atmospheres.

Engineering Computation **MAPH 3014**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential

equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Pure and Applied Mathematics **MATH 3615**

Mathematics (LT, FS and CV) ***MATH 3601***

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equation, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat) engineering applications'. Introduction to theory of functions of a complex variable (CV). Cauchy-Riemann equations. Harmonic functions. Conformal mappings. Cauchy integral formulae.

Mathematics (Integral Calculus) ***MATH 3602***

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stokes' theorem. Applications.

Mathematical Physics (Module D – Differential Equations) ***MAPH 3024***

Review of ODEs and their solution. Systems of coupled linear differential equations (Solution, Critical points, Stability). Types of Partial Differential Equations (1st order forms, 2nd order forms (Heat, Diffusion, Wave, Poisson, Laplace equations), their origins and derivation). Boundary Conditions. Methods of solution of 1st order PDEs (Method of Characteristics-Domains of Influence). Methods of solution of 2nd order PDEs (Separation of Variables, Fourier, Laplace, Fourier Sine, Fourier Cosine). Engineering examples.

Year's Work **CHEN 3021**

Chemical Engineering Laboratory II: A course of laboratory experiments designed to illustrate fundamental chemical engineering and chemical principles and to afford experience of selected unit operations. A written report, detailing measurements, results, discussion and conclusion to be submitted for each experiment.

Fourth Year

Unit Operations II **CHEN 4001**

Calculation methods for multi-stage mass transfer operations. Liquid-liquid extraction. Leaching. The air-water system. Drying mechanisms. Design of water cooling towers and humidification processes. Multicomponent separation processes. Batch distillation. The design of trays and other column contacting devices.

Reactor Design and Automatic Control **CHEN 4002**

Reactor Design: Design of batch, continuous plug-flow, and stirred tank reactors for single and multiple reaction schemes. Non-catalytic and catalytic heterogeneous reactions and reactor design for heterogeneous systems. Mixing and residence time distribution concepts. Unsteady state operation of continuous stirred tank reactors. Non-isothermal reactor performance. Selected examples from chemical engineering and biochemical engineering reactor design.

Automatic Control: Feedback. Transfer functions. Characteristic equations and root locus. Routh-Hurwitz stability. Bode and Nyquist diagrams. State space analysis. Liapunov stability. Pontryagin's maximum principle. Sampled data systems. Microcomputer-based control systems.

Heat Transfer II and Fluid Flow II **CHEN 4003**

Heat Transfer II: Radiant heat exchange. Radiation from gases. Boiling liquids. Condensing vapours. Analysis of heat transfer by convection. Design of heat transfer equipment.

Fluid Flow II: The Navier-Stokes equations. Applications to film flows and viscometric flows. Potential flow. Boundary layer theory. Theories of turbulence. Fluid-particle interactions. Applications to process equipment design. One-dimensional compressible flow in pipes, nozzles and diffusers. Choked flow.

Process Design CHEN 4004

The design method. Chemical engineering specifications. Factories Act. Patents. Process simulation. Capital and operating costs of process plants. Project evaluation methods. Uncertainty and risk in process design. Safety in design and operation of plants. Loss prevention.

Chemical and Biochemical Engineering Processes **CHEN 4005**

A selection from the following topics: Energy management in process plants. Multicomponent distillation. Absorption with chemical reaction. Adsorption. Chromatography. Membrane separation processes. Ion-exchange. Surface phenomena. Sterilisation and pasteurisation. Fermentation processes. Bioreactor performance.

Environmental Studies **CHEN 4009**

Selected topics from the following:

Air Pollution: Introduction. The nature of air pollution. Effects on human health, fauna and materials. Global effects. Monitoring of source and ambient levels of gaseous and particulate pollutants. Outline of current control technologies. Gaussian plume dispersion models. Use of US EPA software. EU and Irish legislation.

Water Pollution: Description of a river in its natural state and the chemical cycles in nature. Chemical tests and analysis of river water and effluents and the significance and interpretation of the results; the nature and effects of water pollution; causes of pollution with particular reference to the results of surveys carried out in Ireland; mathematical models of river pollution and recovery; water quality standards and legislation; effluent treatment models; case studies.

Waste Disposal: Waste Management Act (1996). Definition of Waste and Hazardous Waste. National Waste Database. Waste Flows in Ireland. National Hazardous Waste Management Plan. Methodologies used for the collection of information on waste arisings and disposal/recovery practices. European Waste Catalogue and Hazardous Waste List. Waste Minimisation. Hazardous Waste Incineration. Thermo-chemistry and stoichiometry of incineration reactions. Liquid Injection and Rotary Kiln Incinerator Design. Emission Control. Dioxins. Landfilling of Hazardous Wastes.

Management and its Environment **BMGT 4001**

The Irish economy, its institutions and international relationships. The firm and its environment. Organisational objectives and corporate behaviour. Economic concepts. Market structure and the competitive process. Demand analysis. Forms of organisation, private and public bodies. Management, its nature and functions – Planning, organising, directing, controlling. Financial management. Presentation and analysis of financial statements. Forecasting. Working capital. Capital budgeting. Financial institutions. Marketing management. Market research. Product life cycle. Product mix. Marketing mix. Operations management. Concept of a system. System design, planning and control. Personnel management. Industrial relations. Trade unions. Collective bargaining.

Design Project CHEN 4007

Students undertake a design project which includes the preparation of flow sheets, material and energy balances, detailed design, mechanical design and the preparation of process instrumentation drawings. Safety, loss prevention and environmental impact are included in the design. Capital and operating costs of the plant are evaluated.

Research Project CHEN 4008

Students working singly or in pairs undertake a research project.

Civil Engineering

Second Year

Course Code	*Course Title*	*ECTS Credits*
CVEN 2006	Mechanics of Solids	6
MEEN 2008	Mechanics of Fluids	6
CVEN 2002	Surveying	6
CVEN 2003	Building Construction	6
CVEN 2001	Introduction to Biosystems	6
CVEN 2007	Computer Applications in Civil Engineering	4
CVEN 2004	Engineering Materials I	4
MEEN 2009	Engineering Materials II	4
MATH 2600	Mathematics	8
CVEN 2020	Year's Work	10
	Total	60

Third Year

Course Code	*Course Title*	*ECTS Credits*
CVEN 3004	Theory of Structures	7
CVEN 3005	Design of Structures	7
CVEN 3001	Hydraulics	7
CVEN 3002	Engineering Economy	6
CVEN 3003	Soil Mechanics	7
CVEN 3020	Year's Work	12
MAPH 3034	Engineering Computation	3
MATH 3613	Mathematics	5
MATH 3614	Mathematics	
MAPH 3025	Mathematical Physics	
GEOL 3611	Geology	6
	Total	60

Fourth Year

The academic programme for the Fourth Year of the Civil Engineering degree programme consists of four core subjects and two elective subjects. Candidates must choose the elective subjects in which they propose to present themselves for examination, in consultation with the Head Of Subject. The number admitted to any elective subject will be limited to thirty (30). Admission to any particular elective subject will depend on performance in the Third Year Examination.

Course Code	*Course Title*	*ECTS Credits*
Core Subjects		
CVEN 4001	Civil Engineering Design	25
CVEN 4002	The Engineer and Society	7
CVEN 4020	Engineering Report Course Work	14
Elective Subjects		
Each of the following seven courses constitutes one full elective subject.		
CVEN 4003	Structural Modelling	7
CVEN 4004	Structural Design	7
CVEN 4005	Soil Mechanics and Geotechnical Engineering	7
CVEN 4006	Transportation Operations and Planning	7
CVEN 4010	Hydraulic Engineering Design	7
CVEN 4008	Unit Treatment Processes in Water Engineering	7
Each of the following courses constitutes half an elective subject; any two may be selected as comprising an elective subject.		
MATH 4601	Mathematics	3.5
MATH 4602	Mathematics	3.5
	Total	60

Second Year

Mechanics of Solids — CVEN 2006

Force equilibrium. Statically determinate structures. Trusses and planar frameworks. Rigid bodies supported on deformable supports. Statically indeterminate structures. Concepts of stress and strain. Stress-strain behaviour. Bulk modulus and shear modulus. Plane stress and plane strain. Transformation of axes and the Mohr circle. Principal stresses. Strain energy. Case studies in stress. Bending, shear and torsional stresses in beams. Stress trajectories. Effects of plasticity. Deflection analysis. Buckling of struts. Factors of safety.

Mechanics of Fluids — MEEN 2008

A continuation course on fluid flow from a physical viewpoint. Review of fluid properties. Fluid statics. Kinematics of fluid flow. Continuity equation. Stream function – Two-dimensional-incompressible. Rotational and irrotational motion. Circulation. Equations of irrotational motion. Dynamics of fluids. Force, energy and momentum. Effects of pressure, weight, viscosity, turbulence and compressibility. Dynamic similitude. Boundary layers, surface drag, form drag. Turbo-machinery.

Surveying — CVEN 2002

Survey instruments and their use in plane surveying. Base line measurements, triangulation, calculation and adjustment of traverses. Contouring and topographic survey. Hydrographic surveys. Circular transition and vertical curves. Cross-section and earthwork quantities. Tacheometry, subtense measurement, electronic distance measurement.

Building Construction **CVEN 2003**

Fundamentals of building construction for domestic, industrial and commercial buildings, planning, Building Control and legislation. Site preparation, foundations, ground and suspended floors, roofs, walls, stairs, Radon gas, cost estimating and critical path method scheduling. Construction materials, timber, concrete, structural steelwork, dampness, fire protection, finishes. Water supply, drainage, sewage disposal, heating and ventilation, insulation, condensation, energy use. Site organization, plant and equipment, temporary works.

Introduction to Biosystems **CVEN 2001**

(For Agricultural & Food, Chemical and Civil Engineering students)

Definitive properties and levels of organisation of living systems. Chemical composition of living systems. Cell metabolism. Origin of life-metabolic evolution. Diversity of life forms. Animal and plant tissues and organs. Physiological systems. Protists. Nutrient requirements of organisms. Populations, communities and ecosystems. Biogeochemical cycles. Emergence of man. Impact of man on the biosphere. Social implications of recent advances in biology.

Computer Applications in Civil Engineering **CVEN 2007**

Programming in Visual Basic: control structures, user-friendly interface development, graphical applications, implementation of engineering mathematical examples, developing stable programmes. Using Visual Basic with Applications. Introduction to Visual Fortan. Control structures. Using spreadsheets: general orientation, equation manipulation, graphs, goal seek, solver, matrix inversion, macros.

Engineering Materials I **CVEN 2004**

Timber: structure, strength and durability, manufactured products. Cements: manufacture, types, uses, hydration process. Aggregates. Concrete: structural properties, durability. New and emerging engineering materials. Soils: origin, description/classification. Mass, volume and basic relationships. Microstructure of clayey materials. Compaction suitability criteria for soils in earthworks. Bituminous Materials.

Engineering Materials II **MEEN 2009**

Introduction to Materials, their classification and selection. Fundamentals of material structure and properties. Mechanical properties and their measurement. Introduction to failure mechanisms, ductile and brittle failure, creep and fatigue. Introduction to iron and steel, carbon in steel, the iron/iron carbide phase diagram, types and properties of steels. Welding, weldable structural steel, the heat affected zone, weldability and weld defects. Non-destructive examination, principles and methods. Corrosion, stainless steels. Surface treatment.

Mathematics **MATH 2600**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem.

Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Year's Work — CVEN 2020

Engineering Laboratory. An integrated course of laboratory experiments designed to illustrate the fundamental principles dealt with in lectures and the fundamental principles of engineering measurement.

Graphics and Design: Development of computer-aided drafting skills. Specific topics: working units and co-ordinate systems; seed files, cells and reference files; menus, dialogue boxes, drawing tools and controls; input and output systems; elements – attributes, association, groups; complex and multiline elements; element manipulation and modification; levels; auto-dimensioning; patterning and rendering. Introduction to 3-D modelling.

Engineering Project Work: Students will be required to carry out exercises in oral and written communications.

Third Year

There are no lectures in the third term of Third Year to facilitate industrial placements or study periods in other universities. Examinations will take place after the second term.

Theory of Structures — CVEN 3004

Structural forms and quantitative analysis. Role of the modern structural engineer. Manual vs computer aided design/analysis. Behaviour resistance of structural sections from zero load to collapse for steel, concrete and timber. Analysis for stress resultants of statically determinate structures. Virtual work theorems. Deformation analysis of frameworks.

Stiffness and flexibility formulation for statically indeterminate planar structures. Influence lines. Simple plastic theory. Introduction to buckling. Laboratory experiments designed to illustrate the principles of structural analysis and the properties of materials.

Design of Structures **CVEN 3005**

Codes of practice. Building regulations. Actions on structures including wind load. Design resistance. Load factors. Steel: Steel as a structural material and its use in building. Design of steel beams, girders, trusses, stanchions and simple frames. Design of steel connections. Concrete: Reinforced concrete as a structural material. Design of beams and slabs, columns and column bases and simple statically indeterminate structures. Retaining walls. Timber: Timber as a structural material. Introduction to the design of timber structures.

Hydraulics **CVEN 3001**

Calculation and design for pressure conduits and open channels. Hydraulics of pressure conduits, flow in pipe networks, unsteady flow in pipes. Hydraulic machines including pumps and turbines. Non-uniform flow in open channels; critical depth and hydraulic jump; control sections and transitions in open channels. Groundwater hydraulics of wells, drains and ditches. Elementary physical hydrology: The hydrological cycle and water balances; precipitation; evaporation and transpiration; infiltration and percolation; groundwater storage and outflow; surface runoff.

A course of laboratory experiments illustrating the principles of flow in pressure conduits and open channels. Problems related to the subject matter of the lectures.

Engineering Finance **CVEN 3007**

Management Accounting & Finance:

Management accounting. Cost allocation and absorption. Product costing. Budgeting, responsibility, accounting and motivation. Capital budgeting techniques. Decision-making: cost-volume-profit relationships. Financial analysis. Accounting conventions; statements of standard accounting practice: ratio analysis; financial ill-health (through trading losses, overtrading etc.); capital structure.

Microeconomics with applications in Transportation:

Demand analysis, regulation of transport firms & industries, congestion pricing and the application of cost-benefit analysis.

Public Procurement processes:

General characteristics of various types of procurement, EU regulations and procedures. Risks in Design, construction, operations & maintenance. Value engineering, negotiated change and value for money. Construction Contracts. Project Finance & PPP.

Soil Mechanics CVEN 3003

Soil mechanics problems and their solution. Stresses in soils, Stresses due to applied loads, Stress-strain behaviour. Shear strength of cohesive and cohesionless soils. Total and effective stresses. Excess pore water pressure. Steady state flow and permeability. Earth pressure and rigid earth retaining structures. Bearing pressures and bearing

capacity of foundations. Transient pore water pressure and deformation Consolidation theory. Settlement of foundations. Elastic settlement, allowable building tolerances. Laboratory testing.

Year's Work **CVEN 3020**

Analytical, design and laboratory exercises complementary to the lecture programme in hydraulics, soil mechanics and structures; practical work in surveying, computation and CAD.

Engineering Computation **MAPH 3034**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Pure and Applied Mathematics **MATH 3617**

Mathematics [LT-FS] ***MATH 3613***

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equation, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat), engineering applications.

Mathematics (Integral Calculus) ***MATH 3614***

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stokes' theorem. Applications.

Mathematical Physics (Differential Equations) ***MAPH 3025***

Ordinary differential equations. Linear systems of first order. Phase plane. Singular points. First order p.d.e. How they arise. Sketching characteristics. Solutions. Second order p.d.e. How they arise. Characteristics. Wave and diffusion equations. Motivation for different initial or boundary value problems. Properties of solutions.

Geology **GEOL 3611**

The course provides a general introduction to (a) Geology and geological processes, (b) the application of Geology to Civil Engineering, (c) the methodology for geologically-based site investigation and (d) Engineering Geology problems and Geotechnical solutions. Lectures deal with mineralogy, rock types, tectonics, weathering processing and geomorphology, hydrology and engineering geology (geological aspects of site investigation, slopes, foundations, dams/reservoirs and tunnels). Laboratory-based practical classes deal with mineral and rock identification and map work. Two field classes examine the geological and engineering aspects of Killiney and Bray Head.

Civil Engineering Design CVEN 4001

(a) Preliminary Design of Structures

Qualitative structural behaviour and load paths. Choice of structural material. Preliminary sizing of reinforced concrete members.

(b) Engineering Materials

Elasticity. Stress and strain tensors. Stress function. Plane stress and plane strain problems. Inelastic behaviour. Yield criteria. Plasticity. Viscoplasticity. Viscoelasticity. Composites. Polymers and ceramics. Engineering uses. Fatigue life. Brittle and ductile fracture. Properties of cements, aggregates and concrete. Specification and testing of concrete specimens and products. Design of concrete mixes. Placing of concrete. Highway materials (see under (g)).

(c) Civil Engineering Systems

General systems. Planning and design as conceptual systems. Physical planning and civil engineering systems. Goals and objectives. Projecting the system. Models, networks and continua. Simulation and optimisation. Implementation and evaluation.

(d) Design of Structures

Elastic and elastic-plastic structural analysis & plastic moment redistribution. Prestressed concrete. Analysis and design of slabs. Columns and interaction diagrams. Masonry design. Structural steel design. Composite construction.

(e) Design in Soils Engineering

Site investigation. Harmful constituents in soils. Bearing capacity and deformation of granular and cohesive soils. Shallow and deep foundations. Piles in granular and cohesive soils. Settlement of piled foundations. Pile testing. Flexible earth retaining structures. Sheet piled walls. Reinforced earth. Geotextiles. Stability of highway embankments and cuttings. Case histories. Laboratory testing.

(f) Design of Water Resource Systems

Elements of applied hydrology. Water quantity requirements for domestic and industrial uses. Water sources and their development. Quality of natural waters. Quality standards for potable and industrial water supplies. Water purification processes. Water distribution. Design of sewer systems. Purification of domestic and industrial wastes. Control of water pollution. Atmospheric pollution. Refuse disposal.

(g) Design in Highway Engineering

Properties of highway materials, such as bitumens and aggregates. Specification, testing and quality control of highway construction. Compaction and stabilisation techniques to improve material properties. Design off road drainage and road foundations. Bituminous mix design. Design and management of pavements, including the maintenance of skid resistance. Geometric design of roads and junctions for safety and capacity.

The Engineer and Society CVEN 4002

(a) Engineering Law

Contract law. The promoter-engineer-contractor relationship. The engineer's responsibilities as agent and as arbitrator. The contract form.

(b) Professional Practice

Civil engineering procedure. Various forms of contract. Contract documents, drawings, specifications, bills of quantities, schedules. Sources and presentation of technical information. Report writing. Learned societies and professional bodies.

(c) Environmental Appraisal

Sustainable Development, Statutory Environmental Conservation, Stage of Appraisal, Public Consultation/Stakeholder Communication, EIS Principles and Assessment, Statutory Processes.

(d) Urban and Regional Planning

Law, administration, infrastructure, architecture, landscape design, conservation.

Engineering Report & Course Work CVEN 4021

Engineering Report

Each student must submit a report containing the results of a special project involving experimentation or analysis or design.

Course Work

Each student is required to complete a set of civil engineering design assignments.

Electives:

Structural Modelling CVEN 4003

Approximate methods of analysis using vector and energy approaches. Stiffness formulation. Finite Element analysis. Elastic Plastic Response. Dynamic response. Buckling analysis. Structural Forms – rings, arches, vaults, grillages, plates. Application of computer software. Analysis for material and geometric non-linearity.

Structural Design CVEN 4004

Sources and assessment of structural loading. Design criteria. Selection and control of materials and workmanship. Comparison of elastic and plastic design. Limit state design in reinforced concrete, structural steelwork and timber. Structural masonry. Structural steel and reinforced concrete frameworks and continua. Applications of prestressed concrete and composite steel/concrete construction. Design of timber structures. Design for fire.

Soil Mechanics and Geotechnical Engineering CVEN 4005

Introduction to critical state soil mechanics. Elasticity, plasticity and yielding. Soil models. Characteristic soil parameter values. Partial safety factors and Eurocode 7. Shallow foundations. Raft foundations. Piled/raft foundations. Pile design/construction in Ireland. Ground improvement. 1D compression by tangent modulus approach. Settlement of structures. Structural tolerance to movement. Recent developments in retaining wall analysis and design. Tunnels and tunnelling. Propping, ground anchorages and soil nailing.

Transportation Operations and Planning **CVEN 4006**

Nature of transportation problem. Characteristics of demand and of transport systems. Steps in transportation planning process, generation, distribution, model choice and assignment models. Models to describe behaviour of road links, junctions, bottlenecks and public transport systems. Safety and environmental problems resulting from transportation. Parking characteristics, parking and road solutions for Irish towns. Land use, location and transportation. Development control aspects of transportation.

Hydraulic Engineering Design **CVEN 4010**

Hydrologic design. Dam ancillary works. Stormwater drainage design. River engineering. Pumping station design. Coastal engineering.

Unit Treatment Processes in Water Engineering **CVEN 4008**

Water chemistry, biology and analysis. Principles of sedimentation, flotation, filtration, aeration, flocculation, water softening, demineralisation. Biological processes. Design of water and wastewater treatment processes.

Mathematics **MATH 4601**

A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Mathematics **MATH 4602**

A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Electronic and Electrical Engineering

Second Year Electronic and Electrical Engineering

Course Code	*Course Title*	*ECTS Credits*
EEEN 2003	Circuit Theory 1	*5*
EEEN 2004	Electromagnetics 1	*5*
EEEN 2005	Electronic Circuits 1	*5*
EEEN 2007	Principles of Electrical Energy	*5*
EEEN 2002	Solid State Electronics 1	*5*
MEEN 2001	Applied Dynamics	*5*
MATH 2600	Mathematics	10
EXPH 2605	Experimental Physics*	*5*
EEEN 2020	Year's Work	10
	Total	60

Third Year Electronic and Electrical Engineering

Note: Third year students should note that in the assessment of the BE (Electrical) Degree, the performance of candidates at both the Third and Fourth Year Examinations is taken into account in the following manner:

A scaled percentage of the total mark obtained at the first sitting of the Third Year Examination is added to the total mark obtained in the Fourth Year Examination. The additional mark represents a maximum of 20% of the adjusted overall mark. In the BE Degree, a pass or fail decision is based on the results of the fourth year Examinations, while the ranking of candidates and the award of honours is based on the adjusted overall mark.

Course Code	*Course Title*	*ECTS Credits*
EEEN 3005	Circuit Theory 2	4
EEEN 3006	Electronic Circuits 2	*5*
EEEN 3011	Electrical Machines and Power Systems	*7*
EEEN 3012	Linear Systems: Analysis and Control	*7*
EEEN 3007	Communication Theory 1	4
EEEN 3008	Electromagnetics 2	4
EEEN 3003	Solid State Electronics 2	*5*
EEEN 3002	Computer Engineering 2	4
MAPH 3014	Engineering Computation	3
MATH 3602 MATH 3603 MAPH 3024	Mathematics (Module B) Mathematics (Module C) Mathematical Physics (Module D)	*7*
EEEN 3020	Year's Work	10
	Total	60

Fourth Year Electronic Engineering

Course Code	*Course Title*	*ECTS Credits*
EEEN 4001	Electronic Circuits 3	4
EEEN 4002	Control Systems	4
EEEN 4003	Optoelectronics and Filters	4
EEEN 4004	Digital Signal Processing	4
ECEN 4001	Antennas and Propagation	4
ECEN 4002	Communication Theory 2	4
ECEN 4003	Digital Electronics	4
ECEN 4004	RF Circuits and Systems	4
ECEN 4020	Year's Work	16
Electives:		
(At least ***four*** of the following to be chosen from the permitted combinations with the approval of the Head of Subject)		
ECEN 4007	Microwave Engineering	3
ECEN 4006	Digital Communications	3
EEEN 4005	Biomedical Engineering	3
ECEN 4005	Communication Systems	3
EEEN 4008	Optoelectronics	3
EEEN 4015	Optical Engineering	3
EEEN 4012	Applications of Digital Signal Processing	3
MATH 4602	Mathematics 2	3
MATH 4603	Mathematics 3	3
BMGT 4001	Management and its Environment	3
COMP 4623	Hardware/Software Co-Design	3
	Total	60

Fourth Year Electrical Engineering

Course Code	*Course Title*	*ECTS Credits*
EEEN 4001	Electronic Circuits 3	4
EEEN 4002	Control Systems	4
EEEN 4003	Optoelectronics and Filters	4
EEEN 4004	Digital Signal Processing	4
ELEN 4011	Electrical Machines	4
ELEN 4015	Power System Dynamics and Control	4
ELEN 4016	Power System Economics	4
ELEN 4004	Power Electronics	4
ELEN 4020	Year's Work	16
Electives:		
(Credit will be given for ***four*** of the following to be chosen from the permitted combinations with the approval of the Head of Subject)		
ELEN 4006	Advanced Electrical Machines	3
EEEN 4005	Biomedical Engineering	3
ELEN 4005	Renewable Energy Systems	3
ELEN 4007	Power Electronic Systems	3
EEEN 4008	Optoelectronics	3
ELEN 4014	Power System Transient Analysis and Protection	3
EEEN 4012	Applications of Digital Signal Processing	3
MATH 4602	Mathematics 2	3
MATH 4603	Mathematics 3	3
BMGT 4001	Management and its Environment	3
	Total	60

Second Year Electronic and Electrical Engineering

Circuit Theory 1 EEEN 2003
Elementary network theory. Theory of two-port networks. Electric transients. Alternating current theory with complex number analysis.

Electromagnetics 1 EEEN 2004
Coulomb's law, Gauss' law. Electric potential. Energy and forces in the electric field. Magnetic field. Electromagnetic induction. Energy and forces in the magnetic field.

Electronic Circuits 1 EEEN 2005
Modelling, DC analysis and small-signal analysis. The PN-junction as a circuit element; rectification and power supplies. Models of the bipolar junction transistor, JFET and MOSFET. Large- and small-signal applications of BJTs and FETs: combinational logic, single-stage amplifiers, frequency response.

Principles of Electrical Energy EEEN 2007
Energy conversion processes in electrical power systems. The ideas of generation, transmission and distribution. Power transfer under sinusoidal conditions, via the phasor

representation. Active and reactive power, and power factor correction. Principles, applications and limitations of transformers, from ideal to real. Selected dc and ac machines introduced via fundamental electromagnetic principles, with emphasis on energy conversion. The elements of three-phase analysis, including power in balanced systems and the basic principles of symmetrical components.

Solid State Electronics 1 **EEEN 2002**

Introductory Quantum Mechanics. Energy levels and energy bands for solids. Fermi-Dirac statistics and Fermi level. Conduction in metals. Intrinsic and extrinsic semiconductors. Conductivity and mobility of carriers. Excess carriers; minority and majority conduction, lifetime and diffusion. Semiconductor junctions, including introduction to bipolar transistors, FETs and other devices.

Applied Dynamics **MEEN 2001**

(For Agricultural & Food, Electronic & Electrical and Mechanical Engineering Students)

Three-dimensional force systems: resultants and equilibrium. Topics in friction. Particle kinematics. Plane kinematics of rigid bodies. Plane kinetics of rigid bodies: force and acceleration; impulse and momentum; work and energy. Vibration, free and forced. Central force motion

Computer Engineering 1 **EEEN 2001**

(a) The C Programming Language

Types, operators and expressions. Input/output. Functions and flow of control. Arrays and strings. Dynamic storage allocation. Structures.

(b) Software Engineering

Program design language. Structured programming. Data abstraction.

(c) Algorithms and Data Structures

Linked lists. Pushdown stacks. Queues. Trees.

(d) Digital Electronics

Boolean algebra. Combinatorial logic and the Karnaugh map. Flip-flops and digital memory. Introduction to synchronous design.

Mathematics **MATH 2600**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Experimental Physics EXPH 2605

Two lectures a week during Michaelmas, Hilary and Trinity terms.
Thermal radiation, theory and application. Photons. Light as waves and particles. Quantisation of energy and momentum in atoms. Demonstration of quantised energy levels. Wavelike properties of particles. Wave mechanics and the Schrodinger equation. Time independent wave equations and applications. The one electron atom. Radiation and energy transitions. Atoms in magnetic fields. Anomalous Zeeman effect. Electron spin. Many electron atoms. Pauli exclusion principle. Emission and absorption.

Introduction to statistical mechanics, microstates and macrostates. Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions. Applications to solids. Laser cooling of atoms and ions, Bose-Einstein condensation. Low-dimensional structures: quantum wells, wires and dots. Periodic structures. Lasers: Einstein coefficients, population inversion, feedback and cavity design. Diode lasers, quantum well and quantum cascade lasers. Magnetism, ferromagnetism, domains and boundaries, hysteresis, new magnetic materials.

Laboratory: Four Laboratory experiments involving measurements of the physical quantities discussed in the course of lectures.

Year's Work EEEN 2020

The material presented in courses EEEN 2001 to EEEN *2007* is supplemented by laboratory classes and tutorials in Electrical and Electronic Engineering. These classes constitute the subject *Year's Work*.

Third Year Electronic and Electrical Engineering

Circuit Theory 2 EEEN 3005

Further treatment of two-port networks, including the scattering matrix. Modified nodal analysis. Elements of network topology. Transient and steady state circuit analysis using the Laplace transform. Sinusoidal steady state and transient analysis of transmission lines.

Electronic Circuits 2 **EEEN 3006**

Single- and two-transistor stages. Current mirrors and active loads. Output stages. Operational amplifiers; linear and non-linear operational amplifier applications. Frequency response. Power electronics. Introduction to data converters.

Electrical Machines and Power Systems **EEEN 3011**

Introduction to ideal magnetic circuits. Elementary treatment of eddy currents, hysteresis and magnetic saturation in magnetic circuits. Development of an electrical equivalent circuit for the single phase transformer. Analysis of losses, efficiency and regulation in circuits containing transformers. Fundamental operation of DC machines leading to the development of an electrical equivalent circuit and analysis of DC machines in various circuit configurations. Idealised treatment of distributed windings and calculation of flux distributions and inductances. Rotating fields in three phase machines. Operation of synchronous machines and development of elementary equivalent circuit. Introduction to the analysis of machine operation when connected to power systems. Fundamental operating mechanism of the three phase induction motor and the development of the electrical equivalent circuit leading to the elementary determination of the terminal characteristics of the induction motor.

Function and characteristics of interconnected power systems. Power, reactive power, complex power. Per unit system. Three phase systems. Synchronous machine steady state model. Power transformer steady state model. Resistance, inductance and capacitance of three phase transmission lines. Effects of transposition and bundling. Transmission line steady state models. Steady state stability limit. Surge impedance loading. Formulation and solution of the power flow equations for a multibus system. Symmetrical fault analysis in a multibus system. The method of symmetrical components. Elementary asymmetrical fault analysis.

Linear Systems: Analysis and Control **EEEN 3012**

Signals. Linear Systems. Orthonormal Systems. Fourier Series. Fourier Transform. Convolution. Autocorrelation and Crosscorrelation. White noise. Laplace Transform. Transfer Function. Block Diagrams. Inverse Laplace Transform. Solution of linear, constant coefficient, ordinary differential equations. Performance and pole locations. Routh-Hurwitz Stability Criterion. Root Locus. Frequency Response. Bode Plots. Nyquist Stability Criterion. Sampling Theory. Discrete time signals and systems. Z Transform. Inverse Z Transform. Solution of linear, constant coefficient, ordinary difference equations.

Communication Theory 1 **EEEN 3007**

Introduction to communication systems, signals and channels. Amplitude and angle modulation. Pulse modulation. Digital transmission. Noise and its effects on these systems.

Electromagnetics 2 **EEEN 3008**

Maxwell's equations; Solutions for Maxwell's equations in insulating and conducting media; The Poynting vector; Boundary phenomena; Propagation in ionised gases; Guided propagation; The rectangular waveguide.

Solid State Electronics 2 **EEEN 3003**

Further treatment of PN-junctions, bipolar and FET transistors, including non-idealities, switching behaviour, static, small- and large-signal models. Transistor structures for power, high frequency and integrated circuit applications. Main bipolar and MOS logic families. Introduction to compound semiconductors, quantum devices and heterostructures.

Computer Engineering 2 **EEEN 3002**

(a) Algorithms, Data Structures, and Introduction to Object-Oriented Design

Recursion. Divide-and-conquer algorithms. Sorting Algorithms. Analysis of algorithms and O-notation. Introduction to Object-Oriented Design.

(b) Computer Architectures

Introduction to assembly language. Basic computer architecture. Instruction word formats. Addressing modes. Structure of basic RISC and CISC processors. Interrupts. Serial communications – synchronous and asynchronous. Microcontrollers and peripherals.

Engineering Computation **MAPH 3014**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Pure and Applied Mathematics **MATH 3612**

Mathematics (Module B – Integral Calculus) ***MATH 3602***

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stoke's theorem. Applications.

Mathematics (Module C – Complex Variables) ***MATH 3603***

Cauchy-Riemann equations, Cauchy's Integral Theorems, Taylor and Laurent expansions, Residues, Principle of the argument, stability criteria.

Mathematical Physics (Module D – Differential Equations) ***MAPH 3024***

Review of ODEs and their solution. Systems of coupled linear differential equations (Solution, Critical points, Stability). Types of Partial Differential Equations (1st order forms, 2nd order forms (Heat, Diffusion, Wave, Poisson, Laplace equations), their origins and derivation). Boundary Conditions. Methods of solution of 1st order PDEs (Method of Characteristics-Domains of Influence). Methods of solution of 2nd order PDEs (Separation of Variables, Fourier, Laplace, Fourier Sine, Fourier Cosine). Engineering examples.

Year's Work **EEEN 3020**

The material presented in courses EEEN 3001 to EEEN 3012 is supplemented by laboratory classes in Electrical and Electronic Engineering and in the computer solution of engineering problems.

Electronic Circuits 3 **EEEN 4001**

Principles of feedback including formal two-port analysis and example feedback circuits. Stability of feedback amplifiers, dominant pole and pole-zero compensation. Oscillators: Barkhausen criterion, control of amplitude with large signal gain, general oscillator configuration, crystal oscillator and Wien bridge oscillator. Active filters: Sallen-Key, MFB, state-variable and bi-quad. Phase locked loop, analysis of transient and steady state response. Analogue signal processing circuits: instrumentation amplifiers, chopper stabilised amplifiers, analogue multipliers, V-F and F-V converters. Noise: sources of noise, Johnson noise, Shot noise, available noise power. Noise modelled by voltage and current source (e_n&i_{in}) at input, equivalent input noise for BJT and differential amplifier.

Control Systems EEEN 4002

Modern control theory; state space; observability, controllability and stability; eigenvalue assignment, linear optimal control. Digital control theory: basic principles; discretisation schemes; sample period selection; deadbeat control; observers; stability.

Optoelectronics and Filters **EEEN 4003**

Introduction to optoelectronics; LEDs, lasers, photodetectors.

Analogue filters: transfer functions; approximation problem; realisation of normalised lowpass filters; scaling and transformations; design procedure. Digital filters.

Digital Signal Processing **EEEN 4004**

Discrete Fourier Transform. Fast Fourier Transform. Discrete convolution. Discrete-time linear systems. FIR and IIR digital filters. Finite arithmetic effects.

Antennas and Propagation **ECEN 4001**

Principles of antennae for use from the low frequency to the microwave region of the spectrum, and the factors influencing radio wave propagation in the same range.

Communication Theory 2 **ECEN 4002**

Further treatment of analogue and PCM communications. Principles of digital transmission. Random signal theory. Detection of signals in noise. Decision theory. Introduction to information theory.

Digital Electronics **ECEN 4003**

Logic Families-switching characteristics, noise margins, power dissipation. IC design methodologies and circuit layout. Clocking Schemes and dynamic logic. ASIC design-PLAs, standard cell, gate array, FPGA, full custom. Introduction to VHDL. Combinational logic design. Synchronous and asynchronous sequential logic systems.

RF Circuits and Systems **ECEN 4004**

Radio-frequency electronic circuits and the building blocks of electronic communication systems. Transmission lines. Noise. High-frequency active devices and circuit design. Frequency generators. Radio transmitters and receivers. Modulators and demodulators.

Year's Work **ECEN 4020**

In addition to a major experimental project, laboratory classes are held in Electrical and Electronic Engineering. Students are required to submit a substantial report on their project.

Elective Subjects:

At least **four**, and not more than **five**, of the following subjects must be chosen from permitted combinations, with the approval of the Head of the Subject.

Microwave Engineering **ECEN 4007**

Further treatment of coaxial lines and waveguides; attenuation analysis; cavity resonators; microstrip lines; design and fabrication of hybrid and monolithic MICs; filters and couplers; theory of ferrites with microwave applications; survey of thermionic and solid-state microwave sources and devices; the scattering matrix; computer methods; microwave measurements and selected microwave system applications.

Digital Communications **ECEN 4006**

Further information theory. Channel coding. Bandpass signals and systems. Bandpass transmission. Digital modulation methods. Carrier and symbol synchronisation. Channel characterisation and equalisation.

Biomedical Engineering **EEEN 4005**

This course is intended to serve as an introduction to some of the many ways in which the fields of engineering and medicine interact. Topics covered will include the principles of biomedical apparatus and the application of engineering analysis to the functioning of various physiological systems.

Communication Systems **ECEN 4005**

Topics include: Telecommunication networks, switching and transmission systems. Computer networks, structure and protocols. Introduction to queuing theory.

Optoelectronics EEEN 4008

Role of optics. Optical fibres. Semiconductor sources. Detectors. Fibre systems and components; design and testing. Multiplexing options. Atmospheric links. Integrated optics. Photonics and data storage. Coherent optical communication systems. Opto-electronic sensors. Lasers in industry.

Optical Engineering **EEEN 4015**

Linear systems transforms, System Invariants, (Fractional) Fourier, Fresnel, transfer matrices, Wigner Distribution function. Reflection and Refraction, Geometric/wave optics, Snell, Huygen, dispersion. Lenses and Aberrations, Imaging systems, aberrations, resolution. Applications: Confocal CD laser head read/write, Microlens passive and adaptive arrays. Electromagnetic Theory, Anisotropic and magneto-optic effects, radiation. Diffraction, Fraunhofer/Fresnel regimes, gratings and coherence. Holography (optical phase matched filters), Geometries, models, Applications: Multiplex elements,

interconnects. Optical Signal Processing, Coherent/incoherent complex spatial filters, Joint transform correlators.

Applications of Digital Signal Processing **EEEN 4012**

Digital filter design; Butterworth and Chebyshev filters; impulse invariance techniques; the bilinear transformation; computer-automated techniques and algorithms; spectral analysis, periodogram; speech processing; models for speech signals; short-time Fourier analysis; linear predictive coding; fundamentals of digital image processing; two dimensional Fourier transform; discrete cosine transform; image compression; DSP implementation issues; DSP chip architectures; adaptive filters and signal modelling; Wiener (stochastic) filtering; LMS algorithm. A total of up to 20% of marks may be awarded for course work carried out prior to the examination.

Mathematics 2 MATH 4602

A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Mathematics 3 MATH 4603

A series of lectures on selected topics in Mathematics. Topics will be declared at the beginning of each academic Year.

Management and its Environment **BMGT 4001**

The Irish economy, its institutions and international relationships. The firm and its environment. Organisational objectives and corporate behaviour. Economic concepts. Market structure and the competitive process. Demand analysis. Forms of organisation, private and public bodies. Management, its nature and functions – Planning, organising, directing, controlling. Financial management. Presentation and analysis of financial statements. Forecasting. Working capital. Capital budgeting. Financial institutions. Marketing management. Market research. Product life cycle. Product mix. Marketing mix. Operations management. Concept of a system. System design, planning and control. Personnel management. Industrial relations. Trade unions. Collective bargaining.

Hardware/Software Co-Design **COMP 4623**

Hardware/software co-design models and architectures; hardware languages; target architectures; compilation techniques and tools for embedded systems; design specification; prototyping and emulation.

Fourth Year Electrical Engineering

Electronic Circuits 3 **EEEN 4001**

Principles of feedback including formal two-port analysis and example feedback circuits. Stability of feedback amplifiers, dominant pole and pole-zero compensation. Oscillators: Barkhausen criterion, control of amplitude with large signal gain, general oscillator configuration, crystal oscillator and Wien bridge oscillator. Active filters: Sallen-Key, MFB, state-variable and bi-quad. Phase locked loop, analysis of transient and steady state response. Analogue signal processing circuits: instrumentation amplifiers, chopper stabilised amplifiers, analogue multipliers, V-F and F-V converters. Noise: sources of

noise, Johnson noise, Shot noise, available noise power. Noise modelled by voltage and current source (e_n&i_{in}) at input, equivalent input noise for BJT and differential amplifier.

Control Systems EEEN 4002

Modern control theory; state space; observability, controllability and stability; eigenvalue assignment, linear optimal control. Digital control theory: basic principles; discretisation schemes; sample period selection; deadbeat control; observers; stability.

Optoelectronics and Filters EEEN 4003

Introduction to optoelectronics; LEDs, lasers, photodetectors.

Analogue filters: transfer functions; approximation problem; realisation of normalised lowpass filters; scaling and transformations; design procedure. Digital filters.

Digital Signal Processing EEEN 4004

Discrete Fourier Transform. Fast Fourier Transform. Discrete convolution. Discrete-time linear systems. FIR and IIR digital filters. Finite arithmetic effects.

Electrical Machines ELEN 4011

Magnetic circuits. Effects of eddy currents and hysteresis. Permanent magnets. 1-Phase and 3-Phase power transformers. D.C. commutator machines and machine dynamics. Distributed windings, ideal and practical. Rotating fields. Induction machine. Synchronous machine. Machine ratings and temperature rise. Insulation and insulation coordination.

Power System Economics ELEN 4016

Economic operation of Power Systems. Load Forecasting. Characteristics of Power Generation Units. Heat Rate Curves. Lagrange and optimisation. Kuhn Tucker Conditions. Constrained Economic Dispatch. Reserve Constraints. Transmission Constraints. DC Load Flow. Unit Commitment. Electricity Markets. Marginal Pricing. Pool Markets. Bilateral *Markets*. Transmission Congestion Management. Locational Marginal Pricing. Contracts for Differences. Financial Transmission.

Power System Dynamics and Control ELEN 4015

Power system operation and security in terms of the real power balance – frequency mechanism and the reactive power balance – voltage mechanism. Power system control: automatic voltage regulation, models of exciter and generator, automatic load frequency regulation, models of speed governor, hydraulics, turbogenerator, hydro generator. Automatic generator control. Transient stability: single generator case, equal area criterion, transient stability analysis of large system.

Power Electronics ELEN 4004

Power Electronic devices. Line commutated converters. Power factor and harmonic generated in bridge rectifiers. D.C. Motor drives. Chopper circuits. 1-phase and 3-phase inverters. Induction motor variable speed drives.

Year's Work **ELEN 4020**

In addition to a major experimental project, laboratory classes are held in Electrical and Electronic Engineering. Students are required to submit a substantial report on their project.

Elective Subjects:

At least **four** and not more than **five** of the following subjects must be chosen from permitted combinations with the approval of the Head of the Subject.

Advanced Electrical Machines **ELEN 4006**

Analysis and synthesis of magnetic systems. Numerical solutions of magnetic field problems. Calculation of force by Maxwell stress and energy models. Transient model of induction machine. Effects of harmonics on operation of induction machine. Transient performance of synchronous machine. Switched reluctance motors.

Biomedical Engineering **EEEN 4005**

This course is intended to serve as an introduction to some of the many ways in which the fields of engineering and medicine interact. Topics covered will include the principles of biomedical apparatus and the application of engineering analysis to the functioning of various physiological systems.

Renewable Energy Systems **ELEN 4005**

Aspects of renewable energy systems (e.g. windpower, hydropower, wavepower, photovoltaic conversion, direct solar heating, biomass, hydrogen as an energy vector, introduction to economic analysis).

Power Electronic Systems **ELEN 4007**

Characteristics of electric drives. Principles and implementation of adjustable speed induction motor drives and synchronous motor drives. Principles and implementation of HVDC transmission. Principles of load compensation. Reactive compensation requirements for unbalanced loads. Principles and implementation of controllable reactive compensators using thyristor controlled reactors and thyristor switched capacitors.

Optoelectronics EEEN 4008

Role of optics. Optical fibres. Semiconductor sources. Detectors. Fibre systems and components; design and testing. Multiplexing options. Atmospheric links. Integrated optics. Photonics and data storage. Coherent optical communication systems. Opto-electronic sensors. Lasers in industry.

Power System Transient Analysis and Protection **ELEN 4014**

Travelling waves on transmission lines and cables. Effects of lightning and switching transients. Synchronous machine under fault conditions. Symmetrical fault analysis of large power systems. Sequence impedance networks of synchronous machine, induction machine, transmission lines, transformer. Application of sequence networks to the analysis of single line to ground, double line to ground and line to line faults. General principles of power system protection. Principles of overcurrent, directional, differential and distance protection. Protection system components: relays, current transformers, voltage

transformers, sequence filters, circuit breakers and fuses. Applications to the protection of busbars, rotating machines, transformers, radial lines, meshed networks.

Applications of Digital Signal Processing **EEEN 4012**

Digital filter design; Butterworth and Chebyshev filters; impulse invariance techniques; the bilinear transformation; computer-automated techniques and algorithms; spectral analysis, periodogram; speech processing; models for speech signals; short-time Fourier analysis; linear predictive coding; fundamentals of digital image processing; two dimensional Fourier transform; discrete cosine transform; image compression; DSP implementation issues; DSP chip architectures; adaptive filters and signal modelling; Wiener (stochastic) filtering; LMS algorithm. A total of up to 20% of marks may be awarded for course work carried out prior to the examination.

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The Irish economy, its institutions and international relationships. The firm and its environment. Organisational objectives and corporate behaviour. Economic concepts. Market structure and the competitive process. Demand analysis. Forms of organisation, private and public bodies. Management, its nature and functions – Planning, organising, directing, controlling. Financial management. Presentation and analysis of financial statements. Forecasting. Working capital. Capital budgeting. Financial institutions. Marketing management. Market research. Product life cycle. Product mix. Marketing mix. Operations management. Concept of a system. System design, planning and control. Personnel management. Industrial relations. Trade unions. Collective bargaining.

Mechanical Engineering

Second Year

Course Code	*Course Title*	*ECTS Credits*
MEEN 2011	Applied Dynamics	6
MEEN 2002	Mechanics of Materials	6
MEEN 2003	Thermodynamics	2.5
MEEN 2004	Manufacturing Engineering	6
MEEN 2005	Materials Science and Engineering	6
MEEN 2006	Engineering Measurement	2.5
MEEN 2007	Fluid Mechanics and Heat Transfer	2.5
COMP 2605	Computer Science	2.5
EEEN 2026	Electrical Engineering	2.5
EEEN 2025	Electronic Engineering	2.5
MATH 2604	Mathematics	10
ENRD 2030	Laboratory & Project Work in Mechanical and Electronic & Electrical Engineering	11
	Total	60

Third Year

Course Code	*Course Title*	*ECTS Credits*
MEEN 3008	Thermodynamics	4
MEEN 3007	Fluid Mechanics and Heat Transfer	4
MEEN 3009	Applied Dynamics and Control Systems	5.5
MEEN 3003	Mechanics of Materials	2.5
MEEN 3010	Design and Production	5.5
MEEN 3011	Materials Engineering	5.5
EEEN 3028	Electronic Engineering	4
EEEN 3029	Electrical Engineering	4
MAPH 3014	Engineering Computation	2.5
MEEN 3012	Computer Methods in Engineering	2.5
MATH 3601 / MATH 3602 / MAPH 3024	Mathematics (Module A – LT, FS) / Mathematics (Module B – Integral Calculus) / Mathematical Physics (Module D – Differential Equations)	7.5
ACC 3023	Management Accounting and Finance	2.5
ENRD 3030	Laboratory & Project Work in Mechanical and Electronic & Electrical Engineering	10
	Total	60

Fourth Year

MEEN 4001	Energy Conversion Systems	6
MEEN 4002	Fluid Mechanics and Heat Transfer	6
MEEN 4003	Applied Dynamics and Control Systems	6
MEEN 4004	Managing Manufacturing Enterprise	3
MEEN 4005	Materials Engineering and Design	6
MEEN 4008	Manufacturing Engineering	3
EEEN 4014	Electronic Engineering	3
ECON 4011	The Engineer in Society: The Economy	3
MEEN 4020	Course Work	15

Elective subjects:

Three of the following to be chosen from permitted combinations, with the approval of the Head of Subject:

MEEN 4009	Advanced Composites & Polymer Engineering	3
MEEN 4010	Advanced Materials Processing	3
MEEN 4007	Bioengineering	3
EEEN 4013	Electrical Engineering	3
MEEN 4018	Engineering Failure Analysis	3
MEEN 4015	Manufacturing Information Systems	3
MEEN 4016	Power Generation	3
MEEN 4017	Technical Ceramics	3
	Total	60

Second Year

Thermodynamics MEEN 2003

(For Agricultural & Food and Mechanical Engineering students)

First Law of Thermodynamics; Control system analysis; control volume analysis; steady-state, steady-flow energy equation. Second Law of Thermodynamics; Work and heat; quality of energy; reversible and irreversible processes; Carnot cycle; absolute temperature scale; definition of entropy; Clausius inequality; derivation of T-ds relations. Analysis of thermodynamic cycles; Rankine, Vapour Compression, Brayton-Joule, Otto, Diesel Cycles.

Engineering Measurement MEEN 2006

Generalised measurement systems. Instrument static characteristics. Accuracy and error analysis. Calibration. Uncertainty analysis. Dynamic measurement issues. Statistical issues in measurement, statistical distributions. Measurement of temperature, fluid flow, strain, pressure, force, torque, rotational speed and power. Data acquisition systems.

Applied Dynamics MEEN 2011

(For Biosystems , Electronic & Electrical and Mechanical Engineering Students)

Three-dimensional force systems: resultants and equilibrium. Topics in friction. Particle kinematics. Plane kinematics of rigid bodies. Plane kinetics of rigid bodies:direct methods; impulse and momentum; work and energy. Vibration, free and forced. Central force motion.

Mechanics of Materials **MEEN 2002**

(For Biosystems, Chemical and Mechanical Engineering students)

One dimensional stress and strain. Biaxial stress. Principal stresses and strains in 2-D. Hookes Law. Strain gauges. Thin-walled pressure vessels. Torsion of circular shafts. Bending stresses and deflections. Buckling of slender bars.

Manufacturing Engineering **MEEN 2004**

Introduction to manufacturing. Primary and secondary processing of metals. Casting and forming processes. Joining of metals. Machining of metals. Theory and economics of metal cutting. Machine tools. Gear manufacturing. Grinding. Cutting tool materials. Tool life. Non-traditional machining processes. Numerical control and computer numerical control of machine tools. Programming for CNC. Economics of production. Group technology. Flexible manufacturing systems. Introduction to metrology. Measurement of small linear displacement. Measurement of small angular displacement. Surface metrology.

Economic analysis of engineering investments, discounted cash flows, net present value, equivalent maintenance costs, obsolescence, life-cycle costs and risk. Methods engineering, time standards and productivity improvement in engineering operations. Costing systems, cost reduction and control, and profit optimisation in manufacturing.

Materials Science and Engineering **MEEN 2005**

Introduction to ironmaking and steelmaking. Crystallography. Materials characterisation. Thermodynamics and kinetics of phase transformations. Phase diagrams and microstructure.

Fluid Mechanics and Heat Transfer **MEEN 2007**

Fluid properties; Newton's law of viscosity; steady and unsteady flow; Compressible and incompressible flow. System Analysis: general motion of fluid particles; acceleration of fluid particles; conservation laws. Control Volume Analysis: continuity equation; momentum equation; applications to include impinging jet on flat plate and curved vanes, flow in bends and nozzles; energy equation; head loss and loss factors Bernoulli's equation: derivation and application to pipe and nozzle flow.

Introduction to Conduction, Convection and Radiation Heat Transfer. One-dimensional steady state heat conduction; the plane wall, the cylinder. Thermal resistance, thermal contact resistance, thermal resistance networks, parallel and series networks. U value, the composite wall, the composite cylinder. Insulation: Properties, R value, critical insulation thickness. Heat Exchangers: Types, concurrent and countercurrent flow, temperature profiles, overall heat transfer coefficient, mean temperature difference, fouling.

Electrical Engineering **EEEN 2026**

(For Agricultural & Food and Mechanical Engineering students)

Review of DC analysis, superposition, Thevenin's Theorem.

Transient analysis: RL, RC, LC, RLC circuits.

AC concepts: phasors, complex impedance, combining impedances, AC superposition. Frequency response of 1st and 2nd order circuits. RLC circuits.

DC bridges and measurement. AC power.

Electronic Engineering **EEEN 2025**

(For Agricultural and Food and Mechanical Engineering students)

PN-junction: Diode, LED. Rectification. Power supply design. FET and MOSFET as circuit elements (switch, amplifier). BJT transistor. Simple amplifiers: operating point and bias. AC equivalent circuits.

Computer Science **COMP 2605**

Advanced C programming, data abstraction, modular program design, object-oriented programming, introduction to C++; software engineering, requirements analysis, design and implementation, testing and maintenance. Software systems: operating systems, inter-process communication, UNIX programming, introduction to compilers.

Mathematics **MATH 2604**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Rayleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorisation. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial, geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing, Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

Year's Work in Mechanical Engineering **MEEN 2020**

Drawing and Design: Engineering drawing, free-hand sketching, CAD, design assignments.

Laboratory practical work and tutorials associated with courses in Applied Dynamics, Mechanics of Materials, Thermodynamics, Manufacturing Engineering, Materials Science and Engineering, Engineering Measurement, Fluid Mechanics and Heat Transfer.

Year's Work in Electronic and Electrical Engineering **EEEN 2028**

Laboratory practical work and tutorials associated with courses in Electronic and Electrical Engineering.

Third Year

Thermodynamics **MEEN 3008**

(For Mechanical Engineering students).

Entropy, reversibility and availability. Second Law efficiency.

Rankine, Re-Heat & Regenerative cycles. Brayton-Joule gas turbine cycle. Combined steam & gas turbine cycles. Combined heat & power systems.

Mixtures of gases. Psychrometry. Air Conditioning.

Fuels & Combustion. First Law for reacting systems.

Compressible internal flow: Ideal gas relationships, Mach number and speed of sound. Isentropic flow in converging diverging nozzles. Non-isentropic flow: Fanno and Rayleigh flow, shock waves.

Applied Dynamics and Control Systems **MEEN 3002**

Vibration analysis of lumped parameter systems with one and two degrees of freedom. Two and three dimensional motion of rigid bodies with respect to rotating axes. Computer analysis of mechanisms. Balancing of reciprocating masses.

System modelling. Transfer functions. System simulation. System identification. Transient response of systems. State space representation and analysis. Frequency response. Feedback and closed loop control. Stability and stability criteria. Root locus method. System compensation.

Mechanics of Materials **MEEN 3003**

Basic concepts of Continuum Mechanics, Three dimensional stress and strain. Airy Stress Functions, Failure criteria. Stress concentrations. Introduction to linear elastic fracture mechanics. Calculation of fatigue life. Torsion of non-circular sections. Bending of asymmetric beams.

Materials Engineering **MEEN 3005**

Physical and process metallurgy: heat treatment, surface hardening, metallurgy of welding, ferrous alloys.

Powder metallurgy and ceramics: powder production and processing, sintering mechanisms, powder metallurgical materials including hardmetals; classification and properties of ceramics.

Polymers: structure and classification, polymerisation processes; mechanical behaviour including viscoelasticity, viscolastic mathematical models.

Fluid Mechanics and Heat Transfer **MEEN 3007**

Internal Flow: Reynolds experiment, Entrance region and fully developed flow, Fully developed laminar flow, Hagen-Poisseuille flow, fully developed turbulent flow, dimensional analysis, Moody chart, pipe flow, flow rate measurement.

External Flow: Influence of Reynolds number, qualitative description of a boundary layer, boundary layer thickness, displacement and momentum thickness, momentum integral boundary layer equation, laminar and turbulent flows on flat plate with assumed velocity profiles, wall shear stress, separated flow: influence of pressure gradient. Lift and drag.

Heat conduction: general conduction equation, boundary and initial conditions.

Fin heat transfer: fin equation, boundary conditions, fin temperature distributions, fin heat transfer, fin efficiency, fin effectiveness, fin array effectiveness.

Heat exchangers: heat exchanger types, heat exchanger resistance, heat exchanger U-value, log-mean temperature difference approach.

Design and Production **MEEN 3004**

The design process. Design methodology. Partial and total design. Application of mechanics of materials to design of machines and structures. Product Liability. Design of bolted, welded, riveted joints. Factors affecting fatigue life. Cumulative damage. Design for fatigue. Design of shafts and clamped components for fatigue applications. Gear design. Continuous system modelling. Simulation as a design method. Advanced Continuous Simulation Language (ACSL). Structure of models. System representation with block diagrams. Design of dynamic systems with worked examples. Design assignment. Integration methods. Input/output devices, interpretation of results. Runtime control. Project management. Critical path analysis. Resource and cost control. PERT.

Electrical Engineering **EEEN 3027**

Power and power factor correction: Three phase systems. Power measurement in 3-phase systems.

Safety. Earthing. Fuses. Circuit breakers. Residual current devices. Insulation.

Magnetic devices: B-H curve for iron. Magnetic circuits.

DC machines: machine models, series, shunt and compound connected, speed control, torque speed characteristics, starting.

Single Phase Transformer: Ideal transformer. Approximate equivalent circuit. Open and short circuit.

Induction Machines: Three phase winding and rotating magnetic field, slip, equivalent circuit model, torque and mechanical power, open and short circuit tests, speed control theory and practice.

Electronic Engineering **EEEN 3025**

(For Agricultural & Food and Mechanical Engineering students)

Amplifiers: Frequency response. The operational amplifier: ideal properties, standard circuit configurations, non-ideal behaviour .

Transducers: brief overview and examples.

Filters: Passive, active, implementations using op amps.

Data acquisition: sensor impedance; noise types, sources & precautions; signal conditioning; filtering; differential/single inputs; AtoD conversion.

Digital electronics: Gates, transistor implementation. Fundamentals of digital logic, Boolean algebra, Karnaugh maps. Combinational digital logic building blocks, half adder, full adder. Sequential digital logic: JK flip-flop, D and T flip-flops, memory.

Engineering Computation **MAPH 3014**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimisation.

Computer Methods in Engineering **MEEN 3006**

(For Agricultural & Food and Mechanical Engineering students)

Statistical methods: interpretation of experimental data, curve fitting, statistical analysis, validation of models. Introduction to finite element analysis. Introduction to rapid application development languages.

Pure and Applied Mathematics **MATH 3615**

Mathematics [LT-FS-CV or CofV] (1 unit) * ***MATH 3601***

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equation, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat), engineering applications. Introduction to calculus of variations (CofV).

Or

Introduction to theory of functions of a complex variable (CV). Cauchy-Riemann equations. Harmonic functions. Conformal mappings. Cauchy integral formulae.

Mathematics (Integral Calculus) MATH 3602

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad, div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stoke's theorem. Applications.

* 1 unit = 25 lecture hours.

Mathematical Physics (Module D – Differential Equations) ***MAPH 3024***

Review of ODEs and their solution. Systems of coupled linear differential equations (Solution, Critical points, Stability). Types of Partial Differential Equations (1st order forms, 2nd order forms (Heat, Diffusion, Wave, Poisson, Laplace equations), their origins and derivation). Boundary Conditions. Methods of solution of 1st order PDEs (Method of Characteristics-Domains of Influence). Methods of solution of 2nd order PDEs (Separation of Variables, Fourier, Laplace, Fourier Sine, Fourier Cosine). Engineering examples.

Management Accounting and Finance **ACC 3020**

Fundamentals of management accounting. Purpose of management accounting. Cost terms and purposes. Cost allocation and absorption. Product costing – Job cost, contract costing and process costing. Budgeting, responsibility, accounting and motivation. Capital budgeting techniques. Decision-making: Cost-volume-profit relationships. Relevant costs and the contribution approach to decisions. Financial analysis: Review of financial statements (balance sheet, profit and loss account, statement of sources and uses of funds). Accounting conventions; statements of standard accounting practice: Ratio analysis; financial ill-health (through trading losses, overtrading etc.); capital structure.

Year's Work in Mechanical Engineering **MEEN 3020**

Laboratory practical and design project work associated with lecture courses in Thermodynamics, Fluid Mechanics & Heat Transfer, Applied Dynamics & Control Systems, Materials Engineering, Mechanics of Materials, Design & Production, and Computer Methods in Engineering.

Year's Work in Electronic and Electrical Engineering **EEEN 3020**

Laboratory practical work associated with lecture courses in Electronic Engineering and Electrical Engineering.

Fourth Year

Energy Conversion Systems **MEEN 4001**

Internal Combustion Engines: Introduction to internal combustion engine design and operating characteristics, ideal thermodynamic cycles, engine parameters, engine testing, 4-stroke engine gas exchange processes, supercharging and exhaust gas turbocharging, two-stroke engine scavenging, combustion and pollutant formation in compression ignition and in spark ignition engines, exhaust after-treatment systems.

Building Energy Systems: Psychrometry, thermal comfort, psychrometric processes, adiabatic saturation, heating, cooling, humidification, dehumidification, building air conditioning analysis, cooling towers.

Turbomachinery: Fluid flow in turbomachines. Euler equation. Application to hydraulic and compressible flow turbomachines. Dimensional analysis. Similarity and modelling.

Fluid Mechanics and Heat Transfer **MEEN 4002**

Differential equations of mass and momentum conservation: The Navier-Stokes equations, exact solutions of the Navier-Stokes equation; introduction to lubrication theory; Reynolds averaged Navier-Stokes equations.

Introduction to computational fluid dynamics.

Inviscid flow theory.

Conduction: lumped capacitance method, lumped system analysis.

Convection Heat Transfer: velocity and thermal boundary layers, forced convection, free convection

Heat Exchangers: review, log-mean temperature difference approach, NTU-effectiveness approach.

Radiative Heat Transfer : thermal radiation, blackbody radiation, surface emission, absorption, reflection and transmission; view factors, black surface radiation exchange, diffuse and gray surface radiation exchange, radiation shields.

Applied Dynamics and Control Systems **MEEN 4003**

Multi-dimensional discrete and continuous vibrating systems. Orthogonality properties of normal modes. Rayleigh Quotient and Rayleigh-Ritz Method. Lagrange equations. Angular momentum equations in three dimensions. Random vibrations, spectral analysis. Sampled data control systems. Modern control theory.

Materials Engineering and Design **MEEN 4005**

Strengthening mechanisms in non-ferrous alloys. The light alloys: aluminium, magnesium and titanium. Copper and its alloys. High temperature alloys and coatings. Degradation of metallic materials: creep, fatigue, corrosion and wear. Non-destructive testing and failure analysis of metals. Quality assurance. Fracture toughness testing. Metal forming and casting processes. Case studies in materials selection. Structural adhesives in joint design. Introduction to polymer composites. Introduction to polymer processing.

Managing Manufacturing Enterprise **MEEN 4004**

Management functions and objectives. The competitive and changing manufacturing environment. Types of production. Influence of automation. Production and operations management. Materials control. Production and inventory control. Group technology. Just-in-time. Forecasting principles and methodology. Material requirements planning. Environmental issues. Quality assurance. Total quality management. ISO 9000 quality systems. Safety in the workplace. Safety regulations.

Product life cycle. Product development. Prototyping. Concurrent engineering. Marketing engineering products. Enterprise. New venture research. Planning and early growth management.

Contract law, Professional liability, Product liability, Arbitration, Employment Law, Negligence, Employment Equality.

Manufacturing Engineering **MEEN 4008**

Advanced treatment of conventional and non-conventional manufacturing processes, precision and ultra-precision manufacturing systems, design of machine tools, accuracy of machine tools, machining centres, flexible manufacturing systems, monitoring and diagnostics of manufacturing systems, computer integrated manufacturing.

Electronic Engineering **EEEN 4014**

Non-ideal behaviour of operational amplifiers, sources of noise in measurement, signal conditioning and filtering. Analogue-to-Digital and Digital–to-Analogue converters. Sampling theorem and introduction to digital signal processing. Components of digital systems, counters, decoders, multiplexers. Introduction to computer architecture, addressing, interrupts, input/output. Digital systems, including microcontrollers and microprocessors. Power electronic devices, silicon-controlled rectifiers, thyristors.

The Engineer in Society: The Economy **ECON 4011**

Recent Irish economic history. Population and the labour market. Industrial and trade policies. Finance for development. External economic relations. Macroeconomic policy.

Course Work **MEEN 4020**

Course work includes exercises in computer aided drafting, design and finite element analysis; programming of CNC machining centres; advanced techniques of photo-elastic, brittle lacquer and strain gauge stress analysis; fracture mechanics; vibration and control exercises; data logging and introduction to techniques of data collection and condition monitoring; testing of internal combustion engines and evaluation of results; tests on heat transfer and fluid mechanics rigs and experimental evaluation of water turbines and pumps; tests on tribology rigs.

Project work involves specialisation, on an individual basis, at some depth in one area of the above formal experimental work or in such areas as detailed design of equipment, development of foundry, pattern shop or machine shop technology, for which facilities are available, non-destructive testing including X-ray and gamma ray inspection techniques etc.

Students will carry out individual projects on a self-contained subject, or as an independent member of a team on an integrated subject having several clearly distinguished areas of interest. The project will involve a survey of published literature or such other material as is available, followed by the design and construction of apparatus, experimental measurements and the preparation of a comprehensive report. Some projects will concentrate on design, while others may be more concerned with test and analysis of specific systems or rigs.

Elective subjects:

Three of the following to be chosen from permitted combinations, with the approval of the Head of Subject.

Advanced Composites and Polymer Engineering **MEEN 4009**

Fibre reinforcements. Mechanics of composites. Strength and fracture of composites. Failure analysis and NDE of composites. Design, manufacture and applications of composites. Isothermal flow of viscous non-Newtonian fluids. Viscoelastic response of polymeric fluids. Mixing of polymer melts. Extrusion and extrusion dies. Moulding and forming. Mould design.

Advanced Materials Processing **MEEN 4010**

Innovation in the processing of materials, with a concentration on metals, alloys, and metals matrix composites. Novel solidification and deformation processes. Microstructural evolution during the processing of alloys. Engineered materials, including gradient materials and nonostrucutured materials. Modelling the processing of alloys at macro- and micro-scopic length scales. Advanced characterisation techniques. And a look to the future.

Bioengineering MEEN 4007

Biomechanics: geometry, loading, and kinematics of joints; lubrication and wear of joints; design of joint arthroplasties. Biomaterials: properties of natural materials; biocomaptibility; metallic and polymeric biomaterials; synthetic bioceramics; tissue engineering.

Electrical Engineering **EEEN 4013**

More advanced treatment of EEEN 3027 where appropriate. Synchronisation; infinited busbar and power output of alternators. Transformers; in rush current, PTs and CTs, parallel operation. Three-phase and single-phase induction motors; starting and braking; transient analysis and special applications; linear and stepper motors. Power electronic devices and power-electronic converters and inverters for DC and AC motor drives. Electrical safety, protection, step and touch voltages. Heating of metals and non-conducting materials. Industrial installations, circuit breakers and protection. Industrial tariffs and power factor correction. Sensors and the electrical measurement of mechanical variables.

Engineering Failure Analysis **MEEN 4018**

Case study based approach. Failure mechanisms examined include elastic and plastic deformation, fatigue, brittle fracture and environmentally-induced failures.

Manufacturing Information Systems **MEEN 4015**

Computer Integrated Manufacturing, Supervisory Control and Data Acquisition, Flexible Manufacturing Cells, Programmable Control, Factory Communication, Computer Aided Design and Manufacture, Concurrent Engineering, Product and Process Data Management Systems.

Power Generation **MEEN 4016**

Fossil fuels in power generation: Analysis of power generation cycles, technical, economic and environmental aspects of current and future fossil-fuel power generation technologies.

Nuclear power generation: Nuclear fission and fusion in power generation.

Technical Ceramics **MEEN 4017**

Models of sintering mechanisms. Silicon nitride based ceramics including SiAiONs. DIMOX process and materials. Transformation toughened ceramics. Selected topics in fracture of ceramic materials.

Degree of Bachelor of Science (BSc) Structural Engineering with Architecture

Course Description

This is a three-year BSc programme. The course will provide a thorough grounding in the engineering sciences whilst developing and nurturing the creativity of the student through studio/project work. In addition to Structural Engineering Design principles, History and Theory of Architecture, Building Services and Building Construction techniques will form an integral part of the curriculum.

Examination Regulations

The University Examinations for the Degree of Bachelor of Science (Structural Engineering with Architecture) are:

1 The Second University Examination
2 The Final University Examination for the Degree

For eligibility for admission to each of the examinations, the prescribed course of study for that examination must have been attended satisfactorily.

The Second University Examination may be taken not earlier than the end of the sixth term after matriculation. The Final University Examination for the Degree of Bachelor of Science (Structural Engineering with Architecture) may be taken not earlier than the end of the ninth term after matriculation.

Honours may be awarded at each Summer examination.

The attention of students is directed to the following: Credit for a course, Pass or Honours, requires satisfactory attendance and performance of all work prescribed during the year.

The examination may in each subject include a written and an oral examination.

In all practical examinations, the examiners will, where possible, take into account the work done by the candidate while preparing for the examination as shown by the certified record of his/her work, such as notebooks, project and laboratory reports, library investigations, drawings and designs etc., which must be submitted for inspection.

Time Limit for Passing Examinations

Attention is drawn to the following University Regulations, which will be rigidly enforced:

1) No student will be allowed to present himself/herself for any examination in the University prior to completion of the preceding examination.

b) Students must complete the Second University Examination in Structural Engineering with Architecture within two academic years from the date of passing the First University Examination in Structural Engineering with Architecture.

c) Students failing to pass any of these examinations within the specified interval will be ineligible to proceed further with their Engineering studies in any of the NUI constituent universities. Exceptions to this rule will be granted by the Engineering Programme Board, only for very serious reasons.

d) "Old Regulations" examination papers will be available for one year only following a substantial change in the syllabus of any subject.

General Regulations

Language Requirement
Students who enterend the BSc Structural Engineering with Architecture Programme in 2004 are required to reach a defined level of attainment in a third language, approved by the Programme Board, in order to be eligible for the award of the BSc Degree. A Language Certificate will be awarded to students who pass the Language examination.

Syllabus of Courses

Second Year

Course Code:	*Course Title:*	*ECTS Credits:*
CVEN 2002	Surveying	6
CVEN 2003	Building Construction	6
CVEN 2004	Engineering Materials I	5
MEEN 2009	Engineering Materials II	5
MEEN 2008	Mechanics of Fluids	4
CVEN 2006	Mechanics of Solids	6
CVEN 2007	Computer Applications	4
MATH 2600	Mathematics	9
ARCT 2603	History and Theory of Architecture	4
CVEN 2030	Project Work	11
	Total:	60

Third Year

There are no lectures in the third term of the Third Year to facilitate industrial placement or study periods in other universities. Examinations will take place after the second term.

Course Code:	*Course Title:*	*ECTS Credits:*
MAPH 3034	Engineering Computation	3
MATH 3613	Mathematics	
MATH 3614	Mathematics	5
MAPH 3025	Mathematical Physics	
CVEN 3007	Engineering Finance	6
CVEN 3003	Soil Mechanics	7
CVEN 3004	Theory of Structures	7
CVEN 3005	Design of Structures	7
MEEN 3013	Building Services	8
ARCT 3602	History and Theory of Architecture	4
CVEN 3030	Project Work	13
	Total:	60

Second Year

Surveying **CVEN 2002**

Survey instruments and their use in plane surveying. Base line measurements, triangulation, calculation and adjustment of traverses. Contouring and topographic survey. Hydrographic surveys. Circular transition and vertical curves. Cross section and earthworks quantities. Tacheometry, subtense measurement, electronic distance measurement.

Building Construction **CVEN 2003**

Fundamentals of building construction for domestic, industrial and commercial buildings, planning, Building Control and legislation. Site preparation, foundations, ground and suspended floors, roofs, walls, stairs, Radon gas, cost estimating and critical path method scheduling. Construction materials, timber, concrete, structural steelwork, dampness, fire protection, finishes. Water supply, drainage, sewage disposal, heating and ventilation, insulation, condensation, energy use. Site organization, plant and equipment, temporary works.

Engineering Materials I **CVEN 2004**

Timber: structure, strength and durability, manufactured products. Cements: manufacture, types, uses, hydration process. Aggregates. Concrete: structural properties, durability. New and emerging engineering materials. Soils: origin, description/classification. Mass, volume and basic relationships. Microstructure of clayey materials. Compaction suitability criteria for soils in earthworks. Bituminous Materials.

Engineering Materials II **MEEN 2009**

Introduction to Materials, their classification and selection. Fundamentals of material structure and properties. Mechanical properties and their measurement. Introduction to failure mechanisms, ductile and brittle failure, creep and fatigue. Introduction to iron and steel, carbon in steel, the iron/iron carbide phase diagram, types and properties of steels. Welding, weldable structural steel, the heat affected zone, weldability and weld

defects. Non-destructive examination, principles and methods. Corrosion, stainless steels. Surface treatment.

Mechanics of Fluids **MEEN 2008**

A continuation course on fluid flow from a physical viewpoint. Review of fluid properties. Fluid statics. Kinematics of fluid flow. Continuity equation. Stream function – Two-dimensional-incompressible. Rotational and irrotational motion. Circulation. Equations of irrotational motion. Dynamics of fluids. Force, energy and momentum. Effects of pressure, weight, viscosity, turbulence and compressibility. Dynamic similitude. Boundary layers, surface drag, form drag. Turbo-machinery.

Mechanics of Solids **CVEN 2006**

Force equilibrium. Statically determinate structures. Trusses and planar frameworks. Rigid bodies supported on deformable supports. Statically indeterminate structures. Concepts of stress and strain. Stress-strain behaviour. Bulk modulus and shear modulus. Plane stress and plane strain. Transformation of axes and the Mohr's circle. Principal stresses. Strain energy. Case studies in stress. Bending, shear and torsional stresses in beams. Stress trajectories. Effects of plasticity. Deflection analysis. Buckling of struts. Factor of safety.

Computer Applications in Civil Engineering **CVEN 2007**

Programming in Visual Basic: control structures, user friendly interface developments, graphical applications, implementation of engineering mathematical examples, developing stable programmes. Using Visual Basic with Applications. Introduction to Visual Fortran. Control structures. Using spreadsheets: general orientation, equation manipulation, graphs, goal seek, solver, matrix inversion, macros.

Mathematics **MATH 2600**

Unit 1. Vector spaces and subspaces. Linear independence, bases. Diagonalisation of matrices with distinct eigenvalues. Eigenvalue estimation, Gerschgorin's theorem. Eigenvalues of real symmetric and complex Hermitian matrices. Orthogonal matrices. Diagonalising a real symmetric matrix, central axis theorem. Real orthogonal matrices in 2 and 3 dimensions, rotation matrices. Positive definite matrices, tests for positivity. Quadratic forms, max-min theory of calculus. Least squares, pseudo-inverse. Raleigh's quotient, approximation of eigenvalues and eigenvectors of symmetric matrices. Solution of linear equations: Bernoulli, Gauss-Seidel method. Solving linear differential equations by eigenvector-eigenvalue techniques. Inner products, Gram-Schmidt process, construction of orthogonal polynomials: Legendre, Chebyshev. QR factorization. Singular value decomposition.

Unit 2. Functions of two or more variables. Graphs, contours, continuity. Partial derivatives. Linear approximation. Tangent planes and normals to surfaces. Differentiability, gradient, directional derivative, grad, div and curl. Laplacian. Taylor's theorem for functions of two or more variables. Critical points and their classification. Hessian matrix. Lagrange multipliers. Line integrals, introduction to double integrals and Green's theorem.

Unit 3. Counting procedures. Probability. Conditional probability. Independence. Bayes' theorem. Random variables. Probability distributions. Mean and variance. Binomial,

geometric, Poisson, uniform, exponential and normal distributions. Random samples. Distribution of sample means. Statistical tables and statistical computing. Confidence intervals and hypothesis testing. Student's t-distribution. Paired and independent sample tests. Analysis of variance. Engineering examples.

History and Theory of Architecture **ARCT 2603**

History of Architecture in the Twentieth Century. The second year course in history and theory deals with the development of modern architecture from the latter half of the nineteenth century up to the contemporary period. The course is structured around a lecture series which situates changes and trends in architecture and the work of individual architects in their wider political and cultural context.

Project Work **CVEN 2030**

Engineering Laboratory. An integrated course of laboratory experiments designed to illustrate the fundamental principles dealt with in lectures and the fundamental principles of engineering measurement.

Design. Development of visual communication through sketching, computer-aided drafting skills and model making. A design oriented project introducing students to the skills required to develop a design project through from planning and concept stage to construction and completion.

C*ommunications*. Students will carry out exercises in oral and written communication.

Third Year

There are no lectures in the third term of the Third Year to facilitate industrial placement or study periods in other universities. Examinations will take place after the second term.

Engineering Computation **MAPH 3034**

Error analysis, numerical solution of algebraic and transcendental equations, matrix inversion, determination of eigenvalues and eigenvectors, numerical differentiation and integration, application of finite difference methods to ordinary and partial differential equations, interpolation and sampled data and finite element techniques. Non-linear optimization

Pure and Applied Mathematics **MATH 3617**

Mathematics [LT-FS] ***MATH 3613***

Laplace transform (LT). Heavyside-step and Dirac-Delta functions, convolution, solutions of differential equation, engineering examples.

Fourier series (FS). Hilbert spaces, partial differential equations (wave and heat), engineering applications.

Mathematics (Integral Calculus) ***MATH 3614***

Further advanced calculus. Scalar and vector fields over curves and surfaces. Grad div and curl. Change of variable. Curvilinear co-ordinates. Integration over domains, curves and surfaces. Divergence theorem. Stokes' theorem. Applications.

Mathematical Physics (Differential Equations) ***MAPH 3025***

Ordinary differential equations. Linear systems of first order. Phase plane. Singular points. First order p.d.e. How they arise. Sketching characteristics. Solutions. Second order p.d.e. How they arise. Characteristics. Wave and diffusion equations. Motivation for different initial or boundary value problems. Properties of solutions

Engineering Finance **CVEN 3007**

Management Accounting & Finance: The Balance Sheet, Income Measurement, Cash Flow Statements, Interpretation of Financial Statements, Share Options, Management & Operational Trends, Product Costing & Pricing, Cost Prediction Techniques, Cost-Volume-Profit (CVP) Analysis, Relevant Costs & Decision Making, Decision Making with Scarce Resources, Performance Evaluation, Budgeting.

Transport Economics: Basics of supply and demand; Individual versus market demand; Production; Evaluating the effects of government policies; Market power; Externalities; Road pricing & congestion pricing; Cost-Benefit analysis

Industry Perspective: Public Procurement processes; Risks in Design, construction, operations & maintenance; Value engineering, negotiated change and value for money; Construction Contracts; Project Finance & PPP.

Soil MechanicsCVEN 3003

Soil mechanics problems and their solution. Stresses in soils, Stresses due to applied loads, Stress-strain behaviour. Shear strength of cohesive and cohesionless soils. Total and effective stresses. Excess pore water pressure. Steady state flow and permeability. Earth pressure and rigid earth retaining structures. Bearing pressures and bearing capacity of foundations. Transient pore water pressure and deformation Consolidation theory. Settlement of foundations. Elastic settlement, allowable building tolerances. Laboratory testing.

Theory of Structures **CVEN 3004**

Structural forms. Qualitative analysis. Manual vs computer aided design/analysis. Behaviour resistance of structural sections from zero load to collapse for steel concrete and timber. Analysis for stress resultants of statically determinate structures. Virtual work theorems. Deformation analysis of frameworks. Stiffness and flexibility formulation for statically indeterminate planar structures. Influence lines. Simple plastic theory. Introduction to buckling and dynamics. Laboratory experiments designed to illustrate the principles of structural analysis and the properties of materials.

Design of Structures **CVEN 3005**

Codes of practice. Building regulations. Actions on structures including wind load. Design resistance. Load factors. Steel: Steel as a structural material and its use in building. Design of steel beams, girders, trusses, stanchions and simple frames. Design of steel connections. Concrete: Reinforced concrete as a structural material. Design of beams and slabs, columns and column bases and simple statically indeterminate structures. Retaining

walls. Timber: Timber as a structural material. Introduction to the design of timber structures.

Building ServicesMEEN 3013

Building Load Analysis: Heating and cooling requirements. Design of mechanical ventilation, heating systems, air conditioning systems. Design of hot and cold water services, gas distribution, telephone and communications, waste systems and waste management. Design of electrical distribution systems, emergency generation systems, fire regulations and fire and security systems. Lift systems.

History and Theory of Architecture **ARCT 3602**

The City, Landscape, Garden and Architecture:

An introduction examines representation in its broadest sense from drawing to meaning in architecture. The course investigates the forces and ideas that have shaped the city, the landscape and gardens, and architecture and their interdependencies and mutual influence, from the Minoan culture to the twentieth century.

Project Work **CVEN 3030**

Engineering Laboratory. A number of laboratory experiments designed to illustrate the fundamental principles dealt with in lectures in soil mechanics and structures.

Design. A number of projects will be run examining different building types, the influence of building function on the design from an architectural, a structural engineering and a building services point of view.

Postgraduate Degrees

Degree of Master of Engineering

Degree of Master of Engineering (Structural Engineering with Architecture)

Degree of Master of Engineering Science

Degree of Master of Engineering Design

Degree of Master of Industrial Engineering

Higher Diploma in Technology Management

Degree of Master of Science (Technology Management)

Degree of Doctor of Philosophy

Degree of Doctor of Science (DSc) on Published Work

Guidelines for Full-time Research Students

Degree of Master of Engineering (ME)

(ENMRF0001)

A candidate who is the holder of the Bachelor of Engineering Degree shall be eligible to obtain the Degree of Master of Engineering after the expiration of nine terms from the time at which the candidate obtained the BE Degree.

A candidate:
(a) must pass the prescribed examination;
(b) must present a dissertation; and
(c) must present such evidence of professional experience as may be prescribed.

The following Regulations apply to the ME Degree:

1. Candidates for the Degree of ME must be accepted by the Postgraduate Studies Committee as prospective candidates at least six months before entering for the examination. They are required to give particulars of the branch of study selected, title of the proposed dissertation and details of their professional experience.

2. Candidates must pass a special examination in the special branch of Engineering selected by the candidate. The examination may be held in Summer and the thesis submitted in Autumn. Exemption from the examination may be granted to a candidate who has obtained First Class Honours in the BE Degree, or who submits satisfactory evidence that he/she has been engaged on works of considerable importance.

3. The dissertation shall consist of a record (published or not) of original work, or of an essay on some branch of Engineering involving criticism. The candidate shall be examined on the subject-matter of his/her dissertation or on any matter intimately connected with it.

4. A candidate for the Degree shall have had professional experience of an approved character in a responsible capacity extending over a period of not less than three years. A detailed statement as to such experience vouched for by the Engineer or Engineers in charge must be submitted.

Degree of Master of Engineering (Structural Engineering with Architecture): Mode I

Course Description

This is a two-year course, which provides a thorough grounding in structural engineering in addition to developing a keen understanding of the interface with both Architecture and Building Design and Construction. A major research project will be undertaken during this course. Students with a strong academic background who are interested in research will be encouraged to take this route.

Examination Regulations

The University Examinations for the Degree of ME Mode I (Structural Engineering with Architecture) are:

1 The First University Examination
2 The Final University Examination for the Degree

For eligibility for admission to each of the examinations, the prescribed course of study for that examination must have been attended satisfactorily.

Honours may be awarded at each Summer examination.

The attention of students is directed to the following: Credit for a course, Pass or Honours, requires satisfactory attendance and performance of all work prescribed during the year.

The examination may in each subject include a written and an oral examination.

Candidates for the Final University Examination for the Degree may be required to pass a *viva voce* examination on the subject matter of their research project thesis if the examiner so decides.

In all practical examinations, the examiners will, where possible, take into account the work done by the candidate while preparing for the examination as shown by the certified record of his/her work, such as notebooks, project and laboratory reports, library investigations, drawings and designs etc., which must be submitted for inspection.

Time limit for Passing Examinations

Attention is drawn to the following University Regulations which will be rigidly enforced:

1) No student will be allowed to present himself/herself for any examination in the University prior to completion of the preceding examination.

2) a) Students must pass the First University Examination in ME Mode I (Structural Engineering with Architecture) within two academic years from the date of entering that ME Degree course. First year students who do not pass the First Year University Examination at the end of their first year may be permitted to re-attend their first year lectures but will not be permitted to re-attend practical classes in Drawing Office or

Laboratories. Exceptions to this rule will be made only on the grounds of ill health or some other grave reason.

b) Students failing to pass the examinations within the specified interval will be ineligible to proceed further with their Engineering studies in any of the NUI constituent universities. Exceptions to this rule will be granted by the Academic Council, on the recommendation of the College of Engineering, Mathematical and Physical Sciences, only for very serious reasons.

c) "Old Regulations" examination papers will be available for one year only following a substantial change in the syllabus of any subject.

Entry Regulations and Scholarships

Application and Limitation of Numbers in First Year ME Mode I (Structural Engineering with Architecture)

The number of students that can be accepted will be limited in accordance with the accommodation available. Admission is by competition and may involve an interview. In some circumstances admission may be subject to satisfactory performance in qualifying examinations.

The programme has one intake per year and commences in September. To avoid disappointment applications should be submitted by no later than 31 January of the year of intended entry. Applications received after the closing date may be considered subject to the availability of places.

Intending applicants shall submit an application on a prescribed form to the Programme Co-ordinator. If the Programme Co-ordinator is satisfied as to the applicant's general suitability to undertake the ME Mode I (Structural Engineering with Architecture) programme, the applicant may be called for interview. Candidates for the Degree of ME must obtain permission from the Postgraduate Studies Committee before entering the programme.

Entry Standards

A candidate may qualify for entry by meeting the requirements set out in one of the sections below:
By holding a BSc (Structural Engineering with Architecture) from the National University of Ireland with at least Second Class Honours, Grade 1 (2H1).

By holding a primary degree in Engineering or a related discipline with at least a Second Class Honours, Grade I (2H1) award from a university or other third level institution, subject to the requirement that the College *may* decide that the candidate must achieve a satisfactory performance in a qualifying examination or test whose form shall be decided by the College on the advice of the Programme Co-ordinator

If a qualifying *examination* is deemed appropriate, candidates may be required to study (i) at least two courses of the Third Year of the B.Sc. (Structural Engineering with Architecture) programme; and/or (ii) complete a project on a specified topic.

If a qualifying *test* is deemed appropriate, candidates will be required to complete an essay of *circa* 5,000 words on a given topic and undergo an oral examination on that topic. Candidates must obtain a minimum of a Second Class Honours, Grade I (2H1) in each paper and project of the qualifying examination or in the assessment of the essay for the qualifying test.

Where there is evidence of substantial professional experience in engineering or a related discipline, then the holder of (a) a pass degree or (b) chartered membership of a professional engineering institution approved by the College may, on the recommendation of the Programme Co-ordinator and with the permission of the College, be admitted to the ME Mode I (Structural Engineering with Architecture) degree programme on condition that the candidate *must* take a qualifying examination or a test as outlined above.

A candidate will not be permitted to attend courses for any other university degree or diploma whilst in attendance at the ME Mode I (Structural Engineering with Architecture) Degree programme.

An applicant may have to satisfy an English language requirement before registration.

Registration

A candidate for the ME Mode I (Structural Engineering with Architecture) shall register on or before the date of commencement of the programme and shall re-register annually (if appropriate) at the prescribed times until the studies are completed. Candidates who must sit a qualifying examination shall register first as 'qualifying students for the Degree of ME Mode I (Structural Engineering with Architecture)', and after satisfying the required entry conditions, they will register for the Degree of ME Mode I (Structural Engineering with Architecture).

Candidates must pay the appropriate fees at the specified times.

School Information

The ME – Mode I – course in Structural Engineering with Architecture is run by the School of Architecture, Landscape and Civil Engineering contact details are given below.

Programme Co-ordinator:	Dr. Amanda Gibney
School Address:	School of Architecture, Landscape and Civil Engineering University College Dublin, Earlsfort Terrace, Dublin 2.
School Telephone:	+353-1-716-7302

Course Syllabus – Mode I

First Year

Course Code:	*Course Title:*	*ECTS Credits:*
CVEN P301	Civil Engineering Design (1 and 2)	18
CVEN P302	Civil Engineering Design (3)	7
CVEN P303	The Engineer and Society	7
ARCT P301	Architectural Professional Studies	8
CVEN P304	Construction Management	7
CVEN P350	Project Work	13
	Total:	60

Second Year

Course Code:	*Course Title:*	*ECTS Credits:*
Elective Subjects: 1 from List A and 1 from List B		***16***
List A:		
CVEN P305	Structural Modelling	
CVEN P306	Structural Design	
CVEN P307	Soil Mechanics and Geotechnical Engineering	
List B:		
PEP P316	Planning Law	
PEP P329	Design and the Urban & Rural Environment	
PEP P335	Planning Methodology	
CVEN P351	Research Project	44
Total:		60

First Year

Civil Engineering Design (1 and 2) CVEN P301

Design of Structures

Elastic and elastic-plastic structural analysis & plastic moment redistribution. Prestressed concrete. Analysis and design of slabs. Columns and interaction diagrams. Masonry design. Structural steel design. Composite construction.

Design in Soils Engineering

Site investigation. Harmful constituents in soils. Bearing capacity and deformation of granular and cohesive soils. Shallow and deep foundations. Piles in granular and cohesive soils. Settlement of piled foundations. Pile testing. Flexible earth retaining structures. Sheet piled walls. Reinforced earth. Geotextiles. Stability of highway embankments and cuttings. Case histories. Laboratory testing.

Design of Water Resources Systems

Elements of applied hydrology. Water quantity requirements for domestic and industrial uses. Water sources and their development. Quality of natural waters. Quality standards

for potable and industrial water supplies. Water purification processes. Water distribution. Design of sewer systems. Purification of domestic and industrial wastes. Control of water pollution. Atmospheric pollution. Refuse disposal.

Design in Highway Engineering
Properties of highway materials, such as bitumens and aggregates. Specification, testing and quality control of highway construction. Compaction and stabilization techniques to improve material properties. Design of road drainage and road foundations. Bituminous mix design. Design and management of pavements, including the maintenance of skid resistance. Geometric design of roads and junctions for safety and capacity.

Civil Engineering Design (3) **CVEN P302**

Preliminary Design of Structures
Qualitative structural behaviour and load paths. Choice of structural material. Preliminary sizing of reinforced concrete, steel, timber and masonry members.

The Engineer and Society **CVEN P303**

(a) Engineering Law
Contract law. The promoter-engineer-contractor relationship. The engineer's responsibilities as agent and as arbitrator. The contract form.

(b) Professional Practice
Civil engineering procedure. Various forms of contract. Contract documents, drawings, specifications, bills of quantities, schedules. Sources and presentation of technical information. Report writing. Learned societies and professional bodies.

(c) Environmental Appraisal
Sustainable Development, Statutory Environmental Conservation, Stage of Appraisal, Public Consultation/Stakeholder Communication, EIS Principles and Assessment, Statutory Processes.

(d) Urban and Regional Planning
Law, administration, infrastructure, architecture, landscape design, conservation.

Architectural Professional Studies **ARCT P301**

The outline of the knowledge required to practise architecture.

The Architect as Project Manager: The architect-client appointment; Taking a brief; Auditing and surveying a building or a site; Working with the "design team" and with contractors; Estimating the cost of a job; Calculating how long a project will take; Dealing with planning and other statutory consents; Obtaining tenders and appointing contractors; Forms of construction contract; Administering a project on site; The QTC triangle.

Construction Management **CVEN P304**

Project planning, control and management: cost, cost control, quality and safety. Building Design: materials, construction and assembly of buildings.

Project Work **CVEN P350**

Engineering Laboratory: **Laboratory exercises associated with the lecture programme.**

Design: A series of design projects introducing students to the often conflicting architectural, structural and building services requirements. Conceptual design coupled with substructure and superstructure layout and sizing will be undertaken.

Second Year

Research Project CVEN P351

Each student must carry out a research project under the direction of the supervisor appointed by the Programme Co-ordinator. A thesis is presented by the candidate which is to embody the result of this research project. The student may be required to pass a *viva voce* examination on the subject matter of the thesis if the examiners so decide.

Electives List A:

Structural Modelling **CVEN P305**

Approximate methods of analysis using vector and energy approaches. Stiffness formulation. Finite Element analysis. Elastic Plastic Response. Dynamic response. Buckling analysis. Structural Forms – rings, arches, vaults, grillages, plates. Application of computer software.

Structural Design CVEN P306

Sources and assessment of structural loading. Design criteria. Selection and control of materials and workmanship. Comparison of elastic and plastic design. Limit state design in reinforced concrete, structural steelwork and timber. Structural masonry. Structural steel and reinforced concrete frameworks and continua. Applications of prestressed concrete and composite steel/concrete construction. Design of timber structures. Design for fire.

Soil Mechanics and Geotechnical Engineering **CVEN P307**

Introduction to critical state soil mechanics. Elasticity, plasticity and yielding. Soil models. Characteristic soil parameter values. Partial safety factors and Eurocode 7. Shallow foundations. Raft foundations. Piled/raft foundations. Pile design/construction in Ireland. Ground improvement. 1D compression by tangent modulus approach. Settlement of structures. Structural tolerance to movement. Recent developments in retaining wall analysis and design. Tunnels and tunnelling. Propping, ground anchorages and soil nailing.

Electives List B:

Planning Law — PEP P316

This course studies the legal structures involved in the implementation of the planning process.

The objectives of the course are to introduce the principles of the Irish legal system, to explain the law relating to administration (with particular emphasis on local government) and to provide a clear working knowledge of the Planning Acts and Regulations. The course also addresses issues relating to EU legislation and its implementation in Ireland.

Design and the Urban and Rural Environment — PEP P329

The purpose of this course is to develop the prospective planner's abilities to critically understand, organize and manage the urban, spatial and physical environment, and to appreciate its influence on the daily experience of its inhabitants.

Amongst the objectives of the course are:

- the development of the students' design capabilities;
- the stimulation of students' powers of observation and analysis
- the engendering of an awareness of the importance of design and its influence on the lives of people;
- the provision of an understanding of how change occurs in the physical environment and the constraints imposed by the existing physical fabric on the design process.

Planning Methodology — PEP P335

Planning methodology is concerned with the array of methods and techniques which planners use to make decisions and to evaluate the outcomes of actions taken. Thus the aim of this module is to familiarize students with a wide range of commonly used planning methods and techniques. Planning methodology is best understood as the professional toolkit which helps planners to make decisions across a range of issues. For example, the preparation of development plans requires that planners have a working knowledge of how to gather, interpret and forecast socio-economic information; to set strategic options; to appraise the plan environmentally and to set indicators for performance measurement among other issues. With regard to development control, techniques such as environmental impact assessment and retail impact assessment allow planners to evaluate the likely impact of development proposals. The course seeks to introduce students to, and develop a proficiency in, some of the main practical methods and means by which planners seek to achieve the strategic and tactical goals they have set.

Degree of Master of Engineering (Structural Engineering with Architecture): Mode II

Course Description

This is a two-year course, which provides a thorough grounding in structural engineering in addition to developing a keen understanding of the interface with both Architecture and Building Design and Construction. Strong emphasis will be on creativity, using design skills and understanding to challenge the traditional boundaries of structural design.

Examination Regulations

The University Examinations for the Degree of ME Mode II (Structural Engineering with Architecture) are:

1 The First University Examination
2 The Final University Examination for the Degree

For eligibility for admission to each of the examinations, the prescribed course of study for that examination must have been attended satisfactorily.

Honours may be awarded at each Summer examination.

The attention of students is directed to the following: Credit for a course, Pass or Honours, requires satisfactory attendance and performance of all work prescribed during the year.

The examination may in each subject include a written and an oral examination.

In all practical examinations, the examiners will, where possible, take into account the work done by the candidate while preparing for the examination as shown by the certified record of his/her work, such as notebooks, project and laboratory reports, library investigations, drawings and designs etc., which must be submitted for inspection.

Time limit for Passing Examinations

Attention is drawn to the following University Regulations, which will be rigidly enforced:

1) No student will be allowed to present himself/herself for any examination in the University prior to completion of the preceding examination.

2) a) Students must pass the First University Examination in ME Research (Structural Engineering with Architecture) within two academic years from the date of entering that ME Mode II Degree course. First year students who do not pass the First Year University Examination at the end of their first year may be permitted to re-attend their first year lectures but will not be permitted to re-attend practical classes in Drawing Office or Laboratories. Exceptions to this rule will be made only on the grounds of ill health or some other grave reason.

   b) Students failing to pass the examinations within the specified interval will be ineligible to proceed further with their Engineering studies in any of the NUI constituent universities. Exceptions to this rule will be granted by the Academic

Council, on the recommendation of the College of Engineering, Mathematical and Physical Sciences, only for very serious reasons.

c) "Old Regulations" examination papers will be available for one year only following a substantial change in the syllabus of any subject.

Entry Regulations and Scholarships

Application and Limitation of Numbers in First Year ME Mode II (Structural Engineering with Architecture)

The number of students that can be accepted will be limited in accordance with the accommodation available. Admission is by competition and may involve an interview. In some circumstances admission may be subject to satisfactory performance in qualifying examinations.

The programme has one intake per year and commences in September. To avoid disappointment applications should be submitted by no later than 31 January of the year of intended entry. Applications received after the closing date may be considered subject to the availability of places.

Intending applicants shall submit an application on a prescribed form to the Programme Co-ordinator. If the Programme Co-ordinator is satisfied as to the applicant's general suitability to undertake the ME Mode II (Structural Engineering with Architecture) programme, the applicant may be called for interview. Candidates for the Degree of ME must obtain permission from the College before entering the programme.

Entry Standards

A candidate may qualify for entry by meeting the requirements set out in one of the sections below:
By holding a BSc (Structural Engineering with Architecture) from the National University of Ireland with at least Second Class Honours Grade II (2H2).

By holding a primary degree in Engineering or a related discipline with at least a Second Class Honours Grade II (2H2) award from a university or other third level institution, subject to the requirement that the College *may* decide that the candidate must achieve a satisfactory performance in a qualifying examination or test whose form shall be decided by the College on the advice of the Programme Co-ordinator.

If a qualifying *examination* is deemed appropriate, candidates may be required to study (i) at least two courses of the Third Year of the BSc (Structural Engineering with Architecture) programme; and/or (ii) complete a project on a specified topic.

If a qualifying *test* is deemed appropriate, candidates will be required to complete an essay of *circa* 5,000 words on a given topic, and undergo an oral examination on that topic.

Candidates must obtain a minimum of a Second Class Honours Grade II (2H2) in each paper and project of the qualifying examination or in the assessment of the essay for the qualifying test.

Where there is evidence of substantial professional experience in engineering or a related discipline, then the holder of (a) a pass degree or (b) chartered membership of a professional engineering institution approved by the College may, on the recommendation of the Programme Co-ordinator and with the permission of the College, be admitted to the ME Research (Structural Engineering with Architecture) degree programme on condition that the candidate *must* take a qualifying examination or a test as outlined in above.

A candidate will not be permitted to attend courses for any other university degree or diploma whilst in attendance at the ME Mode II (Structural Engineering with Architecture) Degree programme.

An applicant may have to satisfy an English language requirement before registration.

Registration

A candidate for the ME Mode II (Structural Engineering with Architecture) shall register on or before the date of commencement of the programme and shall re-register annually (if appropriate) at the prescribed times until the studies are completed. Candidates who must sit a qualifying examination shall register first as 'qualifying students for the Degree of ME Mode II (Structural Engineering with Architecture)', and after satisfying the required entry conditions, they will register for the Degree of ME Research (Structural Engineering with Architecture).

Candidates must pay the appropriate fees at the specified times.

School Information

The ME – Mode II – course in Structural Engineering with Architecture is run by the School of Architecture, Landscape and Civil Engineering, contact details are given below.

Programme Co-ordinator:	Dr. Amanda Gibney
School Address:	School of Architecture, Landscape and Civil Engineering University College Dublin, Earlsfort Terrace, Dublin 2.
School Telephone:	+353-1-716-7302

Course Syllabus – Mode II

First Year

Course Code:	*Course Title:*	*ECTS Credits:*
CVEN P301	Civil Engineering Design (1 and 2)	18
CVEN P308	The Professional Engineer	12
CVEN P304	Construction Management	12
CVEN P352	Project Work	18
	Total:	60

Second Year

Course Code:	*Course Title:*	*ECTS Credits:*
CVEN P302	Civil Engineering Design (3)	7
ARCT P301	Architectural Professional Studies	8
ARCT P302	History and Theory of Architecture	4
Elective Subjects: 2 from list A and 1 from List B		***24***
List A:		
CVEN P305	Structural Modelling	
CVEN P306	Structural Design	
CVEN P307	Soil Mechanics and Geotechnical Engineering	
List B:		
PEP P316	Planning Law	
PEP P329	Design and the Urban & Rural Environment	
PEP P335	Planning Methodology	
CVEN P353	Project Work	17
	Total:	60

First Year

Civil Engineering Design (1 and 2) CVEN P301

Design of Structures

Elastic and elastic-plastic structural analysis & plastic moment redistribution. Prestressed concrete. Analysis and design of slabs. Columns and interaction diagrams. Masonry design. Structural steel design. Composite construction.

Design in Soils Engineering

Site investigation. Harmful constituents in soils. Bearing capacity and deformation of granular and cohesive soils. Shallow and deep foundations. Piles in granular and cohesive soils. Settlement of piled foundations. Pile testing. Earth retaining structures. Sheet piled walls. Reinforced earth. Geotextiles. Stability of highway embankments and cuttings. Case histories. Laboratory testing.

Design of Water Resources Systems

Elements of applied hydrology. Water quantity requirements for domestic and industrial uses. Water sources and their development. Quality of natural waters. Quality standards for potable and industrial water supplies. Water purification processes. Water distribution. Design of sewer systems. Purification of domestic and industrial wastes. Control of water pollution. Atmospheric pollution. Refuse disposal.

Design in Highway Engineering

Properties of highway materials, such as bitumens and aggregates. Specification, testing and quality control of highway construction. Compaction and stabilization techniques to improve material properties. Design of road drainage and road foundations. Bituminous mix design. Design and management of pavements, including the maintenance of skid resistance. Geometric design of roads and junctions for safety and capacity.

The Professional Engineer **CVEN P308**

Engineer's responsibility, society and the profession. Law, forms of contract, contract documents, bills of quantities, specifications. Environmental impact assessment and appraisal. Public consultation process. The role of professional societies. Regional and urban planning, infrastructure, landscape design and conservation. Management of people and practice.

Construction Management **CVEN P304**

Project planning, control and management: cost, cost control, quality and safety. Building Design: materials, construction and assembly of buildings. Safety on Construction Sites: safety policies, safety management.

Project Work **CVEN P352**

Engineering Laboratory: Laboratory exercises associated with the lecture programme.

Design: A series of design projects introducing students to the often conflicting architectural, structural and building services requirements. Conceptual design coupled with substructure and superstructure layout and sizing will be undertaken.

Second Year

Civil Engineering Design (3) **CVEN P302**

Preliminary Design of Structures

Qualitative structural behaviour and load paths. Choice of structural material. Preliminary sizing of reinforced concrete, steel, timber and masonry members.

Architectural Professional Studies **ARCT P301**

The outline of the knowledge required to practise architecture.

The Architect as Project Manager: The architect-client appointment; Taking a brief; Auditing and surveying a building or a site; Working with the "design team" and with contractors; Estimating the cost of a job; Calculating how long a project will take; Dealing with planning and other statutory consents; Obtaining tenders and appointing contractors; Forms of construction contract; Administering a project on site; The QTC triangle.

History and Theory of Architecture **ARCT P302**

A series of seminars is offered on various themes which address contemporary and historical issues in architecture, urbanism and landscape. The seminars lay the foundations of the subject area and provide the field from which individual study and research can emerge for the preparation of a dissertation. The preparation of the dissertation involves critical reappraisal of built or published materials, or original research dealing with the primary documents.

Project Work **CVEN P353**

Each student must submit a report containing the results of a special project involving experimentation, analysis or design.

Electives List A:

Structural Modelling **CVEN P305**

Approximate methods of analysis using vector and energy approaches. Stiffness formulation. Finite Element analysis. Elastic Plastic Response. Dynamic response. Buckling analysis. Structural Forms – rings, arches, vaults, grillages, plates. Application of computer software.

Structural Design CVEN P306

Sources and assessment of structural loading. Design criteria. Selection and control of materials and workmanship. Comparison of elastic and plastic design. Limit state design in reinforced concrete, structural steelwork and timber. Structural masonry. Structural steel and reinforced concrete frameworks and continua. Applications of prestressed concrete and composite steel/concrete construction. Design of timber structures. Design for fire.

Soil Mechanics and Geotechnical Engineering **CVEN P307**

Introduction to critical state soil mechanics. Pre-yield behaviour of soils. Yielding. Soil models. Characteristic soil parameter values. Partial safety factors and Eurocode 7. Shallow foundations. Raft foundations. Piled/Raft foundations. Pile design/construction in Ireland. Ground improvement. Settlement of structures. Structural tolerance to movement. Recent developments in retaining wall analysis and design. Tunnels and tunnelling. Soil nailing.

Electives List B:

Planning Law **PEP P316**

This course studies the legal structures involved in the implementation of the planning process.

The objectives of the course are to introduce the principles of the Irish legal system, to explain the law relating to administration (with particular emphasis on local government) and to provide a clear working knowledge of the Planning Acts and Regulations. The course also addresses issues relating to EU legislation and its implementation in Ireland.

Design and the Urban and Rural Environment **PEP P329**

The purpose of this course is to develop the prospective planner's abilities to critically understand, organize and manage the urban, spatial and physical environment, and to appreciate its influence on the daily experience of its inhabitants.

Amongst the objectives of the course are:

- the development of the students' design capabilities;
- the stimulation of students' powers of observation and analysis
- the engendering of an awareness of the importance of design and its influence on the lives of people;
- the provision of an understanding of how change occurs in the physical environment and the constraints imposed by the existing physical fabric on the design process.

Planning Methodology **PEP P335**

Planning methodology is concerned with the array of methods and techniques which planners use to make decisions and to evaluate the outcomes of actions taken. Thus the aim of this module is to familiarize students with a wide range of commonly used planning methods and techniques. Planning methodology is best understood as the professional toolkit, which helps planners to make decisions across a range of issues. For example, the preparation of development plans requires that planners have a working knowledge of how to gather, interpret and forecast socio-economic information; to set strategic options; to appraise the plan environmentally and to set indicators for performance measurement among other issues. With regard to development control, techniques such as environmental impact assessment and retail impact assessment allow planners to evaluate the likely impact of development proposals. The course seeks to introduce students to, and develop a proficiency in, some of the main practical methods and means by which planners seek to achieve the strategic and tactical goals they have set.

(MEngSc) (ENMR0002)

1. Methods of Proceeding to the Degree

The Degree of MEngSc may be obtained by thesis (Mode I) or by examination following a taught course (Mode II).

Mode I

A candidate must carry out a full-time research project for at least three terms under the direction of the supervisor appointed by the Head of the School concerned. The thesis presented by the candidate is to embody the result of this research project. At least one examiner shall be an external examiner. A candidate may be required to pass a *viva voce* examination on the subject matter of the thesis if the examiners so decide. Provision may be made for part time-study on a case-by-case basis.

Mode II

A candidate must attend, for at least three terms, a full-time postgraduate course approved by the College of Engineering, Mathematical and Physical Sciences and must pass a University examination on the subject matter of the course. A candidate may be required to submit a dissertation on a project undertaken as part of the course; this dissertation will form part of the material to be assessed by the examiners.

The College must approve the syllabus of the course to be attended by a candidate proceeding under Mode II.

2.Admission Procedure

An applicant for admission as a candidate for the Degree of MEngSc by Mode I or by Mode II shall submit an application on a prescribed form to the Head of the School in which the applicant wishes to study. If the Head of the School is satisfied as to the applicant's general suitability to undertake an MEngSc programme, the School shall forward the candidate's application to the College Principal for consideration by the College. Candidates for the Degree of MEngSc must obtain permission of the College before entering on the programme.

There are three intakes each academic year in September, January and March to the programme leading to the award of MEngSc (Mode I) by thesis. It may be possible to commence at a different time, subject to the agreement of the Supervisor and with College approval. Normally the closing dates are:

	(i) **September** Intake	(ii) **January** Intake	(iii) **April** Intake
non-EU candidates	31st March	28th July	30th September
EU candidates	28th July	30th November	27th February

Taught Master's Programmes

The programme leading to the award of MEngSc (mode II) by examination has one intake per year and commences in September, and to avoid disappointment applications should be submitted by no later than 31 March for non-EU and 31 July

for EU candidates. Applications received after the closing date may be considered subject to the availability of places.

3.Entry Standards

A candidate must qualify for entry by meeting the requirements of one of the sections 3. 1, 3. 2 or 3. 3 below.

3. 1 By holding a primary degree in Engineering from the National University of Ireland with at least Second Class Honours, Grade II (2H2).

3. 2 By holding a primary degree in Engineering or a related discipline with at least a Second Class Honours, Grade II award from a university or other third level institution, subject to the requirement that the College *may* decide that the candidate must achieve a satisfactory performance in a qualifying examination or test whose form shall be decided by the College on the advice of the Head of the School in which the candidate intends to study.

(a) If a qualifying *examination* is appropriate, candidates will be required to spend one academic year studying (i) at least two courses of the Fourth Year core programme; and (ii) complete a project on a specified topic. The courses studied and project topic will be relevant to the proposed area of research.

(b) If a qualifying *test* is deemed appropriate, candidates will be required to complete an essay of *circa* 5,000 words on a given topic and undergo an oral examination on that topic.

3. 3 Where there is evidence of substantial professional experience in engineering or a related discipline, then the holder of (a) a pass degree or (b) chartered membership of a professional institution approved by the College may, on the recommendation of the Head of the School and with the permission of the College, be admitted to the MEngSc programme on condition that the candidate *must* take a qualifying examination or a test as outlined in 3. 2 above.

4. A candidate may, in exceptional circumstances, be permitted to pursue the practical work of the research project required under Mode I in an institution other than the University, provided that:

(i) The field of research and the institution in which the practical work is to be pursued are approved in advance by the College;

(ii) The course of training in research is supervised directly by a member of the academic staff of the School in which the candidate is studying as if the work were being pursued totally within the University.

5. A candidate will not be permitted to attend courses for any other university degree or diploma whilst in attendance at the MEngSc Degree programme.

6. An applicant may have to satisfy an English language requirement before registration.

7.Registration

A candidate by Mode I or Mode II shall register on or before the date of commencement of the period of study and shall re-register annually (if appropriate) at the prescribed times until the studies are completed. Candidates in the category described by Section 3. 2 (a) shall register first as 'qualifying students' for the Degree of MEngSc, and, after satisfying the required entry conditions, they will register for the Degree of MEngSc by Mode I or Mode II.

Candidates must pay the appropriate fees at the specified times.

Mode II MEngSc Programmes

The College of Engineering, Mathematical and Physical Sciences offers Mode II MEngSc Degree programmes as follows:

Food Engineering, Water & Environmental Engineering, Transportation Engineering, Structural Engineering and Environmental Engineering

Details of the MEngSc (Mode II) programmes provided in Session 2005/06 are as follows:

Food Engineering:

Introduction To Food Engineering **AFFD P001**

Basic modes of heat transfer in foods. Heat transfer with phase change. Heat exchangers in food processing. Mass transfer in food separation processes including: distillation, leaching, filtration, ultrafiltration, reverse osmosis, electrodialysis, centrifugation. Process laboratory

Food Process Engineering **AFFD P002**

Unit processes, heat and mass transfer systems and equipment in food processing including pasteurisation, UHT and aseptic processing, microwave and dielectric heating, crystallisation, freezing, homogenisation, emulsification. Drying theory and applications. Unit processes associated with drying including evaporation, extrusion, packaging and storage. Process simulation, assignments.

Food Product Development **AFFD P003**

Food product development incorporating product conceptualisation, product formulation, sensory analysis, colour measurement, principal component analysis, statistical analysis, shelf life, market analysis. Laboratory practicals. Mini-project involving product and process development for a selected food product or ingredient.

Food Process Development **AFFD P004**

Food process development incorporating process engineering, quality control, plant layout, project management, environmental engineering, legislation, health and safety.

Sensors in Food Process Automation **AFFD P005**

On-line measurement systems for physical properties of foods including optical (NIR, MIR, visible), rheological, ultrasonic and hot wire sensors. Process automation systems. Case studies on selected food products. Laboratory practicals. Assignments.

Advanced Food Process Engineering **AFFD P006**

Novel food manufacturing techniques in one of more selected areas including fermentation, refrigeration, ohmic heating, high pressure processing, supercritical extraction, sous vide processing. Basic theory, process strategy, equipment, food quality, market niche.

Advances in Food Engineering Research **AFFD P007**

Detailed outline of advances in food engineering research in **one** selected area such as rheology, storage systems or dehydration technologies. Basic theory, systems modelling, experimental protocols, instrumentation, data analysis, interpretation and application of results. Assignments including review of advanced research papers.

Project and Research Methods **AFFD P008**

Each student undertakes a major project under the direction of a supervisor, the findings of which are presented in the form of a written dissertation. Initial guidance in project management will be provided by a series of lectures on research methods.

Water & Environmental Engineering:

Unit treatment processes **CVWE P001**

Theory and technology relating to sedimentation, flotation, filtration, chemical coagulation, chemical precipitation, ion exchange, adsorption, disinfection, fluoridation, aeration; design of water and wastewater treatment systems.

Sanitary engineering hydraulics **CVWE P002**

Steady flow in pipes, manifolds and pipe networks; form losses; pumping station hydraulics; waterhammer analysis and control; open channel flow – steady, gradually varied and unsteady; hydraulics of sewer systems; hydraulic structures for flow measurement.

Engineering hydrology **CVWE P003**

The hydrological cycle; water balances; measurement and analysis of hydrological processes; stochastic and deterministic models; analysis of floods and droughts; application of hydrological techniques to water supply, urban drainage, wastewater dilution; other engineering applications such as hydropower, flood forecasting, irrigation and drainage.

Water resource systems analysis **CVWE P005**

Sustainable development and investment in water resource projects; project life cycle; objectives of water resource development; performance indices; engineering alternatives – size, location, allocation and timing; evaluation and selection with multiple objectives; system simulation; sampling experiments; synthetic hydrology; system control; dynamic

programming; heuristic rules; system optimisation; linear and non-linear programming; case studies.

Water quality modelling
Definition and measurement of water quality parameters; pollutant sources, pathways and sinks; pollutant variability; modelling of kinetics; water quality modelling in rivers, dispersion, self-purification, oxygen and mass balance equations; water quality modelling for lakes and reservoirs; estuarine water quality models, tides, saline intrusion, mixing; modelling of discharge to the marine environment, sea outfalls.

Applied chemistry and microbiology **CVWE P004**
Review of basic principles of chemistry; chemical equilibrium in true solutions; gas-liquid and liquid-solid equilibria; surface chemistry; fundamentals of biochemistry; biologically-mediated transformations in aquatic systems; general systems of classification of water-dispersed substances; chemical and biological water quality criteria; critical review of water quality standards; methods of chemical and microbiological analysis.

Environmental management and Environmental engineering **CVWE P006**
Policy, law and administration. Assessment of ecological impact: ecology of wetlands and freshwaters. Air pollution and noise. Disposal of solid and hazardous wastes.

Laboratory programme **CVWE P007**
Students carry out practical work programmes in the following laboratory disciplines:

Water and Wastewater Analysis, Unit Treatment Processes, Hydraulics, and Microcomputers.

Project **CVWE P008**
Each student undertakes a major project under the direction of a supervisor, the findings of which are presented in the form of a written dissertation. Project topics generally relate to engineering aspects of the analysis, design and operation of a water supply and wastewater disposal system.

Computer methods
Computer organisation and computer languages; problem solving and problem development; computer applications in water engineering; computer exercises; practical evaluation of relevant computer packages.

Degree of Master of Engineering Design (MED)

(ENMXF0013)
(ENMXP0019)

Admission Requirements

1. A candidate for the degree must obtain the permission of the College of Engineering, Mathematical and Physical Sciences before entering the course. Application on the prescribed form must be made to the College of Engineering, Mathematical and Physical Sciences (before the second week of October). A candidate for admission must be an engineering graduate or must fulfil the conditions described in section 2 below.

   A candidate for selection will be required to have had suitable industrial experience for a period of at least one year. Candidates who have obtained First Class Honours in the primary degree, or who have pursued a suitable postgraduate course, may be accepted without industrial experience, provided that adequate vacation training has been obtained.

   Candidates will be interviewed in November. The number of entrants to the course shall be limited.

2. A suitable candidate who is not a university graduate, but who is a corporate member of Engineers Ireland (formerly the Institution of Engineers of Ireland), or of equivalent status in a similar professional engineering institution, may be recommended to the College for admission to the course.

Course

The course is a part-time course over two years and will consist of lectures, seminars, tutorials and project work. Project work will account for about 40 per cent of the course and a typed and bound thesis must be presented for examination. The course project and examination must be passed within nine terms from the commencement of studies unless special permission is granted by the College.

Subjects

The subjects will be chosen by students with the permission of the Professor from among the following:

Design Methodology and Practice **MHED P001**

Design as an engineering discipline. How to initiate design. Analytical and experimental support tools for design. Developing the concept. Mechanism modelling. Form modelling. O.E.M. supply sources. Use of standards. Quality assurance. Patents and patenting procedure. Legal responsibilities. Product liability claims. Value analysis. Cost in design and in product. Ergonomics. Aesthetics.

Computer Aided Design **MHED P002**

Product and system design. Computer integrated design and manufacture. Simultaneous engineering. Design for manufacture. Group technology. CAE/CAD/CAM applications.

Solid, surface and wire frame modelling. Programmable graphics. Optimisation of mechanical design. Graphics exchange standards. Computer graphic workstations. Graphic devices and software. Knowledge-based engineering systems.

Design of Machine Elements **MHED P003**

Stress management and analysis. Machine element design, static and dynamic finite element modelling and applications, element shape functions, computer procedures, design with viscoelastic materials, impact absorption, design with anisotropic materials, properties of carbon fibre composites etc.

Materials Selection **MHED P004**

Cast irons. Carbon alloy steel products. Heat treatment of carbon alloy steels. Fabrication and service characteristics of carbon and alloy steels. Non ferrous metals. Heat treatment of non ferrous metals. Fabrication and service characteristics of non ferrous metals. Production processes for polymer materials, ceramics and coatings. Classification methods for metals, polymers and ceramics. Case studies in alternative materials selection and substitution of materials. Material selection by computer.

Production Systems, Design and Management **MHED P005**

Production standard data. Value engineering. Human factors in engineering design. Learning and progress functions. Motivation and industrial relations. Productivity agreements and controls. Plant and investment analysis. Inventory systems. Quality management. Plant engineering systems. Management and organisation. Design of a production system – case study.

Design of Automated Manufacturing Systems **MHED P006**

Types of manufacture: Continuous, batch, one-off. Manufacturing resource planning and control. Computer integrated manufacturing. Just-in-time and kanban methods. Flexible manufacturing systems and cells for metal cutting, welding, assembly etc. off-line CNC and robot programming. Communication networks and protocols. Machine systems engineering. Robot kinematics, dynamics and control. Drive systems, actuators and sensors. Programmable logic controllers.

Microprocessor Applications **MHED P007**

Binary maths, logic, number systems and codes. Microcomputer components and architecture. Instruction sets and assembly language programming. Programme structure. Compilers and high level languages. Ports and input/output. Polling. Interrupt and direct memory access. Microcontrollers. Actuators. Practical exercises in microprocessor based data acquisition and control. Networks. Overview of application design and development.

Digital Electronics Design and Interfacing **MHED P008**

Boolean algebra. Combinational logic. Gates. Minimisation. Examples. Sequential logic elements. Synchronisation. Sequential logic system design. Registers, counters, multiplexers and other MSI components. Programmable logic devices. Circuit operation and types: transistors, TTL, CMOS. Practical circuit design issues: loading, timing, buses, line driving, noise sources and avoidance. Signal conditioning.

Tribology and Design Applications **MHED P009**

Fundamentals of tribology and surface texture interactions. Emphasis on design and energy aspects. Case studies and applications. Practical lubrication examples including Elastohydrodynamics. Application to design of machinery systems. Prototypes and Bearings.

Technology and Innovation Strategy **MHED P010**

Principles of economics, macroeconomics and social indicators, growth models, production functions, the technological factor, industrial policy, venture capital. The role of technology in economic growth, industrial innovation, industrial policy, and sectoral and inter-firm competition. Patenting, licensing and the finance of technology. Technology and skill change. Technology in higher education. Telecommunications. Technological forecasting and assessment. European programmes in science and technology.

Design of Internal Combustion Engines **MHED P011**

Study of internal combustion engine design issues – based on fundamentals of thermodynamics, fluid mechanics, heat transfer and combustion. Four-stroke spark-ignition and compression-ignition engine thermodynamics. Spark-ignition and compression-ignition combustion systems. Fluid flow in intake and exhaust systems. Turbocharging and supercharging. Exhaust emission control systems. Heat transfer in engine cooling systems. Engine-vehicle integration.

Design of Thermal Power Plant **MHED P012**

Thermodynamics of heat engines. First and Second Law analysis of cycles and systems. Equivalent Carnot cycles. Advanced cycles. Combustion systems. Turbomachinery. Flue gas emissions control systems. Auxiliary plant.

Micro-climate Management Design **MHED P013**

Specification of micro-climate. Fundamentals of heat transfer. Psychrometry. Analysis of heat gain calculation methods. Estimation of cooling load. Solar design. Passive cooling. Mechanical heating and cooling. First and Second Law analysis of climate manipulation systems. Energy auditing. Energy management.

Design of Building Energy Systems **MHED P014**

Study of building energy system design issues. Air conditioning systems. Air heating systems. Humidification and dehumidification systems. Air handling equipment. System integration. System control design.

Polymer Matrix Composite Materials: Performance and Design

MHED P015

Fibres. Fibre-matrix interface. Elastic properties – classical laminate theory. Strength of unidirectional laminae. Strength of laminates. Structural component design. Case studies.

Manufacturing and Design with Engineering Polymers **MHED P016**

Extrusion process. Injection moulding. Blow moulding. Thermoforming process. Rotational moulding. Dies and moulds. Environmental aspects of plastics.

Design of Biomechanical Systems **MHED P017**

Introduction to anatomy and physiology. Biomaterials. Mechanics of hard tissue. Mechanics of soft tissue. Bio-viscoelastic solids. Joint mechanics. Bio-viscoelastic fluids. Design of implantable devices.

Design Project Work **MHED P018**

Degree of Master of Industrial Engineering (MIE)

(ENMXP0020)

Course Description

The MIE degree programme provides a structured approach for engineers and scientists to acquire the engineering and managerial disciplines necessary to effectively manage operations across a wide spectrum of industry. The course is designed for those already involved in operations management or hoping to move into the area. It contains a mixture of Analytical, Operations, Technology and Business topics aimed at giving participants a balanced foundation in theory and modern day industrial practice.

Admission of Candidates

1. A candidate for the degree must obtain the permission of the College of Engineering, Mathematical and Physical Sciences before entering on the course. Application on the prescribed form which is obtainable from the School of Electrical, Electronic and Mechanical Engineering must be made to the College of Engineering, Mathematical and Physical Sciences. A candidate for admission must be an Engineering graduate of a recognised university, or must be an Architecture or Science graduate with suitable experience and the required standard of mathematics, or must fulfil the conditions described in Section 2 below.
2. A suitable candidate, who is not a university graduate, but who is a corporate member of Engineers Ireland (formerly the Institution of Engineers of Ireland), or of equivalent status in a similar professional engineering institution, may be recommended to the College for admission to the course.

Part-time Course (Two Years)

The course is a part-time course over two years. Attendance is required for at least six terms after admission and during attendance candidates cannot at the same time engage in any other course in the University.

Students must make arrangements with their employers for release for attendance on the afternoons on which the prescribed courses are held as set out in the timetable.

Modular Course

The programme will be provided as a credit system to be taken by candidates over a period of two or more years. In order to obtain the Degree, candidates must attend an approved set of courses and pass the relevant University Examinations. The courses and credits are shown below and the Degree will be awarded when the candidate has successfully attained a total of 90 credits.

Subjects and Credits

Part A		**Marks**	**Credits**
Core Subjects			
Code			
TBA Eng	Production System Design	100	*5*
TBA Eng	Supply Chain and Logistics	**100**	*5*
MHIE P018	Quality management	**100**	*5*
TBA Eng	Statistical Methods	**100**	*5*
HRM P618	Managing Human Resources	**100**	*5*
TBA	Behaviour, Leadership and Change	**100**	*5*
ACC P623	Management Accounting	**100**	*5*
	Total	**700**	**35**

Part B			
Core Subjects			
Code		Marks	Credits
MHIE P021	Operations Strategy	100	*5*
MHIE P023	Technology, Innovation and Design	100	*5*
TBA	Business System Design	100	*5*
FIN P659	Finance	100	*5*
MIS P651	Management Information systems	100	*5*
MKT P645	Marketing and Innovation	100	*5*
BMGT P768	Strategic Management	100	*5*
	Total	*700*	*35*

Optional Subjects

Students will complete four(4) optional subjects or two(2) optional subjects plus the Project over the two years of the programme. The timing and availability of specific options will be at the discretion of the Programme Co-ordinator.

Code		Marks	Credits
MHIE P019	Project Management	100	5
TBA Eng	Environmental Engineering and Policy	100	5
TBA Eng	New and Emerging Technologies	100	5
MHIE P017	Process Operations and Reliability	100	5
TBA Eng	Technology Integration	100	5
TBA Eng	Statistics and Optimisation	100	5
MHIE P024	System Simulation	100	5
TBA	Economics	100	5
TBA	Local Government	100	5
TBA Eng	Project (Optional|)	200	10

Candidates for the degree are required to complete the course within four years of registration.

MIE Part A

PRODUCTION SYSTEMS DESIGN **TBA Eng**

Operations strategy and competitiveness, process choice, facility location and layout. Job design and work measurement, payment schemes, managing productivity. Lean manufacturing. World Class Manufacturing. Just-in-Time

SUPPLY CHAIN AND LOGISTICS **TBA Eng**

Supply chain concepts, inventory systems, materials management, network capacity planning, logistics, purchasing strategy, outsourcing, information integration and supply chain co-ordination.

QUALITY MANAGEMENT **MHIE P018**

Quality Management philosophy and methodology, the ISO9000 Quality Assurance Standards series. Total Quality Management. Quality Costs, quality auditing.

Benchmarking. Continuous Improvement Value Analysis. Failure Mode and Effects Analysis (FMEA). Business excellence models. Application of statistical methods to process and quality control. Six Sigma.

STATISTICAL METHODS **TBA Eng**

Introduction to probability and statistics. Binomial, Poisson, normal and other probability distributions. Decision theory. Significance tests. Estimation, regression and correlation. Time series. Queueing Theory. Time series forecasting models.

MANAGING HUMAN RESOURCES **HRM P618**

The management of employee relations in Ireland. Human Resource policy and practice, recruitment and selection, performance management, reward systems, employee voice systems, work systems. Models of HRM. Links between HR strategy and business strategy.

PEOPLE, BEHAVIOUR AND CHANGE **TBA**

Systems theory approach to the human side of enterprise, with a focus on the individual, the group and the overall organisation. Developments in social and organisational psychology. Group dynamics, leadership, team development and performance. Transformational leadership. Stress in the workplace. A behavioural model of organisational change.

MANAGEMENT ACCOUNTING **ACC P623**

Fundamentals of cost accounting, purpose of management accounting, cost terms and purposes. Cost-volume-profit relationships, product costing, job costing and process costing. Management control systems, budgeting and standard costing techniques, system design. Responsibility accounting and motivation, decision making. Relevant costs and the contribute approach to decisions, cost allocation and absorption. Decentralisation, performance evaluation and transfer pricing.

MIE Part B

OPERATIONS STRATEGY **MHIE P021**

Management principles and practice. Competitive manufacturing strategies. The management of service operations. Focussed manufacturing. Managing change in manufacturing. Managing the supply chain, make or buy. Global operations. World Class Manufacturing

TECHNOLOGY INNOVATION and DESIGN **MHIE P023**

Product design and development - factors for success. The role of creativity in product success. Stimulating personal and organisational creativity. The formulation of development strategy and the selection and implementation of product development Life Cycle models. The influence of organisational structure and communication on design and development success. National and corporate application of Technology Foresight tools and techniques and the formulation of technology strategy. Intellectual property capture and management.

BUSINESS SYSTEM DESIGN **TBA**

Organisation – internal and external functions, operations and management, decision making, optimising use of resources. Methodology – how to capture resources, reference modelling. Technology – using ICT to develop models, how models are used to design systems

FINANCE **FIN P659**

Financial Institutions: forecasting financial requirements, sources of finance, capital structure. Financial Analysis and planning. Investment appraisal: measurements of return and risk. Cost of Capital. Management and sources of working capital. Long term capital: shares, fixed return and other sources. Mergers and acquisitions. Corporate failure and rehabilitation.

MANAGEMENT INFORMATION SYSTEMS **MIS P651**

Information resource management. Management and decision making. Information systems and the value chain. Information systems and organisational models. Information systems in functional business areas. Information management. Transaction processing systems, management reporting systems, decision support systems, knowledge based systems, office information systems, e – commerce, electronic markets, inter organisational systems, enterprise resource management, business process reengineering. Building management information systems. System development life cycle

MARKETING AND INNOVATION **MKT P645**

The Marketing Process, Core concepts in strategic marketing, managing the marketing process. Market information systems, market surveys. Buyer behaviour. Market segmentation, targeting and positioning. New product development, product policy. Marketing services and quality. Pricing strategies. Advertising and promotion. Channel management and distribution.

Commercialisation of innovation. Evaluation and management methodologies for emerging technologies. Decision parameters, uncertainty, risk, time, subjectivity, utility. Funding innovation, valuation, venture capital market, stock market.

STRATEGIC MANAGEMENT **BMGT P678**

This course examines how the organisation finds and enacts its strategic intentions. The aim is to optimise the positioning and performance of the firm within its business environment through an appreciation of the way organisations work in terms of their structures and management processes. Contemporary paradigms and emerging trends in strategic management will be discussed. Among topics covered are: models of strategic management, strategic control, leadership, organisational politics, corporate culture, business ethics, quality management, organisational change and renewal, organisational learning, and the management of multi-business companies.

OPTIONAL SUBJECTS

Students will either take four subjects from the following list, or two subjects from the list plus the project. The availability and timing of optional subjects will be at the discretion of the Programme Co-ordinator.

PROJECT MANAGEMENT **MHIE P019**

Project definition, project selection, economic analysis, the role of the project manager, project organisation, planning, budgeting and estimation, scheduling, resource allocation, control, project termination.

ENVIRONMENTAL ENGINEERING and POLICY **TBA**

Topics in the area of environmental engineering may include the legal framework, sustainability and environmental policy, environmental impact assessments, emissions controls and trading, waste disposal, environmental economics

NEW AND EMERGING TECHNOLOGIES **TBA Eng**

The impact of technology developments on industrial and commercial activity. Technology areas to be covered will include some of the following –telecommunications, energy, materials, biotechnology, transport.

PROCESS OPERATIONS and RELIABILITY **MHIE P017**

Asset Management, maintenance principles, reliability theory, equipment failure, reliability and risk, preventative and predictive maintenance, process equipment maintenance, recovery, business continuity, health and safety.

TECHNOLOGY INTEGRATION **TBA Eng**

Computer Integrated Manufacturing, manufacturing information systems, concurrent engineering, computer aided design and manufacture, product data management,

database management, factory communication, supervisory control and data acquisition, flexible manufacturing, automation, programmable control.

QUANTITATIVE METHODS **TBA Eng**

Introduction to simulation. Discrete event simulation. Verification and validation of models, Analysis and interpretation of results. Analysis of variance and covariance. Multiple regression. Design of experiments. Evolutionary operation.

SYSTEM SIMULATION **MHIE P024**

Introduction to simulation and modelling, underlying theory and concepts. Problem formulation, verification and validation, analysis of model outcomes. Discrete event simulation, continuous simulation. Computational tools for simulation and modelling. Applications from sectors including: Service, Industrial, Manufacturing and Financial.

ECONOMICS TBA

The course covers topics in micro and macro economics including; economics of the firm – transaction cost and agency theory, application of economic theory on demand, production, cost, pricing, risk and uncertainty to business decisions. National accounts and their compilation. Theory of income determination. The role of money in the economic system.

LOCAL GOVERNMENT **TBA**

Functions of the local authority, regulatory powers and duties, policy aspects and issues. Corporate governance. Local government finance, capital and current expenditure, estimating process, control functions of central government.

PROJECT (Optional) **TBA Eng**

Each student undertakes a major project under the direction of a supervisor. The subject area will relate to operations management and students will be expected to draw on materials from their own professional backgrounds. A dissertation will be presented

Higher Diploma in Technology Management (HDipTechMangt)

(IFHDP0014)

Course Description.
The Higher Diploma in Technology Management is designed to complement the MSc (Technology Management) degree. Lasting for one year rather than two, it offers to interested graduates a less extensive coverage than the degree. As such it meets the needs of graduates who cannot commit to the more demanding time requirements of the Master's programme. The Higher Diploma will be of interest to all executives who manage technology or the process of technology-based innovation, or who occupy or aspire to executive positions in companies driven by technology. Suitably qualified candidates who reach honours standard in the Higher Diploma in Technology Management may petition the Board of Studies to be admitted to the M.Sc.(Technology Management) degree, with exemption on a subject-by-subject basis.

Admission Requirements.
The normal requirement for entry will be a degree or a diploma from a recognised awarding body, together with at least three years' appropriate experience. In exceptional cases, and subject to interview, applicants without such qualifications may be admitted. Such candidates will have to demonstrate significant seniority and career achievement in a technical area or company, as well as satisfying the interview board of their ability to cope with the material in the course. Applicants will be required to complete the GMAT (Graduate Management Admissions Test).

Application Procedure
Application for admission should be made to the Programme Director, Higher Diploma in Technology Management, at The Michael Smurfit Graduate School of Business, UCD, Blackrock, Co. Dublin. The closing date for admission in September is July 25.

Course Structure and Examination Requirements
The course is on a part-time basis over two semesters, commencing in September (Autumn Semester) and January (Spring Semester). There is a total of 10 courses, four of which are core and six optional. The options offered in any year will depend on the interests of the incoming class, and on the number of students wishing to take each option. The Board of Studies may specify prerequisite qualifications for entry into particular options. Five courses will be completed in each semester. The degree must be completed within three years of first registering.

Examinations:
Examinations are held in December and May, and subjects are examined at the end of the semester in which they are taught. Repeat examinations for Autumn semester courses will be offered at the end of the Spring semester and repeat examinations for Spring

semester courses will be offered at the end of the Autumn semester. The Diploma award is determined from the composite grade for the examinations in both semesters.

Core Subjects:

ACC P621	Management Accounting
BMGT P641	Business Strategy
BMGT P640	Organisation and Innovation I
BMGT P643	Marketing New Products

Options:

BMGT P516	Technology Planning and Commercialisation
BMGT P642	Organisation and Innovation II
BMGT P645	Supply Network Strategy
BMGT P518	Development Process Management
MIS P622	Management Information Systems
ECON P200	Business Economics
FIN P623	Finance
MEEN P004	Quantitative Methods for Management
BMGT P644	Technology Strategy
BMGT P649	Technology Policy
BMGT P520	Engineering Economic Analysis

Course Syllabus

Management Accounting **ACC P621**

Nature and role of managerial accounting. Cost terminology and classification. Accounting for materials, labour and overheads; cost allocation and apportionment; overhead absorption. Product and job costing and inventory valuation. Cost behaviour and prediction. Activity based costing. Project costing. Decision-making and relevant costs. Decision-making with scarce resources including linear programming. Decision-making under uncertainty. Budgets, budgetary control and Lotus 1-2-3. Standard costing and variance analysis.

Development Process Management **BMGT P518**

Building and managing a portfolio and pipeline of development projects which fit strategically, balance risks, and generate desired cash flows. Managing multiple projects through later stages of development: procedures for uncertainty reduction and resource allocation. Managing individual projects to deliver quality products to market in a timely and cost-effective manner: using project teams as a mechanism of organisational learning.

Technology Planning and Commercialisation **BMGT P516**

This subject deals, on a less extensive basis than Technology Strategy, with identifying and classifying technologies of interest to the firm. It also deals with practical aspects of acquiring and financing targeted technologies.

Technology Impact Analysis: identifying and classifying technologies by the size and timing of their potential impact on the business. Selecting technologies, which support business strategy; defining strategies for technology acquisition and development.

The Irish and European innovation System: sources of technology and advice, sources of public funding for innovation. Venture capital and private funding sources. Technology acquisition: licensing, joint venture and acquisitions. The art of negotiation in technology acquisition and sale. The protection of Intellectual Property.

Engineering Economic Analysis **BMGT P520**

Plant investment analysis using DCF and other criteria, investment cost estimation; operations, improvement and replacement economics and cost analysis, obsolescence and inflation; leasing; risk analysis; sequential decisions; down-time, maintenance and other aspects of life-cycle cost analysis; large project analysis; utility, multi-objective and statistical decision analysis, value of information; related economic concepts, advanced technology investment.

Organisation and Innovation I **BMGT P640**

Theories of motivation, satisfaction and their relation to performance; intrinsic and extrinsic motivation; goal setting, job design and reward systems. Application to scientists and engineers.

Small group formation and cohesion, group structure, influence processes and leadership. Application to innovation.

Business Strategy **BMGT P641**

Defining the business domain and opportunity space; environmental and competitive analysis; growth ambitions, trajectories and strategies; competitive intent and strategy; building the bases of sustainable advantage; the role of innovation and technology in generating growth options and sustainable advantage.

Organisation and Innovation II **BMGT P642**

Developing structures and systems appropriate to the innovation and technology strategy of the firm. Building competences and knowledge creation for sustainable long-term advantage; organising for incremental, generational and radical innovation.

Marketing New Products **BMGT P643**

Market definition and entry strategy. Product strategy. Defining the role of the product in the marketing mix. Identification of key customer needs and key product characteristics for market success: idea generation; the role of the lead user; measuring customer product perceptions; integrating market need and product design – QFD and other approaches. Product positioning; the marketing mix; advertising, market and product testing; product launch; product life-cycle management.

Technology Strategy **BMGT P644**

Patterns and types of innovation and technology substitution. Technology Impact Analysis: identifying and classifying technologies by the size and timing of their potential impact on the business; selecting technologies which support business strategy; defining

innovation strategy and competitive posture; assessing strength in base, key and emerging technologies; defining strategies for technology acquisition and development; deciding the total budget and identifying sources of financing for R&D; defining the balance of spending between early-stage and late-stage programmes.

Supply Network Strategy **BMGT P645**

Operations strategy, service operations, productivity and performance, network capacity planning, total quality management, strategic supply networks, lean production and supply, time based competition, benchmarking and improvement, network relations.

Technology Policy **BMGT P649**

The National Innovation System. The role of technology in economic growth, industrial innovation, industrial policy, and sectoral and inter-firm competition. Technology and skill change. Technology in higher education. European programmes in science and technology. Technology and economic development; the social shaping of technology; technology indicators; the monitoring of technology/society relations; technology planning and the role of the State; generic and direct intervention measures.

Business Economics **ECON P200**

The course covers topics in micro and macro economics including: economics of the firm – transaction cost and agency theory; application of economic theory on demand, production, cost, pricing, risk and uncertainty to business decisions. National accounts and their compilation. Theory of income determination. The role of money in the economic system.

Finance **FIN P623**

Sources and costs of finance. Capital structure. Interpretation of financial statements. Forecasting financial needs. Capital investment evaluation. Option pricing for R & D project and portfolio evaluation. Company evaluation. Mergers and acquisitions.

Quantitative Methods for Management **MEEN P004**

This course will cover selected topics from the following material.

Statistical Analysis. Introduction to probability and statistics, binomial, Poisson, normal and other probability distributions; significance tests, estimation, regression and correlation, time series. Multivariate statistics for marketing: multiple regression; discriminant analysis, conjoint analysis, Analytic Hierarchy Process.

Optimisation. Operations Analysis and Optimisation: Classical optimisation techniques, search techniques, gradient methods, linear programming, non-linear programming, dynamic programming.

Decision Analysis. Issues of structure, uncertainty and value in decision. Modelling structure; probability and utility assessment; behavioural issues in judgement and decision making. Multi-attribute decision problems. Group decision-making. Decision support products. Computer-based support for planning techniques.

Management Information Systems **MIS P622**

Theoretical Elements and Organisation of Information Systems. Information resource management. Management and decision making. People and organisations. Information systems and models. Information systems in functional business areas. Information management. Case studies.

Technical Components and Applications of Information Systems. Technical foundations of information systems; hardware, software, databases, networks. Technical applications of information systems; transaction processing systems, management reporting systems, decision support systems, knowledge-based systems. Case studies.

Practical Aspects of Information Systems. Building management information systems. The system development life cycle. Strategy, specifying requirements, design, acquisition, development, implementation. Case studies.

Degree of Master of Science (Technology Management) (MSc)

(IFMXP00012)

Course Description

The MSc in Technology Management is a collaboration between the Faculties of Commerce and of Engineering & Architecture. It is designed for graduates who are responsible, or who will soon become responsible, for managing technological innovation, or who work in companies driven by technology.

The management of technological innovation involves putting in place and operating the strategies, structures, staffing and systems needed for the effective development and commercialisation of products and services, together with their associated production processes and supply networks; and for the acquisition, development and timely embodiment of their constituent technologies and supporting knowledge bases. The degree courses will provide a comprehensive coverage of these topics.

Admission Requirements

A candidate for admission must hold an Honours degree deemed appropriate by the Board of Studies, or must fulfil the conditions described below. A candidate who is not a graduate, but who is a corporate member of the Institution of Engineers of Ireland, or of a professional institution, may be eligible for consideration for admission. A candidate must normally have a minimum of three years' relevant work experience in a business/industrial organisation. Applicants will be required to complete the GMAT (Graduate Management Admissions Test).

A candidate whose qualification is not in engineering or science will have to satisfy the Board of Studies of his or her suitability for the programme by virtue of their work experience and by meeting such other criteria as the Board may specify.

Candidates who already hold the MIE or MBA degree may be eligible for exemption on a subject-by-subject basis at the discretion of the Board of Studies.

Qualified candidates who reach honours standard in the Higher Diploma in Technology Management may petition the Board of Studies to be admitted to the MSc(Technology Management) degree, with exemption on a subject-by-subject basis.

Application Procedure

Applications for admission should be made to the Programme Director, MSc (Technology Management), University College Dublin. Telephone: +353-1-716 8012; Fax: +353-1-716 8030; email: nitm@ucd.ie; Website: www.ucd.ie/nitm/main.htm. Applications should be received not later than July 25, for admission in September.

Course Structure and Examination Requirements

The course is on a part-time basis. The current delivery mode starts in September, with classes on Friday afternoon and Saturday morning. It is designed to be completed in two

years, five subjects from the following list in each half year, with a major project in the second year. (An alternative additional mode may be initiated, with classes on three days per month with electronic learning support between classes.) The degree must be completed within five years of first registering.

Examinations:
Examinations are held in December and May, and the subjects examined are those covered in the previous half year. Repeat Examinations for Autumn Semester courses will be offered at the end of Spring Semester and repeat examinations for Spring Semester will be offered at the end of Autumn Semester. Candidates are required to submit a report on a project, undertaken during their second year, before completing their degree. The degree awarded is determined from the composite grade for the written examination in both years and the project report.

Course Content.
The subjects offered will be selected from the following list:

ACC P621	Management Accounting
BMGT P640	Organisation and Innovation I
BMGT P641	Business Strategy
BMGT P642	Organisation and Innovation II
BMGT P643	Marketing New Products
BMGT P644	Technology Strategy
BMGT P645	Supply Network Strategy
BMGT P646	Intellectual Asset Management
BMGT P430	Development Planning and Productivity
BMGT P647	Development Portfolio Management
BMGT P648	Development Project Management
BMGT P649	Technology Policy.
BMGT P651	New Business Development
BMGT P738	Managing Technological Innovation
BMGT P739	Organisational Change
BMGT P429	Issues in Technology Management.
ECON P200	Business Economics
FIN P623	Finance
MEEN P007	Product Design and Development
MEEN P002	Supply Chain Design
MEEN P003	Emerging Technologies
MEEN P004	Quantitative Methods for Management
MEEN P006	Modern Manufacturing Processes
MIS P622	Management Information Systems
MIS ???	Business System Design
MIS P643	Management Support Systems
MIS ???	System Simulation
MKT P648	Business-to-Business Marketing

Year 2:
BMGT P652 Major Project

Course Syllabus

Management Accounting **ACC P621**
Nature and role of managerial accounting. Cost terminology and classification. Accounting for materials, labour and overheads; cost allocation and apportionment; overhead absorption. Product and job costing and inventory valuation. Cost behaviour and prediction. Activity based costing. Project costing. Decision-making and relevant costs. Decision-making with scarce resources including linear programming. Decision-making under uncertainty. Budgets, budgetary control and Lotus 1-2-3. Standard costing and variance analysis.

Organisation and Innovation I **BMGT P640**
Theories of motivation, satisfaction and their relation to performance; intrinsic and extrinsic motivation; goal setting, job design and reward systems. Application to scientists and engineers.

Small group formation and cohesion, group structure, influence processes and leadership. Application to innovation.

Business Strategy **BMGT P641**
Defining the business domain and opportunity space; environmental and competitive analysis; growth ambitions, trajectories and strategies; competitive intent and strategy; building the bases of sustainable advantage; the role of innovation and technology in generating growth options and sustainable advantage.

Organisation and Innovation II **BMGT P642**
Developing structures and systems appropriate to the innovation and technology strategy of the firm. Building competences and knowledge creation for sustainable long-term advantage; organising for incremental, generational and radical innovation.

Marketing New Products **BMGT P643**
Market definition and entry strategy. Product strategy. Defining the role of the product in the marketing mix. Identification of key customer needs and key product characteristics for market success: idea generation; the role of the lead user; measuring customer product perceptions; integrating market need and product design – QFD and other approaches. Product positioning; the marketing mix; advertising, market and product testing; product launch; product life-cycle management.

Technology Strategy **BMGT P644**
Patterns and types of innovation and technology substitution. Technology Impact Analysis: identifying and classifying technologies by the size and timing of their potential impact on the business; selecting technologies which support business strategy; defining innovation strategy and competitive posture; assessing strength in base, key and emerging technologies; defining strategies for technology acquisition and development;

deciding the total budget and identifying sources of financing for R&D; defining the balance of spending between early-stage and late-stage programmes.

Supply Network Strategy **BMGT P645**

Operations strategy, service operations, productivity and performance, network capacity planning, total quality management, strategic supply networks, lean production and supply, time based competition, benchmarking and improvement, network relations.

Intellectual Asset Management **BMGT P646**

Innovation and intellectual assets, technology acquisition strategies, information and knowledge management, technology assessment and valuation, intellectual property, licensing and technology transfer, contractual issues in funding and development, product liability and standards.

Development Planning and Productivity **BMGT P430**

Productivity in innovation: models and metrics; policies and processes to enhance quality, cost and time to market. Product policy: variety and replacement rate; use of the family concept – platforms and generational change; product evolution and technology embodiment scheduling (product-technology roadmapping).

Integrating business, product, technology and aggregate development project plans.

Development Portfolio Management **BMGT P647**

Building and managing a portfolio and pipeline of development projects that fit strategically, balance risks and generate desired cash flows. Stage-gate and other procedures for uncertainty reduction and risk management. Managing the 'fuzzy front end'.

Managing multiple projects through later stages of development. Use of option pricing and other approaches to assess the adequacy of the project pipeline in meeting business objectives.

Development Project Management **BMGT P648**

Managing individual projects to deliver quality products to market in a timely and cost-effective manner; using project teams as a mechanism of organisational learning. The project as a temporary organisation: identifying stakeholders and managing their expectations; light weight and heavy weight project teams – the power of the project and the functional manager. Project start-up processes, goal-setting, work breakdown and assignment, project planning and control tools. Project completion or termination: evaluation, debriefing, learning and knowledge-diffusion, managing emotions.

Technology Policy **BMGT P649**

The National Innovation System. The role of technology in economic growth, industrial innovation, industrial policy, and sectoral and inter-firm competition. Technology and skill change. Technology in higher education. European programmes in science and technology. Technology and economic development; the social shaping of technology; technology indicators; the monitoring of technology/society relations; technology planning and the role of the State; generic and direct intervention measures.

New Business Development **BMGT P651**

The student will be given the opportunity to acquire the basic knowledge required to start a new line of business within a company. This course will be conducted as a seminar, with time devoted to the discussion of ideas by students who have an interest in entrepreneurship. These ideas may come from guest speakers, from the instructors, from the text and other readings or from case material, and from students.

Managing Technological Innovation **BMGT P738**

This course is an introductory overview of material that will be covered in depth throughout the degree.

Introduction: Innovation process models; phases in the innovation process- from idea to concept and from concept to customer; innovation processes as risk management. Balancing long-term and short-term objectives: building the basis of competitive advantage; positioning for competitive advantage; building a pipeline to deliver financial results; efficient product and process development. R&D productivity: models and metrics; design and management procedures to improve quality, cost and time.

Organisational Change **BMGT P739**

This course deals with change at the strategic and operational level. Operational change (new process introduction): unplanned change; models and processes of planned change; the change agent; the diagnostic process; change interventions; evaluation and selection of interventions; implementing planned change – power, politics and resistance. Strategic change: organisational transformation – evolution or revolution; the need for integration and coherence; processes of managing and implementing strategic change; the learning organisation and organisational change.

Issues in Technology Management **BMGT P429**

This course is intended to allow treatment of specific topical issues of interest to the class.

Business Economics **ECON P200**

The course covers topics in micro and macro economics including: economics of the firm – transaction cost and agency theory; application of economic theory on demand, production, cost, pricing, risk and uncertainty to business decisions. National accounts and their compilation. Theory of income determination. The role of money in the economic system.

Finance **FIN P623**

Sources and costs of finance. Capital structure. Interpretation of financial statements. Forecasting financial needs. Capital investment evaluation. Option pricing for R & D project and portfolio evaluation. Company evaluation. Mergers and acquisitions.

Product Design and Development **MEEN P007**

Design process methodology, product design specification, concept generation and selection and product development tools and techniques

Supply Chain Design **MEEN P002**

Process design, facility layout, job design, operations planning and control, inventory, logistics and supply management, quality control and improvement, service process design.

Emerging Technologies **MEEN P003**

The specific technologies chosen will reflect the background and interests of the participants, and will be discussed in conjunction with specialists in each field. Technologies will include some or all of the following: advanced materials, advanced manufacturing, rapid product development; nanotechnology; computation and communication hardware and software; biotechnology, combinatorial chemistry; energy.

Quantitative Methods for Management **MEEN P004**

This course will cover selected topics from the following material.

Statistical Analysis. Introduction to probability and statistics, binomial, Poisson, normal and other probability distributions; significance tests, estimation, regression and correlation, time series. Multivariate statistics for marketing: multiple regression; discriminant analysis, conjoint analysis, Analytic Hierarchy Process.

Optimisation. Operations Analysis and Optimisation: Classical optimisation techniques, search techniques, gradient methods, linear programming, non-linear programming, dynamic programming.

Decision Analysis. Issues of structure, uncertainty and value in decision. Modelling structure; probability and utility assessment; behavioural issues in judgement and decision making. Multi-attribute decision problems. Group decision-making. Decision support products. Computer-based support for planning techniques.

Modern Manufacturing Processes **MEEN P006**

Topics will include manufacturing technology foresight, concurrent engineering, and technologies for the semiconductor, biotechnology and engineering sectors.

Management Information Systems **MIS P622**

Theoretical Elements and Organisation of Information Systems. Information resource management. Management and decision making. People and organisations. Information systems and models. Information systems in functional business areas. Information management. Case studies.

Technical Components and Applications of Information Systems. Technical foundations of information systems; hardware, software, databases, networks. Technical applications of information systems; transaction processing systems, management reporting systems, decision support systems, knowledge-based systems. Case studies.

Practical Aspects of Information Systems. Building management information systems. The system development life cycle. Strategy, specifying requirements, design, acquisition, development, implementation. Case studies.

Business System Design **MIS ????**

Organisation – internal and external functions, operations and management, decision making, optimising use of resources. Methodology – how to capture resources, reference modelling. Technology – using ICT to develop models, how models are used to design systems.

Management Support Systems **MIS P643**

This course studies the range of information systems needed to provide support for management in decision-making, planning and control. The starting point, therefore, is the set of potential managerial problems and opportunities, and the associated information requirements. Organisational diagnostics are considered for problem/opportunity identification.

Solution approaches are developed and used as the basis for describing the structure, characteristics and management of generic categories of systems such as Decision Support Systems (DSS), Executive Information Systems (EIS) and Expert Systems (ES). The management implications of knowledge-based systems will be covered, and students will be asked to develop an application through an Expert System shell.

System Simulation **MIS ????**

Introduction to simulation and modelling, underlying theory and concepts. Problem formation, verification and validation, analysis of model outcomes. Discrete event simulation, continuous simulation. Computational tools for simulation and modelling. Applications from sectors including: Service, Industrial, Manufacturing and Financial.

Business-to-Business Marketing **MKT P648**

This course provides participants with a comprehensive overview of the nature of relationship marketing in international business markets. The concept of relationship management as a process of managing interactions between firms is the central focus of attention. To this end, the interactive and network approaches to understanding international business markets are explored. Particular attention will be given to the management and development of relationships between customers, suppliers and distributors. Specifically the critical dimensions of product development, adoption and diffusion in business markets are investigated. In addition, the impact of technology on business relationships with particular emphasis on eCommerce in business markets and the management implications of manufacturing-marketing interface are considered. Consideration is given to the development of marketing strategy in a business to business context. Finally, as purchasing accounts for a substantial portion of the total costs of a firm, special emphasis will be given to the strategic role of the purchasing function.

Year 2

Project **BMGT P652**

During their second year, students will undertake a major in-company project which will make a measurable difference to the innovative capabilities of their firm. The project will take the place of a conventional thesis.

Degree of Doctor of Philosophy (PhD)

An applicant for admission as a candidate for the degree of Doctor of Philosophy (PhD) shall submit an application to the Professor or the Head of School in which the applicant wishes to study. Candidates for this degree are required to be admitted by the College of Engineering, Mathematical and Physical Sciences on the recommendation of the Professor; their admission must then be confirmed by the Academic Council. Candidates who have not graduated in this University may be admitted if suitably qualified.

There are three intakes each academic year in September, January and March to the programme leading to the award of PhD. It may be possible to commence at a different time, subject to the agreement of the Supervisor and with College approval. Normally the closing dates are:

	(i) **September** Intake	(ii) **January** Intake	(iii) **April** Intake
non-EU candidates	31st March	28th July	30th September
EU candidates	28th July	30th November	27th February

No candidate can be allowed to enter on a course of study and research for the Degree of PhD unless he/she has reached a high Honours standard at the examination for the primary degree or presented such other evidence as will satisfy the Professor and the College of his/her suitability.

The degree is normally taken nine terms after a master's degree or primary degree. A reduction in the number of terms would be dependent on progress by the candidate and would be a matter for consideration and decision by the College.

Candidates for the PhD Degree will be allowed six years from the date of registration in which to complete their degree. If they have not done so within that period they must re-apply for registration.

The thesis must normally be prepared under the supervision of the Professor, but the College may, on the recommendation of the Professor, assign another member of the staff to supervise the candidate's research, under the Professor's general direction. The thesis must be prepared in the University, unless permission is given to the candidate to work elsewhere under the Professor's general direction. Such permission will only be given to candidates who have attended courses in the University for twelve terms before admission to the course for the PhD.

Candidates may enter for examination in January of the year in which their work is to be examined; the time of examination to be arranged as may be convenient to the candidate and the examiners. If the thesis is not presented before 1 February following, the candidate must re-enter.

Candidates may be required to take an oral examination on the subject matter of their thesis.

This degree will not be awarded unless the examiners report that the work is worthy of publication, as a whole or in part, as a work of serious scholarship.

Degree of Doctor of Science (DSc) on Published Work*

A candidate shall be deemed eligible to present for the Degree of Doctor of Science by submitting published work to the National University of Ireland, which must embody the results of original research and a common theme sufficient to indicate that the candidate has achieved a special competence in this aspect of the subject. The work submitted must be of a high standard and contain original contributions to the advancement of knowledge and learning which has given the candidate international distinction in the field of study. Fifteen terms must elapse from the date of obtaining the Degree of Bachelor of Science of the NUI. Further information may be obtained from the National University of Ireland, 49, Merrion Square, Dublin 2, website: www.nui.ie.

* *See Calendar of the National University of Ireland.*

Guidelines for Full-Time Research Students

Introduction

The purpose of these guidelines is to provide a useful source of information for those embarking on a research degree, whether registered for the degree of Masters of Science (MSc), Masters of Engineering Science (MEngSc) or Doctor of Philosophy (PhD). The guidelines outline what is expected of you during your time here as a postgraduate research student and provides guidance on successfully completing a research degree.

These guidelines are intended to provide general guidance for research students. You should be aware, however:

(a) that differences in detail exist between different disciplines. Your School may have its own postgraduate handbook to supplement this document, covering any special arrangements or expectations that apply in your subject. Your supervisor will be able to tell you if this is the case; and

(b) that the postgraduate regulations (on the Web at www.ucd.ie/pgstudy) take precedence over these guidelines. In the event of any inconsistencies, the regulations rather than the guidelines will apply. The regulations are the formal rules to which you are subject, and it is your responsibility to ensure that you have read them and that you understand what is expected of you.

The Nature of Postgraduate Research

Being a research student is different from being an undergraduate or undertaking a taught masters programme. To succeed, you must make an original contribution to the body of knowledge in your chosen discipline. This requires certain abilities such as initiative, independence, the capacity for critical but constructive thinking, as well as a thorough understanding of the relevant academic discipline and competence in the relevant techniques. These abilities should be present in all research students, and should be developed by the combined efforts of the student and the supervisor. The results of these efforts will be expressed primarily in the thesis, which you will write and then defend in an oral examination.

The ideal programme of study for a research degree will seek to achieve the following:

You will have the opportunity, over a sustained period of in-depth study, to enlarge your view of the broad subject area and to study the theoretical foundations and specific techniques of the subject. You will uncover and critically examine the background research of your area. You will be stimulated to develop originality and creativity in your research;

You will have an opportunity to develop skills in making and testing hypotheses, and in developing new theory, undertaking research to discover new facts and contribute new insights into your chosen field;

You will have an opportunity, through critical scrutiny of written work and written presentations, to develop skills in writing and in presenting the results of your research in high-grade international journals and at important national and international conferences.

It may be helpful to think of your research degree as training to becoming a fully professional researcher in your field. This suggests a number of key features:

First, at the most basic level it means that you have something to say that your peers want to listen to;

Second, in order to do this you must have command of what is happening in your subject so that you can evaluate the worth of what others are doing;

Third, you must have the astuteness to discover where you can make a useful contribution;

Fourth, you must be aware of the ethics of research and work within them;

Fifth, you must have mastery of appropriate techniques that are currently being used, and be aware of their limitations;

Sixth, you must be able to communicate your results effectively in the academic and professional arena;

Seventh, all of this must be carried out in an international context; i.e. your professional peer group is worldwide.

Your Responsibilities – the Postgraduate Student

A clear understanding between the supervisor and student needs to be established at an early stage about the supervisor's responsibilities. The understanding must accord with any University, College and School regulations and must cover the nature of guidance or comment the supervisor will offer within the general principle that a thesis should be the student's own work.

In summary, the responsibilities of the research student include:

Complying with postgraduate and university regulations and any other College or School procedures;

Discussing with the supervisor the type of guidance the student finds helpful;

Agreeing a schedule of meetings with the supervisor(s) and attending arranged meetings;

Taking the initiative in raising problems or difficulties, however elementary they may seem;

Attending training and any forms of instruction as required by the supervisor or Head of School;

Attending and presenting at seminars as required by your School;

Maintaining the progress of the work in accordance with the stages agreed with the supervisor, including the presentation of written material as required in sufficient time to allow for comments and discussion before proceeding to the next stage of the research project;

Presenting written material as requested by the supervisor by agreed dates;

Becoming familiar with, and complying with, University and School safety requirements;

Postgraduate students may be required to take part in School activities as an integral component of their responsibilities;

Full-time students should not be engaged in employment outside of the University.

You and Your Supervisor

It is important that you see your supervisor on a regular basis if you are to benefit from the supervisor-student arrangement. The duration and regularity of such meetings will depend to some extent on the nature of your research and your academic progress. You should agree with your supervisor the frequency with which meetings should take place. It is also important that you prepare in advance for prearranged meetings and that you keep any appointments that have been made. You are also expected to meet all deadlines and to submit work on time. You should consult your supervisor about any difficulties, academic or personal, which may be affecting your studies.

Your supervisor's role is essentially to give advice, help and encouragement so that you receive a good training in research and produce a successful thesis. The thesis is, however, to be your own work, and you must accept the responsibility for its eventual success or failure.

Establishing a Relationship with Your Supervisor

You will be told when you first enrol who your supervisor is. In order to establish a good working relationship, you and your supervisor should agree at the outset how to proceed and what each of you expects from the other. Your supervisor will explain to you what kind of guidance you can expect to receive from him or her, and you in turn must ensure that you know exactly what your supervisor expects of you. If you are not sure about your respective responsibilities, you should ask your supervisor for clarification.

Meetings with Your Supervisor

You and your supervisor must meet regularly, and you are both responsible for ensuring that this happens. The nature of these meetings will vary between disciplines. In laboratory-based subjects, where you are likely to be in very frequent contact with your supervisor, there may be less need for formal meetings. In disciplines where researchers tend to work alone, you and your supervisor will need to draw up a schedule of meetings in advance. You should confirm the date of the next meeting at the end of each

supervisory session. Neither you nor your supervisor should cancel scheduled meetings without good reason, and if a meeting is cancelled you should re-arrange it as quickly as possible.

Contacting Your Supervisor Between Meetings

You should be able to contact your supervisor for advice and assistance at other reasonable times outside your planned schedule. You must ensure that you know your supervisor's work telephone number and work e-mail address in case you need to get in touch. The onus is on you to contact your supervisor quickly if you run into difficulty, without waiting for the next planned meeting.

In summary, the responsibilities of the supervisor include:

Giving guidance about the nature of research and the standard expected, the planning of the research programme, appropriate literature and sources, and about the ethos of research;

Discussing with the student the type of guidance and comment the student finds most helpful;

Maintaining contact through regular meetings; the schedule of which should be agreed with the student and reviewed periodically;

Requesting written work as appropriate and returning such work with constructive criticism within a reasonable time;

Ensuring that the student is aware of any inadequacy of progress or in the standard of work.

Equality in the Workplace

All members of the University community are expected to behave responsibly at all times, to observe and abide by the Regulations of the University, and not to engage in an activity which might bring the good name of the University into disrepute.

Policy on Dignity and Respect

UCD is committed to the promotion of an environment for work and study which upholds the dignity and respect of the individual and which supports every individual's right to study and/or work in an environment which is free from any form of harassment, intimidation or bullying.

The University recognises the right of every individual to such an environment and requires all members of the University community to recognise their responsibilities in this regard. For further details, see the UCD Student Handbook (available to download athttp://www.ucd.ie/regist/booklets05-06/studenthandbook.pdf).

Monitoring Progress

Procedures for monitoring the progress of PhD students are as follows:

At the end of the first year of study, research students will be required to undertake a rigorous end-of-year review. This will include completion of standard monitoring forms (which will be available to download from the College website) and a report (including a literature review, research objectives, methodology, progress and preliminary results);

New PhD students may be required to first register for a Masters by Research and reviewed at the end of first year before transferring and registering for a PhD Degree;

Monitoring forms and progress reports shall be reviewed and assessed at School level (individual Schools may also require students to give oral presentations as part of this process);

At the end of each successive year, all research students will be required to complete annual monitoring forms to be 'signed-off' at School level.

Dealing with Difficulties

Delays in Your Progress

If you run into difficulties which cause you to fall behind in your research, it is essential that you take action as quickly as possible before too much time is lost. The first thing you should do is to speak to your supervisor, who may be able to suggest a solution. For example, if you are being hindered by equipment failure or by difficulty in getting access to source material, it may be possible to make other arrangements to let you get on with your work. If your supervisor cannot help, he or she should advise you as to what you should do next, or you can approach your Head of School or the School's head of postgraduate studies, if applicable.

You should keep a written record that you have spoken to your supervisor about the problem, as this will be important if you need to apply for an extension of time at a later stage or if you need to make an appeal or complaint. You should also refer to it in your Progress Monitoring Form.

Difficulties with Your Supervisor

If you and your supervisor cannot establish an effective working relationship, it is important that you take action as quickly as possible, before too much damage is done to your research. You should, if possible, talk to your supervisor about the problem in the first instance. If you feel unable to talk to your supervisor or if talking to your supervisor does not resolve matters, you should talk to your Head of School, who will investigate. It is in everyone's interests for such problems to be sorted out within the School and as informally as possible. If this does not prove possible, and you are still unhappy with your supervision, you should write to the Chair of the College Postgraduate Studies Committee and ask for the matter to be investigated. The Committee may appoint a new supervisor if it thinks this is necessary. You can contact the College Postgraduate Studies Committee through your College Office.

Suspending Your Research

If a specific problem is affecting your research (ill-health, personal or financial circumstances, for example) it may be advisable for you to suspend your research temporarily until the problem has been resolved. This is better than struggling on, missing deadlines and eventually failing to complete on time. The period of suspension will be deducted from the time allowed for completion of your thesis, and you will not be liable for fees while your registration is suspended. You should discuss the situation with your supervisor, who will - if he or she agrees that suspension is the best option – ask the College Postgraduate Studies Standing Committee for permission for you to suspend your research. You must tell your supervisor if you are in receipt of an award from a funding body, as its approval will also be needed for you to suspend. Your supervisor will seek this approval on your behalf.

Your suspension will be for a fixed period of time. It is essential that you make contact with your supervisor before your suspension runs out, either to make arrangements for you to return to your studies or to seek a further suspension. While any request for a further suspension will be considered sympathetically, you must make the request rather than assuming that your suspension will automatically be extended if you do not return to work. If you are in receipt of a studentship, it is particularly important that you keep the University, through your supervisor, informed about your intentions.

Submission of Thesis

Upon completion of the research, the candidate should prepare a thesis, with the advice of the supervisor(s) and in accordance with the guidelines published by the Examinations Office, and should submit the thesis for examination. The candidate must be registered as a student at the time when the thesis is submitted for examination.

Three copies of the thesis, bound in accordance with the guidelines published by the Examinations Office, each accompanied by a document containing a summary of the contents of the thesis not exceeding 300 words, should be submitted, with the examination fee, to the Examinations Office, University College Dublin.

Examination Process

It is the policy of the university that every PhD candidate should be examined orally by the board of examiners. The objectives of the *viva voce* examination are to provide an opportunity for the examiners to clarify any issues of fact which may have arisen in examining the thesis, to test the candidate's knowledge of the thesis topic and related areas of research and, as far as possible, to establish the originality of the candidate's work and ideas. The *viva* also provides an opportunity for the candidate to elaborate on aspects of the research which may not have been included in the thesis and to defend the arguments presented and the ideas developed in the thesis.

Where the examiners are in agreement, they shall submit a joint report to the Academic Council indicating their opinion on the quality of the thesis and of the research on which it is based, and recommending whether the degree should, or should not, be awarded. The examiners should also indicate whether, in their opinion, the thesis, in whole or in part, is worthy of publication. Award of the PhD should not be recommended by the examiners unless they consider that the thesis, in whole or in part, is worthy of publication as a work

of serious scholarship. The report may also indicate whether, in the opinion of the examiners, major or minor corrections to the thesis are required, and shall assign responsibility to one of the intern examiners to ensure that such corrections have been made to the thesis before award of the PhD is approved by the Academic Council.

The report of the examiners may recommend:

Award PhD - no corrections to the thesis required

Award PhD - subject to minor corrections to the thesis

Do not award PhD - revision and re-examination of the thesis required

Do not award PhD - consider award of an appropriate Master's degree

Do Not award PhD

Ethics in Research

UCD maintains the highest standards of integrity in its research activity. Ethical standards are given paramount importance in the University's Research Policy and Strategy and imbue its research culture: "All research should be conducted within an ethical framework consistent with the traditional principles of academic freedom".

UCD's existing structures to promote and promulgate ethical research practice, emphasising integrity and rigour, seek to sustain a culture in which the following general principles are understood and observed; honesty; openness; leadership and cooperation; supervision and training; guidance from professional bodies; best practice in the ownership, recording and storage of primary data samples; best practice in publication. For further details, see the Office for Funded Research Support Services WebPages (www.ucd.ie/ofrss/).

Plagiarism

Plagiarism is using others' ideas and words without clearly acknowledging the source of that information. You should realise that your thesis must be your own work and all quotations from other sources, whether published or unpublished, must be properly acknowledged. Plagiarism is a very serious offence and, when proven against a student, may result in disqualification from the examination for their degree and exclusion from all future examinations of the University. Some joint work is permitted, provided it is properly acknowledged as such. For further information regarding what constitutes plagiarism, see the UCD library website where you can download a Guide to Plagiarism (www.ucd.ie/library/about/printable_guides).

Dissemination of Research

The writing of paper and articles is one of the measures of research. The primary indicator of quality research is the publication of papers in peer reviewed international journals. The writing of high quality publications is considered an integral and essential component of your training in research. Indeed, your research is not considered to be complete until it is available to the wider scholarly community through publications.

As a general rule, it is expected that a *minimum* of one article published in an international journal should result from a Master's Degree by research, and a *minimum* of

three published articles should result from a PhD. It is normal practice for papers to be submitted for publication to be co-authored with your supervisor(s), who will advise you on structure, style, content and potential journals to target. You are also encouraged to make every effort to attend and to present your work at conferences. This is an excellent way for you to become familiar with contemporary developments in your field, and presenting your work enables the wider community informed of its (and yours) existence.

From the beginning of your studies, you should make every effort to become familiar with international journals in your field. You should discuss with your supervisor(s) which are the leading journals in your field.

In addition to publishing, a further output from your research may involve developing *patents and the commercialisation of Intellectual Property*. In this regard, NovaUCD provides advice on the protection and exploitation of Intellectual Property arising from UCD research and details can be found at www.ucd.ie/nova/.