ENGINEERING

Ordinary and Higher Level Courses

N.B. The parts of the Syllabus which are in *italics* will not be examined at Ordinary Level.

GENERAL AIMS

The course represents a study of a wide range of mechanical engineering materials, processes and technological applications integrated with the acquisition of the manipulative skills and techniques necessary for practical resourcefulness, creativity and design realisation in the execution of work.
It aims to promote an educational knowledge of the materials; an understanding of the processes; ability in safely using the skills and tools to achieve objectives through practical work; initiative in the planning and development of technological projects.

SYLLABUS AND EXAMINATION STRUCTURE

The syllabus is presented in two sections:

1. Workshop Processes. This section represents all the practical processes which may be applied in the school workshop integral with the related theory. This section will carry 300 marks in the examination at both levels. Ordinary and Higher:
   There will be 150 marks for a practical examination and 150 marks for assessment of workshop/laboratory work and projects.

2 Materials and Technology. This section represents the wider knowledge and technology as a whole. In the written examinations this section will carry 200 marks at Ordinary level and 300 marks at Higher level

Note: Candidates studying Engineering in the **Leaving Certificate Vocational Programme** may, also study from the material in Appendix 1 as shown at the end of this section. Examination questions in relation to this appendix will be optional.

SYLLABUS

1. Workshop Processes

HEALTH AND SAFETY

Application of strict safety rules and regulations relating to: the person; the work methods and materials; the workshop. The development of safety consciousness through the positive use of safe working practices.
Application of basic first aid principles. The use of appropriate protective clothing and equipment. Special care and protection of face, hands and eyes.
Correct handling, storage and use of materials. Necessity for tidiness, order and safe work methods.
Clear knowledge of safety procedures and systems in the workshop; location and use of fire extinguishers and emergency switches.

BENCHWORK

Marking out using surface place, vee blocks, scribing block and height gauge. Setting out by Cartesian and polar coordinates.

Measuring and gauging using combination set, vernier calipers, micrometer, telescopic gauges, dial gauge, protractor. Use of dial gauge as a simple comparator.
Application of practical safety methods in the operation of the drilling machine. Setting up and aligning work for drilling and reaming. Use of machine vice, angle plate, simple jigs and fixtures. Selection of suitable speeds, feeds and coolants.
Fitting and assembly of parts using pins, dowels, rivets, screws, bolts, nuts and adhesives.
Application of practical safety methods in the operation of the bench or pedestal grinder.
Grinding of cutting points and edges on hand tools, drills and cutters. Selection of grinding wheel and method of mounting the wheel on the machine. Wheel truing and dressing.

HEAT TREATMENT OF METALS

Application of safe working practices to all aspects of the heat treatment process.
Method and purpose of annealing, normalising, hardening and tempering; preheating and postheating: Case hardening of mild steel by the pack carburising method. Use of heat treatment furnace with pyrometric control.

PLASTICS PROCESSING

Application of practical safety methods in the working of plastics.
Identification of plastics by means of simple tests. Cutting, bending, edge finishing and bonding of acrylic sheet.
Sintering and casting of polyethylene; resin casting; simple mould making.
Selection and use of adhesives; advantages of adhesive bonding.
The machining of plastics drilling, turning, milling (or shaping).

FABRICATION AND FINISHING OF METALS

Application of practical safety methods in the use of materials and equipment.
Development of patterns, cutting, bending and rolling of sheet metals. Making of simple joints in sheet metal.
Beaten metalwork: hollowing, planishing and simple repoussé. Decorative finishing including etching and enamelling.
Forgework based on simple designs and patterns.
Joining of materials by means of solder and adhesives.
Construction, use and care of gas welding equipment: cylinders, regulators, gauges and blowpipes. Basic techniques involved in the brazing and welding of mild steel.
Construction, use and care of transformer type arc welding set; selection of electrode and welding current. Downhand butt welding of mild steel.
Gravity die casting and sand casting of aluminium. Use of crucible furnace. Making of simple dies and sand moulds.

MACHINING

Application of practical safety methods in the operation of machine tools and accessories.
Use of the centre lathe and the shaping machine and/or the milling machine.

Selection, care and use of cutting tools. Correct methods of holding the tools and of gripping the work.
Selection of speeds, feeds and coolants. Use of automatic feeds, machine dials and precision measuring equipment.
Parallel turning, knurling and drilling in the lathe. Taper turning including use of topslide and off-set tailstock. Turing between centres, undercutting, boring, screwcutting and eccentric turning.
Flat and angular surfacing, and slot cutting by means of the shaping machine and/or milling machine.

TECHNOLOGY

The manufacture of small tools and simple operational mechanisms from working drawings involving interpretation, sequence of operations, execution of work and testing of finished product.
Dismantling and assembling a range of engineering components derived from prime movers, power transmission systems, brakes and other mechanisms to achieve an appreciation of the technical details of assembly, operation and basic design concepts.
Project design and construction of a working model or prototype using available materials, resources and facilities; the basic functions of research, development, design, production and testing.

2. Materials and Technology

HEALTH AND SAFETY

Basic first aid requirements, personal protection.
Methods of safeguarding machinery and working areas with particular emphasis on moving parts; colour codes; mechanical, electrical and human failures; work space clearances.
Electrical hazards; principles of protective devices and systems; earthing; single and three phase systems; correct use of equipment.
Chemical hazards: poisonous, corrosive, combustible and explosive.
Fire protection methods and equipment.
Statutory safety provisions; accident statistics.

CLASSIFICATION AND ORIGIN OF METALS

Table of the Elements: differences between metals and non-metals; chemical symbols; the importance of alloys.
Physical properties of metals.
General appreciation of historical developments. Outline of systems of mining for ores.
Description of the ores from which iron, copper, lead, zinc, aluminium, tin, silver, gold and other metals originate. *The extraction of metals from ores; important methods of ore dressing and process metallurgy.*

STRUCTURE OF METALS

Microstructure; factors affecting grain size; recrystallisation. Macroscopic examination of specimens. The solidification of metals; dendritic structure; the structure of ingots and castings; atomic lattices. Equilibrium diagrams for simple eutectics and solid solutions. Ways in which metals combine to form alloys: eutectic and eutectoid.

IRON AND STEEL

The important steel making processes. The production of cast iron.
The structure of plain carbon steel; influence of carbon content; equilibrium diagrams.
Classification, properties and uses of carbon steels, *cast irons and alloy steels.*

NON-FERROUS METALS

Production of copper and aluminium from their ores.
Properties and uses of non-ferrous metals and alloys.
Classification of brasses, bronzes, gunmetal, bearing metal and aluminium and zinc based alloys.

HEAT TREATMENT OF METALS

Heat treatment of plain carbon steels; equilibrium diagram; critical points; structural changes. Types of quenching media. Stress relieving.
Case hardening by the pack carburising method.
Carburising, nitriding, flame and induction hardening.
Types of furnace and methods of temperature measurement.
Heat treatment of alloy steels.
Outline knowledge of age hardening.

CORROSION OF METALS

The mechanism of corrosion, electrolytic action; influencing factors.
Methods of minimising corrosion; protective coatings; design features; environment; anodic and cathodic protection.

MATERIALS TESTING.

Strength of materials in tension, compression and shear; bearing, bending and torsion. Stress-strain diagrams; Young's Modules. Proof stress. Determination of the strength of components in tension, compression, shear and bearing.
Methods of testing materials; tensile, hardness, impact, ductility and fatigue. Non-destructive tests using liquids, magnetism, sound, and radiation. General appreciation of creep, thermal and electrical conductivity, expansion, specific heat capacity and environmental exposure tests.

PLASTICS

Outline of the sources, physical structure, manufacture, classification and main forms of supply of plastics.

Methods of waste disposal.
Properties and use of the common thermoplastics polyethylene, polypropylene, PVC, polystyrene, acrylics, PTFE, cellulose acetate, nylon and the thermosetting plastics phenolic resin, polyester resin, epoxy resin, polyurethanes.
Processing of plastics: injection moulding, extrusion, vacuum forming, blow moulding, compression moulding, calendaring, spreading and laminating.

JOINING OF MATERIALS.

Theory of adhesion: Classification of adhesives; forms of supply and use.
Joining of metals and plastics.
Mechanical fastenings.
Soldering and brazing.
Fusion welding: oxyacetylene and electric arc. Use of fluxes and fillers in gas welding.
Differentiation between AC and DC electricity; principle of the transformer. Electrode classification.
Specialised welding processes: inert gas shielded; automatic; resistance.
Welding of plastics.

MACHINING

Basic construction, specification and cutting action of lathe, shaping machine, milling machine and precision and precision grinding machines. Work holding methods.
Cutting tool nomenclature. *The mechanics of machining; forces acting on the cutter; the importance of the rake angle. Type of chip formation.*

Machinability. Power consumed in cutting. Relation between tool life and cutting speed.
Types of cutting fluid, lubricant and methods of application.
Principles of taper turning and of multistart and left hand screw threads.
Principles of simple indexing.
Structure and classification of grind wheels; surface finish.

METROLOGY

Standards of measurement; grades of accuracy. Systems of limits; types of fit. Determination of limits and tolerances from given data. Interchangeability of parts and selective assembly. Limit gauges.
Measurement of screw threads; use of thread form gauges, and profile projector.

Principles involved in using sine bar, slip gauges, precision balls and rollers.
Specification of surface finish.

MANUFACTURING PROCESSES

Principles involved in manufacture by fabrication, casting, forging, rolling, drawing, extruding, pressing and machining.
Properties and common forms of supply of manufacturing products.
General appreciation of the main factors relating to quality control.

TECHNOLOGY

Outline history of technology.
Research into principles and processes. Use of research into possible solutions to problems.
The design function: selection of materials, shapes, sizes and processes.
**Specialised study of a prescribed topic.*
Visitation and studies of local and national industry and institutions.
Careers in engineering.

- The topic prescribed for the Leaving Certificate Examination in 2008 is "*Basic principles of operation and applications of Photovoltaic or Solar Cells."*

- The topic prescribed for the Leaving Certificate Examination in 2009 is "*Basic principles of operation and applications of Hybrid Vehicle Technology."*

ENGINEERING – Appendix 1.

For the **Leaving Certificate Vocational Programme** the course in Engineering will be that of the Leaving Certificate as set out in the Rules and Programme for Secondary Schools. The practical section of this course, Workshop Process, to be interpreted in the context of developing new technology applications and control technology support activities.

General Objectives.

Control Technology

The student will: relating

(i) be able to select and construct appropriate mechanisms to the solution of engineering projects;

(ii) understand and use basic pneumatic circuits for simple control applications;

(iii) understand the function of and use electrical power supplies, circuit components and devices;

(iv) understand and use diodes, resistors and transistors in the construction of basic electronic control circuits;

(v) investigate the role of electronics in the design of fundamental computer hardware.

Computer Aided Design

The student will:

(i) understand and be able to specify the fundamentals of computer architecture and peripherals;

(ii) be able to distinguish between the main features of 2D and 3D CAD software, make simple working drawings on screen and produce printer/plotter hardcopy;

(iii) be able to design and produce part programmes for subsequent CNC machining.

Computer Aided Manufacture

The student will:

(i) operate, control and manage a CNC lathe for part production;

(ii) investigate the role, functions and control parameters of a robot, or robot arm, related to manufacturing technology.