



National Council for Curriculum and Assessment
An Chomhairle Náisiúnta Curaclaim agus Measúnachta

Leaving Certificate Design and Communication Graphics Syllabus

Ordinary level and Higher level

For implementation in September, 2007

**LEAVING CERTIFICATE
DESIGN AND COMMUNICATION GRAPHICS**

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PREFACE

TECHNOLOGY EDUCATION AT SENIOR CYCLE

Introduction

Technology education is an essential component of the curriculum. In a world where encounters with a wide range of technologies are part of the daily life experience of all people at work or at leisure, students should be equipped to face these encounters with the confidence which comes from learning about, through and with a range of technologies. It is equally important that they gain an appreciation and understanding of the complex interface between technology and society. As citizens they should have the capacity to enter discussion on, and make personal judgements on, issues related to the impact of technology on their own lives, on society, and on the environment.

Through technology education students grow in competence, grow in confidence, become more enterprising and are empowered in terms of their ability to control elements of the physical environment. These are important educational outcomes, which contribute significantly to the provision of a broad and balanced curriculum and illustrate why participation in technology education represents a valuable educational experience.

The nature of technology education

Technology is a distinct form of creative activity where human beings interact with their environments, using appropriate materials and processes in response to needs, wants and opportunities. It integrates problem solving and practical skills in the production of useful artefacts and systems.

More specifically, the value of technology education comes from the use of the wide variety of abilities required to produce a drawing or make an artefact, leading to a sense of competence and a feeling of personal empowerment. The acquisition of manipulative skills is an important component of this sense of competence and can help to give students a feeling of control of their physical environment. In a rapidly changing global society, students need to appreciate that technological capability is necessary and relevant for all aspects of living and working. Many subjects can contribute to the development of a technological capability. However, the technology subjects, which incorporate the principles of design and realisation in a creative manner, are central to this development.

Technological capability includes

- the understanding of appropriate concepts and processes
- skills of design and realisation
- the ability to apply knowledge and skills by thinking and acting confidently, imaginatively, creatively and with sensitivity
- the ability to evaluate technological activities, artefacts and systems critically and constructively.

Leaving Certificate technology subjects

Within the Leaving Certificate, technology education is provided through the subjects Architectural Technology, Engineering Technology, Design and Communication Graphics, and Technology, thereby providing progression with junior cycle. These subjects contribute to a broad, balanced and general education of students, with particular reference to their vocational, further education and training aspirations on completion of the Leaving Certificate.

At a more practical level, the technology subjects at senior cycle share a number of common features. The syllabuses

- are constructed on the basis of core areas of study and optional areas of study, reflecting the different topics and sections within the subject area
- are offered at two levels, Ordinary and Higher
- have been designed for completion in 180 hours of class contact time
- place a strong emphasis on practical learning activity
- include a range of assessment components aimed at assessing student achievement in both practical and theoretical aspects of the subjects.

DESIGN AND COMMUNICATION GRAPHICS

INTRODUCTION AND RATIONALE

The Design and Communication Graphics course makes a unique contribution to the student's cognitive and practical skills development. These skills include graphicacy/graphic communication, creative problem solving, spatial abilities/visualisation, design capabilities, computer graphics and CAD modelling. The creative and decision-making capabilities of students in the activities associated with design, are developed through three principal areas of study: design and communication graphics, plane and descriptive geometries and applied graphics. This programme is designed and structured to take cognisance of important developments in the modes of communicating design information. It is intended to develop the creative thinking and problem solving abilities of students.

Plane and descriptive geometries are central in developing an understanding of the graphics code, developing spatial abilities and problem solving skills. The body of knowledge associated with the topics covered will allow students to explore a number of applications associated with design, in architecture, engineering and technology generally. An imaginative approach to problem solving is encouraged through the exploration of a variety of geometric principles and concepts. This is of particular importance when dealing with three-dimensional space in the context of descriptive geometry. This area of study will also lay the foundation for productive and creative use of computer-aided drawing and design (CAD). International standards, codes and practices are applied throughout the course of study.

Five areas of applied graphics are included and students will choose two areas of study from the following options: dynamic mechanisms, structural forms, geologic geometry, surface geometry and assemblies. The two selected options will afford the student the opportunity to explore the principles of plane and descriptive geometries and to develop an understanding of these geometries through practical application. The study of design applications will contribute significantly to the students' appreciation and understanding of their environment.

The development of electronic communication has become extremely important in the world of Information Technology. To participate in this development, it is necessary to be able to electronically generate drawings and design ideas. A study of Computer Aided Design through the design and communication graphics elements enables students to accurately model designs and solutions and to communicate and share these within the electronic environment.

The development of the student's sketching abilities contributes to the development of a range of cognitive modelling skills, including graphic ideation and the definition and refinement of design and problem solving ideas. Sketching is also an efficient means of instant communication, with self and others. In the application of a variety of rendering techniques, the skills of learning to see and visualise are enhanced.

The design and communication area of study will consequently make a significant contribution to student assignments relating to presentation drawings, CAD modelling and design. The design activity and the communication of design will inform all areas of the course.

The symbolic codes and cognitive modelling systems associated with design and communication graphics and CAD encourage students to become problem definers and creative problem solvers. The design theme, which permeates the course, will empower the students to communicate their design ideas and solutions with accuracy, flair and confidence.

AIMS

General aims of technology education

1. To contribute to a balanced education, giving students a broad and challenging experience that will enable them to acquire a body of knowledge, understanding, cognitive and manipulative skills and competencies and so prepare them to be creative participants in a technological world
2. To enable students to integrate such knowledge and skills, together with qualities of co-operative enquiry and reflective thought, in developing solutions to technological problems, with due regard for issues of health and safety
3. To facilitate the development of a range of communication skills, which will encourage students to express their creativity in a practical and imaginative way, using a variety of forms: verbal, graphic, model, etc.
4. To provide a context in which students can explore and appreciate the impact of past, present and future technologies on the economy, society, and the environment.

Aims of Design and Communication Graphics

1. To develop the cognitive and practical skills associated with communication graphics, problem solving and critical thinking
2. To develop the capacity and ability of students in the area of visuo-spatial reasoning
3. To provide a learning environment where students can plan, organise and present appropriate design solutions using a variety of skills, techniques and media
4. To provide a basis for lifelong learning.
5. To develop an appreciation for, and understanding of, aesthetic principles and their importance in design and the human environment.

OBJECTIVES

The objectives of this syllabus are to develop the student's knowledge, understanding, skills and competencies in Design and Communication Graphics, while fostering positive attitudes to the use of graphics in problem solving.

On completion of their studies students should be:

- familiar with the principles, concepts, terminology and methodologies associated with the graphics code
- able to apply the principles of both plane and descriptive geometries to the solution of a variety of abstract and concrete graphic problems
- able to produce neat and accurate drawings that comply with internationally recognised standards and conventions
- able to model, in two and three dimensions, graphic design problems and solutions, utilising a range of appropriate techniques and media with confidence and discernment
- appreciative of the facility which the graphics code provides, in the solution of problems and in the visual communication of data.
- able to utilise freehand sketching, both two and three dimensional, as a means of communication and as an aid to spatial reasoning and refinement
- able to utilise a variety of rendering and presentation techniques in the solution of graphic design problems, in both two and three dimensions
- competent and confident in the application of CAD and other appropriate Information and Communications Technologies (ICT) in the solution, modelling and presentation of graphic design solutions, in two and three dimensions
- able to interpret verbal, written and mathematical information, and to represent it graphically
- able to evaluate design solutions and solve design problems on the basis of sound aesthetic principles and to appreciate the impact of design on the visual quality of the human environment
- appreciative of the broad vocational relevance of Design and Communication Graphics.

SYLLABUS FRAMEWORK

Syllabus Structure

The syllabus comprises three fundamental areas of study:

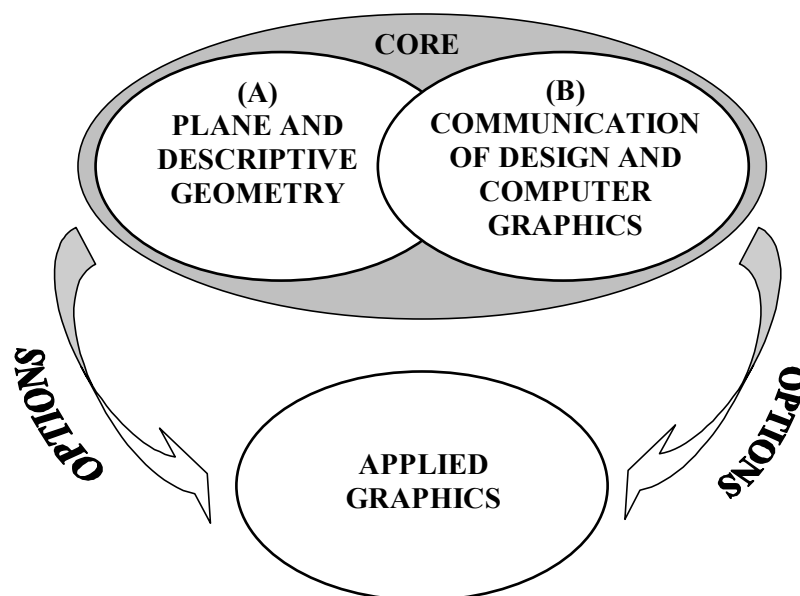
Plane and Descriptive Geometry
Communication of Design and Computer Graphics
Applied Graphics.

The core areas of study (Part One) comprise Plane and Descriptive Geometry and Communication of Design and Computer Graphics. Plane and Descriptive Geometry provides students with a knowledge of essential graphic principles while Communication of Design and Computer Graphics introduces students to the use of graphics in a wide variety of design situations. It also encourages the development of the critical skills of design analysis and creative problem solving through the exploration of a variety of design problems and situations.

The optional areas of study (Part Two) are offered within Applied Graphics where students are introduced to graphic applications in the fields of engineering, science and the human environment. These optional areas of study are

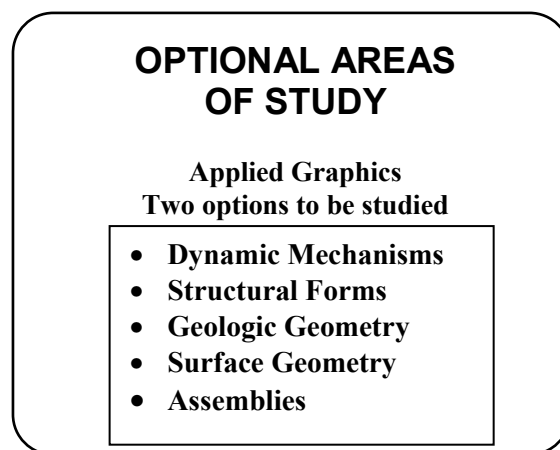
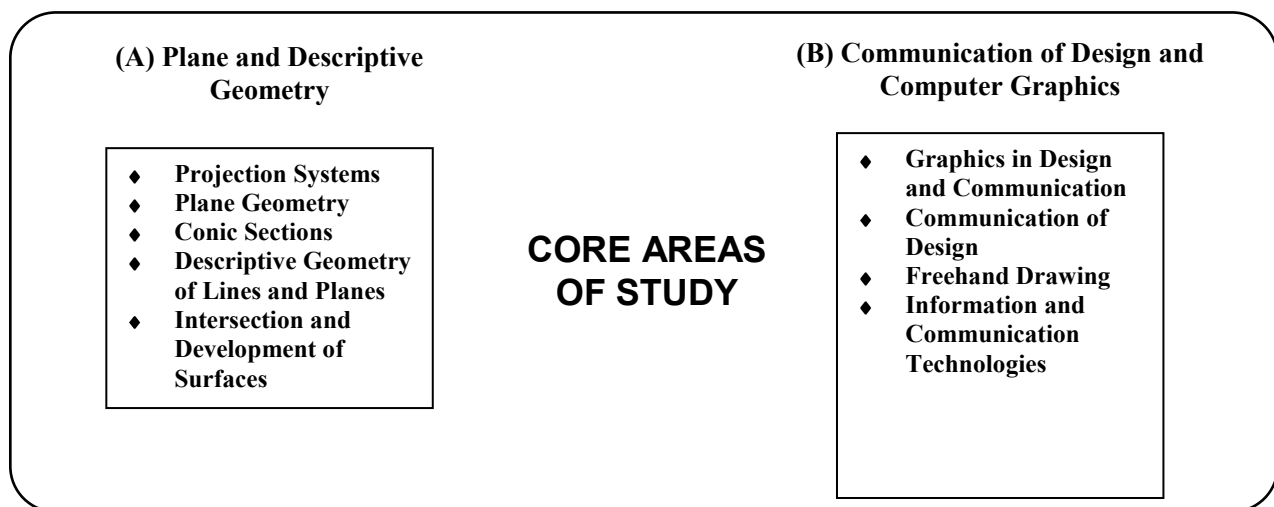
Dynamic Mechanisms
Structural Forms
Assemblies
Geologic Geometry
Surface Geometry

Students are required to study the core and two optional areas within Applied Graphics.



While specific content or topics may be ascribed to an area, many topics are interlinked and complementary, and contribute to the development of the student's graphic and spatial perception.

A more detailed view of the syllabus is shown below



While it is desirable that students studying Design and Communication Graphics at Leaving Certificate level would have previously undertaken the Junior Certificate Technical Graphics course, it is not a pre-requisite.

Differentiation between Ordinary and Higher levels

The syllabus is offered at both Ordinary and Higher levels. The requirements outlined above apply to both levels. While much of the contents of the areas of study is common to both, the depth of treatment required at each level differs significantly. Some material is designated for study and examination at Higher level only. All material specified within the areas of study is examinable.

Presentation of syllabus

The syllabus content is presented in terms of

- Topics
- Teaching/Learning context - indicating the treatment of the topics
- Content areas to be studied
- Learning outcomes

Throughout the syllabus, topics shown in *italics* apply to Higher level students only.

Time Allocation

The syllabus is designed to be taught in 180 hours.

ASSESSMENT

Assessment Components

The syllabus will be assessed in relation to the syllabus objectives and the specified student learning outcomes. There are two assessment components

- 1. A course assignment (40% of marks, of which CAD will form a significant and compulsory component)**
- 2. A terminal examination paper (60% of marks)**

Course Assignment

The purpose of the course assignment is to assess those elements of the course that cannot be readily assessed through the terminal examination, in particular elements of design and communication graphics and the utilisation of ICTs in design. The course assignment will relate to a theme identified by the examining authority. This theme will apply to both Higher and Ordinary level students, who must then proceed to develop a design or project brief in accordance with specified parameters. The assignment will take approximately 40 hours to complete. The completed assignment may take the form of

A design investigation and modification
or
A concept design.

The assessment criteria applying to completed Higher and Ordinary level assignments will differ.

The learning outcomes related to the course assignment will result in students being able to:

- represent design and communication information through sketches, drawings, CAD and other ICT applications
- use appropriate presentation techniques, including colour, rendering and sketching, to represent an artefact and/or design
- produce appropriately dimensioned 2D and 3D drawings and models using CAD
- appreciate, analyse, evaluate and modify artefacts from a design perspective.
- demonstrate design and visualisation skills and techniques

Terminal Examination Paper

A variety of questioning techniques and methods will be utilised throughout the examination, with a flexible and varied approach to the style and presentation being adopted for both Ordinary level and Higher level papers.

A more detailed treatment of assessment issues may be found in the *Guidelines on Assessment* and in the associated sample assessment materials for Leaving Certificate Design and Communication Graphics.

**PART ONE
CORE AREAS OF STUDY**

**(A) PLANE AND DESCRIPTIVE
GEOMETRY
&
(B) COMMUNICATION OF DESIGN
AND COMPUTER GRAPHICS**

CONTENT AND LEARNING OUTCOMES

Content and learning outcomes in *italics* apply to Higher level only

PART ONE (A)

PLANE AND DESCRIPTIVE GEOMETRY

CONTENT AND LEARNING OUTCOMES

While content is arranged under the following elements drawn from Plane and Descriptive Geometry, it is not envisaged that it should be dealt with in isolation, but rather that the inter-relationships between topics be highlighted, developed and investigated. Students should be encouraged to use a variety of techniques and media in their investigations, both formal drawing and freehand sketching, modelling and CAD tools. The emphasis is on the development of students' spatial reasoning, drawing on suitable practical applications as the opportunity arises.

The elements of Plane and Descriptive Geometry are

- 1. Projection Systems**
- 2. Plane Geometry**
- 3. Conic Sections**
- 4. Descriptive Geometry of Lines and Planes**
- 5. Intersection and Development of Surfaces**

PLANE AND DESCRIPTIVE GEOMETRY

1. Projection Systems

The ability to represent three-dimensional space in two dimensions is the basis for the investigation and solution of all solid analytic geometry problems. It is the student's ability to utilise the various systems of projection and to select those most appropriate to the solution of the current situation that provides them with means to define and solve graphic problems.

While some systems of projection have specific applications and utility, others are applicable to a wider variety of situations. It is the purpose of this section to provide students with an understanding of the underlying principles of the systems involved. In some cases there is a clear development and linkage with material dealt with in Junior Certificate Technical Graphics, and while this may form the foundation for the treatment of these areas in this programme, all material should be dealt with as derived from first principles.

Orthographic Projection

Teaching and Learning Context

The student's ability to present three dimensional descriptive geometry problems in a series of ordered logical arrangements is to be fostered. Students are required to have a thorough understanding of the relationship between planes of projection, including auxiliary projection planes and sectioning planes and the orthographic view obtained. Students are required to set up projection planes to satisfy specific requirements. While the main system of projection to be used should be first angle, *Higher Level students are expected to be familiar with third angle projection.*

Areas to be studied

- Definition of a plane
- Principal planes of reference
- Projection of right and oblique solids
- Auxiliary views, *including second and subsequent auxiliary views*
- Sectional views
- True shapes of surfaces and true lengths of lines
- Right solids in contact
- Projection of cube and tetrahedron, *their inscribed and circumscribed spheres*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Represent three dimensional objects in logically arranged two dimensional views
- Apply their knowledge of reference planes and auxiliary projection planes to solving problems using a first auxiliary view
- Present drawings in 1st angle orthographic conventional views
- Project views of right solids such that any face or edge of the solid may be on one of the principal planes of reference
- Solve problems that involve the intersection of solids by simply inclined planes and obliquely inclined planes, using horizontal and vertical section planes
- Determine the projections, inclinations, true length and true shape, of lines and planes
- Construct views of up to three solids having curved surfaces and/or plane surfaces in mutual contact
- Determine point of contact for surfaces in mutual contact
- Construct views of solids given the point of contact
- Depict the solutions of two dimensional problems in three dimensional format
- Represent in two dimensions the cube and tetrahedron from given information.

Higher level only

- *Apply their knowledge of reference planes and auxiliary projection planes to solving problems using a first auxiliary view and subsequent auxiliary views*
- *Present drawings in 3rd angle orthographic conventional views*
- *Project views of oblique solids (axis inclined to one of the principal reference planes only) such that any face or edge of the solid may be on one of the planes of reference or inclined to one or both planes of reference*
- *Solve problems that involve the intersection of solids by simply inclined planes and obliquely inclined planes using simply inclined section planes*
- *Determine the projections of lines given the angles of inclination to the principal planes of reference*
- *Model various problems involving solids in contact, planes of reference and auxiliary planes*
- *Determine the incentre and circumcentre of cube and tetrahedron.*

Pictorial Projection

Teaching and Learning Context

This section of the syllabus provides students with a number of methods whereby a two dimensional representation can depict a three dimensional entity. Students should be encouraged to use various forms of pictorial projection as a precursor to the solution of descriptive geometry problems and as an aid to their definition. The use of freehand sketching in this area should be encouraged, and this element of the programme should be seen as being equally examinable in both the terminal examination and the assignment.

(a) Isometric drawing and axonometric projection

Areas to be studied

- Isometric drawing of solids
- *Derivation, construction and application of the isometric scale*
- The axonometric plane and axes
- Principles of orthogonal axonometric projection (isometric)

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Complete isometric drawings of solids containing plane and/or curved surfaces
- Complete a portion of the axonometric plane given the projection of the axes of the planes of reference
- Determine the true shape of the planes of reference, showing the axonometric plane
- Determine the isometric projections of solids, including the sphere, using the isometric scale
- Project a two dimensional view of an object from its axonometric view
- Demonstrate a knowledge of the principles involved in the isometric scale.

Higher level only

- *Project orthogonal axonometric views of objects when the axes are inclined in isometric, dimetric or trimetric positions.*

(b) Perspective Drawing/Projection

Areas to be studied

- Principles of pictorial perspective drawing
 - parallel and angular perspective
 - vanishing points for horizontal lines
 - *derivation of vanishing points for inclined lines*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Demonstrate a knowledge of vanishing points, picture plane, ground line and horizon lines
- Determine the vanishing points and height lines for horizontal lines
- Complete perspective drawings of given objects.

Higher level only

- *Determine the vanishing points for sets of inclined lines. (Auxiliary vanishing points).*

PLANE AND DESCRIPTIVE GEOMETRY

2. Plane Geometry

Teaching and Learning Context

While having distinct and direct analytical links, the study of plane geometry provides students with a valuable support for other areas of the syllabus. Students should be familiar with the supporting theorems and axioms appropriate to the various elements in this section.

Areas to be studied

- Construction of plane figures
- *Construction of loci*
- Circles in contact with points, lines and curves

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Construct triangles, quadrilaterals and regular polygons of given side/altitude, inscribed and circumscribed about a circle
- Apply the principles and properties of plane figures in a problem solving setting.

Higher level only

- *Use the principle of loci as a problem solving tool.*

PLANE AND DESCRIPTIVE GEOMETRY

3. Conic Sections

Teaching and Learning Context

The importance of conic sections in many areas of engineering and science, as well as naturally occurring phenomena, is to be emphasised. Treatment of the conic sections will focus on their definition as plane loci, as well as sections of a cone. Students will be expected to be familiar with the basic properties and constructions applicable to the ellipse, hyperbola and parabola. The application of these principles in other areas of the syllabus will provide ample scope for three-dimensional modelling and computer generation/simulation.

Areas to be studied

- Terminology for conics
- The ellipse, parabola and hyperbola as sections of a right cone
- Understanding of focal points, focal sphere, directrix and eccentricity in the context of conic sections
- *Derivation of focal points, focal sphere, directrix and eccentricity for conic sections*
- Construction of conic curves as geometric loci
- Geometric properties common to the conic curves
- Tangents to conics
- *Construction of hyperbola from focal points and transverse axis*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Understand the terms used in the study of conics, viz. Chord, focal chord, directrix, vertex, ordinate, tangent, normal, major and minor axes/auxiliary circles, eccentricity, transverse axis
- Construct ellipse, parabola, hyperbola as true sections of solid cone
- Construct the conic sections, the ellipse, parabola and hyperbola, as plane loci from given data relating to eccentricity, foci, vertices, directrices and given points on the curve
- Construct ellipse, parabola and hyperbola in a rectangle given principal vertice(s)
- Construct tangents to the conic sections from points on the curve.

H.L. Only

- *Understand the terms used in the study of conics, double ordinate, latus rectum, focal sphere, etc.*
- *Construct ellipse, parabola, hyperbola as true sections of solid cone and derive directrices, foci, vertices and eccentricity of these curves*
- *Construct tangents to the conic sections from points outside the curve*
- *Construct a double hyperbola given the foci and a point on the curve, or given the length of the transverse axis and the foci*
- *Determine the centre of curvature and involute for conic sections.*

PLANE AND DESCRIPTIVE GEOMETRY

4. Descriptive Geometry of Lines and Planes

Teaching and Learning Context

The relationship and projection of spatial points and lines is fundamental to the solution of descriptive geometry problems. Of equal importance is an understanding of the significance and use of planes, including the principal planes of projection. While virtually all areas and topics utilise and manipulate planes in a particular manner, it is expected that all students should be conversant with the fundamental relationships and principles of both planes and lines. In their treatment of this area students are to be encouraged to model problems and solutions, and to utilise CAD facilities in the manipulation and exploration of the topic. Students should be encouraged to examine all areas of descriptive geometry relative to this area, in order that its relevance and importance be fully appreciated.

Areas to be studied

- Definition of planes, simply inclined and oblique
- Determination of oblique and *tangent* planes
- True shape and inclinations of planes to principal planes of reference
- Intersection of oblique planes, lines and *dihedral angle*
- Sectioning of right solids by oblique planes
- *Treatment of planes as laminar surfaces given rectangular co-ordinates*
- *Properties and projections of skew lines*
- *Spatial relationships between lines and planes*

Learning outcomes

Students should be able to:

Higher and Ordinary levels

- Distinguish between simply inclined and obliquely inclined plane surfaces
- Determine the angle of inclination between given planes and the principal planes of reference
- Determine the true length and inclination of given lines
- Establish the true shape of an obliquely inclined plane.
- Determine the line of intersection between two planes
- Determine the projections and true shape of sections of solids resulting from simply inclined and oblique cutting planes.

Higher level only

- *Construct obliquely inclined planes given the angles of inclination to the principal planes of reference and to include a given line or point*
- *Establish the dihedral angle between two intersecting planes*
- *Display knowledge of the relationships between planes and lines*
- *Understand the concept of a laminar surface defined by spatial co-ordinates*
- *Solve a variety of problems involving the intersection, inclination and positioning of laminar plane surfaces*
- *Define the concept of skew lines and their use in solving practical problems*
- *Establish various spatial relationships between skew lines and other lines and planes, including distance, inclination and direction.*

PLANE AND DESCRIPTIVE GEOMETRY

5. Intersection and Development of Surfaces

Teaching and Learning Context

The physical world we inhabit is bounded by a variety of solids and surfaces that divide and surround our three dimensional environment. A virtual infinity of concrete examples is easily accessible to students and these examples should be used where possible in the teaching/learning interaction. In as many areas as possible this topic should be related to the areas of planes, lines and various forms of projection. Students should be encouraged to model solutions.

Areas to be studied

- Surface development and envelopment of right solids
- *Surface development and envelopment of oblique solids*
- Intersection of surfaces of prisms, pyramids¹ and spheres, their frustra and composite solids and development of same
- *Intersection of right and oblique solids and their surface development*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Development and envelopment of right regular solids, their composites and frustra
- Determine and project true distance lines between specified points on the surfaces of solids
- Find the intersection of given lines and planes with given planes and curved surfaces
- Establish the surface intersections of prisms, pyramids, spheres, their frustra and composite solids, where the intersecting solids have their axes parallel to at least one of the principle planes of reference².

Higher level only

- *Developments and envelopment's of the surfaces of oblique prisms and pyramids*
- *Complete the intersection details of regular and oblique solids wherein their axes are parallel to one of the principle planes of reference.*

¹ Pyramid and prism are taken to include the cone and cylinder respectively.

² Principal planes of reference refers to the horizontal and vertical planes.

PART ONE (B)

COMMUNICATION OF DESIGN AND COMPUTER GRAPHICS

CONTENT AND LEARNING OUTCOMES

Communication of Design and Computer Graphics is part of the core of essential experiences for all students of Design and Communication Graphics. This section of the syllabus should account for approximately 25% of the available teaching time. While some of the material contained in this part of the syllabus lends itself to assessment through the terminal examination paper, a significant proportion of the topics and learning outcomes lend themselves to assessment through the course assignment and through coursework generally. While the area as outlined here is self-contained, it is envisaged that its contents will be integrated with other parts of the course.

Building on and contributing to, plane and descriptive geometry, this area should develop the student's ability to select and employ appropriate methods of graphic representation in the communication of ideas and information. Graphic techniques in representing form, light and shade should be developed. All students should be proficient in the use of freehand drawings both as an efficient communication medium and as a graphic ideation tool. Students should utilise CAD software in the context of the communication of design and as a developmental tool to aid visualisation. The teacher should at all times have in mind the value of this area in contributing to skills which are of equal, if not greater value, to the communication and problem solving skills, i.e. spatial visualisation, graphic ideation and creative reasoning. A thematic approach is seen as appropriate to developing and contextualising the cognitive and psychomotor skills associated with this area of the programme.

COMMUNICATION OF DESIGN AND COMPUTER GRAPHICS

1. Graphics in Design and Communication

Teaching and Learning Context

It is important to put the graphics code in historical perspective and to ensure that students are familiar with a variety of techniques and associated media. They should also understand how the various elements of drawing interrelate as arts of the graphics language. They should be able to distinguish between stages and functions in design graphics, for example idea sketching and computational sketching. In order to properly explore these elements students should have knowledge of design strategies and be involved in design activities.

Areas to be studied

- Drawing from a historical perspective
- Design strategies
- Reflection on processes of design
- Design appraisal
- *Generation of design briefs*
- Interpretation of design briefs
- Ideas sketching
- Design problem solving
- Design communication

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Compare traditional graphic communication methods with modern electronic methods and appreciate the advantages and disadvantages of both
- Understand the steps required to bring a project from situation/brief, to final working drawings
- Form an opinion on design as it affects the function, ergonomics and aesthetic qualities of everyday artefacts
- Display a knowledge of the rudiments of good design - proportion, colour, materials, ergonomics, and value for money
- Interpret and analyse given design briefs
- Understand the principles of the interpretation of graphic instructions as they apply to the solution of a design brief.

Higher level only

- *Evaluate design with reference to function, ergonomics and aesthetic qualities*
- *Generate design briefs appropriate to given problems.*

COMMUNICATION OF DESIGN AND COMPUTER GRAPHICS

2. Communication of Design

Teaching and Learning Context

In exploring this area, students should develop their skills by exploring real or hypothetical design situations. They should see that all such detail design or working drawings should convey all the information necessary for the production of an artefact and should be readily understandable to any who might be required to read them. Presentation techniques such as line weighting, balloon referencing, detail extraction, etc. should be used. Student's drawings should conform to relevant contemporary international drawing systems and conventions.

Areas to be studied

- Drawing conventions, symbols and standards
- Presentation methods and layout
- Design drawings and associated processes
- Pictorial and orthographic working and assembly drawings
- Balloon extraction detailing
- Exploded pictorial views
- Dimensioning and notation
- Schematic diagrams

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Use graphical symbols as necessary to convey a design to the correct drawing standards
- Create drawings and layouts that make appropriate use of materials available to achieve a pleasing presentation
- Use graphics, both orthographic and three dimensional to explain design function and methods of assembly
- Produce drawings, which can be used by a third party, to produce an artefact
- Use standards pertaining to dimensioning and notation
- Produce schematic diagrams to explain familiar operations.

Higher level only

- *Design schematic diagrams to explain familiar operations.*

COMMUNICATION OF DESIGN AND COMPUTER GRAPHICS

3. Freehand Drawing

Teaching and Learning Context

Students should see freehand drawing as an important tool in explaining as well as solving problems. While specific attention should be given to developing freehand techniques students should also be encouraged in developing and exploring solutions to formal problems in plane and descriptive geometries. They should also be able to represent light, tone and texture and see a freehand drawing as the most immediate way of representing an idea or defining a concept.

Areas to be studied

- Materials for freehand drawing
- Observation techniques
- Representing shape, form, texture and material
- Light and shade
- Design sketching
- Freehand detailing
- The use of colour

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Use freehand sketching as a tool to explain an idea
- Produce freehand drawings
- Select the most suitable medium for producing and rendering sketches and drawings
- Identify the surfaces of an object relative to each other in three dimensional space
- Use various methods of rendering and colouring to enhance a drawing.

Higher level only

- *Analyse critically the texture and colour of a surface and choose suitable rendering media by which the surface can be accurately represented*
- *Represent graphically the effects light and shade have on surfaces.*

COMMUNICATION OF DESIGN AND COMPUTER GRAPHICS

4. Information and Communication Technologies

Teaching and Learning Context

The contribution of Information and Communication Technologies to design is considerable. Developments in this area have provided designers with tools and techniques to explore and represent design elements in ways that were not previously possible. The development and exploitation of computer technology provides a powerful and versatile tool for the rapid solution of problems and presentation of design ideas. As part of their essential studies in this area, students will be introduced to the fundamentals of two-dimensional CAD, with more advanced two and three dimensional work being developed where appropriate throughout the course.

The course assignment provides students with ample opportunities to exploit the features of both two and three-dimensional CAD software.

(a) CAD Applications

Areas to be studied

- File management
- Graphics and CAD terminology
- Graphics and CAD software
- Generate working drawings from part and assembly models
- CAD sketching principles
- 3D part modelling
- Creating 3D assemblies
- Generation of presentation drawings from parametric models
- *Generation of exploded views and animated sequences from parametric models*
- Model editing
- *Part modelling and editing using sweeps and lofts*
- Use of templates and libraries
- Data exchange between applications
- Graphic output

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Appreciate the power of contemporary hardware and software as they apply to design and communication of design
- Use the various computer input and output devices as they relate to CAD
- Use CAD drawings to produce three-dimensional CAD models
- Understand the impact of design intent in CAD modelling
- Generate multi-view drawings from 3D models
- Produce presentation drawings from CAD models
- Effectively use the editing features of CAD software
- Exchange data between applications
- Efficiently use the standard tools and manipulation features of CAD software.

Higher level only

- *Produce exploded and assembled presentation drawings*
- *Realise in the CAD model the design intent*
- *Use CAD modelling to explore geometric concepts and principles*
- *Import and export files*
- *Animate sequences.*

(b) ICT and Graphics

Areas to be studied

- File management and organisation
- File formats and extensions
- Image transfer
- *Image processing, transfer and manipulation*
- Web research
- Presentation techniques using ICT and CAD software

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Create folders and save files to designated locations using recognised naming conventions
- Use and understand the various file formats and images associated with CAD and related ICT software
- Transfer images from CAD software to ICT packages as an aid to compiling a document, making a presentation (copy/paste) or producing a photo-real representation of a model (export/insert, render to file)
- Convert an image from one format to another
- Use search engines and URL's on the Internet as a research tool
- Download text and images from the Internet for analysis, editing and reproduction in a DTP package
- Capture images using a range of media (for example: digital cameras, scanners, screen capture, Internet, other)
- Make slides with a CAD package of key steps involved in creating a drawing.

Higher level only

- *Manipulate images to achieve special effects*
- *Use slides or other animation techniques to illustrate graphic design solutions.*

Course Assignment

Teaching Learning Context

Students will explore a variety of artefacts in the context of their design, and represent these, using a variety of appropriate media. The coursework assignment is intended to engage students in the creative activity associated with design and the variety of elements involved in communication of design. This area will deal with topics, which are not readily assessed through a terminal examination. The main course assignment will relate to a theme or topic, which will require investigation and decision making on the part of the student. A variety of media will be encouraged in the design and communication solutions, but Computer Aided Design by way of modelling will be required from all participants. The teacher will endeavour to create a teaching environment which will accommodate creative thought and action, while developing the necessary cognitive and practical skills, associated with design and communication of design.

Learning outcomes

Students should be able to

- Observe, measure and represent graphically details of real artefacts
- Select preferred methods of graphic representation in the communication of existing designs
- Represent design and communication information through sketches, CAD and other ICT applications
- Produce to approved standards appropriately dimensioned 2D and 3D drawings and models on paper and CAD
- Use appropriate presentation techniques, including colour, rendering and sketching to represent an artefact and/or design.
- Demonstrate design and visualisation skills and techniques.
- Appreciate, analyse, evaluate and modify artefacts and products from a design perspective
- Take a reflective approach to their design proposals and solutions
- Include the principles of inclusive and user-centered design.
- Critically evaluate realised assignments.

Note: Ordinary and Higher levels will be differentiated by depth of treatment and the level of design and creativity expected in the response.

**PART TWO
OPTIONAL AREAS OF STUDY**

APPLIED GRAPHICS

CONTENT AND LEARNING OUTCOMES

Content and learning outcomes in *italics* apply to Higher level only

PART TWO - OPTIONAL AREAS OF STUDY CONTENT AND LEARNING OUTCOMES

APPLIED GRAPHICS

Students will study two optional areas of study from this part of the syllabus. The optional areas of study are

- 1 Dynamic Mechanisms**
- 2 Structural Forms**
- 3 Geologic Geometry**
- 4 Surface Geometry**
- 5 Assemblies**

Students should be encouraged to investigate their physical environment and to apply the principles of plane and descriptive geometries to the solution of a variety of problems in the areas of science, engineering, architecture, geography, etc. Students should be able to select the most appropriate methods to depict and solve these problems, both in terms of illustrative method used and the mechanism for its utilisation.

By nature these topics are highly practical and visible and it is envisaged that applications would be dealt with in conjunction with, rather than in isolation from, the underlying principles introduced in the core areas of study. At all times the development of the student's spatial abilities and graphic intelligence is to be fostered and encouraged.

APPLIED GRAPHICS

1. Dynamic Mechanisms

Teaching and Learning Context

While much of the study of Design and Communication Graphics deals with elements that are static, plane and descriptive geometries can be equally useful in the solution of dynamic problems. Students will be introduced to many of the "special curves" as the path plotted by a point undergoing a dynamic transformation. The use of models and computer simulations to depict these movements forms an integral part of the teaching and learning methodology to be employed, in the context of applications.

Areas to be studied (in an applied context)

- The common geometric loci: involutes, helices, conical spirals, and Archimedean spirals
- Construction of loci defined by the movement of circles relative to lines and circles
- Construction of tangents at a point on an involute, Archimedean spiral, cycloid, epicycloid and hypocycloid
- Determination of loci from linkage mechanisms
- Construction of cam profiles and displacement diagrams depicting uniform velocity, simple harmonic motion, uniform acceleration and retardation for knife edge followers
- *Construction of cam profiles and displacement diagrams depicting uniform velocity, simple harmonic motion, uniform acceleration and retardation for roller and flat followers*

Learning outcomes

Students should be able to:

Higher and Ordinary levels

- Construct the involute of a circle and regular polygons
- Construct the helix and conical spiral from given data
- Construct a spiral given the longest and shortest vector length or given a vector length and the angular increase in length
- Use a trammel to solve problems on loci
- Construct the locus of a point in a link mechanism
- Construct radial plate cams of given uniform velocity, simple harmonic motion, uniform acceleration and retardation to knife edge followers
- Construct cam profiles and displacement diagrams
- Construct displacement diagrams for given cam profiles
- Understand the applications for all the curves constructed
- Construct standard cycloids.

Higher level only

- *Construct epicycloids, hypocycloids and trochoids*
- *Construct a tangent at a point on an involute, Archimedean spiral, cycloid, epicycloids, hypocycloid and trochoid*
- *Construct radial plate cams of given uniform velocity, simple harmonic motion, uniform acceleration and retardation to roller and flat followers*
- *Construct involute and epicycloidal gear profiles.*

APPLIED GRAPHICS

2. Structural Forms

Teaching and Learning Context

The human environment, both natural and manufactured, provides an ideal resource for graphic investigation, study and analysis. Students are to be encouraged to model elements from this section, both physically and with the aid of CAD software. Investigation of the historical development of common structural forms, including the arch, dome and vault, together with the representation of these and other structures using line diagrams is to be an intrinsic part of this area.

Areas to be studied

- Structural forms, natural and manufactured
- Singly and doubly ruled surfaces
- The hyperbolic paraboloid as a ruled surface
- *The hyperbolic paraboloid as a surface of translation*
- *Plane directors*
- The hyperboloid of revolution, projections and sections
- Sections through singly and doubly ruled surfaces
- *The geodesic dome of not more than four points of frequency*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Investigate the development of structural forms in a historical context
- Identify the key structural forms including arches, domes, vaults, frames and surface structures
- Produce line drawings of the basic structural forms
- Produce two dimensional drawings of arches, domes, vaults, and surface structures
- Construct a hyperbolic paraboloid as a ruled surface
- Determine the true shape of sections through curved surfaces
- Project views and sections of a hyperboloid of revolution.

Higher level only

- *Relate the key properties of structural forms to their design and construction*
- *Produce three-dimensional drawings of arches, domes, vaults, and surface structures*
- *Determine plane directors for ruled surfaces, and construct ruled surfaces given plane directors and directrices*
- *Project views of a hyperbolic paraboloid defined as a surface of translation*
- *Construct geodesic domes of four points of frequency*
- *Investigate and represent structural forms as they occur in the environment.*

APPLIED GRAPHICS

3. Geologic Geometry

Teaching and Learning Context

The graphic investigation of natural geologic features provides geographers and engineers with a versatile analytic tool, capable of revealing many of the features hidden beneath the world's surface.

Areas to be studied

- Appropriate symbols and notation
- Interpolation and plotting of contours
- Methods of showing slopes and gradients
- Profiles determined from contours
- *Use of skew-boreholes in mining problems*
- Determining the true dip of ore strata
- *Determining the apparent dip of ore strata*
- Strike and thickness of strata
- Determination of outcrop
- Cutting and embankment sections for level constructions
- *Cutting and embankment sections for inclined constructions*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Understand concepts such as bearings, grid layout, true north, etc.
- Interpolate and plot contours on a map for given data
- Show profiles determined from contours
- Determine cuttings and embankments for level roads and surfaces
- Determine the true dip, strike and thickness of strata
- Determine the outcrop points for given strata.

Higher level only

- *Determine cuttings and embankments for inclined roads and surfaces*
- *Determine the apparent dip of strata*
- *Solve mining problems through the use of skew boreholes.*

APPLIED GRAPHICS

4. Surface Geometry

Teaching and Learning Context

An understanding of surfaces, their relationships, intersections and developments is an intrinsic part of understanding the manufactured environment through architecture, engineering, design and packaging. This area will explore relevant examples taken from the environment.

Areas to be studied

- Dihedral angles between surfaces
- Surface developments of containers and structures such as plane intersecting roof surfaces, sheet metal containers, hoppers and transition pieces
- Projections and developments of intersecting prismatic, right cylindrical, transition and ducting details
- *Projections and developments of intersecting prismatic, oblique cylindrical, oblique conical transition and ducting details*
- Projection and developments of transition pieces connecting rectilinear to rectilinear and circular to circular cross section
- *Projection and developments of transition pieces connecting circular to rectilinear cross section*

Learning outcomes

Students should be able to

Higher and Ordinary levels

- Determine the dihedral angles between adjacent plane surfaces forming solid objects
- Prepare surface developments of surface containers, intersecting roof surfaces, and sheet metal fabrications
- Determine the lines and points of intersection between two intersecting surfaces or objects
- Develop intersecting ductwork involving prismatic and right cylindrical surfaces
- Determine the developments of transition pieces between ducts of circular/circular and rectilinear/ rectilinear cross-section.

Higher level only

- *Develop intersecting ductwork involving oblique prismatic and oblique cylindrical surfaces*
- *Determine the developments of transition pieces between ducts of circular/rectilinear cross-section.*

APPLIED GRAPHICS

5. Assemblies

Teaching and Learning Context

The interpretation of machine and flat-pack assembly drawings is a necessary skill for many household and other common assemblies/products, and these are seen as primary sources of material for study. Students should begin with examples of simple assemblies of just a few components and should gradually develop the ability to interpret and communicate more complex multipart assemblies. These skills are developed through the ability to interpret, model and represent multi-view projections from a number of single components. Assemblies provide the ideal platform for 3D CAD modeling and manipulation as well as the generation of ortho-views and sections. The practical value of these skills should not be underestimated. In addition to becoming familiar with dimensioning, sectioning, hatching and joining, students will learn appropriate symbols and abbreviations.

The number and complexity of the components required for any assembly task will differentiate Higher and Ordinary level studies in this option.

Areas to be studied

- Interpretation of exploded and assembled drawings
- Drawings – layout and conventions
- System of projection
- Sectional views
- Hatching
- Dimensioning
- Joining methods
- Machine surface and texture symbols
- Modelling assemblies in 3D CAD

Learning Outcomes

Students should be able to

Higher and Ordinary levels

- Understand product assembly drawings
- Interpret assembly drawings.
- Draw assembled views from drawings of a small number of single components
- Draw the views essential to the representation of an assembly
- Draw single plane sectional views
- Hatch sectioned parts in each view
- Fully dimension drawings
- Measure components to be drawn and relate the model/drawing to the artefact
- Generate CAD models of assemblies
- Apply balloon detailing
- Use abbreviations and symbols.

Higher level only

- *Draw a number of sectional views*
- *Draw views that have been sectioned.*
- *Indicate on the drawing, surface finish as appropriate*
- *Indicate methods of assembly.*