8439
ADVANCED ENGINEERING DESIGN DRAFTING (12A)

40S/40E/40M

A Design Drafting Course

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Course Description

Advanced Engineering Design Drafting is intended for students in the transition phase of engineering design drafting.

Curriculum content focuses on engineering product design and manufacturing. Students will present their design solutions to others.

Topics include the following:

- principles of design
- drafting, engineering, and manufacturing standards
- manufacturing materials, fasteners, standard components, and processes
- computer model parts, assemblies, and sub-assemblies for visualization, simulations, and finite element analysis
- part, assembly, and development drawings

Students will apply safety procedures and employability skills independently. Students will continue to develop their knowledge, skills, and attitudes in the areas of career development, sustainability, and new and emerging technologies in engineering design drafting and manufacturing.

Cross-curricular learning outcomes, which include those in design drafting math, science, and the interpretation of technical documents, are to be integrated into the course.

The learning outcomes are organized by Technology Fundamentals (F), Technology Skills (S), and Professional Practice (P) strands. For instructional purposes, the sequence of learning outcomes and the learning outcomes included in each unit of study can vary based on the projects within the course.

Goal 1: Solve problems using the **design process**.

GLO 1.1: Define design problems.

SLO 12A.F.1.1.1	Describe the relationship between the design process and the creation and revision of engineering or manufacturing drawings.
SLO 12A.F.1.1.2	Define design problems related to manufacturing processes (e.g., machining, milling, injection moulding, casting).

SLO 12A.S.1.1.1 Use a structured model in the creation, refining, and revision of advanced engineering drawings.

GLO 1.2: Research and analyze information for design solutions.

SLO 12A.F.1.2.1 Identify how engineering design principles affect the selection of the manufacturing process.

SLO 12A.F.1.2.2 Compare the factors (e.g., manufacturing processes, material properties, cost, availability, standard components) that influence design.

SLO 12A.F.1.2.3 Compare sustainable engineering principles (e.g., energy, service life, recycling, resource consumption, social impact) to solve engineering problems.

SLO 12A.F.1.2.4 Assess universal design principles to include in engineering design solutions.

SLO 12A.F.1.2.5 Consider aesthetic principles (e.g., colour, balance, texture, form, proportion) in relation to engineering design.

SLO 12A.S.1.2.1 Select and incorporate engineering design principles into design solutions.

SLO 12A.S.1.2.2 Create and revise sketches and notes based on engineering research.

SLO 12A.S.1.2.3 Select and incorporate materials and manufacturing processes into design solutions.

SLO 12A.S.1.2.4 Select and incorporate engineering aesthetic, sustainability, and universal design principles into design solutions.

SLO 12A.S.1.2.5 Research and reference information from various engineering and manufacturing sources (e.g., websites, manufacturer specifications, engineering tables, *Machinery's Handbook*).

SLO 12A.S.1.2.6 Analyze and predict consequences of design modifications.

GLO 1.3: Synthesize information and ideas to create design solutions.

SLO 12A.F.1.3.1 Identify the decision-making process required to arrive at the best (compromised) design solution (e.g., cost, materials, manufacturing process, recyclability, performance, ease of manufacture and repair).

SLO 12A.F.1.3.2 Identify sketching techniques related to specialized media (e.g., charcoal, paint, felt pen, pen and ink).

SLO 12A.S.1.3.1 Select design solutions based on engineering and manufacturing research.

SLO 12A.S.1.3.2 Create and revise freehand sketches to illustrate the refined engineering design solution.

Goal 2: **Communicate** design solutions.

GLO 2.1: Prepare **computer models** of design solutions.

SLO 12A.F.2.1.1 Describe the functions of computer models, including visualization, model to engineering drawing, simulations, model to computer-integrated manufacturing, and finite element analysis.

SLO 12A.F.2.1.2 Define complex geometric construction principles related to engineering design.

SLO 12A.F.2.1.3 Examine engineering features for parts and assemblies (e.g., cylinders, fillets, chamfers, holes, standard components, knurl, taper, boss, ribs, webs).

SLO 12A.F.2.1.4 Describe the process of modelling parts and the relationships of sub-assemblies to higher level assemblies.

SLO 12A.F.2.1.5 Explain how developments (e.g., parallel and radial line developments and intersections) are used in 3-D product manufacturing (e.g., packaging, sheet metal products).

SLO 12A.S.2.1.1 Incorporate engineering features into computer model parts, sub-assemblies, and assemblies.

SLO 12A.S.2.1.2 Use a computer model to visualize design solutions, create manufacturing drawings, and perform finite element and motion analysis.

SLO 12A.S.2.1.3 Apply complex geometric construction principles.

GLO 2.2: Prepare working and presentation drawings and documents.

Layout (F)

SLO 12A.F.2.2.1 Identify the components (e.g., title block information, border with zones, view arrangements, parts lists, revision blocks, general tolerance notes, projection symbol) of an engineering drawing.

SLO 12A.F.2.2.2 Identify engineering symbols (e.g., cylinders, fillets, chamfers, holes, standard components, knurl, taper, boss, ribs, webs) for orthographic, auxiliary, and section drawings.

Line Work (F)

SLO 12A.F.2.2.3 Identify engineering line types (e.g., object, hidden, centre, construction, extension, dimension lines, break lines, phantom lines, hatch lines) and their intended use.

SLO 12A.F.2.2.4 Select engineering line types.

Dimensioning and Annotating (F)

SLO 12A.F.2.2.5 Identify advanced engineering tolerancing, geometric dimensioning and tolerancing, fits, and annotation standards.

Layout (S)

SLO 12A.S.2.2.1 Use engineering drawing components (e.g., title block information, border with zones, view arrangements, parts lists, revision blocks, general tolerance notes, projection symbols).

SLO 12A.S.2.2.2 Create orthographic, auxiliary, and section drawings of complex parts, sub-assemblies, and assemblies using engineering symbols.

SLO 12A.S.2.2.3 Create pattern development (e.g., parallel and radial line developments and intersections) drawings for a 3-D object (e.g., packaging, sheet metal products).

SLO 12A.S.2.2.4 Create schedule tables and parts lists.

SLO 12A.S.2.2.5 Revise drawings to ensure consistency and to organize and assemble a set of working drawings.

SLO 12A.S.2.2.6 Combine orthographic, section, auxiliary, detail, and isometric drawings into a set of working drawings.

Line Work (S)

SLO 12A.S.2.2.7 Select and use line types for engineering applications based on standards.

Dimensioning and Annotating (S)

SLO 12A.S.2.2.8 Use advanced industry standard engineering tolerancing, geometric dimensioning and tolerancing, fits, and annotation.

Goal 3: Use appropriate **materials and processes** of building/ manufacturing.

GLO 3.1: Describe **materials** used in design solutions.

SLO 12A.F.3.1.1 Compare materials (e.g., ferrous and non-ferrous metals, woods, plastics, composites) used in manufacturing parts.

SLO 12A.F.3.1.2 Compare standard parts based on use and material properties.

SLO 12A.S.3.1.1 Select and incorporate materials and standard parts into design solutions.

GLO 3.2: Describe **building/manufacturing processes** used in design solutions.

SLO 12A.F.3.2.1 Identify manufacturing processes (e.g., grinding, polishing, reaming, knurling) for engineering design.

SLO 12A.F.3.2.2 Identify project management considerations (e.g., timelines, material supplies, project management software, waste) for design solutions.

SLO 12A.S.3.2.1 Select manufacturing processes for design solutions.

Goal 4: **Present** design solutions.

GLO 4.1: Plan and organize presentations of design solutions.

SLO 12A.F.4.1.1 Identify presentation methods for engineered parts and products.

SLO 12A.S.4.1.1 Select presentation methods for engineered parts and products (e.g., oral, written, 2-D/3-D freehand sketch, overlay graphic, physical or digital 3-D model).

GLO 4.2: Use presentation production methods.

SLO 12A.F.4.2.1 Differentiate among the formats and functions of technical reports, design briefs, and scope-of-work documents.

SLO 12A.F.4.2.2 Differentiate among the formats and functions of visual presentation formats for parts and assemblies (e.g., presentation software, presentation sections, detailed views, physical models).

SLO 12A.S.4.2.1 Create written technical reports and scope-of-work documents supporting choice of parts and products.

SLO 12A.S.4.2.2 Communicate effectively using presentation software incorporating design elements (e.g., formatting, layout, font size).

SLO 12A.S.4.2.3 Create visual presentations supporting choice and placement of parts and products.

SLO 12A.S.4.2.4 Simulate motion in a 3-D CADD model.

GLO 4.3: Present/defend design solutions.

SLO 12A.F.4.3.1 Describe elements and communication techniques (e.g., appearance and dress, enunciation and volume, body language) of presentations for technical information.

SLO 12A.F.4.3.2 Discuss out-of-school student competitions related to engineering design drafting.

SLO 12A.S.4.3.1 Present product design solutions to an audience (e.g., group) and respond to questions and feedback.

Goal 5: Describe and apply the common **tools and equipment** used in design drafting.

GLO 5.1: Describe and use **drawing and modelling tools and equipment**.

SLO 12A.F.5.1.1 Identify advanced sketching tools and media.

SLO 12A.F.5.1.2 Identify physical modelling tools (e.g., drills, scroll saws, band saws, sanders, CNC router, 3-D printer).

SLO 12A.F.5.1.3 Identify advanced measuring devices (e.g., calipers, radius gauges, thread pitch gauges, thickness gauges, go-no-go gauges, feeler gauges, micrometers).

SLO 12A.S.5.1.1 Use sketching tools and media.

SLO 12A.S.5.1.2 Use physical modelling tools (e.g., drills, scroll saws, band saws, sanders, CNC router, 3-D printer).

SLO 12A.S.5.1.3 Use advanced measuring devices (e.g., calipers, radius gauges, thread pitch gauges, thickness gauges, go-no-go gauges, feeler gauges, micrometers).

GLO 5.2: Describe and use **computer hardware and equipment**.

SLO 12A.F.5.2.1 Identify function and use of advanced 3-D modelling hardware.

SLO 12A.F.5.2.2 Identify function and use of advanced input devices (e.g., 3-D scanning equipment).

SLO 12A.F.5.2.3 Identify function and use of advanced output devices (e.g., rapid prototyping, CNC machines).

SLO 12A.S.5.2.1 Operate input devices (e.g., digital camera, scanner, 3-D scanner).

SLO 12A.S.5.2.2 Operate output devices (e.g., printers, plotters, rapid prototyping).

SLO 12A.S.5.2.3 Troubleshoot computer and printer/plotter problems.

GLO 5.3: Describe and use **software**.

SLO 12A.F.5.3.1 Identify simulation and finite element analysis components of engineering software.

SLO 12A.F.5.3.2 Discuss advanced features of office software in the design and presentation process.

SLO 12A.F.5.3.3	Identify information communication technologies (e.g., RSS feeds, blogs, technical websites, discussion boards) related to design drafting.
SLO 12A.S.5.3.1	Use simulation and finite element analysis components of engineering software.
SLO 12A.S.5.3.2	Use advanced features of office software in the design and presentation process.
SLO 12A.S.5.3.3	Manage project data using the file sharing and management features of CADD software.
SLO 12A.S.5.3.4	Manage, organize, and share project files in a networked environment.
SLO 12A.S.5.3.5	Use and manipulate digital images, at an advanced level, to obtain and record information (e.g., portfolio collection, research).
SLO 12A.S.5.3.6	Use information communication technologies (e.g., RSS feeds, blogs, technical websites, discussion boards) related to engineering design drafting.

Goal 6: Describe and apply transferable **cross-curricular knowledge and skills** that relate to design drafting.

GLO 6.1: Describe and apply **mathematical concepts** as they relate to design drafting.

SLO 12A.F.6.1.1	Identify the buildable levels of precision used in engineering drawings.
SLO 12A.F.6.1.2	Demonstrate an understanding of straight-line interpolation and extrapolation.
SLO 12A.F.6.1.3	Identify product estimation techniques, including material and labour costs.
SLO 12A.S.6.1.1	Produce engineering models and drawings to a buildable precision.
SLO 12A.S.6.1.2	Use straight-line interpolation and extrapolation.
SLO 12A.S.6.1.3	Estimate material, equipment, and labour costs.
SLO 12A.S.6.1.4	Research and calculate sizes of standard components (e.g., bolts, pins, gears).

GLO 6.2: Read, interpret, and communicate information.

SLO 12A.F.6.2.1	Identify sources of technical information (e.g., material specifications, ISO, SAE, *Machinery's Handbook*).
SLO 12A.F.6.2.2	Read and interpret information from engineering tables (e.g., fits, screw thread, drill sizes).

SLO 12A.S.6.2.1 Organize and record technical information from oral, visual, material, print, or electronic sources.

SLO 12A.S.6.2.2 Read, interpret, and apply technical information from text, tables, charts, and graphs.

SLO 12A.S.6.2.3 Communicate using the language and terminology of engineering design drafting.

GLO 6.3: Understand **scientific concepts** as they apply to design drafting.

SLO 12A.S.6.3.1 Apply the scientific applications used in engineering design solutions (e.g., gravity, mechanical advantage, vectors).

Goal 7: Demonstrate an awareness of **sustainability** as it pertains to design drafting.

GLO 7.1: Understand the impact of architectural/engineering design on the **environment**.

SLO 12A.F.7.1.1 Identify sustainable materials and manufacturing processes that affect engineering design solutions (e.g., electrical conservation, lean manufacturing, conservation of resources, cradle to cradle, alternative energy).

SLO 12A.F.7.1.2 Differentiate between traditional and sustainable manufacturing processes and their impacts on the environment.

SLO 12A.S.7.1.1 Incorporate sustainable materials and manufacturing processes in engineering design solutions.

GLO 7.2: Describe the impact of architectural/engineering design on **human health and well-being**.

SLO 12A.F.7.2.1 Identify human health and well-being sustainable materials and manufacturing processes that affect engineering design solutions (e.g., ergonomics, coatings, sharp edges, health and safety manufacturing, servicing, user and recycling implications).

SLO 12A.F.7.2.2 Differentiate among natural and synthetic materials, and sustainable manufacturing processes and their impact on human health and well-being.

SLO 12A.S.7.2.1 Incorporate human health and well-being sustainable materials and manufacturing processes in engineering design solutions.

GLO 7.3: Recognize the **economic impact** of sustainable practices in architectural/engineering design.

SLO 12A.F.7.3.1 Identify economic sustainable materials and manufacturing processes that affect engineering design solutions (e.g., solar, geothermal, wind, hydroelectric, renewable materials, rigorous prototyping).

SLO 12A.F.7.3.2 Differentiate between traditional and sustainable manufacturing processes and their economic impacts.

SLO 12A.S.7.3.1 Incorporate economic sustainable materials and manufacturing processes in engineering design solutions.

Goal 8: Understand the **evolution** of design drafting, including its **technological progression and emerging trends**.

GLO 8.1: Describe the **evolution of design drafting, including its technological progression and emerging trends**.

SLO 12A.F.8.1.1 Discuss emerging trends related to the role of designer/draftsperson and the use of working drawings in manufacturing.

SLO 12A.F.8.1.2 Describe emerging styles and trends and their impact on the selection of materials and manufacturing processes (e.g., nanotechnology, manufacturing in space, local manufacturing/cottage industries, serviceability, new trends in manufacturing).

Goal 9: Follow the **ethical and legal standards** in design drafting.

GLO 9.1: Incorporate the local and national **building codes and standards as well as manufacturing and engineering standards** into designs.

SLO 12A.P.9.1.1 Identify the commonly used standards for engineering drafting.

SLO 12A.P.9.1.2 Produce technical drawings to CAN/CSA, ISO, and ANSI standards.

SLO 12A.P.9.1.3 Follow government regulatory guidelines.

SLO 12A.P.9.1.4 Use CADD standards (e.g., discipline specific, trade specific, organization) based on design project requirements.

SLO 12A.P.9.1.5 Describe the legal (e.g., as enunciated by government regulatory guidelines, professional associations) and contractual (e.g., manufacturers, material suppliers) obligations of engineering drawings.

GLO 9.2: Describe the **ethical expectations** of designers.

SLO 12A.P.9.2.1 Consider the ethical implications of compromise in making technical design decisions (e.g., costs, inadequate design).

Goal 10: Demonstrate a knowledge of and ability to recognize and apply appropriate **health and safety** requirements and practices to maintain a safe workplace.

GLO 10.1: Demonstrate an awareness of **rights, responsibilities, and safety procedures** for specific tools, equipment, and working environments.

SLO 12A.P.10.1.1 Demonstrate and value safe work practices and procedures.

SLO 12A.P.10.1.2 Demonstrate ergonomically correct procedures to avoid injury (e.g., stress, strain).

SLO 12A.P.10.1.3 Demonstrate personal responsibility for health and safety.

SLO 12A.P.10.1.4 Demonstrate the safety features of tools and equipment.

SLO 12A.P.10.1.5 Follow emergency evacuation procedures.

SLO 12A.P.10.1.6 Use appropriate aids to minimize risk of injury.

SLO 12A.P.10.1.7 Use appropriate personal protective equipment.

SLO 12A.P.10.1.8 Locate first aid stations and fire extinguishers.

SLO 12A.P.10.1.9 Demonstrate an awareness of external health and safety programs and certifications.

GLO 10.2: Describe **health and safety laws and regulations**.

SLO 12A.P.10.2.1 Describe the reporting process for injuries.

SLO 12A.P.10.2.2 Identify WHMIS symbols and terminology, and follow WHMIS guidelines, including the location of MSDS sheets.

SLO 12A.P.10.2.3 Comply with health and safety legislation and practices.

Goal 11: Demonstrate **employability skills** required in design drafting.

GLO 11.1: Demonstrate fundamental **employability skills**.

SLO 12A.P.11.1.1 Describe the importance of employability skills in school, work, and daily life.

SLO 12A.P.11.1.2 Listen and ask questions to clarify problems and instructions.

SLO 12A.P.11.1.3 Locate, gather, and organize design drafting information using appropriate technology and information systems.

SLO 12A.P.11.1.4 Assess situations and identify problems and possible solutions.

GLO 11.2: Demonstrate **personal management** skills.

SLO 12A.P.11.2.1 Demonstrate interest, initiative, and effort.

SLO 12A.P.11.2.2 Manage time to complete tasks/projects within stated time frames.

SLO 12A.P.11.2.3 Demonstrate accountability for own actions and for the actions of one's team.

SLO 12A.P.11.2.4 Respond constructively to changes.

SLO 12A.P.11.2.5 Demonstrate a willingness to learn continuously.

SLO 12A.P.11.2.6 Appreciate the need for continuous learning in technologically dependent occupations.

GLO 11.3: Demonstrate **teamwork** skills.

SLO 12A.P.11.3.1 Be respectful toward, open to, and supportive of the thoughts, opinions, and contributions of others in a group.

SLO 12A.P.11.3.2 Contribute information and skills to achieve the goals of a group.

SLO 12A.P.11.3.3 Contribute willingly to classroom/shop learning activities.

SLO 12A.P.11.3.4 Accept assistance from and offer it to others.

SLO 12A.P.11.3.5 Collaborate with peers and industry professionals.

Goal 12: Describe **career opportunities** in design drafting.

GLO 12.1: Describe **post-secondary opportunities** related to design drafting.

SLO 12A.P.12.1.1 Identify industry and association certifications related to engineering design drafting.

GLO 12.2: Describe **career opportunities** available in design drafting across industries.

SLO 12A.P.12.2.1 Explore engineering careers related to the manufacturing industry.

GLO 12.3: Create, maintain, and present a **portfolio**.

SLO 12A.P.12.3.1 Organize and reflect on engineering samples for inclusion in a design drafting portfolio.