OCR
Oxford Cambridge and RSA

Cambridge NATIONALS LEVEL 1/2

ENGINEERING DESIGN

Cambridge NATIONALS

R107 Developing and presenting engineering designs

J831/J841

Schemes of work

Version 1

CONTENTS

INTRODUCTION

This teaching resource, which we've developed with Nationals Engineering teachers, contains two types of schemes of work.

- A **longer term** plan which covers the whole academic year over three terms and suggests the order in which each Learning Outcome (LO) could be taught. Links to other units and LOs within Nationals Engineering are also shown.

- A **medium term** plan which also covers the whole academic year over three terms and suggests the order in which each LO could taught but also provides classroom activities and any links to other resources which might be useful. We've also included 'Have they got it?' linking to activities other LOs in this unit and/or other units and LOs within Nationals Engineering. This includes performing practical activities by which learners confirm their understanding.

Link to qualification

Cambridge Nationals Level 1/2 Engineering Design

See our range of planning and teaching resources including delivery guides, project approaches, teaching activities, teacher guides and resources lists.

See our range of assessment resources including past paper, mark schemes, examiners' reports, candidate exemplars and set assignments.

Scheme of work (longer term plan – academic year)

	Learning Outcome	Topic area/theme (from R107 specification)	Links to other Cambridge Nationals Engineering units and LOs
Autumn Term	LO1	Types of drawing.	**R105 LO1** – Understand the design cycle and the relationship between design briefs and design specifications.
	LO1	Generating design ideas.	**R105 LO1** – Understand the design cycle and the relationship between design briefs and design specifications. **R105 LO2** – Understand the requirements of design specifications for the development of a new product.
	LO1	2D sketches.	**R106 LO2** – Be able to research existing products.
	LO1	3D sketches – oblique.	
	LO1	3D sketches – perspective.	
	LO1	3D sketches – 3D grammar.	
	LO1	3D sketches – crating.	
	LO1	Rendering using shade, tone, and texture.	
	LO1	Annotation and labelling techniques.	**R105 LO2** – Understand the requirements of design specifications for the development of a new product. **R106 LO2** – Be able to research existing products.
	LO1	Using IT software to produce, modify, and enrich design proposals.	

	Learning Outcome	Topic area/theme (from R107 specification)	Links to other Cambridge Nationals Engineering units and LOs
Spring Term	**LO2**	Types and purpose of technical drawings.	**R106 LO2** – Be able to research existing products. **R108 LO1** – Know how to plan the making of a prototype.
	LO2	Scale drawing.	
	LO2	Orthographic drawings – introduction.	
	LO2	Orthographic drawings – line conventions and standards.	
	LO2	Sectional drawings.	
	LO2	Isometric drawings.	
	LO2	Exploded drawings.	**R106 LO3** – Be able to analyse an existing product through disassembly.
	LO2	Assembly drawings.	**R108 LO1** – Know how to plan the making of a prototype.
	LO2	Labelling and annotation techniques.	**R108 LO1** – Know how to plan the making of a prototype.
	LO2	Parts lists.	**R108 LO1** – Know how to plan the making of a prototype.

	Learning Outcome	Topic area/theme (from R107 specification)	Links to other Cambridge Nationals Engineering units and LOs
Summer Term	**LO3**	Computer Aided Design (CAD) basics.	
	LO3	3D shape production.	
	LO3	3D shape assemblies.	
	LO3	3D generation of textures.	
	LO3	Manipulating 3D generated designs.	
	LO3	2D CAD generation of parts.	
	LO3	2D CAD generation of assemblies.	
	LO3	Adding rendering and animation.	
	LO3	Presentation techniques – display boards, PowerPoint.	**R106 LO2** – Be able to research existing products.
	LO3	Modelling and prototypes.	**R108 LO3** – Be able to produce a prototype.

Scheme of work (medium term plan – more detailed by academic term)

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	1	**LO1**	Types of drawing.	Learners could be presented with a range of drawings and be asked to sort them into 2D drawings, 3D drawings, sketches and technical drawings. Learners could be asked to match the drawings with the correct name and suggest when and where each drawing type could be used.	**R107 LO1** – Learners will be able to identify a range of drawing techniques.	
	2	**LO1**	Generating design ideas.	Learners could be introduced to a range of techniques to practice generating a range of design ideas. Learners could practice development strategies such as product feature permutation (arranging the features of designs in different arrangements) or thinking strategies such as the SCAMPER creative thinking process. Learners could practice techniques using example design brief.	**R107 LO1** – Learners will be able to use hand-sketching and drawing techniques to design and present ideas and concepts.	https://www.bbc.co.uk/bitesize/guides/zrx7xfr/revision/2 provides an overview of different design strategies. https://www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking/ is a guide to using the SCAMPER technique for creative thinking.
	3	**LO1**	2D sketches.	Learners could start with simple mark making techniques, becoming comfortable generating freehand curves, lines, and circles. Learners could be presented with examples of 2D sketching to emulate and practice with. Learners could be set an example brief from which to sketch a range of ideas.	**R107 LO1** – Learners will be able to use hand-sketching and drawing techniques to design and present ideas and concepts, i.e. freehand sketching in 2D.	Go to https://www.creativebloq.com/ and search for '*sketching*' for a range of guides and steps to controlled mark making.
	4	**LO1**	3D sketches – oblique.	Learners could be introduced to the basic principles of oblique sketching and discuss the need to foreshorten lines. They could set up drawing boards and use set squares to add oblique perspective to simple shapes. While practicing learners could be provided with an oblique paper underlay to begin with. Learners could be asked to generate a range of objects drawn in 2D in oblique.	**R107 LO1** – Learners must be able to use hand-sketching and drawing techniques to design and present ideas and concepts, i.e. freehand sketching in 3D.	Go to https://civilseek.com/ and search for '*oblique*' for examples and videos of oblique drawing.

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	5	LO1	3D sketches – perspective.	Learners could be guided through generating one-point and two-point perspectives sketches. Learners could practice drawing construction lines and assembling simple shapes in perspective.	**R107 LO1** – Learners will be able to use hand-sketching and drawing techniques to design and present ideas and concepts, i.e. freehand sketching in 3D.	Go to https://www.studentartguide.com/ and search for '*one point perspective*' or '*two point perspective*' for guides on these techniques.
	6	LO1	3D sketches – 3D grammar.	Learners could generate shapes in perspective especially focusing upon curved and cylindrical shapes. Learners could look at examples of drawn cylinders and be provided with a guide on how to distort curved shapes successfully.	**R107 LO1** – Learners will be able to use hand-sketching and drawing techniques to design and present ideas and concepts, i.e. freehand sketching in 3D.	
	7	LO1	3D sketches – crating.	Learners could practice blocking out shapes (crating) to create drawings of products. Images of products could be provided for assistance. Learners could underlay layout paper onto their blocked-out frame to practice drawing in their product. Learners could be provided with a brief or develop a sketch from an earlier task.	**R107 LO1** – Learners will be able to use hand-drawing techniques to design and present ideas and concepts, i.e. freehand sketching in 3D.	Go to https://dandtfordandt.wordpress.com/ and search '*strategy resource tasks*' for activities and help sheets on crating and other 2D and 3D drawing styles.
	8	LO1	Rendering using shade, tone, and texture.	Learners could add shade and tone to provided shapes, stating with simple shapes, becoming gradually more complex. Learners could add tone and shade to provided outlines of existing products. Learners could produce flat samples of a range of textures before applying them to 3D sketches.	**R107 LO1** – Learners will be able to use hand-sketching and drawing techniques to design and present ideas and concepts, i.e. rendering using shade, tone, and texture.	Go to https://www.artistsandillustrators.co.uk/ has numerous articles and examples when searching for '*tone*', '*texture*' or '*shade*'.
	9	LO1	Annotation and labelling techniques.	Learners could be guided as to the difference between annotation and labelling. Learners could revise theory from R105 to create a list of possible labels and annotations that could be referred to e.g. key features, functions, dimensions, materials, construction/manufacturing methods, access to components and areas for further investigation.	**R107 LO1** – Learners will be able to use annotation and labelling techniques that communicate design ideas.	

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	10	LO1	Using IT software to produce, modify, and enrich design proposals.	Learners could use computers to modify scanned drawings and sketches created earlier in this LO. Learners could be guided to add annotations and labels digitally. Learners could also be guided in using graphic programs to practice overpainting their scanned sketches (digital colouring).	**R107 LO1** – Learners will be able to enrich and modify designs using IT software.	

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	1	**LO2**	Types and purpose of technical drawings.	Learners could research and produce a report on technical drawings, how they differ to sketching and common types of technical drawing. Learners could be introduced to British Standards in technical drawing. Learners could be asked to match the products represented in different drawing styles. Learners could be tasked with reading and interpreting pertinent data off different drawings.	**R107 LO2** – Learners will be able to identify and interpret 2D and 3D technical drawings.	
	2	**LO2**	Scale drawing.	Learner could be introduced to scale through a variety of scale technical drawings and comparing the scales used on each. Learners could suggest suitable scales that could be used in the drawing of a range of different sized items. Learners could practice scale by completing an enlargement or reduction of an image using a simple grid technique. Learners could generate a scale drawing of an arrangement of simple objects such as building bricks.	**R107 LO2** – Learners will be able to interpret and produce technical drawings to scale.	Go to https://www.stem.org.uk/ and search for '*scale drawing*' for a variety of resources and activities. https://www.basic-mathematics.com/ contains a very simple introduction to scale drawing. Use the Basic Mathematics Search facility to locate this.
	3	**LO2**	Orthographic drawings – introduction.	Learners could be introduced to examples of orthographic drawing and note the layout. Learners could be asked to practice orthographic drawing simple cuboid models. Learners could take photos of each angle and lay them out for reference. Learners could check each other's drawings for inaccuracies.	**R107 LO2** – Learners must be able to interpret and produce 2D orthographic drawings.	https://civilseek.com/orthographic-projection-drawing/ introduces orthographic projection. Go to https://www.wisc-online.com/ and search for '*orthographic projection*' for a range of resources and exercises.
	4	**LO2**	Orthographic drawings – line conventions and standards.	Learners could analyse a completed orthographic drawing taking note of the key and standards employed. Learners may modify their previous orthographic drawing to use thin, thick and dotted lines. Learners should be guided to use correct dimension conventions and add a suitable scale. Learners could consolidate their learning by writing their own guide how to draw orthographic.	**R107 LO2** – Learners must be able to interpret and produce 2D orthographic drawings using line conventions.	https://design-technology.org/CDT10clockP1orthodrawing.htm contains a guide to drawing line styles and a sample project idea.

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	5	**LO2**	Sectional drawings.	Learners could discuss the purpose and use of sectional drawings and how they may be useful in conveying hidden technical information. Learners could practice by adding a cross sectional cutaway to the orthographic drawing produced in the previous task. Learners could be provided with suitable small objects (where possible cut through) to produce a cross sectional drawing at actual size.	**R107 LO2** – Learners must be able to interpret and produce sectional drawings.	http://www.technologystudent.com/prddes1/orthogrp2.html illustrates sectional views of objects.
	6	**LO2**	Isometric drawings.	Learners could be introduced to the rules of drawing in isometric. Learners could discuss the advantages of isometric drawing compared to oblique and the advantage of isometric being used as a standard around the world. Learners could draw simple objects in isometric projection, working up to more complicated products. Learners could consolidate previous tasks and improve their drawing by adding dimensions, tone, and texture.	**R107 LO2** – Learners must be able to interpret and produce isometric drawings.	Go to https://www.creativebloq.com/ and search for 'isometric drawing' for a comprehensive guide.
	7	**LO2**	Exploded drawings.	Learners could be provided with existing exploded drawings to review. Learners could begin by drawing simple disassembled products or building bricks. To practice drawing their own designs learners could then take an isometric drawing from the previous task and use layout paper to duplicate the parts in an exploded layout. Learners could be tasked with explaining the purpose and advantages of an exploded drawing.	**R107 LO2** – Learners must be able to interpret and produce exploded drawings.	https://www.stem.org.uk/resources/elibrary/resource/446794/exploded-views contains activities and guides to create exploded diagrams.
	8	**LO2**	Assembly drawings.	Learners could be guided through the purpose of an assembly drawing. It could be highlighted that these can consist of one or more isometric, sectional or exploded drawings. Learners could be tasked with producing an assembly drawing either of an existing object or based upon one of the previous design tasks.	**R107 LO2** – Learners must be able to interpret and produce assembly drawings.	https://www.designingbuildings.co.uk/wiki/Assembly_drawing provides an overview of assembly drawings.
	9	**LO2**	Labelling and annotation techniques.	Learners could use their previously produced technical drawings to add annotations and labels. Learners could use notation to add detail and clarity to their assembly drawings. Learners could refer to labels required in industry standards but also apply some notes from LO1 labelling tasks.	**R107 LO2** – Learners must be able to add labels, annotations, and notes to drawings.	

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	10	LO2	Parts lists.	Learners could add part listings to assembly drawings, either provided or generated in previous tasks. Learners could research stock forms of the materials they wish to use for this task and could differentiate any standard components they wish to include. Learners could be reminded of the convention of using millimetres in technical drawings.	**R107 LO2** – Learners will be able to interpret and produce drawings with parts lists.	http://tolerancing.net/engineering-drawing/parts-list.html provides guidance on parts lists, and other pages covering other aspects of engineering drawing.

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	1	**LO3**	Computer Aided Design (CAD) basics.	Learners could be presented with examples of CAD drawings in digital format to explore. Learners could identify the advantages of digital designs e.g. for checking, modifying, sending to clients. Learners could discuss how CAD designs are useful in Optimise and Validate stages of the design cycle. Learners could be introduced to CAD software they will be using and become familiar with the advantages and limitations of each program they will be using. Learners could be given simple tasks to begin engaging with this software and could also be given some guided time to experiment freely with programs to encourage familiarity.	**R107 LO3** – Learners will be able to use CAD software to produce and communicate design proposals.	Go to https://all3dp.com/ and search for '*what is CAD*' for a range of useful introductory article to Computer Aided Design (CAD).
	2	**LO3**	3D shape production.	Learners could use 3D CAD software to learn how to generate a range of basic shapes or parts (using sketch-based features and tools). Learners could practice controlling sizes of shapes and adding bevels. Learners could also take the opportunity to become familiar with navigating around the shape and recording their work either though screen recoding or screen grabs. Learners could produce a short presentation on how to generate shapes.	**R107 LO3** – Learners will be able to use CAD software to produce 3D shapes and parts.	There is a range of free and paid-for CAD software available including: https://www.autodesk.co.uk/ https://www.solidworks.com/ https://solidedge.siemens.com/en/
	3	**LO3**	3D shape assemblies.	Learners could be tasked with assembling more complex shapes (i.e. creating assemblies from parts). Learners could be given simple product design tasks to complete in 3D. Learners could be guided on how to make separate component parts and then combine them into a finished product.	**R107 LO3** – Learners will be able to use CAD software to produce 3D assemblies.	The following links provide useful video tutorials for different CAD software packages. Similar are available on YouTube, and for other CAD software. https://www.autodesk.co.uk/products/fusion-360/learn-support http://www.solidworkstutorials.com/ https://solidedge.siemens.com/en/resources/tutorials/

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Summer Term	4	LO3	3D generation of textures.	Learners could experiment with adding texture and lighting effects to the 3D models they have created using CAD software.	R107 LO3 – Learners will be able to use CAD software to add textures and lighting to 3D models.	Go to https://www.youtube.com/ and search for 'adding textures' for the chosen CAD software
	5	LO3	Manipulating 3D generated designs.	Learners could be guided to explore the functionality of their CAD package to produce assemblies, exploded drawings and animations. Learners could use screen recording software to record their design being rotated and assembled/disassembled. Learners could use these clips to make a short video presentation of their design.	R107 LO3 – Learners will be able to use CAD software to produce assemblies, exploded views and animations.	
	6	LO3	2D CAD generation of parts.	Learners could use 2D software packages to generate simple drawings of shapes or parts. This could already be part of the 3D CAD modelling software being used. Learners could take designs previously created using 3D modelling and present these using software as 2D drawings. Learners could practice controlling the layout, size, and accuracy of designs.	R107 LO3 – Learners will be able to use CAD software to produce 2D drawings of simple parts.	https://www.techsoft.co.uk/ Products/Software/TechSoft-Design-V3 https://www.adobe.com/uk/ products/illustrator.html has alternative free and paid-for CAD software
	7	LO3	2D CAD generation of assemblies.	Learners could use CAD software to generate more complex 2D drawings. Learners could practice creating 2D drawings of assemblies. They could be presented with small engineered products to created 2D drawings for.	R107 LO3 – Learners will be able to use CAD software to produce 2D drawings of assemblies.	
	8	LO3	Adding rendering and animation.	Learners could use a CAD package to add textures and shade to a 3D model. Learners could practice masking off areas and applying texture, tone and shadows to their images. Learners could add animations to 3D models previously created.	R107 LO3 – Learners will be able to use CAD software to add rendering and animation to 3D models.	

	Event	Learning Outcome	Topic area/subtopic Area (from R107 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	9	LO3	Presentation techniques - display boards, PowerPoint.	Learners could practice presenting work produced in previous tasks through a PowerPoint presentation. Learners could be given a display board to show some of their design ideas and proposals. They could be asked to present and per review their design proposals.	**R107 LO3** – Learners will be able to communicate design proposals.	There are plenty of guides to using PowerPoint. The following video tutorial provides a beginner guide https://www.youtube.com/watch?v=XF34-Wu6qWU
	10	LO3	Modelling and prototypes.	Learners could produce models to support their design. Learners could use drawings produced for LO3 to produce simple CAM outcomes e.g. 3D printing. Learners could record themselves presenting and explaining the features of their model.	**R107 LO3** – Learners will be able to communicate design proposals.	Video resources could be used to show the purpose of creating prototypes and models of products. The following provides a brief introduction https://www.youtube.com/watch?v=gWk6br5Ngkc

OCR Resources: *the small print*

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