OCR
Oxford Cambridge and RSA

Cambridge **NATIONALS LEVEL 1/2**

ENGINEERING DESIGN

Cambridge NATIONALS

R108 3D design realisation

J831/J841

Schemes of work

Version 1

www.ocr.org.uk/subjects/engineering

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 R108 specification)	Links to other Cambridge Nationals Engineering units and LOs
Autumn Term	**LO1**	Interpreting a specification.	**R105 LO2** – Understand the requirements of design specifications for the development of a new product.
	LO1	Process for making a prototype model.	**R105 LO1** – Understand the design cycle and the relationship between design briefs and design specifications.
	LO1	Planning tools: using Gantt charts.	**R110 LO1** – Be able to plan for the making of a pre-production product.
	LO1	Planning tools: using flow charts.	**R110 LO1** – Be able to plan for the making of a pre-production product.
	LO1	Material consideration.	**R109 LO1** – Know about properties and uses of engineering materials.
	LO1	Cutting lists.	**R107 LO1** – Be able to generate design proposals using a range of techniques.
	LO1	Tools and equipment.	**R109 LO2** – Understand engineering processes and their application.
	LO1	Time requirements.	
	LO1	Planning stages.	
	LO1	Testing, evaluation, and quality control.	**R112 LO1** – Understand the importance of quality control. **R112 LO2** – Be able to assess product quality from inspection and quality control techniques.

	Learning Outcome	Topic area/theme (from R108 specification)	Links to other Cambridge Nationals Engineering units and LOs
Spring Term	**LO2**	Identifying hazards in production plans.	**R106 LO3** – Be able to analyse an existing product through disassembly.
	LO2	Researching risk.	**R106 LO3** – Be able to analyse an existing product through disassembly. **R110 LO1** – Be able to plan for the making of a pre-production product.
	LO2	Producing risk assessments.	**R106 LO3** – Be able to analyse an existing product through disassembly.
	LO2	Personal Protective Equipment (PPE).	**R106 LO3** – Be able to analyse an existing product through disassembly.
	LO2	Assessing hazards and risks, and taking precautions.	**R106 LO3** – Be able to analyse an existing product through disassembly.
	LO2	Safe use of hand tools.	**R109 LO2** – Understand engineering processes and their application. **R110 LO2** – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Safe use of machinery.	**R109 LO2** – Understand engineering processes and their application. **R110 LO2** – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Safe use of chemicals and solvents.	
	LO3	Selection of appropriate materials.	**R109 LO1** – Know about properties and uses of engineering materials. **R107 LO1** – Be able to generate design proposals using a range of techniques.
	LO3	Cutting and shaping.	**R106 LO1** – Know how commercial production methods, quality and legislation impact on the design of products and components. **R110 LO3** – Be able to modify a production plan for different scales of production.

	Learning Outcome	Topic area/theme (from R108 specification)	Links to other Cambridge Nationals Engineering units and LOs
Summer Term	**LO3**	Use of jigs and templates.	**R110 LO3** – Be able to modify a production plan for different scales of production.
	LO3	Fixings in assembly.	**R106 LO1** – Know how commercial production methods, quality and legislation impact on the design of products and components. **R110 LO3** – Be able to modify a production plan for different scales of production.
	LO3	Methods of recording: diary of making.	
	LO4	Methods of recording: difficulties and solutions.	
	LO4	Comparing a product to a specification.	
	LO4	Making improvements: features and functions.	
	LO4	Making improvements: aesthetics and ergonomics.	
	LO4	Making improvements: alternative processes and techniques.	
	LO4	Reviewing performance: planning.	
	LO4	Reviewing performance: practical ability.	

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

	Event	Learning Outcome	Topic area/subtopic Area (from R108 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	Interpreting a specification.	Learners could match provided example products with their product specification. Learners could be provided with specifications for very simple products or components and tasked with producing a summary of what is required from the physical product.	**R108 LO1** – Learners will be able to interpret a product specification, relating this to a physical product.	https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/design-requirements-examples provides a range of design requirement examples.
	2	LO1	Process for making a prototype model.	Learners could be presented with images of professionally produced prototypes. Learners could be tasked with researching the purpose of prototypes, how they are used and the advantages they bring to the design process. Learners could identify the stages needed to plan and produce a prototype and be guided as to the requirements of each stage.	**R108 LO1** – Learners will be able to interpret a product specification and relate this to process for making a prototype.	https://home.howstuffworks.com/product-prototyping-process.htm gives a description of the prototyping process and its purpose.
	3	LO1	Planning tools: using Gantt charts.	Learners could be presented with an example Gantt chart and be tasked with reading and interpreting information off the chart. They could then be tasked with producing a Gantt chart for making a simple prototype, followed by presentation and discussion.	**R108 LO1** – Learners will be able to use planning tools when planning the making of a prototype.	https://www.gantt.com/ includes the history of Gantt charts, how they are produced and links to free software. Go to www.technologystudent.com and search for '*planning time chart*' for for examples of how to plan a project.
	4	LO1	Planning tools: using flow charts.	Learners could be introduced to flowcharts through simple examples relating to a simple practical task. Learners could be tasked to identify what the task achieves and what the different shaped boxes in the flowchart indicate. Learners could then be introduced to the full range of symbols and use these to create a flowchart for a range of sample task.	**R108 LO1** – Learners will be able to use planning tools when planning the making of a prototype.	See the following website for the history of flowcharts, and a guide to their production. Includes links to software tools to produce flowcharts: https://www.zenflowchart.com/flowchart/

	Event	Learning Outcome	Topic area/subtopic Area (from R108 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**	Material consideration.	Learners could be introduced to material properties through discussion and tables showing these. Learners could explore material properties through handling a selection of sample materials. Learners could be asked to match materials with a product or component it would be suitable for. Learners could practice using a specification to interpret material preferences. This task could be linked to the following cutting list task.	**R108 LO1** – Learners will be able to consider material requirements and availability when planning the making of a prototype.	https://www.bbc.co.uk/bitesize/guides/zjgyb82/revision/1 provides guidance on the physical and working properties of a range of materials suitable for making prototypes.
	6	**LO1**	Cutting lists.	Learners could be introduced to a range of stock forms and sizes for common materials. Learners could use this information to review a supplied cutting list, checking for errors. Learners could practice interpreting a product specification and associated cutting list, noting the use of standard units of measurement. Learners could use this example to set out their own cutting list suitable to make a prototype product.	**R108 LO1** – Learners will be able to read and produce cutting lists when planning the making of a prototype.	
	7	**LO1**	Tools and equipment.	Learners could be introduced a range of tools suitable for making a prototype. They could be shown how the tools are used safely, and the operations they perform. Learners could handle tools, and their use could be demonstrated practically or using videos.	**R108 LO1** – Learners will be able to identify tool and equipment requirements when planning the making of a prototype.	https://www.bbc.co.uk/bitesize/guides/zbstng8/revision/3 has an introductory guide to selecting tools, equipment and processes for making a product or prototype.

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
	8	**LO1**	Time requirements.	Learners could undertake a range of practical tasks to develop a sense of realistic timings. Alternatively, learners could reference supplied data providing rough timings for different common tasks. Learner could use this information to produce timing estimates for a series of consecutive tasks. They could be asked to identify impact on overall time through additional time requirements such as curing/drying times or setup and preheat times involved in some processes. Learners could practice laying out timings in table format as part of a production plan or using Gantt charts.	**R108 LO1** – Learners will be able to consider time requirements when planning the making of a prototype.	
	9	**LO1**	Planning stages.	Learners could be introduced to example planning documents and tasked with commenting on the layout and order of them. Learners could specifically look at long or multi part processes that may need to be broken down into several stages. This could be linked well to the previous activities on materials selection, use of tools and time requirements. Learners could be presented with a completed prototype and tasked with creating planning stages in a sensible and logical sequence for its production.	**R108 LO1** – Learners will be able to consider planning stages when planning the making of a prototype.	

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Autumn Term	**10**	**LO1**	Testing, evaluation, and quality control.	Learners could be introduced to techniques for checking and evaluating the quality of a prototype that should be considered at the planning stage. They could be introduced to the basic concepts of product testing and quality control (QC). They could discuss the implications of not considering quality during the making of the prototype. They could create a simple plan showing checks to be made along with the timing of these during production.	**R108 LO1** – Learners will be able to consider testing, evaluation and quality control when planning the making of a prototype.	http://www.design-technology.info/QAandQC/ Introduction to quality control and quality assurance. https://www.youtube.com/ has numerous videos on quality control procedures used in industry (e.g. visual inspection, taking and checking measurements, destructive and non-destructive testing etc).

	Event	Learning Outcome	Topic area/subtopic Area (from R108 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**	Identifying hazards in production plans.	Teachers could begin with explaining the difference between hazards and risk, illustrating these with examples. Learners could review existing production plans and be tasked with identifying where hazards could occur during stages of production.	**R108 LO2** – Learners will be able to identify and consider hazards and risks in production plans.	Go to https://www.hse.gov.uk and search for '*workshop health and safety*' and '*engineering*' for a range of resources relating to environmental and process safety, including guides and documents. Go to https://worksmart.org.uk/ and search for '*hazards and risk*' for an explanation of the differences between each.
	2	**LO2**	Researching risk.	Learners could be introduced to official documentation that relate to health and safety and safe working e.g. HASAWA, PUWER, RIDDOR, The Workplace (Health Safety and Welfare) Regulations, PPE at Work Regulations etc. Learners could be tasked with reviewing or researching the key point from selected document and creating a short review presentation of the key points to their peers. Learners could be asked to summarise how these documents might impact their own workshop environment and practices.	**R108 LO2** – Learners will be able to identify and consider hazards and risks in production plans.	http://www.legislation.gov.uk/uksi/1992/3004/contents/made contains information relating to a range of Regulations relevant to safe working.
	3	**LO2**	Producing risk assessments.	Learners could be introduced to example risk assessment documents. Learners could read and summarise some of these documents to become familiar with layout and content. This should include how risks can be mitigated through different working practices, the use of guarding and protective devices, and the use of PPE etc. Learners could be provided with a risk assessment template and be tasked to produce risk assessments for different activities they are going to perform in the workshop. They could discuss their outcomes with their peers.	**R108 LO2** – Learners will be able to produce and use risk assessments for practical activities.	The HSE website includes comprehensive guides to risk assessment including templates: https://www.hse.gov.uk/risk/ Go to www.worksmart.org.uk search for '*five steps to a risk assessment*'.

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	**4**	**LO2**	Personal Protective Equipment (PPE).	Learners could be asked to identify a range of different PPE items (e.g. safety glasses, gloves, footwear etc.). Learners could identify basic PPE that may be used in all workshop setting. They could then identify specific situations where additional items of PPE would be required. Learners understanding could be checked by presenting a range of situations in conjunction with risk assessments and asking learners to give recommendations for suitable PPE.	**R108 LO2** – Learners will be able to identify and use Personal Protective Equipment (PPE) during practical activities.	The HSE website includes comprehensive guides to risk assessment including templates: https://www.hse.gov.uk/risk/
	5	**LO2**	Assessing hazards and risks, and taking precautions.	Learners could be introduced to safe working practices specific to their working environment. They could be guided how to check tools and machinery before use and reminded of hazards and associated risks discussed in previous tasks. Learners could be presented with different situations either using photos or in a workshop and be tasked with identifying the hazards present. They could write a report identifying the hazards then suggest suitable precautions that could be taken. Learners could consolidate this by producing a table of common hazards within the workshop and corresponding precautions. As part of these activities learners could review PPE recommendations from previous actives.	**R108 LO2** – Learners will be able to assess hazards and risks, and take precautions when using tools and machines.	Go to https://worksmart.org.uk/ and search for *'hazards and risk'* for an explanation of the differences between each. https://www.hse.gov.uk/risk/controlling-risks.htm provides advice on controlling risk.
	6	**LO2**	Safe use of hand tools.	Learners could be guided on safe practice when using common hand tools used when making a prototype. Learners could practice using the hand tools themselves through a range of focused, controlled activities. Learners could consolidate their learning by producing notes for each hand tool about their correct and safe use.	Learners will be able to assess hazards and risks, and take precautions when using tools and machines.	A range of videos can be found on www.youtube.com about the safe use of tools, equipment and machines.

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Spring Term	**7**	**LO2**	Safe use of machinery.	Learners could be introduced to manually controlled machinery (e.g. pillar drill, hot wire cutter, laser cutter, lathe etc.). Learners could be briefed on correct use of these machines and additional safety considerations for each. Learners could add notes on correct and safe use of this equipment to their previous notes on hand tools. Learners could then practice using a range of machinery by undertaking focused, controlled activities.	**R108 LO2** – Learners will be able to assess hazards and risks, and take precautions when using tools and machines.	A range of videos can be found on www.youtube.com about the safe use of tools, equipment and machines.
	8	**LO2**	Safe use of chemicals and solvents.	Learners could be tasked to card match a range of adhesives and solvents with their typical uses. Learners could undertake small focused practical tasks to be guided on correct use of common chemicals and solvents. Learners could use the information to generate a reference table on their safe use, referring to previous activities on hazards, risks and the use of PPE.	**R108 LO2** – Learners will be able to undertake safe working procedures when using materials, chemicals, finishes and solvents.	
	9	**LO3**	Selection of appropriate materials.	Learners could be led in discussion to decide what makes a material suitable for a prototype. (e.g. material properties, ease of use during prototype making, cost etc.). Learners could be guided that material choice is often situation dependent. Learners could be tasked with reviewing a selection of materials available for a range of example products or components. Learners could undertake sample practical tasks to be able to fully comment on the application of materials in terms of ease of working and processing.	**R108 LO3** – Learners will be able to select and use appropriate materials to produce a prototype.	http://www-materials.eng.cam.ac.uk/mpsite/DT.html has a range of resources and case studies related to material selection of products.
	10	**LO3**	Cutting and shaping.	Learners could be tasked to list as many methods of cutting and shaping materials they are familiar with. Learners could be presented with a range of example components with different geometry and be tasked with selecting suitable methods of shaping. Learners could compare responses with each other. Learners who have not undertaken theory elsewhere on cutting and shaping could undertake a range of guided practical tasks using different marking out, cutting and shaping methods.	**R108 LO3** – Learners will be able to safely use tools and processes to cut and shape materials.	https://studyrocket.co.uk/revision/gcse-design-and-technology-aqa/design-and-technology-aqa/how-to-shape-and-form-using-cutting-abrasion-and-addition contains a short quick reference list of cutting and shaping methods for different material.

	Event	Learning Outcome	Topic area/subtopic Area (from R108 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**	Use of jigs and templates.	Learners could be introduced to jigs and templates and how they are used in manufacturing. Learners could be tasked with describing the purpose and advantage of using jigs and templates. Learners could undertake a practical task using templates and jigs and review how they contribute to ease of manufacture, quality, and accuracy of final products.	**R108 LO3** – Learners will be able to use preparation and assembly methods.	https://www.bbc.co.uk/bitesize/guides/z6cbcj6/revision/2 shows how to use templates, jigs and patterns when making a prototype.
	2	**LO3**	Fixings in assembly.	Learners could be introduced to range of fixings (temporary and permanent). These could first be separated by learners into temporary and permanent fixings. Learners could undertake a practical activity to gain familiarity and understanding by fastening two pieces of material using a range of fixings. They could be presented with a variety of situations and tasked to justify the best method of fixing for each.	**R108 LO3** – Learners will be able to use preparation and assembly methods.	
	3	**LO3**	Methods of recording: diary of making.	Learners could be guided on how to effectively record a practical activity using a diary of making. This could begin with simple practical activities undertaken previously, such as using fixings and jigs, or using fixings. Learners could practice recording their activity through written entries and sketches. They could practice making the same entries as a photo or video diary. Learners could develop or use a template to compete for each stage of the making process to ensure consistency in content and detail. This should include annotations to explain what is being presented.	**R108 LO3** – Learners will be able to use methods to record key stages of making a prototype.	

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	**4**	**LO3**	Methods of recording: difficulties and solutions.	Learners could be presented with one or more making tasks with a documented method that is not suitable. Learners could review why the proposed method set out is not suitable to achieve the desired outcome. Learners could then be tasked with devising an alternative method, attempting the method, and recording the result. They could produce a checklist of points to review when looking back at their own making records.	**R108 LO3** – Learners will be able to review methods for recording key stages of making a prototype.	
	5	**LO4**	Comparing a product to a specification.	Learners could review a completed product against the original product specification and any supplied drawings. Requirements such as dimensions, finish, tolerances, and appearance could be considered. Learners could also be given a mini project to review a product or prototype that has several inconsistences compared with the requirements of its product specification. Learners could identify and review which are incorrect, making suggestions on how these could be corrected.	**R108 LO4** – Learners will be able to evaluate a prototype – comparing the prototype and production plan against product specification.	https://www.ocr.org.uk/Images/269542-analysis-testing-and-evaluation-topic-exploration-pack-teacher-s-pack.pdf provides a comprehensive guide to evaluation through testing and analysis of prototype work. It contains simple activities designed to guide learners to write evidence-based evaluation.
	6	**LO4**	Making improvements: features and functions.	Learners could be guided on the difference between a product's function and its features. They could be provided with a prototype and its specification to evaluate and identify if the product's function and features meet the specification. Learners could be tasked with theorising how the product might better meet the requirements of the specification. They could explain their improvement through text and diagrams or in a short presentation.	**R108 LO4** – Learners will be able to evaluate a prototype - features and function.	

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	7	**LO4**	Making improvements: aesthetics and ergonomics.	Learners could be guided on the difference between ergonomics and anthropometrics. They could again be provided with a prototype and its corresponding product specification to evaluate. This could be an extension of the previous task. Learners could undertake 'customer research' within class to analyse the suitability of the product to meet user needs. They could be tasked with theorising how the product might better meet the requirements of the specification. They could explain their improvement through text and diagrams or in a short presentation.	**R108 LO4** – Learners will be able to evaluate a prototype - aesthetics and ergonomics.	
	8	**LO4**	Making improvements: alternative processes and techniques.	Learners could be provided with a prototype and its corresponding product specification to evaluate as an extension to previous tasks. This time they could analyse the manufacture methods used to make the product, and investigate more suitable processes. They could present their findings along with justification for using alternative manufacturing methods as a short presentation.	**R108 LO4** – Learners will be able to evaluate a prototype - modelling and prototype processes and alternative manufacturing techniques.	
	9	**LO4**	Reviewing performance: planning.	Learners could be provided example making plans containing errors and inefficiencies. They could be tasked with identifying ways of improving the plans. Learners could be guided in how to critically review their own plans and how they have been produsued, possibly with the provision of a question grid or sentence starters. For practice, learners could review plans already produced by themselves in this unit, making suggestions for improvements.	**R108 LO4** – Learners will be able to evaluate own performance - management of time and resources, planning and preparation.	

	Event	Learning Outcome	Topic area/subtopic Area (from R108 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	**10**	**LO4**	Reviewing performance: practical ability.	Learners could be shown how to create a SWOT analysis. They could be tasked to create a SWOT analysis related to their own practical skills in using tools and equipment, and in realising a prototype. Learners could be asked to card sort a range of practical activities according to how confident and competent they are in each. For practice, learners could move on to suggesting ways their skills and practical activities developed during this unit could be improved. This could be with the provision of prompts or sentence starters.	**R108 LO4** – Learners will be able to evaluate own performance – precision and accuracy achieved, quality of outcome.	

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