

Cambridge **NATIONALS LEVEL 1/2**



ENGINEERING MANUFACTURE

R109 Engineering materials, processes and production

J832/J842

Schemes of work

Version 1

CONTENTS

Introduction	3
Scheme of work (longer term plan – academic year)	
Autumn term	4
Spring term	5
Summer term	6
Scheme of work (medium term plan – more detailed by academic term)	
Autumn term	7
Spring term	9
Summer term	11

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 be 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

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/>

See our range of planning and teaching resources on the link below (including delivery guides, project approaches, teaching activities, teacher guides and resources lists).

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/planning-and-teaching/>

See our range of assessment resources on the link below (including past paper, mark schemes, examiners' reports, candidate exemplars and set assignments).

<https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-award-certificate-j832-j842/assessment/>

Scheme of work (longer term plan – academic year)

	Learning Outcome	Topic area/theme (from R109 specification)	Links to other Cambridge Nationals Engineering units and LOs
Autumn Term	LO1	Types of engineering materials – metals: ferrous and non-ferrous.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO1	Types of engineering materials – polymers: thermoplastics and thermosetting plastics.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO1	Types of engineering materials – ceramics, composites, smart, new and emerging materials.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO1	Properties of engineering materials.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO1	Materials testing processes – destructive testing.	R112 LO2 – Be able to assess product quality from inspection and quality control techniques.
	LO1	Materials testing processes – non-destructive testing.	R112 LO2 – Be able to assess product quality from inspection and quality control techniques.
	LO1	Characteristics of materials.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO1	Use of materials.	R110 LO1 – Be able to plan for the making of a pre-production product.
	LO2	Basic engineering processes – hand material removal techniques.	R110 LO1 – Be able to plan for the making of a pre-production product. R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Basic engineering processes – hand forming techniques.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.

	Learning Outcome	Topic area/theme (from R109 specification)	Links to other Cambridge Nationals Engineering units and LOs
Spring Term	LO2	Basic engineering processes – hand joining methods – soldering, brazing, welding.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Basic engineering processes – hand joining methods – riveting, adhesives, threaded fasteners, self-tapping screws.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Basic engineering processes – heat treatment methods.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Basic engineering processes – surface finishing methods.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Machine Processes – machine material removal methods.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Machine processes – machine forming.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Machine processes – machine moulding.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product.
	LO2	Safe use of tools and equipment – features of machines, hazards, risks, PPE.	R110 LO2 – Be able to use processes, tools and equipment safely to make a pre-production product. R111 LO3 – Be able to set up and use CNC equipment to manufacture components.
	LO3	Computer controlled production processes – Computer Numerical Control (CNC) – lathes and milling machines.	R111 LO1 – Be able to plan for the production of components on CNC machines. R111 LO4 – Know about applications of computer-controlled processes used to manufacture products.
	LO3	Computer control production processes – CNC laser cutting and welding.	R111 LO1 – Be able to plan for the production of components on CNC machines. R111 LO4 – Know about applications of computer-controlled processes used to manufacture products.

	Learning Outcome	Topic area/theme (from R109 specification)	Links to other Cambridge Nationals Engineering units and LOs
Summer Term	LO3	Computer control production processes – CNC water jet cutting, punching, press brake machine.	R111 LO1 – Be able to plan for the production of components on CNC machines. R111 LO4 – Know about applications of computer-controlled processes used to manufacture products.
	LO3	Computer control production processes – additive manufacturing.	R111 LO1 – Be able to plan for the production of components on CNC machines. R111 LO4 – Know about applications of computer-controlled processes used to manufacture products.
	LO4	Impact of modern technology – automation.	R111 LO3 – Be able to set-up and use CNC equipment to manufacture components. R112 LO3 – Know how modern technologies can be used in quality control.
	LO4	Impact of modern technology – impact on quality.	R111 LO3 – Be able to set-up and use CNC equipment to manufacture components. R112 LO3 – Know how modern technologies can be used in quality control.
	LO4	Impact of modern technology – impact on workforce.	R112 LO4 – Principles of lean manufacturing.
	LO4	Impact of modern technology – impact on costs.	R112 LO4 – Principles of lean manufacturing.
	LO4	Digital communication – uses in research and development.	R112 LO3 – Know how modern technologies can be used in quality control.
	LO4	Digital communication – materials supply and control.	R112 LO3 – Know how modern technologies can be used in quality control. R112 LO4 – Know the principles of lean manufacturing.
	LO4	Global Manufacturing – global supply chain and business benefits.	R112 LO4 – Know the principles of lean manufacturing.
LO4	Global Manufacturing – standardisation of processes and procedures.	R112 LO4 – Know the principles of lean manufacturing.	

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

	Event	Learning Outcome	Topic area/subtopic Area (from R109 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 engineering materials – metals: ferrous and non-ferrous.	Learners will be introduced to categories of materials starting with metals. Ferrous, non-ferrous and alloys should be discussed. A range of products could be provided and used, with learners determining which category of material they have been manufactured from.	R110 LO1 – Learners are required to identify materials for a product to be manufactured.	www.technologystudent.com and search for 'materials technology'. Search for 'BBC Bitesize how to identify materials'.
	2	LO1	Types of engineering materials – polymers: thermoplastics and thermosetting plastics.	Learners will be introduced to thermoplastics and thermosetting plastics. Learners should investigate a range of polymer materials and explain their uses in a range of applications.	R110 LO1 – Learners are required to identify materials for a product to be manufactured.	www.technologystudent.com and search for 'plastics research'. Search for 'BBC Bitesize how to identify materials'.
	3	LO1	Types of engineering materials – ceramics, composites, smart, new and emerging materials.	Learners will be introduced to other materials including ceramics, composites and smart materials. Use a range of products and focus on materials used.	R110 LO1 – Learners are required to identify materials for a product to be manufactured.	YouTube video: https://www.youtube.com/watch?v=UzkUvWiNeDs Search for 'BBC Bitesize physical and working properties - materials'.
	4	LO1	Properties of engineering materials.	Properties of materials will be investigated with a focus on malleability, ductility, conductivity, hardness, machinability, corrosion resistance and elasticity. Investigate a range of materials used on products comparing properties of each.	R110 LO1 – Learners are required to identify materials for a product to be manufactured, explaining why they are suitable.	YouTube video: https://www.youtube.com/watch?v=KWzrOvJzzIE www.britannica.com and search for 'materials testing'.
	5	LO1	Materials testing processes – destructive testing.	Learners could be shown video of destructive testing on material, and discuss the benefits and disadvantages of using this technique on different products. Learners could carry out impact tests on a range of materials, recording the results in graph form when measured using alternative materials.	R112 LO2 – Learners are required to identify the range of destructive tests available, explaining the reasons for their use.	YouTube video: https://www.youtube.com/watch?v=KWzrOvJzzIE www.britannica.com and search for 'materials testing'.

	Event	Learning Outcome	Topic area/subtopic Area (from R109 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Autumn Term	6	LO1	Materials testing processes – non-destructive testing.	Learners could be shown video(s) of non-destructive testing on material and identify the benefits of using these on different products/materials.	R112 LO2 – Learners are required to identify the range of non-destructive tests available, explaining the reasons for their use.	You Tube video links: https://www.youtube.com/watch?v=tIE3eK0g6vU https://www.youtube.com/watch?v=UM6XKvXWVFA https://www.youtube.com/watch?v=bHTRmTQDZzg
	7	LO1	Characteristics of materials.	Learners could research the characteristics of materials. Class could be split into groups, each producing information on a materials category and feeding back to the group.	R110 LO1 – Learners are required to identify materials for a product to be manufactured	Search for 'BBC Bitesize how to identify materials'. Search for 'BBC Bitesize characteristics of materials'.
	8	LO1	Use of materials.	Learners could review why materials are used for specific applications. A quiz could be held with students having to identify materials used for given applications.	R110 LO1 – Learners are required to identify materials for a product to be manufactured	www.stem.org.uk search for 'application of engineering materials'.
	9	LO2	Basic engineering processes – hand material removal techniques.	Videos could be used illustrate hand material removal processes. If resources are available learners could observe or perform practical activities within a workshop area. A range of materials could be provided to learners on which material removal is carried out. Learners could be given a range of hand tools to select from.	R110 LO2 – Learners will be expected to identify and safely use the correct hand tools to remove material when manufacturing a pre-production prototype.	Range of videos on www.youtube.com search for either: 'hand sawing', 'hand filing' or 'hand threading'
	10	LO2	Basic engineering processes – hand forming techniques.	Suitable videos showing hand forming techniques could be useful to illustrate hand forming techniques. Learners could watch or undertake simple practical activities such as forging, casting and bending.	R110 LO2 – Learners could use hand forming techniques when manufacturing a pre-production prototype.	Range of videos on www.youtube.com search for either: 'forging', 'casting' or 'bending'.

	Event	Learning Outcome	Topic area/subtopic Area (from R109 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	Basic engineering processes – hand joining methods – soldering, brazing, welding.	Learners could watch demonstrations or carry out a range of simple practical activities. Soldering of electrical components onto a circuit board, brazing metals together, and welding metal components onto a structure could be carried out. Videos could be used to explain each joining process in detail.	R110 LO2 – Learners could use hand joining methods when manufacturing a pre-production prototype.	Range of videos on www.youtube.com search for either: 'soldering', 'brazing' or 'welding'.
	2	LO2	Basic engineering processes – hand joining methods – riveting, adhesives, threaded fasteners, self-tapping screws.	Learners could carry out a product investigation to determine the method of joining each product part. Independent research into joining methods could be done considering benefits and limitations of each.	R110 LO2 – Learners could use hand joining methods when manufacturing a pre-production prototype.	www.technologystudent.com search for 'joints and fixings'.
	3	LO2	Basic engineering processes – heat treatment methods.	Learners could research into the reasons for heat treatment, and different heat treatment methods. They could identify what metals each type is suitable for and the benefits of each method.	R110 LO2 – Learners could use heat treatment methods when manufacturing a pre-production prototype.	Search for 'BBC Bitesize heat treatment'.
	4	LO2	Basic engineering processes – surface finishing methods.	Learners could research why products have surface finishes applied to them. Practical product investigation could be carried out, identifying the finishing method applied and discussing the viability of alternative methods.	R110 LO2 – Learners could use surface finishing methods when manufacturing a pre-production prototype.	www.technologystudent.com search for 'finishing methods to material'.
	5	LO2	Machine Processes – machine material removal methods.	Videos could be used to illustrate a range of machine material removal processes. Machine removal processes include: turning using a lathe, drilling using a pillar drill, milling using a milling machine and grinding using a grinding wheel. Learners should be able to identify and name the basic features of each type of machine.	R110 LO2 – Learners will use manual machines when manufacturing a pre-production prototype (e.g. drilling, turning, milling).	Range of videos on www.youtube.com search for either: 'using a pillar drill', 'using a lathe', 'using a milling machine' or 'using a grinding wheel'.
	6	LO2	Machine processes – machine forming.	Learners could carry out research into a range of machine forming processes including die and investment casting, shell moulding, forging, extrusion and press forming. They could identify the advantages and disadvantages of each process linking this to the choice of materials and their suitability for each process.	R110 LO2 – Learners could use machine forming when manufacturing a pre-production prototype.	Range of videos on www.youtube.com search for either: 'die and investment casting', 'shell moulding', 'forging', 'extrusion' and 'press forming'.

	Event	Learning Outcome	Topic area/subtopic Area (from R109 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	Machine processes – machine moulding.	Learners could investigate machine moulding processes, engaging in a range of practical activities if possible, to vacuum forming a part, e.g. a lid for a box. They could compare alternative machine moulding processes: vacuum forming, injection moulding, blow moulding, rotational and compression moulding.	R110 LO2 – Learners could use machine moulding when manufacturing a pre-production prototype.	www.technologystudent.com search for ' <i>plastic manufacturing processes</i> '. Range of videos on www.youtube.com search for either: ' <i>vacuum forming</i> ', ' <i>injection moulding</i> ', ' <i>blow moulding</i> ', ' <i>rotational and compression moulding</i> '.
	8	LO2	Safe use of tools and equipment – features of machines, hazards, risks, PPE.	Practical activities could be used to illustrate the importance of safe working. Learners could begin by identifying hazards and risk for manual and machine operations. This should be related to safe working on machines, and their safety features e.g. pillar drill, lathe, milling machine. They could undertake simple risk assessments including the need to use personal protective equipment (PPE) and appropriate warning signage.	R110 LO2 – Learners will follow safety procedures and use appropriate PPE when using tools and equipment. R111 LO3 – Learners will safely set up and use CNC equipment when manufacturing a component.	Health and Safety at Work Act: https://www.hse.gov.uk/legislation/hswa.htm Health and safety in engineering: https://www.hse.gov.uk/engineering/ Includes a useful workshop guide booklet on to health and safety in engineering workshops.
	9	LO3	Computer controlled production processes – Computer Numerical Control (CNC) – lathes and milling machines.	Learners could research into different CNC turning and milling processes, producing a tabulated comparison the applications of each. If access to resources is available, a demonstration of CNC turning, or milling could be shown to candidates.	R111 LO1 – Learners will be able to plan for use of a specific CNC machine. R111 LO4 – Learners will research wider applications of computer control processes used in product manufacture.	Search Internet for ' <i>CNC lathe</i> ' or ' <i>CNC milling machine</i> '
	10	LO3	Computer control production processes – CNC laser cutting and welding.	Learners could research CNC laser cutting and CNC welding, summarising the key features and benefits of each technique. If access to resources is available, a demonstration of CNC laser cutting could be shown to candidates.	R111 LO1 – Learners will be able to plan for use of a specific CNC machine. R111 LO4 – Learners will research wider applications of computer control processes used in product manufacture.	Search Internet for ' <i>CNC laser cutting</i> ' or ' <i>CNC welding</i> '

	Event	Learning Outcome	Topic area/subtopic Area (from R109 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 control production processes – CNC water jet cutting, punching, press brake machine.	Learners could carry out research into CNC production processes identifying their benefits and limitations. Applications of each process should also be identified.	R111 LO1 – Learners will be able to plan for use of a specific CNC machine. R111 LO4 – Learners will research wider applications of computer control processes used in product manufacture.	Range of videos on www.youtube.com search for either: 'water jet cutting', 'CNC punching', 'CNC press brake'
	2	LO3	Computer control production processes – additive manufacturing.	Learners could carry out research into CNC additive manufacturing technique such as stereolithography, sintering, fused deposition modelling. Each method could be summarised in a table along with example applications and relative benefits and disadvantages.	R111 LO1 – Learners will be able to plan for use of a specific CNC machine. R111 LO4 – Learners will research wider applications of computer control processes used in product manufacture.	https://additivemanufacturing.com/basics/ provides a basic introduction to additive manufacturing technologies.
	3	LO4	Impact of modern technology – automation.	Learners could research into the benefits of modern technology within a production environment. They could explain how automated production will increase output, improves speed and accuracy of production and result in products getting into the marketplace quicker.	R111 LO3 – Learners will compare the benefits and disadvantages of CNC processes with manually controlled machines. R112 LO3 – Learners will investigate how modern technology can be used in quality control.	www.themanufacturer.com search for 'technology in manufacturing'. www.wisegeek.com search for 'what is automated manufacturing'.
	4	LO4	Basic engineering processes – surface finishing methods.	Learners could begin by researching the relative advantages of modern technology on improving quality. They could practically compare a batch of handmade products to those manufactured using computer control methods. A table of quality checks could be produced to determine accuracy and quality of each manufacturing method.	R111 LO3 – Learners will compare the benefits and disadvantages of CNC processes on quality. R112 LO3 – Learners will investigate how modern technology can be used in quality control.	www.wisegeek.com search for 'what are the different kinds of quality control techniques?'.

	Event	Learning Outcome	Topic area/subtopic Area (from R109 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	5	LO4	Impact of modern technology – impact on workforce.	Learners could be provided with case studies to discuss the impact that modern technology has made to a workforce. Comparison of a workforce using traditional methods to computer controlled methods could be carried out.	R112 LO4 – Learners will understand the principles of lean manufacturing, and its impact on the workforce.	https://www.sig-uk.org/wp-content/uploads/2019/02/EEF-Reinventing-the-Manufacturing-Workforce-Made-UK.pdf provides useful information and case studies of how the manufacturing workforce needs to change with modern technology.
	6	LO4	Impact of modern technology – impact on costs.	Using a given scenario, learners could consider how the initial outlay for modern technology can impact on a company in terms of money, profits, workforce and cost of production. Clear effects on initial investment, fewer skilled workers, reduced costs of production and potential profits should be discussed.	R112 LO4 – Learners will understand the principles of lean manufacturing, and its impact on manufacturing costs.	The following guide from the Royal Academy of Engineering provides a comprehensive overview of modern manufacturing, including the impacts of investment on costs https://www.raeng.org.uk/publications/reports/an-insight-into-modern-manufacturing-etf-report
	7	LO4	Digital communication – uses in research and development.	Learners could research how digital communication methods are used in research and development. Applications include the use of Computer Aided Design (CAD), video conferencing, Internet research and electronic communication of designs and drawings. The advantages and limitations of these methods could be included in the discussion.	R112 LO3 – Learners will investigate the use of computers in Computer Integrated Engineering (CIE)/ Computer Integrated Manufacture (CIM).	https://www.themanufacturer.com/articles/creating-modern-manufacturing-workplace/ provides a case study of how digital communications has been used by the workforce at Aston Martin to increase productivity.
	8	LO4	Digital communication – materials supply and control.	Learners could be a given a case study to determine how production control methods are used to monitor manufacturing operations. Learners should consider how materials are delivered within a production context (Just in Time (JIT)), the reduction of stock levels, the use of automated ordering systems and how this data is shared and transferred electronically.	R112 LO3 – Learners will investigate the use of computers in Computer Integrated Engineering (CIE)/ Computer Integrated Manufacture (CIM). R112 LO4 – Learners will investigate materials supply and movement in manufacturing.	https://www.tradegecko.com/inventory-management/what-is-just-in-time-inventory-management provides and overview of JIT along with real case studies. You Tube video: https://www.youtube.com/watch?v=AH5Bn8iguNM

	Event	Learning Outcome	Topic area/subtopic Area (from R109 specification)	Suggestions for delivery/activities (including scope and depth)	'Have they got it?' – internal unit links with commentary	Useful external resources
Summer Term	9	LO4	Global Manufacturing – global supply chain and business benefits.	Learners could investigate the supply chain for a global manufacturing company. This could include explaining how the business operates and the benefits to the company of a globalised manufacturing approach.	R112 LO4 – Learners will investigate the 7 lean wastes and how these are applied to manufacturing (which could be in a global context).	www.ewmfg.com search for 'what is a global manufacturer'.
	10	LO4	Global Manufacturing – standardisation of processes and procedures.	Learners could identify how standardised manufacturing processes and procedures are used in global context highlighting examples. Learners could research into production methods used across different manufacturing facilities identifying the importance of working to set procedures.	R112 LO4 – Learners will investigate Design for Manufacturing and Assembly (DFMA) which considers standardisation.	You Tube video: https://www.youtube.com/watch?v=nDv5lC8YJpk

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