

Cambridge **NATIONALS LEVEL 1/2**

ENGINEERING DESIGN



**R105 Design briefs, design specifications and
user requirements**

J831/J841

Schemes of work

Version 1

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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-design-level-1-2-award-certificate-j831-j841/>

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-design-level-1-2-award-certificate-j831-j841/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-design-level-1-2-award-certificate-j831-j841/assessment/>

Scheme of work (longer term plan – academic year)

| | Learning Outcome | Topic area/theme (from R105 specification) | Links to other Cambridge Nationals Engineering units and LOs |
|-------------|------------------|--|---|
| Autumn Term | LO1 | The design cycle. | |
| | LO1 | Identifying design needs. | R108 LO1 – Know how to plan the making of a prototype. |
| | LO1 | Information informing the design brief. | R108 LO1 – Know how to plan the making of a prototype. |
| | LO1 | The relationship between design brief and specification. | R108 LO1 – Know how to plan the making of a prototype. |
| | LO1 | The design phase. | R107 LO1 – Be able to generate design proposals using a range of techniques. R107 LO2 – Know how to develop designs using engineering drawing techniques and annotation. |
| | LO1 | The optimise phase. | R108 LO3 – Be able to produce a prototype. |
| | LO1 | The validate phase. | R106 LO3 – Be able to analyse an existing product through disassembly. R108 LO4 – Be able to evaluate the success of a prototype. |
| | LO2 | User needs. | |
| | LO2 | Product safety. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R108 LO2 – Understand safe working practices used when making a prototype. |
| | LO2 | Product requirements – part 1. | R107 LO1 – Be able to generate design proposals using a range of techniques. |

| | Learning Outcome | Topic area/theme (from R105 specification) | Links to other Cambridge Nationals Engineering units and LOs |
|-------------|------------------|---|---|
| Spring Term | LO2 | Product requirements – part 2. | R107 LO1 – Be able to generate design proposals using a range of techniques. |
| | LO2 | Manufacturing considerations: scales of production. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R107 LO1 – Be able to generate design proposals using a range of techniques. R108 LO1 – Know how to plan the making of a prototype. R110 LO3 – Be able to modify a production plan for different scales of production. R111 LO1 – Be able to plan the production of components on Computer Numerical Control (CNC) machines. |
| | LO2 | Durability, resilience, and tolerances. | |
| | LO2 | Manufacturing considerations: Just in Time (JIT). | |
| | LO2 | Manufacturing considerations: manufacturing processes. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R107 LO1 – Be able to generate design proposals using a range of techniques. R108 LO1 – Know how to plan the making of a prototype. R108 LO2 – Understand safe working practices used when making a prototype. R109 LO1 – Understand engineering processes and their application. |
| | LO2 | Manufacturing considerations: standard and pre-manufactured components. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R107 LO1 – Be able to generate design proposals using a range of techniques. |
| | LO2 | Manufacturing considerations: DFMA. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R107 LO1 – Be able to generate design proposals using a range of techniques. |

| | Learning Outcome | Topic area/theme (from R105 specification) | Links to other Cambridge Nationals Engineering units and LOs |
|-------------|------------------|--|--|
| Spring Term | LO2 | Manufacturing considerations: disassembly. | R106 LO3 – Be able to analyse and existing product through disassembly. |
| | LO2 | Production costs. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. |
| | LO2 | Regulations and Safeguards. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. |

| | Learning Outcome | Topic area/theme (from R105 specification) | Links to other Cambridge Nationals Engineering units and LOs |
|-------------|------------------|---|---|
| Summer Term | LO3 | Market Pull/Technological Push. | |
| | LO3 | Cultural and fashion trends. | |
| | LO3 | Legislative design requirements/ signs and symbols. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. |
| | LO3 | Iconic design. | |
| | LO3 | Life Cycle Analysis. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R112 LO4 – Know the principles of lean manufacturing. |
| | LO3 | Sustainability. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. |
| | LO3 | End of Life. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. |
| | LO3 | Environmental Pressures. | R112 LO4 – Know the principles of lean manufacturing. R107 LO1 – Be able to generate design proposals using a range of techniques. |
| | LO3 | New and emerging materials. | |
| | LO3 | New and emerging technologies. | R106 LO1 – Know how commercial production methods, quality and legislation impact on the design of products and components. R109 LO1 – Know about developments in engineering processes. |

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

| | Event | Learning Outcome | Topic area/subtopic Area (from R105 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 | The design cycle. | Learners will be introduced to all phases of the design cycle. Learners could independently order the phases of the design cycle. Learners could theorise why that order is important and the advantage of this order. Learners could investigate how the design process has been applied to modern commercially manufactured products e.g. cars, vacuum cleaners. | R105 LO1 – Learners will be able to identify the order of the phases of the design cycle and why this is important. Learners should be able to articulate what happens in each of the phases and the impact on product outcomes. | www.isixsigma.com search for 'IDOV'; covers the use of the design cycle in industry. |
| | 2 | LO1 | Identifying design needs. | Learners could be introduced to the design brief and the difference between situation and context. Learners could produce example design briefs based upon example situation and context scenarios. Learners could use the brief to explain what a suitable product outcome might be for the client and for the user. | R105 LO1 – Learners will be able to identify the purpose of the design brief. They will be able to explain both situation and context including needs of the client and customer. | https://www.bbc.co.uk/bitesize and search for 'Investigating OCR' |
| | 3 | LO1 | Information informing the design brief. | Learners will be introduced to types of research. They could undertake both primary and secondary research for an example brief and evaluate their findings. This could be linked to the task in identifying design needs. They could research materials and processes and consider budget and cost of production. | R105 LO1 – Learners will be able to identify types of information that can be used to identify design needs. Learners will be able to explain a range of ways to collect this information. | https://www.entrepreneur.com/ search for 'how to do market research' |
| | 4 | LO1 | The relationship between design brief and specification. | Learners could be guided how to develop a design specification based on design brief and research. Learners could do a card-sort matching exemplar specification against their respective design briefs. Learners could write a specification based upon a sample brief. They could conclude by writing up 'ten things to include in a successful specification'. | R105 LO1 – Learners will be able to describe how a design specification is derived from the design brief. They will be able to identify the importance and role of the client and the user. They will be able to generate specifications and know which pertinent points should be included in a specification. | https://www.sciencedirect.com/topics/engineering/design-specification https://www.bbc.co.uk/bitesize search for 'design specification' |

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| Autumn Term | 5 | LO1 | The design phase. | Learners could be introduced to a range of sketch and technical drawings and asked to identify the advantages of each one. Learners could be given a range of sketch ideas and asked to identify the most suitable against a brief and specification. They could then be asked to develop the design. An example manufacturing plan could be provided for learners to identify the purpose and features. Learners could be asked to explain the advantages of such a plan. | R105 LO1 – Learners will be able to describe the process of designing. They will be able to identify drawing conventions including technical drawing standards and the key features of different styles of drawing. Learners will understand the purpose of a manufacturing plan. | https://ocw.mit.edu/ search for <i>design handbook</i> |
| | 6 | LO1 | The optimise phase. | Learners could discuss the purpose of a prototype; case studies could be presented e.g. Dyson. Learners should then be introduced to error proofing. They could be presented with suitable products e.g. plugs/sockets on various devices or a flash drive to help explain how error proofing works. Learners could develop conclusions on how the optimise phase improves reliability, accuracy and quality of products. | R105 LO1 – Learners will be able to explain what a prototype is and its purpose. Learners should be able to describe the concept and purpose of error proofing including advantages. | https://leanfactories.com/ search for 60 common examples of Poke yoke for a guide and numerous examples of error proofing https://www.interaction-design.org/ search for 'get started with prototyping' https://www.usability.gov/ search for 'prototyping' |
| | 7 | LO1 | The validate phase. | Learners could discuss types of testing that can be applied to a product that they can think of. Learners could then be introduced to a further range of types of tests including virtual, focus group and destructive testing. They could match test types with example products or review a case study on how toys are tested before production. As some further activity learners could practice evaluating products success against brief and specification. They could either use example products or create a product themselves. | R105 LO1 – Learners will be able to describe different ways of testing a prototype and give the relative advantages of each type of testing. Learners will be able to evaluate products against a product brief and product specification. | https://www.isixsigma.com/ search for 'the importance of the validate phase' https://www.youtube.com/ Search for 'testing products' or 'product testing' for a range of videos of products being tested in various ways |

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| Autumn Term | 8 | LO2 | User needs. | Learners could be introduced to core ideas of user needs, aesthetics, ergonomics and anthropometrics. Learning could be led through analysis of suitable products e.g. game controllers or chairs and identifying how they meet the specific needs of the user. Anthropometric data would be required to design such a product. Learners could take measurements to create anthropometric data and explain why this is important for the user. | R105 LO2 – Learners will be able to explain the importance and implications of ergonomic and/or anthropometric references in the design specification. Learners will be able to explain how data is generated and how it may be utilised in product development. | https://www.bbc.co.uk/bitesize and search for 'considering usability when designing' |
| | 9 | LO2 | Product safety. | Learners could theorise the potential implications of unsafe products and therefore the importance of product safety. They could expand upon implications for the client, the customer, and the designer. Learners could be provided with common symbols associated with quality and safety and be asked to research their meaning. | R105 LO2 – Learners will be able to explain both the importance and the implications of safety standards in a design specification. | https://www.gov.uk search for 'CE marking' https://www.bsigroup.com/en-GB/ and search for 'kite mark' https://www.btha.co.uk/ and search 'toy safety' for common safety symbols |
| | 10 | LO2 | Product requirements – part 1. | Learners could be introduced to product requirements in the context of design briefs. They could match descriptions to headings for the following: product function, features, performance, target group/intended users, working environment. Learners could be presented with a case study product/object and asked to reverse engineer the product requirements that must have existed for the product using these headings. | | |

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| Spring Term | 1 | LO2 | Product requirements – part 2. | Learners could continue to explore product requirements in the context of design briefs. They could match descriptions to headings for the following: limitations and constraints (size, weight and functional limitations), appearance, ergonomics and lifecycle. Again, a case study product could be used to examine these. | R105 LO2 – Learners will be able to identify the key points included as part of product requirements. | |
| | 2 | LO2 | Manufacturing considerations: scales of production. | Learners could be introduced to scales of production. Learners could be given a range of products and asked to match them with the most appropriate scales of production. Learners could be asked to investigate the start-up costs of large-scale manufacturing and produce a 'fact file' of each scale of manufacture. They could discuss how easy and costly it is for each scale of production to influence the design of a product. Case studies of each scale of production can be given through videos or through site visits. | R105 LO2 – Learners will be able to identify mass, batch and one-off scales of production (and within these prototypes and continuous production). Learners will be able to verbalise the advantages of these different scales and how they may be suitable for different products. | https://www.youtube.com/ search for 'scales of production' |
| | 3 | LO2 | Durability, resilience, and tolerances. | Learners could be introduced to the term durability and resilience in the context of the design of products. They could also be shown why components that go to make products need to be manufactured to specific tolerances, and the consequences of this on manufacturing and cost. Case studies of different products could be used to illustrate these considerations. | R105 LO2 – Learners will be able to explain the terms durability and resilience in the context of products. They will also be able to explain tolerances, and their importance in designing products. | https://www.satra.com/product_testing/ search for 'durability' for some interesting case studies of product testing for durability |
| | 4 | LO2 | Manufacturing considerations: Just in Time (JIT). | Learners could use case studies e.g. cars or chocolate bars to explain how Just In Time (JIT) makes the process more efficient and cost effective. | R105 LO2 – Learners will be able to describe the concept of Just In Time (JIT) and explain how it provides advantages to certain scales and styles of production. | https://www.ifm.eng.cam.ac.uk search for 'just in time' www.planview.com search for 'just in time' https://www.youtube.com/watch?v=cAUXHJBB5CM YouTube has numerous case studies such as this one from Toyota |

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| Spring Term | 5 | LO2 | Manufacturing considerations: manufacturing processes. | Learners could be introduced to a range of manufacturing processes applied to metals and polymers. They should be analysed in terms of complexity, accuracy, setup costs and production costs. These should be related back to prior learning on scales of production. Where suitable equipment is available, learners may be able to practice some of these processes. | R105 LO2 – Learners will be able to identify a range of common manufacturing processes used in industry. They will be able to identify how they suit different scales of manufacture and the advantages of these processes. | |
| | 6 | LO2 | Manufacturing considerations: standard and pre-manufactured components. | Learners could be introduced to standard components. They could list as many standard components as come to mind. They could look at or create a diagram of how one factory can supply components for many products reducing the need for experts / specialist machinery in many other factories. Learners could disassemble small mechanical or electronic products and identify all standard and pre-manufactured components. This can then be linked to larger products that use easily replaced components e.g. bikes. | R105 LO2 – Learners will be able to identify and explain a range of common standard components. They must be able to explain how they provide advantage in terms of costs and accuracy. They will be able to articulate what constitutes a pre-assembled component. | https://www.youtube.com has a range of videos on use of and types of standard components |
| | 7 | LO2 | Manufacturing considerations: DFMA. | Learners can be led through a case study - either through exploded drawings or physical disassembly of small products. Learners should be given opportunity to assess the study using previous knowledge of manufacturing processes and standard components. Learners could also be guided to consider material choices. | R105 LO2 – Learners will be able to explain the concept of Design for Manufacture and Assembly (DFMA), along with examples of its application in the design of a product. | |
| | 8 | LO2 | Manufacturing considerations: disassembly. | Learners could be introduced to the concept of disassembly and temporary fixings. Learners may physically disassemble simple products and attempt to explain the various advantages of being able to take a product apart. Learning could be consolidated with a case study of example products. | R105 LO2 – Learners will be able to describe the concept of design for disassembly and identify the benefits of this. Learners will be able to identify temporary fixings, including the benefits of using this type of fixing. | www.ceguide.org search for 'disassembly/ deconstruction' for a description and case study |

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| Spring Term | 9 | LO2 | Production costs. | Learners could start by looking at several examples of a similar product and discussing which might be the most expensive. Learners should be guided though how material availability affects cost and how manufacturing processes vary in cost. They could produce a web of all costs involved in getting a product from raw material to customer. They could also refer to the cost of setting up scales of production and JIT. | R105 LO2 – Learners will be able to articulate a range of effects on production cost including complexity, setup, manufacturing processes and material availability. | |
| | 10 | LO2 | Regulations and Safeguards. | Learners could start by matching symbols with descriptions for: copyright, trademark, European Conformity (CE). Learners could discuss their understanding of the purpose of copyright and then be guided to the difference between copyright, patent, registered design and trademark. Learners could then research the work of the BSI, and the CE marking. They could match product standards (e.g. BS or EN standards) with example product types. | R105 LO2 – Learners will be able to explain why product regulations and safeguards are important. They should be able to reference safety, quality and protection of intellectual property and protection by law. Learners should be able to explain what British Standards and European Conformity are. They should be able to identify relevant symbols. | https://www.gov.uk/browse/business/intellectual-property includes details of how to protect designs |

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|-------------|-------|------------------|---|--|--|---|
| Summer Term | 1 | LO3 | Market Pull/Technological Push. | <p>Learners could be presented with examples of different products that have developed significantly over time – e.g. cameras, cars, bikes, music devices and asked to identify how they have changed.</p> <p>Case studies could be used to illustrate the difference between market pull and technology push.</p> <p>The difference between consumer led and technology led change should be emphasised in consolidation.</p> | R105 LO3 – Learners will be able to explain market pull and technology push and how they influence the design of new products. | https://www.stem.org.uk/ and search for 'development of the mobile phone' |
| | 2 | LO3 | Cultural and fashion trends. | Teachers could use examples to illustrate how cultural and fashion trends impact the design and popularity of new products. Suitable case studies could be used, such as the cultural shift towards sustainable living and green transport/electric vehicles. | R105 LO3 – Learners will be able to explain how cultural and fashion trends inform the development of new products. | https://www.marketingsociety.com/the-library/top-10-cultural-shifts-watch-2019 includes examples of cultural trends |
| | 3 | LO3 | Legislative design requirements/ signs and symbols. | Learners could be introduced to signs and symbols for materials and product safety. Learners could be given symbols or find them on products and could then research their meanings. Learners should be reminded of symbols for regulations and safeguards and then identify the meaning of a range of safety symbols e.g. flammable warnings, the lion mark, age restrictions etc. | R105 LO3 – Learners will be able to identify and explain safety symbols from awarding organisations e.g. BSI and CE. Learners will be able to identify a range of signs and symbols applied to products. | http://www.safekids.co.uk/ search for 'toy safety symbols' reviews the main symbols found on children's toys |
| | 4 | LO3 | Iconic design. | Learners could be shown a variety of products considered iconic. They could consider what they have in common and describe which they consider the most iconic. Learners could write up their own definition of an iconic product and could investigate and report on an iconic product. | R105 LO3 – Learners will be able to identify some iconic products. They will be able to explain how these products influence new product design. | https://www.100designs.cc/ presents a large collection of classic and iconic designs with background https://www.youtube.com/ searching for '(what is) iconic design' will offer a range of descriptions with examples |

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| Summer Term | 5 | LO3 | Life Cycle Analysis. | Learners could produce a case study of suitable products e.g. cars, mobile phones, glass bottles. Life cycle information for most common products can be researched by learners on the internet. Learners should be guided through the concept of recycling materials and reusing components. They could then relate this to the product they have researched. | R105 LO3 – Learners will be able to explain what product life cycle is and the typical stages it consists of. | https://www.stem.org.uk/ and search for 'product life cycle' https://practicalaction.org/ and search for 'environmental sustainability' |
| | 6 | LO3 | Sustainability. | Learners could chart the journey of commonly used materials e.g. timber/plastic/steel from source to product and identify all environmental impact including the concept of embodied energy. Learners could sort materials and energy sources into renewable and non-renewable. Learners could use this information to identify and report on ways to make existing products more sustainable. | R105 LO3 – Learners will be able to identify renewable and non-renewable energy sources. They will be able to identify forms of energy used in processing and transport and the impact of non-renewable sources. | https://www.nationalgeographic.org/ search for 'renewable resources' https://practicalaction.org/schools/environmental-sustainability/ has activities related to product sustainability |
| | 7 | LO3 | End of Life. | Learners could be introduced to the 6 R's – they may be introduced by matching each of the 6 R's to their description. Learners could also discuss which are the most environmentally friendly. Learners may look at a range of products and identify which of the 6 R's they represent. They could consolidate by redesigning a product to improve its environmental credentials using the 6 R's. | R105 LO3 – Learners will be able to name the 6 Rs and differentiate between them. Learners will be able to give examples of each and be able to implement them in design. | https://practicalaction.org/schools/6-rs/ has activities related to the 6 R's https://www.citymetric.com/ search 'materials made of waste products' |
| | 8 | LO3 | Environmental Pressures. | Learners could be introduced to the concept of ethical design. This could be presented through debate of a product that is ethically contentious either through its use, advertising or imagery. They could be introduced to the concept of 'fairtrade' and products. | R105 LO3 – Learners will be able to identify social and ethical impact of engineered products and how this influences their design. | |

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| Summer Term | 9 | LO3 | New and emerging materials. | Learners could be introduced to a range of modern, smart, and composite materials. This could be through samples and demonstration, but more likely through case study. Learners could research the applications of such materials e.g. carbon fibre in racing vehicles or aerogel in the aviation industry. Learners could prepare a short presentation for their peers. | R105 LO3 – Learners will be able to name a range of smart, modern, and composite materials including their properties and applications. | https://www.bbc.co.uk/bitesize/guides/zdtmtv4/revision/1 provides new and emerging technologies description https://www.sciencedirect.com/search?qs=smart+materials for some applications of smart materials |
| | 10 | LO3 | New and emerging technologies. | Learners could be introduced to a variety of new technologies and manufacturing methods. This could be done via a timeline. Learners could be introduced to the advantages of computer learning, computer control and Artificial Intelligence (AI). This can be linked back to automation and mass production. For additive manufacturing they could describe the advantages of additive processes such as 3D printing. | R105 LO3 – Learners will be able to identify how new technologies have improved design and manufacturing processes. They will be able to identify advantages and disadvantages. | https://www.raeng.org.uk/publications/reports/made-for-the-future is an extensive report on the impact of additive technologies https://www.automation.com/ has a variety of downloadable resources in resources section. Also search ' <i>Internet of Things (IoT), Smart Manufacturing and Industry 4.0</i> ' |

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