2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 9

Mechanical design

M/506/7275

Guided learning hours: 60

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LEVEL 3

UNIT 9: MECHANICAL DESIGN

M/506/7275

Guided learning hours: 60

Essential resources required for this unit: technical drawing equipment (e.g. paper, pens), suitable products/components to disassemble, appropriate tools and PPE for disassembly

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

The successful manufacture of mechanical components and products depends on well planned, accurate and complete design solutions.

The aim of this unit is for learners to develop the knowledge, understanding and skills to be successful in their design of mechanical engineering components and products.

Learners will develop knowledge and understanding of engineering drawings, both freehand graphical techniques, and more formal drawing techniques. They will also be able to select the appropriate engineering materials to achieve their design solutions.

Learners will be able to produce a design that can be manufactured, successfully, and learn how to optimise a design to improve performance.

TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.

Anything which follows an i.e. details what must be taught as part of that area of content. Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, although these do not need to be the same ones specified in the unit content.

For internally assessed units, you need to ensure that any assignments you create, or any modifications you make to an assignment, do not expect the learner to do more than they have been taught, but must enable them to access the full range of grades as described in the grading criteria.

Please note – if learners are completing this unit as part of the Extended Diploma qualification they will be required to complete the synoptic unit 25: Promoting continuous improvement. Before your learners complete the assessment of this unit, you must refer to the specification and model assignment requirements for unit 25, so if applicable you can ensure learners gather the appropriate feedback on their own performance and performance of the system, process or artefact that they may have produced in this unit.

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
1. Be able to use graphical and engineering drawing techniques to communicate design solutions	1.1 current British standard (e.g: PP 8888-2:2007 *'Engineering drawing practice: a guide for further and higher education to BS 8888:2006, Technical product specification')* conventions and symbols i.e. • drawing sheet layout – borders and titles • scales • orthographic projection – third angle • isometric and oblique projection • types of lines, lettering, annotation and parts lists • sectional views • standard components, i.e. o threaded fasteners o springs o bearings • assemblies • dimensioning • graphical symbols • tolerances, limits and fits • surface texture • mechanisms, i.e. o levers, o gears o pulleys 1.2 techniques to create freehand 2D and 3D drawings and sketches, and the application of rendering techniques, i.e. • use of drawing pens, pencils, and markers • use of perspective views • use of 'thick and thin line' technique • use of rendering to show light source, shading, colour and surface texture • layout and presentation of freehand design sketches

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
	1.3 hand-drawing techniques to create formal 2D and 3D engineering drawings complete with parts and assemblies, i.e. • use of drawing pens and pencils • use of drawing instruments • use of templates, stencils and radius aids • formal drawing layout and presentation skills 1.4 application of drawing, sketching and rendering skills in the creation and development of designs for engineering products or components, i.e. • use of freehand sketching in the generation of a range of design ideas and variations • use of rendering techniques to improve the visualisation of design possibilities in real-life • use of formal drawings to communicate design solutions with technical detail
2. Be able to select appropriate engineering materials to achieve design solutions	2.1 how to investigate the use of materials in existing products and components, i.e. • safe product disassembly • safe testing • internet research 2.2 how to determine material requirements for a new design scenario (e.g. environmental and spatial aspects, function and performance • requirements, frequency of use, maintenance and cost factors, tolerances involved) 2.3 how to select the most suitable materials to satisfy a material specification, i.e. • using appropriate material databases and resources • using appropriate material selection charts o consideration of the properties of materials and key factors in their selection, (e.g. strength versus cost, strength versus toughness, stiffness versus density) 2.4 how to justify material selection in design solutions, i.e. • materials' properties • methods of processing and finishing • availability and sustainability • forms of supply and relative cost • fitness for the intended purpose
3. Be able to design components that can be successfully manufactured	3.1 how to investigate the different manufacturing methods used in existing products and components, i.e. • safe product disassembly • safe testing • internet research

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
	3.2 the principles of Design for Manufacture and Assembly (DFMA). in manufacturing processes, (e.g. design for casting, design for machining, design for sheet metal design and fabrication, design for injection moulding) 3.3 the limiting factors in manufacturing processes and their impact when applying DFMA, e.g. • material choice • dimensional tolerances • further processes required such as finishing • alternative manufacturing processes 3.4 how to design a component or product applying knowledge of manufacturing and materials and DFMA principles, , i.e. • use of common parts across components and products • design simplification – reduce the number of different parts and processes • design for ease of assembly of parts • compatibility of materials and processes • detailing of correct tolerances and surface finish • 'Sustainable Design' – e.g. Life Cycle Analysis, maintenance, repair and replacement factors
4. Be able to optimise design to improve performance	4.1 the practical application of design optimisation, i.e. • operational performance and efficiency • weight and economy of materials • quality • manufacturability • efficiency of manufacture/assembly/installation time • sustainability/environmental aspects/life cycle costs • marketability • serviceability 4.2 key aspects of an optimum design solution, i.e. • design constraints (e.g. performance requirements for the design to be feasible) • design variables (e.g. choice of material, thickness of material) • design objectives (e.g. minimum weight) 4.3 use of statistics and mathematical calculations in the optimisation of designs, i.e. • construction of tables, charts, graphs, histograms or frequency polygons to represent data relating to possible design improvements • analysis of testing results • determination of probability (e.g. calculating probability of failure or malfunction)

GRADING CRITERIA

LO	Pass	Merit	Distinction
	The assessment criteria are the Pass requirements for this unit.	To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:	To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:
1. Be able to use graphical and engineering drawing techniques to communicate design solutions	P1: Use freehand 2D and 3D sketches to communicate designs.	M1: Enhance 2D and 3D sketches using rendering techniques.	D1: Use accurate formal 2D and 3D drawings to produce a design solution, using rendering techniques and technical detail.
	P2: Use British Standards in engineering drawings.		
2. Be able to select appropriate engineering materials to achieve design solutions	P3: Determine material requirements for a design scenario based on investigation of existing products and components.	M2: Create a design for components justifying materials and manufacturing processes selected.	D2: Design components incorporating and justifying in detail the use of DFMA principles and design optimisation.
3. Be able to design components that can be successfully manufactured	P4: Determine appropriate manufacturing requirements for components based on investigation of existing products and components.		
	P5: Create a design for components.		

LO	Pass	Merit	Distinction
4. Be able to optimise design to improve performance	P6: Identify key aspects of designs and suggest modifications.	M3: Modify designs of components products to improve ease of assembly or sustainable design.	
	P7: * Use statistics and mathematical calculations to interpret the outcomes of design optimisation. *(*Synoptic assessment from Unit 1 Mathematics for engineering)*		

*SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

When learners are taking an assessment task, or series of tasks, for this unit they will have opportunities to draw on relevant, appropriate knowledge, understanding and skills that they will have developed through other units. We've identified those opportunities in the grading criteria. Learners should be encouraged to consider for themselves which skills/knowledge/understanding are most relevant to apply where we have placed an asterisk.

ASSESSMENT GUIDANCE

LO1: Be able to use graphical and engineering drawing techniques to communicate design solutions
Learners should be able to demonstrate 2D and 3D sketching techniques and also formal drawing techniques using a range of suitable examples. Teachers might wish to make available suitable example exercises in order that learners can demonstrate a range of suitable sketching and drawing techniques.

LO2: Be able to select appropriate engineering materials to achieve design solutions
Learners should be able to determine material requirements based on a scenario for an existing component of product. For P3 learners could safely disassemble an existing product in order to investigate the materials from which it is manufactured. For M2 learners are required to create a design and justify the selection of materials and manufacturing processes. Teachers might select a suitable component or components for learners to design. D2 encompasses both LO2 and LO3 in the design of a component and selection of materials and processes.

LO3: Be able to design components that can be successfully manufactured
For P4 learners should determine the manufacturing requirements based on investigation of an existing product. The product might be that already safely dismantled for P3 in LO2. It could, however, be a different product or products.

LO4: Be able to optimise design to improve performance
Learners should identify key aspects of designs, and make appropriate modifications. Teachers might provide suitable examples or case studies for learners. P7 requires learners to perform calculations in order to interpret design optimisation and so provides an opportunity to develop and apply skills learnt in Unit 1. It might also provide the opportunity for the use of ICT (e.g. spreadsheets).

Feedback to learners: you can discuss work-in-progress towards summative assessment with learners to make sure it's being done in a planned and timely manner. It also provides an opportunity for you to check the authenticity of the work. You must intervene if you feel there's a health and safety risk.

Learners should use their own words when producing evidence of their knowledge and understanding. When learners use their own words it reduces the possibility of learners' work being identified as plagiarised. If a learner does use someone else's words and ideas in their work, they must acknowledge it, and this is done through referencing. Just quoting and referencing someone else's work will not show that the learner knows or understands it. It has to be clear in the work how the learner is using the material they have referenced to inform their thoughts, ideas or conclusions.

For more information about internal assessment, including feedback, authentication and plagiarism, see the centre handbook. Information about how to reference is in the OCR Guide to Referencing available on our website: http://www.ocr.org.uk/i-want-to/skills-guides/.

MEANINGFUL EMPLOYER INVOLVEMENT - a requirement for the Foundation Diploma, Diploma and Extended Diploma (tech level) qualifications

The 'Diploma' qualifications have been designed to be recognised as Tech Levels in performance tables in England. It is a requirement of these qualifications for centres to secure for every learner employer involvement through delivery and/or assessment of these qualifications.

The minimum amount of employer involvement must relate to at least one or more of the elements of the mandatory content (this unit is a mandatory unit in the Mechanical Engineering and Design pathway).

Eligible activities and suggestions/ideas that may help you in securing meaningful employer involvement for this unit are given in the table below.

Please refer to the *Qualification Handbook* for further information including a list of activities that are not considered to meet this requirement.

Meaningful employer engagement	Suggestion/ideas for centres when delivering this unit
1. Learners undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification.	Placements with engineering firms, in the engineering design department, researching common component/product design standards.
2. Learners undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	Tasks set on product design or re-design of components, using industry standard equipment and standards, written to determine if a design of the product is capable of manufacture within that business. (D/PFMEA, FEA)
3. Learners take one or more units delivered or co-delivered by an industry practitioner(s). This could take the form of master classes or guest lectures.	Lectures from practicing design engineers involved in product design, development and testing. Input to include examples of design principles, drawing standards and working documentation within professional commercial engineering practice.
4. Industry practitioners operating as 'expert witnesses' that contribute to the assessment of a learner's work or practice, operating within a specified assessment framework. This may be a specific project(s), exercise(s) or examination(s), or all assessments for a qualification.	Input from practicing design engineers assessing the clarity of engineering drawings and correct identification of design principles, during learners' project work and documentation.

To find out more
ocr.org.uk/engineering
or call our Customer Contact Centre on **02476 851509**

Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**

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