2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 12

Mechanical simulation and modelling

F/506/7278

Guided learning hours: 60

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LEVEL 3

UNIT 12: MECHANICAL SIMULATION AND MODELLING

F/506/7278

Guided learning hours: 60

Essential resources required for this unit: Computer Aided Design (CAD) software capable of performing mechanical simulations (see assessment guidance)

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

Engineering companies, once they have designed components, must carry out CAD simulation and modelling to test that design and fitness for purpose.

The aim of this unit is for learners to develop the skills required to carry out simulations of components, products, assemblies or systems within Computer Aided Design (CAD) software packages – this will include simulations of reactions within mechanical assemblies, and simulations to assess the manufacturability of components.

To assess subsequent operational performance, learners will develop the knowledge and skills to be able to carry out Finite Element Analysis (FEA) and Computational Fluid Dynamic (CFD) simulations utilising Computer Aided Design (CAD) software packages, in order to assess the performance of components, products or systems.

Learners will use this information to identify potential issues and subsequent improvements to designs.

This unit builds directly on skills gained in Unit 10 Computer Aided Design (CAD). It is strongly recommended that this unit should be studied first.

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.

<table>
<tr><th>Learning outcomes

The Learner will:</th><th>Teaching content

Learners must be taught:</th></tr>
<tr><td>1. Be able to carry out simulations to establish reactions in moving mechanical assemblies</td><td>1.1 How to add motion to simulations i.e.
• kinematics i.e.
o displacement
o velocity
• acceleration, i.e.
o manual movement
o automated movement (e.g. motors, drives)
o directional movement i.e.
- linear
- rotary
• animation (e.g. automated motion, recorded video format)
• machines and mechanisms e.g.(levers pulleys gears cams chains belts)
1.2 how to simulate interference and collisions i.e.
• interference fits
• tolerance issues
• collision detection</td></tr>
<tr><td>2. Be able to carry out simulations to assess the manufacturability of components or products</td><td>2.1 how to determine component properties i.e.
• mass properties
• volume
• surface area
• centre of gravity
2.2 how to perform draft analysis i.e.
• casting
• pressing
• injection moulding
2.3 specific manufacturing techniques or processes i.e.
• tool creation i.e.
o press tools (e.g. pressings, sheet metal)
o material properties (e.g. stretch compensation, malleability material thickness)</td></tr>
</table>

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
	• moulding i.e. o creation of mould tools from component geometry o mould tool separation simulation o mould flow analysis (computational fluid dynamics (CFD)) • machining i.e. o tool path simulation o machine process simulation o jigs and fixture location o tooling interference o animation and simulation of production processes (e.g. simulated cutting paths, pressing simulations, mould flow simulations) 2.4 how to perform factory simulation i.e. • production lines • component travel • robotic or automated assembly lines, i.e. o motion and collision analysis o automation simulations
3. Be able to carry out Finite Element Analysis (FEA) simulations to assess the operational performance of components	3.1 how to determine operational performance of components i.e. • displacement • strain • stress 3.2 how to assess operational loads i.e. • forces • pressures • accelerations • temperatures • types of simulation (e.g. impact loading, bending, static loading, linear and non-linear analysis, pressure, torsion) 3.3 setting up an analysis i.e. • boundary conditions (e.g. fixtures) • loads i.e. o direction o magnitude o units • checking for appropriate deformation 3.4 interpreting results of FEA i.e. • Von Mises Stresses • displacement • Factor of Safety (FOS) • modification of geometry or material based on results • selection or modification of material to improve performance (e.g. definitive yield strength, elastic limits)

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
4. Be able to carry out Computational Fluid Dynamic (CFD) simulations to assess the operational performance of components	4.1 fundamentals of CFD i.e. • aerodynamics • heat transfer i.e. o electrical o electronic (e.g. heat sinks in electronic systems) 4.2 fluid flow i.e. • mould flow analysis • liquid processing applications • fluid flow through systems i.e. o flow patterns o pressure o velocity 4.3 materials and boundary conditions 4.4 how to apply relevant geometry i.e. • simplified model geometry for simulation purposes • enclosed geometry representative of simulation conditions • export and manipulation of solid or surface geometry for simulation purposes o configurations (e.g. using configurations to assess variations in simulations for product families) 4.5 how to interpret results i.e. • pressure • temperature • flow rate • trajectory patterns and flows

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 carry out simulations to establish reactions in moving mechanical assemblies	P1: Carry out a simulation within a mechanical design assembly. * *synoptic link to Unit 3 Principles of Mechanical Engineering*		
	P2: Simulate interferences, collision or tolerance issues within a mechanical assembly.		
2. Be able to carry out simulations to assess the manufacturability of components or products	P3: Carry out a simulation to assess the manufacture of a component or product.	M1: Suggest manufacturing improvements to the design of a component or assembly based on simulation results.	
3. Be able to carry out Finite Element Analysis (FEA) simulations to assess the operational performance of components	P4: Set up a Finite Element Analysis (FEA) simulation that reflects realistic boundary conditions.	M2: Recommend improvements to the design of a component based on the results of a Finite Element Analysis (FEA) simulation.	D1: Evaluate the results of a component modification to improve its operational performance based on the results of Finite Element Analysis (FEA) simulation.
	P5: Use mathematic, scientific and engineering principles to prove the accuracy of a Finite Element Analysis (FEA) simulation. * *synoptic link to Unit 2 Science for Engineering and Unit 3 Principles of Mechanical Engineering*		

LO	Pass	Merit	Distinction
	P6: Carry out a Finite Element Analysis (FEA) of a component or product.		
4. Be able to carry out Computational Fluid Dynamic (CFD) simulations to assess the operational performance of components	P7: Setup a Computational Fluid Dynamics (CFD) simulation that reflects realistic boundary conditions.	M3: Recommend improvements to the design of a component, product or system based on the results of a Computational Fluid Dynamics (CFD) simulation.	D2: Evaluate the results of a component, product or system modification to improve its operational performance based on the results of Computational Fluid Dynamics (CFD) simulation.
	P8: Use mathematic, scientific and engineering principles to prove the accuracy of a Computational Fluid Dynamics (CFD) simulation. ** synoptic link to Unit 2 Science for Engineering and Unit 3 Principles of Mechanical Engineering*		
	P9: Carry out a Computational Fluid Dynamics (CFD) simulation of a component, product or system.		

*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 carry out simulations to establish reactions in moving mechanical assemblies
Learners should use Computer Aided Design (CAD) software in order to perform mechanical simulations. It is anticipated that learners will already have skills at using CAD software to design and produce 2D and 3D models (from Unit 10).   Teachers might provide suitable examples on which learners can perform simulation.

LO2: Be able to carry out simulations to assess the manufacturability of components or products
Learners should use CAD software to perform simulations to assess the manufacturability of components or products. Simulation software might include conventional CAD software packages used for design and simulation, and software packages to simulate Computer Numeric Control (CNC) operations. Teachers might provide suitable examples on which learners can perform simulation.

LO3: Be able to carry out Finite Element Analysis (FEA) simulations to assess the operational performance of components
Learners should use simulation software to carry out Finite Element Analysis (FEA). P5 provides the opportunity to apply scientific and engineering principles, and may link to a number of other units in the qualification. Teachers might supply suitable examples on which learners can perform a FEA.

LO4: Be able to carry out Computational Fluid Dynamic (CFD) simulations to assess the operational performance of components
Learners should be able to use simulation software in order to carry out a Computational Fluid Analysis (CFD) simulation. P8 provides the opportunity to apply scientific and engineering principles, and may link to a number of other units in the qualification. Teachers might supply suitable examples on which learners can perform a CFD simulation.

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.

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.	• Students undertake work placements in engineering or manufacturing businesses where mechanical simulation and modelling tools are used. Students should get the opportunity to practically undertake simulations within the industrial environment based on the company’s product profile.
2. Learners undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	• Project set on product design or redesign of components (likely to be integrated with the CAD unit in this qualification), using industry standard equipment and design standards, to determine if the design of a product is capable of manufacture. (CAD/CAM, CFD analysis, FEA all to be incorporated) • Employers set the criteria required for a given simulation based on their business practices. This could include loads or environmental conditions that form the basis of the student’s operational range of performance.

Meaningful employer engagement	Suggestion/ideas for centres when delivering this unit
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.	• Ensure employer input through master classes where employers showcase best practice methodologies in the use of CAD tools. • Lecture from practicing CAD/CAM engineers involved in product design, development and simulation/testing. Input to include examples of common design principles, mechanical simulation tools, and working documentation used within professional commercial engineering practice. • Employers deliver sessions that showcase the link across skills and units. This may include the link between Mechanical Simulation and Modelling and Computer Aided Design (CAD) or Mechanical Simulation and Modelling and mechanical principles or science and mathematics.
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.	• Review from practicing CAD/CAM engineers relating to the accuracy of students' CAD simulations and correct application of design and testing principles during project work and documentation. This may be the simulation of an engineering component under physical stress conditions or analysis of its aerodynamic efficiency.

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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