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ENGINEERING

Unit 15

Electrical, mechanical, hydraulic and
pneumatic control

Model assignment

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Please note:

You can use this assignment to provide evidence for summative assessment, which is when the learner has completed their learning for this unit and is ready to be assessed against the grading criteria.

You can use this assignment as it is, or you can modify it or write your own; we give more information in this document under Guidance for tutors.

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Guidance for tutors on using this assignment

General

OCR Cambridge Technical model assignments are available to download from our website: www.ocr.org.uk.

The purpose of this assignment is to provide a scenario and set of tasks that are typical of how engineers would use electrical, mechanical, hydraulic and pneumatic control, to enable you to assess your learner against the requirements specified in the grading criteria. The scenario and its tasks are intended to give a work-relevant reason for applying the skills, knowledge and understanding needed to achieve the unit.

This assignment will not instruct learners how to meet the highest grade. Whether learners achieve a pass, merit or distinction will depend on what evidence they produce.

You can modify the scenario we provide in this assignment to make it more relevant to your local or regional needs. Please refer to the information under 'Modifying the model assignment' later in this section.

You don't have to use this assignment. You can use it as a guide to help you to design your own assignment, and we provide an assignment checking service. You'll find more information on these matters in section 8 of the qualification handbook.

In the tasks, we'll refer to the format of evidence. Learners are **not** required to follow that format **unless** we tell them otherwise.

It's essential that the work every learner produces is their own. Please make sure you read through the information we give on authenticity in section 8 of the qualification handbook and make sure that your learners and any staff involved in assessment understand how important authenticity is.

We provide this assignment to be used for summative assessment. You must not use it for practice or for formative assessment.

Before using this assignment to carry out assessment

Learners will need to take part in a planned learning programme that covers the knowledge, understanding and skills of the unit.

When your learners are ready to be assessed, they must be provided with a copy of the following sections of this assignment:

- General information for learners
- Assignment for learners
- Evidence Checklist

They may carry out preparation prior to undertaking the tasks and there is no time limit for this.

When completing the assignment

You should use this assignment in conjunction with the unit specification and qualification handbook.

Please note – if learners are completing this model assignment as part of the Extended Diploma qualification they will be required to complete the synoptic unit 25: Promoting continuous improvement. Before your learners complete this model assignment, 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 will produce in this model assignment.

Resources to complete the tasks

There are resource requirements for this assignment.

Learners should apply their knowledge and understanding of, electrical, mechanical, and hydraulic and pneumatic control by investigating industry based systems. We have provided suggested sectors in each task however these are not exhaustive and should be tailored to meet centre resources and local employer support.

Every learner will also need access to the following:

- For the first task in task 1 you will need to provide access to information on applications that use control systems. You should make sure that the examples allow learners to fully consider the unit specification points 1.1, 1.2 and 1.3.
For the second task in task 1 you could provide learners with practical experience of equations of motion and dynamic forces and balancing rotating forces. For example, for P3 you could supply data for learners to prove that forces in equilibrium are equal to zero and for M1 you could facilitate a scenario for learners to look at how out of balance forces could cause physical damage. You could show how these forces are corrected by a site visit to a tyre fitting company to see how forces in rotation are calibrated when balancing a wheel.
For the third task in task 1 you will need to provide learners with suitable experiments or data that show how power losses due to friction occur in a specific control system. This could be achieved by introducing varying loads and measuring the power efficiency for a given system.
- For task 2 you will need to provide access to information on automated control applications that use electrical control systems. Information will be required on systems utilising sensors and actuators. Learners will need access to information to describe common types of actuator to fully consider unit specification point 2.2. You will also need to provide access to information so that learners can investigate a range of motor types for P6 as in unit specification point 2.3, and analyse motor control for D2 as in unit specification point 2.4
Learners will need access to suitable experiments or data so that they can explain the causes of energy losses and reduced efficiency in electrical actuators as in unit specification point 2.5. Learners will also require access to suitable data to satisfy M3 in order that they can make a justified selection of an electric motor for a given output requirement with reference to unit specification point 2.6.
- For task 3 you will need to provide access to suitable information and data so that learners can investigate both hydraulic and pneumatic control systems. In this task information will be required for both hydraulic and pneumatic power sources, valves and actuators in order that learners can fully consider unit specification points 3.1, 3.2, 4.1 and 4.2.
Learners will need access to information on fluid transmission systems for both hydraulic and pneumatic systems so that they can undertake an analysis for criteria M4 and M5. This could be data produced from a practical system(s) but must cover unit specification points 3.3, 4.3 and 4.4.
Learners are also required to evaluate the suitability of hydraulic and pneumatic systems for different control applications. Learners will require access information covering a range of different systems for which they can evaluate this suitability to satisfy D3.

Tutor information to support the tasks

The application(s) to be investigated will need to be suitable for learners to access appropriate elements of mechanical, electrical, hydraulic and pneumatic control. This may mean they need to investigate more than one application to meet the grading criterion.

In task 1 learners will need to draw on their knowledge from Unit 2 Science for engineering. They could also draw on knowledge from Unit 3 Principles of mechanical engineering should this unit be selected.

In task 2 learners will need to draw on their knowledge from Unit 2 Science for engineering. They can also draw on knowledge from Unit 4 Principles of electrical and electronic engineering should this unit be selected.

In task 3 learners will need to draw on their knowledge from Unit 2 Science for engineering.

Health and Safety and the use of resources

Health and safety will need to be considered should any of the tasks, or parts of the tasks be undertaken as practical activities. This should include appropriate risk assessments, safe working methods statements and the use of appropriate personal protective equipment (PPE). Learners should be encouraged to take part in assessing risk before conducting any practical activity.

Time

You should plan for learners to have 13–16 hours to complete this assignment.

Learners must be allowed sufficient time to complete all the tasks. The amount of time may vary depending on the nature of the tasks and the ability of individual learners. To help with your planning, against each of the tasks we've given an indication of how long it should take.

Learners can produce evidence in several sessions.

Format of evidence

Learners have to produce evidence that demonstrates how they have met the grading criteria. At the very least they must produce evidence that meets **all** of the pass criteria.

Please make sure your learners realise that missing just one pass criterion means they will not pass the unit, even if they have successfully met the merit and distinction criteria.

We don't have specific requirements for the format of evidence in this assignment. We've said what format the evidence could take for each task. For example, if we say 'You could include a report on ...', the evidence doesn't have to follow any specific reporting conventions. You can modify the format of the evidence, but you must make sure the format doesn't prevent the learner from accessing the grading criteria.

It's possible that certain formats for evidence can naturally cover several grading criteria and avoid the need for excessive amounts of evidence. For example, a report can be a good way to pull together evidence to meet several grading criteria.

For more guidance on generation and collection of evidence, please refer to the section 8 'Internal Assessment', in the qualification handbook.

Group work

This assignment hasn't been written to include group work. If you plan to ask learners to work in a team to complete work for assessment, you need to determine at which point in an assessment task learners can work together.

You must be sure that each learner can produce evidence of their own contribution to each grading criterion. You can give constructive feedback to learners about working as a group and direct them on team working skills because evidence of team working skills is not required by the unit. See our information on authentication, including group work and feedback to learners, in section 8 of the qualification handbook.

If witness statements are used to support learners' evidence, you'll need to complete an individual statement for each learner.

After completing the assignment

Once the learner has submitted their work to you to be assessed, you must judge or 'mark' the work against the grading criteria for the unit and identify one grade for the unit. For further information about assessment, please refer to section 8 of the qualification handbook.

Your assessment decisions must be quality assured across the cohort of learners in your centre who are being entered for the same unit. This must be done through an internal standardisation process. We give information on internal assessment and standardisation in the qualification handbook.

Reworking the assignment

If you and the learner feel they've not performed at their best during the assessment, the learner can, at your discretion, improve their work and resubmit it to you for assessment. If a learner is working on improving their work before it is resubmitted, you and the learner must continue to make sure the work is the learner's own.

Any feedback you give to the learner must not direct them on how to improve their work. You can identify what area of the work could be improved but you cannot give the learner any details about how they could improve it. You must follow the guidelines given in section 8 of the qualification handbook under 'Authenticity of learner work'.

Modifying the model assignment

The tasks in this assignment allow learners access to the full range of grades detailed in the grading criteria of this unit.

If you modify this assignment you must **not** change the grading criteria provided in the tasks for the learner or in the evidence checklist. These grading criteria are taken from the unit.

You can modify the scenario to suit your local or regional needs and the tasks may be contextualised to match any changes you have made to the scenario.

You can modify the type of evidence and the format it takes, unless we expressly state that evidence must take a specific format.

You must also make sure that you avoid discrimination, bias and stereotyping and support equality and diversity. For more information, please see the section 'Designing your own assignments for internally assessed units' in section 8 of the qualification handbook.

If modifications are made to the model assignment, whether to the scenario alone, or to both the scenario and individual tasks, it's your responsibility to make sure that all grading criteria can still be met and that learners can access the full range of grades.

If you're using this model assignment and delivering the Foundation Diploma, Diploma or Extended Diploma you have an opportunity to secure meaningful employer involvement by working with an employer to modify it.

General information for learners

Q ***What do I need to do to pass this assignment?***

A You need to produce evidence to meet the requirements of **all** the pass criteria for the unit this assignment relates to. If you miss just one pass criterion, you will not achieve this unit and will receive an unclassified result.

Q ***What do I need to do if I want to get a merit or distinction for this assignment?***

A For a merit, you need to produce evidence to meet the requirements of **all** the pass criteria for the unit this assignment relates to **and** you need to produce evidence to meet **all** the merit criteria.

For a distinction, in addition to the above, you also need to meet **all** the distinction criteria for this unit.

Q ***What help will I get?***

A Your tutor will support you when completing this assignment and will make sure that you know what resources or facilities you need and are allowed to use. We've given your tutor information about how much support they can give you.

Q ***What if I don't understand something?***

A It's your responsibility to read the assignment carefully and make sure you understand what you need to do and what you should hand in. If you are not sure, check with your tutor.

Q ***I've been told I must not plagiarise. What does this mean?***

A Plagiarism is when you take someone else's work and pass this off as your own, or if you fail to acknowledge sources properly. This includes information taken from the internet.

It's not just about presenting a whole copied assignment as your own; you will also be plagiarising if you use the ideas or words of others without acknowledgement, and this is why it's important to reference your work correctly (see Q&A below for more information on referencing).

Plagiarism has serious consequences; you could lose the grade for this unit or you may not be allowed to achieve the whole qualification.

Always remember that the work you produce must be your own work. You will be asked to sign a declaration to say that it is.

Q ***What is referencing and where can I find out more information about it?***

A Referencing is the process of acknowledging the work of others. If you use someone else's words and ideas in your assignment, you must acknowledge it, and this is done through referencing.

You should think about why you want to use and reference other people's work. If you need to show your own knowledge or understanding about an aspect of subject content in your assignment, then just quoting and referencing someone else's work will not show that **you** know or understand it. Make sure it's clear in your work how you are using the material you have referenced **to inform** your thoughts, ideas or conclusions.

You can find more information about how to reference in *The OCR Guide to Referencing* available on our website: <http://www.ocr.org.uk/Images/168840-the-ocr-guide-to-referencing>.

Q ***Can I work in a group?***

A Yes. However, if you work in a group at any stage, you must still produce work that shows your individual contribution. Your tutor can advise you how to do this.

Q ***Does my work for each task need to be in a particular format?***

A You can present your work in a variety of ways – it can be handwritten, word-processed, on video or in digital media. What you choose should be appropriate to the task(s) and your tutor can advise you. There may be times when you need proof that you have completed the work yourself: for example, if you do something during work placement that you want to use as evidence, the tutor might ask the employer to provide a witness statement.

Make sure you check the wording in each task carefully. For each task, we'll tell you if your evidence has to be in a specific format:

- If we say use the word '**must**', for example 'You must produce a report' or 'Your evidence/work must include a diagram', then you must produce the work in the stated format.
- If we use the word '**could**', for example 'You could include sketches of your ideas' or 'You could do this by annotating your diagram', this means that you are not required to follow the format we have given, but you must make sure that the work you do produce allows you to demonstrate the requirements of the grading criteria.

If you are unsure about what evidence you need, please ask your tutor.

Q ***Can I ask my tutor for feedback on my work?***

A Yes, but they can't give you detailed feedback.

We have given your tutor instructions on what kind of feedback they can give you. For example, they are **not** allowed to tell you exactly what to do to make your work better, but they **can** remind you about what they've taught you and you can use this additional learning to try and improve your work independently. They can say what they've noticed might be wrong with your work, for example if your work is descriptive where an evaluation is required, but your tutor can't tell you specifically what you need to do to change it from a description to an evaluation – you will need to work out what you need to do and then do it for yourself.

Q ***When I have finished, what do I need to do?***

A If you have included the personal details (such as name, address or date of birth) of someone other than yourself in your work, this must be blanked out (anonymised) – your tutor will tell you how to do this. You don't need to do this for information contained in references.

You can complete the evidence checklist to show your tutor where they can find the evidence for each grading criterion in your work. You should make sure your work is labelled, titled and in the correct order for assessing.

Hand in the work that you've completed for each task to your tutor. They might ask to see your draft work, so please keep your draft work in a safe place.

Q ***How will my work be assessed?***

A Your work will be marked by someone in your centre who has been authorised to do so. They will use the information in the grading criteria to decide which grade your work meets. The grading criteria are detailed in each unit and are also given in the tasks within this assignment. Please ask your tutor if you are unsure what the grading criteria are for this assignment.

Assignment for learners

Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control

Scenario

Investigating automation systems

OCR Automation provides consultancy and advice to a wide range of clients wanting to automate their engineering systems or processes.

The Engineering Manager at OCR Automation has asked you to investigate and report on the application of automation in control systems in order to demonstrate how mechanical, electrical, hydraulic and pneumatic control can be applied. Sectors you could investigate are listed below:

- manufacturing and production e.g. car assembly or food production line
- aircraft, train or passenger vehicle control system e.g. power plant or transmission
- energy and utilities e.g. temperature regulation or climate control.

The report that you produce must consider mechanical and electrical elements (including motor selection), and how hydraulic and pneumatic control can be applied in automated control systems.

The tasks

Task 1: Mechanical elements

(This task should take between 4 and 5 hours.)

Learning Outcome 1: 'Understand mechanical elements of control systems' is assessed in this task.

Your first task is to investigate applications that use mechanical control system elements such as those found in the following:

- manufacturing and production e.g. car assembly or food production line
- aircraft, train or passenger vehicle control system e.g. power plant or transmission
- energy and utilities e.g. temperature regulation or climate control.

You will need to produce a report using suitable examples from your investigations above to:

- explain how mechanical elements of motion (linear, rotary and intermittent/continuous) are used in control systems and
- describe how the different types of mechanisms produce rotary to linear, linear to rotary and intermittent motion.

Your second task is to investigate and report on how equations of motion and dynamic forces relate to moving systems and the importance of balancing rotating masses.

Your third task is to investigate comparisons between power-in against power-out (efficiency) for a system that uses linear and/or rotary motion. You should demonstrate how power loss occurs in a control system due to mechanical friction.

Pass	Merit	Distinction
P1: Explain the application of different types of motion in control systems.	M1: Explain the importance of balancing rotating masses.	D1: Demonstrate how power loss occurs in a specific control system due to mechanical friction.
P2: Describe common mechanisms used in control systems.		
P3: Describe how equations of motion and dynamic forces relate to moving systems.		
Evidence		
Your evidence could be in the form of a written report including outcomes of any practical experiments and calculations undertaken.		

Task 2: Electrical elements

(This task should take between 4 and 5 hours.)

Learning Outcome 2: 'Understand the electrical elements of control systems' is assessed in this task.

Your task is to investigate applications that use electric control system elements such as those found in the following:

- manufacturing and production e.g. car assembly or food production line
- aircraft, train or passenger vehicle control system e.g. power plant or transmission
- energy and utilities e.g. temperature regulation or climate control

You will need to produce a report using suitable examples from your investigations above to:

- explain the role of electrical sensors and actuators in a control system
- describe common types of electrical actuators
- describe a range of electric motor types
- analyse how servo motors and AC motors are controlled
- explain energy losses and reduced efficiency due to friction, resistance of windings, eddy current and hysteresis in electrical actuators
- justify the choice of electric motors used for given output requirements including power, torque, speed and duty cycle.

Pass	Merit	Distinction
P4: Explain the role of electrical sensors and actuators in a control system.	M2: Explain energy losses and reduced efficiency in electrical actuators.	D2: Analyse how servo motors and AC motors can be controlled.
P5: Describe common types of electrical actuators.		
P6: Describe a range of electric motor types.	M3: Justify the selection of an electric motor for given output requirements.	
Evidence		
Your evidence could be in the form of a written report including outcomes of any practical experiments and calculations undertaken.		

Task 3: Hydraulic and pneumatic systems

(This task should take between 5 and 6 hours.)

Learning Outcome 3: 'Understand simple hydraulic systems' and **Learning Outcome 4:** 'Understand simple pneumatic systems' are assessed in this task.

Your task is to investigate applications that use hydraulic and pneumatic system elements such as those found in the following:

- manufacturing and production e.g. car assembly or food production line
- aircraft, train or passenger vehicle control system e.g. power plant or transmission
- energy and utilities e.g. temperature regulation or climate control

You will need to produce a report using suitable examples from your investigations above to:

- describe power sources in both hydraulic and pneumatic systems
- explain how valves and actuators can be applied in both hydraulic and pneumatic systems
- analyse fluid transmission in hydraulic and pneumatic systems
- evaluate the suitability of hydraulic and pneumatic systems for different control systems.

Pass	Merit	Distinction
P7: Describe power sources for hydraulic systems	M4: Analyse fluid transmission in hydraulic systems.	D3: Evaluate the suitability of hydraulic and pneumatic systems for different control systems.
P8: Explain the application of valves and actuators in different hydraulic systems.		
P9: Describe power sources for pneumatic systems.	M5: Analyse fluid transmission in pneumatic systems.	
P10: Explain the application of valves and actuators in different pneumatic systems.		
Evidence		
Your evidence could be in the form of a written report including outcomes of any practical experiments and calculations undertaken.		

Evidence Checklist

OCR Level 3 Cambridge Technicals in Engineering Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control

LEARNER NAME:

For PASS have you: (as a minimum you have to show you can meet every pass criterion to complete the unit)	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Explained the application of different types of motion in control systems. (P1)	
Described common mechanisms used in control systems. (P2)	
Described how equations of motion and dynamic forces relate to moving systems (P3)	
Explained the role of electrical sensors and actuators in a control system. (P4)	
Described common types of electrical actuators. (P5)	
Described a range of electric motor types. (P6)	
Described power sources for hydraulic systems. (P7)	
Explained the application of valves and actuators in different hydraulic systems. (P8)	
Described power sources for pneumatic systems. (P9)	
Explained the application of valves and actuators in different pneumatic systems. (P10)	

For Merit have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Explained the importance of balancing rotating masses. (M1)	
Explained energy losses and reduced efficiency in electrical actuators. (M2)	
Justified the selection of an electric motor for given output requirements. (M3)	
Analysed fluid transmission in hydraulic systems. (M4)	
Analysed fluid transmission in pneumatic systems. (M5)	

For Distinction have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Demonstrated how power loss occurs in a specific control system due to mechanical friction. (D1)	
Analysed how servo motors and AC motors can be controlled. (D2)	
Evaluated the suitability of hydraulic and pneumatic systems for different control systems. (D3)	

To find out more
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Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**



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