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ENGINEERING

Unit 7

Electrical devices

Model assignment

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Contents

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.

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 electrical and electronics engineers would use electrical devices 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. Every learner will need access to the following resources:

- In task 1, for the first part learners will require access to suitable information and data to allow them to investigate the application and function of semi-conductor devices. This should be for a thyristor, metal-oxide field-effect transistor (MOSFET) and insulated gate bipolar transistor (IGBT).
  In the second part, learners will require access to suitable circuits and data to analyse the operation of a single thyristor, MOSFET and IGBT in single device circuits. This could be undertaken as a practical activity or using circuit simulations.

- In task 2, for the first part learners will require access to information and data to explain the application and function of programmable logic devices as indicated in the Unit Specification 1.2.
  For the second task learners will require access to information and data to be able to compare the internal architecture and system configurations (e.g. input ports, output ports, peripheral devices) for the devices indicated in the Unit Specification 1.3.

- In task 3, for the first part learners will require access to suitable information and data to investigate and identify the application and function of electrical sensors that can be used to measure light, temperature, force/pressure, position, speed, flow and sound. Typical examples are given in Unit Specification 2.1.
  In the second part learners will require access to information and data to be able to investigate and explain applications and the function of electrical actuators that provide linear and rotary motion. For linear motion both electric and solenoid-operated actuators should be covered.
  For the final part learners will require access to practical resources to safely perform experiments to evaluate the operation of an electrical sensor and an electrical actuator.

- In task 4, learners will require access to information and data to investigate sensor output types (as shown in Unit Specification 3.1). They will require a sensor interface circuit (i.e. potential divider or bridge) and sensor data to be able to calculate signal voltage scaling using resistors.

  Data will be required so that learners can calculate baud and bit rate for a serial data signal (see Unit Specification 3.3). You should consider providing a range of data to ensure learners can produce their own calculations.

  Information and data will also be required so that learners can evaluate the design of both high-pass and low-pass filters using op-amps.

- In task 5, learners will require access to electrical devices that use smart and modern materials as detailed Unit Specification 4.1. You could make SMA and QTC materials available to learners so these can be investigated practically.

Tutor information to support the tasks

In task 1, for P1, applications and functions of semiconductor devices could be investigated theoretically using online data sheets or through practical experimentation. For D1 analysis of suitable circuits (containing a single thyristor, a single MOSFET and a single IGBT) could be undertaken as a practical activity or using circuit simulations.

In task 2 online data could be used to theoretically investigate programmable logic devices. In the second task for task 2 tutors could introduce system configurations in which programmable devices are used practically (e.g. a washing machine or CNC machine controller).

For task 3 it should be noted that for the third task learners are only required to evaluate practically the operation of one type of electrical sensor and one type of actuator.

For task 4 when supplying data for the calculations required in P6 and P8 you should consider providing a range of data to ensure learners can produce their own calculations. Both sensor interfacing and op-amp filtering could be demonstrated or verified through building practical circuits or using circuit simulation.

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 14–19 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. If you supply your own drawings to support a different scenario, these must be sufficiently detailed for learners to complete the tasks.

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 7: Electronic devices

Scenario

Electrical and electronic devices form crucial parts of electronic systems.

Semiconductor devices are frequently used as switches, with typical applications including electronic switching circuits, power switching and motor speed controllers.

Programmable devices are commonplace in many electrical and electronic systems. This includes domestic appliances, personal electronics, transport systems, retail and commerce applications and industrial automation. There are many other applications.

Sensors and actuators enable electronic circuits to sense the environment around them, and to perform some control over this environment. Almost all electrical and electronic systems will include a range of sensors and actuators.

Sensors and actuators require connecting to an electronic circuit which will either read their output signal (sensors), or control them in some way (actuators). Often, sensors do not provide the correct signal to allow direct connection (or interfacing) to the circuit – and their signal must be altered or conditioned in some way. Other interfacing techniques are used to convert analogue signals so that they may be used with a programmable (digital) device.

Smart and modern materials are now finding their place in a number of everyday applications – including back-lighting in TVs, touch screens on mobile devices and electrically controlled privacy glass. There are even a number of smart and modern materials either react to electrical stimulation or interact to be able to control an electrical signal.

Your tasks for this assignment are to investigate the application and operation of electronic devices.

Task 1: Semiconductor devices

(This task should take between 2 and 3 hours.)

Learning Outcome 1: 'Understand semi-conductor and programmable devices' is assessed in this task. Please see Task 2 for programmable devices.

Your first task is to investigate the applications and functions of the following semi-conductor devices:

- thyristor
- metal-oxide field-effect transistor (MOSFET)
- insulated gate bipolar transistor (IGBT).

Your second task is to analyse the operation of a single thyristor, MOSFET and IGBT in single device circuits. You might perform this analysis using practical circuits or through a simulation. Your tutor will provide you with suitable circuits.

Pass	**Merit**	**Distinction**
P1: Explain applications and functions of semi-conductors.		D1: Analyse the operation of individual circuits containing a single thyristor, a single MOSFET and a single IGBT.
Evidence		
A written technical report or presentation. You could also include evidence in the form of annotated circuit diagrams and/or photographs.		

Task 2: Programmable devices

(This task should take between 3 and 4 hours.)

Learning Outcome 1: 'Understand semi-conductor and programmable devices' is assessed in this task. Please see Task 1 for semi-conductors.

Your first task is to explain the applications and functions of programmable logic devices, including:

- programmable logic array (PLA)
- programmable array logic (PAL)
- field programmable gate array (FPGA)
- static random access memory (SRAM)
- electrically programmable read only memory (EPROM)
- flash memory.

Your second task is to investigate and compare the internal architecture of programmable devices, including system configurations of real circuits using programmable devices including:

- microprocessor
- microcontroller
- programmable interface controller (PIC)
- programmable logic controller (PLC).

Pass	**Merit**	**Distinction**
P2: Explain applications and functions of programmable logic devices.	M1: Compare internal architecture and typical system configurations in programmable devices and systems.	
Evidence		
A written technical report or presentation. You could also include evidence in the form of annotated circuit diagrams and/or photographs.		

Task 3: Sensors and actuators

(This task should take between 3 and 4 hours.)

Learning Outcome 2: 'Understand electrical sensors and actuators' is assessed in this task.

Your first task is to investigate and identify the application and function of electrical sensors that can be used to measure the following:

- light
- temperature
- force/pressure
- position
- speed
- flow
- sound.

Your second task is to investigate and explain the applications and function of electrical actuators that can be used to control:

- linear motion (electric and solenoid operated)
- rotary motion (electric operated).

Your third task is to evaluate the operation of an electrical sensor and an electrical actuator through practical tasks or experiments.

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td>P3: Identify applications and function of electrical sensors used to measure physical properties.</td><td rowspan="2">M2: Evaluate practically the operation of an electrical sensor and an electrical actuator.</td><td rowspan="2"></td></tr>
<tr><td>P4: Explain applications and function of electrical actuators.</td></tr>
<tr><td colspan="3">Evidence</td></tr>
<tr><td colspan="3">A written technical report or presentation. You could also include evidence in the form of annotated diagrams and/or photographs showing the task or experiments you have performed.</td></tr>
</table>

Task 4: Signal conditioning and signal conversion

(This task should take between 3 and 4 hours.)

Learning Outcome 3: 'Understand how to use signal conditioning techniques and signal conversion devices' is assessed in this task.

Your tasks are listed below. You will need to refer to your tutor for details of the sensors, circuits and data needed to complete some of the tasks.

- Investigate and describe types of output signal produced by sensors.
- Using the circuit and data provided by your tutor, calculate the values of resistors required to scale the output signal from the sensor.
- Explain the operation of a serial to parallel and parallel to serial converter.
- Calculate the bit and baud rate for a data signal.
- Analyse the operation of analogue to digital and digital to analogue converters.
- Evaluate how operational amplifiers are used in circuits to achieve high and low-pass filtering.

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td>P5: Describe sensor output signal types.</td><td rowspan="4">M3: Analyse the operation of analogue to digital and digital to analogue conversion devices.</td><td rowspan="4">D2: Evaluate the design of op-amp circuits for a high-pass and low-pass filter.</td></tr>
<tr><td>P6: Calculate the value of resistors in a potential divider or bridge circuit to scale a sensor output voltage signal using sensor calibration data.</td></tr>
<tr><td>P7: Explain the operation of serial to parallel and parallel to serial conversion devices.</td></tr>
<tr><td>P8: Calculate baud and bit rate for a serial data signal.</td></tr>
<tr><td colspan="3">Evidence</td></tr>
<tr><td colspan="3">A written technical report or presentation that must include all calculations.
You could also include evidence in the form of annotated diagrams and/or photographs showing the tasks you have performed.</td></tr>
</table>

Task 5: Smart and modern materials

(This task should take between 3 and 4 hours.)

Learning Outcome 4: 'Understand the application of smart and modern materials in electrical devices' is assessed in this task.

Your first task is to investigate the application of smart and modern materials in electrical devices. You should concentrate on materials that are either electrically stimulated, or that can interact with electrical signals to include:

- Quantum Tunnelling Composite (QTC)
- Shape Memory Alloy (SMA)
- electroluminescent (EL)
- electrochromic
- conductive polymers
- piezoelectric
- electrostrictive
- electroheological (ER) fluids
- thermoelectric
- electro-optic.

Your second task is to explain the operation of Quantum Tunnelling Composite (QTC) and Shape Memory Alloy (SMA) in an electrical device. You could base your explanation on findings from practical experiments.

Pass	**Merit**	**Distinction**
P9: Describe applications of smart and modern materials in electrical devices.	M4: Explain the operation of QTC in an electrical device and SMA in an electrical device.	
Evidence		
A written technical report or presentation. You could also include evidence in the form of annotated diagrams and/or photographs showing outcomes of any experiments.		

Evidence Checklist

OCR Level 3 Cambridge Technicals in Engineering
Unit 7: Electrical devices

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 applications and functions of semi-conductors (P1)	
Explained applications and functions of programmable logic devices (P2)	
Identified applications and function of electrical sensors used to measure physical properties (P3)	
Explained applications and function of electrical actuators (P4)	
Described sensor output signal types (P5)	
Calculated the value of resistors in a potential divider or bridge circuit to scale a sensor output voltage signal using sensor calibration data (P6)	
Explained the operation of serial to parallel and parallel to serial conversion devices (P7)	
Calculated baud and bit rate for a serial data signal (P8)	
Described applications of smart and modern materials in electrical devices (P9)	

For Merit have you:	**Where can your tutor find the evidence? Give page no(s)/digital timings, etc.**
Compared internal architecture and typical system configurations in programmable devices and systems (M1)	
Evaluated practically the operation of an electrical sensor and an electrical actuator (M2)	
Analysed the operation of analogue to digital and digital to analogue conversion devices (M3)	
Explained the operation of QTC in an electrical device and SMA in an electrical device (M4)	

For Distinction have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Analysed the operation of individual circuits containing a single thyristor, a single MOSFET and a single IGBT (D1)	
Evaluated the design of op-amp circuits for a high-pass and low-pass filter (D2)	

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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