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OCR
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Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 5

Electrical and Electronic Design

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 engineers would use electrical and electronic design principles 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:

- For task 1 learners will require access to suitable circuit diagrams and component datasheets in order to complete the task. For P1 and P2, circuits have been included in this assignment which can be used, modified or you can provide your own set of circuit diagrams. For P3, learners could use circuit 1 or you could provide a different circuit diagram or a set of values that enable learners to compare results of adding and subtracting two sinusoidal AC waveforms.
- Task 2, for P7 in addition to circuit 1 you must also provide additional data/datasheet to enable learners to perform individual calculations of primary and secondary values and turns ratio in a transformer.
- Task 3, P9 will require access to data such as schematic diagrams of examples of suitable applications where a system approach has been applied to an electrical design. For example, in an energy efficient working environment a sensor detects movement, which is fed to a controller, to regulate room temperature and lighting. If no movement is detected the room is set to its energy efficient condition (lights off, temperature set to low). At least two examples must be provided that cover the systems approach to electrical design given in 3.1 of the unit content and a range of input and output devices listed in 3.2 and 3.3 of the unit content.
- Task 4 requires access to data sheets and suitable circuits relating to semi-conductor devices in 4.1 of the unit content and integrated circuits in 4.2 of the unit content.
- Task 5 requires access to data, such as block diagrams, which demonstrate the functions of programmable devices in diverse applications, for example an engine control system and a washing machine controller could both use a microcontroller but are diverse in their function.

Tutor information to support the tasks

We have not provided a comprehensive set of circuits for learners to analyse due to the diverse range and application of circuits and electrical and electronic devices.

Circuits 1 and 2 provided in the scenario can be used where indicated in the tasks and further information is provided below to support their use.

Circuit 1 – Regulated Power Supply	• Circuit protection (fuse) • Application of a step-down transformer • Diodes for AC to DC rectification • A semi-conductor device used as a voltage regulator • Smoothing and filtering using capacitors • An LED used as an indicator
Circuit 2 – DC Motor Speed Controller (PWM)	• Application of a semi-conductor device (555 timer) • A RC circuit (charging and discharging of a capacitor with a resistor) • Diodes to allow flow of current in one direction only when charging and discharging the capacitor • A transistor used as a switch • A DC motor along with switch for motor reversal • Circuit provides sources of electromagnetic interference (transformer, motor, transistor switching)

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 10–15 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 do require that evidence **must** take a specific format for some of the tasks in this assignment Task 1. We have made that clear in the tasks. Where we prescribe the format, we state this as 'Your evidence **must** include xxx'. When we do not prescribe the format, we say 'You could include a report on…'. Please look out for this and make sure learners realise that we have prescribed the format for some/all of the tasks. The evidence does not have to follow any specific reporting conventions. You can modify the format of the evidence but you must make sure the format does not 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. When providing your own circuit diagrams and data/data sheets 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 5: Electrical and Electronic Design

Scenario

Investigating electrical and electronic design

Electrical and electronic devices enable a diverse range of circuits to be designed and constructed in order to perform a wide range of functions that can be used in many applications. Some examples of different types of electrical and electronic circuit functions include:

- Power supplies
- Motors and motor speed controllers
- Audio amplifiers and sound effect generators
- Digital logic circuits.

Typical applications include:

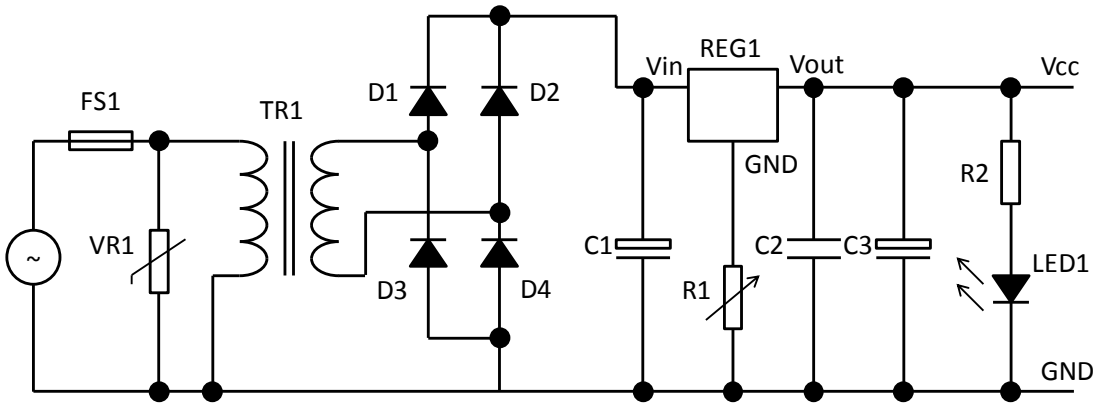
- Hand-held and portable devices (e.g. mobile phone, MP3 player)
- Domestic appliances (e.g. kitchen appliances, entertainment systems)
- Industrial control systems
- Medical applications
- Transportation (e.g. cars, trains, planes).

In this assignment you will need to consider suitable circuits to complete some of the tasks. The tasks will tell you which circuit to use or if your tutor will provide it.

Circuit 1 and circuit 2 below are examples of typical simple electronic circuits. You will need to refer to them when instructed to do so in the tasks.

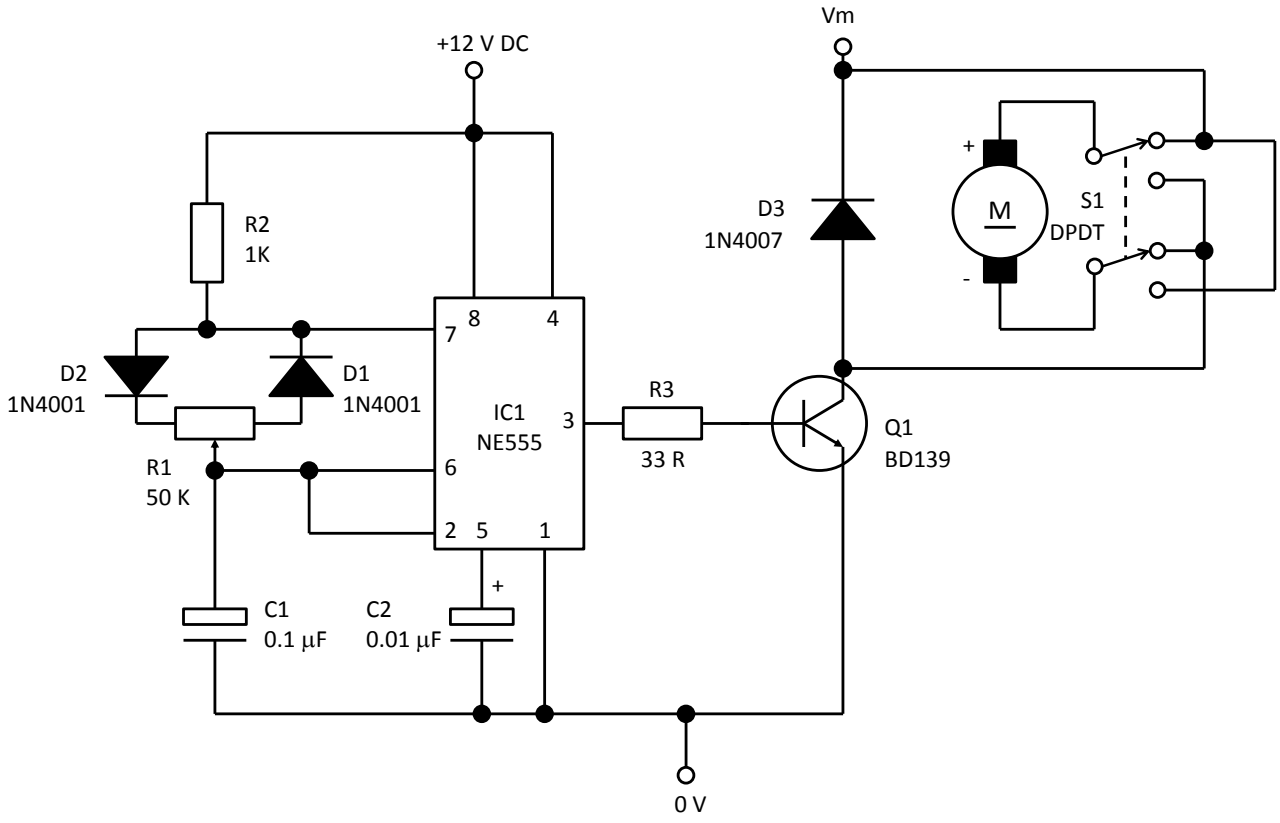
Circuit 1 shows a regulated power supply which converts mains voltage to a regulated 12 V output. It could be used to power the motor speed controller in circuit 2, or to charge a battery. Circuit 2 is a motor speed controller that can be used to control the speed of a DC motor using the principle of pulse width modulation.

Circuit 1: Regulated Power Supply (12 V)



Label	Part number or Value
FS1	2A / 240 V
VR1	275 V diameter 10 mm
TR1	240 V/12 V 5VA
D1 to D4	IN4001
C1	2200 μF / 25 V Electrolytic
C2	0.1 μF / 25 V Ceramic
C3	10 μF / 25 V Electrolytic
R1	4.7 K
R2	1 K
REG1	7812
LED1	L-7113LID

Circuit 2: DC Motor Speed Controller (Pulse Width Modulation – PWM)



Task 1: Using AC and DC circuit theory

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

Learning Outcome 1: 'Be able to apply AC and DC circuit theory to circuit design', is assessed in this task.

Your task is use DC circuit theory including Kirchhoff's law to determine the relationship between current, voltage and resistance in DC networks including the charge and discharge of a capacitor - you can use circuit 1 and/or 2 given in the scenario or your tutor may provide you with alternative circuit diagram(s).

You will use AC circuit theory to make comparisons of sinusoidal AC waveforms both graphically and by phasor diagram. Your tutor will provide you with either a circuit diagram or set of values to do this. You will also need to explain the significance of power factor, the application and operation of passive filters in AC circuits.

You will use relevant circuit theory to explain power sources for both AC and DC circuits including their applications and features. You should also look at methods of circuit protection for both AC and DC applications making comparisons as to why you would choose a specific method of circuit protection over another in different power supply applications.

You should now apply your AC and DC circuit theory to design **your own** power supply circuit that includes:

- a transformer
- a rectifier
- smoothing capacitors
- a voltage regulator
- circuit protection.

Pass	Merit	Distinction
P1: use DC circuit theory to calculate current, voltage and resistance in DC networks	M1: use Kirchhoff's laws to determine the current in a network.	D1: design a power supply circuit that includes a transformer, rectifier, smoothing capacitors, voltage regulator and circuit protection.
P2: determine the relationship between the voltage and current for a charging and discharging capacitor.	M2: explain the application and operation of low-pass and high-pass filters.	
P3: compare the results of adding and subtracting two sinusoidal AC waveforms graphically and by phasor diagram.		
P4: explain the significance of power factor in AC circuits.		
P5: explain different power sources and their applications and features.		
P6: compare methods of circuit protection for different applications.		

Evidence

You must show clearly how you have used AC and DC theory to analyse and design circuits that meet the grading criteria. This could be in the form of annotated circuit diagrams along with written explanations of power factor, passive filters, power sources and methods of circuit protection.

Your evidence **must** include:

- your mathematical calculations of electrical values
- graphical diagram(s) showing waveforms and phasor diagram(s).

Your evidence should include:

- an annotated copy of your own power supply circuit design.

Task 2: Electromagnetism

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

Learning Outcome 2: 'Understand the application of electromagnetism in electrical design', is assessed in this task.

Your task is to calculate primary and secondary current, voltage ratio and turns ratio in a transformer. You can use circuit 1 as a starting point but you must also perform your **own** calculations - your tutor will provide you with the data to do this.

You will investigate electromagnetic capability and the reasons for magnetic screening when designing electrical circuits.

You will investigate the performance of a DC generator with reference to field winding configurations (series and shunt) and an AC motor single and three-phase arrangement.

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td>P7: calculate primary and secondary current, voltage ratio and turns ratio in a transformer.</td><td>M3: explain electromagnetic compatibility (EMC).</td><td rowspan="2">D2: evaluate the performance of a motor and a generator with reference to electrical theory.</td></tr>
<tr><td>P8: explain the reasons for magnetic screening in electrical design and how it can be achieved.</td><td></td></tr>
<tr><td colspan="3">Evidence</td></tr>
<tr><td colspan="3">You must show how you have used relevant theory of electromagnetism to meet the requirements of the grading criteria. This could be in the form of annotated circuit diagrams along with written explanations of electromagnetic capability and the reasons for magnetic screening in electrical circuit design and a written evaluation of motor and generator performance.
Your evidence must include:
• your mathematical calculations of primary and secondary current, voltage and turns ratio.</td></tr>
</table>

Task 3: A systems approach

(This task should take between 1 and 2 hours.)

Learning Outcome 3: 'Be able to apply a systems approach to electrical design', is assessed in this task.

Your task is to investigate different examples of electrical and electronic applications which use a systems approach to electrical and electronic design and the function, application and operation of a range of input and output devices in these examples. Your tutor will provide you with examples for you to investigate.

Pass	**Merit**	**Distinction**
P9: explain with examples the systems approach to electrical and electronic design.		
P10: explain applications, function and operation of a range of input and a range of output devices.		
Evidence		
You must show clearly how a systems approach can be used in electrical and electronic design to meet the grading criteria. This could be in the form of labelled and annotated block diagrams to explain the systems approach to electrical and electronic design and a written explanation of the function, application and operation of a range of input and output devices.		

Task 4: Using semi-conductors

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

Learning Outcome 4: 'Be able to use semi-conductors in electrical and electronic design', is assessed in this task.

Your task is to investigate the function and application of semi-conductor process devices and integrated circuits in electrical and electronic circuits. Your tutor will provide you with examples for you to investigate.

Pass	**Merit**	**Distinction**
P11: explain the function and application of semi-conductor process devices and integrated circuits in circuit design	M4: analyse the operation of a diode and a single NPN transistor amplifier within a circuit	D3: analyse the operation of individual circuits containing a single op-amp, single flip-flop and combinational logic functions.
Evidence		
You must show clearly how the function and application of semi-conductor devices and integrated circuits are used in circuit design to meet the grading criteria. This could be in the form of labelled and annotated circuit diagrams to explain the function and application of semi-conductor process devices and integrated circuits in circuit design together with a written analysis of the operation of a diode and a single NPN transistor amplifier within a circuit of individual circuits and the operation of individual circuits containing a single op-amp, single flip-flop and combinational logic functions.		

Task 5: Programmable devices

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

Learning Outcome 5: 'Understand the application of programmable process devices in electronic design', is assessed in this task.

Your task is to investigate applications that use programmable devices. You should consider the function and layout of diverse (different) applications which use programmable devices. Your tutor will provide you with applications for you to investigate.

Pass	**Merit**	**Distinction**
P12: explain the function and layout of diverse applications which use programmable devices.	M5: analyse the operation of diverse applications which use programmable devices.	
Evidence		
You must show clearly how programmable devices are used in diverse applications to meet the grading criteria. This could be in the form of annotated diagrams explaining the layout and function of programmable devices in diverse (different) applications and a written analysis of their operation in diverse (different) applications.		

Evidence Checklist

OCR Level 3 Cambridge Technicals in Engineering
Unit 5: Electrical and Electronic Design

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.
Used DC circuit theory to calculate current, voltage and resistance in DC networks. (P1)	
Determined the relationship between the voltage and current for a charging and discharging capacitor. (P2)	
Compared the results of adding and subtracting two sinusoidal AC waveforms graphically and by phasor diagram. (P3)	
Explained the significance of power factor in AC circuits. (P4)	
Explained different power sources and their applications and features. (P5)	
Compared methods of circuit protection for different applications. (P6)	
Calculated primary and secondary current, voltage ratio and turns ratio in a transformer. (P7)	
Explained the reasons for magnetic screening in electrical design and how it can be achieved. (P8)	
Explained with examples the systems approach to electrical and electronic design. (P9)	
Explained applications, function and operation of a range of input and a range of output devices. (P10)	
Explained the function and application of semi-conductor process devices and integrated circuits in circuit design. (P11)	
Explained the function and layout of diverse applications which use programmable devices. (P12)	

For Merit have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Used Kirchhoff's laws to determine the current in a network. (M1)	
Explained the application and operation of low-pass and high-pass filters. (M2)	
Explained electromagnetic compatibility (EMC). (M3)	
Analyse the operation of a diode and a single NPN transistor amplifier within a circuit (M4)	
Analysed the operation of diverse applications which use programmable devices. (M5)	

For Distinction have you:	Where can your tutor find the evidence? Give page no(s)/digital timings, etc.
Designed a power supply circuit that includes a transformer, rectifier, smoothing capacitors, voltage regulator and circuit protection. (D1)	
Evaluated the performance of a motor and a generator with reference to electrical theory. (D2)	
Analysed the operation of individual circuits containing a single op-amp, single flip-flop and combinational logic functions. (D3)	

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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