OCR LEVEL 3
CAMBRIDGE TECHNICALS
IN ENGINEERING
UNIT 6
D/506/7272
GUIDED LEARNING HOURS: 60
CIRCUIT SIMULATION AND MANUFACTURE
UNIT
VERSION 2
LEVEL 3

UNIT 6: CIRCUIT SIMULATION AND MANUFACTURE

D/506/7272

Guided learning hours: 60

Essential resources required for this unit: circuit schematic design and simulation software, PCB design software, PCB manufacturing facilities, PCB/circuit construction tools (see specification), electrical/electronic components, suitable PPE, physical test equipment (assessment guidance)

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

For electrical and electronic devices to function, they depend on their circuits operating normally. Circuit simulation and safe, effective manufacture of circuit boards is therefore a key function within electrical engineering companies.

The aim of this unit is for learners to develop the ability to make working printed circuit boards (PCBs).

Learners will develop the ability to use computer aided design (CAD) software to design and simulate electronic circuits, and then to design PCBs. They will go on to be able to safely manufacture and construct PCBs.

Learners will also develop their fault-finding techniques for PCBs, to test and rectify, where possible, faults on circuits. They will also gain knowledge on the commercial manufacture of circuits, including manufacturing process methods and quality assurance techniques.
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, though 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 they must enable them to access the full range of grades as described in the grading criteria.

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>Teaching content</th>
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</thead>
<tbody>
<tr>
<td><strong>The Learner will:</strong></td>
<td><strong>Learners must be taught:</strong></td>
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</tbody>
</table>
| 1. Be able to use Computer Aided Design (CAD) for circuit design and simulation | 1.1 circuit schematic diagram drawing using CAD software i.e.  
  - schematic capture / schematic design  
  - component library  
  - connection or interconnection  
  - grid  
  1.2 circuit simulation and test using CAD software i.e.  
  - design checking, design rule checking  
  - SPICE (Simulation Program with Integrated Circuit Emphasis)  
  - setting and adjusting component parameters  
  - netlist/node list  
  - circuit analysis using virtual instruments |
| 2. Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs) | 2.1 printed circuit board (PCB) layout production to include both track and component views i.e.  
  - parts and component libraries  
  - manual component placement  
  - automatic component placement  
  - manual and automatic routing of PCB tracks  
  - correct track and pad sizing  
  - requirements for double-sided or multiple circuit boards (e.g. mother and daughter boards)  
  - design constraints (e.g. size of PCB)  
  - incorporation of test points or test indicators  
  - inclusion of mounting holes  
  - inclusion of component and pin identification (e.g. labels, pin 1 identification)  
  - export files (e.g. Gerber, DXF, IDF, csv, txt)  
  - bill of material (BOM) production |
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| 3. Be able to manufacture and construct electronic circuits safely | 3.1 safe manufacture of PCBs (e.g. photoresist methods, etch resist methods, engraving)  
3.2 circuit construction following circuit diagram(s)  
3.3 safe circuit construction using appropriate methods (e.g. component assembly, PCB soldering techniques, use of appropriate hand tools, heat sinks for delicate components)  
3.4 correct order for circuit construction (e.g. use of integrated circuit holders through the placement of heat sensitive components)  
3.5 connecting between boards and final assembly techniques (e.g. ribbon cable, connecting plugs and sockets, PCB to case fittings, sleeves, insulation, heat shrink, screw terminals) |
| 4. Be able to test and perform fault-finding on electronic circuits | 4.1 visual inspection techniques for testing electronic circuits i.e.  
- fitting of incorrect components  
- mis-placed components  
- dry joints  
- bridged or damaged PCB tracks  
4.2 appropriate testing and fault-finding techniques, (e.g. continuity testing, test-point voltage, current measurement, signal tracing (e.g. half-split, input to output, output to input))  
4.3 use of physical test equipment, (e.g. power supplies, multi-meter, logic probe, oscilloscope, signal generator)  
4.4 techniques for design verification through comparison with simulation data  
4.5 fault rectification |
| 5. Understand commercial circuit manufacture | 5.1 application of discrete, through hole and surface mount component types  
5.2 benefits and drawbacks to the manufacturer of using surface mount components and using alternatives  
5.3 applications and reasons for using multiple layer PCBs  
5.4 manufacturing processes used within commercial circuit construction, i.e.  
- flow solder process  
- pick and place robot  
- manual component placement  
5.5 quality assurance methods used during commercial printed circuit board (PCB) production, i.e.  
- automatic test  
- visual inspection |
## GRADING CRITERIA

<table>
<thead>
<tr>
<th>LO</th>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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<tbody>
<tr>
<td></td>
<td>The assessment criteria are the Pass requirements for this unit.</td>
<td>To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:</td>
<td>To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:</td>
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<tr>
<td>1.</td>
<td>Be able to use Computer Aided Design (CAD) for circuit design and simulation</td>
<td>P1: Produce circuit schematic diagram drawings using CAD software.</td>
<td>M1: Perform circuit analysis including the use of virtual instrumentation.</td>
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<td>P2: Carry out circuit simulation using CAD software. <em>Synoptic link to Unit 4 Principles of electrical and electronic engineering</em></td>
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<td>D1: Evaluate circuit operation and associated printed circuit board layout using CAD software, implementing appropriate design modifications.</td>
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<td>2.</td>
<td>Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)</td>
<td>P3: Produce PCB layouts using CAD software to include track and component views.</td>
<td>M2: Analyse functionality of printed circuit board layout using CAD software.</td>
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<td>3.</td>
<td>Be able to manufacture and construct electronic circuits safely</td>
<td>P4: Interpret circuit diagram to construct printed circuit board.</td>
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<td>P5: Safely manufacture a printed circuit board using appropriate techniques.</td>
<td>D2: Safely manufacture, test and verify a fully working electronic circuit, to include identification and rectification of faults, using a variety of construction methods.</td>
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<td>P6: Safely assemble components to printed circuit board. <em>Synoptic link to Unit 2 Science for engineering</em></td>
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<td>4. Be able to test and perform fault-finding on electronic circuits</td>
<td>P7: Perform testing of an electronic circuit using a multimeter. *Synoptic link to Unit 4 Principles of electrical and electronic engineering</td>
<td>M3: Undertake testing of the operation of an electronic circuit using different physical test equipment and fault finding techniques.</td>
<td>D2: Safely manufacture, test and verify a fully working electronic circuit, to include identification and rectification of faults, using a variety of construction methods.</td>
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<td>5. Understand commercial circuit manufacture</td>
<td>P8: Identify applications of different component types used in commercial circuit construction.</td>
<td>M4: Compare manufacturing processes and quality assurance methods used in commercial circuit construction.</td>
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<td>P9: Explain the benefits and drawbacks to manufacturers of using surface mount components and alternatives.</td>
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<td>P10: Explain the use of multiple layer PCBs in commercial circuit manufacture.</td>
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*SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS*

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

**ASSESSMENT GUIDANCE**

**LO1:** Be able to use Computer Aided Design (CAD) for circuit design and simulation  
Learners should be able to use suitable circuit schematic design and simulation software to produce schematic circuit diagrams, perform circuit analysis and analyse circuit operation. Evidence might include circuit schematic drawings and outcomes of circuit simulation.

**LO2:** Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)  
Learners should be able to suitable software to produce PCB layouts, and to analyse functionality. Evidence might include finished PCB layouts including evidence of the evaluation of functionality.

**LO3:** Be able to manufacture and construct electronic circuits safely  
Learners should be able to manufacture printed circuit boards, and safely assemble components to the PCB using appropriate techniques. Evidence might include a documentary record of circuit construction (e.g. log book), which could include photographs.

**LO4:** Be able to test and perform fault-finding on electronic circuits  
Learners should be able to use appropriate tools and techniques to test the operation of an electronic circuit. Evidence might include a record of tests performed and readings taken.

**LO5:** Understand commercial circuit manufacture  
Learners might use appropriate sources of information to investigate commercial circuit manufacture. Evidence might be in the form of a technical summary.
MEANINGFUL EMPLOYER INVOLVEMENT - a requirement for the Foundation Diploma and 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 of the mandatory units (this unit is a mandatory unit in the Electrical and Electronic Engineering pathway), although we encourage you to find ways to engage with employers for other units as well.

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.

<table>
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<tr>
<th>Meaningful employer engagement</th>
<th>Suggestion/ideas for centres when delivering this unit</th>
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<tr>
<td>1. Learners undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification.</td>
<td>Placements with working with engineering electrical/electronic design departments of businesses involved in circuit manufacture, researching the CAD software used, and system standards used to check conformity of manufacture.</td>
</tr>
<tr>
<td>2. Learners undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).</td>
<td>Task set to use CAD to design and simulate electrical circuits using industry standard equipment and standards, to determine if the design of the circuit is suitable for a given application.</td>
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<tr>
<td>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.</td>
<td>Lecture from practicing electrical/electronic design engineers involved in product circuit design, development and commercial testing. Content to include examples of electrical/electronic CAD simulation methods (e.g. SPICE) and the processes involved in commercial circuit manufacture, including testing.</td>
</tr>
<tr>
<td>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.</td>
<td>Review by practicing electrical engineers relating to the accuracy of learners’ PCB designs, and/or a review of the manufactured circuit with relation to the design produced and its fitness for purpose.</td>
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A quick guide to explain when and how the Cambridge Technicals Resources could be used

CPD
Advice and Guidance on Specification/Qualification including:
- face to face events
- online training available from Professional development site (whenever needed)

Admin Tools (AT)
- Rules of Combination Calculator (ROCC)
- Progress Tracker

Teaching Support Tools (TST)
- Delivery Guide
- Project Approach to Delivery
- Resources Links
- Skills Guides

Classroom Tools (CT)
- Lesson Element
- Skills Guides

Excel tool to ensure the correct units are selected for the learners, including any barred combinations.

Set up the Progress Tracker (AT)
Excel tool to record learners’ names and ensure the correct units are selected for the learners, ready to start recording their progress.

Update the Progress Tracker (AT)
Record the teacher’s grade per Learning Outcome as the learners progress through their units. Overall grade is automatically calculated. OCR Moderators must confirmed the learners' grade following moderation.

In the classroom (CT)
Lesson Elements are identified to a specific unit and offer activities which help the learners to understand various concepts or build on their existing knowledge. Lesson Elements are in two parts; Teacher Instructions/answers and Learner Task sheet. Most Lesson Elements are pdf and printable, some are on-screen interactive as well.

Skills Guides can help review/refresh skills in a variety of topics areas. There are a number of topics covered including, Managing Projects, Research, Presentation Skills. Go to: www.ocr.org.uk/i-want-to/skills-guides/

Further information:
To see examples of these resources for Cambridge Technicals go to: www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3/
To see the Professional Development website, go to: www.ocr.org.uk/i-want-to/professional-development/

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If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: www.ocr.org.uk/expression-of-interest
Contact us

Staff at the OCR Customer Contact Centre are available to take your call between 8am and 5.30pm, Monday to Friday.

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