National 5 Course Specification

National 5 Practical Electronics

Course code:	C860 75
Course assessment code:	X860 75
SCQF:	level 5 (24 SCQF credit points)
Valid from:	session 2017–18

The course specification provides detailed information about the course and course assessment to ensure consistent and transparent assessment year on year. It describes the structure of the course and the course assessment in terms of the skills, knowledge and understanding that are assessed.

This document is for teachers and lecturers and contains all the mandatory information you need to deliver the course.

This edition: April 2017, version 1.0

Contents

Course overview **1**

Course rationale 2

Purpose and aims 2

Who is this course for? 3

Course content **4**

Skills, knowledge and understanding 4

Skills for learning, skills for life and skills for work 8

Course assessment **9**

Course assessment structure: question paper 9

Course assessment structure: practical activity 11

Grading 16

Equality and inclusion **17**

Further information **18**

Course overview

The course consists of 24 SCQF credit points which includes time for preparation for course assessment. The notional length of time for a candidate to complete the course is 160 hours.

The course assessment has two components.

Component	Marks	Scaled mark	Duration
Component 1: question paper	60	30	1 hour
Component 2: practical activity	70	n/a	See course assessment section

Recommended entry	Progression
Entry to this course is at the discretion of the centre. Candidates should have achieved the fourth curriculum level or the National 4 Practical Electronics course or National 4 Engineering Science course or equivalent qualifications and/or experience prior to starting this course.	♦ other qualifications ♦ further study, employment and/or training

Conditions of award

The grade awarded is based on the total marks achieved across all course assessment components.

Course rationale

National Courses reflect Curriculum for Excellence values, purposes and principles. They offer flexibility, provide more time for learning, more focus on skills and applying learning, and scope for personalisation and choice.

Every course provides opportunities for candidates to develop breadth, challenge and application. The focus and balance of assessment is tailored to each subject area.

Electronics brings together elements of technology, science and mathematics and applies these to real-world challenges. The course provides progression from experiences and outcomes in craft, design, engineering and graphics, and in science. It provides a solid foundation for those considering further study or a career in electronics, electrical engineering and related disciplines. The course also provides a valuable complementary practical experience for those studying engineering science, physics or other science courses.

The electronics industry is vital to everyday life in our society and plays a major role in the economy. It contributes not only to manufacturing, but to other sectors such as finance, telecommunications, material processing, oil extraction, weather forecasting and renewable energy. Within all of these sectors, a wide range of job opportunities are available for people with skills in electronics.

The National 5 Practical Electronics course provides a broad practical introduction to electronics. The course encourages candidates to become responsible and creative in their use of technologies and to develop attributes such as flexibility, enthusiasm, perseverance, reliability and confidence.

Purpose and aims

The aims of the course are for candidates to develop:

- knowledge and understanding of key concepts in electronics and apply these in a range of contexts
- a range of practical skills in electronics, including skills in analysis and problem-solving, design skills, skills in the safe use of tools and equipment, and skills in evaluating products and systems
- awareness of the importance of safe working practices in electronics
- an understanding of the role and impact of electronics in changing and influencing society and the environment

The course is mainly practical in nature. The aims of the course are developed through practical projects and investigative tasks in a range of contexts.

Who is this course for?

The course provides sufficient breadth, flexibility and challenge to meet the needs of all learners. It is particularly beneficial for those considering a career or further study in electronics, electrical engineering, physics, and related disciplines.

The course has a skills-based approach to learning. It takes account of the needs of all learners and provides sufficient flexibility to enable learners to achieve in different ways.

Course content

The National 5 Practical Electronics course has three areas of study.

Circuit design
In this area, candidates develop an understanding of key electrical concepts and electronic components. Candidates analyse electronic problems, design solutions to these problems and explore issues relating to electronics.

Circuit simulation
In this area, candidates use simulation software to assist in the design, construction and testing of circuits and systems and to investigate their behaviour.

Circuit construction
In this area, candidates gain experience in assembling a range of electronic circuits, using permanent and non-permanent methods. They develop skills in practical wiring and assembly techniques, carrying out testing and evaluating functionality.

Skills, knowledge and understanding

Skills, knowledge and understanding for the course

The following provides a broad overview of the subject skills, knowledge and understanding developed in the course:

- awareness of safe working practices in electronics
- analysing electronic problems and designing solutions to these problems
- simulating, testing and evaluating solutions to electronic problems
- skills in using a range of test equipment
- constructing electronic circuits using permanent (soldering) and non-permanent methods
- knowledge and understanding of the systems approach to electronics, including sub-systems
- knowledge and understanding of the use of concepts and principles associated with a range of electronic and electromagnetic components and circuits
- knowledge and understanding of combinational logic
- understanding of key electrical concepts — current, voltage, resistance, power, analogue/digital, capacitance, magnetic effect of current
- applying electronic knowledge and skills in a range of contexts

Skills, knowledge and understanding for the course assessment

The following provides details of skills, knowledge and understanding sampled in the course assessment:

Content and concepts
Use appropriate SI units, scientific notation and the prefixes pico (p), nano (n). micro (μ), milli (m), kilo (k), and mega (M). Use appropriate relationships to determine voltage, current, resistance or power for a resistor network supplied by a d.c. source. The network should contain a maximum of three resistors. $V = IR$ $R_T = R_1 + R_2 + ...$ $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ $P = IV$ or $P = I^2R$ or $P = \frac{V^2}{R}$ Use appropriate relationships to determine voltage or resistance in a voltage divider circuit. (eg calculate the switch over voltage of an op-amp used in comparator mode). $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ $V_2 = \frac{R_2}{R_1 + R_2} \times V_S$ From an oscilloscope trace of a sinusoidal or square wave determine the peak voltage and the period and frequency of the signal, given the Y-gain and time base settings. $f = \frac{1}{T}$ Identify an oscilloscope trace/signal as either analogue or digital. Describe the effect on the timing of the output waveform of changing the capacitance of a capacitor in a given circuit. State that when a current flows in a conductor there is a magnetic field in the region surrounding the conductor. State that the magnetic field can be made stronger by coiling the conductor. Describe the operation of electromechanical devices.

Circuit simulation and design
Explain the benefits of electronic circuit simulation prior to circuit construction. Identify two input logic gates from symbols. Identify two input logic gates from truth tables. Complete the truth table for an identified two input logic gate. Determine the output and intermediate logic levels of a combinational logic circuit consisting of a maximum of four inputs and a maximum of two outputs. Given a printout of a simulated circuit, identify potential faults, eg incorrect supply voltage, incorrect resistor values or wrong component orientation (test points to be included). Given a layout diagram of a circuit, identify potential faults, eg incorrect supply voltage, incorrect resistor values or wrong component orientation. Compile a pre-power up checklist for a given simulation printout, layout diagram or circuit diagram. Describe the operation of a number of simple circuits: a transistor analogue switching circuit, bi-stable switching circuit, half-adder circuit, 741 comparator. Using a block diagram, design a circuit to solve a given problem. Identify the input, process and output stages of a given circuit. Given circuit diagrams, complete IC pin-out diagrams and circuit layout diagrams. Given circuit layout diagrams, produce circuit diagrams. Determine costs of constructing circuits given component codes and component costs.

Circuit construction
Convert resistance values stated in ohms, kiloohms and megaohms into the notation used in BS1852 notation or R notation, eg 270R, 27K, 5K8, 2M7. Determine the resistance of a resistor and the tolerance in this value, given its colour code (using the convention of three colours + tolerance colour). Calculate the maximum and minimum resistances of a given resistor with a specified tolerance. Given a circuit specification and an incomplete circuit diagram, identify any missing key components and complete circuit diagrams.

Circuit construction
Identify and draw the circuit symbols for, and describe the function of, the following components (using American National Standards Institute (ANSI) and International Electrotechnical Commission (IEC) symbols): ♦ power supplies ♦ resistors (fixed, variable, LDR and thermistor) ♦ diodes ♦ capacitors (electrolytic and non-electrolytic) ♦ transistors (bipolar and n-channel enhancement MOSFET) ♦ input/output devices (switch, relay, motor, buzzer, lamp, LED, solenoid and speaker) ♦ connectors and wires ♦ fuses ♦ logic gates (AND, OR, NOT, NOR, XOR and NAND) ♦ ICs (logic gates, 7400 series or equivalent, 555 timer) ♦ op-amp circuits (741 op-amp comparator mode only) ♦ voltmeter and ammeter Select appropriate scale and range on a multimeter for measuring voltage, resistance and current. Describe the use of a logic probe and continuity tester in circuit testing. State at least two safety measures to be taken when soldering. Describe the uses of prototype board, stripboard and pcb in electronic design and construction. Describe uses for each of the following cable types: multi-strand, ribbon, co-axial or fibre-optic. State an advantage of colour coding or numbering bundled wiring. Give examples of where either colour coding or numbering is used.

Skills, knowledge and understanding included in the course are appropriate to the SCQF level of the course. The SCQF level descriptors give further information on characteristics and expected performance at each SCQF level (www.scqf.org.uk).

Skills for learning, skills for life and skills for work

This course helps candidates to develop broad, generic skills. These skills are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and draw from the following main skills areas:

2 Numeracy

2.3 Information handling

4 Employability, enterprise and citizenship

4.2 Information and communication technology (ICT)

5 Thinking skills

5.3 Applying
5.4 Analysing and evaluating

These skills must be built into the course where there are appropriate opportunities and the level should be appropriate to the level of the course.

Further information on building in skills for learning, skills for life and skills for work is given in the course support notes.

Course assessment

Course assessment is based on the information provided in this document.

The course assessment meets the key purposes and aims of the course by addressing:

- breadth — drawing on knowledge and skills from across the course
- challenge — requiring greater depth or extension of knowledge and/or skills
- application — requiring application of knowledge and/or skills in practical or theoretical contexts as appropriate

This enables candidates to:

- apply breadth and depth of skills, knowledge and understanding from across the course to answer questions in electronics
- show that they can apply the knowledge and skills developed through the course by taking part in a practical activity which requires them to solve an appropriately challenging practical electronics problem

The course assessment has two components: a question paper and a practical activity. The relationship between these two components is complementary, to ensure full coverage of the knowledge and skills of the course.

Course assessment structure: question paper

Question paper 60 marks

The purpose of the question paper is to assess breadth, challenge and application of skills, knowledge and understanding from across the course.

The question paper also assesses inquiry skills and analytical thinking skills.

The question paper gives candidates the opportunity to demonstrate the following skills, knowledge and understanding by:

- making accurate statements
- describing information, providing explanations and integrating knowledge
- applying knowledge of electronics to new situations, interpreting information and solving problems
- selecting information
- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions based on evidence/information

The question paper has a total of 60 marks. This is scaled to 30 marks and is worth 30% of the overall marks for course assessment.

The question paper contains restricted and extended response questions.

The majority of marks are awarded for demonstrating and applying knowledge and understanding. The other marks are awarded for applying inquiry and analytical thinking skills.

A question paper insert containing relevant data and formulae is provided.

Setting, conducting and marking the question paper

The question paper is set and marked by SQA, and conducted in centres under conditions specified for external examinations by SQA. The question paper is 1 hour in duration.

Specimen question papers for National 5 courses are published on SQA's website. These illustrate the standard, structure and requirements of the question papers candidates sit. The specimen papers also include marking instructions.

Course assessment structure: practical activity

Practical activity 70 marks

The practical activity assesses candidates' ability to apply electronic knowledge and skills to solve an appropriately challenging practical problem, and is designed to allow candidates to demonstrate their ability to work independently.

This component allows assessment of skills which cannot be assessed through the question paper, for example circuit simulation, construction and testing.

Practical activity overview

The practical activity gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- analysing a problem
- designing an electronic solution to the problem
- simulating a solution to the problem
- constructing a solution to the problem
- applying safe working practices
- testing the solution
- reporting and evaluating on the solution

The practical activity has 70 marks and is worth 70% of the overall marks for course assessment.

The practical activity enables clear demonstration of the application of knowledge and skills from across the course.

Guidelines for the practical activity include questions/tasks/prompts which lead candidates through the task in clear stages.

Marks are awarded for:

- analysis and design
- simulating a solution
- construction using safe working practices
- testing the solution
- reporting and evaluating on the solution

Evidence must include:

- the completed solution
- a record of progress through the activity (such as an informal log or blog produced by the candidate)
- a short report on the testing of the solution (in written, electronic or oral form)

Setting, conducting and marking the practical activity

Setting

The practical activity is:

- set by SQA; a bank of practical activities is provided, and there is choice from this bank
- set at a time appropriate to the candidate's needs
- conducted under some supervision and control

Conducting

The practical activity is:

- an individually produced piece of work from each candidate
- started at an appropriate point in the course
- conducted under some supervision and control

Full instructions for candidates are contained within each task.

The practical activity is carried out under open-book conditions, but supervised to ensure that the work presented is the candidate's own.

Marking

The practical activity has a total of 70 marks.

Marks are awarded for:

♦ analysis and design	7 marks
♦ designing and simulating a solution	7 marks
♦ construction using safe working practices	44 marks
♦ testing the solution	7 marks
♦ reporting on the solution	5 marks

Evidence is internally marked by centre staff in line with SQA's marking instructions. Marking instructions are contained within the practical activity assessment task.

The assessor may give candidates support and guidance to help them progress through each stage of the activity. Where any significant amount of support is provided, this should be reflected in the marks awarded.

The practical activity is designed to discriminate between candidates and therefore is expected to provide a wide range of marks. Stronger candidates should be able to complete the activity successfully with minimal support and guidance. Weaker candidates may not be able to complete all aspects of the activity within a reasonable time, or may require significant assistance, and so would achieve a lower mark.

Once the activity has been completed and assessed, it must not be returned to the candidate for further work to improve their mark.

All marking is quality assured by SQA.

Assessment conditions

Controlled assessment is designed to:

- ensure that all candidates spend approximately the same amount of time on their practical activities
- prevent third parties from providing inappropriate levels of guidance and input
- mitigate concerns about plagiarism and improve the reliability and validity of SQA awards
- allow centres a reasonable degree of freedom and control
- allow candidates to produce an original piece of work

Time

The practical activity is assessed in a single assessment event. Candidates should be assessed at an appropriate point, normally when they have completed most of the work in the course.

Time is required for:

- preparation for the practical activity, which could include considering exemplars and practising required skills
- carrying out the stages of the practical activity, with assessor guidance and support
- assessing the process and completed solution

Supervision, control and authentication

There are two levels of control.

Under a high degree of supervision and control	Under some supervision and control
♦ the use of resources is tightly prescribed ♦ all candidates are within direct sight of the supervisor throughout the session(s) ♦ display materials which might provide assistance are removed or covered ♦ there is no access to e-mail, the internet or mobile phones ♦ candidates complete their work independently ♦ interaction with other candidates does not occur ♦ no assistance of any description is provided	♦ candidates do not need to be directly supervised at all times ♦ the use of resources, including the internet, is not tightly prescribed ♦ the work an individual candidate submits for assessment is their own ♦ teachers/lecturers can provide reasonable assistance

The practical activity is conducted under some supervision and control.

Assessors must exercise their professional responsibility in ensuring that evidence submitted by a candidate is the candidate's own work.

Assessors should put in place processes to authenticate evidence, ensuring that the work is the candidate's own. For example:

- regular checkpoint/progress meetings with candidates
- short spot-check personal interviews
- checklists which record activity/progress
- photographs, film or audio evidence

Resources

As this is an open-book assessment, there are no restrictions on the resources that candidates may have access to.

Reasonable assistance

Candidates must undertake the assessment independently. However, reasonable assistance may be provided prior to the formal assessment process taking place. The term 'reasonable assistance' is used to try to balance the need for support with the need to avoid giving too much assistance. If a candidate requires more than what is deemed to be 'reasonable assistance', they may not be ready for assessment or it may be that they have been entered for the wrong level of qualification.

Reasonable assistance may be given on a generic basis to a class or group of candidates, for example advice on how to develop a project plan. It may also be given to candidates on an individual basis. When reasonable assistance is given on a one-to-one basis in the context of something the candidate has already produced or demonstrated, there is a danger that it becomes support for assessment and assessors need to be aware that this may be going beyond reasonable assistance.

Candidates may seek clarification on the wording of a brief or specification or instructions for the assessment if they find them unclear. In this case, the clarification should normally be given to the whole class.

Some guidance may be provided during the analysis and design stages, but the candidate must work independently throughout the implementation, testing and evaluation stages.

Assessor input and advice on the candidate's analysis and design is acceptable in order to allow the candidate to progress to the next stages of the assessment. The assistance provided must be recorded so that the candidate's own analysis and design work can be judged/marked fairly.

As the practical activity is a summative assessment, support and guidance during implementation, testing and evaluation stages must be limited to minimal prompts and questioning, referring the candidate to the instructions provided in the assessment task. Where candidates are observed to be following unsafe working practices, the assessor must intervene.

However, some assistance may also be given during fault-finding if the candidate has already carried out appropriate tests but is still unable to diagnose faults, which may be, for

example, due to faulty components rather than any shortcomings in the candidate's construction techniques.

As part of the preparation for assessment, group work approaches can be helpful to simulate real-life situations, share tasks and promote team-working skills. However, group work is not appropriate once formal assessment has started.

Evidence to be gathered

The following candidate evidence is required for the assessment:

- the completed solution (constructed circuit or photographs and/or hard copy from simulation software)
- a record of progress through the task, including all items of evidence specified within the assessment task
- a short report on testing the solution (in written, electronic and/or oral form)
- evidence of candidate's degree of independence and safe working (eg detailed assessor observation notes)

Evidence must be retained for quality assurance purposes.

Volume

There is no word count.

Grading

A candidate's overall grade is determined by their performance across the course assessment. The course assessment is graded A–D on the basis of the total mark for all course assessment components.

Grade description for C

For the award of grade C, candidates will typically have demonstrated successful performance in relation to the skills, knowledge and understanding for the course.

Grade description for A

For the award of grade A, candidates will typically have demonstrated a consistently high level of performance in relation to the skills, knowledge and understanding for the course.

Equality and inclusion

This course is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

For guidance on assessment arrangements for disabled candidates and/or those with additional support needs, please follow the link to the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements.

Further information

The following reference documents provide useful information and background.

- National 5 Practical Electronics subject page
- Assessment arrangements web page
- Building the Curriculum 3–5
- Design Principles for National Courses
- Guide to Assessment
- SCQF Framework and SCQF level descriptors
- SCQF Handbook
- SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work
- Coursework Authenticity: A Guide for Teachers and Lecturers
- Educational Research Reports
- SQA Guidelines on e-assessment for Schools
- SQA e-assessment web page

Administrative information

Published: April 2017 (version 1.0)

History of changes to course specification

Version	Description of change	Authorised by	Date

Note: You are advised to check SQA's website to ensure you are using the most up-to-date version of the course specification.