SCOTTISH QUALIFICATIONS AUTHORITY

TECHNOLOGICAL STUDIES
Intermediate 2

Third edition – published December 1999

SCOTTISH QUALIFICATIONS AUTHORITY

NOTES OF CHANGES TO ARRANGEMENTS
THIRD EDITION PUBLISHED ON CD-ROM DECEMBER 1999

COURSE TITLE: Technological Studies (Intermediate 2)

COURSE NUMBER: C036 11

National Course Specification

Course Details: Core skills statements expanded

National Unit Specification

All Units: Core skills statements expanded

SCOTTISH QUALIFICATIONS AUTHORITY

National Course Specification

TECHNOLOGICAL STUDIES (INTERMEDIATE 2)

COURSE NUMBER C036 11

STRUCTURE

This course has four mandatory units, as follows:

D186 11	***Applied Electronics (Intermediate 2)***	***1 credit (40 hours)***
D187 11	***Systems and Control (Intermediate 2)***	***1 credit (40 hours)***
D188 11	***Mechanical Systems (Intermediate 2)***	***0.5 credit (20 hours)***
D185 11	***Energy (Intermediate 2)***	***0.5 credit (20 hours)***

In common with all courses, this course includes 40 hours over and above the 120 hours for the component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment. This time is an important element of the course and advice on its use is included in the course details.

It is suggested that delivery of course units are approached in the following order but a unit need not necessarily be completed before commencing the next unit:

- Applied Electronics (Intermediate 2)
- Systems and Control (Intermediate 2)
- Mechanical Systems (Intermediate 2)
- Energy (Intermediate 2).

This order will ensure that concepts are encountered at an appropriate stage of the course and can be reviewed, reinforced and further developed through application within later units.

Administrative Information

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Course Specification (cont)

COURSE Technological Studies (Intermediate 2)

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained:

- Standard Grade Technological Studies at grade 3 or 4.

Centres may also wish to consider qualifications in other related subjects.

It is recommended that candidates should have achieved at least a grade 4 in Standard Grade Mathematics or demonstrated competency in equivalent NC units.

CORE SKILLS

Complete core skills for the course	Problem Solving	Int 2
	Numeracy	Int 2
	IT	Int 1
Additional core skills components for the course	None	

For information about the automatic certification of core skills for any individual unit in this course, please refer to the general information section at the beginning of the unit.

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Course Specification: course details

COURSE Technological Studies (Intermediate 2)

RATIONALE

The rationale for Technological Studies at Intermediate 2 has been developed further from that contained in the *Arrangements Document for Technological Studies on the Standard Grade* (SEB 1990) and *Amendments to the Arrangements* (1992). In line with the systems approach, and applying this methodology to the learning process, the depth of treatment of topics introduced at Standard Grade is developed further. For example, in electronics, the level of understanding is developed from a sub systems base to a study at component base level. In a similar manner, topics such as energy, mechanical systems and programmable systems are treated in a more formal manner, thus developing a depth of knowledge and understanding appropriate to Intermediate 2.

At Standard Grade much emphasis is placed on the acquisition of problem solving skills and the application of these skills in the development of a solution to a technological problem, for which a project report is produced. It is not considered necessary or appropriate for candidates to repeat this experience at Intermediate 2.

At Intermediate 2, the ability to evaluate the function and operation of systems is enhanced through the development of knowledge and understanding in key areas such as mechanical systems and control. An understanding of the performance of systems is enhanced through the development of skills in calculating energy transformation, efficiency, and force and motion transmission.

While, by the nature of the course, much time is spent in consolidating and reviewing Standard Grade concepts, it is also necessary to develop skills that will enhance the ability of candidates aiming to undertake the Higher course in Technological Studies. For example, in the electronics unit, candidates will develop the ability to handle discrete components and to verify the operation of systems, using test equipment and software simulation. The establishment of key skills and abilities at this level should ensure effective progression from Standard Grade and articulation to Higher level.

To ensure that the course remains relevant to the industrial and commercial fields, it is important that every opportunity is taken to expose candidates to real applications of technological systems and to reflect actual technological practice. To reinforce this approach, candidates are required to access information from data tables and data sheets.

A feature of any technological course is that candidates are not only required to process information and to develop understanding of concepts but, in addition, they are required to demonstrate capability in applying concepts to the solution of practical problems. This will be a permeating aspect of this course.

Any course in technology would be seen to fail if it did not take into account the wider issues faced by technologists and engineers in considering the effects of technological change. The Scottish CCC document *Technology Education in Scottish Schools* identifies technological capability as consisting of four elements:

- technological perspective
- technological confidence
- technological sensitivity
- technological creativity.

While the elements of perspective, confidence and creativity are clearly encompassed within the assessable aspects of the course, the importance of technological sensitivity should be recognised and given due consideration.

Within the context of the course, adequate time should be set aside to consider the social, economic and environmental issues of technologically driven change and the impact of these issues on society.

As a trading nation, it is important that the significant role played by manufacturing industry in the generation of employment and the creation of wealth is widely recognised. To maintain and improve the economic standing of the country among the other industrialised nations, there is a continued need to attract young people of the highest ability into the technology and technology-related professions. Intermediate 2 Technological Studies provides candidates with the opportunity to experience the challenge of modern technology at first hand and, in doing so, seeks to develop positive attitudes to, and a continuing interest in, careers within technology.

Course Aims

Candidates, having completed the Intermediate 2 course in Technological Studies should be able to:

- understand and identify the systems approach in the analysis of a technological system
- understand and apply control techniques in the analysis of a technological system
- evaluate the performance of technological systems, using quantitative methods where appropriate
- make appropriate measurements to verify the operation of a technological system
- communicate information in written, oral and graphical forms
- demonstrate and apply knowledge and understanding of appropriate terminology, calculations, facts and concepts associated with technological systems
- select, interpret and apply technological information
- participate in the analysis of technological systems.

COURSE CONTENT

There are benefits to be gained by taking the course in Technological Studies rather than only studying individual units.

When units are studied as part of a course, opportunities exist for candidates to experience a range of integrated problems. Such problems may require solutions that extend beyond the boundaries of the discrete units.

A description of the content and outcomes of each of the four units which comprise the course follows.

All of the course content will be subject to sampling in the external assessment

A data booklet will be available for reference in work during the course and in the unit tests. For external examinations, a list of formula will be provided.

Applied Electronics (Intermediate 2)

Outcomes

1 Demonstrate knowledge and understanding of the relationship between current and voltage in simple resistive d.c. networks.

2 Design and construct a simple electronic control system to meet a given specification.

3 Design and construct a simple combinational logic system to meet given specifications.

Content

Combined series-parallel resistive networks: consisting of not more than two parallel resistors in series with two other resistors.

Principles of the voltage divider. Fixed voltage divider. Use of variable resistors and analogue input transducers in voltage dividers.

Electronic components: simple switches, LDR, thermistor, resistor, variable resistor, bipolar transistor, diode, LED, relay.

Use input transducer characteristics from the data booklet to design a voltage divider to meet a given specification.

The n-p-n transistor as a switch (common emitter mode); switching circuits using transistors and voltage dividers. The need for circuit protection and associated techniques.

Current gain of an n-p-n transistor.

Operational characteristics: resistance change of sensors, saturation conditions for transistors.

Test equipment: multi-meter.

Simple calculations: applying voltage proportion rules to voltage divider circuits; find input voltage; transistor current gain based on the load being connected to the collector. All calculations assume that the transistor is at the point of 'saturation' (assume $I_e \simeq I_c$).

Use of a relay in a transistor circuit to switch a separate (high voltage or high current) circuit.

Use of computer simulation and construction to evaluate a simple electronic control system.

Operational characteristics: operating voltages.

Truth tables – maximum of three inputs. Development of simple Boolean expressions from truth tables or circuit specifications.

Logic functions and their associated truth tables: AND, OR, NOT, NAND, NOR.

Construction of truth tables for combinational logic diagrams. Production of combinational logic diagrams from truth tables.

Construction of truth tables and logic diagrams from written specifications for a simple system.

Use of data sheets in selecting logic ICs. Graphical representation of solutions to combinational logic problems.

Use of logic ICs and pin-out diagrams. Comparison of TTL and CMOS families of ICs (in terms of operational characteristics).

Use of computer simulation and construction to evaluate simple combinational logic systems.

National Course Specification: course details (cont)

COURSE Technological Studies (Intermediate 2)

Systems and Control (Intermediate 2)

Outcomes

1 Describe the main types of control systems.

2 Investigate common applications of electronic control systems.

3 Evaluate a program written in PBASIC for use with a microcontroller.

4 Develop a control sequence and use it to control a simple mechatronic system, by means of a microcontroller.

Content

Principles of operation of control systems.

Graphical methods: system diagram; block diagram; circuit diagram, flowchart.

Graphical representation of circuit elements such as voltage dividers, error detector and output transducers.

Control systems: open loop, closed loop, digital, analogue.

Input transducers: temperature, light, displacement, moisture, fluid level.

Output transducers: light, heat, motion.

Common applications of electronic control systems: on/off (two state), sequential, continuous.

Evaluation of control systems.

Introduction to microcontrollers including RAM, ROM, ALU, EEPROM, clock.

Binary and decimal systems of counting; conversion from one number system to the other.

Creating input signals to a microcontroller from analogue and digital devices.

Simple control routines: systems with up to 3 inputs and 2 outputs.

Use of flowcharts as the basis of a structured, top-down approach to programming.

Writing control programs in the high level language, PBASIC; inputs, outputs, loops and time delays.

Setting up simple loops; looping through a sequence or program 'N' times and looping continuously.

Controlling the speed of a motor by a microcontroller. Controlling simple mechatronic devices by a microcontroller.

National Course Specification: course details (cont)

COURSE Technological Studies (Intermediate 2)

Mechanical Systems (Intermediate 2)

Outcomes

1 Design, construct and evaluate pneumatic systems.

2 Describe the operation and performance of mechanisms.

Content

Graphical methods for representation of mechanical and pneumatic systems: circuit diagram; system diagram; block diagram (showing boundary and energy transformations).

Pneumatic circuits: a typical circuit would consist of a 5/2 air-operated valve control of a double-acting cylinder. Electrical control valves and simple time delay circuits should be used.

Calculations: to determine piston force, operating pressure, area and diameter.

Mechanisms: force multiplier systems such as levers, linkages, pulleys, cranks and gears.

Speed control systems: gears, pulleys, sprockets.

Calculations to determine: force ratio (mechanical advantage), speed ratio, moment, torque.

Energy (Intermediate 2)

Outcomes

1 Identify and quantify various forms of energy and work done.

2 Describe how energy is converted and transferred within a system.

3 Carry out measurements and calculations on energy transfer processes.

4 Carry out calculations relating to an energy audit for a system.

Content:

Forms of energy: potential, kinetic, strain, electrical, thermal, work done, power.

Calculations: $E_p = mgh$, $E_k = {}^1/_2mv^2$, $E_s = {}^1/_2Fx$, $E_e = VIt$, $E_h = Cm\Delta T$, $W = Fs$, $P = \frac{E}{t}$.

System: any system which involves 2–4 energy transfers.

Description of energy transfers within an energy system.

Principles of energy conservation and energy losses.

Energy transfer processes: measurement of energy transfers, calculations relating to energy transfers.

Calculations relating to energy audits: inputs, outputs, energy losses and efficiency, $\eta = \frac{\text{Energy out}}{\text{Energy in}}$.

National Course Specification: course details (cont)

COURSE Technological Studies (Intermediate 2)

ASSESSMENT

To gain the award of the course, the candidate must pass all the unit assessments as well as the external assessment. The external assessment will provide the basis for grading attainment in the course award.

When the units are taken as component parts of a course, candidates will have the opportunity to achieve levels beyond that required to attain each of the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards course estimates, and to provide evidence for appeals. Additional details are provided, where appropriate, with the exemplar assessment materials. Further information on the key principles of assessment are provided in the paper, *Assessment*, published by HSDU in May 1996.

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

There will be one written examination paper, with a time allocation of 2½ hours.

The paper will comprise two parts, as follows:

Section A (60 marks)
Approximately eight short answer questions will be set to test knowledge and understanding of discrete aspects of the course content. Candidates should attempt **all** questions in this section.

Section B (40 marks)
Three extended, integrated questions will be set. Candidates should attempt **two** questions from this section. These questions will test knowledge and understanding and the ability to deal with integrated course content.

During the course and in unit tests for internal assessment candidates will be expected to extract information from a data booklet supplied by the awarding authority. For the external examination a range of formulae will be included in the question paper.

GRADE DESCRIPTIONS

The descriptions below are of expected performance at grade C and at grade A. They are intended to assist candidates, teachers, lecturers and users of the certificate, and to help establish standards when question papers are being set. The grade of an award will be based on the total score obtained in the examination.

Grade C

In order to obtain a C, the candidate should be able to:

- use appropriate knowledge, understanding and skills acquired through the study of the component units of this course
- demonstrate ability to integrate skills acquired in the component units to solve problems of a theoretical nature
- apply knowledge and understanding to solve problems presented in familiar contexts.

Grade A

In order to obtain an A, the candidate should be able to:

- use knowledge, understanding and skills at a depth of treatment beyond those required for the basic study of the component units of this course
- demonstrate the ability to integrate skills acquired in component units to solve more complex problems of a theoretical nature
- apply knowledge and understanding to solve problems presented in less familiar contexts.

APPROACHES TO LEARNING AND TEACHING

Where appropriate, arrangements should be made to ensure that there will be no artificial barriers to learning and assessment. The nature of a candidate's special needs should be taken into account when planning learning experiences and selecting assessment instruments. Alternative arrangements should be made as necessary.

Detailed subject guides may give further advice and information on:

- support materials for each course
- appropriate learning and teaching approaches
- core skills as they relate to the subject
- assessment
- appropriate access for candidates with special educational needs.

Approaches to learning and teaching for Applied Electronics (Intermediate 2)

The purpose of this unit is to develop further the systems approach to electronics established at Standard Grade to a component-based level. The ability to handle Ohm's law and resistor networks is reviewed. The voltage divider circuit and transistor driver are introduced at a component-based level. Combinational logic systems are developed in a more formal manner. In addition to developing a component-based understanding of the operation of electronic devices, practical capabilities are developed by using electronic components for construction and use is made of computer simulation.

This unit should be the first presented in the course. It deals with concepts which are applied in other units and thus offers opportunities for integration of content. Candidates are required to develop an understanding of the function and operation of electronic devices and apply quantitative analysis to verify the operation of simple electronic systems.

Each outcome has been structured to address a body of knowledge that will enable candidates to analyse simple electronic systems. Candidates will be involved in simulating, constructing and evaluating electronic systems to given specifications. The main topics of study are d.c. networks, transistor based electronic systems, transistors and combinational logic systems. Candidates are required to carry out practical activities in circuit construction and simulation. In addition to this, aspects of technological sensitivity that relate to Applied Electronics could be discussed.

Candidates should be introduced to resistive d.c. networks, associated calculations and construction techniques. Candidates would be expected to select an appropriate sensor, use a data sheet to find sensor resistance at a specified physical property level and make calculations to determine the passive resistor value to enable a simple voltage divider to be constructed. Candidates would also be expected to select a transistor based output driver and appropriate output devices. The need for component protection using a diode should be understood.

The basic operational characteristics of CMOS and TTL logic ICs should be discussed and candidates should be sufficiently aware of these to suggest a specific family of devices for a particular application. Standard layout and interpretation of truth tables should be covered. Using the resulting expression, candidates would be expected to draw a logic diagram using symbols for standard gates.

Approaches to learning and teaching for Systems and Control (Intermediate 2)

The purpose of this unit is to consolidate and review concepts associated with control which were established at Standard Grade prior to developing new aspects of control. The representation of control systems using block diagrams is reviewed. Methods of transistor switching and their application with electronic control circuits are dealt with. The control language PBASIC is introduced. Control sequences are developed to control simple mechatronic devices. The knowledge and understanding of electronic devices developed in the unit Applied Electronics (Intermediate 2) is used in the analysis and evaluation of electronic control systems.

The outcomes have been structured to address a body of knowledge that will enable candidates to analyse control systems and develop control sequences. Candidates will apply this knowledge in using a high level programming language (PBASIC) to control mechatronic devices.

Outcomes 1-4 could be overtaken in the context of assignments which bring industrial/domestic perspectives to the applications of control systems.

It is anticipated that candidates will be familiar with the concepts of open loop and closed loop control. Systems representation and the use of block diagrams should be dealt with and the concept of a system boundary should be developed. Candidates should become familiar with the standard representation of closed loop control systems and the concept of negative feedback to an error detector.

Candidates would benefit from undertaking a series of problem solving activities relating to common applications of control.

Candidates should become familiar with the PBASIC instruction set and be able to carry out number conversions from binary to decimal and decimal to binary.

It is anticipated that candidates will have prior experience of developing simple control programs, using high-level languages and constructing and interpreting simple flowcharts.

Candidates should become familiar with the basic layout and operation of a microcontroller system. Programs will be developed using a high-level language (PBASIC).

Candidates will be required to interpret and evaluate PBASIC programs.

From a given specification, candidates will be required to construct a flow chart, develop a control sequence and use it to control a simple mechatronic system.

Candidates should be introduced to the use of the BASIC Stamp microcontroller, eg bit testing, setting loops and generating sub-procedures.

Approaches to learning and teaching for Mechanical Systems (Intermediate 2)

The purpose of this unit is to consolidate and review work on pneumatic systems and mechanical systems undertaken at Standard Grade. Candidates are expected to develop abilities in analysing the performance of mechanical systems by measurement and calculation.

Candidates will be given a series of problem solving activities based on pneumatic systems. Candidates must be able to interpret pneumatic systems from circuit diagrams. Candidates will be expected to construct and evaluate pneumatic systems from given specifications. Related calculations should be carried out.

Candidates should be introduced to a range of mechanisms. They should be able to describe the operation and performance of mechanisms. Typically, candidates should be able to describe the mode of operation of a compound gear train. Candidates should be able to describe how to adjust input and output conditions of mechanisms. Related calculations should be carried out.

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are relevant to the candidate.

The opportunity should be taken to relate content, where possible, to other units on the course. This could be achieved by incorporating mechanical systems into control systems. In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

Approaches to learning and teaching for Energy (Intermediate 2)

The purpose of the Energy unit is to develop abilities in recognising and measuring energy forms and calculating energy conversions. Candidates should be able to analyse energy conversions and transformations and to apply this knowledge in carrying out related calculations. The need for an energy audit should be clearly understood, along with its use in seeking to improve the overall efficiency of a system.

Candidates should be able to identify and quantify a range of different forms of energy. They should be able to perform simple calculations relating to energy, power and work done.

Candidates should be introduced to a range of energy transfer systems describing the conservation of energy within systems.

Candidates are expected to describe energy transfer and energy loss within a system. The principle of conservation of energy should be considered.

Candidates should have access to a range of energy transfer devices that will enable them to carry out measurements of the energy transfer process. They should be able to apply these results. Further calculations should be undertaken making use of these measurements.

The candidate should appreciate the importance of energy audits. Calculations should be carried out on energy input, output, losses and overall efficiency for a given system.

SPECIAL NEEDS

This course specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

SUBJECT GUIDES

A Subject Guide to accompany these Arrangements documents has been produced by the Higher Still Development Unit (HSDU) in partnership with the Scottish Consultative Council on the Curriculum (SCCC) and Scottish Further Education Unit (SFEU). The Guide provides further advice and information about:

- support materials for each course
- learning and teaching approaches in addition to the information provided in the Arrangements documents
- assessment
- ensuring appropriate access for candidates with special educational needs.

The Subject Guide is intended to support the information contained in the Arrangements document. The SQA Arrangements documents contain the standards against which candidates are assessed.

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Applied Electronics (Intermediate 2)

NUMBER D186 11

COURSE Technological Studies (Intermediate 2)

SUMMARY

This unit is designed to enable candidates to develop an understanding of d.c. networks and simple electronic systems.

OUTCOMES

1 Demonstrate knowledge and understanding of the relationship between current and voltage in simple resistive d.c. networks.

2 Design and construct a simple electronic system to meet a given specification.

3 Design and construct a simple combinational logic system to meet given specifications.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following:

- Standard Grade Technological Studies at grade 3 or 4
- Standard Grade Physics at grade 3 or 4
- equivalent NC units.

CREDIT VALUE

1 credit at Intermediate 2.

Administrative Information

Superclass: XL

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Applied Electronics (Intermediate 2)

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	Int 2
	Numeracy	Int 2
	IT	Int 1
Additional core skills components for the unit	None	

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Applied Electronics (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Demonstrate knowledge and understanding of the relationship between current and voltage in simple resistive d.c. networks.

Performance criteria

(a) Calculations of the equivalent resistance of a d.c. network are carried out correctly.
(b) Using Ohm's law, calculations of currents, voltages and voltage drops are carried out correctly.
(c) A d.c. network is constructed to meet a given specification.

Note on range for the outcome

Resistive d.c. networks: series, parallel, combined series and parallel.

Given specification (for construction): 2 parallel resistors in series with 2 other resistors.

Evidence requirements

Written and graphical evidence for PCs (a) and (b). Performance evidence for PC (c).

OUTCOME 2

Design and construct a simple electronic system to meet a given specification.

Performance criteria

(a) Data sheets are interpreted correctly in the selection of electronic components.
(b) The selection of electronic components is justified in terms of their operational characteristics.
(c) Calculations related to voltage divider circuits and transistor gain are carried out correctly.
(d) The need for component protection is explained clearly.
(e) A simple electronic system is evaluated correctly against a given specification, using computer simulation.
(f) A simple electronic system is constructed to meet a given specification.

Note on range for the outcome

Simple system: input – voltage divider
process – npn transistor

Evidence requirements

Written and graphical evidence for PCs (a) to (d). Performance evidence for PCs (e) and (f).

National Unit Specification: statement of standards (cont)

UNIT Applied Electronics (Intermediate 2)

OUTCOME 3

Design and construct a simple combinational logic system to meet given specifications.

Performance criteria

(a) The basic operational characteristics of common integrated circuit logic families are described clearly.
(b) Data sheets are interpreted correctly in the selection of integrated circuits.
(c) Combinational logic systems are analysed correctly using truth tables and Boolean expressions.
(d) The graphical representation of logic systems is in accordance with the data booklet.
(e) A simple logic circuit is evaluated correctly against a given specification, using computer simulation.
(f) A simple logic circuit is constructed to meet a given specification.

Evidence requirements

Written and graphical evidence for PCs (a) to (d). Performance evidence for PCs (e) and (f).

National Unit Specification: support notes

UNIT Applied Electronics (Intermediate 2)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

A data booklet will be issued by SQA in connection with this unit.
Guidance for each outcome is given below.

Outcome 1

Combined series-parallel resistive networks: consisting of not more than two parallel resistors in series with two other resistors.

Outcome 2

Principles of the voltage divider. Fixed voltage divider. Use of variable resistors and analogue input transducers in voltage dividers.
Electronic components: simple switches, LDR, thermistor, resistor, variable resistor, bipolar transistor, diode, LED, relay.
Use input transducer characteristics from the data booklet to design a voltage divider to meet a given specification.
The n-p-n transistor as a switch (common emitter mode); switching circuits using transistors and voltage dividers. The need for circuit protection and associated techniques.
Current gain of an n-p-n transistor.
Operational characteristics: resistance change of sensors, saturation conditions for transistors.
Test equipment: multi-meter.
Simple calculations: applying voltage proportion rules to voltage divider circuits; find input voltage; transistor current gain based on the load being connected to the collector. All calculations assume that the transistor is at the point of 'saturation' (assume $I_e \simeq I_c$).
Use of a relay in a transistor circuit to switch a separate (high voltage or high current) circuit.
Use of computer simulation and construction to evaluate a simple electronic control system.

Outcome 3

Construction of truth tables for combinational logic diagrams. Production of combinational logic diagrams from truth tables.
Logic functions and their associated truth tables: AND, OR, NOT, NAND, NOR
Construction of truth tables and logic diagrams from written specifications for a simple system.
Use of data sheets in selecting logic ICs. Graphical representation of solutions to combinational logic problems.
Use of logic ICs and pin-out diagrams. Comparison of TTL and CMOS families of ICs (in terms of operational characteristics).
Use of computer simulation and construction to evaluate simple combinational logic systems.
Truth tables – maximum of three inputs. Development of simple Boolean expressions from truth tables or circuit specifications

National Unit Specification: support notes (cont)

UNIT Applied Electronics (Intermediate 2)

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The purpose of this unit is to develop further the systems approach to electronics established at Standard Grade to a component-based level. The ability to handle Ohm's law and resistor networks is reviewed. The voltage divider circuit and transistor driver are introduced at a component-based level. Combinational logic systems are developed in a more formal manner. In addition to developing a component-based understanding of the operation of electronic devices, practical capabilities are developed by using electronic components.

Where appropriate, opportunities should be taken to ensure that learning and teaching is contextualised in industrial/commercial applications. Candidates are expected to design and construct systems to meet given specifications. Such systems should be based on transistor control and combinational logic applications.

This unit deals with concepts which are applied in other units and thus offers opportunities for integration of content. In presenting this unit, teachers and lecturers should ensure that there is a balance between direct teaching and practical activities.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

National Assessment Bank materials have been created specifically to assess knowledge and understanding for each outcome. Assessments can take place either at the completion of an outcome or as an end of unit test. Centres must ensure that tests are conducted under appropriate conditions. Candidates should be allowed to use the Technological Studies data booklet. Candidates should be issued with clean copies of this booklet for use during tests.

Outcome 1 requires candidates to construct resistive d.c. networks. Outcomes 2 and 3 require candidates to simulate, construct and evaluate electronic systems to given specifications. It is the responsibility of the centre to ensure that evidence of candidate performance is recorded in an appropriate way. All evidence of performance must be retained by the centre. The assessment of this unit is subject to central moderation by the SQA.

Candidates generate evidence by means of their response to written tests, proficiency in practical activities and systems evaluation.

In order to gain success in the written test for an outcome, each candidate must achieve at least the cut-off score for that outcome. In order to succeed in practical activities, the candidate must simulate, construct and evaluate a system to meet a given specification. Evidence of performance must be recorded in an appropriate manner. Simulation and construction performance must be observed directly. Candidates' evaluation of a system can be in the form of either a written or oral report. Details should be recorded of the particular system(s) dealt with by each candidate.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into acount when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Systems and Control (Intermediate 2)

NUMBER D187 11

COURSE Technological Studies (Intermediate 2)

SUMMARY

This unit is designed to enable candidates to study control systems and control programs, and their applications.

OUTCOMES

1 Describe the main types of control systems.
2 Investigate common applications of electronic control systems.
3 Evaluate a program written in PBASIC for use with a microcontroller.
4 Develop a control sequence and use it to control a simple mechatronic system, by means of a microcontroller.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following:

- Standard Grade Technological Studies at grade 3 or 4

CREDIT VALUE

1 credit at Intermediate 2.

Administrative Information

Superclass: VE

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Systems and Control (Intermediate 2)

CORE SKILLS

Complete core skills for the unit	Problem Solving	Int 2
Additional core skills for the unit	Using Graphical Information	Int 1

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Systems and Control (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Describe the main types of control systems.

Performance criteria

(a) Open loop and closed loop control systems are identified correctly.
(b) The application of error detectors in closed loop control systems is described clearly.
(c) The operation of a control system is described clearly.
(d) Open loop and closed loop control system diagrams are represented correctly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

OUTCOME 2

Investigate common applications of electronic control systems.

Performance criteria

(a) The main sub systems of a typical electronic control system are identified correctly.
(b) The differences between analogue and digital transducers are described clearly.
(c) Data sheets are interpreted correctly in the selection of transducers to meet given specifications.
(d) Common applications of electronic control systems are described clearly.

Note on range for the outcome

Common applications: on/off (two state), continuous, sequential.

Electronic control systems: voltage divider based inputs and npn transistor processes with appropriate output transducers.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

National Unit Specification: statement of standards (cont)

UNIT Systems and Control (Intermediate 2)

OUTCOME 3

Evaluate a program written in PBASIC for use with a microcontroller.

Performance criteria

(a) Number system conversions are carried out correctly.
(b) The basic operation of a microcontroller is described correctly.
(c) PBASIC Instruction Set commands are explained clearly.
(d) The use of PBASIC commands in structured programs is evaluated correctly.

Note on the range for the outcome

Number system conversions: decimal to binary, binary to decimal.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

OUTCOME 4

Develop a control sequence and use it to control a simple mechatronic system, by means of a microcontroller.

Performance criteria

(a) A specified control sequence is represented correctly by a flowchart using symbols from a data booklet.
(b) A specified control sequence is developed successfully in a high level programming language.
(c) A control sequence written in a high level programming language is used successfully to control a simple mechatronic system.
(d) Interfacing devices, required to provide control of a simple mechatronic system, are used correctly.

Note on the range of the outcome

Simple mechatronic system: 3 inputs, 2 outputs.

Evidence requirements

Written and graphical evidence for PCs (a) and (b). Performance evidence for PCs (c) and (d).

National Unit Specification: support notes

UNIT Systems and Control (Intermediate 2)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

Content

A data booklet will be issued by SQA in connection with this unit.

Guidance for each outcome is given below.

Outcome 1	Principles of operation of control systems. Graphical methods: system diagram; block diagram; circuit diagram, flowchart. Graphical representation of circuit elements such as voltage dividers, error detector and output transducers. Control systems: open loop, closed loop, digital, analogue.
Outcome 2	Input transducers: temperature, light, displacement, moisture, fluid level. Output transducers: light, heat, motion. Common applications of electronic control systems: on/off (two state), sequential, continuous. Evaluation of control systems.
Outcomes 3 and 4	Introduction to microcontrollers including RAM, ROM, ALU, EEPROM, clock. Binary and decimal systems of counting; conversion from one number system to the other. Creating input signals to a microcontroller from analogue and digital devices. Simple control routines: systems with up to 3 inputs and 2 outputs. Use of flowcharts as the basis of a structured, top-down approach to programming. Writing control programs in the high level language, PBASIC; inputs, outputs, loops and time delays. Setting up simple loops; looping through a sequence or program 'N' times and looping continuously. Controlling the speed of a motor by a microcontroller. Controlling simple mechatronic devices by a microcontroller.

NB This unit deals with electronic and microcontroller control systems. Pneumatic control systems are not required.

National Unit Specification: support notes (cont)

UNIT Systems and Control (Intermediate 2)

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The purpose of this unit is to consolidate and review concepts associated with control which were established at Standard Grade. The representation of control systems using block diagrams is reviewed. Transistor switching and its application within electronic control circuits is dealt with. The control language PBASIC is introduced. Control sequences are developed to control simple mechatronic devices. The knowledge and understanding of electronic devices developed in the unit Applied Electronics (Intermediate 2) is used in the analysis and evaluation of electronic control systems.

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are seen to be relevant to the candidate. Candidates are expected to develop control sequences to control mechatronic systems.

In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

National Assessment Bank materials have been created specifically to assess knowledge and understanding for each outcome. Assessments can take place either at the completion of an outcome or as an end of unit test. Centres must ensure that tests are conducted under appropriate conditions. Candidates should be allowed to use the Technological Studies data booklet. Candidates should be issued with clean copies of this booklet for use during tests.

Outcome 4 requires candidates to carry out practical activities. It is the responsibility of the centre to ensure that evidence of candidate performance is recorded in an appropriate way. All evidence of performance must be retained by the centre. The assessment of this unit is subject to central moderation by the SQA.

Candidates generate evidence by means of their response to written tests, proficiency in practical activities and systems evaluation.

In order to gain success in the written test for an outcome, each candidate must achieve at least the cut-off score for that outcome. Success in the practical activity must be observed by the teacher or lecturer. The practical activity is based on the control of a mechatronic device by a microcontroller. Evidence of performance must be recorded in an appropriate manner. Simulation and construction performance must be observed directly. A candidate's evaluation of a system can be in the form of either a written or oral report. Details should be recorded of the particular system dealt with by each candidate.

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Mechanical Systems (Intermediate 2)

NUMBER D188 11

COURSE Technological Studies (Intermediate 2)

SUMMARY

This unit is designed to enable candidates to study pneumatic systems and mechanisms.

OUTCOMES

1 Design, construct and evaluate pneumatic systems.
2 Describe the operation and performance of mechanisms.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following:

- Standard Grade Technological Studies at grade 3 or 4
- equivalent NC units.

CREDIT VALUE

0.5 credit at Intermediate 2.

Administrative Information

Superclass: VE

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Mechanical Systems (Intermediate 2)

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	Int 2
	Numeracy	Int 1
Additional core skills components for the unit	Using Number	Int 2

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Mechanical Systems (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Design, construct and evaluate pneumatic systems.

Performance criteria

(a) Diagrams are interpreted correctly in describing the operation of a pneumatic system.
(b) The graphical representation of pneumatic systems is in accordance with given standards.
(c) Calculations to determine cylinder pressure and piston force and area are carried out correctly.
(d) A pneumatic system is constructed to meet a given specification.
(e) A pneumatic system is evaluated correctly against a given specification.

Note on range for the outcome

PCs (a) and (b) Pneumatic systems: combinational control, sequential control.

Evidence requirements

Written and graphical evidence for PCs (a) to (c). Performance evidence for PCs (d) and (e).

OUTCOME 2

Describe the operation and performance of mechanisms.

Performance criteria

(a) Graphical representation of mechanisms is appropriate.
(b) Diagrams are interpreted correctly in describing the operation of mechanisms.
(c) Calculations related to mechanisms are carried out correctly.
(d) Methods used to adjust the performance of mechanisms are described clearly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

National Unit Specification: support notes

UNIT Mechanical Systems (Intermediate 2)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

A data booklet will be issued by SQA in connection with this unit.

Guidance for each outcome is listed below.

Outcome 1	Pneumatic circuits: a typical circuit would consist of a 5/2 air-operated valve control of a double-acting cylinder. Electrical control valves and simple time delay circuits should be used. Calculations: to determine piston force, operating pressure, area and diameter.
Outcomes 1 and 2	Graphical methods for representation of mechanisms and pneumatic systems: circuit diagram; system diagram; block diagram (showing boundary and energy transformations).
Outcome 2	Mechanisms: force multiplier systems such as levers, linkages, pulleys, cranks and gears. Speed control systems: gears, pulleys, sprockets. Calculations to determine: force ratio (mechanical advantage), speed ratio, moment, torque.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Candidates will be given a series of problem solving activities based on pneumatic systems. Candidates must be able to interpret pneumatic systems from circuit diagrams. Candidates will be expected to construct and evaluate pneumatic systems from given specifications. Related calculations should be carried out.

Candidates should be introduced to a range of mechanisms. They should be able to describe the operation and performance of mechanisms. Typically, candidates should be able to describe the mode of operation of a compound gear train. Candidates should be able to describe how to adjust input and output conditions of mechanisms. Related calculations should be carried out.

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are relevant to the candidate.

The opportunity should be taken to relate content, where possible, to other units on the course. This could be achieved by incorporating mechanical systems into control systems. In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

National Unit Specification: support notes (cont)

UNIT Mechanical Systems (Intermediate 2)

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Both outcomes of this unit must be assessed by a written test. The tests should be closed book with the teacher/lecturer in attendance to ensure examination conditions within the classroom. Candidates should be allowed to use the data booklet.

In order to gain success in the written test for an outcome, the candidate must achieve at least the cut-off score for that outcome. In addition, each candidate has to construct a pneumatic system and evaluate it against a given specification.

SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Energy (Intermediate 2)

NUMBER D185 11

COURSE Technological Studies (Intermediate 2)

SUMMARY

This unit is designed to enable candidates to study different forms of energy and describe how they are converted and transmitted within systems.

OUTCOMES

1 Identify and quantify various forms of energy and work done.
2 Describe how energy is converted and transferred within a system.
3 Carry out measurements and calculations on energy transfer processes.
4 Carry out calculations relating to an energy audit for a system.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained the following:

- Standard Grade Technological Studies at grade 3 or 4

CREDIT VALUE

0.5 credit at Intermediate 2.

Administrative Information

Superclass: RC

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Energy (Intermediate 2)

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit Problem Solving Int 2

Additional core skills components for the unit None

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Energy (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1

Identify and quantify various forms of energy and work done.

Performance criteria

(a) Various forms of energy are identified correctly.
(b) Simple calculations relating to energy, power and work done are carried out correctly.

Note on range for the outcome

Forms of energy: potential, kinetic, strain, electrical, thermal.

Calculations: $E_p = mgh$, $E_k = {}^1/_2mv^2$, $E_s = {}^1/_2Fx$, $E_e = VIt$, $E_h = Cm\Delta T$, $W = Fs$, $P = \frac{E}{t}$.

Evidence requirements

Written and graphical evidence for PCs (a) and (b).

OUTCOME 2

Describe how energy is converted and transferred within a system.

Performance criteria

(a) Forms of energy are identified correctly at various stages within a system.
(b) Energy changes within a system are described correctly.
(c) The main energy losses from a system are identified and explained clearly.

Note on range for the outcome

Forms of energy: potential, kinetic, strain, electrical, thermal.

System: any system with 2 to 4 energy transfers.

Evidence requirements

Written and graphical evidence for PCs (a) to (c).

National Unit Specification: statement of standards (cont)

UNIT Energy (Intermediate 2)

OUTCOME 3

Carry out measurements and calculations on energy transfer processes.

Performance criteria

(a) Simple measurements relating to mass, force, temperature and time are carried out accurately using appropriate equipment.
(b) Calculations of energy transfers are carried out correctly.

Evidence requirements

Performance evidence for PC (a). Written and graphical evidence for PC (b).

OUTCOME 4

Carry out calculations relating to an energy audit for a system.

Performance criteria

(a) Calculations of energy inputs to a system are carried out correctly.
(b) Calculations of energy outputs from a system are carried out correctly.
(c) Calculations of energy losses for a system are carried out correctly.
(d) Calculation of the overall efficiency of a system is carried out correctly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

National Unit Specification: support notes

UNIT Energy (Intermediate 2)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

A data booklet will be issued by SQA in connection with this unit.

Guidance for each outcome is given below.

Outcome 1 Forms of energy: potential, kinetic, strain, electrical, thermal, work done, power.
Calculations: $E_p = mgh$, $E_k = {}^1/_2mv^2$, $E_s = {}^1/_2Fx$, $E_e = VIt$, $E_h = Cm\Delta T$, $W = Fs$, $P = \frac{E}{t}$.

Outcome 2 System: any system which involves 2–4 energy transfers.
Description of energy transfers within energy system.
Principle of energy conservation and energy losses.

Outcome 3 Energy transfer processes: measurement of energy transfers, calculations relating to energy transfers.

Outcome 4 Calculations relating to energy inputs, outputs, energy losses and efficiency, $\eta = \frac{\text{Energy out}}{\text{Energy in}}$.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The purpose of the Energy unit is to develop abilities in recognising and measuring energy forms and calculating energy conversions. Candidates should be able to analyse energy conversions and transformations and to apply this knowledge to the energy audit of a system. The need for an energy audit should be clearly understood, along with its use in seeking to improve the overall efficiency of a system.

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are seen to be relevant by the candidate. Candidates are expected to develop control sequences to control mechatronic systems.

In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

National Unit Specification: support notes (cont)

UNIT Energy (Intermediate 2)

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

National Assessment Bank materials have been created specifically to assess knowledge and understanding for each outcome. Assessments can take place either at the completion of an outcome or as an end of unit test. Centres must ensure that tests are conducted under appropriate conditions. Candidates should be allowed to use the Technological Studies data booklet. Candidates should be issued with clean copies of this booklet for use during tests.

Outcome 3 requires candidates to carry out measurements on an energy transfer. Details should be recorded of the particular system dealt with by each candidate. It is the responsibility of the centre to ensure that evidence of candidate performance is recorded in an appropriate way. All evidence of performance must be retained by the centre. The assessment of this unit is subject to central moderation by the SQA.

Candidates generate evidence by means of their response to written tests, proficiency in practical activities and systems evaluation. Details should be recorded of the particular system used by each candidate.