Course/Unit Support Notes

Advanced Higher Engineering Science Course/Unit Support Notes

Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

May 2015, version 2.0

Contents

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Advanced Higher Engineering Science Course. Although primarily intended for teachers and lecturers who are delivering the Course and its Units, it may be useful to share some aspects with learners.

These support notes cover both the Advanced Higher Course and the Units in it.

The Advanced Higher Course/Unit Support Notes should be read in conjunction with the relevant:

Mandatory information:

- Course Specification
- Course Assessment Specification
- Unit Specifications

Assessment support:

- Specimen and Exemplar Question Papers and Marking Instructions
- Exemplar Question Paper Guidance
- Guidance on the use of past paper questions
- Coursework Information:
  - General assessment information
  - Coursework Assessment Task*
- Unit Assessment Support*

*These documents are for assessors and are confidential. Assessors may access these through the SQA Co-ordinator in their centres.

Related information

Advanced Higher Course Comparison

Further information on the Course/Units for Advanced Higher Engineering Science

This information begins on page 14 and both teachers and learners may find it helpful.

Equality and inclusion

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Course/Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Course.

It is important that centres are aware of and understand SQA's assessment arrangements for disabled learners, and those with additional support needs, when making requests for adjustments to published assessment arrangements. Centres will find more guidance on this in the series of publications on Assessment Arrangements on SQA's website: www.sqa.org.uk/sqa/14977.html.

The greater flexibility and choice in Advanced Higher Courses provide opportunities to meet a range of learners' needs and may remove the need for learners to have assessment arrangements. However, where a disabled learner needs reasonable adjustment/assessment arrangements to be made, you should refer to the guidance given in the above link.

General guidance on the Course/Units

Aims

The aims of the Course are to enable learners to:

- extend and apply knowledge and understanding of key engineering concepts, principles and practice through independent learning
- understand and apply the relationships between engineering, mathematics and science
- develop skills in investigation and research in an engineering context
- analyse, design, construct and evaluate creative solutions to complex engineering problems
- communicate advanced engineering concepts clearly and concisely, using appropriate terminology
- develop an informed understanding of the role and impact of engineering in changing and influencing our environment and society, including ethical implications

Progression

In order to do this Course, learners should have achieved the Higher Engineering Science Course.

Learners who have achieved this Advanced Higher Course may progress to further study, employment and/or training. Opportunities for progression include:

- Progression to further/higher education:
  - For many learners a key transition point will be to further or higher education, for example to Higher National Certificates (HNCs)/Higher National Diplomas (HNDs) or degree programmes, for example degree programmes in various branches of Engineering or Physics.
  - This Course provides good preparation for learners progressing to further and higher education as learners doing Advanced Higher Courses must be able to work with more independence and less supervision. This eases their transition to further/higher education. Advanced Higher Courses may also allow 'advanced standing' or partial credit towards the first year of study of a degree programme.
  - Advanced Higher Courses are challenging and testing qualifications — learners who have achieved multiple Advanced Higher Courses are regarded as having a proven level of ability, which attests to their readiness for higher education in Higher Education Institutions in other parts of the UK as well as in Scotland.
  - For many learners, progression will be directly to employment or work-based training programmes.

This Advanced Higher Engineering Science could be part of the Scottish Baccalaureate in Science. The Scottish Baccalaureates in Expressive Arts, Languages, Science and Social Sciences consist of coherent groups of subjects at Higher and Advanced Higher level. Each award consists of two Advanced Highers, one Higher and an interdisciplinary project that adds breadth and value, helping learners to develop generic skills, attitudes and confidence that will help them make the transition into higher education or employment.

Hierarchies

Hierarchy is the term used to describe Courses and Units which form a structured progression involving two or more SCQF levels.

This Course is designed in hierarchy with the corresponding Course at Higher and has a similar Course structure and similar Unit titles as the Higher Course.

Centres should be aware that although the mandatory knowledge and skillset may be similar across the hierarchical Units in Higher and Advanced Higher Courses, there are differences in the:

- depth of underpinning knowledge and understanding
- complexity and sophistication of the applied skills
- way in which learners will learn: namely, they will take more responsibility for their learning at Advanced Higher and work more autonomously

A table showing the relationship between the mandatory Higher and Advanced Higher knowledge and understanding is included at the end of this document. This table may be useful for:

- ensuring seamless progression between levels
- identifying important prior learning for learners at Advanced Higher

Teachers/lecturers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

Skills, knowledge and understanding covered in this Course

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the Course.

Teachers and lecturers should refer to the *Course Assessment Specification* for mandatory information about the skills, knowledge and understanding to be covered in this Course.

The development of subject-specific and generic skills is central to the Course. Learners should be made aware of the skills they are developing and of the

transferability of them. It is the transferability that will help learners with further study and enhance their personal effectiveness.

The table below shows where there are likely to be opportunities to develop mandatory skills in or across the Units. However, the delivery mode adopted and the approaches to learning and teaching will determine how and where the opportunities arise.

Mandatory skills and knowledge	Engineering Project Management	Electronics and Control	Mechanisms and Structures	Course assessment
researching and investigating complex engineering problems		✓	✓	✓
designing, developing, simulating, building, testing and evaluating solutions to complex engineering problems in a range of contexts		✓	✓	✓
applying mathematical techniques to analyse and solve engineering problems		✓	✓	✓
communicating complex engineering concepts clearly and concisely using appropriate terminology	✓	✓	✓	✓
knowledge and understanding of the wide role and impact of engineering on society and the environment, including ethical implications	✓			✓
in-depth knowledge and understanding of aspects of electronic and microcontroller-based systems, and their application		✓		✓
in-depth knowledge and understanding of aspects of mechanisms and structures, and their application			✓	✓
knowledge and understanding of the relevance of energy, efficiency and sustainability to complex engineering problems and solutions	✓	✓	✓	✓
applying engineering knowledge, understanding and skills in a range of contexts		✓	✓	✓
ability to plan, manage and implement a challenging engineering project	✓			✓

Approaches to learning and teaching

Advanced Higher Courses place more demands on learners as there will be a higher proportion of independent study and less direct supervision. Some of the approaches to learning and teaching suggested for other levels (in particular, Higher) may also apply at Advanced Higher level but there will be a stronger emphasis on independent learning.

For Advanced Higher Courses, a significant amount of learning may be self-directed and require learners to demonstrate a more mature approach to learning and the ability to work on their own initiative. This can be very challenging for some learners, who may feel isolated at times, and teachers and lecturers should have strategies for addressing this. These could include, for example, planning time for regular feedback sessions/discussions on a one-to-one basis and on a group basis led by the or lecturer (where appropriate).

Learners should be encouraged to use an enquiring, critical and problem-solving approach to their learning. Learners should also be given the opportunity to practise and develop research and investigation skills and higher-order evaluation and analytical skills.

Learners will engage in a variety of learning activities as appropriate to the subject, for example:

- researching information for their subject rather than receiving information from their teacher or lecturer
- using active and open-ended learning activities such as research, case studies and presentation tasks
- making use of the internet to assist research
- recording in a systematic way the results of research and independent investigation from different sources
- presenting findings/conclusions of research and investigation activities in a presentation
- participating in group work with peers and using collaborative learning opportunities to develop team working
- drawing conclusions from complex information
- using appropriate technological resources (eg web-based resources)
- participating in visits to industrial or civil engineering sites

Teachers/lecturers should support learners by having regular discussions with them and giving regular feedback. Some learning and teaching activities may be carried out on a group basis and, where this applies, learners could also receive feedback from their peers.

Teachers/lecturers should, where possible, provide opportunities to personalise learning and enable learners to have choices in approaches to learning and teaching. The flexibility in Advanced Higher Courses and the independence with

which learners carry out the work lend themselves to this. In particular, in this Course learners have opportunities to:

- select and investigate a real-world engineering project in the *Engineering Project Management* Unit
- research aspects of engineering of interest to themselves in both the *Electronics and Control* and *Mechanisms and Structures* Units
- plan, manage and implement a challenging engineering project on a topic they have chosen, for their Coursework project

Teachers/lecturers should also create opportunities for, and use, inclusive approaches to learning and teaching. This can be achieved by encouraging the use of a variety of learning and teaching strategies that suit the needs of all learners. Innovative and creative ways of using technology can also be valuable in creating inclusive learning and teaching approaches.

Approaches to structuring the Course

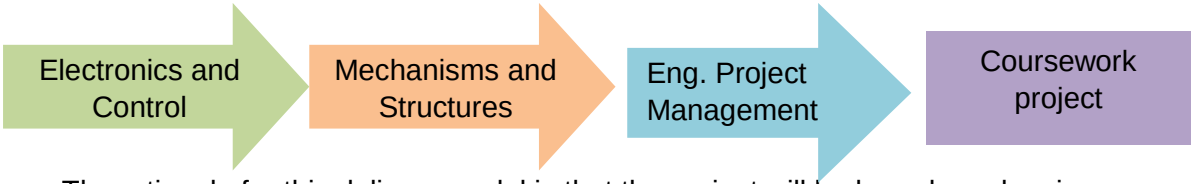
A centre is free to sequence the teaching of the Outcomes, Units and/or Course in any order it wants. For example, each Unit could be delivered separately in any sequence, or the Units may be delivered in a combined way as part of the Course. If this approach is used, the Outcomes within Units may either be partially or fully combined.

The project assesses application of knowledge, understanding and skills developed through the other Units, so it will normally be delivered towards the end of the Course. However, it may be possible to begin work on the project at an earlier stage, but only where it is clear that learners have already gained the required skills and knowledge.

Mechanisms and Structures, and *Electronics and Control*, can be taught in either order, or in parallel. This provides flexibility for centres, regarding access to equipment, as this may need to be shared with other groups.

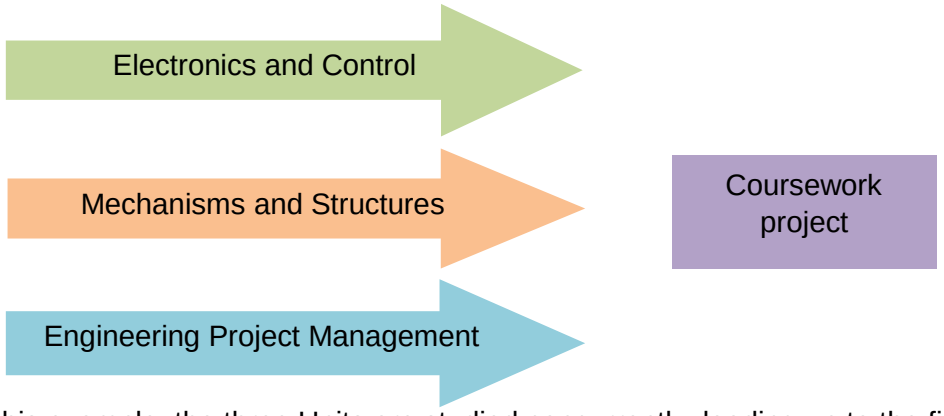
Taking all of the above into account, the following example Course structures might be considered.

Example 1: Sequential delivery of the Units, with *Engineering Project Management* as the final Unit, leading on to the Coursework project



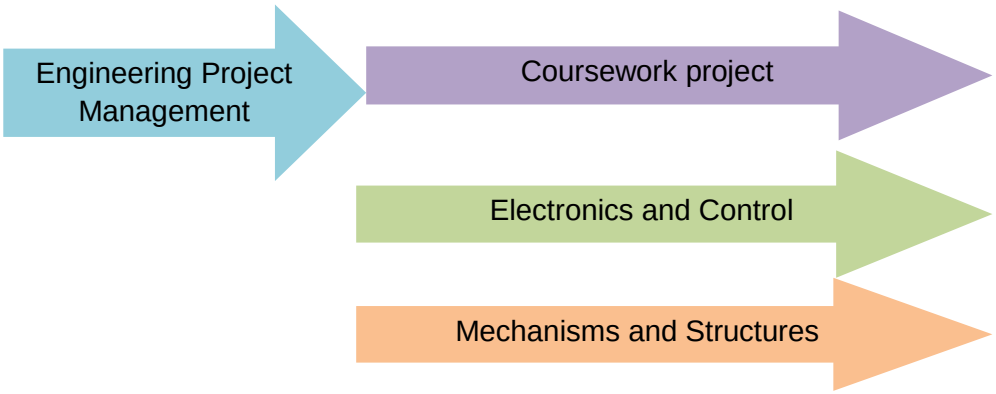
The rationale for this delivery model is that the project will be based on planning and research carried out during the *Project Management* Unit, and the knowledge and understanding developed in the *Electronics and Control*, and *Mechanisms and Structures,* Units.

Example 2: Concurrent delivery of Units



In this example, the three Units are studied concurrently, leading up to the final project. Combinations or hybrids of these two examples are also possible.

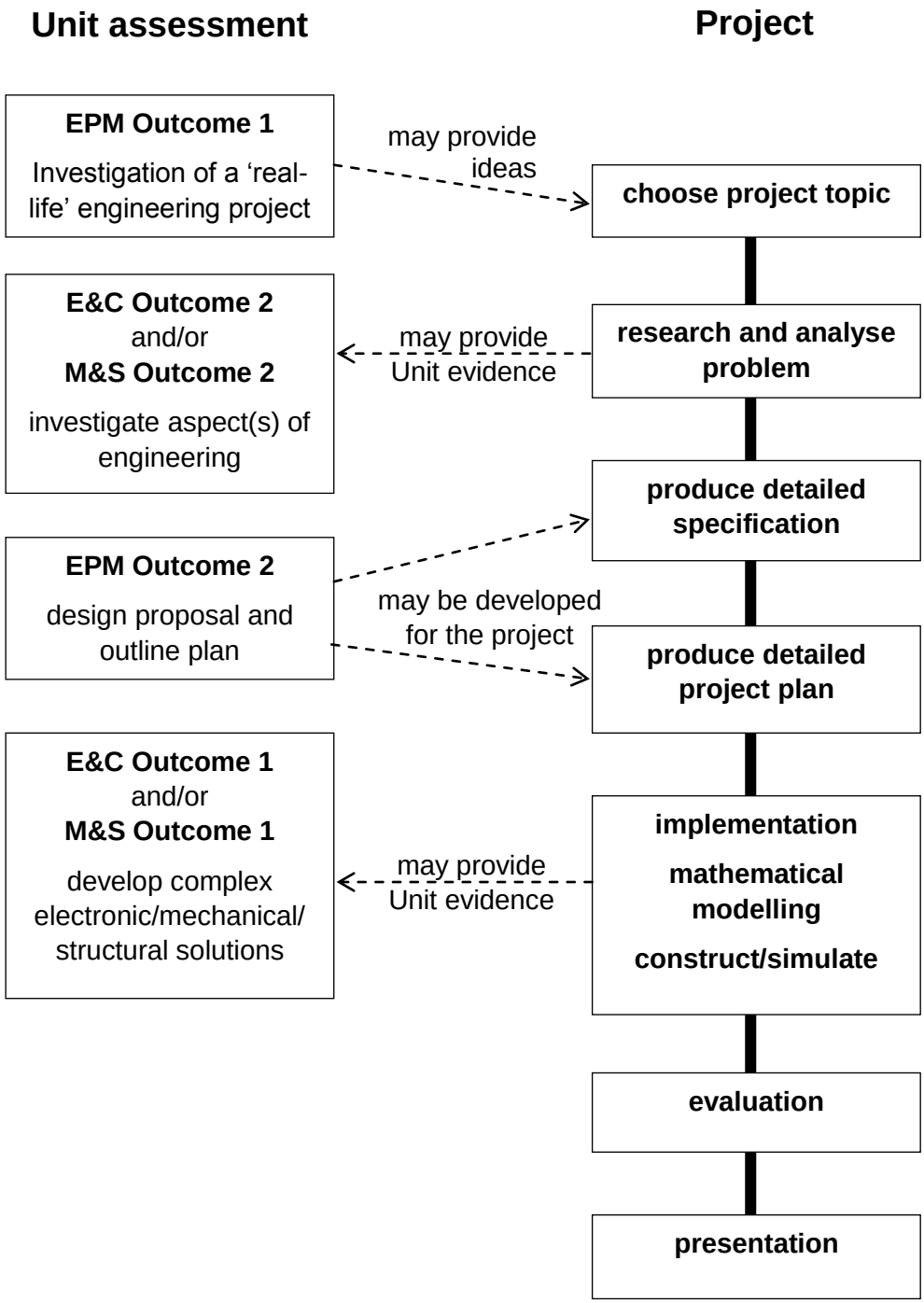
Example 3: Concurrent delivery of Units and Coursework project



In this example, the *Engineering Project Management* Unit is used as an introduction to the Coursework project, which then continues throughout the Course. Aspects of *Electronics and Control* and *Mechanisms and Structures* can be studied alongside the project, with relevant learning from these informing the project development.

There may be opportunities to contextualise approaches to learning and teaching to Scottish contexts in this Course. This could be done through mini-projects or case studies.

The diagram below summarises relationships between Unit Assessment and the Coursework project, indicating how it may be possible to provide an integrated approach to assessment, if using a hybrid approach to Course delivery similar to example 3 above.



Developing skills for learning, skills for life and skills for work

Details of these skills can be found in the *Course Specification* and the *Unit Specifications* for this Course.

Approaches to assessment

Assessment in Advanced Higher Courses should reflect the investigative nature of the Course at this level, together with high-level problem-solving and critical thinking skills and skills of analysis and synthesis.

This emphasis on higher-order skills, together with the more independent learning approaches that learners will use, distinguishes the added value at Advanced Higher level from the added value at other levels.

There are different approaches to assessment, and teachers/lecturers should use their professional judgement, subject knowledge and experience, as well as their understanding of their learners and their varying needs, to determine the most appropriate approaches and, where necessary, to consider workable alternatives.

Assessments must be fit for purpose and should allow for consistent judgements to be made by all teachers/lecturers. All assessment should be conducted in a supervised manner to ensure that the evidence provided is valid and reliable.

Unit assessment

Units will be assessed on a pass/fail basis. All Units are internally assessed against the requirements shown in the *Unit Specification*.

Assessments must ensure that the evidence generated demonstrates, at the least, the minimum level of competence for each Unit. Teachers/lecturers preparing assessment methods should be clear about what that evidence will look like.

Teachers/lecturers should refer to the following documents to ensure that all the requirements of Unit assessment are met:

- *Advanced Higher Engineering Project Management Unit Specification*
- *Advanced Higher Electronics and Control Unit Specification*
- *Advanced Higher Mechanisms and Structures Unit Specification*
- *Unit Assessment Support package 1: portfolio approach*
- *Unit Assessment Support package 2: Unit-by-Unit approach for each Unit*
- *Unit Assessment Support package 3: combined approach*

Unit Assessment Support packages are available on SQA's secure website (www.sqa.org.uk/sqasecure)

In particular, assessors should refer to the **judging evidence tables** within the Unit Assessment Support packages for guidance on making assessment judgements for each Outcome and Assessment Standard.

The structure of an assessment used by a centre can take a variety of forms, for example:

- individual pieces of work could be collected in a folio as evidence for Outcomes and Assessment Standards
- assessment of each complete Outcome
- assessment that combines the Outcomes of one or more Units
- assessment that requires more than the minimum competence, which would allow learners to prepare for the Course assessment

Teachers/lecturers should note that learners' day-to-day work may produce evidence which satisfies the assessment requirements of a Unit, or Units, either in full or partially. Such naturally-occurring evidence may be used as a contribution towards Unit assessment. However, this naturally-occurring evidence must still be recorded and evidence such as written reports, recording forms, PowerPoint slides, drawings/graphs, video footage or observational checklists, provided.

In this Advanced Higher Course, it may be that a strand of work which contributes to a Course assessment method is started when a Unit is being delivered and is completed in the Course assessment. In such cases, it is important that the evidence for the Unit assessment is clearly distinguishable from that required for the Course assessment. For example, the design proposal and plan required for Outcome 2 of the *Engineering Project Management* Unit is likely to be taken forward and developed by a learner into the Coursework project.

Added value

Advanced Higher Courses include assessment of added value which is assessed in the Course assessment.

Information given in the *Course Specification* and the *Course Assessment Specification* about the assessment of added value is mandatory.

In Advanced Higher Courses, added value involves the assessment of higher-order skills such as high-level and more sophisticated investigation and research skills, critical thinking skills and skills of analysis and synthesis. Learners may be required to analyse and reflect upon their assessment activity by commenting on it and/or drawing conclusions with commentary/justification. These skills contribute to the uniqueness of Advanced Higher Courses and to the overall higher level of performance expected at this level.

In this Course, added value will be assessed by means of a project and a question paper.

Preparation for Course assessment

Teachers/lecturers should refer to the following documents to ensure that all the requirements of Course assessment are met:

- Advanced Higher Engineering Science *Course Assessment Specification*
- Advanced Higher Engineering Science *General Assessment Information*
- Advanced Higher Engineering Science *Coursework assessment task (available at http://www.sqa.org.uk/sqasecure)*

Each Course has additional time that may be used at the discretion of the teacher/lecturer to enable learners to prepare for Course assessment. This time may be used near the start of the Course and at various points throughout the Course for consolidation and support. It may also be used for preparation for Unit assessment and, towards the end of the Course, for further integration, revision and preparation, and/or gathering evidence for Course assessment. For this Course, the assessment methods are a project and a question paper.

Preparation for the Coursework project

In relation to preparing for the project, teachers/lecturers should explain the requirements to learners and the amount and nature of the support they can expect. However, at Advanced Higher level, it is expected that learners will work with more independence and less supervision and support.

Learners should be given opportunities to develop and practise the skills required for the project including:

- selecting a topic
- gathering and researching information
- project planning
- evaluating and analysing findings
- developing and justifying conclusions
- presenting information

Detailed information on the Coursework project Component of Course assessment can be found in the *General Assessment Information* and the *Coursework assessment task* (project).

The **General Assessment Information** includes:

- an overview of the project, what it is for and its intentions
- the conditions for undertaking the project
- possibilities and limitations in relation to 'reasonable support and guidance'
- the evidence that has to be gathered
- and the actual Marking Instructions for each of the project aspects
- suggested engineering science project topics that might be interesting for the candidate to consider, although these are not mandatory

The **Coursework assessment task** includes:

- an overview of the project
- Marking Instructions (identical to those in the General Assessment Information)
- an assessment record
- comprehensive guidance for the candidate for each aspect of the project (this is found in Appendix 1, which can be detached and given to candidates)

Appendix 1 of the **Coursework assessment task** also provides the candidate with:

- guidance on recording progress
- the assessment requirements for each aspect of the project
- what to consider for each aspect
- additional guidance on research ethics if required
- suggested engineering science project topics

Preparation for the question paper

In relation to preparing for the question paper, learners should be given opportunities to develop and practise the skills required by:

- practising question paper techniques
- revising for the question paper

To support this learning, teachers/lecturers and learners may find it helpful to refer to:

- Advanced Higher Engineering Science *Specimen Question Paper*
- Advanced Higher Engineering Science *Exemplar Question Paper*
- Advanced Higher Engineering Science *Guidance on the use of past paper questions*

Authenticity

In terms of authenticity, there are a number of techniques and strategies to ensure that learners present work that is their own. Teachers/lecturers should put in place mechanisms to authenticate learners' evidence.

For more information, please refer to SQA's *Guide to Assessment*.

Further information on Course/Units

Approaches to learning and teaching

Engineering Project Management (Advanced Higher) Unit

It is recommended that if this Unit is being delivered as part of the Advanced Higher Engineering Science Course, it should be delivered concurrently with the other Units. If being delivered as a stand-alone Unit, then every opportunity should be taken to allow learners to apply and integrate engineering knowledge and skills from previous learning.

Notes on delivery of Outcome 1

The key word for this Outcome is 'investigate'. Teachers/lecturers should encourage each learner to embark on their own independent investigation, providing support and guidance as required.

Examples of suitable projects to be investigated could include, for example:

- a local civil engineering project (eg a road extension, new bridge or building, or a renovation project)
- an industrial process (eg the operation of a chemical plant or power station)
- a university-based research project (eg new designs for wave power generation devices)

Suitable projects can be large or small-scale, but must involve engineering processes, and can either be currently under development or recently completed. The investigation could involve site visits; it could also be based on printed or online sources of information.

When investigating project development and management, learners may consider aspects of resource management, time management, cost-allocation management, product life cycle planning and critical path analysis.

Notes on delivery of Outcome 2

Learners will need clear guidance on the suitability of their chosen engineering problem, to ensure it is both suitably challenging and realistically possible within time and resource constraints, especially if the learner intends to take the design proposal forward and implement a solution for the Course assessment.

Learners may need teacher/lecturer input on developing a design proposal and project planning. The project plan could be a critical path analysis, an activity-on-node diagram or a Gantt chart. The plan should show each of the activities required to complete the proposal, the time required for each activity and the dependencies between activities.

Electronics and Control (Advanced Higher) Unit

Notes on delivery of Outcome 1

Possible learning activities that would meet the Unit standards and cover the mandatory Course concepts could include:

- analysing circuits using nodal analysis by:
  - labelling all circuit parameters and distinguishing unknown from known
  - identifying all nodes of the circuit
  - selecting a node as the ground node and giving it a potential of 0 V; all other voltages in the circuit are measured with respect to the ground node
  - labelling the voltages and polarities at all other nodes
  - applying Kirchhoff's Current Law at each node and expressing the branch currents in terms of the node voltages
  - solving the resulting two simultaneous equations for the node voltages
  - now that the node voltages are known, the branch currents may be obtained using Ohm's law
- designing transistor biasing circuits for a given output load
- calculating the switch-on and switch-off threshold values for a Schmitt trigger or an unknown resistor value if given one of the thresholds, and sketching a hysteresis curve of the output a Schmitt trigger showing the threshold voltages
- investigating and calculating values for a basic integrating op-amp used as a ramp generator
- calculating the frequency of a Wien bridge oscillator, using the expression $f=1/(2\pi RC)$
- designing a suitable 555 timer circuit with a single unknown, using the expression $f= 1.44 / (R_1 +2R_2) C$
- studying the principles and applications of A-D and D-A conversion
- investigating the basic principles of power generation, for example:
  - drawing a single-line schematic of the electricity supply system that includes interconnected generators, transmission system, distribution system, industrial and low voltage loads, relevant transformers and small-scale generation; the schematic should show at least two feeders in all systems to allow for duality of supply and one spur feeder, and should be annotated with relevant voltage levels
  - explaining the function of each item of apparatus in the electricity supply system and the requirement of alternative feed routes
  - describing at least four energy sources and listing typical ratings for each, explaining load matching
- developing high-level language programs (possibly using C or another high-level control language) to solve control problems involving multiple inputs and outputs, and proportional control
- creating programs that include input, output, branching, loops (fixed, continuous, nested), time delays, logic and arithmetical operations, and subroutines

Wherever possible, practical activities should be used to develop understanding.

Notes on delivery of Outcome 2

Learners should choose a topic or application within the broad areas of electronic, electrical or control engineering, carry out some research (probably internet-based), and report on their findings. The results of this research may be used to support the learner's Coursework project.

Mechanisms and Structures (Advanced Higher) Unit

Notes on delivery of Outcome 1

Possible learning activities that would meet the Unit standards and cover the mandatory Course concepts could include:

- analysis and calculation of forces and torque within drive systems, for example using Hooke's law as a workable approximation to determine the shear stress in a member with a torque applied to it (assuming a uniform shear stress in the member the shear force can then be calculated)
- using tables of data to select materials and standard sections, to meet a given requirement for a simple beam design; calculations can then be carried out to investigate a loaded beam using the general bending equation
- use of equations of equilibrium in a beam with type 1 and type 2 support
- applying the conditions of static equilibrium to complex structural systems, and carrying out calculations to determine the magnitude and direction of support reactions
- beam analysis (for forces acting in three dimensions, by resolving into two orthogonal planes)
- free-body diagram for a beam under the action of gear or pulley forces
- investigating complex plane triangulated frames using the method of sections to determine the magnitude and nature of the internal forces in the members
- evaluation of the distribution of shear force and bending moment for loaded beams, by using free-body diagrams and calculations to determine the magnitude of support reactions; the shear force and bending moment applied to loaded beams can then be investigated and diagrams drawn up

Notes on delivery of Outcome 2

Learners should choose a topic or application within the broad areas of mechanical, structural or civil engineering, carry out some research (probably internet-based), and report on their findings. The results of this research may be used to support the learner's Coursework project.

Comparison of skills, knowledge and understanding for Higher and Advanced Higher

The following table shows the relationship between the mandatory Higher and Advanced Higher knowledge and understanding. This table may be useful for:

- ensuring seamless progression between levels
- identifying important prior learning for learners at Advanced Higher

Teachers/lecturers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

Course themes		
Topic	**Higher**	**Advanced Higher**
The systems approach	complex system, sub-system and control diagrams the role of feedback in a system closed-loop, two-state and proportional feedback use of error detection in a closed-loop system	use of system, sub-system and control diagrams to analyse complex engineering systems, including time and event based systems
Energy and efficiency	calculations related to energy audits: inputs, outputs, energy losses and efficiency applied calculations involving efficiency, work done and power, using: $E_w = Fd$ $P = E/t$, $E_k = ½ mv^2$ $E_p = mgh$ $E_e = VIt$ $E_h = cm\Delta T$ Efficiency $\eta = E_{out}/E_{in} = P_{out}/P_{in}$	use of energy audits and cost implications to inform engineering decisions applied calculations involving efficiency, work done and power, in complex situations, using: $E_w = Fd$ $P=E/t$, $E_k = ½ mv^2$ $E_p = mgh$ $E_e = VIt$ $E_h = cm\Delta T$ Efficiency $\eta = E_{out}/E_{in} = P_{out}/P_{in}$
Calculations and mathematical techniques	manipulating and combining given formulae to obtain answers solving structural problems using trigonometric functions and substitution in simultaneous equations	extracting data for use in analysis and calculations manipulating and combining given formulae to obtain answers solving simultaneous equations solving quadratic equations applying trigonometric techniques using integration and differentiation in familiar contexts

Engineering Contexts and Challenges/Engineering Project Management		
Topic	**Higher**	**Advanced Higher**
Engineering roles and disciplines	the role of the professional engineer within a project, including communication and team working the skills and specialist knowledge required within projects	research and development resource management time management (including critical path analysis and Gantt charts) cost-allocation management (capital costs, direct costs, in direct costs, oncosts) product life cycle planning
Impacts of engineering	examples of social and economic impacts (positive and negative) of engineering examples of environmental impacts (positive and negative) of engineering sustainability of engineering solutions emerging technologies and their impact	social and economic impacts of engineering sustainability and environmental impacts of engineering

Analogue electronic control systems		
Topic	**Higher**	**Advanced Higher**
Voltage, current, and resistance		Kirchhoff's Laws and nodal analysis (with two unknowns) of circuits
Voltage dividers	variable resistors, LDR and thermistor in voltage dividers use of input transducer characteristics (from data booklet) to design voltage dividers to meet specification	
Transistors and amplifiers	function and purpose of BJTs (bipolar junction transistors), 741ICs (building blocks) and op-amps (devices for amplifying voltage signals) function of op-amp configurations: inverting, non-inverting, comparator, difference amplifier, summing amplifier design of BJT circuit as a current amplifier calculation of relationship between input and output voltages for different op-amp configurations calculation of current gain (h_{FE}) of an npn transistor design of MOSFET (n-channel enhancement mode) circuit as a voltage operated switch	designing transistor biasing circuits for a given output load Schmitt triggers, including use to produce square waves integrating amplifiers use of 555 and Wien Bridge oscillators to generate shaped waveforms and clock signals
Generation and transmission		basic principles of electrical power generation basic principles of electrical power transmission, including: transformers, advantages of AC, main components of the national grid (step-up and step-down transformers, high voltage transmission, control centre) AC-DC and DC-AC conversion

Digital electronic control systems		
Topic	**Higher**	**Advanced Higher**
Digital logic	logic functions: AND, OR, NOT, NAND, NOR, EOR and combinations conversion to NAND equivalent development of Boolean expressions from truth tables, logic diagrams or circuit specifications construction of truth tables and logic diagrams from written specifications	
Microcontroller control systems	controlling a motor using pulse width modulation control routines with up to four inputs and four outputs	interfacing microcontrollers principles and applications of A-D and D-A conversion
Flowcharts and programming	use of infinite and finite loops and time delays use of logic and arithmetic operations to make decisions	developing programs using an appropriate high-level language to solve control problems involving multiple inputs and outputs, and proportional control using a range of constructs that include input, output, branching, loops (fixed, continuous, nested), time delays, logic and arithmetical operations, subroutines

Mechanisms and Structures		
Context	**Higher**	**Advanced Higher**
Drive systems	selection of appropriate drive systems (including simple and compound gear trains, belt drives and chain drives) in different contexts the purpose of couplings (rigid and flexible — all types), bearings and joints in shafts friction in brakes and clutches calculation of torque: T = Fr	analysis and calculation of forces and torque within drive systems
Pneumatics	sequential control circuits with up to two cylinders electro-pneumatic control circuits	
Structures and forces	resolving triangle/polygon of forces, resultant/equilibrium calculation of reaction forces in simply supported beams where loads are not horizontal or vertical, with hinge and roller supports, with UDLs (uniformly distributed loads) use of nodal analysis to calculate the size and nature of forces in frames	Free-body diagram for a beam under the action of gear or pulley forces use of equations of equilibrium for simply supported beams (including forces acting in three dimensions, by resolving into two orthogonal planes) and cantilever beams bending moment diagrams and shear force diagrams
Materials	calculation of Young's Modulus of elasticity and factor of safety use of strain gauges stress-strain graphs calculation of strain energy: $E_s = ½ Fx$	second moment of area general beam bending equation maximum values of deflection for cantilever, simply supported and built-in beams subject to either a point load or a UDL

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled candidates and/or those with additional support needs) — various publications are available on SQA's website at: www.sqa.org.uk/sqa//14977.html.
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specification
- Design Principles for National Courses
- *Guide to Assessment*
- Principles and practice papers for curriculum areas
- *SCQF Handbook: User Guide* and SCQF level descriptors
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- *Skills for Learning, Skills for Life and Skills for Work: Using the Curriculum Tool*
- *Coursework Authenticity: A Guide for Teachers and Lecturers*

Administrative information

Published: May 2015 (version 2.0)

History of changes to Advanced Higher Course/Unit Support Notes

Version	Description of change	Authorised by	Date
2.0	Additional example of course structure and delivery included, with diagram showing a combined approach to assessment. Further advice given on delivery of Units within 'Approaches to learning and teaching' section. Adjustments made to the comparative tables in the **'**Comparison of skills, knowledge and understanding for Higher and Advanced Higher' section, for consistency with Course Assessment Specification. General restructuring of document to signpost information available within other documents, and improve overall readability.	Qualifications Development Manager	May 2015