



National
Qualifications

Engineering Science Project General assessment information

This pack contains general assessment information for centres preparing candidates for the project Component of Advanced Higher Engineering Science Course assessment.

It must be read in conjunction with the specific assessment task for this Component of Course assessment which may only be downloaded from SQA's designated secure website by authorised personnel.

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Introduction

This is the general assessment information for the Advanced Higher Engineering Science project.

This project is worth 90 marks out of a total of 150 marks. This is 60% of the overall marks for the Course assessment. The Course will be graded A-D.

Marks for all Course Components are added up to give a total Course assessment mark which is then used as the basis for grading decisions.

This is one of two Components of Course assessment. The other Component is a question paper.

This document describes the general requirements for the assessment of the project Component for this Course. It gives general information and instructions for assessors.

It must be read in conjunction with the assessment task for this Component of Course assessment.

Equality and inclusion

This Course assessment has been designed to ensure that there are no unnecessary barriers to assessment. Assessments have been designed to promote equal opportunities while maintaining the integrity of the qualification.

For guidance on assessment arrangements for disabled candidates and/or those with additional support needs, please follow the link to the Assessment Arrangements web page: www.sqa.org.uk/sqa/14977.html

Guidance on inclusive approaches to delivery and assessment in this Course is provided in the *Course/Unit Support Notes*.

What this assessment covers

This assessment contributes 60% of the total marks for the Course.

The assessment will assess the skills, knowledge and understanding specified for the project in the *Course Assessment Specification*. These are:

- ◆ practical application of knowledge and skills from across the Course to develop a solution to an appropriately challenging and complex engineering problem
- ◆ skills in implementing a solution to the problem, and evaluating and reporting on that solution

Assessment

Purpose

The purpose of this assessment is to generate evidence for the Added Value of this Course by means of a project.

Assessment overview

The project will be based on a meaningful task providing appropriate challenge and requiring application at an appropriate level. This may be based on the design proposal and project plan developed in the *Engineering Project Management* Unit.

The project should clearly demonstrate application of knowledge and/or skills (including the use of mathematical techniques) at an appropriate level, related to one or more of mechanisms, structures, electronics and control (as defined in the 'Further mandatory information on Course coverage' section of the *Course Assessment Specification*), and application of knowledge and/or skills from the candidate's own research into other aspects of engineering.

The project is designed to allow candidates to demonstrate their ability to work independently, as they are required to do in the other Component of the Course assessment, the question paper.

The project is set by centres within SQA guidelines. Candidates may choose the topic for their project in discussion with centre staff.

Marks will be awarded for:

- ◆ research and analysis of the chosen problem
- ◆ producing a specification
- ◆ producing a detailed project plan
- ◆ mathematical modelling/analysis
- ◆ constructing/simulating a solution
- ◆ evaluating the development process and solution, and identifying possible further developments
- ◆ presenting/communicating the solution, including its possible uses and its implications

The project will be internally marked by centre staff, in line with the Marking Instructions provided in this document.

Full instructions for candidates are contained within the assessment task.

Suitable problems could include, but are not limited to, the following:

- ◆ Design and build a radio-controlled robotic device to perform a specified type of task.
- ◆ Design and build a model renewable energy device.
- ◆ Develop a scale model of a 24hr lighting system based on renewable energy (wind/wave/solar) and rechargeable batteries which must run constantly, even when no direct energy is available.
- ◆ Develop a simple automated robot to do a simple task: for example, a scale model warehouse delivery system, restocking three sales points from a store when items are removed.
- ◆ Investigate stress concentration at a sudden change of geometry in a component: compare computer simulation versus experimental values, using strain gauges with an appropriate electronic amplifier.
- ◆ Create a stable platform for a sensitive instrument: using a 2/3 axis accelerometer to detect attitude, and microcontroller-based drive to adjust table attitude.
- ◆ Develop a rotational speed sensor and a lateral movement sensor to measure vibration of a rotating shaft, using disc(s) on a shaft to provide (small) mass imbalance.
- ◆ Develop a variable speed propulsion system for a remotely operated underwater vehicle (ROV) or an autonomous vehicle of some sort.
- ◆ Develop an active neutral buoyancy system for an ROV: investigate how to adjust buoyancy to match water conditions.
- ◆ Investigate improving lift/drag ratio of an aerofoil (evolutionary design): develop a force sensor to detect overall lift and overall drag on an aerofoil, and devise a model which enables quick changes to be made to an aerofoil section between measurements of lift and drag.
- ◆ Develop two vehicles that avoid each other while moving between definite locations in a confined space.
- ◆ Develop a distance measurement system or system for measuring physical dimensions for use underwater.
- ◆ Study how buildings behave during earthquakes at different shaking frequencies, by modelling tall buildings using slender materials and creating a shaking table on which they can stand.
- ◆ Construct a rig to test the output of an electric motor by means of a brake test or other; measure the power input to the motor and the power output, to validate the stated performance of the motor.
- ◆ Construct a rig to test the transmission efficiency of a gear box for different arrangements.
- ◆ Design and build frame structures to avoid obstacles, investigating compression and buckling of slender bars.

It is important for mentors/assessors to discuss potential project ideas with candidates, to ensure that they involve sufficient complexity and challenge to be appropriate for Advanced Higher, but are also achievable within the constraints of time, expertise and resources available.

Assessment conditions

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

This assessment will be carried out over a period of time. Candidates should start at an appropriate point in the Course. This will normally be after they have started work on the Units in the Course.

This is an open-book assessment. There are no restrictions on the resources to which candidates may have access.

Independent working and 'reasonable assistance'

Candidates must undertake the assessment independently. However, reasonable assistance may be provided prior to, and during the formal assessment process, as described below.

Reasonable assistance should be limited to constructive comment and/or questioning. Assessors should **not** adopt a directive role or provide specific advice on how to re-phrase, improve responses or provide model answers, as this would constitute support for assessment and assessors need to be aware that this would be going **beyond** reasonable assistance.

In the construction/simulation aspects, practical technical advice may also be provided where required, as practical skills are not being assessed.

Preparing candidates for assessment

In addition to providing learning activities to develop candidates' subject knowledge and skills, assessors may give advice on generic skills, such as how to produce a project plan or conduct research. This would normally be given to a class or group of candidates.

Advising candidates on choice of topic/problem

Candidates are not assessed on choosing a suitable problem for their project, so assessor input and advice on the candidate's choice of a problem should be given, to ensure that the chosen problem is suitably complex and challenging, but is achievable.

Additional support and guidance to candidates during the project

Candidates should work independently once the formal assessment process has started, with assessor input limited to constructive comment and/or questioning, as described above.

However, it may be necessary to provide more significant assessor input and advice for some candidates during the early stages of the project – research and analysis, producing a specification and producing a detailed project plan – to allow them to continue to later stages. Any significant advice and guidance given to a candidate, over and above reasonable assistance, should be recorded by the assessor and be reflected in the marks awarded for those aspects. This would generally mean a mark from the lower bands for these aspects.

Supervision

The project will be conducted under some supervision and control. This means that although candidates may complete part of the work outside the learning and teaching setting, assessors should put in place processes for monitoring progress and ensuring that the work is the candidate's own and that plagiarism has not taken place, for example:

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

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

Once the project has been completed and all evidence submitted, it must not be returned to the candidate for further work to improve their mark.

Evidence to be gathered

The following candidate evidence is required for this assessment:

- ◆ the specification and detailed project plan
- ◆ the candidate's 'record of progress' through the project, including reflective commentary and all items of evidence specified within the task
- ◆ evidence of the completed solution (models or photographs and/or hard copy from simulation software)
- ◆ qualitative and quantitative evaluation of the solution and development process
- ◆ the candidate's presentation or report on the solution, its possible uses and its implications
- ◆ detailed assessor observation notes, providing evidence of the candidate's degree of independence and safe working practices

This evidence must be retained for quality assurance purposes.

Record of progress

Entries in the candidate's 'record of progress' contribute to the marks to be awarded for the process-based aspects of the project: research and analysis, mathematical modelling/analysis, and constructing/simulating the solution.

Research and evaluation

Marks for the research and evaluation aspects may be based on evidence produced at various stages throughout the project, and are not limited to initial research or final evaluation.

General Marking Instructions

In line with SQA's normal practice, the following general Marking Instructions are addressed to the marker. They will also be helpful for those preparing candidates for Course assessment.

The assessment task will be set by SQA and conducted, marked and internally verified in centres, under conditions set by SQA.

All marking will be quality assured by SQA.

General Marking Principles for the project

This information is provided to help you understand the general principles you must apply when marking candidate responses to this project. These principles must be read in conjunction with the detailed Marking Instructions, which identify the key features required in candidate responses.

- (a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the detailed Marking Instructions for this assessment.
- (b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

Detailed Marking Instructions for the project

Marks will be awarded for the following aspects:

	Marks available
Research and analysis of the chosen problem	10
Producing a specification	10
Producing a detailed project plan	10
Mathematical modelling/analysis	20
Constructing/simulating a solution	20
Evaluating the development process and solution, and identifying possible further developments	10
Presenting/communicating the solution, including its possible uses and its implications	10

Assessors should allocate a mark for each of these aspects by following the instructions given below. This mark should be recorded on the assessment record, **with detailed comments justifying why each mark was awarded.**

Marks for internally-assessed Components must be submitted to SQA by the centre. Evidence for this assessment should be retained in the centre for SQA quality assurance purposes. Further information on this will be provided by SQA.

For each of the aspects, the assessor should select **the band descriptor which most closely describes** the evidence gathered. Note, this means that in some cases, the evidence does not match exactly all the elements listed for any of the band descriptors, and an element of judgment will be required by the assessor.

Once the best fit has been selected, follow this guidance:

- ◆ If the evidence almost matches the level above, the highest available mark from the range should be awarded.
- ◆ If the candidate's work just meets the standard described, the lowest mark from the range should be awarded.
- ◆ If neither of the above is appropriate, then a mark from the middle of the range should be awarded.

Notes:

- ◆ If the evidence completely matches the highest level band descriptor for any aspect, and has been produced by the candidate working independently, full marks should be awarded for that aspect.
- ◆ Zero (0) marks should be awarded for any aspect where no appropriate evidence has been produced by the candidate.

The marks awarded should be based on the **candidate's independent work**.

Band descriptors for research and analysis of the chosen problem

Marks for this aspect should be based on research and analysis of the problem/need and the production of a project proposal plan. This section should include:

- ◆ analysis of the problem and identifying appropriate factors to research
- ◆ a research strategy, detailing how the information is going to be found
- ◆ evidence of completed research, drawing meaningful conclusions

	Marks
◆ complete and detailed notes from relevant research and analysis, including formally referenced sources	8-10
◆ some notes from relevant research and analysis, including sources	5-7
◆ some limited notes from research and analysis	1-4
If there is no evidence of research and analysis, award 0 marks for this aspect.	
<p>Information for assessors</p> <p><i>It may be that some candidates are unable to produce sufficient initial research and/or analysis to allow them to progress the project in a meaningful way. Where this is the case, the assessor can choose to assist the candidate to produce enough initial research and/or analysis to allow progress to further stages of the project.</i></p> <p><i>In such cases, the candidate should be marked only on the work produced independently. Bearing in mind that research will be ongoing throughout the project, a final mark should not be awarded until the project is completed. Appropriate assessor comments should be made against this section in the candidate's marking record to support the mark awarded.</i></p>	

Band descriptors for producing a specification

Marks for this aspect should be based on the specification produced by the candidate.

	Marks
<ul style="list-style-type: none"> ◆ complete and detailed specification from initial proposal, including numerical values of all inputs and outputs ◆ identification of all main sub-systems, processes and interactions between sub-systems 	8-10
<ul style="list-style-type: none"> ◆ partially complete specification, lacking detailed information ◆ identification of most inputs, processes and outputs 	5-7
<ul style="list-style-type: none"> ◆ incomplete specification, omitting several significant inputs, processes or outputs 	1-4
<p>If there is no evidence of the specification being based on meaningful research and analysis, award 0 marks for this aspect.</p>	
<p>Information for assessors</p> <p><i>It may be that some candidates are unable to produce a specification which will allow them to progress the project in a meaningful way. Where this is the case, the assessor can choose to assist the candidate in producing a minimum specification which will allow the candidate to progress to further stages of the project.</i></p> <p><i>In such cases, the candidate should be marked only on the work produced independently. Appropriate assessor comments should be made against this section in the candidate's marking record to support the mark awarded.</i></p>	

Band descriptors for producing a detailed project plan

Marks for this aspect should be based on the detailed project plan produced by the candidate. The plan should include:

- ◆ a Gantt chart and/or Critical Path Analysis (with detail of intermediate and final targets)
- ◆ detail on what resources are required, when they are required and how they will be sourced
- ◆ evidence of continuous auditing of the plan, with detailed commentary of any refinements made throughout the project. Evidence of this may also appear in the ‘record of progress’

	Marks
<ul style="list-style-type: none"> ◆ complete and detailed project plan, including full details of resources, time management and intermediate targets ◆ evidence of ongoing refinement of the plan ◆ detailed reflective commentary on any changes to plan 	8-10
<ul style="list-style-type: none"> ◆ complete project plan covering resources, time management and intermediate targets, but lacking some detail ◆ some reflective commentary on any changes to the plan 	5-7
<ul style="list-style-type: none"> ◆ incomplete project plan (eg covering time management only, or outline plan only) 	1-4
If there is no evidence of a detailed project plan, award 0 marks for this aspect	
<p>Information for assessors</p> <p><i>This aspect of the project should be revisited throughout as the candidate makes alterations in light of decisions and changes arising from modelling and simulating/constructing a solution. It is expected that the plan will be altered throughout the process. Bearing in mind this iterative process, the planning stage should not be marked until the project is completed.</i></p> <p><i>Updates and refinement to the project plan should be dated to show the frequency and regularity of review. Review does not always need to result in changes – where this is the case, this should be noted.</i></p> <p><i>It may be that some candidates are unable to produce a logical or useful project plan which will allow them to progress the project in a meaningful way. Where this is the case, the assessor can choose to assist the candidate in producing a minimum project plan.</i></p> <p><i>In such cases, the candidate should be marked only on the work produced independently. Bearing in mind that planning will be ongoing throughout the project, a final mark should not be awarded until the project is completed. Appropriate assessor comments should be made against this section in the candidate’s marking record to support the mark awarded.</i></p>	

Band descriptors for mathematical modelling/analysis

This section should be systematic and thorough and include mathematics appropriate to the level of **Advance Higher Engineering Science**, such as quadratic equations, calculus. It should be noted that this section not only involves mathematical calculations, but could also include developing complex control programs, etc. A more detailed list of possibilities is given in Appendix 1 of the Coursework assessment task.

	Marks
<ul style="list-style-type: none"> ◆ mathematical modelling/analysis using a range of techniques appropriate to the level of the Course ◆ results applied to several aspects of the project solution ◆ using realistic, fully justified numerical values ◆ detailed reflective commentary 	17-20
<ul style="list-style-type: none"> ◆ mathematical modelling/analysis using at least two techniques appropriate to the level of the Course ◆ results applied to at least two aspects of the project solution ◆ using realistic numerical values ◆ some reflective commentary 	13-16
<ul style="list-style-type: none"> ◆ some mathematical modelling/analysis using at least one technique appropriate to the level of the Course ◆ some results applied to at least one aspect of the project solution ◆ using realistic numerical values ◆ some reflective commentary 	10-12
<ul style="list-style-type: none"> ◆ some mathematical modelling/analysis using basic techniques ◆ some results applied to at least one aspect of the project solution ◆ using some realistic numerical values ◆ few entries in 'record of progress' for this aspect, with little reflective commentary 	5-9
<ul style="list-style-type: none"> ◆ limited mathematical modelling/analysis using simple techniques ◆ limited application to the project solution ◆ limited use of realistic numerical values 	1-4
<p>If there is no evidence of mathematical modelling/analysis, award 0 marks for this aspect.</p>	

Band descriptors for constructing/simulating a solution

Marks for this aspect should be based on evidence of construction or simulation carried out by the candidate at any stage of the project.

	Marks
<ul style="list-style-type: none"> ◆ all main sub-systems constructed or simulated with full description of how a complete, fully integrated solution could be implemented ◆ clear evidence of application of knowledge and skills from the course or own research, related to the specification ◆ decisions on materials and components fully justified ◆ detailed reflective commentary 	17-20
<ul style="list-style-type: none"> ◆ several sub-systems constructed or simulated, with outline description of how a complete, fully integrated solution could be implemented ◆ some evidence of application of knowledge and skills from the course or own research, related to the specification ◆ some decisions on materials and components justified ◆ some reflective commentary 	13-16
<ul style="list-style-type: none"> ◆ at least two sub-systems simulated or constructed ◆ limited evidence of application of knowledge and skills from the course or own research, related to the specification ◆ some decisions on materials and components justified ◆ some reflective commentary 	10-12
<ul style="list-style-type: none"> ◆ one sub-system simulated or constructed ◆ limited evidence of application of relevant knowledge and skills ◆ limited justifications for decisions on materials and components ◆ no reflective commentary 	5-9
<ul style="list-style-type: none"> ◆ few aspects of design simulated or constructed ◆ no evidence of application of relevant knowledge and skills ◆ no justifications for decisions on materials and components ◆ no reflective commentary 	1-4
<p>If there is no evidence of construction/simulation, award 0 marks for this aspect.</p>	

Band descriptors for evaluating the development process and solution, and identifying possible further developments

Marks for this aspect should be based on evidence of the candidate's final evaluation of the project, any evaluation carried out by the candidate throughout the project and the candidate's 'record of progress' for this aspect.

Note: Evaluative comments should refer to the specification.

	Marks
<ul style="list-style-type: none"> ◆ complete and detailed qualitative evaluation of the solution, with valid, relevant and clear conclusions ◆ complete and detailed quantitative evaluation of the solution, with valid, relevant and clear conclusions ◆ relevant and justified evaluative commentary on the development process and candidate's own performance, referring to entries in the candidate's 'record of progress' and project plan ◆ detailed descriptions of possible further developments 	8-10
<ul style="list-style-type: none"> ◆ some qualitative and quantitative evaluation of the solution, with some valid and relevant conclusions ◆ some evaluative commentary on the development process ◆ some descriptions of possible further developments 	5-7
<ul style="list-style-type: none"> ◆ limited evaluation of the solution and/or the development process and/or descriptions of possible further developments 	1-4
<p>If there is no evidence of evaluation and identification, award 0 marks for this aspect.</p>	

Band descriptors for presenting/communicating the solution, including its possible uses and its implications

Marks for this aspect should be based on evidence of the candidate's 'record of progress' and final presentation or communication of the project.

	Marks
<ul style="list-style-type: none"> ◆ presentation or communication of the solution is complete, detailed and well structured, and includes relevant and detailed commentary on possible uses and implications ◆ 'record of progress' is detailed, reflective and with content appropriate to Advanced Higher level 	8-10
<ul style="list-style-type: none"> ◆ presentation or communication of the solution is mainly complete and relevant, and includes some relevant commentary on possible uses and implications ◆ 'record of progress' is detailed and reflective 	5-7
<ul style="list-style-type: none"> ◆ presentation or communication of the solution is incomplete, lacks detail, and includes only limited commentary on possible uses and implications ◆ basic 'record of progress' 	1-4
<p>If there is no evidence of presenting/communicating the solution, award 0 marks for this aspect.</p>	

Administrative information

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History of changes

Version	Description of change	Authorised by	Date
1.1	Changes made to the band descriptors for each aspect of the project.	Qualifications Manager	September 2016

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