Advanced Higher Coursework Assessment Task

Advanced Higher Engineering Science Project Assessment task

This document provides information for teachers and lecturers about the coursework component of this course in terms of the skills, knowledge and understanding that are assessed. It **must** be read in conjunction with the course specification.

Valid from session 2024-25 and until further notice.

This edition: September 2024 (version 2.0)

Contents

Introduction

This document contains instructions for teachers and lecturers, recording documentation, marking instructions, and instructions for candidates for the Advanced Higher Engineering Science project. You must read it in conjunction with the course specification.

This project is worth 75 marks. This is 50% of the overall marks for the course assessment.

This is one of two course assessment components. The other component is a question paper.

Instructions for teachers and lecturers

Note: these instructions are written for teachers and lecturers. Where 'teachers and lecturers' are mentioned, this would also include any centre-designated assessors.

Candidates must choose a problem or issue as the basis of their project, and agree this with you to ensure that it is appropriate and provides suitable depth.

Projects must include content (and consist of major sub-systems) from the areas of study for both 'electronics and control' **and** 'mechanisms and structures'. You can find further details of these areas in the 'Skills, knowledge and understanding for the course assessment' section of the course specification.

You must ensure that candidates have access to any resources necessary for their project. However, they must complete the project independently — no group working is permitted.

Once project work is completed and assessed, you cannot return it to a candidate for further work or to improve their marks — it cannot be re-assessed.

You can find the assessment conditions in the course specification.

Evidence

Candidate evidence must be at an appropriate level for Advanced Higher Engineering Science. Evidence includes prints from simulation software, photographs of built models, records of testing, and an evaluation.

Candidates must produce a record of progress **and** a project response. The record of progress should contain information that supports candidates' decisions and the marks awarded by the assessor. The project response should address each stage of the project.

The 'Marking instructions' section provides complete information on the evidence required.

All evidence is internally assessed. You must retain it for quality assurance purposes.

Internal assessment appeals

Once you have fully assessed the project, you must let candidates know their project mark. You must inform candidates that their result is provisional, as their work is subject to external verification by SQA. You must inform candidates of their final result after external verification.

This assessment only permits a single attempt within an academic session, so no re-assessment attempts are possible. If candidates do not achieve their desired result, you must inform them of your centre's internal assessment appeals process, and what options are available to them.

Recording documentation

Advanced Higher Engineering Science project: assessment record

Candidate name: _____ SCN: _____ Centre: _____

Project title: _____ Assessor: _____

Outline (5 marks)	**Mark awarded**	**Total marks**	**You must provide comments to support your assessment judgements and the marks awarded**
Project aims, objectives and methodology (3 marks)			
Outline specification and resource requirements (2 marks)			

Research, analysis and specification (15 marks)	**Mark awarded**	**Total marks**	**You must provide comments to support your assessment judgements and the marks awarded**
Analysis of the problem or issue and identifying suitable factors to research (5 marks)			
Research (5 marks)			
Specification (5 marks)			

Production and maintenance of a project plan (10 marks)	**Mark awarded**	**Total marks**	**You must provide comments to support your assessment judgements and the marks awarded**
Project plan (7 marks)			
Project plan maintenance and/or refinement (3 marks)			

Mathematical modelling and analysis (15 marks)	Mark awarded	Total marks	You must provide comments to support your assessment judgements and the marks awarded
Mathematical modelling and analysis of a major 'electronics and control' sub-system (5 marks)			
Mathematical modelling and analysis of a major 'mechanisms and structures' sub-system (5 marks)			
Mathematical modelling and analysis of **another** major 'electronics and control' **OR** 'mechanisms and structures' sub-system (5 marks)			

Constructing and/or simulating a solution (15 marks)	Mark awarded	Total marks	You must provide comments to support your assessment judgements and the marks awarded
Construction and/or simulation of a major 'electronics and control' sub-system (5 marks)			
Construction and/or simulation of a major 'mechanisms and structures' sub-system (5 marks)			
Materials and components (3 marks)			
Reflective commentary on construction and/or simulation (2 marks)			

Evaluation (10 marks)	Mark awarded	Total marks	You must provide comments to support your assessment judgements and the marks awarded
Evaluation of the solution (4 marks)			
Evaluation of the process (4 marks)			
Further developments (2 marks)			

Presentation (5 marks)	Mark awarded	Total marks	You must provide comments to support your assessment judgements and the marks awarded
Presentation of the solution (3 marks)			
Record of progress (2 marks)			

Total marks for project:

Marking instructions

The following marking instructions are for the Advanced Higher Engineering Science project. In line with SQA's normal practice for internally assessed coursework, they are addressed to the designated centre assessor. They will also be helpful for those preparing candidates for course assessment.

General marking principles

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

a Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.
b If a candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance.
c Only mark candidates on the work they produce independently.
d Record the marks on the assessment record provided, with detailed comments to support your assessment judgements.

Area	Marks
Outline	**5**
Research, analysis and specification	**15**
Production and maintenance of a project plan	**10**
Mathematical modelling and analysis	**15**
Constructing and/or simulating a solution	**15**
Evaluation	**10**
Presentation	**5**

Detailed marking instructions

Outline (5 marks)

Award marks for an outline of the chosen problem or issue. This should include:

- aims of project
- project objectives
- methodology
- initial analysis
- basic outline specification
- resource requirements

Some candidates may be unable to produce sufficient initial analysis to allow them to progress the project in a meaningful way. Where this is the case, you can help them to produce enough initial analysis to allow them to progress to the next stage of the project.

Project aims, objectives and methodology (3 marks)	**Mark range**
Outline contains aims of project, project objectives and methodology, and relevant initial analysis (including formally referenced sources)	**3**
Outline contains aims of project, project objectives and methodology, and relevant initial analysis	**2**
Some limited notes on aims of project, project objectives and methodology, and relevant initial analysis	**1**
Outline specification and resource requirements (2 marks)	**Mark range**
Basic outline specification: outline contains notes on key resources required, scheduling and/or timings, milestones, and contacts	**2**
Some limited notes on key resources required, scheduling and/or timings, and contacts	**1**

Research, analysis and specification (15 marks)

Award marks for research, analysis and a specification of the problem or issue. This should include:

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

Some candidates may be unable to produce sufficient research, and/or analysis, and/or a specification to allow them to progress the project in a meaningful way. Where this is the case, you can help them produce this to allow them to progress to further stages of the project.

As research is ongoing throughout the project, do not award a final mark until the project is complete.

Analysis of the problem or issue and identifying suitable factors to research (5 marks)	**Mark range**
Identifies all major sub-systems and the interaction between them Complete and detailed notes from relevant analysis, including formally referenced sources	**5**
Identifies some sub-systems and the interaction between them Notes from relevant analysis, including formally referenced sources	**4**
Identifies some sub-systems Some notes from relevant analysis, including sources	**3**
Some notes from relevant analysis	**2**
Limited notes from analysis	**1**

Research (5 marks)	**Mark range**
Detailed research strategy, including information required, how to find the information, and complete and detailed notes from relevant research (including formally referenced sources and meaningful conclusions)	**5**
Research strategy, including information required and detailed notes from relevant research (including formally referenced sources and meaningful conclusions)	**4**
Research strategy, including notes from relevant research (including sources and meaningful conclusions)	**3**
Research strategy, including notes from relevant research	**2**
Some limited notes from research	**1**

Specification (5 marks)	Mark range
Complete and detailed specification developed from outline, covering all sub-systems (including numerical values of all inputs and outputs)	**5**
Specification developed from outline, covering most sub-systems (including numerical values of most inputs and outputs)	**4**
Specification developed from outline, covering some sub-systems (including numerical values of some inputs and outputs)	**3**
Specification developed from outline, covering some sub-systems	**2**
Incomplete specification, omitting several sub-systems and significant inputs, processes or outputs	**1**

Production and maintenance of a project plan (10 marks)

Award marks for a project plan. This should include:

- a list of actions, critical path analysis and a Gantt chart (or equivalent time-management tool), with details of intermediate and final targets
- details of what resources are required, when they are required and how you will source them
- evidence of continuous auditing and/or maintaining the plan, with detailed, reflective commentary on any refinements made throughout the project

Candidates should revisit this stage regularly, as they need to update their project plans throughout the process.

Candidates should date any updates and refinements to their project plans to show the frequency and regularity of review. A review does not always need to result in changes; however, if it does, they should note this.

Some candidates may be unable to produce a logical or useful project plan to allow them to progress the project in a meaningful way. Where this is the case, you can help them produce a basic project plan.

As planning is ongoing throughout the project, do not award a final mark for this stage until the project is completed.

Project plan (7 marks)	**Mark range**
Complete project plan, including a list of actions, critical path analysis, and Gantt chart (or other time-management tool), detailing intermediate and final targets Complete resource list, including information on, for example, how they will be sourced and when they will be required	**7**
Project plan, including a list of actions and Gantt chart (or other time-management tool), detailing final targets Resource list covering most resources, including information on, for example, how they will be sourced and when they will be required	**6**
Project plan, including Gantt chart (or other time-management tool), detailing final targets Resource list covering some resources, including information on, for example, how they will be sourced and when they will be required	**5**
Project plan, including Gantt chart (or other time-management tool), detailing some targets Resource list covering some resources	**4**
Project plan, including Gantt chart (or other time-management tool), detailing some targets	**3**
Project plan, including Gantt chart (or other time-management tool)	**2**
Incomplete project plan, for example covering time management only or outline plan only	**1**

Project plan maintenance and/or refinement (3 marks)	Mark range
Evidence of ongoing refinement of the plan Detailed, reflective commentary on any changes to the plan	**3**
Evidence of some ongoing refinement of the plan Some reflective commentary on any changes to the plan	**2**
Minimal evidence of changes or refinement to the plan	**1**

Mathematical modelling and analysis (15 marks)

Award marks for an analysis during the development phase or analysis of the completed solution.

Projects must include content (and consist of major sub-systems) from the areas of study for both 'electronics and control' **and** 'mechanisms and structures'. You can find further details of these areas in the 'Skills, knowledge and understanding for the course assessment' section of the Advanced Higher Engineering Science course specification. This should include:

- mathematical modelling and analysis of a major 'electronics and control' sub-system
- mathematical modelling and analysis of a major 'mechanisms and structures' sub-system
- mathematical modelling and analysis of another major 'electronics and control' or 'mechanisms and structures' sub-system

This stage should be systematic, thorough, and include mathematics appropriate to the level of the course (for example quadratic equations and calculus at SCQF level 6 mathematics in this SCQF level 7 project).

It involves a range of mathematical calculations, and could include developing complex control programs, or similar. The numerical values used should be realistic and fully justified, and the results applied to the project solution.

Note: if candidates use computer modelling as evidence of assessment for this stage, do **not** award marks in the following stage for the same piece of evidence.

Mathematical modelling and analysis of a major 'electronics and control' sub-system (5 marks)	**Mark range**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of three mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, fully justified numerical values Detailed, reflective commentary	**5**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of two mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, justified numerical values Some reflective commentary	**4**
Mathematical modelling and analysis, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique is correctly used Results are applied to the project solution, using realistic numerical values Some reflective commentary	**3**

Mathematical modelling and analysis of a major 'electronics and control' sub-system (5 marks)	**Mark range**
Mathematical modelling and analysis, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique has been attempted Results are applied to the project solution, using realistic numerical values	**2**
Limited mathematical modelling and analysis, with limited use of realistic numerical values	**1**
Mathematical modelling and analysis of a major 'mechanisms and structures' sub-system (5 marks)	**Mark range**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of three mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, fully justified numerical values Detailed, reflective commentary	**5**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of two mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, justified numerical values Some reflective commentary	**4**
Mathematical modelling and analysis, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique is correctly used Results are applied to the project solution using realistic numerical values Some reflective commentary	**3**
Mathematical modelling and analysis, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique has been attempted Results are applied to the project solution using realistic numerical values	**2**
Limited mathematical modelling and analysis, with limited use of realistic numerical values	**1**

Mathematical modelling and analysis of another major 'electronics and control' or 'mechanisms and structures' sub-system (5 marks) Note: this must be a different sub-system from the one chosen above, and must use different mathematical modelling and analysis techniques.	**Mark range**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of three mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, fully justified numerical values Detailed, reflective commentary	**5**
Mathematical modelling and analysis, using a range of techniques appropriate to the level of the course A minimum of two mathematical modelling or analysis techniques are correctly used Results are applied to the project solution using realistic, justified numerical values Some reflective commentary	**4**
Mathematical modelling and analysis, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique is correctly used Results are applied to the project solution using realistic numerical values Some reflective commentary	**3**
Mathematical modelling and analysis of a major 'electronics and control' or 'mechanisms and structures' sub-system, using techniques appropriate to the level of the course A minimum of one mathematical modelling or analysis technique has been attempted Results are applied to the project solution using realistic numerical values	**2**
Limited mathematical modelling and analysis of a major 'electronics and control' or 'mechanisms and structures' sub-system, with limited use of realistic numerical values	**1**

Constructing and/or simulating a solution (15 marks)

Award marks for evidence of construction and/or simulation carried out at any stage of the project.

Projects must include content (and consist of major sub-systems) from the areas of study for both 'electronics and control' **and** 'mechanisms and structures'. You can find further details of these areas in the 'Skills, knowledge and understanding for the course assessment' section of the Advanced Higher Engineering Science course specification. This should include:

- evidence of the construction and/or simulation of a major 'electronics and control' sub-system
- evidence of the construction and/or simulation of a major 'mechanisms and structures' sub-system
- justification of materials and components used
- a description of the purpose of the major sub-systems
- reflective commentary on the construction/simulation, including any changes made

Note: if candidates use computer modelling as evidence of assessment for the previous stage, **do not** award marks in this stage for the same piece of evidence.

Construction and/or simulation of a major 'electronics and control' sub-system (5 marks)	**Mark range**
Major sub-system correctly constructed or simulated, with names, values and function of all components correctly annotated A full description of the purpose of the sub-system and how it would integrate into the full system	**5**
Major sub-system correctly constructed or simulated, with names, values and function of most components correctly annotated A description of the purpose of the sub-system	**4**
Major sub-system constructed or simulated, with names, values and function of some components annotated A description of the purpose of the sub-system	**3**
Major sub-system constructed or simulated, with names and values of some components annotated	**2**
Major sub-system constructed or simulated	**1**

Construction and/or simulation of a major 'mechanisms and structures' sub-system (5 marks)	**Mark range**
Major sub-system correctly constructed or simulated, with names, values and function of all components correctly annotated A full description of the purpose of the sub-system and how it would integrate into the full system	**5**
Major sub-system correctly constructed or simulated, with names, values and function of most components correctly annotated A description of the purpose of the sub-system	**4**
Major sub-system constructed or simulated, with names, values and function of some components annotated A description of the purpose of the sub-system	**3**
Major sub-system constructed or simulated, with names and values of some components annotated	**2**
Major sub-system constructed or simulated	**1**
Materials and components (3 marks)	**Mark range**
All decisions on choice of materials and components fully justified	**3**
Some decisions on choice of materials and components justified	**2**
Limited justification for decisions on choice of materials and components	**1**
Reflective commentary on construction and/or simulation (2 marks)	**Mark range**
Detailed, reflective commentary including any changes made	**2**
Some reflective commentary	**1**

Evaluation (10 marks)

Award marks for evidence of a final evaluation of the project, any evaluation carried out throughout the project, the record of progress and a project plan. This should include:

- qualitative and quantitative evaluation of the solution
- evaluation of the process
- comments on potential further developments

Note: evaluative commentary must refer to the problem or issue.

Evaluation of the solution (4 marks)	**Mark range**
Complete and detailed qualitative and quantitative evaluation of the solution with valid, relevant and clear conclusions	**4**
Some qualitative and quantitative evaluation of the solution with some valid and relevant conclusions	**3**
Limited qualitative and quantitative evaluation of the solution with limited valid and relevant conclusions	**2**
Limited, basic, or simple evaluation of the solution	**1**
Evaluation of the process (4 marks)	**Mark range**
Relevant and justified evaluative commentary on the development process and candidate's own performance, referring to entries in the record of progress and project plan	**4**
Some evaluative commentary on the development process and candidate's own performance, referring to entries in the record of progress and project plan	**3**
Some evaluative commentary on the development process	**2**
Limited evaluation of the development process	**1**
Further developments (2 marks)	**Mark range**
Detailed descriptions of possible further developments	**2**
Descriptions of possible further developments	**1**

Presentation (5 marks)

Award marks for the record of progress and a final presentation of the project. This must include:

- the completed project, containing all evidence
- the candidate's record of progress (that refers to progress throughout the project) and project plan, including all reflective commentary

Note: candidates **do not** need to make a verbal presentation.

Presentation of the solution (3 marks)	**Mark range**
The solution is complete, detailed and well-structured Relevant and detailed commentary throughout the project Includes, for example, suitably titled sections, annotated and titled diagrams, and graphs	**3**
The solution is mainly complete and fairly well-structured Some relevant commentary throughout the project Includes, for example, suitably titled sections, annotated and titled diagrams, and graphs	**2**
The solution is incomplete, lacks detail, and includes only limited commentary on possible uses and implications	**1**
Record of progress (2 marks)	**Mark range**
Detailed and reflective record of progress, with content appropriate to the level of the course	**2**
Basic record of progress, with content appropriate to the level of the course	**1**

Instructions for candidates

This assessment applies to the project for Advanced Higher Engineering Science.

The project is worth 75 marks. This is 50% of the overall marks for the course assessment.

It assesses the following skills, knowledge and understanding from across the course, in the context of an investigation of an engineering science problem or issue:

- 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
- applying in-depth knowledge and understanding of aspects of electronic and microcontroller-based systems
- applying in-depth knowledge and understanding of aspects of mechanisms and structures
- applying engineering skills, knowledge and understanding in a range of contexts
- planning, managing and implementing a challenging engineering project

Marks are awarded for:

Area	Marks
Outline	**5**
Research, analysis and specification	**15**
Production and maintenance of a project plan	**10**
Mathematical modelling and analysis	**15**
Constructing and/or simulating a solution	**15**
Evaluation	**10**
Presentation	**5**

You can find further information in the 'Detailed marking instructions' section of this document.

Your teacher or lecturer will let you know if there are any specific conditions for doing this assessment.

In this assessment, you have to:

- identify, research and analyse an engineering problem or issue that integrates content from the 'electronics and control' and 'mechanisms and structures' areas of study
- demonstrate engineering science skills and creativity
- design and construct and/or simulate a solution to the engineering science problem or issue
- evaluate your solution

In this document, there is:

- information on how much support and guidance your teacher or lecturer can give you
- information on what evidence you must produce for each stage of the project
- guidance on choosing a suitable problem or issue for your project
- guidance on how you might approach each stage of the project

Support from your teacher or lecturer

You must complete this project independently; however, your teacher or lecturer can provide you with guidance to help develop your thinking as you progress. This could include:

- general support in class on broad areas of study, such as research skills or project planning
- constructive questioning
- constructive comments and face-to-face meetings

This level of support is considered reasonable assistance, and it will not affect your final mark. However, your teacher or lecturer cannot tell you specifically how to proceed with your project, how to rephrase or improve responses, or provide you with model answers.

Evidence to be gathered

You must produce a record of progress **and** a project response.

Your record of progress should contain all the information to support your decisions, as your assessor will use this to award marks.

The 'Marking instructions' section provides complete information on the evidence required.

All evidence is internally assessed and must be retained for quality assurance purposes.

Guidance on recording your progress

You will work on your project over several months and, during that time, produce many pieces of evidence. You need a method of keeping track of your progress and a way of organising all the evidence you produce.

One way of doing this is to keep a diary of the work you complete. This might consist of written notes kept in a notebook or loose-leaf folder, or an electronic diary or blog.

However you choose to record this, you must include:

- regular notes on any work you have done (daily or weekly)
- notes describing any help you required
- reflective and evaluative commentary on your progress

Although the record of progress is not a formal report, your teacher or lecturer will refer to it when awarding marks.

It is important that you regularly update this with relevant comments relating to the progress of your project and the decisions you make throughout. Remember to record your reflective entries in your record of progress at the same time, as you will need to refer to them when evaluating your project.

It is useful to link your record of progress to any evidence you produce. Evidence can include annotated printouts, sketches, screenshots, and diagrams, as appropriate. You should store these items in the loose-leaf folder, or if you are using an electronic blog, you could make links to the items of evidence. You must label, date and annotate all evidence as you produce it, and store it safely.

You should discuss your progress with your teacher or lecturer at regular intervals.

Guidance on choosing a suitable problem or issue

The project lets you develop your knowledge and understanding of engineering science at Advanced Higher level, and apply this to a problem or issue that interests you.

Your project must include content (and consist of major sub-systems) from the areas of study for both 'electronics and control' **and** 'mechanisms and structures'. You can find further details of these areas in the 'Skills, knowledge and understanding for the course assessment' section of the Advanced Higher Engineering Science course specification.

Choosing a problem or issue

You must choose a problem or issue for your project.

You may already have an idea or wish to explore ideas with your teacher or lecturer. You can also get ideas from sources such as online resources, industry news, television, local business partners, or STEM ambassadors.

You may be able to complete your project within the centre, but you could consider a project that requires collaboration with a university, college or local industry — your teacher or lecturer can advise on this.

You must ensure you choose a problem or issue that has enough depth and complexity to allow for multiple major sub-systems; some need to be constructed and/or simulated, and others need mathematical modelling and analysis.

Suggestions for project ideas

Listed below are possible project ideas for you to consider. These are only examples; you can choose or adapt one of these or use an idea of your own — you do not have to choose from this list.

- 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 24-hour lighting system based on renewable energy (wind, wave or solar) and rechargeable batteries — which must run constantly, even when no direct energy is available.
- Develop an automated robot to do a simple task, for example a scale model warehouse delivery system that restocks three sales points from storage 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- or 3-axis accelerometer to detect attitude and a 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 disks 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-to-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 that enables quick changes to be made to an aerofoil section between measurements of lift and drag.
- Study how buildings behave during earthquakes at different shaking frequencies by modelling tall buildings using slender materials and creating a shaking table to stand them on.
- 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 gearbox for different arrangements.
- Develop an automated handling system for bicycles on buses or trains.
- Develop a fully autonomous electric (model) vehicle, built to scale.

- Develop a smart mass transit system (pedestrian), for example moving floors, lifts, or escalators.
- Develop a smart traffic management system or integrated public transport system.
- Develop a self-sufficient power transmission and distribution system for an island community.
- Develop a system to make public buildings energy efficient and energy neutral.
- Develop mechanical systems that sense and avoid each other while moving between definite positions and heights in a confined space, for example multiple cranes in power plants or tall buildings.
- Develop a humanitarian engineering system to bring water, power, and transport links to an affected community — this could include charging points and other essential infrastructure.
- Develop a funfair rollercoaster safety system.
- Develop a flight simulator system to allow safe training for flight crew.
- Develop a structure to span a river that allows vehicles to cross — during the lifetime of the structure, the stress on it should be able to be monitored and recorded.
- Develop a retractable roof for a sports stadium.
- Develop a weighing system for planes to ensure they are not overloaded before take-off.
- Develop a personal transport system that moves forward, backward, and turns as a user leans in different directions.

Choosing a suitable problem or issue — checklist

Use the following checklist when considering ideas for your project problem or issue.

	yes	no
Will your project problem or issue allow you to apply some knowledge and skills of both 'electronics and control' and 'mechanisms and structures' at Advanced Higher level?	☐	☐
Will your problem or issue require you to apply some knowledge and skills from your own research?	☐	☐
Will your problem or issue allow you to apply generic skills in planning, research, analysis, problem solving, and evaluation?	☐	☐
Will you be able to complete your project in the time available?	☐	☐
Can you overcome all potential barriers to carrying out your project, for example health and safety issues, permissions, and logistics?	☐	☐
Do you have access to any necessary expertise, resources, and equipment?	☐	☐

If you answer 'no' to any of the above questions, you need to reconsider your problem or issue.

You could keep an annotated copy of this checklist in your record of progress, under the heading 'choosing a suitable problem or issue'.

Project stages

Project proposal (0 marks)

Once you have decided on a problem or issue, you must produce a project proposal.

Your project proposal is not assessed — there are no marks available for it; however, it is an essential piece of work. It forms the initial discussions with your teacher or lecturer, supports the planning of your project, and ensures that your project is viable.

The project proposal is a brief description of your project idea — the problem or issue. It should show how you plan to meet the project requirements, for example ensuring that:

- you use the relevant knowledge and skills
- you carry out your own research
- the project is feasible within the timescale
- any barriers to completion can be overcome
- all expertise, resources and equipment are available

Your proposal should aim to:

- convince your teacher or lecturer that the project is both worthwhile and feasible, and that the proposed approach is the best possible
- state the aims and the objectives of your project
- specify a time limit in terms of weeks and hours per week
- identify any key pieces of equipment or components needed to complete the project, and a rough budget for completing it
- identify any skills shortages that could hamper completion, and how and when you address them
- identify milestones when your teacher or lecturer can monitor your progress
- describe any resources, in particular what data and services your teacher or lecturer (and department) are expected to provide
- establish a professional approach to the project, its planning and record keeping

When you have written your proposal, you must discuss it with your teacher or lecturer and obtain approval before you continue.

Evidence required

You must produce a project proposal. It can be produced on a single side of A4 paper, but should take up no more than two sides.

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Outline (5 marks)

You need to produce an outline for your project.

Your outline should identify and list the key stages of your project and include an estimated timeline for implementation. You will need to add more detail later, once you have carried out some research and developed a specification.

Ask your teacher or lecturer about the final submission date and insert an appropriate target date for each intermediate stage. This enables you to complete your project in good time. You may find that you need to adjust what you plan to do as your project develops, and you should keep a record of this with reasons for the changes. You will need to review this regularly with your teacher or lecturer.

A structure for an outline is shown below. This is not prescriptive, but it should encourage you to think about the stages shown.

- Introduction (aims of the project):
  - write a statement on the context (the background to the project problem or issue)
  - write a statement on the essential features of the problem or issue that the project aims to solve the solution (partially or in full)
- Project statement (objectives):
  - write an expanded statement on each of the project objectives
  - clarify the desired outcomes from these objectives by the end of the project
- Methodology:
  - indicate an approximate sequence of work to be carried out for each stage of the project
  - allocate approximate times and target dates for each section of the project
  - describe the approach to be taken at key stages of the project
  - define the advantages and disadvantages of each approach (for example simulate, test existing technology, and construct prototype)
- Initial analysis:
  - identify the system requirements (for example major inputs and outputs) and formally reference your sources
- Basic outline specification and any definitions that a non-specialist reader would require:
  - note any skills to be learned and when they would be needed
- Resource requirements:
  - identify software, hardware, tools, facilities, space, funding and data required for project completion
  - identify data to be collected by testing, and data to be found from other sources

Evidence required

You must produce an outline of the project.

This should include:

- an outline of the project proposal, containing:
  - aims of the project
  - project objectives
  - methodology
  - initial analysis
  - basic outline specification
  - resource requirements

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Research, analysis and specification (15 marks)

You need to research and analyse the problem or issue, and produce a specification for a solution.

To do this, you must apply some knowledge and/or skills from your own research. Some of this research could be at the start of the project, when you are analysing the problem or issue and finding out how you can solve it. However, if you encounter new challenges, you are likely to carry out more research at later stages.

Evidence required

This should include:

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

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Guidance on sources

You cannot present someone else's work as your own — this is plagiarism. You must reference everything that comes from another source.

Use the following guidelines to help you do this:

- Insert "quotation marks" around any text that has come from other sources, and clearly identify what those sources are.
- It is good practice to rephrase things in your own words, where possible. When you do this, you should still reference the original source.
- Acknowledge the sources of diagrams, illustrations and images.
- Write a bibliography — a list of references — including all sources.
- Use a recognised referencing system, for example the Harvard referencing system, and use this consistently throughout.

Production and maintenance of a project plan (10 marks)

Your outline gave target dates for the key stages of your project. You now need to produce a complete project plan, covering resource management as well as time management. It must include all sub-tasks and intermediate targets, especially for the implementation part of your project.

Use your project plan to monitor and track progress throughout your project. You must continually reflect on your progress by referring to (and amending, if required) your project plan.

Note: you must keep your **outline** as evidence of your initial planning.

Evidence required

This should include:

- a list of actions, critical path analysis and a Gantt chart (or equivalent time-management tool), with details of intermediate and final targets
- details of what resources are required, when they are required, and how you will source them
- evidence of continuous auditing and/or maintaining of the plan, with detailed, reflective commentary on any refinements made throughout the project

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Project plan

You must continue to update your project plan to document your progress and include detailed, reflective commentary on any changes.

Mathematical modelling and analysis (15 marks)

You must apply a range of mathematical techniques appropriate to the level of the course (SCQF level 6 mathematics in this SCQF level 7 project).

Your project must include content covering the areas of study for both 'electronics and control' **and** 'mechanisms and structures'. You can find further details of these areas in the 'Skills, knowledge and understanding for the course assessment' section of the Advanced Higher Engineering Science course specification.

Depending on the nature of your project, you could include some of the following:

- using quadratic equations to determine values
- using integration or differentiation
- using nodal analysis to solve electronic problems
- using equations of equilibrium for simply supported beams
- applying the general beam bending equation
- applying complex digital logic
- developing complex control programs
- calculating component values
- consideration of tolerances
- using complex simulation software

You may be familiar with some of these techniques, but you can also use techniques that you have learned through your own research or reading.

Use the results of your mathematical modelling and analysis as a basis for making design decisions, for example to justify why you chose particular sizes and/or values of components and/or devices.

During the implementation section of the project, you should be continually testing aspects of your solution. This could be through physical testing of systems and sub-systems, or through simulation and modelling. You should keep a record of all testing carried out, the test results, and any resulting actions taken.

Note: there could be some overlap between this section and the next section (for example, mathematical modelling and analysis would inform construction; simulation could be part of mathematical modelling and analysis). However, if you use computer modelling as evidence of assessment in this section, you **cannot** re-use it in the next section.

Evidence required

This should include:

- mathematical modelling and analysis of a major ‘electronics and control’ sub-system
- mathematical modelling and analysis of a major ‘mechanisms and structures’ sub-system
- mathematical modelling and analysis of another major ‘electronics and control’ or ‘mechanisms and structures’ sub-system

This stage should be systematic, thorough, and include mathematics appropriate to the level of the course (for example quadratic equations and calculus at SCQF level 6 mathematics in this SCQF level 7 project).

It involves a range of mathematical calculations, and could include developing complex control programs, or similar. The numerical values used should be realistic and fully justified, and the results applied to the project solution.

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Project plan

You must continue to update your project plan to document your progress and include detailed, reflective commentary on any changes.

Constructing and/or simulating a solution (15 marks)

Choose two major sub-systems — one 'electronics and control' and one 'mechanisms and structures'.

After analysing the sub-systems, you must construct and/or simulate them. You can find further details in the 'Skills, knowledge and understanding for the course assessment' section of the Advanced Higher Engineering Science course specification.

During the implementation section of the project, you should continually test aspects of your solution. This could be physically testing the systems and sub-systems, or through simulation and modelling. You should keep a record of all testing carried out, the test results, and any resulting actions taken.

Note: there could be some overlap between this section and the previous section (for example, mathematical modelling and analysis would inform construction; simulation could be part of mathematical modelling and analysis). However, if you use computer modelling as evidence of assessment in the previous section, you **cannot** re-use it in this section.

Evidence required

This should include:

- evidence of the construction and/or simulation of a major 'electronics and control' sub-system
- evidence of the construction and/or simulation of a major 'mechanisms and structures' sub-system
- justification of materials and components used
- a description of the purpose of the major sub-systems
- reflective commentary on the construction/simulation, including any changes made

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Project plan

You must continue to update your project plan to document your progress and include detailed, reflective commentary on any changes.

Evaluation (10 marks)

You must now evaluate your work.

You must reflect on the work you have done across the project and describe possible further developments of your solution (although you do not need to implement any of these).

Evidence required

This should include:

- qualitative and quantitative evaluation of the solution
- evaluation of the process
- comments on potential further developments

Record of progress

You must continue to update your record of progress to document what you have done, including reflective commentary, as appropriate.

Project plan

You must continue to update your project plan to document your progress.

Presentation (5 marks)

You must present your solution in a professional, well-structured way. Anyone reading it must be able to understand your thought process and what you are trying to say.

Note: you do not need to make a formal 'presentation' (such as talking to slides or reporting to an audience) for this project.

Evidence required

This must include:

- the completed project, containing all evidence
- the candidate's record of progress (that refers to progress throughout the project) and project plan, including all reflective commentary

Administrative information

Published: September 2024 (version 2.0)

History of changes

Version	Description of change	Date
2.0	Removal of 'detailed' from before 'project plan' throughout. Detail is defined in marks breakdown. Refined differentiation of marks in 'Research' (pg7). Minor clarification of language elsewhere. Recording documentation updated to make it accessible.	September 2024

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

Security and confidentiality

This document can be used by SQA approved centres for the assessment of national courses and not for any other purpose.