

SQA Advanced Unit Specification

General information for centres

Unit title: Measurement Systems 2

Unit code: HV6F 48

Unit purpose: This Unit is designed to enable candidates to gain knowledge and understanding of a range of strain, position and vibration measurement systems.

On completion of the Unit candidates should be able to:

- 1 Design strain measurement systems.
- 2 Explain the principle of operation of position measurement systems.
- 3 Explain the principle of operation of vibration measurement systems.

Credit points and level: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit will be at the discretion of the centre and the following recommendations are for guidance only. Candidates should have a wide knowledge of Measurement and Control Engineering. There could also be the advantage of possessing or working towards the SQA Advanced Units: HV67 47 Measurement Systems 1 and HV63 47 Distributed Control Systems.

Core Skills: There are opportunities to develop the Core Skills of Written Communication (Writing), Written Communication (Reading) and Problem Solving (Critical Thinking) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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Assessment: Outcome 1 in this Unit should be assessed by an assignment that asks candidates to design strain measurement systems. The candidate's response to the assignment should be a minimum of 1,000 words and should be completed in four hours.

Outcomes 2 and 3 in this Unit should each be assessed by a separate assignment in which candidates are asked to explain the operation of position and vibration measurement systems. The candidate's response to the assignments for Outcomes 2 and 3 should be a minimum of 1,000 words per assignment with each assignment being completed in three hours.

The assessments for the three Outcomes should be carried out at the end of the delivery of each Outcome.

It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

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Unit specification: statement of standards

Unit title: Measurement Systems 2

Unit code: HV6F 48

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Design strain measurement systems

Knowledge and/or skills

- ◆ Strain gauge measurement system
- ◆ Load cell measurement system

Evidence Requirements

In this Outcome all of the knowledge and/or skills items above should be assessed. The evidence should be presented in response to an assignment in which the candidate is set the task of designing two strain measurement systems.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ Design a strain gauge measurement system for a given application that includes the following:
 - research and select suitable component parts of a strain gauge measurement system for the given application
 - sketch the strain gauge measurement system and clearly show the position and type of strain gauge(s) used and the bridge measuring circuit
 - explain the principle of operation of the strain gauge measurement system
- ◆ Design a load cell measurement system for a given application that includes the following:
 - research and select suitable components parts of a load cell measurement system for the given application
 - sketch the load cell measurement system and clearly show the position and type of load cell(s) used and the bridge measuring circuit
 - explain the principle of operation of the load cell measurement system

Evidence should be generated through an assignment undertaken in open book conditions.

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Assessment guidelines

The assessment of this Outcome should take the form of an assignment in which candidates have access to manufacturers' data sheets, textbooks, notes and the internet. The recommended time allocation for the assignment is four hours. The candidate's response to the assignment should be a minimum of 1,000 words.

It is essential that centres ensure that evidence generated is the candidate's own work.

Outcome 2

Explain the principle of operation of position measurement systems

Knowledge and/or skills

- ◆ Linear displacement measurement system
- ◆ Angular displacement measurement system
- ◆ Proximity measurement system

Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be provided in response to specific questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above. In any assessment of this Outcome two out of three knowledge and/or skills items should be included.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of two out of three knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all two items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain, with the aid of a sketch, the principle of operation of a linear displacement measurement system
- ◆ explain, with the aid of a sketch, the principle of operation of an angular displacement measurement system
- ◆ explain, with the aid of a sketch, the principle of operation of a proximity measurement system

Evidence should be generated through an assignment undertaken in open book conditions.

Assessment guidelines

The assessment of this Outcome should take the form of an assignment. The recommended time allocation for the assignment is three hours. The candidate's response to the assignment should be a minimum of 1,000 words.

It is essential that centres ensure that evidence generated is the candidate's own work.

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Outcome 3

Explain the principle of operation of vibration measurement systems

Knowledge and/or skills

- ◆ Seismic accelerometer type of vibration measurement system
- ◆ Dynamic load cell type of vibration measurement system

Evidence requirements

In this Outcome all of the knowledge and/or skills items above should be assessed. The evidence may be provided in response to specific questions.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain, with the aid of a sketch, the principle of operation of a seismic accelerometer type of vibration measurement system
- ◆ explain, with the aid of a sketch, the principle of operation of a dynamic load cell type of vibration measurement system

Evidence should be generated through an assignment undertaken in open book conditions.

Assessment guidelines

The assessment of this Outcome should take the form of an assignment. The recommended time allocation for the assignment is three hours. The candidate's response to the assignment should be a minimum of 1,000 words.

It is essential that centres ensure that evidence generated is the candidate's own work.

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Administrative information

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Superclass category:	WD
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Version	Description of change	Date

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Unit specification: support notes

Unit title: Measurement Systems 2

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

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

Guidance on the content and context for this Unit

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

- 1 Design strain measurement systems.
- 2 Explain the principle of operation of position measurement systems.
- 3 Explain the principle of operation of vibration measurement systems.

This Unit is at SCQF level 8 and has been devised as a mandatory Unit within the new SQA Advanced Diploma in Measurement and Control Engineering award. However this does not preclude the use of this Unit in other awards where award designers feel this to be appropriate.

In designing this Unit, the Unit writer has identified the range of topics that they would expect to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. While it is not mandatory for centres to use this list of topics, it is recommended that they cover them.

A list of topics for each Outcome is given below.

Outcome 1

Design strain measurement systems (14 hours)

- ◆ Definitions of stress and strain
- ◆ Definitions of different types of strain including tensile, compressive, axial, bending, shear and torsional
- ◆ Definition and industrial applications for strain gauges
- ◆ Causes of strain including pressures, forces, moments, heat and structural changes in the material
- ◆ Young's Modulus of Elasticity
- ◆ Gauge factor
- ◆ Different types of strain gauges for measuring axial, bending, shear and torsional strain
- ◆ Optimum position to install strain gauges for measuring axial, bending, shear and torsional strain
- ◆ Effects of ambient temperature changes on a strain gauge measurement system
- ◆ Use of dummy gauges to compensate for ambient temperature changes
- ◆ Wheatstone bridge measuring circuit for strain gauges
- ◆ Calibration of a strain gauge measurement system
- ◆ Definition and industrial applications for load cells

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- ◆ Load cells based on strain gauges including
 - bending beam load cell
 - shear beam load cell
- ◆ Wheatstone bridge measuring circuit for load cells
- ◆ Calibration of a load cell measurement system

Outcome 2

Explain the principle of operation of position measurement systems (16 hours)

- ◆ Definitions of linear displacement, angular displacement and proximity
- ◆ Industrial applications for linear displacement, angular displacement and proximity measurement
- ◆ Methods of measuring linear displacement including
 - linear variable differential transformer (LVDT)
 - linear potentiometer
 - variable area capacitance transducer
- ◆ Methods of measuring angular displacement including
 - rotary potentiometer
 - tachometer
 - optical shaft encoder
 - synchro-resolver
- ◆ Methods of measuring proximity including
 - microswitch
 - Reed switch sensor
 - variable reluctance proximity switch
 - Hall effect proximity switch
 - optical sensor
- ◆ Calibration methods for linear displacement, angular displacement and proximity measurement systems

Outcome 3

Explain the principle of operation of vibration measurement systems (10 hours)

- ◆ Definition and industrial applications for vibration measurement systems
- ◆ Principles and laws of vibration including
 - simple harmonic motion (sine waves)
 - Newton's Law of Motion (second law)
 - free vibration
 - forced vibration
- ◆ Seismic piezoelectric accelerometers including
 - high impedance class
 - low impedance class
- ◆ Dynamic load cells
- ◆ Calibration methods for vibration measurement systems

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Unit assessment

Assignment for Outcome 1	4 hours (including class time)
Assignment for Outcome 2	3 hour (including class time)
Assignment for Outcome 3	3 hour (including class time)

Guidance on the delivery and assessment of this Unit

This Unit has been designed to incorporate sufficient time to allow the lecturer to teach, in a student centred way, different methods of measuring strain, position and vibration.

The content of Outcomes 1, 2 and 3 means that they are not a direct follow on to each other and hence they could be delivered in any order.

Due to the range of topics covered in each Outcome it is recommended that each Outcome is assessed at the end of delivery for that Outcome.

The knowledge and skills of each Outcome could be supported by practicals.

Details on approaches to assessment are given under Evidence requirements and Assessment guidelines under each Outcome in the SQA Advanced Unit specification: Statement of Standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of Written Communication (Writing), Written Communication (Reading) and Problem Solving (Critical Thinking) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. With regard to assessment, planning would be required of the Centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessments were conducted under controlled, supervised conditions.

For information on open learning, please refer to *SQA guide assessment and quality assurance of open and distance learning (A1030, Feb 2001)*.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

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General information for candidates

Unit title: Measurement Systems 2

This Unit has been designed to provide you with the knowledge and skills that will enable you to understand a range of strain, position and vibration measurement systems.

In Outcome 1 you will learn about different methods of measuring strain. This will include learning about the basic construction and principle of operation of different types of strain measurement systems.

In Outcome 2 you will learn about different methods of measuring position. This will include learning about the basic construction and principle of operation of different types of position measurement systems.

In Outcome 3 you will learn about different methods of measuring vibration. This will include learning about the basic construction and principle of operation of different types of vibration measurement systems.

The formal assessment for this Unit will consist of three assignments.

The assignment for Outcome 1 will assess your competence in designing strain measurement systems. Your response to this assignment should be a minimum of 1,000 words and should be completed in four hours.

The assignments for Outcomes 2 and 3 will assess your competence in explaining the operation of a range of position and vibration measurement systems. Your response to each assignment should be a minimum of 1,000 in length and should be completed in three hours.

You will be allowed access to any relevant notes, manufacturers' data sheets, text books and the internet when carrying out the assignments.

The assessments for Outcomes 1, 2 and 3 will be carried out at the end of the delivery of the Outcomes.