

**Arrangements for:**

**HNC Mechatronics  
(Award Number: G87L 15)**

**and**

**HND Mechatronics  
(Award number: G87M 16)**

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## **Acknowledgement**

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

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## History of changes

It is anticipated that changes will take place during the life of the qualification and this section will record these changes. This document is the latest version and incorporates the changes summarised below. Centres are advised to check SQA's APS Navigator to confirm they are using the up to date qualification structure.

**NOTE:** Where a Unit is revised by another Unit:

- ◆ No new centres may be approved to offer the Unit which has been revised.
- ◆ Centres should only enter candidates for the Unit which has been revised where they are expected to complete the Unit before its finish date.

| Version number | Description  | Date     |
|----------------|--|----------|
| 07             | <b>Addition of Units:</b> JOHA 34 Computer Programming and JOH9 34 Data Security added as Optional units to HNC and HND frameworks   | 08/04/19 |
| 06             | Revision of Unit: DE1K 33 Workplace Communication in English has been revised by H8T2 33 and finishes on 31/07/2016.   | 11/05/15 |
| 05             | Removal of finish date from unit DG4P 35 <i>Mathematics for Engineering 3</i> . Addition of Credit Transfer Table <i>see Page 21</i> .   | 16/01/15 |
| 04             | <b>Revision of Units:</b> D77G 34 <i>Communication: Practical Skills</i> revised by H7MB 34. DG4H 33 <i>Mathematics for Engineering 1: Electronics and Electrical</i> revised by H7K0 33 <i>Engineering Mathematics 1</i> . DG4L 34 <i>Mathematics for Engineering 2</i> revised by H7K1 34 <i>Engineering Mathematics 2</i> on <b>HNC</b> and <b>HND</b> frameworks finishing 31/07/2016. | 21/10/14 |
| 03             | <i>Engineering Mathematics 3</i> (H7K2 34), <i>Engineering Mathematics 4</i> (H7K3 35) and <i>Engineering Mathematics 5</i> (H7K4 35) added as optional Units to HND framework.  | 20/08/14 |
| 02             | Updated regarding broadening Units and Graded Unit information.  | 09/01/08 |
|                |  |          |
|                |  |          |
|                |  |          |
|                |  |          |

# 1 Introduction

This is the Arrangements Document for the revised Group Awards in:

HNC Mechatronics

HND Mechatronics

These Group Awards were validated in June 2006. This document includes: background information on the development of the Group Awards, their aims, guidance on access, details of the Group Award structures and guidance on delivery and assessment.

## 2 Rationale for the revision of the awards

### 2.1 Group Award Titles

In the context of this document the term Mechatronics should be understood to mean the integration of electronics, electrical engineering, computer technology, control engineering with mechanical engineering in the design, manufacture and maintenance of a wide range of engineering products and processes. A candidate who studies the HNC and HND in Mechatronics will, therefore, gain knowledge, understanding and skills in electronics, electrical engineering, computer technology, control engineering and mechanical engineering. However, more critically the candidate studying the awards will learn to integrate her/his knowledge, understanding and skills of these engineering and computing disciplines when designing, manufacturing or maintaining mechatronic systems.

The term Mechatronics had its origins principally in the electronics industry although mechatronic technicians and incorporated engineers are also employed in other industries. Mechatronics is a form of multidisciplinary engineering but with the inclusion of computer technology and programming and with a strong focus on the integration of engineering and computing knowledge, understanding and skills to solve engineering problems. The intention of using the title Mechatronics in this document is to provide candidates, lecturers, Higher Education, employers and professional bodies with a clear, unambiguous title.

### 2.2 History and Market Research to support the HNC and HND Mechatronics Awards

#### 2.2.1 History

SCOTVEC first introduced an HNC Mechatronics in the early nineties. This was followed in 1993–1994 by the development of a HND Mechatronics. The HNC and HND Mechatronics were revalidated in the mid-nineties as part of a major national development of HN Engineering awards which saw the introduction of an overarching HN Engineering Framework. The revised awards presented in this document represent a further development of the HNC and HND Mechatronics award structures taking into account the new SQA, HN Design Principles and the latest developments in technology, working practices and education.

## 2.2.2 Market Research

The development of the revised HNC and HND Mechatronics awards included extensive market research which is summarised in Figure 2.2.

| Stakeholder         | Method   |
|---------------------|--|
| All                 | Major desk based research gathering and analysing data from various sources (eg SEMTA, FutureSkills Scotland etc.)   |
| Centres             | A major consultation event with centre staff took place early on in the development of the revised HNC and HND Mechatronics. Following this and once the frameworks had been ‘firmed up’ and new Units written further consultations with centres took place by means of post using appropriately designed questionnaires. |
| Employers           | Consultation took place through a questionnaire survey and members of the Qualification Design Team (QDT) consulting industrial contacts on the framework structure and Unit content.  |
| Higher Education    | A letter was sent to a number of Scottish universities seeking views on possible articulation routes between the HNC and HND Mechatronics and degree courses run by these universities.  |
| Professional Bodies | A representative of the Institution of Engineering and Technology (IET) advised the QDT on the status of the award in relation to membership of the IET.   |
| Candidates          | While not consulted directly details of candidates’ experiences of previous HNC and HND Mechatronics awards were provided by QDT members. These experiences were taken into account fully in the design of the new awards.   |

**Figure 2.2 Market Research**

### **3 Aims of the award**

#### **3.1 General Aims of the HNC Mechatronics**

The general aims of this award are to:

- 3.1.1 enhance candidates' employment prospects
- 3.1.2 support candidates' Continuing Professional Development and career development
- 3.1.3 enable progression within the SCQF (Scottish Credit and Qualifications Framework)
- 3.1.4 develop candidates' ability to apply analysis and synthesis skills to the solution of mechatronic problems
- 3.1.5 develop learning and transferable skills (including Core Skills).

#### **3.2 Specific Aims of the HNC Mechatronics**

The specific aims of this award are to:

- 3.2.1 provide an award that will allow candidates to work now, or in the future, as mechatronic technicians and incorporated engineers.
- 3.2.2 provide an award that creates a route towards meeting the academic requirements for Incorporated Engineer status and will allow candidates to progress to HND Mechatronics and/or degrees in Mechatronics or related subject discipline areas.

The revised HNC award will also allow candidates to:

- 3.2.3 develop a range of Communication knowledge and skills relevant to the needs of incorporated engineers
- 3.2.4 develop knowledge, understanding and skills in a range of core mechatronics principles, mechanical principles, electrical and electronic principles and robotic and control principles at technician and incorporated engineering levels.
- 3.2.5 develop a range of specialised knowledge and skills in areas of engineering and related disciplines relevant to Mechatronics
- 3.2.6 on successful completion of the award, achieve the Core Skill Communication at SCQF level 6, and the component Using Number of the Core Skill Numeracy at SCQF level 6. The candidate will also be provided with opportunities to develop aspects of Core Skills in Information Technology, Using Graphical Information, Problem Solving and Working with Others.

### **3.3 General Aims of the HND Mechatronics**

The same as for the HNC Mechatronics award but with the addition of the following:

- 3.3.1 Develop candidates' knowledge and skills in planning, scheduling and project management.
- 3.3.2 Develop investigation skills.

### **3.4 Specific Aims of the HND Mechatronics**

The same as for the HNC Mechatronics award but with the addition of the following:

- 3.4.1 Develop an award that on successful completion will allow candidates to progress to a degree in Mechatronics or related subject discipline areas.
- 3.4.2 Develop knowledge and understanding of the external and internal factors that influence the performance of modern companies.
- 3.4.3 Recognise the important role Continuing Professional Development plays in career development.
- 3.4.4 Expand on the range of knowledge, understanding and skills in core principles and technology subjects developed as part of the HNC Mechatronics.
- 3.4.5 Develop a range of specialised knowledge and skills in areas of engineering and related disciplines relevant to Mechatronics.
- 3.4.6 On successful completion of the award, achieve the Core Skills in Communication at SCQF level 6, Problem Solving at SCQF level 6 and the Using Number component of the Core Skill Numeracy at SCQF level 6. Candidates will also be provided with opportunities to develop the Core Skill Using Graphical Information component of the Numeracy Core Skill at SCQF level 6 and the Working with Others Core Skill at SCQF level 6.



### 3.5 How the General Aims are met in the HNC and HND Mechatronics award structures

*The reader may wish to have the appropriate award framework information in Sections 5.1 to 5.5 available when reading the comments in the Table below.*

| Aim No. | How it is met in the HNC and HND  |
|---------|---|
| 3.1.1   | For several years HNC and HND Mechatronics qualifications have equipped candidates to seek employment in a wide range of manufacturing, service and public sector organisations. Market research indicates that the HNC and HND Mechatronics are still regarded as the minimum qualifications required by many organisations to work at mechatronic technician and incorporated engineer levels.  |
| 3.1.2   | There has been a tradition of candidates in employment taking HNC Mechatronics awards on a part-time basis to increase their knowledge and understanding of Mechatronics and enhance their career development. In recent years, with increased commonality between HNC and HND Mechatronics awards and greater flexibility in the way these awards are delivered, candidates in employment have progressively more taken an HND on a part-time basis to expand their knowledge and skills in Mechatronics and improve their career prospects. The two revised awards contain a balance of core principles and up to date knowledge and skills in Mechatronics which lends themselves to the continuous professional development and career development of candidates working at mechatronic technician and incorporated engineer levels. Furthermore, the award structures have been designed to allow for easy progression between HNC and HND awards. |
| 3.1.3   | All Units within the new HNC and HND Mechatronics awards have been levelled at SCQF levels 6, 7 or 8. The two new awards also conform to the SQA levelling requirements for HNC and HND awards. Thus, successful completion of one or both awards will allow progression within the SCQF.   |

| Aim No. | How it is met in the HNC and HND  |
|---------|---|
| 3.1.4   | The nature of Mechatronics as a discipline lends itself to both the analysis and synthesis of problems. For example, when a complex Mechatronics system is analysed (using say, a block diagram approach) by breaking it down into separate functional parts or alternatively the synthesis of a complex system from simpler engineering systems. The two new awards allow these important skills to be developed further both in the technical subjects and in the core Communication and Business Awareness and Continuing Professional Development Units.  |
| 3.1.5   | <p>The revised HNC and HND Mechatronics awards provide centres with an opportunity to enhance learning skills not least by creating opportunities for candidates to combine theory and practice to achieve a real understanding of a subject. For example, some Units recommend significant use of practical work and/or computer simulation to reinforce learning. It is also anticipated that centres will use innovative delivery approaches that may make use of sophisticated mechatronics, electrical and electronic, mechanical and control laboratory equipment and/or on-line delivery and/or Virtual Learning Environments to enhance candidate learning.</p> <p>By their very nature engineering courses require the transfer of technical knowledge and skills from one area to another. For example, a significant level of mechatronics principles and mathematics has been included in both HNC and HND Mechatronics awards because these subjects provide underpinning knowledge, understanding and skills which are used elsewhere in both awards. Candidates will also have an opportunity to use the Communication knowledge and skills developed in the mandatory core Unit in other parts of the awards to support such activities as report writing, presentation and group work. Core Skills in general, and problem solving in particular, have been regarded as very important by the QDT since it is recognised that a good level of competence in these is essential in the work of technicians and incorporated technician.</p> |
| 3.3.1   | The double credit (16 SCQF points) Engineering Project Graded Unit in the HND Mechatronics award provides opportunities for candidates to develop both their planning and project management knowledge and skills.  |
| 3.3.2   | The Business Awareness and Continuing Professional Development Unit provides candidates with the opportunities to develop their investigative skills by exploring the external and internal factors that affect the performance of a modern company and the different ways that people learn. The Engineering Project also requires candidates to undertake some investigations into the background to and a range of solutions for their engineering project.  |

### 3.6 How the Specific Aims are met in the HNC and HND Mechatronics award structures

*The reader may wish to have the appropriate award framework information in Sections 5.1 to 5.5 available when reading the comments in the Table below.*

| Aim No. | How it is met in the HNC and HND   |
|---------|--|
| 3.2.1   | <p>The HNC and HND Mechatronics awards have been recognised for many years by employers and other stakeholders of these awards as appropriate qualifications for persons wishing to work at mechatronics technician or senior technician levels. Market research indicates that there is a growing demand for people with technician level skills in Mechatronics especially as companies automate a lot more of their processes. Thus, it is confidently anticipated that those achieving the HNC and HND Mechatronics awards will find employment as mechatronics technicians and incorporated engineers in a wide range of small, medium and large companies.</p>   |
| 3.2.2   | <p>The QDT consulted with the Institution of Engineering and Technology (IET) regarding the status of the two awards with regard to meeting the Institution's membership requirements. The QDT have been advised that the awards partially satisfy the underpinning educational requirements for Incorporated Engineer registration.</p> <p>Given the clear progression routes that have been established between existing HNC and HND Mechatronics awards and degree courses by many FE colleges and universities, it is strongly anticipated that similar progression routes will also be developed between the revised HNC and HND Mechatronics awards and degree courses. Thus, HNC and HND Mechatronics awards will continue to form very important 'stepping stones' towards candidates achieving degrees (and, thus, satisfy fully the academic requirements for Incorporated Engineer status). Those universities who have responded to requests for information on articulation have indicated that the HNC Mechatronics may allow direct entry to the second year of some degree programmes (although only the first year in some other cases) while the HND Mechatronics may allow entry to the third year of a few degrees, but more typically only the first or second year of degrees.</p> |

| Aim No. | How it is met in the HNC and HND  |
|---------|---|
| 3.2.3   | <p>The current HNC and HND Mechatronics awards contain a separate Communication Unit within their mandatory core section. Market research information gathered through various consultations indicated that there continued to be solid support for the inclusion of a distinct Communication Unit in the mandatory core of both the HNC and HND. The benefit of having a separate Communication Unit is that it significantly improves the prospect of sufficient attention being given to the teaching of this crucial subject area. A separate Unit also makes it possible to ensure that the Communication Core Skill at SCQF level 6 is fully embedded within the HNC and HND awards. Award designers considered this a more appropriate way to ensure that these Core Skills are included in HN Engineering awards then trying to embed such Core Skills across, say, a range of engineering Units.</p> <p>A number of respondents to various surveys have expressed their concerns about Communication not being seen as relevant by candidates because it is not delivered and assessed within an engineering context. The QDT has addressed this concern by supporting the production of Communication assessment exemplar materials specifically contextualised to engineering. This exemplar material has been produced and is stored on the SQA secure website.</p>                                       |
| 3.2.4   | <p>Market research involving engineering employers indicates that they place a high priority on employees having the correct technical and practical skills to function effectively in their job. Whilst there continues to be a debate about the precise nature of such technical and practical skills it is clearly important that mechatronic technicians and incorporated engineers have a sound knowledge and understanding of core Mechatronic principles. Such knowledge and understanding will serve candidates well in employment and provide the platform for learning more advanced technical skills. The mandatory section of the new HNC Mechatronics award reflects this concentration on core principles by providing studies in the key areas of Mechatronics namely: mechatronics systems, interfacing electronics, electrical engineering principles, engineering principles, Computer Aided Draughting for Engineers and robotic systems. The QDT also took the view that a knowledge and understanding of mathematics is fundamental to the work of mechatronic technicians and has included a Mathematics unit (with the Using Number component of the Core Skill Numeracy at SCQF level 6 embedded within it) within the mandatory section of the HNC Mechatronics award. The inclusion of mathematics within the mandatory section has been widely supported during various consultations.</p> |

| Aim No. | How it is met in the HNC and HND   |
|---------|--|
| 3.2.5   | <p>In the 2 credit optional section candidates will be able to specialise further in two of the following areas: materials, CNC, safety, PLC, assembly or high level engineering programming, information technology: applications software, measurement, pneumatics and hydraulics, quality management, industrial plant maintenance, employment experience, personal development planning and workplace communication.</p> <p>The QDT has operated on the principle that as new technologies evolve appropriate new Units will be developed (providing there is sufficient demand for them) and added to the optional section of the HNC Mechatronics framework.</p>   |
| 3.2.6   | <p>The Communication Core Skill at SCQF level 6 has been incorporated into the HNC Mechatronics award through the mandatory core Unit, Communication: Practical Skills There was strong support for the inclusion of the Numeracy Core Skill at SCQF level 6 within both HNC and HND Mechatronics awards. The QDT has adopted the Unit Mathematics for Engineering 1: Electronics and Electrical within the mandatory section of the HNC Mechatronics. The Core Skill component Using Number at SCQF level 6 (Higher) is embedded in this Unit. Candidates may achieve the Core Skill in Information Technology at SCQF level 6 if they take the optional unit Information Technology: Applications Software 1. Candidates may achieve the Working with Others Core Skill at SCQF level 6 if they successfully complete the optional Unit Employment Experience 2. Opportunities to develop the Core Skills component Using Graphical Information and the Core Skill Problem Solving plus other Core Skill components are signposted in individual Unit specifications and in the grids in Appendix 1.</p> |
| 3.4.1   | See comments under 3.2.2   |

| Aim No.             | How it is met in the HNC and HND   |
|---------------------|--|
| 3.4.2<br>&<br>3.4.3 | <p>It has been a tradition to deliver some form of Business Studies Unit in HND Engineering awards looking at issues such as costing /pricing of products and services. However, the focus of the new Business Awareness and Continuing Professional Development Unit is quite different looking as it does at the changing industrial environment in which technicians and incorporated engineers have to work nowadays. This environment is characterised by globalisation of the market place leading to world-wide marketing opportunities and competitive pressures; greater use of advanced technologies and the predominance of Small and Medium Sized Enterprises in the British economy. It is important that HND Mechatronics award candidates are suitably prepared to work in this ever-changing employment environment. The Business Awareness and Continuing Professional Development Unit seeks to do this by allowing candidates to explore the external factors that affect the performance of modern companies and the ways in which companies are responding to these external pressures internally. The Unit also has an Outcome on the important role that continuous learning and Continuing Professional Development will increasingly play in helping candidates to obtain sustainable and rewarding employment. Consultation with the FE sector and other interested stakeholders of HND Mechatronics awards has shown a strong measure of support for the Business Awareness and Continuing Professional Development Unit.</p> |
| 3.4.4               | <p>The mandatory section of the HND Mechatronics award contains all the Units in the mandatory section of the HNC Mechatronics award. In addition, within the mandatory section of the HND Mechatronics awards there are Units which allow candidates to expand their knowledge, understanding and skills in the key areas of Mechatronics such as materials selection, high level programming, high level language external I/O transfer, industrial plant maintenance, engineering design, engineering measurement or electronic testing skills, robotics and animatronics, and PLC.</p> <p>The QDT also considered it important to build on the mathematical skills developed in the Mathematics for Engineering 1: Electronics and Electrical Unit by including another core Mathematics Unit (entitled Mathematics for Engineering 2) within the mandatory section of the HND award. The main subject area of this Unit is Calculus.</p>  |

| Aim No. | How it is met in the HNC and HND   |
|---------|--|
| 3.4.5   | <p>In the 7 credit optional section of the HND Mechatronics candidates will be able to specialise further in the following areas: robotic systems, CNC, implementing small area networks, engineering drawing or engineering communication, information technology: applications software, industrial systems, project management, safety, assembly language programming, microprocessors and microcontroller technology, quality, engineering practical skills, more advanced electrical engineering, statics and strength of materials, dynamics, MCU/MCP I/O hardware control, engineering measurement, electronic testing skills, PLC, mathematics, employment experience, personal development planning, workplace communication and work role effectiveness. The Mathematics for Engineering 3 Unit has been included in the optional section to support candidates in articulating to degree courses.</p>   |
| 3.4.6   | <p>The Communication Core Skill at SCQF level 6 (Higher) has been incorporated into the HND Mechatronics award through the mandatory core Unit Communication: Practical Skills. The component Using Number of the Core Skill Numeracy at SCQF level 6 is embedded within the Unit Mathematics for Engineering 1: Electronics and Electrical. The Problem Solving Core Skill at SCQF level 6 is embedded within the double credit Mechatronics: Graded Unit 2 Project. Candidates may achieve the Core Skill in Information Technology at SCQF level 6 if they take the optional Unit Information Technology: Applications Software 1. Candidates may achieve the Core Skill Working With Others at SCQF level 6 if they take the optional Unit Employment Experience 2. Opportunities to develop the Core Skill component Using Graphical Information and other Core Skill components are signposted in individual Unit specifications and in the grids in Appendix 1.</p> |

## **3.7 Target Groups**

### **HNC Candidates**

Candidates at HNC level may already be in employment and will attend centres on a day-release or other part-time basis. The HNC framework structure is flexible enough to allow centres to deliver the HNC award by various modes of delivery for example, two-year day-release, evening attendance etc.

The options chosen by employed candidates may reflect the branch of industry in which they are employed or may be used to gain knowledge of other areas within Mechatronics in order to improve their career opportunities in the employment market. Part-time candidates may also use the HNC award to gain entry to degree level studies.

Full-time HNC candidates may be school leavers who have not gained the required university entry qualifications and who are using the award as an alternative means of gaining access to a university education. Full-time candidates may also be more mature persons who are seeking a change of employment.

Since the HNC award forms an integral part of the HND award, it is likely that full-time candidates will complete 15 Unit credits in the first year of the course, 12 of these being the HNC requirements. Full-time candidates will therefore have completed the first year of the HND programme and may, if they wish, continue to the second year of the HND award.

### **HND Candidates**

The HND programme will normally be delivered on a two-year full-time basis, although this does not preclude other delivery patterns. HND candidates will normally be school leavers who have an interest in some aspect of Mechatronics and wish to include this in their career path. The typical HND candidate will therefore be a young person who has not gained the required university entrance qualifications from school or who feels the need to gain a more in-depth knowledge of Mechatronics before embarking on a university career. The Units of the HNC/HND framework have been designed to introduce candidates to many of the concepts and principles surrounding Mechatronics before taking various subjects to a more advanced level.

Mature candidates may also embark on the HND programme. Such candidates may not have studied for some time and will require additional support in developing their learning skills.

## **3.8 Employment Opportunities**

For information on employment opportunities please see Aim 3.1.1 in Section 3.5 and Aim 3.2.1 in Section 3.6.



## **4 Access to awards**

### **4.1 Access requirements**

Admission to the HNC and HND Mechatronics awards should be based on a broad approach to candidate selection but, at the same time, should ensure that candidates are chosen who have the potential and ability to complete the awards successfully. To this end, the following are simply recommendations and should not be seen as a definitive or prescriptive list of entry requirements. Their purpose is simply to give guidance to the selection of candidates. It is recommended that candidates should possess the following:

- ◆ One Higher from Physics, Technological Studies, Mechatronics or Mathematics and at least three Standard Grades 1–2/Intermediate 2 passes which must include Mathematics, Physics or Technological Studies and English.
- ◆ National Certificate Group Award (NCGA) in Engineering, Electronics or Electrical Engineering.
- ◆ Qualification comparable to the above, gained through other awarding bodies such as GSCE, City & Guilds, Edexcel etc.
- ◆ At the discretion of the Principal of the presenting centre for applicants with a different experiential background (eg relevant SVQs) who could benefit from taking the award or Units within the award: eg adult returners, overseas students with relevant work experience.

### **4.2 Recommended Core Skills Entry Level**

The recommended Core Skills entry levels for both the HNC and HND Mechatronics awards are as follows:

- ◆ Communication SCQF level 5
- ◆ Information Technology SCQF level 5
- ◆ Numeracy SCQF level 5
- ◆ Problem Solving SCQF level 5
- ◆ Working with Others SCQF level 4

### **4.3 Alternative Access Arrangements**

The presenting centre may operate alternative access arrangements in cases where the candidate is convinced that he/she already has the required competences in a given area. These arrangements are as follows:

- ◆ Assessment on demand
- ◆ Credit transfer
- ◆ Accreditation of prior learning
- ◆ Relevant work experience

Individual presenting centres will require to outline their systems for each of these as part of any approval procedure.

#### **4.4 Candidates who have English as an additional language**

A Unit entitled Workplace Communication in English has been included in the optional section of both the HNC and HND Mechatronics awards to support those candidates for whom English is an additional language.

## 5 Awards structure

### 5.1 HNC Mechatronics Engineering (Award No. G87L 15) 12 Unit Credits

#### Mandatory Units (9 Credits)

| Section                                      | Credit Value | SCQF level | Product Code | Product Title                              |
|--|--------------|------------|--------------|--|
| Common Core                                  | 1            | 7          | H7MB 34*     | Communication: Practical Skills            |
| Principles and Technology<br><br>(8 Credits) | 1            | 6          | H7K0 33*     | Engineering Mathematics 1                  |
|  | 1            | 7          | DW8T 34      | Mechatronic Systems Elements               |
|  | 1            | 8          | DW8R 35      | Mechatronic Systems                        |
|  | 1            | 7          | DW8P 34      | Interfacing Electronics                    |
|  | 1            | 6          | DW6W 33      | Electrical Engineering Principles 1        |
|  | 1            | 7          | DR3L 34      | Engineering Principles                     |
|  | 1            | 7          | DR1X 34      | Computer Aided Draughting for Engineers    |
|  | 1            | 7          | DW8W 34      | Robotics and Animatronics: An Introduction |

#### Optional Units (max 2 Credits)

| Credit Value | SCQF level | Product Code | Product Title                                   |
|--------------|------------|--------------|---|
| 1            | 7          | DT46 34      | Materials Selection                             |
| 1            | 7          | DT5P 34      | CNC   |
| 1            | 7          | D77H 34      | Employment Experience 2                         |
| 1            | 7          | DR2D 34      | Safety Engineering and the Environment          |
| 1            | 7          | DG31 34      | Applications of Programmable Logic Controllers  |
| 1            | 7          | DG58 34      | High Level Engineering Software                 |
| 1            | 7          | D75X 34      | Information Technology: Applications Software 1 |
| 1            | 7          | DG59 34      | MCU/MPU Assembly Language Programming           |
| 1            | 7          | H7K1 34*     | Engineering Mathematics 2                       |
| 1            | 7          | DT9X 34      | Pneumatics and Hydraulics                       |
| 1            | 7          | DT8Y 34      | Quality Management: An Introduction             |
| 1            | 8          | DT9W 35      | Applied Industrial Plant Maintenance            |
| 1            | 7          | DE3R 34      | Personal Development Planning                   |
| 1            | 6          | H8T2 33*     | Workplace Communication in English              |
| 1            | 7          | DT9R 34      | Engineering Measurement                         |
| 1            | 7          | DG3N 34      | Electronic Testing Skills                       |
| 1            | 7          | J0HA 34*     | Computer Programming                            |
| 1            | 7          | J0H9 34*     | Data Security                                   |

\*Refer to History of Changes for revision changes.

#### Graded Unit (1 Mandatory Credit)

| Credit Value | SCQF level | Product Code | Product Title                           |
|--------------|------------|--------------|---|
| 1            | 7          | DX3H 34      | Mechatronics: Graded Unit 1 Examination |

**Note:** The Unit Mechatronic Systems is the only Unit at SCQF level 8 in the mandatory section of the HNC. This levelling occurred as a result of redeveloping the previous double-credit Unit which when separated into two single Units gave rise to one of the Units being levelled at SCQF level 8.

## 5.2 HND Mechatronics Engineering (Award No. G87M 16) 30 Unit Credits

### Mandatory Units (20 Credits)

| Section                                       | Credit Value | SCQF level               | Product Code   | Product Title  |
|---|--------------|--------------------------|--|--|
| Common Core<br>(2 Credits)                    | 1            | 7                        | H7MB 34*   | Communication: Practical Skills                            |
|   | 1            | 8                        | DG3D 35  | Business Awareness and Continuing Professional Development |
| Principles and Technology<br><br>(18 Credits) | 1            | 7                        | DR1X 34  | Computer Aided Draughting for Engineers                    |
|   | 1            | 6                        | H7K0 33*   | Engineering Mathematics 1                                  |
|   | 1            | 7                        | DW8T 34  | Mechatronic Systems Elements                               |
|   | 1            | 8                        | DW8R 35  | Mechatronic Systems  |
|   | 1            | 7                        | DW8P 34  | Interfacing Electronics                                    |
|   | 1            | 6                        | DW6W 33  | Electrical Engineering Principles 1                        |
|   | 1            | 7                        | DR3L 34  | Engineering Principles                                     |
|   | 1            | 7                        | DW8W 34  | Robotics and Animatronics: An Introduction                 |
|   | 1            | 7                        | H7K1 34*   | Engineering Mathematics 2                                  |
|   | 1            | 7                        | DT46 34  | Materials Selection  |
|   | 1            | 8                        | DG5A 35  | High Level Language: External I/O Transfer                 |
|   | 1            | 8                        | DT9W 35  | Applied Industrial Plant Maintenance                       |
|   | 1            | 8                        | DW8M 35  | Engineering Design Process: Mechatronics                   |
|   | 1<br>or<br>1 | 7<br>or<br>7             | DT9R 34<br>or<br>DG3N 34   | Engineering Measurement<br>or<br>Electronic Testing Skills |
|   | 1            | 8                        | DW8V 35  | Robotics and Animatronics                                  |
|   | 1            | 7                        | DT9X 34  | Pneumatics and Hydraulics                                  |
| 1<br>or<br>1                                  | 7<br>or<br>7 | DG31 34<br>or<br>DW8N 34 | Applications of Programmable Logic Controllers<br>or<br>Engineering Systems Interfaced with Programmable Logic Controllers |  |
| 1   | 7            | DG58 34                  | High Level Engineering Software  |  |

### Optional Units (max 7 Credits)

| Credit Value | SCQF level   | Product Code             | Product Title  |
|--------------|--------------|--------------------------|--|
| 1            | 8            | DT9Y 35                  | Robotic Systems  |
| 1            | 7            | DT5P 34                  | C.N.C  |
| 1            | 7            | DG40 34                  | Implementing Small Local Area Networks                 |
| 1            | 8            | DN4D 35                  | Control Systems Behaviour                              |
| 2            | 8            | DG4P 35                  | Mathematics for Engineering 3                          |
| 1<br>or<br>1 | 7<br>or<br>7 | DR1W 34<br>or<br>DV9N 34 | Engineering Drawing<br>or<br>Engineering Communication |
| 1            | 7            | D75X 34                  | Information Technology: Applications Software 1        |
| 1            | 8            | DT5V 35                  | Industrial Systems                                     |
| 1            | 7            | A6AX 34                  | Project Management                                     |
| 1            | 7            | D77H 34                  | Employment Experience 2                                |
| 1            | 7            | DR2D 34                  | Safety Engineering and the Environment                 |
| 1            | 7            | DG59 34                  | MCU/MPU Assembly Language Programming                  |
| 1            | 8            | DG4X 35                  | Microprocessor and Microcontroller Technology          |
| 1            | 7            | DT8Y 34                  | Quality Management: An Introduction                    |

\*Refer to History of Changes for revision changes.

| Credit Value | SCQF level | Product Code | Product Title  |
|--------------|------------|--------------|--|
| 1            | 7          | DW6X 34      | Electrical Engineering Principles 2                                |
| 1            | 7          | DR1T 34      | Statics and Strength of Materials                                  |
| 1            | 7          | DT9T 34      | Dynamics   |
| 1            | 8          | DG5C 35      | MCU/MPU I/O Hardware Control                                       |
| 1            | 7          | DT9R 34      | Engineering Measurement  |
| 1            | 7          | DG3N 34      | Electronic Testing Skills  |
| 1            | 7          | DG31 34      | Applications of Programmable Logic Controllers                     |
| 1            | 7          | DW8N 34      | Engineering Systems Interfaced with Programmable Logic Controllers |
| 1            | 7          | DE3R 34      | Personal Development Planning                                      |
| 1            | 6          | H8T2 33*     | Workplace Communication in English                                 |
| 1            | 7          | DG6E 34      | Work Role Effectiveness  |
| 1            | 8          | DG6G 35      | Work Role Effectiveness  |
| 1            | 7          | DR1W 34      | Engineering Drawing  |
| 1            | 7          | DV9N 34      | Engineering Communication  |
| 1            | 7          | H7K2 34*     | Engineering Mathematics 3  |
| 1            | 8          | H7K3 35*     | Engineering Mathematics 4  |
| 1            | 8          | H7K5 35*     | Engineering Mathematics 5  |
| 1            | 7          | J0HA 34*     | Computer Programming   |
| 1            | 7          | J0H9 34*     | Data Security  |

\*Refer to History of Changes for revision changes.

### Graded Unit (3 Mandatory Credits)

| Credit Value | SCQF level | Product Code | Product Title                           |
|--------------|------------|--------------|---|
| 1            | 7          | DX3H 34      | Mechatronics: Graded Unit 1 Examination |
| 2            | 8          | DX3J 35      | Mechatronics: Graded Unit 2 Project     |

## 5.3 Conditions of the Award

The conditions of award for HNC and HND Mechatronics qualifications are as follows:

### 5.3.1 HNC Mechatronics

A candidate will be awarded the HNC Mechatronics on successful completion of 11 Unit credits plus the 1 credit Graded Unit based on the HNC Mechatronics award structure shown in Section 5.1. More specifically this award structure requires that candidates achieve the following:

- ◆ 9 Unit credits in the Mandatory Section of the HNC framework in Section 5.1
- ◆ Any 2 Unit credits from the optional section of the HNC framework in Section 5.1
- ◆ Mechatronics Graded Unit 1: Examination

### 5.3.2 HND Mechatronics

A candidate will be awarded HND Mechatronics on successful completion of 27 Unit credits plus 3 Graded Unit Assessment credits based on the HND Mechatronics award structure shown in Section 5.2. More specifically this award structure requires that candidates achieve the following:

- ◆ 20 Unit credits in the Mandatory section of the HND framework in Section 5.2
- ◆ Any 7 Unit credits from the optional section of the HND framework in Section 5.2
- ◆ Mechatronics Graded Unit 1: Examination
- ◆ Mechatronics Graded Unit 2: Project

## 5.4 Core Skills Exit Profile

### HNC Mechatronics

#### Core Skills Exit Profile

A candidate who successfully achieves an HNC Mechatronics will automatically obtain the following Core Skills exit profile:

- ◆ Communication at SCQF level 6  
(embedded in the Unit Communication: Practical Skills)
- ◆ Using Number component of the Numeracy Core Skill at SCQF level 6 (embedded in the Unit Mathematics for Engineering 1: Electronics and Electrical)

### HND Mechatronics

#### Core Skills Exit Profile

A candidate who successfully achieves an HND Mechatronics will automatically obtain the following Core Skills exit profile:

- ◆ Communication at SCQF level 6  
(embedded in the Unit Communication: Practical Skills)
- ◆ Using Number component of Numeracy Core Skill at SCQF level 6  
(embedded in the Unit Mathematics for Engineering 1: Electronics and Electrical)
- ◆ Problem Solving at SCQF level 6  
(embedded in the Unit Mechatronics Graded Unit 2: Project)

Opportunities for candidates to develop Core Skill components as part of the delivery of the mandatory Units in the HNC and HND Mechatronics are signposted in Appendix 1.

## 5.5 Mapping information

Information on the way in which individual Units map into the aims of the awards can be found in the Tables in Sections 3.5 and 3.6.

## 5.6 Articulation, professional recognition and credit transfer

### 5.6.1 Articulation

The QDT wrote to several universities in Scotland regarding possible articulation routes between the HNC and HND Mechatronics awards and degree courses offered in these universities. Those universities who responded to requests for information on articulation indicated that the HNC Mechatronics may allow direct entry to the second year of some degree programmes (although only the first year in some other cases) while the HND Mechatronics may allow entry to the third year of a few degrees, but more typically only the first or second year of degrees.

### 5.6.2 Professional Body Recognition

The QDT has consulted with the IET (Institution of Engineering and Technology) about the status of the HNC and HND Mechatronics awards with regard to future membership of the IET. The response received is similar to that received for all other HN Engineering awards in the HNC/HND Engineering framework: namely, once validated the Institution will approve the awards as partially satisfying the underpinning educational requirement for Incorporated Engineer registration.

### 5.6.3 Credit Transfer Arrangements

A document, entitled HNC/HND Mechatronics — Credit Transfer Decisions, has been developed which contains information on credit transfer arrangements between the old HN Mechatronics Units and the new HN Units. A copy of this document is included in Appendix 2. This document has been designed to make it as straightforward as possible for course admission tutors to work out the amount of credit transfer a candidate with ‘old’ HN Units can count towards the new HNC/HND Mechatronics awards. The use of this document is illustrated below.

#### **An Example of the use of the Guide to Credit Transfer Document**

A candidate has a number of HN Units towards an old HNC award. The candidate now wishes to study for a new HND Mechatronics. A course admission tutor has been given the task of determining the level of credit transfer the candidate has towards the new HND Mechatronics.

#### **List of Units successfully achieved as part of the old HNC award**

| <b>Unit Number</b> | <b>Unit Title</b>   |
|--------------------|---|
| A6AN 04            | Information Technology Applications 2                                   |
| D5P3 04            | Communication: Presenting Complex Communication for Vocational Purposes |
| BA24 04            | Fundamentals of Quality Assurance                                       |
| D4FJ 04            | Application of Programmable Logic Controllers                           |
| D4JH 04            | Mathematics for Engineering   |
| D4J1 04            | Industrial Plant Services: Pneumatics and Hydraulics                    |
| A4RR 04            | Engineering Programming   |
| D4HX 04            | Industrial Plant Maintenance  |
| D4FR 04            | Combinational Logic   |

**Credit Transfer Available to Candidate (using Credit Transfer Decision Document)**

| <b>Old Unit Title &amp; Number</b>  | <b>New Unit Title &amp; Number</b>                                  | <b>Credit Value</b> | <b>Status (Full, Partial or No Credit Transfer)</b>   |
|---|---|---------------------|---|
| Information Technology Applications 2 (A6AN 04)                                   | Information Technology: Applications Software 1 (D75X 34)           | 1                   | Full  |
| Communication: Presenting Complex Communication for Vocational Purposes (D5P3 04) | Communication: Practical Skills (D77G 34)                           | 1                   | Partial   |
| Mathematics for Engineering (D4JH 04)   | Mathematics for Engineering 1: Electronics and Electrical (DG4H 33) | 1                   | Partial Outcomes 1 and 2 of Mathematics for Engineering Unit only (Recommend new Unit is taken) |
| Fundamentals of Quality Assurance (BA24 04)                                       | Quality Management: An Introduction (DT8Y 34)                       | 1                   | None  |
| Application of Programmable Logic Controllers (D4FJ 04)                           | Applications of Programmable Logic Controllers (DG31 34)            | 1                   | Full  |
| Industrial Plant Services: Pneumatics and Hydraulics (D4J1 04)                    | Pneumatics and Hydraulics (DT9X 34)                                 | 1                   | Full  |
| Engineering Programming (A4RR 04)   | High Level Engineering Software (DG58 34)                           | 1                   | Full  |
| Combinational Logic* (D4FR 04)  | Combinational Logic* (DG3C 34)                                      | 1                   | No transfer available   |
| Industrial Plant Maintenance (D4HX 04)  | Applied Industrial Plant Maintenance (DT9W 35)                      | 1                   | Full  |
|   | <b>Total</b>  | <b>7</b>            |   |

It can be seen from the above table that the candidate can obtain 7 full credits towards the new HND Mechatronics award using the credit transfer documents.

\* Please see HNC and HND Electronics Arrangements document. Tutors may be required to check the credit transfer documents in other HN Engineering Arrangements documents to obtain details of the full credit transfer opportunities available to a candidate.



| New Unit Title            | New Unit Code | Old Unit Title   | Old Unit Code | Credit Transfer Conditions  |
|---------------------------|---------------|--|---------------|---|
| Engineering Mathematics 1 | H7K033        | Mathematics for Engineering 1:Electronics and Electrical   | DG4H33        | To gain credit transfer to the new unit candidates will have to provide additional evidence relating to functions as specified in the Evidence requirements in respect of the first three knowledge/skills in Outcome 1 and relating to vectors as specified in the first three knowledge/skills in outcome 3.            |
| Engineering Mathematics 1 | H7K033        | Mathematics for Engineering 1:Mechanical and Manufacturing | DT5X33        | To gain credit transfer to the new unit candidates will have to provide additional evidence relating to functions as specified in the Evidence requirements in respect of the first three knowledge/skills in Outcome 1 and relating to 3D vectors and complex numbers as specified in the knowledge/skills in outcome 3. |
| Engineering Mathematics 2 | H7K134        | Mathematics for Engineering 2                              | DG4L34        | To gain credit transfer to the new unit candidates will have to provide additional evidence relating to trigonometric and hyperbolic functions as specified in the Evidence requirements in respect of Outcome 1.   |

## 6 Approaches to delivery and assessment

### 6.1 Content and Context

Throughout the design and development of the HNC and HND Mechatronics awards the QDT has placed a high priority on producing awards that allow candidates to develop appropriate technical and practical skills. As indicated earlier, it is not possible to quantify such technical and practice skills in exact detail. However, the QDT has taken the view that the best way to prepare candidates to meet the changing technical and practical requirements of the modern Mechatronics industry is to ensure candidates have a solid foundation of theory and practical upon which they can build new knowledge, understanding and skills. Thus, the mandatory section of the HNC Mechatronics contains fundamental studies in Electrical Engineering, Mechanical Engineering Principles, Interfacing Electronics, Mechatronic Systems and Robotics. The HND Mechatronics mandatory section builds on and extends these studies. The studies in Mechatronics are underpinned by the inclusion of a core Mathematics Unit in the HNC and another core Mathematics Unit in the HND. The QDT believes that a good grasp of mathematics is essential to an understanding of Mechatronics.

The optional sections of both the HNC and HND Mechatronics provide candidates with the opportunity to specialise in technical and/or non-technical subjects. In line with normal good practice centres are encouraged to advise candidates to choose those options that best meet their future career and educational aspirations.

The QDT has also ensured that the two new awards contain opportunities for candidates to develop a range of related skills which would make the holder of the awards better prepared for employment and/or degree studies. For example, the Communication: Practical Skills Unit has been included within the mandatory sections of both HNC and HND awards to provide candidates with the opportunity to develop their written and group discussion skills about complex vocational issues.

Although a discrete Information Technology Unit is not included within the HNC and HND mandatory sections, centres will still have the opportunity to develop the candidates Information Technology and programming skills through Units such as High Level Engineering Software which is an option in the HNC but mandatory within the HND. Even where centres choose not to select this Unit from the optional section of the HNC there are a number of opportunities to further develop Information Technology knowledge and skills within individual Units (eg in the Units Information Technology: Applications Software 1, MCU/MPU Assembly Language Programming).

A new type of Business Studies Unit, entitled Business Awareness and Continuing Professional Development has been included within the mandatory core of the HND Mechatronics. This Unit focuses on two areas which the QDT considered important to working in the modern engineering industry, namely the external and internal factors that affect business performance and the need for continuing learning and development if candidates are to have sustainable and rewarding employment in the future.

## 6.2 Delivery

The new HNC and HND Mechatronics awards can be delivered on a full-time, block-release, part-time day or part-time evening basis.

In timetabling the two new awards, centre staff should take account of information contained in the Recommended Prior Knowledge and Skills statement in Unit specifications in sequencing the delivery of Units. For example, the Mechatronic Systems Elements Unit would normally be delivered before the Mechatronic Systems Unit. Examples of a full-time HNC Mechatronics and 2nd Year HND Mechatronics timetables are shown in Appendix 3.

One of the key reasons the QDT has sought to reduce the time candidates have to spend on summative Unit assessment is to provide lecturers with more time to deliver Units. Lecturers are encouraged, in particular, to use this additional time to reinforce learning in core principles and technologies and enhance the development of candidates' practical skills.

Lecturers may use a variety of teaching and learning approaches in delivering the Units in the HNC and HND Mechatronics awards. These may include lecturing, group work, laboratory and practical work, computer simulation (using appropriate software packages), project work and case studies. The use of open and distance learning and on-line materials may help to supplement and support the learning that takes place in the classroom, laboratory or workshop.

Industrial visits are encouraged wherever possible to provide 'real life' industrial examples of the application of the theory and practice learnt in the classroom, laboratory or workshop.

The QDT recognises the very important role computer simulation, such as robotics and mechatronics software, plays in the modern engineering industry. The QDT would actively encourage the use of computer simulation wherever appropriate but not at the expense of candidates doing practical work. The QDT believes it is very important that candidates get as much exposure as possible to practical Mechatronics hand skills, the use of measuring and test equipment and other practical activities if they are to be suitably prepared to work in industry. The optional Unit Engineering Practical Skills, is currently being developed to allow candidates with limited practical experience to develop the appropriate hand skills and experience in using measuring and test equipment.

Lecturers should also seek opportunities to integrate Core Skills within their teaching and learning programme. Such opportunities may be included in the following Units (the following list is not intended to be exhaustive):

### Communication

- ◆ Providing candidates opportunities to develop their oral skills by allowing them to give full answers to questions asked by the lecturer and by giving an oral presentation in the Mechatronics: Graded Unit 2 Project.
- ◆ Develop complex, vocationally specific reading skills (eg Applied Industrial Plant Maintenance, Mechatronic Systems etc.)
- ◆ Develop report writing skills in a number of Units (eg Engineering Design Process, Mechatronics: Graded Unit 2 Project etc.)
- ◆ Allowing candidates to develop their Communication skills in group work activities (eg Communication: Practical Skills, Materials Selection)

## **Numeracy**

- ◆ Reinforcing numeracy and mathematical skills when teaching electrical engineering topics (eg Engineering Principles, Electrical Engineering Principles, Mechatronic Systems Elements and Mechatronic Systems etc.)
- ◆ Reinforcing using graphical information skills by use of a range of graphical representations (eg Engineering Principles, Computer Aided Draughting for Engineers etc.)

## **Information Technology**

- ◆ Develop information technology skills through the application of I.T. within a Mechatronics context (eg Information Technology Application Software, High Level Engineering Software etc.).

## **Problem Solving Skills**

- ◆ Develop critical thinking skills through the application of engineering principles and technologies to solve engineering problems (all engineering Units).
- ◆ Develop planning and organisational skills (eg Engineering Design Process, Applied Industrial Plant Maintenance etc.).
- ◆ Develop reviewing and evaluation skills through, for example, the review and evaluation of the outcomes of assignments and project work (eg Engineering Design Process, Mechatronics: Graded Unit 2 Project etc.).

## **Working with Others**

- ◆ Develop working with others skills through group discussion on the solution to engineering problems (eg Safety Engineering and the Environment - role play scenario, carry out a suitable risk assessment) and laboratory and project work (eg Quality Management: An Introduction , Project Management, Materials Selection etc.)

Opportunities to develop Core Skills components in individual mandatory Units are signposted in the tables in Appendix 1.

## **6.3 Assessment**

### **6.3.1 Assessment Strategy**

From the outset of developments the HN Mechatronics QDT recognised the need to have an appropriate assessment strategy in place for the HNC and HND Mechatronics awards. Such a strategy was developed and is shown below:

#### **Aims**

The aims of the strategy are to ensure that:

- 1 Consistent, rigorous and efficient approaches are adopted to the development and administration of HN Mechatronics assessment instruments at both Unit and Graded Unit levels, which satisfy nationally, agreed standards.
- 2 The assessment load on students and staff is sensible and that assessment does not unduly detract from teaching and learning.

- 3 As far as possible reliable and rigorous moderation processes are put in place in order to ensure that consistent national standards are achieved for all HN Mechatronics assessments.

## **Objectives**

Listed below are the measures that have been put in place to meet the aims:

- 1 Develop nationally at least one assessment exemplar pack for each mandatory Unit, which clearly sets out the standards of assessment expected in the Unit.
- 2 Adopt a holistic approach to Unit assessment. The implications of this are as follows:
  - i Assessment instruments will normally be designed only to sample knowledge and skills in a Unit (this is consistent with the new HN Unit format)
  - ii A Unit assessment strategy will be adopted, where possible, to produce a single assessment instrument for the whole Unit. Where this is not possible the assessment strategy will seek to ensure that the minimum number of assessment instruments is used, consistent with maintaining agreed national standards.
- 3 Whilst not seeking to be entirely prescriptive with regard to the time spent on assessment in each HN Unit, over assessment should be avoided if the following guidelines are adopted for the maximum time spent on HN Unit assessment:
  - i One and a half to two hours per Unit credit for HN Units at SCQF levels 6 and level 7
  - ii Two to two and a half hours per Unit credit for HN Units at SCQF level 8
- 4 Produce assessment exemplar packs for the two Graded Units. For the Graded Unit examination produce at least one sample exam paper to show the standards expected in such a paper. Likewise, for the 2 credit Graded Unit Mechatronics Project produce a set of materials which clearly sets out the standards of candidate response required to achieve a Grade A and Grade C.
- 5 Actively encourage colleges to work in partnership in producing Graded Unit assessment materials, which meet nationally agreed standards reducing, in turn, the workload on staff in individual colleges.
- 6 Ensure that consistent and rigorous internal and external moderation procedures operate through both HN Unit level and the Graded Unit procedures. This places a clear responsibility on both colleges and the SQA.

As far as has been practical the above objectives have been adhered to when developing assessment exemplar and Graded Unit materials.

### 6.3.2 Graded Units

The purpose of the Graded Units in both the HNC and HND awards is to assess the candidate's ability to apply and integrate knowledge and/or skills gained within individual Units. By this means candidates will demonstrate that they have achieved the principal aims of the awards. The Graded Units also provide the means by which candidate achievement can be graded.

HNC Mechatronics candidates will undertake a **1 Credit Graded Unit** at SCQF level 7. This will be in the form of a 3 hour written examination.

HND Mechatronics candidates will also do the HNC Graded Unit but, in addition, will undertake a **2 Credit Graded Unit** at SCQF level 8. This will take the form of a practical assignment/project.

#### Types of Graded Units

##### **Mechatronics: Graded Unit 1 — Examination**

The specification for the Mechatronics: Graded Unit 1 Examination can be found on the SQA website ([www.sqa.org.uk](http://www.sqa.org.uk)). It will be noted that the Graded Unit draws on topics in the mandatory Units of the HNC Mechatronics which are studied by all candidates.

The assessment for the Mechatronics: Graded Unit 1 consists of an examination paper which should last three hours.

It is recommended that candidates do not sit the Graded Unit examination until the end of the HNC (1st year of the HND), given the range of Units that it draws from.

##### **Mechatronics: Graded Unit 2 - Project**

The specification for the Mechatronics: Graded Unit 2 Project may also be found on the SQA website ([www.sqa.org.uk](http://www.sqa.org.uk)). The nature of the project activity detailed in the specification is such that it is likely that centres will wish their candidates to embark on it from the start of the second year of the HND Mechatronics programme. As it is anticipated that centres will deliver the HNC Mechatronics as part of the first year of the HND, it is recommended that candidates have completed all HNC Mechatronics Units, including Mechatronics: Graded Unit 1, before commencing the project.

In principle, the project can draw on any mandatory Units in the HND Mechatronics framework. The project can be taken from one Mechatronics area (eg Mechatronics, Robotics and Animatronics) or it can span more than one technical area. However, its principal purpose is not to integrate technical content (this is covered in Mechatronics: Group Award Graded Unit 1) but rather to combine such knowledge and skills as planning, construction, testing, evaluating and reporting.

### 6.3.3 Assessment Exemplar Materials

Assessment exemplar packs are in the process of being produced for the following new units and Graded Unit in the HNC and HND Mechatronics awards:

|         |   |
|---------|---|
| DW8T 34 | <i>Mechatronic Systems Elements</i>             |
| DW8R 35 | <i>Mechatronics Systems</i>                     |
| DW8P 34 | <i>Interfacing Electronics</i>                  |
| DW8M 35 | <i>Engineering Design Process: Mechatronics</i> |

|         |   |
|---------|---|
| DW8W 34 | <i>Robotics and Animatronics: An Introduction</i> |
| DW8V 35 | <i>Robotics and Animatronics</i>                  |
| DX3H 34 | <i>Mechatronics: Graded Unit 1</i>                |

The reader is advised to consult the Arrangements documents for the HN awards shown below, or the SQA Qualifications Officer responsible for the HNC and HND Mechatronics awards, to check the availability of other assessment exemplars in the HNC and HND Mechatronics frameworks.

### **Formative Assessment**

Formative assessment should be used throughout the delivery of Units to reinforce learning, build candidates' confidence and prepare candidates for summative assessment.

## **6.4 Resources**

### **Practical Resources**

Centre staff are advised to read individual Unit specifications carefully to identify the consumables, equipment and/or software requirements to deliver Units. Some Units have specific requirements. For example, the Unit Computer Aided Draughting in Engineering has to use industrially specific software.

While not all Units require practical resources, centres are strongly recommended to provide candidates with access to practical laboratory and workshop facilities appropriate to the HNC and HND Mechatronics. For example, when candidates undertake the Robotics and Animatronics Units it would be helpful if they had access to small scale and industrial size robots. Where the latter is not possible it would be a good idea to arrange a suitable industrial visit so that candidates can see such robots in operation.

When teaching Interfacing Electronics it would be good to let candidates see and examine a range of passive and active components. Likewise when teaching robotic systems candidates should be able to view in detail the types of motors, transducers etc. used in these systems. The same visual inspection principles can also be applied to other Units. Good charts or other visual aids showing various item(s) or various parts of an item of Mechatronic equipment can also be good teaching aids.

The QDT strongly recommends the use of simulation software to support teaching and learning. However, the team does not believe that such software should be used at the expenses of practical laboratory or workshop activities. The team strongly considers that such practical activities represent the best way for candidates to relate the theory they learn in the classroom to practical Mechatronics.

The QDT believes that there is a very rich and varied range of teaching and learning resources available to deliver the HNC and HND Mechatronics Units. Such learning resources include textbooks, reports, papers, standards, CDs, DVDs and numerous sites on the Internet. Some centres may already have good learning resources in their learning libraries/Virtual Learning Environments. It is anticipated that the Qualification Support Team (QST) for the HNC and HND Mechatronics will provide a useful forum for the identification and sharing of learning resources.

## Continuing Professional Development

The QDT are firmly of the view that active staff CPD is essential if the delivery and assessment of individual HNC and HND Mechatronics Units are to be kept up to date, relevant and interesting. Staff CPD activities could be in subject areas such as the following (the list is not intended to be exhaustive):

- ◆ Learning to use specialist engineering software
- ◆ Modern manufacturing methods (possibly involving the use of robots)
- ◆ Telecommunications applicable to Mechatronic systems
- ◆ Programmable Logic Controllers/Microcontrollers
- ◆ New teaching and assessment methodologies
- ◆ E-learning
- ◆ New or revised standards and regulations
- ◆ Issues relating to health and safety

## 6.5 Open and Distance Learning

Advice on the use of open and distance learning is given in individual Unit specifications. However, where it is used with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangement would be required to be put in place to ensure that the assessment or assessments were conducted under the conditions specified in the Unit specification. For example, in the case of a Unit which involved a Unit end test a centre would have to make arrangements for the test to be conducted under controlled, supervised conditions. Likewise, where a Unit involves a practical based assessment, a centre would have to make arrangements for candidates to come into the centre to undertake the assessment under the conditions specified in the Unit specification or make suitable alternative arrangements.

It should be noted that the same requirements as specified in the previous paragraph apply where part or all of a Unit is delivered on-line.

## 7 General information for centres

### Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* ([www.sqa.org.uk](http://www.sqa.org.uk)).

### Internal and external moderation

All instruments of assessment used within this/these Group Awards should be internally moderated, using the appropriate policy within the centre and the guidelines set by SQA.

External moderation will be carried out by SQA to ensure that internal assessment is within the national guidelines for these qualifications.

Further information on internal and external moderation can be found in SQA's Guide to Assessment and Quality Assurance for Colleges of Further Education ([www.sqa.org.uk](http://www.sqa.org.uk)).



## 8 General information for candidates

The new HNC and HND Mechatronics awards have been designed by a team of educators and industrialists with a view to allowing you to meet the educational requirements to work as a mechatronics technician or incorporated engineer. The two new qualifications contain up-to-date and relevant Mechatronics subject content and skills and have also been designed to satisfy the new SQA Higher National Design Principles.

The Qualification Design Team (QDT) has designed the two awards so that you will have opportunities to learn and understand the core principles and technologies that underpin Mechatronics. Learning these will be essential in providing you with a platform for tackling many Mechatronics tasks and in allowing you to develop a more in-depth knowledge of Mechatronics. At the same time studying the new HNC and HND Mechatronics will provide you with opportunities to develop sound practical Mechatronics investigation, construction, testing and project skills which are critical to being a good mechatronics technician and/or incorporated engineer.

As well as studying Mechatronic subjects you will also take a Unit in Communication skills within the HNC Mechatronics programme. Good Communication skills are essential to understanding technical material and when communicating with others whether on an individual basis or when working as part of a team.

The Communication Unit is also mandatory within the HND Mechatronics award. There is an additional mandatory core Unit in the HND Mechatronics award entitled Business Awareness and Continuing Professional Development. This Unit will provide you with an awareness of the business pressures on modern engineering companies and what strategies they are adopting to meet these pressures. The Unit will also provide you with the opportunity to develop your own career and education development plan for the next five years or so.

As already mentioned Mechatronics is very much about learning, understanding and integrating core principles and technologies whilst also doing practical work such as using and applying specific hand tool and materials as well as project work. Thus, while taking the HNC and HND Mechatronics you can anticipate that the teaching and learning approaches adopted by your lecturers will include the following: lecturing, group work, practical mechatronics work, inspection and testing, computer simulation of mechatronic systems and project work.

The QDT has ensured that assessments in the two awards meet national standards. The two awards have been designed to optimise assessment so that sufficient time is available for you to learn the Mechatronics principles and technologies and the practical skills that are essential to being a good Mechatronic technician and incorporated engineer.

You can expect to do assessment at individual Unit level and at qualification level. At Unit level assessment will consist of some form of written end test, or a combination of short written test and practical exercise or a purely practical exercise. Your lecturer should tell you at the start of the Unit what form the Unit assessment will take. In addition, to Unit tests there will also be a 3 hour examination at HNC level and an additional 2 credit project at HND level.

The QDT does not wish to place any artificial barriers in the way of potential candidates wanting to study the two awards. However, it would be unfair to enrol a candidate into the HNC and HND who did not have a realistic chance of successfully achieving either or both awards. The QDT would therefore recommend that a candidate has one of the following qualifications before entering the HNC and HND Mechatronics:

- 1 One Higher from Physics, Technological Studies, Mathematics or Mechatronics and at least three Standard Grades 1–2/ Intermediate 2 passes which must include Mathematics, Physics or Technological Studies and English.
- 2 A National Certificate Group Award in Engineering, Electronics or Electrical Engineering.
- 3 Equivalent qualifications or experience to those shown in (1) and (2).

An HNC or HND Mechatronics no longer satisfies the full academic requirements to become an incorporated engineer (a degree is now required). However, the two qualifications do partially satisfying the underpinning educational requirement for Incorporated Engineer registration.

The new HNC and HND Mechatronics awards provide a solid platform for candidates to proceed to the advanced stages of some degree programmes in engineering. Ask your lecturer about progression arrangements your college has with any university.

## 9 Glossary of terms

**SCQF:** This stands for the Scottish Credit and Qualification Framework, which is a new way of speaking about qualifications and how they inter-relate. We use SCQF terminology throughout this guide to refer to credits and levels. For further information on the SCQF visit the SCQF website at [www.scqf.org.uk](http://www.scqf.org.uk)

**SCQF credits:** One HN credit is equivalent to 8 SCQF credit points. This applies to all HN Units, irrespective of their level.

**SCQF levels:** The SCQF covers 12 levels of learning. HN Units will normally be at levels 6–9. Graded Units will be at level 7 and 8.

**Subject Unit:** Subject Units contain vocational/subject content and are designed to test a specific set of knowledge and skills.

**Graded Unit:** Graded Units assess candidates' ability to integrate what they have learned while working towards the Units of the Group Award. Their purpose is to add value to the Group Award, making it more than the sum of its parts, and to encourage candidates to retain and adapt their skills and knowledge.

**Dedicated Core Skill Unit:** This is a Unit that is written to cover one or more particular Core Skills, eg HN Units in Information Technology or Communications.

**Embedded Core Skills:** This is where the development of a Core Skill is incorporated into the Unit and where the Unit assessment also covers the requirements of Core Skill assessment at a particular level.

**Signposted Core Skills:** This refers to the opportunities to develop a particular Core Skill at a specified level that lie outwith automatic certification.

**Qualification Design Team:** The QDT works in conjunction with a Qualification Manager/Development Manager to steer the development of the HNC/HND from its inception/revision through to validation. The group is made up of key stakeholders representing the interests of centres, employers, universities and other relevant organisations.

**Consortium-devised HNCs and HNDs** are those developments or revisions undertaken by a group of centres in partnership with SQA.

**Specialist single centre and specialist collaborative devised HNCs and HNDs** are those developments or revisions led by a single centre or small group of centres who provide knowledge and skills in a specialist area. Like consortium-devised HNCs and HNDs, these developments or revisions will also be supported by SQA.

## 10 Appendices

Appendix 1: Core Skills Development

Appendix 2: Credit Transfer Grids

Appendix 3: Delivery and Assessment Guidelines

See following pages for appendices.

## **Appendix 1: Core Skills Development**

## 1 Core Skills Development

The Core Skills recognised by SQA at SCQF level 2 to SCQF level 6 are:

- ◆ Communication
- ◆ Information Technology
- ◆ Numeracy
- ◆ Problem Solving
- ◆ Working with Others

All practical teaching and learning activities of the HNC/HND Mechatronics awards provide an environment for the application and natural development of skills in Problem Solving, Numeracy and Information Technology to a significant level beyond those recommended at entry. The Core Skills of Communication, involving work with others and Numeracy (Using Number) are formally assessed and accredited in the mandatory Units of the awards. Other Units have been designed to incorporate relevant elements of the Core Skills contextualised to meet the specific identified needs of industry and Higher Education. Candidates who achieve the HNC award will, therefore, develop Core Skills to the following levels as a minimum:

- |                          |              |
|--------------------------|--------------|
| ◆ Communication          | SCQF level 6 |
| ◆ Information Technology | SCQF level 6 |
| ◆ Numeracy               | SCQF level 6 |
| ◆ Problem Solving        | SCQF level 6 |
| ◆ Working with Others    | SCQF level 6 |

Awareness and development of Core Skills is further enhanced by the requirement for candidates, supported by assessors, to take responsibility for their personal learning, and, working co-operatively, communicate effectively on a range of practical work. The Graded Unit for both awards integrates and applies knowledge and skills developed, and encourages candidates to demonstrate and develop transferable key skills to a level which will facilitate progress to future destinations in education and industry.

## 2 Outline of Core Skills elements related to award activities

|   |  |  |
|---|--|--|
| <b>Level</b>  | <b>Communication — Written — reading</b>   |  |
| 6   | Analyse, summarise and evaluate complex written communication  |  |
| <i>Critical reading of background information, technical specifications, manufacturers' advice. Investigative research.</i>   |  |  |
| <b>Level</b>  | <b>Communication — Written — writing</b>   |  |
| 6   | Produce well-structured, accurate written communication on complex topics  |  |
| <i>Collation/presentation of complex data in structured lab. reports, technical specifications, formal investigative reports to industry standard.</i>  |  |  |
| <b>Level</b>  | <b>Communication — Oral</b>  |  |
| 6   | Produce and respond to oral communication on a complex topic   |  |
| <i>Group technical discussions, presentations to colleagues, formal business meetings.</i>  |  |  |
| <b>Level</b>  | <b>Numeracy — Using Number</b>   |  |
| 6   | Apply in combination a wide range of numerical, statistical and other mathematical skills to process complex information in generalised contexts |  |
| <i>Interpreting, calculating and presenting detailed complex technical data. Measurement and calculation for accurate engineering specifications meeting safety and other demands...</i>  |  |  |
| <b>Level</b>  | <b>Numeracy — Using Graphical Information</b>  |  |
| 6   | Apply a wide range of graphical skills to interpret and present complex information in generalised contexts.                                     |  |
| <i>Interpreting, producing and presenting detailed, complex engineering data in graphic formats, annotated to industry standard.</i>  |  |  |
| <b>Level</b>  | <b>Information Technology</b>  |  |
| 6   | Use an IT system independently to process a range of information   |  |
| <i>Practical Programming, Design and development of Engineering assignments, Computer Aided Draughting, Website research for underpinning information; collation and presentation of written and graphic materials to industry standard</i> |  |  |
| <b>Level</b>  | <b>Problem Solving — Planning and Organising</b>   |  |
| 6   | Plan, organise and complete a task   |  |
| <i>Strategic planning for all aspects of a comprehensive range of complex practical Engineering tasks, on-going critical evaluation and completion within accuracy requirements, available and appropriate resources and timescales.</i>    |  |  |
| <b>Level</b>  | <b>Problem Solving — Reviewing and Evaluating</b>  |  |
| 6   | Review and evaluate a complex problem solving activity   |  |
| <i>Reviewing and modifying design solutions as appropriate. Discussing and presenting conclusions to others.</i>  |  |  |
| <b>Level</b>  | <b>Working with Others</b>   |  |
| 6   | Work with others in a group to analyse, plan and complete an activity  |  |
| <i>Group and interpersonal technical discussions, negotiations and problem solving activities related to technical issues.</i>  |  |  |

### **3 Signposting — opportunities for Core Skills development**

Centres delivering the HNC/HND awards in Mechatronics will have specific policies and dedicated support mechanisms for the development of Core Skills. They will make use of entry skills diagnostic profiling and have a range of specialist learning resources, including Virtual Learning Environments, with dedicated support staff to ensure that candidates meet identified needs for the award, the local market and individual candidate requirements in Core Skill competencies.

The following guide focuses on signposting development of Core Skills in the mandatory section of the awards. Skills developed at HNC level will be enhanced by more advanced practical work at HND, and will also occur in the context of the wide range of Units offering options to be selected to meet vocational and academic needs.

## HNC Mechatronics

### Communication (SCQF level 6)

#### Skill component Written Communication (Reading)

##### Read and Understand complex written communication

- a Identify and summarise significant information, ideas and supporting detail.
- b Evaluate effectiveness in meeting purpose and needs of readership.

| Unit  | Knowledge and Skills/ Evidence  | a | b |
|---|---|---|---|
| Communication: Practical Skills   | Outcome 1— Analysis, understanding and detailed evaluation of a range of complex information on vocationally related issues.  | ✓ | ✓ |
| Mechatronic Systems Elements  | Review and evaluation of manufacturers' data on industrial, commercial and household mechatronic systems: application of significant information in practical contexts. | ✓ | ✓ |
| Interfacing Electronics   | Interpretation, analysis, and evaluation of complex textual and graphic information as background research.   | ✓ | ✓ |
| Knowledge and skills across the award requires in depth reading and evaluation of a range of complex paper and electronic text and graphical information and data. Independent investigative research into all aspects of Mechatronics and Engineering, including theory and practice on current industry issues will underpin study and practical activities. The ability to evaluate and summarise accurately is integral to technical reporting. |   |   |   |



## Written Communication (Writing)

### Produce well-structured Written Communication on complex topics

- a Present essential ideas/information in a logical and effective order.
- b Use a structure which takes account of purpose/links points for clarity and impact.
- c Use conventions which are effectively adapted for audience.
- d Use accurate spelling, punctuation, sentence structures.
- e Vary sentence structure, paragraphing, vocabulary to suit purpose and target audience.

| Unit   | Knowledge/Skills/Evidence  | a | b | c | d | e |
|--|--|---|---|---|---|---|
| Communication: Practical Skills  | Assessed: Outcome 2 Production of extended written report/business documents (minimum 1,000 words) on vocational issues.                               | ✓ | ✓ | ✓ | ✓ | ✓ |
| Engineering Principles   | Laboratory evaluative reports (minimum 500 words each) on statics and strength of materials, dynamics and thermofluids.                                | ✓ | ✓ | ✓ | ✓ | ✓ |
| Interfacing Electronics  | Investigative reports, with annotated graphics, on wireless and fibre optic properties and interfacing techniques.                                     | ✓ | ✓ | ✓ | ✓ | ✓ |
| Robotics and Animatronics: An Introduction   | Outcome 4: Summary and written analysis of construction approaches and techniques used to produce prototype. Formal evaluation of product and process. | ✓ | ✓ | ✓ | ✓ | ✓ |
| <p>An ability to report coherently and concisely on practical activities and to document work to a professional standard of content and presentation is integral to achievement. This includes the maintenance of records underpinning the process of investigation and experimentation, such as log books and laboratory reports. All written work must be presented formally in acceptable industry formats with accurate, correctly annotated graphics.</p> |  |   |   |   |   |   |

## Oral Communication

### Produce and respond to oral Communication on a complex topic

- a Use vocabulary and a range of spoken language structures consistently and effectively with appropriate formality.
- b Convey all essential ideas/information/opinions accurately and coherently with appropriate varied emphasis.
- c Structure to take full account of purpose and audience.
- d Take account of situation and audience during delivery.
- e Respond to others taking account of their contribution.

| Unit  | Knowledge/Skills/Evidence  | a | b | c | d | e |
|---|--|---|---|---|---|---|
| Communication: Practical Skills   | Assessed: Outcome 3 — Agenda contribution to task based meeting in a real or simulated vocational context. Production of formal meeting documentation. | ✓ | ✓ | ✓ | ✓ | ✓ |
| <p>Group working across the award will reflect industry practice with discussion and evaluation of theoretical and practical issues as standard. Candidates will be encouraged to share any industrial experience. Personal interviews and guidance from assessors will encourage candidates in analytical exploration of and problem solving approaches to complex issues. Units recommend oral questioning by the assessor to assure individual understanding of all aspects of knowledge and skills.</p> |  |   |   |   |   |   |

**Using Information Technology (SCQF level 6)**

**Use an IT system independently to process a range of information**

- a Use a range of it equipment paying attention to security and other users.
- b Resolve a simple hardware or software problem.
- c Use software in an unfamiliar context requiring analysis, design, integration of data, decision on format.
- d Carry out searches to extract and present information from electronic sources.

| Unit  | Knowledge/Skills/Evidence   | a | b | c | d |
|---|---|---|---|---|---|
| CAD for Engineers   | Using IT equipment and an appropriate range of commercial software to design and modify data, and to output engineering drawings. Use of CAD system to generate 3D shapes.                              | ✓ | ✓ | ✓ | ✓ |
| Mechatronic Systems Elements  | Knowledge and understanding of features and typical applications of a programmable logic controller, microcontroller and a personal computer in mechatronic systems.                                    | ✓ | ✓ | ✓ | ✓ |
| Mechatronic Systems   | Research on approaches to programmable applications. Outcome 3 —Practical programming of computer/microcontroller to operate mechatronic systems.   | ✓ | ✓ | ✓ | ✓ |
| Communication: Practical Skills   | Outcome 2 — Research of complex information from electronic sites. Use of software to present and collate investigative reports, and to produce meeting records and reports to a professional standard. | ✓ | ✓ | ✓ | ✓ |
| <p>An advanced level of understanding and practical skill in a range of uses and applications of technology underpins all practical work undertaken by candidates. Security, consideration for other users and the managing of any technical problems will be a routine aspect of all practical activities.</p> |   |   |   |   |   |

## Numeracy (SCQF level 6)

### Skill component — Using Number

#### Apply a wide range of numerical skills

- a Work confidently with a numerical or statistical concept.
- b Decide on steps and operations to be carried out.
- c Carry out a number of sustained complex calculations.

| Unit   | Knowledge/Skills/Evidence  | a | b | c |
|--|--|---|---|---|
| Engineering Principles   | Underpinning knowledge for the Unit requires understanding of statics, strengths and tolerances in materials, and resultant implications for engineering applications. | ✓ | ✓ | ✓ |
| Mathematics for Engineering 1  | Application of algebraic techniques to manipulate expressions/solve equations. Completion of a range of operations involving complex numbers.                          | ✓ | ✓ | ✓ |
| CAD for Engineers  | Interpretation, creation and production of engineering drawings using complex, sustained calculations.   | ✓ | ✓ | ✓ |
| Robotics and Animatronics: An Introduction   | Outcome 2 — Calculation of load requirements for electro-mechanical components and substrates.   | ✓ | ✓ | ✓ |
| <p>Theoretical and underpinning knowledge for all Units requires an understanding of sophisticated numerical concepts and the ability to undertake sustained and complex calculations in contexts where interpretation and checking of information is essential to good practice. Candidates will routinely demonstrate practical understanding and interpretation of numerical, statistical and graphic data, with a focus on Numeracy as a tool to be used and applied efficiently and critically in practical contexts.</p> |  |   |   |   |

## Numeracy (SCQF level 6)

### Skill component — Using graphical information

#### Apply a wide range of graphical skills in everyday and generalised contexts

- a analyse and interpret significant features of graphical information in relation to the underlying variables.
- b select appropriate forms — tables, graphs, charts, diagrams or qualitative form — to communicate information.

| Unit  | Knowledge/Skills/Evidence  | a | b |
|---|--|---|---|
| Mathematics for Engineering 1   | Analysis of trigonometric functions/graphs.  | ✓ |   |
| Electrical Engineering Principles   | Interpretation of circuit/wiring diagrams.   | ✓ |   |
| Engineering Principles  | Outcome 1 — Laboratory assignment on materials strengths includes conclusions in graphic form as sketch and table of results.                    | ✓ | ✓ |
| CAD for Engineers   | Review of engineering drawings. Using a commercial CAD system to create and modify engineering and composite drawings and to generate 3D shapes. | ✓ | ✓ |
| Mechatronic Systems Elements  | Outcome 5 — Calibration and analysis of calibration results.   | ✓ | ✓ |
| <p>Theoretical and underpinning knowledge for all Units requires an understanding of graphical concepts, an ability to interpret and present information in graphic form for maximum effect and impact, to interpret and use standard symbols and annotations and to interpret and present graphical information in reports and specifications to an industry standard.</p> |  |   |   |

## Problem Solving (SCQF level 6)

### Skill components

#### Critical Thinking

- ◆ Analyse a complex situation or issue

#### Planning and Organising

- ◆ Plan organise and complete a complex task

#### Reviewing and Evaluating

- ◆ Review and evaluate a complex problem solving activity

| Unit   | Knowledge/Skills/Evidence   | CT | PO | RE |
|--|---|----|----|----|
| Electrical Engineering Principles  | Underpinning practical work interpreting circuit/wiring diagrams, wiring up circuits, using electrical test equipment and interpreting experiment results.  | ✓  | ✓  | ✓  |
| Interfacing Electronics  | Identification and analysis of appropriate interface components to connect stages in a multi-stage circuit.   | ✓  | ✓  | ✓  |
| CAD for Engineers  | Planning, design, and use of a commercial CAD package to create and modify engineering and composite drawings and to generate 3D shapes.  | ✓  | ✓  | ✓  |
| Mechatronic Systems  | Outcome 3 — Practical programming for operation of Mechatronic systems, planned within resources and safety considerations, reviewed and evaluated.   | ✓  | ✓  | ✓  |
| Robotics and Animatronics: An Introduction   | Outcome 4 — Research and experimentation, prior to creation of a prototype model, developed to a given specification. Evaluation of strengths and weaknesses of process and product within given limitations and constraints. | ✓  | ✓  | ✓  |
| <p>All elements of the Core Skill will be critical to competences developed and applied across the award. All Units require an analytical and practical approach to problem solving in Engineering contexts, with analytical interpretation of a remit, strategic planning and implementation requiring accuracy, safety and the ability to work within resources and to timescales. Evaluation and modification of approaches to meet identified objectives as appropriate will be integral to achievement.</p> |   |    |    |    |

## Working with Others (SCQF level 6)

### Work with Others in a group to analyse, plan and complete an activity

- a Analyse the activity and identify component tasks and roles.
- b Agree allocation of activities taking account of group strengths and weaknesses.
- c Support co-operative working.
- d Evaluate and draw conclusions about own contribution, justifying with evidence.

| Unit  | Knowledge/Skills/Evidence   | a | b | c | d |
|---|---|---|---|---|---|
| Communication: Practical Skills   | Outcome 3 — Task based group meeting with supporting documentation-assessed. Underpinning understanding of group dynamics. Analytical approach to practical group work including checklist evaluation of approaches to improving own and group performance. | ✓ | ✓ | ✓ | ✓ |
| Robotics and Animatronics: An Introduction  | Formative work will involve co-operative working with a range of others in analysis of component tasks, prior to planning, designing and individually presenting a prototype.   | ✓ | ✓ | ✓ | ✓ |
| <p>All elements of the Core Skill will be developed across the award in the formative experimental work which will involve group discussion and co-operative review of technical issues. Candidates will be encouraged to share any industrial experience with the class group. Practical work will require an analytical and evaluative approach to communicating with and supporting others in the development of effective working practice.</p> |   |   |   |   |   |

## HND Mechatronics — Core Skill Signposting

### Communication (SCQF level 6)

#### Skill component Written Communication (Reading)

##### Read and Understand complex written communication

- a Identify and summarise significant information, ideas and supporting detail.
- b Evaluate effectiveness in meeting purpose and needs of readership.

| Unit  | Knowledge and Skills/Evidence   | a | b |
|---|---|---|---|
| Business Awareness and CPD  | Research of key external factors and internal company measures affecting business achievement requires extensive review of legislative and economic constraints and supports. Evaluation in the context of Action Planning. | ✓ | ✓ |
| Materials Selection   | Review and evaluation of detailed information on strengths, properties, environmental impact and applications of materials. Evaluation of effectiveness in practical contexts.  | ✓ | ✓ |
| Applied Industrial Plant Maintenance  | In depth understanding of land based and marine Health and Safety legislation, COSHH, regulations on noise control, PPE, workers' health.   | ✓ | ✓ |
| Robotics and Animatronics   | Interpretation, analysis, and evaluation of complex text based and graphic information as background research for experimental work on robotic interactivity.   | ✓ | ✓ |
| <p>Knowledge and skills across the award will require in depth study, evaluation and practical application of complex paper based and electronic sources of written and graphic information. Investigative research, analysis and evaluation of complex information relevant to advanced study of Mechatronics for all work, including the Graded Unit assignment, will include critical reading of current industry case studies, legislative and safety requirements and professional source materials.</p> |   |   |   |



## Written Communication (Writing)

### Produce well-structured Written Communication on complex topics

- a Present essential ideas/information in a logical and effective order.
- b Use a structure which takes account of purpose/links points for clarity and impact.
- c Use conventions which are effectively adapted for audience.
- d Use accurate spelling, punctuation, sentence structures.
- e Vary sentence structure, paragraphing, vocabulary to suit purpose and target audience.

| Unit   | Knowledge/Skills/Evidence   | a | b | c | d | e |
|--|---|---|---|---|---|---|
| Materials Selection  | Outcome 4 — Investigative formal report analysing and evaluating materials and component properties.  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Robotics and Animatronics  | Outcome 4 — Structured 1500 word formal report on development and construction of a prototype model.  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Applications of Programmable Logic Controllers   | Outcome 3 — Formal report in accepted industrial format detailing program for safe control of an industrial process.  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Business Awareness and CPD   | Production of written Action Plan of CPD — use of professional format, terminology and presentation.  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Graded Unit  | Production of extended written report and supporting technical specifications and log books documenting and evaluating the product and process of the practical assignment. | ✓ | ✓ | ✓ | ✓ | ✓ |
| <p>An ability to report on and document practical activities to a professional standard of content and presentation is integral to achievement. This includes maintenance of records underpinning the process of investigation and experimentation, such as log books and laboratory reports. All written work will be presented formally in industry format, using correct terminology, with accurate graphics and standard annotation.</p> |   |   |   |   |   |   |

## Oral Communication

### Produce and respond to oral Communication on a complex topic

- a Use vocabulary and a range of spoken language structures consistently and effectively with appropriate formality.
- b Convey all essential ideas/information/opinions accurately and coherently with appropriate varied emphasis.
- c Structure to take full account of purpose and audience.
- d Take account of situation and audience during delivery.
- e Respond to others taking account of their contribution.

| Unit   | Knowledge/Skills/Evidence  | a | b | c | d | e |
|--|--|---|---|---|---|---|
| Robotics and Animatronics  | Team participation recommended in the development of a fast prototype will encourage coherent group discussion of technical issues, using appropriate terminology. | ✓ | ✓ | ✓ | ✓ | ✓ |
| Graded Unit 2  | Assessed — Evaluation of practical assignment — oral presentation on development of product including response to in depth questions from assessor and peer group. | ✓ | ✓ | ✓ | ✓ | ✓ |
| <p>Group working across the award will reflect industry practice with discussion and evaluation of theoretical and practical issues and problems as standard. Candidates will be encouraged to share industry experiences orally in analytical exploration of complex design solutions. Oral questioning by the assessor will be used to complement written testing and to assure in depth understanding of all aspects of knowledge and skills.</p> |  |   |   |   |   |   |

## Using Information Technology (SCQF level 6)

### Use an IT system independently to process a range of information

- a Use a range of it equipment paying attention to security and other users.
- b Resolve a simple hardware or software problem.
- c Use software in an unfamiliar context requiring analysis, design, integration of data, decision on format.
- d Carry out searches to extract and present information from electronic sources.

| Unit  | Knowledge/Skills/Evidence   | a | b | c | d |
|---|---|---|---|---|---|
| High Level Language: External I/O Transfer  | Application of a high level programming language solution to parallel and serial data transfer problems in an engineering environment.  | ✓ | ✓ | ✓ | ✓ |
| Applied Industrial Plant Maintenance  | Outcome 3 — Development of a computerised maintenance schedule for a new or modified installation.                                      | ✓ | ✓ | ✓ | ✓ |
| Engineering Systems Interfaced with Programmable Logic Controllers  | Developing and evaluating a programme to operate a sequential system interfaced to programmable logic controllers.                      | ✓ | ✓ | ✓ | ✓ |
| Robotics and Animatronics   | Research of complex information from electronic sites. Use of software in experimental approaches to prototype design and construction. | ✓ | ✓ | ✓ | ✓ |
| High Level Engineering Software   | Writing and testing linear and non linear programs. Writing, testing and documenting a control program.                                 | ✓ | ✓ | ✓ | ✓ |
| <p>An advanced level of understanding and practical skill in the uses and applications of technology underpins all work undertaken across the award. Candidates also make use of technology in their research and in collating, modifying and integrating data. The ability to apply sophisticated software engineering concepts to electrical and electronic engineering design solutions and problem solving is integral to achievement. Security, consideration for other users and the managing of technical problems will be a routine aspect of all practical activities.</p> |   |   |   |   |   |

## Skill component — Using Number

### Apply a wide range of numerical skills

- a Work confidently with a numerical or statistical concept.
- b Decide on steps and operations to be carried out.
- c Carry out a number of sustained complex calculations.

| Unit   | Knowledge/Skills/Evidence  | a | b | c |
|--|--|---|---|---|
| Mathematics for Engineering 2  | Application of differentiation and integration techniques to a range of engineering problems.  | ✓ | ✓ | ✓ |
| Materials Selection  | Underpinning knowledge for the Unit requires understanding of statics, strengths and tolerances in materials, limits, and resultant implications for engineering applications. | ✓ | ✓ | ✓ |
| Engineering Design Process: Mechatronics   | Outcome 3 — Design calculations to assure accuracy and safety including strength, tolerance, stress limitations within required specifications.                                | ✓ | ✓ | ✓ |
| Business Awareness and CPD   | Underpinning knowledge requires an understanding of broad trends in a range of financial and efficiency concepts including costing, budgeting, marketing and promotion         | ✓ | ✓ | ✓ |
| Robotics and Animatronics  | Research involving several operations using numerical concepts and complex calculations in system interactivity to support design of fast prototype.                           | ✓ | ✓ | ✓ |
| <p>Theoretical and underpinning knowledge for all Units requires an understanding of sophisticated numerical concepts using formulae and symbols, and the ability to undertake sustained and complex calculations where interpretation and checking of information in context is essential to accuracy. Candidates will routinely demonstrate practical understanding and interpretation of numerical, statistical and graphic data in practical workplace contexts, creating models to clarify the significance of information. The focus is on numeracy as a tool to be used and applied efficiently and critically in practical contexts.</p> |  |   |   |   |

## Numeracy (SCQF level 6)

### Skill component — Using graphical information

#### Apply a wide range of graphical skills in everyday and generalised contexts

- a analyse and interpret significant features of graphical information in relation to the underlying variables
- b select appropriate forms — tables, graphs, charts, diagrams or qualitative form to communicate information

| Unit  | Knowledge/Skills/Evidence  | a | b |
|---|--|---|---|
| Mathematics for Engineering 2   | Interpretation of engineering data. Outcome 2 — all solutions calculated in engineering problems must show major steps including graphs.   | ✓ | ✓ |
| Engineering Design Process: Mechatronics  | Investigate, analyse and evaluate design products. Outcome 3 — development of a partial Product Design Specification for a mechatronic design process from customer/user requirements. | ✓ | ✓ |
| Engineering Measurement   | Outcome 1 — Read and interpret engineering drawings.   | ✓ | ✓ |
| Pneumatics and Hydraulics   | Understanding of industrial drawings. Application of step diagrams and logic diagrams in fault finding and correction.   | ✓ | ✓ |
| <p>The award requires that candidates are evaluating, testing, fault finding and providing solutions on an on-going basis, demanding an in depth and detailed understanding of a range of complex graphical concepts. An ability to interpret, modify and present complex information and data using scientific and engineering notation in industrial contexts is integral to achievement.</p> |  |   |   |

## Problem Solving (SCQF level 6)

### Skill components

#### Critical Thinking

- ◆ Analyse a complex situation or issue

#### Planning and Organising

- ◆ Plan organise and complete a complex task

#### Reviewing and Evaluating

- ◆ Review and evaluate a complex problem solving activity

| Unit  | Knowledge/Skills/Evidence  | CT | PO | RE |
|---|--|----|----|----|
| Applied Industrial Plant Maintenance  | Selection, implementation and evaluation of a CMSS software maintenance solution.  | ✓  | ✓  | ✓  |
| Pneumatics and Hydraulics   | Designing, assembling and testing pneumatic or hydraulic systems, fault finding on a fluid power system.   | ✓  | ✓  | ✓  |
| High Level Language: External I/O Transfer  | Applying, testing and evaluating a high level programming language solution to parallel and serial data transfer problems in an engineering environment.<br>Practical development of fast prototype involving analysis, solution selection, sizing and scoping, iterative design/fast prototyping, testing and evaluation. | ✓  | ✓  | ✓  |
| Robotics and Animatronics   | Investigating, analysing, developing and evaluating a PDS, utilizing concurrent/simultaneous/parallel engineering to a specified brief.  | ✓  | ✓  | ✓  |
| Engineering Design Process  | Researching a practical assignment, including aspects such as identifying and analysing components of a design task to meet a remit within resources.  | ✓  | ✓  | ✓  |
| Graded Unit 2   | Undertaking the assignment, with on-going analysis of performance against brief and targets.<br>Evaluation of effectiveness of process and product, reassessment of objectives and revision of goals.  | ✓  | ✓  | ✓  |
| All elements of the Core Skill will be critical to the award in which all Units require an analytical, creative and practical approach to problem solving in Engineering contexts. Analytical interpretation of a remit, strategic planning and implementation of a range of approaches will require accuracy and the ability to work strategically within resources and to agreed timescales. Evaluation and modification of approaches to solutions to meet identified objectives as appropriate will be integral to achievement. |  |    |    |    |

## Working with Others (SCQF level 6)

### Work with Others in a group to analyse, plan and complete an activity

- a Analyse the activity and identify component tasks and roles.
- b Agree allocation of activities taking account of group strengths and weaknesses.
- c Support co-operative working.
- d Evaluate and draw conclusions about own contribution, justifying with evidence.

| Unit   | Knowledge/Skills/Evidence  | a | b | c | d |
|--|--|---|---|---|---|
| Engineering Design Process: Mechatronics   | Theoretical knowledge assessed of interaction and negotiation techniques used with a client during all stages of the design process.   | ✓ | ✓ | ✓ | ✓ |
| Applications of Programmable Logic Controllers   | Formative opportunities for analytical approach to practical group work in preparing a PLC program for safe control of an industrial process.  | ✓ | ✓ | ✓ | ✓ |
| Robotics and Animatronics  | Formative work can involve co-operative working with a range of others in analysis of component tasks, prior to planning, designing and individually presenting a prototype.                                     | ✓ | ✓ | ✓ | ✓ |
| Graded Unit 2  | Task based group work may underpin the various stages of the assignment involving team work in recognising limitations of knowledge, approaching and liaising with expert sources and utilising group strengths. | ✓ | ✓ | ✓ | ✓ |
| <p>All elements of the Core Skill will be developed across the award. Practical work requires an analytical and evaluative approach to communicating with others. The award provides opportunities to develop skills in listening and communicating as an integral aspect of effective working practice.</p> |  |   |   |   |   |

## **Appendix 2: Credit Transfer Grids**



**HN Unit Transfer Decision Document Grid: Mechatronics HNC/HND (New Unit titles in alphabetical order)**

| <b>Old Unit Title</b>   | <b>Old Unit No</b> | <b>New Unit Title</b>                          | <b>New Unit No</b> | <b>Credit Value</b> | <b>Status (Full, Partial or No Credit Transfer)</b> |
|---|--------------------|--|--------------------|---------------------|---|
| Application of Programmable Logic Controllers                           | D4FJ 04            | Applications of Programmable Logic Controllers | DG31 34            | 1                   | Full  |
| No Equivalent   |                    | Business Awareness & CPD                       | DG3D 35            | 1                   | None  |
| CNC Machining   | D4FP 04            | CNC  | DT5P 34            | 1                   | Full  |
| Communication: Presenting Complex Communication for Vocational Purposes | D5P3 04            | Communication: Practical Skills                | D77G 34            | 1                   | Partial   |
| Computer Aided Draughting   | D4FW 04            | Computer Aided Draughting for Engineers        | DR1X 34            | 1                   | Full  |
| No Equivalent   |                    | Electrical Engineering Principles 1            | DW6W 33            | 1                   | None  |
| No Equivalent   |                    | Employment Experience 2                        | D77H 34            | 1                   | None  |
| No Equivalent   |                    | Engineering Design Process: Mechatronics       | DW8M 35            | 1                   | None  |
| Design Drawing and Communication for Engineers                          | D4GD 04            | Engineering Drawing                            | DR1W 34            | 1                   | Full  |
| Metrology: Dimensional  | D4JS 04            | Engineering Measurement                        | DT9R 34            | 1                   | None  |
| No Equivalent   |                    | Engineering Principles                         | DR3L 34            | 1                   | None  |

| <b>Old Unit Title</b>   | <b>Old Unit No</b> | <b>New Unit Title</b>                                     | <b>New Unit No</b> | <b>Credit Value</b> | <b>Status (Full, Partial or No Credit Transfer)</b> |
|---|--------------------|---|--------------------|---------------------|---|
| Fundamentals of Quality Assurance                                       | BA24 34            | Quality Management: An Introduction                       | DT8Y 34            | 1                   | None  |
| Engineering Programming: Assembly Language                              | D4HA 04            | MCU/MPU Assembly Programming                              | DG59 34            | 1                   | Full  |
| Engineering Programming   | A4RR 04            | High Level Engineering Software                           | DG58 34            | 1                   | Full  |
| No equivalent   |                    | Implementing Small Local Area Networks                    | DG40 34            | 1                   | None  |
| Industrial Plant Maintenance  | D4HX 04            | Industrial Plant Maintenance                              | DN40 34            | 1                   | Partial<br>(Recommendation: complete new Unit)      |
| Information Technology Application 2                                    | A6AN 04            | Information Technology: Applications Software 1           | D75X 34            | 1                   | Full  |
| Material Selection & Testing  | D4JF 04            | Material Selection  | DT46 34            | 1                   | Full  |
| Mathematics for Engineering<br>Introductory Mathematics for Engineering | D4JH 04<br>D4JB 04 | Mathematics for Engineering 1:<br>Electronic & Electrical | DG4H 33            | 1                   | Partial<br>(Recommendation: complete new Unit)      |
| Calculus 1 for Engineering<br>Calculus 2 for Engineering                | A5NK 04<br>A5P2 04 | Mathematics for Engineering 2                             | DG4L 34            | 1                   | Full  |

| <b>Old Unit Title</b>   | <b>Old Unit No</b> | <b>New Unit Title</b>                         | <b>New Unit No</b> | <b>Credit Value</b> | <b>Status (Full, Partial or No Credit Transfer)</b> |
|---|--------------------|---|--------------------|---------------------|---|
| Calculus 2 for Engineering<br>Advanced Calculus for Electrical and Electronic Engineering         | A5P2 04<br>A5P3 04 | Mathematics for Engineering 3                 | DG4P 35            | 1                   | Partial<br>(Recommendation: complete new Unit)      |
|   |                    | Mechatronic Systems                           | DW8R 35            | 1                   |   |
|   |                    | Mechatronic Systems Elements                  | DW8T 34            | 1                   |   |
| Microprocessor Systems Fundamentals<br>Microcontroller: Architecture, Programming and Application | D4JV 04<br>D4JT 04 | Microprocessor and Microcontroller Technology | DG4X 35            | 1                   | Partial<br>(Recommendation: complete new Unit)      |
| Industrial Plant Services: Pneumatics and Hydraulics  | D4J1 04            | Pneumatics and Hydraulics                     | DT9X 34            | 1                   | Full  |
| No Equivalent   |                    | Robotics and Animatronics: An Introduction    | DW8W 34            | 1                   | None  |
| No Equivalent   |                    | Robotics and Animatronics                     | DW8V 35            | 1                   | None  |

## **Appendix 3: Delivery and Assessment Guidelines**

**HNC Mandatory Unit Delivery Grid**  
**HND Mandatory Unit Delivery Grid**

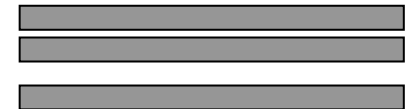
# (1) HNC: Guidelines for Delivery of Mandatory Units

(Also Year 1 of the HND Award)

It is recognised that timetabling in a four block system is not done by every centre. The above grid is therefore only a guide indicating the order of delivery of Units.

| Centre Year   | Block 1 | Block 2 | Block 3 | Block 4 |
|---|---------|---------|---------|---------|
| Unit Title  |         |         |         |         |
| Communication: Practical Skills                           |         |         |         |         |
| Mechatronic Systems Elements                              |         |         |         |         |
| Electrical Engineering Principles 1                       |         |         |         |         |
| Engineering Principles                                    |         |         |         |         |
| Interfacing Electronics                                   |         |         |         |         |
| Mechatronic Systems                                       |         |         |         |         |
| Mathematics for Engineering 1: Electronics and Electrical |         |         |         |         |
| Robotics and Animatronics: An Introduction                |         |         |         |         |
| Mechatronics: Graded Unit 1                               |         |         |         |         |
| Option 1  |         |         |         |         |
| Option 2  |         |         |         |         |

The HNC Units will normally make up the first year of the HND timetable.



**(2) HND: Guidelines for Delivery of Mandatory Units  
(Year 2 of the HND Award)**

| Centre Year                                | Block 1 | Block 2 | Block 3 | Block4 |
|--|---------|---------|---------|--------|
| Unit Title                                 |         |         |         |        |
| Materials Selection                        |         |         |         |        |
| Engineering Measurement                    |         |         |         |        |
| Business Awareness and CPD                 |         |         |         |        |
| Pneumatics and Hydraulics                  |         |         |         |        |
| High Level Engineering Software            |         |         |         |        |
| High Level Language: External I/O Transfer |         |         |         |        |
| Applications of PLCs                       |         |         |         |        |
| Mathematics for Engineering 2              |         |         |         |        |
| Engineering Design Process: Mechatronics   |         |         |         |        |
| Robotics and Animatronics                  |         |         |         |        |
| Applied Industrial Plant Maintenance       |         |         |         |        |
| Options X 7                                |         |         |         |        |
| Mechatronics: Graded Unit 2                |         |         |         |        |

As with the previous HNC grid, it is recognised that timetabling in a four block system is not done by every centre. The above grid is therefore only a guide indicating the order of delivery of Units.

Centres may wish to spread the delivery of Units over more than one block which would allow more Units to be delivered in parallel.

Whichever delivery arrangement is used, it is important to complete the delivery of **ALL** the HND Units over the two years of a full-time programme.