Skills
Development
Scotland

Graduate Apprenticeships

Framework document for

IT: Software Development

at SCQF level 10

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Document control

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Terms and abbreviations

Term	Meaning
SDS	Skills Development Scotland
GA(s)	Graduate Apprenticeship(s) / Apprentice(s)
SCQF	Scottish Credit and Qualifications Framework
TEG	Technical Expert Group
QA	Quality Assurance
ITSD	IT: Software Development
BSc	Bachelor of Science
IT	Information Technology
UKSPEC	UK Standard for Professional Competence
IEng	Incorporated Engineer
CEng	Chartered Engineer
ICT	Information and Communication Technology

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Contents

1. Graduate Apprenticeships in Scotland

1.1 Purpose of the Graduate Apprenticeship framework document

The purpose of this document is to provide employers and learning providers with information required to deliver a Graduate Apprenticeship in **IT: Software Development**. The framework sets out the skills and learning outcomes identified through employer consultation that are required to support the development of this programme.

This framework document should be read in conjunction with the following publications:

1. Work-based Learning Principles
2. Product Specification at **SCQF level 10**
3. Quality Assurance Guidance

This documentation is available on the Skills Development Scotland (SDS) corporate website:

www.skillsdevelopmentscotland.co.uk

1.2 What are Graduate Apprenticeships?

Graduate Apprenticeships (GAs):

- are accredited work-based learning programmes that lead to degrees or degree-level, professionally recognised qualifications
- are part of the apprenticeship family, supporting the transition into employment by providing work-based learning pathways from Foundation and Modern Apprenticeships to Higher and Graduate Apprenticeships, at SCQF Levels 8 –11
- have been developed as part of the Scottish Government's approach to developing Scotland's young workforce and Skills Development Scotland's work-based learning strategy

1.3 Why do we need Graduate Apprenticeships in Scotland?

International experience demonstrates how degree-level apprenticeships can drive economic growth. We believe this approach can benefit the Scottish economy.

The range of approaches taken in countries including Switzerland and Germany to develop employer-led, work-based learning pathways to learning and employment provide the basis for how Scotland can use work-based learning to improve the operation of the labour market and to deliver economic growth[1]. Skills Development Scotland is now leveraging the development of Graduate Apprenticeships to support this change.

[1] **PWC (2015) Young Workforce' Index: How well are OECD economies developing the economic potential of their young people?**

1.4 Who develops Graduate Apprenticeships?

Graduate Apprenticeships are developed by Skills Development Scotland through consultation with employers, universities, professional bodies and qualification authorities in the form of Technical Expert Groups (TEGs). The TEGs act as advisory groups on behalf of the sector and are based on the current and future skills needs of industry. They advise on the topics and related outcomes that should be included in a framework.

More information about who was involved in the development of this framework can be found in **Appendix C**.

1.5 Who are Graduate Apprenticeships for?

Graduate Apprenticeships provide a new way into degree-level study for individuals who are either currently in employment or are entering into employment. GAs are available to employees aged 16 or over.

1.6 Who delivers Graduate Apprenticeships?

Graduate Apprenticeships are delivered by universities in partnership with employers and college learning providers. An up-to-date list of learning providers and the frameworks they offer can be found on **www.apprenticeships.scot**.

2. Delivery

As Graduate Apprentices are work-based degrees, the place of employment is the place of learning. The learning and skills development must be fully integrated into both the **delivery and assessment** of the degrees when part of a Graduate Apprenticeship. This integration can only be satisfactorily achieved by proper planning and design prior to delivery and not by add-on components or ad-hoc modifications.

The authenticity of the programme is shown in the way employers are involved in the design and delivery of the degrees and the way in which work-based learning is positioned as integral to both the learning and the assessment needed for successful completion of the programmes.

GA are designed as full-time programmes. They are not part-time or sandwich courses. Attendance at the place of learning will be agreed between the provider and the employer sending individuals on the programmes. Examples of how this might work are:

- by day release or
- by block release of three or four-week duration, three times per year
- through distance learning with an initial “boot camp or induction”

Fundamentally, most of an individual’s time should be spent in the workplace on directed study.

In designing the degrees to meet the work-based learning requirements of the GA, learning providers must ensure that they also meet the principles and criteria noted here:

Box 1. Principles and criteria

This GA is an **SCQF level 10** work-based degree. All proposed university degree programmes for this GA framework must:

- be **480 credits**
- be based on a partnership between employers and the learning provider
- evidence how the programmes exemplify the work-based learning requirements
- have clear goals and aspirations in support of equality and diversity with appropriate monitoring and other processes in place
- demonstrate how they will ensure that apprentices, upon graduation, will consistently achieve the necessary industry skills, knowledge and competence defined in **Appendix A**
- develop learning through reflection and review of work processes and experience
- meet the requirements to apply for professional body recognition

NB Delivery models based on sandwich years or industrial placement block release are not considered as work-based learning as part of this framework.

The successful delivery of Graduate Apprenticeships depends upon an effective partnership between the apprentice, the employer and the learning provider. This will involve additions to their normal responsibilities for employees, learning providers, and apprentices.

Delivery of the content of the GA will be agreed by the participating learning providers, which may involve delivery of specialist or employer-specific content. Employers should also be closely involved with all aspects of the programme, including the course specification, delivery, and assessment of practical activities.

The learning provider has responsibility for the quality assurance and enhancement of all elements of the programmes but they must adhere to the SDS specified documents referenced in **Section 1** and any additional guidance documentation provided as part of their competitive grant award. Practical activities must make use of the work environment and course content must take account of the technologies used in the apprentice’s employment.

Apprentices must have individual learning and training plans. The learning provider and existing employer HR systems should be co-ordinated during the development of the individual learning and training plan to ensure that the required employer contextualisation is effective. Even within a specific employer, there may be apprentices who use differing technologies.

3. Roles and responsibilities

3.1 Role of the employer

Apprentices are employees and subject to the standard terms and conditions applying to all employees.

Employers participating in the Graduate Apprenticeship programme must:

- consider whether a candidate has a reasonable chance of achieving the chosen programme during the selection process – this includes not only the course content but the acquisition of wider graduate attributes
- provide agreed information to support the candidate's application to the degree course
- provide apprentices with suitable opportunities to gain the type of experience in the workplace that will support their learning and skills acquisition
- provide each apprentice with a nominated mentor who must be readily accessible to the apprentice and to the learning provider
- liaise with the learning provider on the content and practical activities in the apprentice's individual learning and training plan
- provide information that will support the individual apprentice and their assessment

3.2 Role of the learning provider

Apprentices are both employed by the employer, as well as enrolled with the learning provider. As such they should have access to the same facilities as any other student.

GA course design and delivery must adhere to the principles detailed in preceding sections and in addition the learning provider must:

- adopt a flexible approach to considering the suitability of candidates by taking account of the portfolio of previous learning and experience an individual brings to the programme – this will include any relevant Foundation or Modern Apprenticeship undertaken – and support best practice in assessing individuals and in gathering evidence from employers where this is required
- liaise with the employer on the content and practical activities in the apprentice's individual learning plan

In addition, the learning provider should liaise with existing employer Training and Development and Quality Assurance (QA) systems to minimise double assessment. Development and meaningful implementation of individual learning plans is an essential component of the GA and assessments should take account of existing evidence wherever possible.

New evidence that directly relates to the workplace may be authenticated by employers or the individual's mentor.

There are a range of different delivery mechanisms, but the integration of knowledge within contextualised learning opportunities must be the overriding factor.

3.3 Content delivery and assessment

Content delivery and assessment responsibilities:

	Employer	***Learning Provider***	***Other***
Delivery of knowledge and understanding content	✓ Employer specific topics	✓ Generic and non-employer specific	✓ Private providers
Assessment of practical application	✓	✓	✓ Apprentice
Development of personal and business skills	✓ Specification, delivery, progress monitoring, assessment and mentoring	✓ Specification, delivery, progress monitoring and assessment	✓ May be a third party used for delivery, monitoring and assessment

4. Entry

4.1 Eligibility

- Graduate Apprenticeships are available to new and existing employees of participating employers.
- Candidates must be at least 16 years of age. However, the suitability of an individual for entry onto a GA will be decided by the employer and their learning provider partner.
- Candidates must be resident in Scotland throughout the Graduate Apprenticeship. In addition to this, their employer's working premises must also be located in Scotland. When applying to become a Graduate Apprentice the individual will be required to satisfy the employer that they have the right to live and work in the UK.
- Entry requirements are likely to vary across learning providers. For courses where there is a mandatory requirement for a specific subject, learning providers should consider ways they can provide support to individuals who don't hold a traditional qualification but have nevertheless shown aptitude and competence at the necessary level.

4.2 Recognition of prior learning

Candidates will undergo a selection process for a Graduate Apprenticeship, based on employer HR processes. The admissions departments need to take account of this and liaise with employers to provide advice and guidance on the prior learning and experience that will be accepted for entry onto the course.

A more flexible approach to entry requirements should be adopted by learning providers, and be done in consultation with employers. This should involve consideration of candidates on a case by case basis, who have completed relevant Foundation, Modern or Technical Apprenticeships as well as industry / vendor certifications.

Universities and other providers are asked to consider ways they can optimise the apprentice's prior learning within the programme to ensure there is no unnecessary repetition of learning.

5. Demand

This sector covers both the manufacture of hardware including computers, consumer electronics and telecommunication equipment and the development and publishing of software, web sites and data management activities. This is a fast-paced sector where new job roles and competencies evolve quickly.

Employment[2]

In 2017, **employment in the sector was 62,200** accounting for two per cent of all employment in Scotland. This makes it **one of the smallest Key Sectors in Scotland** measured by employment. Since the recession in 2008 employment in the sector has grown by 13 per cent, compared to a one per cent decline for all industries. More recently (since 2015) employment has declined by two per cent, compared to no growth across all industries. This suggests that despite being a relatively small key sector in terms of employment, it has been a source of jobs growth since the recession although recently there have been job losses.

The highest levels of employment were in Edinburgh, East and Midlothian (15,100) and Glasgow (12,600). There was a high concentration in West Lothian where employment in the sector was more than three times the national average. Employment in the sector was also above average in Fife, Edinburgh, East and Midlothian and the West Region. This suggests that although nationally the sector is small, there are a number of regions mostly in the central belt where the sector is an important source of jobs. Typically, rural factors and logistics have been barriers in the sector; however, technological developments are reducing the limitations of location and geography. Continued improvements in broadband and connectivity infrastructure will increase opportunities across Scotland.

[2] Oxford Economics Regional and Sectoral Forecast (2000-27)

The recent employment decline in the sector is not forecast to continue. By 2020, employment in the sector will have increased by 1,400, an increase of two per cent. The growth is expected to continue over the longer term up to 2027, growing by seven per cent. This is more than double the rate of growth than all industries, which are expected to grow by three per cent. Growth will create jobs in the sector and the need to replace workers will also generate demand. **Based on employment in 2017, six per cent of the workforce will need to be replaced by 2027. The sector's net requirement for workers up to 2027 will be 8,000**. This is one per cent of the net requirement for workers across all industries.

In line with current employment, the greatest proportion of the total net requirements for workers in Digital Technologies sector will be located in Edinburgh, East and Midlothian (30 per cent); and Glasgow (20 per cent).

Occupation[3]

In 2017, the majority (66 per cent) of the Digital Technologies workforce were in higher level occupations. The proportion of the workforce in mid and lower level occupations was lower, 17 per cent each. In 2027 there will be a small change in the occupational structure of the workforce with two per cent more of the workforce being in higher level occupations and one per cent fewer in both mid and lower level occupations.

Graduates are most in demand by employers of technology staff and those with technology, science and maths disciplines are most sought after. However, 31% of graduates in technology roles do not have a computer science degree, representing the importance of transferable skills and aptitude and the willingness of employers to consider a range of career and learning pathways.[4]

Digital and Technology Occupations in Other Sectors[5]

Digital growth is no longer just consigned to Digital Technology companies as technology is now transforming and underpinning many sectors. Consequently, there is increased demand for highly skilled individuals with technology skills to support the businesses. For example, the increasing importance of technology within Financial Services has led to the emergence of the sub-sector, Fintech, the amalgamation of Digital Technologies and Financial Services.

[3] Oxford Economics Regional and Sectoral Forecast (2000-27)

[4] Digital Scotland 'Scotland's Digital Technologies Summary Report 2017' in conjunction with SDS, EKOSgen, and Oxford Economics

[5] Digital Scotland 'Scotland's Digital Technologies Summary Report 2017' in conjunction with SDS, EKOSgen, and Oxford Economics

In 2016, **90,000 people were employed in technology roles across all sectors in Scotland;** 60 per cent of these were in non-technology sectors. Technology occupations increased by 10 per cent from 2015 to 2016, and are forecast to continue to grow. Forecast demand, accounting for new and replacement demand, estimates **12,800 annual vacancies for technology roles in Scotland**.

The number of technology professionals employed in other sectors is growing faster than for technology businesses, further illustrating the demand for technology skills across all industries. This growth represents a significant opportunity for young people and other new entrants, but also means it is important that employers have a buoyant talent pipeline to support these vacancies.

Digital and ICT Skills Investment Plan

The Digital and ICT Skills Investment Plan (SIP) developed in 2014 identifies actions to support the growth ambitions of the sector. GAs could support a number of these actions including broadening the future talent pipeline for Digital Technology skills.

New Developments Influencing Demand for GAs

The Scottish Government awarded SDS additional funding for cyber security careers events focusing on Work Based Learning (WBL) opportunities – as part of this, SDS has also committed to running industry events to raise awareness of GAs among employers (as well as MAs and FAs).

6. The framework

6.1 Overview

The **IT: Software Development (ITSD)** Graduate Apprenticeship is based on industry defined needs and has been developed in collaboration with employers and the education sector to allow knowledge, understanding, skills and competence to be developed with the necessary attributes industry expects from its graduates.

Within the **ITSD** Graduate Apprenticeship, the degree content must be delivered per the principles and outcomes detailed in this framework.

The specific Graduate Apprenticeship included in this framework is:

- **IT: Software Development (ITSD)**

The output of this framework will be a Graduate Apprenticeship at **SCQF level 10** entitled:

Graduate Apprenticeship in BSc (Hons) IT: Software Development

6.2 Purpose

The purpose of the Graduate Apprenticeship in **IT: Software Development** is to produce graduates with:

- Competence in custom software development processes, including the knowledge, skills, and professional competences necessary to begin practice as a software engineer in a business environment
- Ability to confidently work as an individual and as part of a team to develop and deliver quality software deliverables
- Skills to design appropriate solutions in a range of application contexts/domains using software development approaches that deliver business value
- Skills to build and test software solutions for a range of application contexts/domains
- Ability to reconcile conflicting project objectives, finding acceptable compromises recognising the limitations of capability, capacity, cost, and time
- Understanding of current theories, models, and techniques that provide a basis for problem identification and analysis, software design, development, implementation, verification, and documentation and how to apply these
- Understanding of the importance of applying negotiation, effective work habits, leadership, and good communication with stakeholders in a typical software development business environment
- The ability to learn new models, techniques, and technologies as they emerge and appreciate the necessity of such continuing professional development
- Skills, knowledge and understanding of the need to embed cyber security resilience requirements throughout the software development life cycle

The **IT: Software Development** GA is aimed at high potential, mathematical, creative-thinking students who are interested in the design and development of software applications and systems. Alongside building technical aspects of complex software systems, the taught programme would cover team-working, personal / interpersonal, management and project skills spread across all roles that drive fundamental technologies of the world today.

6.3 Occupational outcomes

The **IT: Software Development** GA is aimed at employment in the following areas:

- Software Development
- Software Testing
- Web Development
- Database Architecture and Development

6.4 Learning outcomes

Please refer to **Appendix A** and **B** for a full list of learning outcomes for the **IT: Software Development** GA.

6.5 Professional recognition

The **ITSD** GA framework supports the achievement of professional recognition as relevant to the degree specified. The achievement of a degree as part of a GA, including the professional experience gained, and the completion of the work-based project, will provide the evidence of recognised accomplishment and acceptance as a full and professional practitioner in the IT industry through IEng recognition.

The UK Standard for Professional Competence (UKSPEC) sets out the competence and commitment required for registration as an Incorporated Engineer (IEng). The degrees that have been designed to be used within the **IT: Software Development** GA include the range of learning and skills outcomes that demonstrate the required competence and commitment to achieve Incorporated Engineer (IEng) recognition. A candidate on completion of a GA will also be on course to demonstrate the requirements for Chartered Engineer (CEng) in the future.

6.6 Related Scottish apprenticeship frameworks

The following Scottish Apprenticeship frameworks and qualifications are relevant pathways that may contribute toward progression into the **IT: Software Development** GA. The apprenticeships are eligible for funding contributions from Skills Development Scotland, and provide individuals and employers with a range of alternative pathways at different levels of entry:

In school:

- Foundation Apprenticeship in ICT and Digital (SCQF level 6)

FA ICT and Digital SCQF 6

IT: Software Development (SCQF level 10)

Post-school:

- Modern Apprenticeship in Information Technology (SCQF level 6)

MA Information Technology SCQF L6

- Modern Apprenticeships in IT and Telecommunications (SCQF levels 5)

MA IT and Telecommunications SCQF L5

- Technical Apprenticeship in Information Security (SCQF level 8)

Technical Apprenticeship Information Security SCQF8

- Technical Apprenticeship in IT and Telecommunications (SCQF level 8)

Technical Apprenticeship IT and Telecommunications SCQF L8

- Technical Apprenticeship in Data Analytics (SCQF level 8)

Technical Apprenticeship in Data Analytics SCQF L8

Appendix A. Topics and high-level outcomes

IT: Software Development (SCQF level 10)

This section details the high-level learning and skills outcomes for the GA in IT: Software Development that must be covered within the degree.

This presents a broad set of employer defined outcomes against which universities can position their intended provision to meet the high-level learning outcomes and flavour the programme for their intended employer audience.

Topics and high-level learning and skills outcomes:

Learning and skills outcomes for IT: Software Development
1. Business
1.1. Business functions, behaviours, ethics, and courtesies
1.2. Business strategy and management
1.3. Business finance and accounting
2. Technology
2.1. Software development essentials
2.2. Data and algorithms
2.3. Software modelling and analysis
2.4. Software architecture
2.5. Software requirements management
2.6. Software design
2.7. Software verification and testing
2.8. Software development process
2.9. Software development in context
2.10. Software configuration and release management
2.11. Software deployment
2.12. Software maintenance
2.13. Legacy systems
2.14. Software quality
2.15. Data modelling, database development, and data analysis
2.16. Software security

3.	**Personal and interpersonal**
3.1.	Communications
3.2.	Personal attributes
3.3.	Professional attributes
3.4.	Team working
4.	**Software project and delivery management**
4.1.	Project management approaches and methodologies
4.2.	Project planning
4.3.	Project execution
4.4.	Agile project delivery
4.5.	Risk assessment and management

Appendix B. Low-level outcomes examples

The next section provides examples of low level learning and skills outcomes which employers may expect individuals to cover in a Graduate Apprenticeship **IT: Software Development** degree.

The low-level learning and skills outcomes are not intended to be used as a pro-forma curriculum.

Each learning provider will have their own approach to delivering the degree and progression between stages. The low-level skills and derived learning outcomes that are detailed in the following sections will provide guidance to ensure that each degree covers the desired learning outcomes appropriately.

Table 1 Skills and knowledge coverage in business

1. Business
1.1. Business functions, behaviours, ethics, and courtesies
1.2. Business strategy and management
1.3. Business finance and accounting

1.1. Business behaviours, ethics and courtesies

ITSD1.1.a. Understood and mastered basic *business behaviour, ethics and courtesies*, demonstrating timeliness and focus when faced with distractions and the ability to complete tasks to a deadline with high quality

ITSD1.1.b. Demonstrated an understanding of basic business functions and own employer’s organisational structure and that of its senior leadership team

ITSD1.1.c. Understanding of and be able to demonstrate competence in time management

ITSD1.1.d. Apply basic management considerations: prioritisation, task versus responsibility management, managing up and across the organisation, people considerations

ITSD1.1.e. Understand employment relations issues and the application of policies and procedures for managing these relationships, and the application of good practice relating to equality and diversity issues in the workplace

1.2. Business strategy and management

ITSD1.2.a. Understand own employer’s business objectives and strategy and its position in the market and how own employer adds value to its clients through the services and/or products it provides

ITSD1.2.b. Gained an appreciation of the strategic importance of data analytics for business decision making

ITSD1.2.c. Gained an appreciation of the strategic importance of business processes and demonstrated an ability to document and understand them

ITSD1.2.d. Understand the principles of business transformation by being able to decompose and abstract a non-obvious business problem, structure it, collect relevant information, consider options and make recommendations

1.3. Business Finance and Accounting

ITSD1.3.a. Be able to conduct a security risk assessment for a defined business context that includes documenting what information is at risk, the type and level of risk realised; and the impact of the risk being realised

ITSD1.3.b. Understand that information is an organisational asset that has utility and a value which may be relative depending on the perspective taken. Recognise that it has attributes relating to confidentiality, possession, integrity, authenticity and availability, any of which can make it vulnerable to attack

ITSD1.3.c. Understand that business information is vulnerable to threats from systems and people

ITSD1.3.d. Understand the difference between threat, risk, attack and vulnerability. Be able to describe typical threats, attacks and exploits and the motivations behind them

Table 2 Skills and knowledge coverage in technology

2. Technology
2.1. Software development essentials
2.2. Data and algorithms
2.3. Software modelling and analysis
2.4. Software architecture
2.5. Software requirements management
2.6. Software design
2.7. Software verification and testing
2.8. Software development process
2.9. Software development in context
2.10. Software configuration and release management
2.11. Software deployment
2.12. Software maintenance
2.13. Legacy systems
2.14. Software quality
2.15. Data modelling, database development, and data analysis
2.16. Software security

2.1. Software development essentials

ITSD2.1.a. Understand the foundations of custom software development that support the design and construction of software products, including the transformation of a design into an implementation, the tools used during this process, formal software construction methods and maintainability

ITSD2.1.b. Understand software design and development methodology (e.g., structured or object-oriented), and be able to apply appropriate industry standard design notation such as UML and agile user story management

ITSD2.1.c. Select, with justification, an appropriate set of tools to support the development of a range of software products

ITSD2.1.d. Explain the potential benefits and drawbacks of using formal specification languages

ITSD2.1.e. Understand the software development process as aligned to industry practice

2.2. Data and algorithms

ITSD2.2.a.	Write programs that use each of the following data structures: arrays, strings, linked lists, stacks, queues, and hash tables
ITSD2.2.b.	Understand language at a level lower than data structures and differences e.g. distinction between Double and BigDecimal
ITSD2.2.c.	Use pseudo code or a programming language to implement, test, and debug algorithms for solving problems
ITSD2.2.d.	Confidently design and apply algorithms for manipulating data in programming solutions for a variety of computational problems
ITSD2.2.e.	Understand search techniques with pros/cons and be able to implement with regard to complexity and memory management
ITSD2.2.f.	Understand common pitfalls and mitigations

2.3. Software modelling and analysis

ITSD2.3.a.	Understand the role and purpose of modelling to visualise and better understand and document the system being developing and the proposed design solutions
ITSD2.3.b.	Understand the distinction between analysis and design models e.g. robustness analysis vs. object level interaction diagrams
ITSD2.3.c.	Apply a wide variety of industry standard software modelling techniques, including object and state-based approaches to model aspects of the domain and system behaviour and to aid design of software
ITSD2.3.d.	Analyse the problem domain to establish a basis for the creation of a software design, to describe what the customer require through solution design modelling
ITSD2.3.e.	Understand common pitfalls and mitigations

2.4. Software architecture

ITSD2.4.a.	Understand the differences between multi-tiered (1/2/3) architectures and layers and identify their merits. Be able to formulate a system according to a multi-tier architecture, so that the presentation, the application processing and the data management can be separated into different logical processes
ITSD2.4.b.	Understand concepts such as separation of concerns, loose coupling, etc.
ITSD2.4.c.	Software architecture, as an aid to software design
ITSD2.4.d.	Understand common pitfalls and mitigations

2.5. Software requirements management

ITSD2.5.a. Understand the requirements development process: elicitation, specification, analysis, and management and the use of tools for managing requirements, and how requirements, design, implementation and verification are linked together to control development and ensure quality

ITSD2.5.b. Elicit and negotiate requirements using a variety of techniques

ITSD2.5.c. Be competent in writing clear and concise functional and non-functional requirements

ITSD2.5.d. Represent functional and non-functional requirements for different types of systems using industry standard practices for formal and informal techniques (UML, User Requirements notation)

ITSD2.5.e. Organize and prioritize requirements for some innovative client-server application of very small size

ITSD2.5.f. Validate requirements according to criteria such as feasibility, clarity, testable, freedom from ambiguity, etc.

ITSD2.5.g. Understand common pitfalls and mitigations

2.6. Software design

ITSD2.6.a. Discuss the properties of good software design including the nature and the role of associated documentation, appreciating that design increasingly covers use of existing code and 3rd party elements that may be an alternative to development of code from scratch through make/buy decisions

ITSD2.6.b. Select and apply appropriate design patterns in the construction of software using industry standard documentation such as GoF (the "Gang of Four")

ITSD2.6.c. Understand the different contexts for HCI (mobile devices, consumer devices, business applications, web, business applications, collaboration systems, games, etc.) and be able to define a user-centred design that explicitly recognises the user and is DDA compliant (Disability Discrimination Act)

ITSD2.6.d. Create and specify a software design for a medium-size software product using a software requirement specification, an accepted program design methodology (e.g., structured or object-oriented), and appropriate design notation

ITSD2.6.e. Understand common pitfalls and mitigations

2.7. Software verification and testing

ITSD2.7.a. Describe in detail the purpose of, and distinguish between the different types and levels of verification (analysis, demonstration, test, formal proof, inspection etc.) and testing (unit, integration, systems, and acceptance) including the role and value of test driven development techniques

ITSD2.7.b. Analyse requirements to determine appropriate testing strategies understanding the trade-off between the extent and cost of testing vs. Quality requirements

ITSD2.7.c. Create, evaluate, and implement a test plan for a medium-size code segment

ITSD2.7.d. Develop and execute accurate and clear test scripts through UI harnesses against acceptance criteria, requirements and internal and/or external standards using industry standard unit and component testing tools

ITSD2.7.e. Be competent in developing automated tests within the build phase for web applications at a transaction and method level

ITSD2.7.f. Assess test results against expected results and acceptance criteria and through traceability to requirements, presenting and communicating results effectively using appropriate communication styles

ITSD2.7.g. Understand common pitfalls and mitigations

2.8. Software development process

ITSD2.8.a. Explain the importance of a software process for governing software development both technically, and in terms of cost control, quality, adherence of technical strategy, IPR identification etc.

ITSD2.8.b. Understand the software life cycle, its phases and the deliverables that are produced, compare the traditional waterfall model to newer models such as agile, test –led development and other appropriate models

ITSD2.8.c. Select, with justification software development models and process elements most appropriate for the development and maintenance of a diverse range of software products

ITSD2.8.d. Understand the nature of industry standard software development process, including distributed work (e.g. onshore, near shore and offshore), to understand benefits and drawbacks of each and key enablers to make each model successful

ITSD2.8.e. Understand common pitfalls and mitigations

2.9. Software development in context

ITSD2.9.a. Understand the fundamental components of technology solutions in a range of typical modern business environments and explain their interactions for any applicable target system - including games console, smart-phone, embedded system understanding the differences that these environments bring

ITSD2.9.b. Understand the contexts of real time and embedded systems development as well as component software within hardware systems

ITSD2.9.c. Demonstrate the capability to select, with justification, and apply an appropriate set of tools to support the development of a range of software products of medium size

ITSD2.9.d. Create a specification for a user interface based on requirements and implement a range of GUI's for different contexts at different levels of detail from specifications

ITSD2.9.e. Develop and test a range of small and medium-scale technology solutions (programmes, apps or games), utilising an industry standard method and programming language

ITSD2.9.f. Understand common pitfalls and mitigations

2.10. Software configuration and release management

ITSD2.10.a. Recognise the difference between configuration management at a software component/function level, and configuration of a release

ITSD2.10.b. Define configuration management processes for use throughout the product development life cycle in storing software deliverables and controlling and tracking changes to software both at component and release level, using configuration management tools effectively, and apply change management processes properly

ITSD2.10.c. Modify software designs and deliverables following sound change control approaches and change control tools

ITSD2.10.d. Understand the importance of version control and the difference between software level versus component level version control

ITSD2.10.e. Be competent in using and applying industry standard version control tools to manage software deliverables

ITSD2.10.f. Select and apply configuration management and change control tools for use within software development projects

ITSD2.10.g. Be able to apply industry standard release management frameworks (e.g. Puppet) to release and manage software artefacts

ITSD2.10.h. Understand common pitfalls and mitigations

2.11. Software deployment

ITSD2.11.a. Understand the organisational context into which software is deployed and the human and business issues associated with deployment

ITSD2.11.b. Recognise the challenges of deploying software releases which form part of a software or hardware system, perhaps with other software elements from a 3rd party, and embedded systems. Being able to interact to agree dependencies on interfaces, processing speed, resource utilisation etc. and staged deployment in to maturing prototypes and systems

ITSD2.11.c. Develop and apply user documentation and training materials as part of software development and deployment activities

ITSD2.11.d. Design and develop training materials and plan end user training following software deployment

ITSD2.11.e. Understand common pitfalls and mitigations

2.12. Software maintenance

ITSD2.12.a. Understand the impact of developing software for systems which need to be maintained for extended operational periods (e.g. avionics could be ~25 years), and be aware of the importance of documentation rigour in these circumstances, when contrasted against fast changing IT software where changes are likely to occur at a far higher frequency

ITSD2.12.b. Read and analyse existing software behaviour in order to improve its efficiency, reliability, and maintainability

ITSD2.12.c. Maintain and update software as required to ensure continued effectiveness or in response to external factors

ITSD2.12.d. Understand the role and purpose of refactoring in improving programming solutions efficiency, scalability, maintainability and extensibility and be able to revise the performance of existing code to provide for scalability and extensibility

ITSD2.12.e. Understand common pitfalls and mitigations

2.13. Legacy systems

ITSD2.13.a. Gain an understanding of legacy architectures and technologies (e.g. mainframe/COBOL etc.)

ITSD2.13.b. Identify and review legacy system documentation, whilst appreciating that documentation is often missing, inadequate and out-of-date

ITSD2.13.c. Analyse existing legacy software, and review the source code if available, appreciating that part or all of the system may be implemented using an obsolete programming language

ITSD2.13.d. Identify legacy system data architecture, and understand that the data processed by the system may be distributed in different files which have incompatible structures. There may be data duplication and the data itself may be out of date, inaccurate and incomplete

ITSD2.13.e. Understand the risks associated with replacing or keeping and maintaining legacy systems, and that keeping legacy systems in use avoids the risks of replacement but making changes to existing software usually becomes more difficult and expensive as systems get older

ITSD2.13.f. Understand common pitfalls and mitigations

2.14. Software quality

ITSD2.14.a. Explain and apply recognised principles to the building of high-quality software components, understanding the difference between safety and quality, and how mechanisms that improve quality may be used to partially underpin a safety argument

ITSD2.14.b. Interpret and apply standards for software quality planning and assurance (e.g. ISO/IEC 9126 - international standard for the evaluation of software quality)

ITSD2.14.c. Compare and contrast the different methods and techniques used to assure the quality of a software development processes and deliverables

ITSD2.14.d. Awareness of industry standard static and dynamic code analysis frameworks (e.g. FindBugs, Checkstyle, etc.)

ITSD2.14.e. Understand common pitfalls and mitigations

2.15. Data modelling, database development, and data analysis

ITSD2.15.a. Describe the basic principles of the relational data model and the issues of scale and management of large data or big data

ITSD2.15.b. Be competent at developing a range of industry standard database models, including state and process models

ITSD2.15.c. Create a relational database schema that incorporates key, entity integrity, and referential integrity constraints

ITSD2.15.d. Implement a database-driven web site, explaining the relevant technologies involved in each tier of the architecture and the accompanying performance trade-offs

ITSD2.15.e. Write stored procedure queries that deal with parameters and have some control flow, to provide given functionality

ITSD2.15.f. Understand the role of data mining, the algorithms developed to address different data mining goals and the application of these algorithms to real-world problems including big data

ITSD2.15.g. Design, implement and evaluate big data analysis systems

ITSD2.15.h. Understand common pitfalls and mitigations

2.16. Software security

ITSD2.16.a. Understand the nature of risk to information and information systems and define what cyber security is, and explain its importance when developing software solutions and mitigating risk

ITSD2.16.b. The importance of determining and managing risk for threats and vulnerabilities to information systems on an ongoing basis

ITSD2.16.c. Understand human aspects of information security including client data protection and the data protection act

ITSD2.16.d. Awareness of the types of testing that are commonly applied to identify vulnerabilities in software and how to make software more resilient to threats

ITSD2.16.e. Design in robust, scalable and future-proof software security solutions that meet specific and generic requirements, and internal/external security standards and best practice

ITSD2.16.f. Correctly apply the organisation’s security architecture to any systems or solutions development activities. Rewrite a simple program to remove common vulnerabilities, such as buffer overflows, integer overflows, and race conditions

ITSD2.16.g. Understand common pitfalls and mitigations

Table 3 Skills and knowledge coverage in personal and interpersonal

3. Personal and interpersonal	
3.1.	Communications
3.2.	Personal attributes
3.3.	Professional attributes
3.4.	Team working

3.1. Communications

ITSD3.1.a. Identify the purpose of the communication, the audience and the outcomes to be achieved. Decide which method of communication to use and the level of formality required

ITSD3.1.b. Make concise, engaging and well-structured verbal presentations, arguments and explanations of varying lengths, with and without the use of media, always taking into account the audience viewpoint.

ITSD3.1.c. Competent in active listening appreciating others views and contributions

ITSD3.1.d. Give and receive feedback constructively applying appropriate techniques and incorporate it into his/her own development and life-long learning

ITSD3.1.e. Effectively prepare and deliver presentations using relevant presentation media products such as PowerPoint, Prezi etc., and the use of appropriate visualisations and images to present information and ideas clearly and convincingly

ITSD3.1.f. Be fluent in written communications with the ability to articulate complex issues, selecting an appropriate structure and with appropriate tone, style and language

ITSD3.1.g. Be competent at selling, questioning, negotiating and closing techniques in a range of interactions and engagements, both with internal and external stakeholders

3.2. Personal attributes

ITSD3.2.a. Be creative, self-motivated, self-aware and able to reflect on successes and failures in ways that strengthen positive attitude and develop self-reliance through an understanding of their own personal preferences, styles, strengths and weaknesses

ITSD3.2.b. Is able to identify the preferences, motivations, strengths and limitations of other people and apply these insights to work more effectively with and to motivate others

ITSD3.2.c. Be able to understand the outputs from and apply insights by using personal profiling tools such as Myers Briggs Type Indicator, or Kirton Adaption/Innovation Indicator

ITSD3.2.d. Be able to put forward, demonstrate value and gain commitment to a moderately complex technology-oriented solution, demonstrating understanding of business need, using open questions and summarising skills and basic negotiating skills

ITSD3.2.e. Apply analytical and critical thinking skills to Technology Solutions development and to systematically analyse and apply structured problem-solving techniques to them

3.3. Professional attributes

ITSD3.3.a. Capability to deal with different, competing interests within and outside the organisation with excellent negotiation skills

ITSD3.3.b. Conduct effective research, using literature and other media, into IT and business-related topics

ITSD3.3.c. Demonstrate competence in gathering information from people using a variety of techniques including interviewing

ITSD3.3.d. Understanding of performance evaluation tools and be able to demonstrate competence in designing and applying performance evaluation tools (including 360-degree feedback)

ITSD3.3.e. Understanding of the importance of learning strategies and techniques in own development and life-long learning and for corporate learning and development

ITSD3.3.f. Understand the principles of personal development planning, and create, implement and maintain a personal development portfolio and a personal action plan

3.4. Team working

ITSD3.4.a. Plan and implement work goals, objectives, priorities and responsibilities with others

ITSD3.4.b. Within the team, communicate, identify different abilities and potential and show respect for individuals.

ITSD3.4.c. Understand how teams work effectively to produce technology solutions, working with team members to identify and solve problems and disagreements, sharing feedback with others on the achievement of team objectives and making suggestions and encouragement for improving team-working

Table 4 Skills and knowledge coverage in software project and delivery management

4.	Software project and delivery management
4.1.	Project management approaches and methodologies
4.2.	Project planning
4.3.	Project execution
4.4.	Agile project delivery
4.5.	Risk assessment and management

4.1. Project management approaches and methodologies

ITSD4.1.a. Understanding of the software development lifecycles and processes

ITSD4.1.b. Follow a systematic methodology for initiating, planning, executing, controlling, and closing technology solutions projects

ITSD4.1.c. Apply industry standard processes, methods, techniques and tools to execute projects

ITSD4.1.d. Be familiar with structured programme and project management environments, such as 'waterfall' methods, and be able to apply the underpinning philosophy and principles of agile in a project situation even in a non-agile environment. Be able to communicate technical and agile concepts to non-technical people

ITSD4.1.e. Interpret and use standards in software project management, including PRINCE2, ISO 10006 (project management quality) and ISO 12207 (software development process) along with the SEI’s CMMI model

4.2. Project planning

ITSD4.2.a. Identify all stakeholders involved in the project and agree the purpose of the project with all relevant stakeholders

ITSD4.2.b. Identify and agree the project scope, timescale, aims and objectives and be able to construct a project specification and plan for a multi-threaded project, including resources and budget

ITSD4.2.c. Understand how to estimate the range of digital development activities and produce overall estimates of costs/effort and allocating and managing appropriate phased contingency

4.3. Project execution

ITSD4.3.a. Manage a project (typically less than six months, no inter-dependency with other projects and no strategic impact) including identifying and resolving deviations and the management of problems and escalation processes

ITSD4.3.b. Recognise how to identify and manage deviations from the planned schedule of a project

ITSD4.3.c. Understand the importance of regular project reviews and the need to effectively manage the project review process, including planning and management

ITSD4.3.d. Understand the issues of quality, cost and time concerned with project implementation, including contractual obligations and resource constraints

4.4. Agile project delivery

ITSD4.4.a. Understanding of agile project delivery and be able to roll out a business system project accurately and timely in a customer friendly way and consistent with the business needs

ITSD4.4.b. Identify the importance of delivering value early and often, iterating and continuously improving workflows where necessary

ITSD4.4.c. Understand the need to identify and manage project deliverables

ITSD4.4.d. Recognise the principles of quality assurance for project deliverables, including contractual obligations

ITSD4.4.e. Awareness of the roles & responsibilities of a typical agile project management team and how they interact

4.5. Risk assessment and management

ITSD4.5.a. Identify, analyse and prioritise project risks and issues

ITSD4.5.b. Record and communicate risks through risk reports, registers or logs

ITSD4.5.c. Plan and implement contingency plans and risk responses

ITSD4.5.d. Track risks and associated tasks

ITSD4.5.e. Understand the nature of risk and how to respond to risks

Appendix C. Framework development summary

A GA framework sets out the required knowledge, skills and learning outcomes identified through employer and key partner consultation to support the delivery of a Graduate Apprenticeship programme. This is achieved through employer and key partner input to Technical Expert Groups (TEGs).

TEGs are short life working groups designed to act as an advisory group on behalf of the sector and contributes to the development and course design of a GA. TEGs are integral to the process of developing GAs that provide quality, consistency and relevance to industry.

Each TEG is made up of employers, professional or industry bodies, learning providers, and subject/technical experts from the related industry.

The following organisations were consulted in the development of this framework:

IT: Software Development (SCQF level 10)

Employers	Learning providers	Qualification and industry bodies
HPE BT DFID Virgin Media CGI Standard Life	Glasgow Caledonian University Open University Edinburgh Heriot Watt University	TechPartnership

Skills Development Scotland

This framework is also available on the Skills Development Scotland corporate website:
www.skillsdevelopmentscotland.co.uk