The Loughborough University Systems Engineering MSc. Apprenticeship

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LOUGHBOROUGH UNIVERSITY

Change Record

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GLOSSARY

Course and Programme used as equivalent terms

Academic Registry	Central department that maintains all policy and processes concerning student administration, and responsible for student enrolment, assessment, and graduation.
ADESE	Associate Dean Education & Student Experience
AHEP 4	Accreditation of Higher Education Programmes (AHEP), fourth edition is the standard with which the MSc. complies for accreditation by the IMechE and IET. This standard belongs to the Engineering Council.
AI	Artificial Intelligence
Apprenticeship Agreement	Legally binding document outlining the terms and conditions of the apprenticeship, including the apprentice's role, training, and responsibilities, and is signed by the employer and apprentice.
Assignment	An assessed piece of work set as part of the degree programme (coursework)
AUVs	Autonomous Underwater Vehicles
Block Teaching/Module	Teaching of a subject is concentrated into a short period of time (for this programme, the blocks are 1 week on campus, but approximately 11 weeks overall)
Capstone Project	The culminating and final, academic assignment that allows Apprentices to apply their accumulated knowledge and skills to a real-world problem or topic, showcasing their understanding – will also be referred to as the Individual Project.
CLD	Causal Loop Diagram
Conditional Offer	At application you are offered a place on the programme subject to meeting certain specified conditions or to providing specified additional information.
Credits	Credits are a standard unit used to quantify and grade student work the taught modules on the Apprenticeship are worth 15 credits and the Individual Project is worth 60 credits. A full MSc is worth180 credits.
DAS	Digital Apprenticeship Service – the government online platform where employers and training providers manage their apprentices records.
DEFSTAN	Defence Standard
Degree Classification	The Masters degree Classifications show the level at which you achieved your degree and are broken down as Distinction (70% and above), Merit (60-69%), Pass (50-59%), or Fail (below 50%)
DfE	Department for Education (Government ministerial department)
EPA	End Point Assessment

EPAO	End Point Assessment Organisation
ESFA	Education and Skills Funding Agency
Functional Skills	Equivalent to GCSE (level 2) in essential skills for university entry. Usually refers to Mathematics and English.
Gateway	Decision that the Apprentice is ready to prepare for End Point Assessment
GDPR	General Data Protection Regulation. Governs responsibility of the institution and individuals with respect to handling personal information.
HFI	Human Factors Integration
ID card	You collect your student ID card to complete the registration process and officially enrol at Loughborough University. Your student ID card will provide access to buildings across the campus, including the library. It also proves your student status.
IET	The Institution of Engineering and Technology
IfATE	Institute for Apprenticeships and Technical Education (replaced by Skills England)
IfSE	Institute for Systems Engineering – the UK professional institute for Systems Engineering, was formerly called INCOSE UK
ILO	Intended Learning Outcome (related to AHEP4) the learning outcomes expected to be acquired/achieved from participation in the programme.
IMechE	Institute of Mechanical Engineers
INA	Initial Needs Assessment
INCOSE	**IN**ternational **CO**uncil on **S**ystems **E**ngineering. The international professional institute for Systems Engineering. The UK Chapter is called INCOSE UK but is changing in 2025 to the Institute for Systems Engineering (IfSE)
Independent Study	Independent study is a core element of postgraduate education, where students take responsibility for their learning, managing their time, and conducting in-depth research – also known as Self Guided Study.
KSB	Knowledge, Skills, and Behaviours – the attributes that are developed by the apprenticeship and must be recorded and evidenced for each apprentice.
LEARN	The Loughborough University virtual learning environment – the official source of information for each module
Level 7	MSc. level education (level 6 is Bachelor's degree level)
Levy	Apprenticeship levy is a fund set up by government through which large employers contribute 0.5% of their wage bill that they can subsequently use to fund apprenticeships.

LOA	Leave Of Absence
LOA	Levels Of Autonomy
MAYTAS	An online platform in which to manage your Apprenticeship. You will be able to log your Off the Job Hours, Progress Reviews and Evidence Portfolio from here when activated.
M&S	Modelling and Simulation
MBSE	Model-Based Systems Engineering
MC	Mitigating Circumstances (part of university procedures)
ML	Machine Learning
Module	An instructional unit within a wider curriculum. The modules on this programme focus on a particular aspect of Systems Engineering and are worth 15 credits (taught component)
Module Specification	Module Specifications detail the aims, learning outcomes, content, and assessment methods for individual modules, providing a comprehensive overview of each module's content and expectations
NASA	National Aeronautics and Space Administration (USA)
OIA	Office of the Independent Adjudicator for Higher Education. An independent national body set up to review student complaints.
OTJ	Off-The-Job learning. These are hours for which you are paid but are allocated to training aligned to the apprenticeship standard.
Portfolio	Evidence and narrative to demonstrate that apprentice has acquired relevant Knowledge, Skills, and Behaviours.
PREVENT	Government programme for keeping people and communities safe from the threat of terrorism. All members of staff and students must be trained in awareness of the PREVENT programme and their responsibilities within it.
Programme Specification	A Program Specification will outline the aims, learning outcomes, structure, and assessment methods of a particular degree program.
Progress Review Meetings	Meetings of Apprentice, University Mentor, and Workplace Mentor for purposes of monitoring progress and advising on apprenticeship related matters. Also, referred to as Tripartite Meetings or PRMs.
PSRB	Professional Statutory and Regulatory Body. A body, usually and institute, that is chartered to accredit higher education degrees.
QAA	The Quality Assurance Agency for Higher Education
SEMAP	Systems Engineering Masters Apprenticeship Programme
Safeguarding	Duty of care towards vulnerable people (children or adults); all staff and students have safeguarding responsibility within the university.

Semester	Division of the Academic Year. Semester 1 usually runs from October – January, Semester 2 from February – May, Semester 3 from June to September.
Skills England	Unifying body under DfE for addressing national skills training
STO107	The level 7 Systems Engineering Apprenticeship standard, currently at version V1.2
SWAI	Student Wellbeing and Inclusivity Service
UK-SPEC	UK Standard for Professional Engineering Competence, see AHEP4
Tripartite Meetings	Meetings of Apprentice, University Mentor, and Workplace Mentor for purposes of monitoring progress and advising on apprenticeship related matters. Now referred to as 'Progress Review Meetings' or PRMs.
UKPRN	UK Provider Reference Number (for Loughborough: 10004113)
Unconditional Offer	Acceptance onto the programme based on information provided in your application.
University Mentor	Sometimes referred to as Tutor. A mentor appointed by the University; works alongside the Workplace Mentor to support the apprentice
V&V	Validation and Verification
Viva Voce	An oral examination that allows you to defend your thesis and demonstrate your understanding of the subject matter to a panel of examiners, ultimately determining whether you have met the requirements for your degree.
Workplace Mentor	Mentor appointed by the employer. Works alongside the University Mentor to support the apprentice.
WS	Wolfson School
WSP	Wolfson School part P (Postgraduate) module (Level 7)

The Loughborough Systems Engineering MSc. Apprenticeship Handbook

1 Introduction

Welcome to the Systems Engineering Level 7 Apprenticeship. This handbook provides a comprehensive description of the Level 7 Apprenticeship Programme covering both the technical and administrative aspects of your studying with us.

Part-time and Fulltime students studying the Systems Engineering MSc. are advised that this document will be helpful for the technical aspects, but they are referred to the University's Student Handbook for administrative aspects.

1.1 Studying Systems Engineering at Master's Level

Systems Engineering is concerned with integration across traditional disciplines and domains to create holistic solutions to complex system challenges [1] . It can be described as a practitioner subject through which technology is created, operated, and managed over its entire lifecycle. Nigel Cross expressed this very well: *Technology involves a synthesis of knowledge and skills from both sciences and the humanities, in the pursuit of practical tasks* [2]. Thus, unlike other Master's courses that you might undertake, in which you study a single discipline and, likely, begin with theory, Systems Engineering is concerned with *Praxis*. It is about translating theory into action; it is about application of knowledge through acquired skills and behaviours.

This programme will develop your knowledge, skills, and behaviours in such a way that you appreciate a system from an holistic perspective that includes technical, human and natural science attributes. You will appreciate that technical competence must sit alongside empathetic behaviours in order to manage the whole system. We shall not be much concerned with practical applications, rather than abstract concepts, but as Master's level we must go beyond pedagogy to an andragogical form of learning in which students develop a knowledge of themselves as learners. You will develop a deeper understanding of the subject through research and practical problem-solving. You will become self-directed learners, i.e. you formulate your own questions and lines of enquiry as you deepen your Systems Engineering knowledge, skills, and behaviours.

Critical thinking is essential for Master's students; you will go beyond learning facts to develop a critical understanding of why systems behave as they do, and then use that understanding to create complex systems as part of the academic programme and in your workplace. University assessment and assessment of work-based knowledge, skills, and behaviour are at a level commensurate with critical understanding and professional practice.

1.2 Layout of Handbook

After a description of the roles and responsibilities associated with the apprenticeship, this book is divided into two parts. Part 1 provides information on the technical part of the apprenticeship and includes a detailed description of each module. Part 2 provides a comprehensive description of all administrative aspects of the apprenticeship.

1.3 Key Dates

Key dates are provided in Table 1.

Event	2024/2025	2025/2026*	2026/2027*
Application Deadline	02/09/2024	01/09/2025	31/08/2026
Initial Assessments (week commencing)	09/09/2024	08/09/2025	07/09//2026
Induction (one day on campus) includes Workplace Mentor Training	23/09/2024	22/09/2025	21/09/2026
Applied Systems Thinking (one working week on campus)	07/10/2024	06/10/2025	05/10/2025
Systems Architecture (one working week on campus)	18/11/2024	17/11/2025	16/11/2025
Verification & Validation (one working week on campus)	03/02/2025	09/02/2026	01/02/2026
Systems Design (one working week on campus)	03/03/2025	13/04/2026	01/02/2026
Industry liaison meeting	Twice a year dates TBC	Twice a year dates TBC	Twice a year dates TBC
EPA Day	Once a year dates TBC	Once a year dates TBC	Once a year dates TBC
Interim Examinations Board – Semester 1 results are approved			
Progression Board – Results approved for continuing students/apprentices			
Finalist Board – Results and degree classifications are approved			

Table 1: Key dates for programme delivery

*Please note these dates have yet to be finalised

1.4 Monthly Systems Engineering Events

Events that take place on a monthly basis to support or recruit Systems Engineering students.

- Every 1st Wednesday – Portfolio Workshop

- 1 hour online session covering preparation of materials for End Point Assessment; apprentices should attend regularly to support their evidence collection and consolidation of apprenticeship learning.

- Every 3rd Wednesday – AM and PM Prospective Apprentice Information Session
  - 30 minute session aimed at people considering undertaking the apprenticeship and managers considering the Loughborough programme to upskill their teams.

- Every 4th Wednesday – Evening Lecture
  - Guest lecturers from industry and academia covering a wide variety of systems-related topics; supports more general learning about Systems Engineering and serves as a forum for the sharing of good practice.

Note that individual sessions may be scheduled differently to accommodate public holidays or other major events.

2 Responsibilities During an Apprenticeship

These are the principal roles associated with your apprenticeship

The Apprentice

When an apprentice joins an Apprenticeship programme they are expected to attend and accurately record all required off-the-job training - committing to the learning activities required for each module, undertake progress reviews regularly, updating the University of any change of Circumstances and observe with University Regulations - full details can be found in the Training Plan and The University's Regulations about your responsibilities whilst you are in your apprenticeship programme.

Your Line Manager or Workplace Mentor

We recommend that your line manager and workplace mentor are different people but understand that in some circumstances the two roles may be undertaken by one person.

With respect to the apprenticeship, the role of the **Line Manager** is to support the apprentice in structuring on-the-job learning so that the knowledge, skills, and behaviours developed in the programme may be practiced effectively in the workplace. This may include temporary secondments to ensure that Systems Engineering roles not usually included in the apprentice's work programme may be experienced. To ensure that the apprentice's schedule includes the off-the-job training as bookable hours and to enable module attendance when needed. The Line Manager should support the apprentice and mentor in making the gateway decision prior to EPA.

The **Workplace Mentor** supports the apprentice with professional advice to help develop their Systems Engineering abilities, identification of opportunities to practice their skills, supporting the apprentice's well-being and wider professional development, and identifying training opportunities outside of the apprenticeship curriculum. The mentor should be familiar with the apprenticeship programme and the EPA. Specifically, they will attend the tripartite review meetings and review academic progress, acquisition of KSB evidence for the portfolio and EPA report and attend the EPA as company observer (or identify a suitable substitute). The mentor should assume the role of critical friend. Mentoring guidance is provided in Appendix B. There is also a duty to maintain links with the provider (University)

Your University Mentor

The University provides all apprentices with a mentor (tutor) to support their studies. In some cases, this may be and academic member of staff, in others it is an experienced systems engineer appointed by the university. Similar to the Workplace Mentor, the University Mentor supports development and progress towards the EPA. They provide information about academic study and have a pastoral responsibility towards tutees.

The University

The University is responsible for working with you and your employer to successfully achieve your apprenticeship and to enable you to benefit from the time you spend at university and in learning. We are responsible for delivering the skills that you need in your off the job learning and for preparing you for your End-Point Assessment. We also award the MSc which underpins the apprenticeship, and we are responsible for complying with university and apprenticeship regulations. Our wider responsibilities are set out in the Training Plan and in our contract with your employer.

Your Employer

When an employer implements an apprenticeship programme in their organisation, they sign an agreement with government requiring them to support and implement the principles that underpin an apprenticeship. This means that they make specific commitments in their contract with the University and in the Training Plan with you about the actions they will take to support you whilst you are in the apprenticeship programme.

Part 1: Technical Handbook

The Loughborough University Level 7 Apprenticeship in Systems Engineering is currently delivered to 40 organisations. The programme has been developed through strong engagement with UK industry and delivers a comprehensive and in-depth understanding of modern Systems Engineering together with the practical skills required to implement it in industry. The Unique Selling Point for the programme is its focus on Model-Based Systems Engineering (MBSE) that is delivered by thought leaders in the field from academia and UK industry.

Apprentices on the Loughborough programme come from various stages in their career: some are recent graduates who will need a good understanding of Systems Engineering for their role; some are experienced engineers aiming to modernise their Systems Engineering knowledge; many have been in an engineering role for a few years and have been selected by their employer as being on a trajectory towards Systems Engineering leadership in an integration role; many achieve that new role during their time on the programme. In our recruitment, we are open to apprentices that have a non-traditional route into academic study, valuing the industrial experience that they may bring.

3 Systems Engineering Apprenticeship Standard

All apprenticeships are governed by a standard that describes the occupational profile to which it is relevant, the duties usually undertaken by someone holding that occupational role, and Knowledge, Skills, and Behaviours (KSBs) associated with carrying out the duties. The KSBs define the curriculum for the apprenticeship, and apprentices must demonstrate adequate attainment of them to be awarded the apprenticeship completion certificate.

There is an Assessment Plan associated with each standard that explains in detail how the KSBs will be assessed and describes the overall assessment process used in the apprenticeship.

3.1 Duties of a Systems Engineer

The Apprenticeship Standard associates fifteen duties with the various parts of the Systems Engineering process. The Programme aims to cover these duties although demonstration of competence in their acquisition should take place in the workplace. These duties are shown in Figure 1 and for each of the modules, the relevant duties are listed. Apprentices may use this to guide their choice of options to align with current or anticipated responsibilities in the workplace.

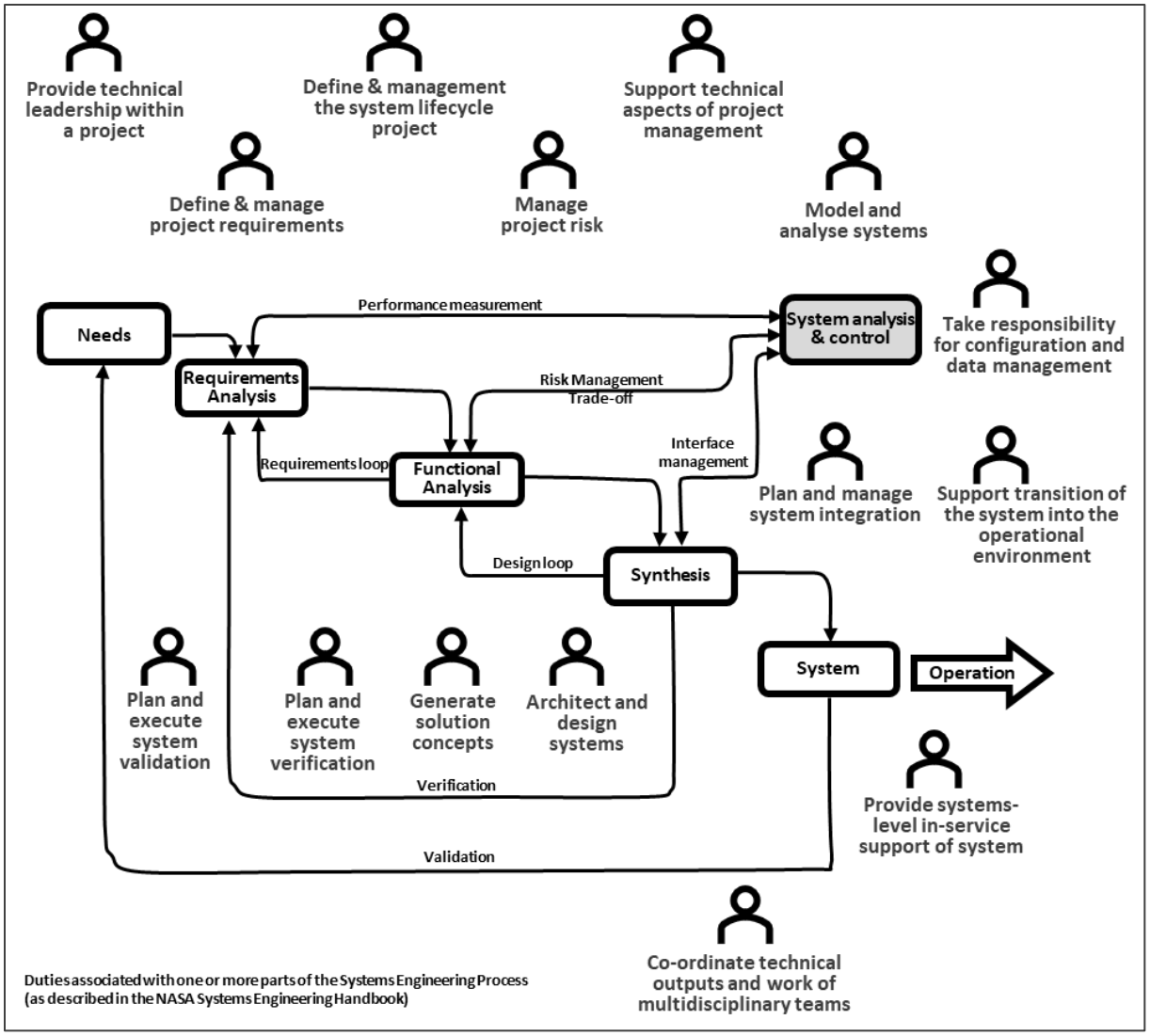

Figure 1: Duties of a Systems Engineer as related to the Systems Engineering processes described in the NASA Systems Engineering Handbook.

4 The Curriculum

Over the last ten years, MBSE has increasingly been adopted by systems organisations. It is a significant contribution to the digital transformation taking place across many industries. Our curriculum reflects that evolution and, in response to feedback from apprentices, their employers, and other industry experts, the programme has a solid core of MBSE. The programme is aligned to AHEP4, which is the new Accreditation Standard published by the UK Engineering Council and against which the Systems Engineering programme will apply to the IMechE and IET for continued accreditation in 2025. Thus, it meets the educational requirements for those seeking chartership. It also addresses the Knowledge, Skills, and Behaviours (KSBs) required by the level 7 Systems Engineer (degree) apprenticeship, ST0107, v1.2 (see Table 6) enabling apprentices to achieve an MSc. in Systems Engineering and an Apprenticeship Certificate.

A key feature of the apprenticeship model is that the apprentices are required to practice and demonstrate their learning in the workplace in a practical manner.

The first year of the apprenticeship comprises four compulsory modules that provide the MBSE core. In the second-year apprentices choose three optional modules (from six) and complete the Group Project (compulsory) as a capstone, integrating knowledge from across the programme. The third year is devoted to an individual project in a topic agreed by the employer, university, and apprentice. This must be relevant to the employer's interests.

4.1 Curriculum and Apprenticeship Support

We provide below the curriculum with a short description of each module and a mapping of modules to Knowledge, Skills and Behaviours (KSBs) in Table 6. The apprenticeship schedule, which includes additional elements, is also provided with explanation.

The basic structure of the programme is shown in Figure 2; it comprises five compulsory modules, three options, and one compulsory individual project.

	Year 1	Year 2	Year 3	End Point Assessment (EPA)
Semester 1	• Applied Systems Thinking • Systems Architecture	• Option 1 • Option 2	• Individual Project	
Semester 2	• Validation & Verification • Systems Design	• Option 3 • Group Project		

Figure 2: Basic Structure of Programme

Apprentices choose three options from six modules listed in Table 2 (there is no constraint on which semester they choose from):

	Technical options	**Enterprise options**
Semester 1	Machine Learning – Principles & Applications for Engineers	Holistic Engineering
	Mechatronic Systems Design	
	Electromagnetic Systems for Defence[1]	

[1] This module is sector specific and is only available to apprentices that work in the defence supply chain

Semester 2	Digital and Data Engineering	Enterprise & Capability Engineering
	Modelling, Simulation & Visualization for Engineering	

Table 2: Optional Modules

It should be noted that teaching does not take place in semester 3: during this period (Jun-Sept), apprentices will undertake consolidation activities in years 1 and 2. In year 3, the individual project continues into semester 3 with the dissertation submission date in late August and the project viva voce in early September.

5 Teaching, Assessment and more

5.1 Teaching

The Apprenticeship is delivered as a block-taught programme with each module you undertake being delivered over the course of one-week of intensive teaching (around 35 - 40 hours - Monday - Friday) based at our Loughborough campus in which you will engage with most of the learning and teaching for the module.

There are pre-module readings, lectures and activities to do prior to the start of a teaching week, and follow up information, activities and assessments to complete in the weeks following. Most of these are based in our Online Learning Environment.

The course consists of a mix of in-person Lectures, Seminars, Tutorials, Independent Study, Group Work, Workshops, Practical Sessions and study via accessing online materials. The degree is assessed primarily by coursework but also includes some group work.

This means students are expected to engage with eight in-person taught modules over a two-year timescale, and modules are taught in a one-week block (therefore, two weeks per semester - typically).

The remaining 16 months of the programme are dedicated to students completing a Capstone Project and preparations for their end point assessment, most of which takes place at the Apprentice's workplace – this equates to about 40 months.

5.2 Credits and Study Timeline

The breakdown of a typical study plan is as follows – but this plan can be flexible, and some modules can be carried over to Year 2 or 3 at the Programme Leader's discretion:

Year 1 4 modules at 15 credits each Total 60 credits

Year 2 4 modules at 15 credits each Total 60 credits

Year 3 Final project at 60 credits Total 60 credits

Total credits for MSc 180

Last 4 – 6 months of Programme Dedicated to End Point Assessment Preparations

5.3 Assessment

Module Title	Exam	Essay	Code	Report	Presentation	Case Study	VIVA Voce	Other	Groupwork
Applied Systems Thinking				75%		15%		10%	0%
Systems Architecture				60%	40% (G)				40%
Validation and Verification				60%		40% (G)			40%
Systems Design				60%		40% (G)			40%
Group Project				15% (G) 10% (G) 50%	25% (G)				50%
Mechatronic System Design				60%	40% (G)				40%
Modelling, Simulation and Visualization for Engineering				80%				20%	0%
Enterprise and Capability Engineering		80%				20%(G)			20%
Machine Learning - Principles and Applications for Engineers			20%			30% (G)	50%		30%
Holistic Engineering				100%					0%
Electromagnetic Systems for Defence				100%					0%

* (G) = Groupwork

Table 3: Module coursework completed outside of the Taught Sessions usually carry a Deadline 7 – 8 weeks after the work is set.

5.4 Guide to grading criteria

For consistency, generic grading criteria are used, and grade descriptions can also be considered as feedback. Generic descriptors may be made specific through reference to individual module Intended Learning Outcomes.

Grade	Indicative requirements
80 - 100%	Outstanding: The student has exceeded the requirements of a Pass with Distinction. having fully met all the ILOs. There is evidence or excellent scholarship including the ability to critically evaluate data and methods, synthesize information and arguments, perform original and detailed analyses and understand how to deal with complexity and uncertainty.
70 - 79%	Pass with Distinction: The student has met the ILOs. with evidence of comprehensive knowledge and very good understanding of current concepts and theories and their application to unseen or non-standard engineering problems. The student has demonstrated a critical approach using a wide range of evidence, analysis, reasoning and discussion. There is sustained evidence of a mature and independent approach to complex problem solving with an ability to select, justify and use innovative solution methods. There is evidence of a thorough appreciation of aspects of the subject that are uncertain, unknown or contradictory.
60-65%	Pass with Merit: The student has met the ILO, with evidence of comprehensive knowledge and good understanding of current concepts and theories and their application to seen and some unseen engineering problems. The student has demonstrated a critical approach based on application of evidence, analysis, reasoning and discussion. There is evidence of an ability to act independently to identify and define a problem and select, justify and use methods aimed at its accurate solution. There is evidence of an awareness of aspects or the subject that are uncertain, unknown or contradictory.
50 - 59%	Pass: The student has met the ILOs with evidence of detailed knowledge and understanding of current concepts and theories and their application to seen engineering problems. The student has demonstrated a generally critical approach using individual judgement and reasoning, but there is some limitation in the ability to conceptualise and/or apply theory and discuss findings in relation to the wider aspects of the subject. There is evidence of an ability to solve standard problems accurately through an application of acquired knowledge and skills.
40-49%	Marginal Fail: The student has marginally failed to meet the ILOs, shown limited evidence of knowledge and understanding of key concepts and theories and their limited application to seen engineering problems. The student has insufficient appreciation of the complexities or the subject, but the work is in the most part descriptive, rather than based on argument and logical reasoning. There is little evidence or an ability to apply learning accurately to solve a limited range of standard problems.
1 -39%	Fail: The student has not met all the ILOs and has only limited knowledge of key concepts and theories, with little or no recognition of the complexity of the subject. The work is largely descriptive, and analyses and discussions are minimal and/or not properly justified. Knowledge and understanding fall significantly short of the required threshold level.
0	Non submission: Nothing presented by the coursework deadline.

Table 4: Generic Grading Criteria for MSc.

5.5 Assessment and Marking Procedures

More information about Assessment feedback can be found in the University's Academic Quality Procedures Handbook.

Furthermore, information about the Marking Process can be found in the University's Student Handbook.

5.6 Coursework

If you are struggling with your coursework your first port of call should be the Module Leader for information, advice and referrals to any other sources or services. You may also be able to talk to your Academic Tutor – but sometimes this can depend upon their specialism and the module in question.

If you want to know if you are on the right track, you can use the following points to help:

- Read the Question – it may sound apparent but sometimes ensuring your understanding of the coursework question
  - What must be submitted?
  - When does it have to be submitted?
  - Where are the marks allocated?
  - What are the expectations?
- *Re-Read the Question*
  - If you are unsure: clarify with lecturer
  - If you are sure: **still clarify with lecturer**
- Checking
  - Most lecturers will feedback on draft work, so if you want to send them your outline, your partially completed work or your first draft most will be happy to let you know you are on the right track
  - They will provide guidance on content and quality
  - They will **not** provide a grade

5.7 Degree Classifications as Part of a Postgraduate Degree Apprenticeship Programme

To be eligible for the award of Postgraduate Certificate, candidates must have accumulated at least 60 credits excluding the Project module [WSP765].

To meet the Professional Statutory and Regulatory Body (PSRB) Requirements for the award of an accredited Master of Science degree students must normally achieve a minimum of 180 credits.

However, exceptionally, where all required PSRB learning outcomes have been met, the requirement to achieve 180 credits in each Part may be waived at the discretion of the Programme Board and students will remain eligible for an accredited MSc degree where they have met the following criterion:

No more than 20 credits worth of modules in total may fall in the range 40% to 49% - usually taught modules are worth 15 credits, so only one module can fall in the range 40% to 49%.

Your Programme Mark will be calculated on the basis of your weighted Module Marks and, if you have achieved 180 credits for a Master's degree, used to determine whether you are eligible for a Merit or Distinction:

Classification	**Mark**
Distinction	180 Credits and Programme Mark of 70% or above
Merit	180 Credits and Programme Mark of 60% or above
Pass	Programme Mark of 50% or above

Table 5: Degree Classification for MSc.

The Programme Board has the discretion to lower any of these thresholds by two percentage points. See Regulation XXI and your Programme Specification for full details.

6 Module details

Each module follows broadly the same structure (Figure 3). Prior to the module there is 10 to 20 hours mandatory preparation accessed online in the form of bite-sized lectures, exercises, and directed reading. In some modules some online training in tools will be provided. The module is delivered through one-week on campus that consists of lectures, practical systems methods and tools, mini projects, group work, and case studies. Most modules include a short assessment during the on-campus week to provide formative feedback to apprentices. Following the module there is an assignment, which is due seven weeks after the end of the module. Online tutorials are provided to support apprentices in their assignment.

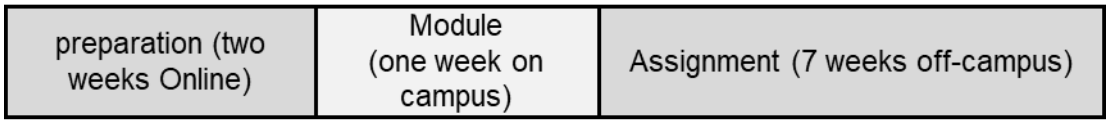

Figure 3: Basic module Structure

All taught modules are 15 credits; the generally accepted estimate across all universities is an expectation of 10 hours of student effort per credit. For the Systems modules, this is typically distributed as:

- Preparation (online) ~15 hours
- Module week (on campus) ~ 40 hours

- Assessment total effort ~40 hours (note this may include more than one component)
- Self-directed study for consolidation and deepening knowledge ~ 55 hours

The duration of the activities is matched to the Off-the-Job training (average 6 hours per week) required under the Institute For Apprenticeship And Technical Education for all apprenticeships.

Module Codes

All modules have an identifier; for modules belonging to the Wolfson school, the identifier begins with WS.

25	WS	P	XXX
Year	School	Part	Number

For Apprenticeship modules, the first digit of the number is always 7.

6.1 Compulsory Modules

Applied Systems Thinking (compulsory) [WSP062 / WSP762]

This module develops holistic thinking skills and provides apprentices with systems thinking tools for use in projects and policy.

Typically, apprentices will use the learning from this module to help understand complex problems prior to developing solution strategies. They gain an understanding of how to critically analyse academic papers, which will be important for later modules and especially their individual project, and more generally in assembling reliable information for projects in the workplace.

The Soft Systems Methodology is frequently adopted by apprentices concerned with organisational systems, either in the workplace or for their project. Techniques from this methodology are also helpful for eliciting customer requirements as part of the Systems Engineering process.

Duties

This module underpins all other modules on the programme by introducing the principles of thinking in systems and underpins all the duties defined in the Apprenticeship Standard; that appreciation is particularly relevant to the duty:

- Define and manage the system lifecycle for a project.

Principal content:

- Systems concepts and key principles from systems science
- Critical thinking, including critical reading and appreciation of academic and other literature
- Soft Systems Methodology
- Causal loops and systems dynamics modelling
- Emergence and risk
- N-squared technique
- Systemigrams
- Double diamond problem/solution analysis
- Systems models and modelling techniques, including model selection
- Research methodologies
- Ethical and inclusive practices in engineering
- Effective learning strategies

During this module, apprentices begin an assessed Learning Journal that will support the development of their portfolio.

Assessment

- In-class exercise (15%)
- Individual Assignment (75%)
- Learning Journal (10%)

Industry contribution

Includes contributions from senior UK MoD staff in the form of facilitated exercise in Soft Systems Methodology.

Systems Architecture (compulsory) [WSP072 / WSP772]

This module provides a practical introduction to model driven architecture and analysis. The apprentices will learn a system definition and architecture design process aligned to ISO/IEC 15288 and how to model the architecture of a system and use it to assess system functionality and behaviour.

Systems Architecture provides the basis for MBSE and is a pre-requisite module for Systems Design and Verification and Validation modules.

Although we teach MBSE using specific tools, such as magicdraw, our approach is to teach principles and good practice in a tool-agnostic way. This is important to ensure that all apprentices are effective systems contributors to their employers on their return after a module, irrespective of the toolset used by their employer, so that apprentices are able to deploy the knowledge and skills they acquire directly in their own workplace for design and systems integration. At Loughborough, it is our objective to develop the future leaders in systems engineering, with a strong grasp of systems principles and practical applications.

Duties

This module covers the following duties from the Apprenticeship Standard:

- Define and manage project requirements
- Model and analyse systems
- Architect and design systems

Principal content:

A logical and scientific basis for systems architecture, using:

- models and transformations between models.
- relationships between systems architecting and systems engineering, especially conceptual system design.
- practical use of the Unified and Systems Modelling Languages for system development.
- metamodels, modelling system requirements, structure, and behaviour; structured analysis and design.
- model driven architecture and analysis.
- system of system architecture.
- research and advanced methods in the international community.

Assessment

- Group case study, in-class (40%)
- Individual mini-project (60%)

Industry contribution

Includes lecture contributions from QinetiQ and BAE Systems staff

Validation and Verification (compulsory) [WSP067 / WSP767]

This module builds on Systems Architecture module to provide practical knowledge of verification and validation (V&V) for testing and acceptance of systems from a systems and model-based viewpoint using procedures and tests aligned to ISO/IEC 15288.

Verification ensures that the realised characteristics of a systems are consistent with its expected design characteristics; this is established through a set of carefully defined tests. Validation ensures that the operational capability of a system meets the needs and expectations of the customer; it is sometimes referred to as 'acceptance'.

Duties

This module, therefore, equips the apprentice with two of the duties of a systems engineer as defined by the Apprenticeship Standard:

- Plan and execute system verification
- Plan and execute systems validation

Principal content:

- V&V procedures and tests;
- reliability and other non-functional testing and evaluation, such as Fault Tree Analysis; software testing;
- V&V design and analysis;
- robustness metrics, design of experiments;
- approaches to concurrent system design and V&V;
- using the Systems Modelling Languages (SysML) for requirements maintenance and test definition;
- using MATLAB for design space visualisation and exploration;
- research and advanced methods in the international community.

Assessment

- Group case study, in-class (40%)
- Individual mini-project (60%)

Systems Design (compulsory) [WSP066 / WSP766]

This module extends the previous MBSE modules to provide practical knowledge of design and requirements engineering from a systems and model-based viewpoint. Apprentices will learn a system design process aligned to ISO/IEC 15288 and how to model a system and use models for system design and analysis. The particular feature of systems design, as opposed to regular engineering design, is the consideration of the relationship of the systems of interest to its supersystem and subsystems; it has an emphasis on the integration aspects of design. Through this apprentices become more effective in their management of interfaces.

Duties

This module addresses the following duties from the apprenticeship standard:

- Define and manage project requirements
- Model and analyse systems
- Generate solution concepts
- Architect and design systems
- Plan and manage systems integration

Principal content:

- system design process and engineering for the life cycle;
- structured analysis and design;
- relationship between system design, architecture, and V&V;
- requirements engineering; system integration; using the Systems Modelling Languages (SysML) for system modelling and design specification;
- a model-based approach to Quality Function Deployment and design trades; behavioural modelling and analysis; non-functional analysis;
- research and advanced methods in the international community.

Assessment

- Group case study, in-class (40%)
- Individual mini-project (60%)

Industry contributions

Includes lecture contributions from QinetiQ and BAE Systems staff

Group Project (compulsory) [WSP085 / WSP785]

The module occurs as the last taught module and provides a capstone project in which the knowledge and skills from across the programme are brought together to tackle a complex problem. The module begins with apprentices working online during the preceding six weeks to write their Systems Engineering Management Plan (SEMP). They receive written feedback on this before the module week begins so that they can incorporate new learning into their project activity. The project requires the apprentices to integrate a number of disparate models within a systems architecture to solve a problem set by the module leader. This is exactly the type of activity that many organisations are trying to execute in MBSE at present. The module leader acts as chief engineer and meets daily with the groups to provide feedback and clarify requirements in a typical Systems Engineering fashion. On the last day of the module, the apprentices must demonstrate functionality of the modelling environment they have created and provide results for the systems problem they have been assigned.

Group size is 4 - 6 students. Team structure and allocation of roles is a group responsibility.

The project is extremely demanding, but we receive excellent feedback from stakeholders regarding its applicability for modern day Systems Engineering featuring, as it does, an important goal in MBSE practice.

Duties

The Group Project covers most duties in apprenticeship standard, with the exception of support transition of the system into the operational environment and provide system-level in-service support of the system. These two duties will generally be experienced within the apprentices' workplaces.

Assessment

- Systems Engineering Management Plan, group (15%)
- Demonstration of delivered systems, group presentation (25%)
- Solution documentation for delivered system, group (10%)
- Individual report (50%)

Industry contributions

Led by former head of systems research at Thales UK.

Principal Content

As a capstone project, the module draws on the content of all preceding modules; in particular it brings together the content of the preceding compulsory modules as an integrated whole to embed what has been learned by practice.

Individual Project (compulsory) [WSP502 / WSP765]

The project, worth 60 credits, takes place throughout year 3 and must be aligned to business needs of the sponsoring organisation. The objective of the project is for apprentices to demonstrate application of systems engineering knowledge and skills developed on the programme on a complex, business-relevant question. Usually, the projects include a research element, but may also be oriented towards systems design.

3-4 months after commencement, apprentices must present their work at a gateway meeting with their examiner and project tutor. This ensures that their work is on track; it has value of 6 credits. After five months, an unassessed design review is offered, in which an independent expert with industry experience will evaluate the project progress so far and provide feedback to the apprentice in their choice and execution of systems techniques. After 10 months a project report and viva are used to assess performance on the project.

Because the MSc. project may also be used for the End Point Assessment of the apprenticeship; we support students to structure their project activity to maximise the opportunity to meet relevant Knowledge, Skills and Behaviours. This can also be helpful where the apprentice's main work activities are in sensitive areas.

The following are examples of recent projects, most of which have been subsequently exploited by the employer:

- A Model-Based Systems Engineering (MBSE) Approach to support Human Factors Integration (HFI) for UK Defence Projects (Submarines).
- De-coupling from National Grid (closure of last coal-fired power station) – technical and commercial complexity
- A new automated allocation of function system (AOFS) incorporating new proposed levels of autonomy (LOA) to safely trade off human or machine control in submarine vehicle control systems.
- Implementation of Machine Learning as a Mitigation Technique for Poor Network Quality – managing user experience in computer gaming.
- Towards Building Trust In Autonomous Underwater Vehicles (AUVs) For Defence – Adopted as official guidance by UK MoD and currently being developed as a DEFSTAN.
- Design and Practice for Reliability Centred Maintenance of Reverse Osmosis Plants for Submarine Applications – used to validate decisions around desalination using RO technique.
- Feasibility Study - To explore viable options to achieving net-zero across within the maritime industry – reached conclusions about future alternative fuels.
- Safety considerations for an optionally manned / unmanned military aircraft. Role of the human in system safety.
- Constructing a computer simulation of a System of Simulated Satellites
- The Integration of Complex Systems in the Defence Environment (submarines) – technique deployed in UK MoD project.

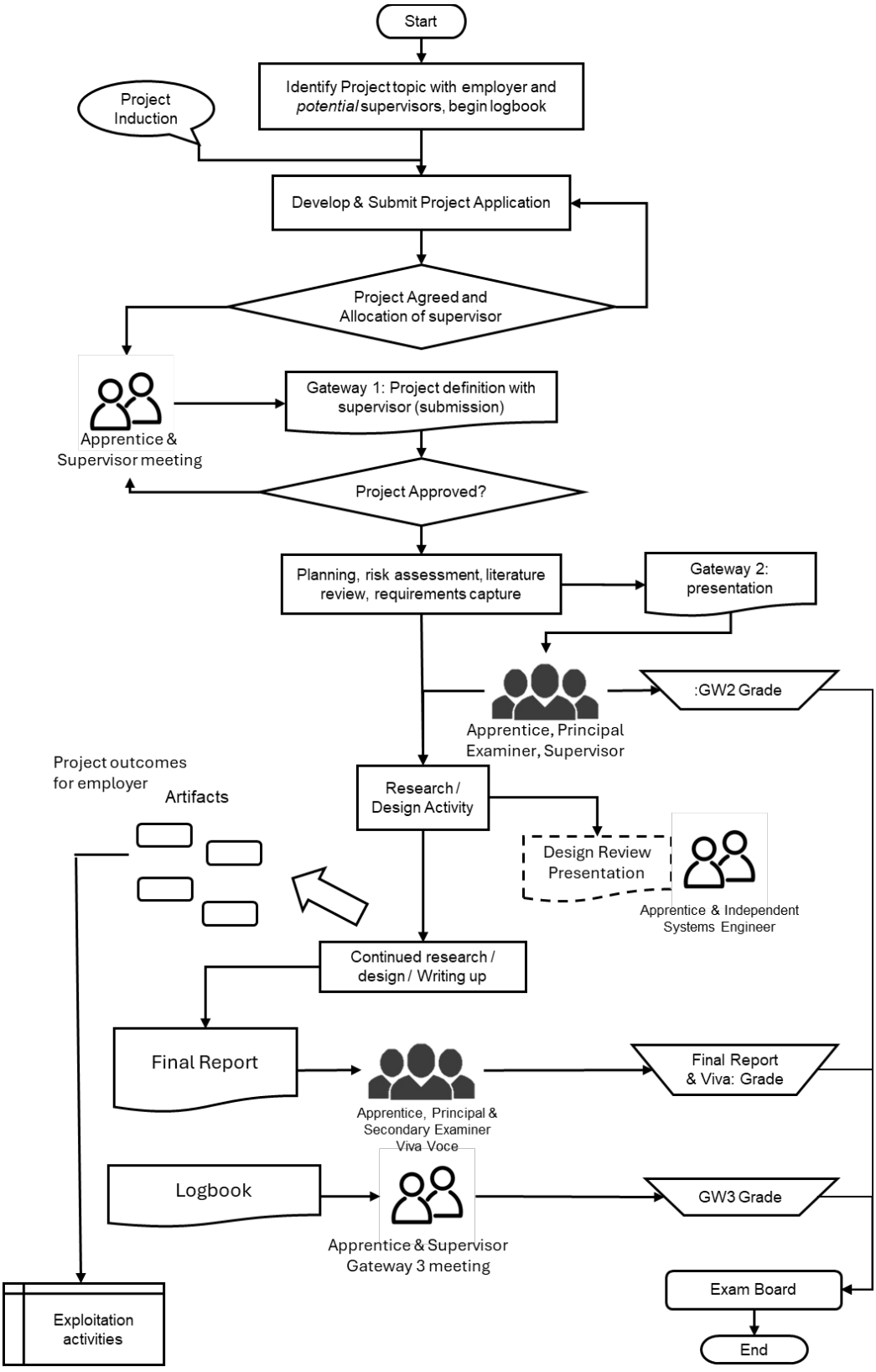

Figure 4: Flowchart showing Individual Project Activities and Events

6.2 Optional Modules

Apprentices must select 3 from 7 options.

Mechatronic Systems Design (optional) [WSP068 / WSP768]

The module takes a practical perspective of the integration of sensors and actuators within a system, covering not just the theory but the practical implementation of mechatronic systems.

Apprentices are advised that some knowledge of control Systems Engineering and Matlab/Simulink is required. Appropriate training, including exercises, for those less familiar with these subjects is available from the virtual learning environment (LEARN) to be executed prior to the module week.

Duties

The module provides practical knowledge that will be useful in the workplace for the design of technical systems. The module principally covers the following duties from the apprenticeship standard:

- Model and analyse systems
- Generate solution concepts

Principal content:

- Sensors: Sensed quantities; Sensor types and principles; Uses of Sensors; Dynamics of Sensors; Sensor systems; smart sensors; Sensor fault detection and redundancy.
- Actuation: Basic principles; Hydraulic systems; Pneumatic systems; Electrical systems; Advanced materials; Choice of actuation system; Open and closed loop actuator; Actuator Fault Tolerance and redundancy.
- System design of sensor/actuator systems and control systems.
- Awareness of the application of Matlab/Simulink for analysing mechatronic systems and their associated sensors, actuators and controllers.

Assessment

- Group exercise and presentation, in-class (40%)
- Individual technical report (60%)

Industry contributions

The module includes a lecture contribution from Rolls Royce staff on practical control systems.

Holistic Engineering (optional) [WSP071 / WSP771]

This module provides apprentices with a systematic understanding of the range of challenges associated with complex engineering projects undertaken by enterprises, and the techniques applied to overcome them. The perspective presented is that of a Chief Engineer and the module gives a 21st century view of what the role of Chief Engineer entails.

The module is led by former Chief Engineer, Hawk Aircraft, and supported by former Chief Engineer, Eurofighter Typhoon, and former Chief Engineer (UK), F35 Lightening. The sessions with Chief Engineers comprise a 60- 90 min lecture, followed by a structured session designed to make the apprentices question the Chief Engineer, and then reflect on the answers and extract the links between the theory and the applied industrial experience of large, sometimes unmanageable problems.

Duties

This module provides insight into the following principal duties from the apprenticeship standard.

- Provide technical leadership within a project
- Support transition of the system into the operational environment
- Provide systems-level in-service support of the system
- Support technical aspects of project management
- Co-ordinate technical outputs and work of multi-disciplinary teams

Principal content:

The case studies from real programmes will be used to illuminate a range of critical topics including:

- requirements definition,
- problem analysis,
- system architecture,
- the product/service lifecycle,
- engineering organisation design etc,

Assessment

- Individual assignment to develop a whole product-process lifecycle model (100%)

Industry Contributions

Led by and includes contributions from three former BAE Systems Chief Engineers.

Machine Learning - Principles and Applications for Engineers (optional) [WSP074 / WSP774]

This module is designed to cultivate the ability to not only comprehend the fundamentals of Machine Learning (ML) but also to empower students to apply these models effectively to various problems. The course will guide students in developing the practical skills necessary to utilize ML in diverse contexts, ensuring they can seamlessly integrate theory with real-world applications. This module introduces machine learning concepts in sufficient depth to enable systems engineers to understand and critique applications associated with system design.

Duties

This module addresses the duty:

- Generate solution concepts

Principal Content:

- Introduction to Artificial Intelligence (AI) with focus on Machine Learning (ML).
- Establish the main steps in a typical ML project.
- Supervised ML techniques.
- Learning by fitting a model to data.
- Optimizing ML metrics.
- Handling, cleaning, and preparing data.
- Feature selection and tuning.
- The main technical challenges of ML.
- Principles for unsupervised learning techniques.
- Most common learning algorithms with practical applications.
- Introduction to Artificial Neural Networks and insights into deep learning.
- Challenges of ML applicability in the real world.

Assessment

- Group case study, problems to be solved in-class and then presentation (30%)
- Machine Learning Case study, individual, computer code (20%), viva voce (50%)
    - Machine Learning to be developed to solve a problem

Industry contribution

Includes contributions from Ch. Tech. Consultant in AI and Machine Learning, Thales, UK.

Modelling, Simulation and Visualization for Engineering (optional) [WSP076 / WSP776]

The module provides apprentices with a systematic understanding of the role of modelling, simulation and visualization in engineering, systems design, and manufacturing, and equips them with the skills to create, integrate, and interpret models for practical problems. A key feature is to ensure that apprentices take a critical approach to modelling ensuring that they can justify and verify application of models.

In addition to introducing various modelling approaches and tools the module includes practical work on agent-based modelling and demonstrations in the Advanced VR Research Centre to provide context behind the theory.

Duties

- Model and analyse systems
- Generate solution concepts

Principal content

- Role of modelling & simulation in design, training, optimisation, and analysis
- Model types and their applications (physical, experimental, systems, process)
- Managing model uncertainty
- Simulation tools human-in-the-loop, digital twin, agent-based modelling)
- Visualization tools, virtual and augmented reality
- Validation and verification of models, interpretation of results

Assessment

- Systems Dynamics model and report (80%)
- Agent-Based Simulation with suitable visualization of results (20%)

Enterprise and Capability Engineering (optional) [WSP460 / WSP760]

Based around case studies and substantial input from senior practitioners, this module explores a variety of topics related to Systems of Systems and the delivery of complex capabilities by an enterprise.

Transport systems, defence capabilities, national energy infrastructure are all examples of complex systems of systems that require the systems managed and/or operated by multiple organisations to interoperate effectively and within a sustainable commercial environment. This module considers some of the principal capabilities, presented by industry experts, and the technical, organisational, and cultural frameworks through which they are brought together. A scenario exercise is conducted at the start of the module that informs understanding and is taken forward by apprentices as a case study.

The module focuses substantial effort on understanding the nature of risk and uncertainty in complex projects. Apprentices will be able to better understand the nature of risk management in their workplace to inform their own approach to system delivery.

Duties

- Define and manage the system lifecycle for a project
- Manage project risk
- Plan and manage systems integration
- Provide systems-level in-service support of the system
- Support technical aspects of project management
- Co-ordinate technical outputs and work of multi-disciplinary teams

Principal content:

- Capability concepts and practical delivery
- Mission Engineering
- System of Systems (SoS) concepts
- Network design
- Modelling and architecting techniques for SoS
- systems life-cycle management
- Risk management in complex environments
- Cyber-physical systems.
- Through-life costs
- Obsolescence management
- Logistics

Assessment

- Group case study, in-class presentation (20%)
- Individual assignment (80%

Industry contribution

The module includes contributions from senior staff in: The Mitre Corporation, BAE Systems, UK MoD, Lockheed Martin UK, Jaguar Land Rover, Aspire Consulting, Pendyne Consulting.

Digital and Data Engineering (optional) [WSP078 / WSP778]

First delivery will be from Oct. 2025, i.e. for the Oct. 2024 cohort. The module will equip apprentices with a comprehensive knowledge and understanding of Digital Engineering and Data Engineering concepts and approaches. Students will acquire the skills to design, implement, and manage advanced systems engineering projects involving significant digital and data components, and develop an appreciation of the impact of digital technologies and digitalisation on systems engineering.

Industry is undergoing a digital transformation that is changing approaches to technology development and support and introducing new levels of complexity with which systems engineers must grapple. This module will enable apprentices to understand the nature of digital transformation and to engage strategically with it in the workplace.

Duties

- Model and analyse systems
- Generate solution concepts
- Support transition of the system into the operational environment
- Provide systems-level in-service support of the system
- Support technical aspects of project management
- Take responsibility for configuration and data management

Principal content:

- strategies for data acquisition, storage, processing, and analysis, with an emphasis on maintaining data integrity, scalability, and reliability.
- evaluation and application of tools and services for managing varied data structures, streams, and sources.
- scientific, mathematical, technical, and engineering foundations of data-centric and data-driven methodologies.
- ethical, legal, and social implications of digital and data technologies.

Assessment

- In-class group mini-practical (25%)
- Data Strategy (75%)

Industry contribution

Development of the module is being supported by staff leading digital engineering from Frazer-Nash, Perkins, QinetiQ, UK MoD, and BAE Systems.

6.3 Specialist Technical Modules

Electromagnetic Systems for Defence [WSP777]

This module is not a standard Systems Engineering module but covers a relevant technical discipline that is described as a Quality Characteristic in the INCOSE Handbook [3], and was previously described as specialty engineering. **This module is ONLY suitable for people working in the defence supply chain.**
The module is delivered as part of the Dstl-sponsored Electromagnetic Environment Hub.

Duties

4. Model and analyse systems

Principal Content

- Cyber and Electromagnetic Activities,
- The Radio Spectrum,
- Modulation,
- Electromagnetic Immunity,
- Radio Systems,
- Electronics,
- Science and Technology in the Electromagnetic Environment
  The module follows a traditional patter comprising mostly lectures with two lab sessions during the week.

It aims to equip students with the knowledge, understanding and skills to address problems in Electromagnetic Defence. Students will be equipped to:

- Understand the general scope of Cyber and Electromagnetic Activities in a military environment.
  - Know in a broad sense how state and non-state adversaries may use the Electromagnetic Environment.
- Know the core of electromagnetic theory, including the implications of Maxwells equations.
- Understand the regulation of the radio spectrum in the international context and legal aspects of operating in the UK.
- Understand the electromagnetic immunity characteristics of electronic circuits and communications devices.
- Know in a broad sense how a third parties might intervene in a radio communications system and the legal aspects of doing so.
- Critically analyse a defence scenario, outlining the Electromagnetic Environment aspects of the key electronic systems.
- Critically analyse case studies for electronic attack and identify the required S&T knowledge base to mitigate.

Assessment

- Coursework Report (100%)

Industry contribution

The module includes guest lectures from Dstl and BAE Systems.

7 Reference Material used to inform the Curriculum

The subject relevant benchmarks for this programme are:

- UK Quality Assurance Agency for Higher Education [QAA] Subject Benchmark Statement for Engineering, 2023
- Engineering Council [UK]. UK-SPEC, UK Standard for Professional Engineering Competence, 4th Edition, 2020
- Engineering Council [UK]. The Accreditation of Higher Education Programmes, 4th Edition, 2020
- Master's degree characteristics, the Quality Assurance Agency for Higher Education, 2020.
- Systems Engineer Master's Degree Apprenticeship Standard, ST0107, 2022.

Additionally, all competencies are measured from the INCOSE Systems Engineering Competency Framework, INCOSE-TP-2018-002-0-10 and as such the INCOSE Systems Engineering Handbook Version 5 (Ju l2023), to which Prof. Henshaw and Prof. Rabbets are contributing editors.

A key text for Architecting and associated MBSE is 'Essential Architecture and Principles of Systems Engineering', Dickerson C.E., and Ji, S, 1st Ed., CRC Press, 2021. (ISBN 9781032100968). **This is a textbook authored by our staff that is used internationally in the teaching of systems architecting using a model-based approach**. The textbook was written to support the three MBSE modules in the Loughborough programme; its adoption by other institutions, including in the US, demonstrates international recognition of the Loughborough MBSE curriculum.

- Hirshorn, Steven R., NASA Systems Engineering Handbook, NASA SP-2016-6105 Rev. 2 (2016)

8 Additional Support

We are aware that some apprentices who join us through non-traditional routes may need additional support also, application of software tools for systems problems may be unfamiliar for some apprentices. To address this, mathematics required knowledge is highlighted and apprentices may access the Loughborough University Mathematics Learning Support Centre.

8.1 Training in Tools and Applications

Through an arrangement with MATHWORKS Ltd., we have a two-day hybrid training programme available to all apprentices offering basic training in System Composer and other applications. This occurs early in the second semester every academic year accessible to apprentices in any of their study years. The training provides apprentices with the opportunity to learn the basics of one of the most used engineering analysis tools in the context of systems engineering. The training also illustrates to students a possible solution to systems engineering tool interoperability, which feeds into their studies in the Group Project module.

8.2 Functional Skills

Prior to 2025, it was a requirement for apprentices to provide evidence of level 2 (GCSE-level) qualification in English and Mathematics. This is no longer a requirement but any apprentice with a concern about functional skills should raise this either an Initial Needs Assessment (INA) or with their mentors. The University is able support development and qualification in functional skills.

9 Module Mapping to Apprenticeship Standard

Table 6 shows the mapping of the core Systems Engineering modules to the Systems Engineer Master's Degree Apprenticeship Standard, ST0107, 2022. Group C modules in general contribute to K14 (Scientific, technical, engineering, and mathematics fundamentals and a broad technical domain knowledge for the relevant industry) but not to the systems-specific KSBs.

It is possible to use evidence from the academic programme (e.g. artefacts created for assessment) in the portfolio, however, apprentices are advised that several skills, and all behaviours, can only effectively be evidenced from the work environment.

Note on error in IFATE published assessment plan. The assessment plan published by IFATE contains an error on the mapping of KSBs. On page 45, under group 5 assessment in table 8, Professional Discussion, it includes Monitoring and Control, and K14 (Scientific, technical, engineering, and mathematics fundamentals and a broad technical domain knowledge for the relevant industry). This is an error, it should be: S14 (Define and collect operation data for monitoring and control of a system), as will be clear from the criteria alongside it.

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
B1	Adopt an holistic thinking approach to system development	✓	✓			✓	✓				✓	✓	
B2	Performs negotiations with stakeholders recognising different styles of negotiating parties and adapts own style accordingly.			✓						✓		✓	

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
B3	Adopt a critical thinking approach using a logical critique of work including assumptions, approaches, arguments, conclusions, and decisions	✓				✓	✓				✓	✓	✓
B4	Take personal responsibility for health and safety practices and sustainable development	✓				✓			✓	✓	✓		
B5	Operate with integrity and in an ethical manner, and ensure that team members perform with integrity and in an ethical manner	✓				✓			✓	✓	✓	✓	✓
B6	Take a proactive and systematic approach to resolving operational issues.	Can only be practically carried out at workplace											
B7	Maintain awareness of developments in sciences, technologies and related engineering disciplines	✓		✓			✓	✓	✓		✓	✓	✓
K1	Systems engineering lifecycle processes	✓	✓	✓					✓	✓	✓		
K2	The role a system plays in the super system of which it is a part		✓	✓					✓	✓	✓		

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
K3	The characteristics of good quality requirements and the need for traceability		✓	✓	✓		✓					✓	✓
K4	The distinction between risk, issue, and opportunity and the different forms of treatment available					✓			✓		✓	✓	✓
K5	The benefits and risks associated with modelling and analysis	✓	✓	✓		✓	✓	✓	✓			✓	✓
K6	How creativity, ingenuity, experimentation and accidents or errors, often lead to technological and engineering successes and advances	✓	✓	✓	✓		✓		✓			✓	✓
K7	Different types of systems architecture and techniques used to support the architectural design process ie the specification of systems elements and their relationships	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
K8	Non-functional design attributes such as manufacturability, testability, reliability, maintainability, affordability, safety, security, human factors, environmental impacts, robustness and resilience, flexibility, interoperability, capability growth, disposal, cost, natural variations, etc	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
K9	Integration as a logical sequence to confirm the system design, architecture, and interfaces	✓	✓	✓					✓	✓	✓		✓
K10	Interface management and its potential impact on the integrity of the system solution	✓	✓	✓					✓	✓	✓		
K11	Systems verification against specified requirements and characteristics and the need to execute it in a logical sequence		✓	✓	✓		✓					✓	
K12	The relationship between verification, validation, and acceptance			✓	✓			✓				✓	
K13	The purpose and importance of system validation in relevant commercial context								✓		✓	✓	
K14	Scientific, technical, engineering, and mathematics fundamentals and a broad technical domain knowledge for the relevant industry					✓	✓			✓			
K15	How to take account of health and safety legislation and sustainable development requirements in the relevant industry	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
K16	The relationship of service quality to user satisfaction and cost, risk, and availability of the operational system			✓		✓			✓	✓	✓	✓	✓
K17	The elements of a project management plan including statement of work, work breakdown structure, resource allocation, scheduling, management plan, monitoring, risk management, change requests, record keeping, and acceptance					✓			✓		✓	✓	✓
K18	The commercial and financial environment in which a project is being executed eg procurement model, interest rates, exchange rates								✓	✓	✓	✓	
K19	The role of systems engineering planning as part of an overall project / programme plan								✓	✓	✓	✓	
K20	The legal, commercial, and security constraints that affect the management of data and information eg General Data Protection Regulation, handling of specific commercial contract restrictions (Can identify relevant legal and commercial constraints on information management)					✓		✓		✓			

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
K21	Support and sustainability needs of a deployed system or product										✓		
S1	Select appropriate lifecycle for a system or element of a system and establish its lifecycle stages and the relationships between them (Has used enterprise-level policies, procedures, guidance and/or best practice to select lifecycles governing the project and defined dependencies and transitions between lifecycle stages)			✓	✓			✓				✓	
S2	Define context of a system from a range of viewpoints including system boundaries and external interfaces (Led a team systems thinking activity aligned to purpose of an activity in which they were involved)		✓	✓	✓			✓	✓	✓	✓		
S3	Use appropriate methods to analyse stakeholder needs to produce good quality, consistent requirements with acceptance criteria and manage them throughout system development		✓	✓								✓	
S4	Identify, analyse, recommend treatment, and monitor and communicate risks and opportunities throughout project					✓			✓		✓	✓	✓

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
S5	Generate a physical, mathematical, or logical representation of a system entity, phenomenon or process		✓	✓	✓	✓	✓	✓		✓		✓	✓
S6	Apply creativity, innovation and problem solving techniques to system development or operation (Has Demonstrated this skill by leading an innovation team.)	✓							✓	✓	✓	✓	✓
S7	Define the systems architecture and derived requirements to produce an implementable solution that enables a balanced and optimum result that considers all stakeholder requirements across all stages of the lifecycle		✓	✓	✓		✓	✓	✓	✓		✓	
S8	Identify, define, and control interactions across system or system element boundaries		✓	✓				✓	✓	✓	✓	✓	
S9	Assemble a set of system elements and aggregate into the realised system, product, or service using appropriate techniques to test interfaces, manage data flows, implement control mechanisms, and verify that elements and aggregates perform as expected		✓	✓	✓			✓	✓	✓	✓	✓	

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
S10	Define verification plans (including tests) to obtain objective evidence that a system of system element fulfils its specified requirements and characteristics		✓	✓	✓		✓	✓	✓	✓		✓	
S11	Provide objective evidence that the operational system fulfils its business or mission objectives and stakeholder requirements and expectations			✓					✓	✓	✓	✓	
S12	Communicate effectively with all stakeholders of the project	✓	✓	✓	✓	✓	✓		✓		✓		✓
S13	Integrate a system into its operational environment, including the provision of support activities (eg specification of site preparation, training, logistics, etc)		✓	✓				✓	✓	✓	✓	✓	
S14	Define and collect operation data for monitoring and control of a system								✓			✓	
S15	Initiate design change proposals in response to system failure or degradation		✓		✓		✓	✓	✓	✓	✓	✓	

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
S16	Create and maintain project management plan, including work breakdown structure, scheduling, and risk management					✓			✓			✓	✓
S17	Balance project scope, time, cost, risk, and resources to optimise product or service quality and return on investment					✓			✓			✓	✓
S18	Manage and control system elements and configuration over the project or programme lifecycle ensuring overall coherence of the design is maintained in a verifiable manner throughout the lifecycle										✓		
S19	Plan, execute, and control the storage and provision of information to stakeholders					✓		✓		✓			
S20	Coordinate and maintain effective and workable plans across multiple disciplines											✓	
S21	Identify concepts and ideas in sciences, technologies and engineering disciplines beyond their own discipline that could benefit the project solution	✓		✓			✓	✓	✓	✓	✓	✓	✓

KSB (ILO Mapped)		Applied Systems Thinking	Systems Architecture	Systems Design	Validation and Verification	Machine Learning – Principles and Applications for Engineers	Mechatronic System Design	Modelling, Simulation and Visualization for Engineering	Holistic Engineering	Digital and Data Engineering	Enterprise and Capability Engineering	Group Systems Project	MSc Individual Project
S22	Partition between discipline technologies and work with specialists to derive discipline specific requirements		✓	✓				✓	✓		✓		

Table 6: Mapping of Modules to Knowledge, Skills, and Behaviours of SEMAP Standard

All MSc are subject to a common set of university regulations and procedures; however, the apprenticeship model adds a layer of bureaucracy and compliance requirements associated with the funding mechanism employed. Apprenticeships have a curriculum developed collaboratively with industry to meet contemporary needs and there is a requirement to demonstrate the effectiveness of the training through impact in the workplace. Similarly, access to levy funding places an obligation on employers to provide adequate support to apprentices that includes mentoring and an average of ***at least 6 hours per week*** paid training time (referred to as Off-The-Job hours).

Administration covers the following broad areas:

- Recruitment and induction, including initial assessment of individual training needs and the development of a tailored programme of training[2]
- Monitoring of compliance requirements: OTJ hours, regular review meetings, academic progress, collection of evidence for EPA
    - Provision of data for statutory bodies (ESFA, OFSTED, Skills England, QAA)
- Apprentice support: all matters associated with wellbeing, safeguarding, and negotiating the university processes[3].
- End Point Assessment: preparation and management of evidence and supporting documentation

All matters relating to administration of the apprenticeship are covered in this section of the handbook; where appropriate, university processes are referenced, and apprentices should also consult these for matters related to their academic study.

10 Regulations that affect you and your Apprenticeship

10.1 Safeguarding & Prevent

The University is committed to ensuring the safety and physical and emotional wellbeing of its apprentices, students, staff and visitors and to creating an environment conducive to study, learning and the advancement of knowledge. Our policies apply to all staff, students and apprentices at Loughborough University.

Our Safeguarding Policy applies to safeguarding concerns regarding any registered student or apprentice, staff member or visitor at the University. The University is committed to fulfilling its responsibilities in safeguarding any children or vulnerable adults who may be at risk of harm or exploitation.

The University is committed to both to protecting freedom of speech and academic freedom and to protecting and safeguarding its students and apprentices from the risk of being drawn into terrorism. Our

[2] In this guide, we use the terms 'training' and 'education' fairly synonymously, but it is worth noting that the role of universities is Education, which concerns the way that people think as opposed to the learning of formulaic tasks, more usually associated with training.

[3] We recognise that for regular students, the university processes soon become familiar, but for part-time students and apprentices who access the processes less frequently, some additional support and advice is helpful.

policy balances our legal duty to have 'due regard to the need to prevent people from being drawn into terrorism', with our commitment to freedom of speech and the importance of academic freedom.

10.2 University Regulations

The University's General Regulations provide the framework for all programmes and can be found at: http://www.lboro.ac.uk/governance/regulations/ (see Regulation XXI for Postgraduate Awards)

As part of your apprenticeship, you will join the body of students and learners also studying at the University. Our Terms and Conditions of Study explain the contract which comes into force when you accept an offer of an apprenticeship place at the University during the formal application process, and the second contract which is applicable once you have become a fully registered student of the University.

10.3 Apprenticeship Regulations

The apprenticeship programme is part of the government's funded support for skills, and it is the responsibility of the Education & Skills Funding Agency (ESFA) to ensure that funding from the apprenticeship levy is spent on high-quality apprenticeships. For this purpose, the ESFA publish formal set of rules which govern apprenticeship delivery – the Apprenticeship Funding Rules. These set out how the apprenticeship programme must be run, and in signing the agreement with government, your employer undertakes to implement the responsibilities and support the University to comply with the rules that govern the apprenticeship programme.

There are two key rules that govern for your learning; the apprenticeship must take place during the apprentice's typical working week, and the apprentice must spend at least six hours per week of their time as apprentice in off the job learning. The University has designed both requirements into the programme that you are following, and your Training Plan sets out how and when your off and on-the-job learning will take place. Failure to meet either requirement will mean that your employer and the University are not complying with this important apprenticeship principle and Funding Rule.

10.4 What information we collect and hold about you and your apprenticeship

The University collects and processes information about apprentices for various teaching, research and administrative purposes, including the health, safety and welfare of individuals. You are given the opportunity to opt out of various categories of processing on your registration form. You may not opt out of the requirement to share appropriate information with your employer, as this is a requirement of the tripartite working which forms the basis of the apprenticeship.

The apprenticeship programme is part of the Education and Skills Funding Agency's programme for government. The ESFA generally collects data on behalf of the Secretary of State for the purposes of fulfilling the Secretary of State's statutory functions which means that some data collection about you is mandatory. The Department for Education use apprenticeship data to track the apprenticeship programme which forms part of the formal government Statistical Release. Where the ESFA shares data with a third party who undertakes work for the ESFA, this is undertaken under contract and is subject to a data-sharing agreement, specifying the secure management of the data.

You can view the ESFA Privacy Notice which explains what personal data is collected by the Department for Education, through the Education and Skills Funding Agency, and how it is handled for apprenticeships.

10.5 Confidentiality

All personal information will be treated strictly in accordance with current data protection legislation. This means that confidentiality will be respected and that all appropriate security measures will be taken to prevent unauthorised disclosure. Personal information is used for stated purposes only and you will be advised of any changes.

Some of the personal information processed by the University is classed as "sensitive" data under data protection legislation (for example, racial or ethnic origin, marital status, health records etc). Appropriate security will be in place to ensure that information (such as medical certificates) is retained confidentially and kept no longer than is necessary. You are entitled to have access to and/or request a copy of the information held about you to ensure that it is accurate and that it is being dealt with properly.

10.6 Keeping your data up to date

The University takes every precaution to ensure that data remains accurate and up to date. It is important that you inform your Programme Administrator about any changes to your personal information and that we have valid contact details for you throughout your apprenticeship. You can update address information, emergency contact details, data usage preferences and more at:
www.lboro.ac.uk/registry/student/self-service

10.7 Information Shared Between Apprentices, Employers and the University

As part of your apprenticeship the University will share your assignment grades with your employer via the Progress Review process, or where employer contract agreements stipulate progression data is required. Your Line Manager will also have access to the notes and Action Plans from Progress reviews.

11 The Apprenticeship Journey

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11.1 Application and Eligibility to study

We recommend that applicants start their submission as soon as possible and no later than two weeks before the Application Deadlines, which is usually the first Monday of September.

There are several documents that will be required as part of your application, including:

- A copy of your undergraduate degree certificate or details of your relevant Industry Experience
- An academic transcript showing the modules studied and marks attained for your undergraduate degree, if applicable
- A personal statement which should briefly explain your motivation for studying this programme
- A copy of your current passport
- An employer reference on letter-headed paper
- Evidence of a Level 2 English and mathematics qualifications (usually GCSE or equivalent). More information on what kind of qualifications can be accepted is on the gov.uk site.
    - If you do not have any evidence available or cannot request it from an awarding body, you will be required to undertake functional skills assessment(s) at the start of the apprenticeship. Under current rules, it must be within the first year of the apprenticeship, however, we encourage and facilitate it shortly after induction so that this does not become an ongoing burden on the apprentice. Note evidence of level 2 English and Mathematics is not a condition of entry onto the programme, but it is a condition of completion of the apprenticeship.

11.2 Responding to your offer

Once the university has received your application to study and has had a chance to consider it, along with any relevant documentation you've submitted, you will be notified of the outcome of our decision as soon as possible. You will receive an email with an offer to study, which will fall into one of the below categories:

- **Conditional** – you are required to provide further information or documentation to fulfil the application requirements and receive an unconditional offer
- **Unconditional** – you have been accepted onto the course based on what you have already provided, and no further information is required

After receiving an offer, you should respond as soon as possible by logging into your Online Application Portal Account and accessing the "Reply to Offer Details" link.

Once you have accepted the offer, the University will generate a unique Student Number on your behalf which will be sent to you via the email stated on your application. You will then enter the apprenticeship eligibility stage.

11.3 Apprenticeship Eligibility and compliance documentation

You will need to complete the following documents with your employer prior to commencing the apprenticeship:

1. **The Apprenticeship Agreement**
   This is a basic form that identifies your occupation, the standard you will be meeting, the duration of your apprenticeship and Off The Job (OTJ) training hours you will receive.
2. **Apprentice Checklist and Declaration**
   This form captures vital information about you that we may not obtain from anywhere else in the admissions process. The University needs this when reporting to the government to enable us to draw fees from the levy to support your apprenticeship. Please complete this and send it back to us, along with a copy of your contract of employment - this is to verify your contract status with your current organisation.
3. **Initial Assessment**
   This document requires you, your Workplace Apprenticeship Mentor, and Line Manager to evaluate your knowledge and skills against the apprenticeship standard (skills scan) and disclose any relevant prior learning or learning support requirements. This form will be evaluated to ascertain your current levels of knowledge and skills to ensure you are not undertaking or duplicating learning which you have already attained.

These documents are required as soon as possible (at least two weeks before induction), particularly document 3, the Initial Assessment. This document must be reviewed ahead of you starting your programme in a joint discussion with your Workplace Apprenticeship Mentor / Line Manager or similarly appointed Organisational contact and the Programme Director, Professor Michael Henshaw or Deputy Director, Dr. Siyuan Ji.

The assessment the Programme Director makes could confirm any exemptions or adjustments to your learning which would also alter the contractual and financial obligations to your employer. Our Programme Director must assess each apprentice in turn and liaise with your employer on any such exemption, so your early submission will be greatly appreciated.

Once all these documents are returned, we will be able to produce and send to you a prepopulated Training Plan which you and your Workplace Apprenticeship Mentor will review and sign.

A list of modules and their respective dates can be found on our Programme Structure, whilst we aim to keep module timetables the same year on year, modules may change dates or semesters in subsequent Academic Years. You are required to have a full plan in place at the outset, but please be reassured that this individual learning plan is subject to change, and we are flexible and accommodating to learner needs.

11.4 Induction

The Apprenticeships Team will send you a communication outlining details of the induction, including date, time and location.

You will be expected to attend the programme induction in person, held at the Loughborough University campus – attendance is compulsory and should you not be able to attend you may need to defer your Application until the next Academic Year.

We ask that you forward the details of your induction to your Workplace Apprenticeship Mentor so that they can attend if they are able to. If they already mentor another Loughborough University apprentice, they will not be required to attend. If this is their first foray into a Loughborough University Apprenticeship Programme and/or mentoring, the induction would be beneficial as it provides specific information and training relevant to an understanding of the programme.

Where possible, inductions are scheduled on a Friday or Monday to be least disruptive to the working week for you and your Workplace Apprenticeship Mentor. There are accommodation options available on campus should you wish to stay overnight instead of travelling on the day.

11.5 Registration

Please ensure that all communications sent to you via the University are reviewed as soon as possible in the lead-up to the start of your programme. You will be emailed your IT credentials which will allow you to log into the University's Virtual Learning environment – LEARN, your student email and more.

You will also be required to complete your registration to confirm your student enrolment on the programme – this will include uploading a photograph for your ID card, which you will be able to collect in your first week of teaching if you complete the registration in enough time.

11.6 Communications from the University to Apprentices

Once you have registered successfully, you will receive a university email of the form:

Initial(s).Surname-year@lboro.ac.uk

You should note that **all official communications from the university will use this university email address**, personal or company emails will not be used. It is, therefore, very important that you check your university email frequently.

11.7 Timeline

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11.8 Off the Job Hours (OTJ)

Your Training Plan sets out the minimum number of off the job hours (for ESFA Funding Rules) that you need to meet, at six hours per week on average. Within the Training Plan, there is a section entitled 'Individualised Learning Plan (ILP)'; this sets out the modules you will take and breaks down the total hours per module and expected OTJ. In general, the total hours across all modules and the individual project is 1,800 of which at least 1,050 is expected to be OTJ.

Learning activities will include module attendance and assessment, additional reading and activities to deepen and consolidate module learning, other relevant training (outside of the academic endeavour) that supports acquisition of knowledge, skills, and behaviours aligned to the apprenticeship standard.

Records must be maintained to evidence that apprentices are spending an average of at least 6 hours a week of their time on off the job training. This can be spread across multiple weeks as an average, however if you do not undertake some active learning after a period of four weeks this is classed as a **Break in Learning**.

Apprentices are required to keep monthly records of any off the job learning they complete within their contracted hours. You will be provided with a document to track and record your Off the Job training; **you must keep the OTJ Apprentice Record up to date on a weekly basis and submit these to the University monthly.**

Your OTJ learning will be reviewed at every Progress Review meeting. Your Academic Mentor and Workplace Mentor should be provided with an up-to-date record of the OTJ learning; please remember to make monthly submission of OTJ via the LEARN Portal

What constitutes Off the Job Training?

Generally, the off the job element of the apprenticeship can be described as any activity where the Apprentice is completing learning or training towards the L7 Systems Engineering Standard during their normal working hours.

We usually recommend that this be a time where you are not undertaking "normal" work activities. However, learning can occur at any given time within your usual working hours and pattern.

The Funding Agency has provided the following questions, as criteria, to enable Apprentices and Employers decide whether an activity can be included in the 20% OTJ learning hours:

- Did the activity take place during the Apprentice's contracted working hours?
- Did the activity impart new knowledge or skills, or demonstrate recognised behaviours?
- Can the activity be directly linked to the L7 Systems Engineering Standard?

If an affirmative answer can be given to all questions, then the activity can be included as OTJ hours.

Your OTJ learning will be reviewed as part of your Progress reviews. If you are unable to undertake any OTJ hours in a particular week, the deficit must be made up in the following weeks, as Apprentices must be involved in active learning throughout the apprenticeship otherwise this is classed as a break in learning and could affect the end date of your Apprenticeship.

You must record some learning activity every four weeks **-** we highly recommend that if you have no Module Learning scheduled that you join one of our Evening Lectures - these take place once a month, usually the 4th Wednesday between 18:00 - 19:00, on TEAMS and in person. If your working hours mean you are unable to attend online, sessions are recorded so you can review them later within your working hours.

11.9 Progress Review Meetings[4]

The Progress Review process is a requirement of ESFA put in place to check if you are 'on schedule' against your Training Plan.

These should take place every 12 weeks at minimum and at least one each year should ideally be face to face. Initially these meetings will be added to your calendar as a recurring 10 weekly meeting with all involved parties, this allows for a two week overlap in case of sickness or emergency cancellation of the meeting, but if these dates and times clash with your availability these can be adjusted by contacting WSApprenticeships@lboro.ac.uk

In these meetings you will

- Check on any well-being matters
- Review your academic progress
    - Including your Coursework outcomes.
- Discuss the acquisition of KSBs
    - Including reviewing evidence and KSB attainment against the Apprenticeship Standard
- Additionally, all meetings should briefly review:
    - Responsibilities and accountability as set out in the Learning Plan.
    - Your attendance.
    - Your Off the Job Hours.
- Take time to discuss future actions and raise any issues.

If any meetings cannot take place within the 12-week timeframe, it is essential that the next meeting happens as soon thereafter as possible and that subsequent meetings happen in a slightly shorter timeframe to make up any lost time deficit.

[4] These were previously called Tripartite Meetings.

11.10 Portfolio Evidence

Apprentices are required to compile a portfolio of evidence to demonstrate that they have met the knowledge, skills and behaviours requirements of the apprenticeship. This is common across all degree-level apprenticeships, but there is comparatively little information about what it should contain. The guidance provided on the INCOSE UK website (and our own apprenticeship LEARN page) describes the content and suggested layout.

As an Apprentice you should start collecting the evidence that may be used in the portfolio as soon as possible, although its final compilation will be completed later in their programme and finalised during the End Point Assessment period.

For apprentices, their progress in collecting evidence will be an important consideration during the Progress Review meetings with their tutors and mentors.

Monthly online workshops, usually on the 1st Wednesday of the month 17:00-18:00, provide guidance and act as drop-in sessions where each month different groups of KSBs or areas of interest are reviewed.

Workplace Mentors are encouraged to participate and contribute to these sessions to ensure tripartite teams are well-informed.

Attendance is optional and you do not have to attend every month – we hope even one or two sessions will help as a basis of information but also these can be used as a drop in to answer questions. We have found that by sharing experience within a small group and the provision of guidance from the University, apprentices are able to manage their evidence collection more effectively and position themselves efficiently for the construction of their portfolio when it is required. This is applicable to all apprentices whether recent starters or some way into their programme.

It is essential that you collect evidence and develop your portfolio over the course of the programme. In this way you will be ready for EPA gateway directly your MSc. results are announced.

We recommend that you read the published guidance https://incoseuk.org/Normal_Files/Professional_Development/SEMAP_Assessment in advance of the portfolio workshop.

11.11 Apprenticeship Management System – Maytas

Still in Draft form at present – will be updated in due course

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12 Managing your studies – Mitigating Circumstances (MC) Claims, Coursework Extensions, Break in Learning and Additional Support

During your Apprenticeship, you may encounter difficult situations, life changes, work priorities etc.. There are several processes in place at Loughborough University to provide support and assistance when life takes an unexpected turn.

12.1 Getting back into Studying

For those of you coming back into Higher Education there are Study Skills Support pages with useful information available to you via the Library found here:

https://www.lboro.ac.uk/services/library/topics/study-skills/

The following Referencing Software may also be of use to you:

https://www.lboro.ac.uk/services/library/topics/mendeley/

12.2 Mitigating Circumstances

If you experience genuinely exceptional circumstances beyond your control which you feel adversely affected your ability to engage with your assessment you may ask for your circumstances to be considered by the relevant Review Board by using the University's Mitigating Circumstances Procedures after the submission of your Assessment.

You can log in to the Self-Service portal to make a claim for mitigating circumstances.

Further guidance on submitting a claim of mitigating circumstances can be found at the following link: https://www.lboro.ac.uk/students/handbook/exams/mitigating-circumstances/

All claims will be considered fairly and sympathetically. You will need to explain the impact of the circumstances on your studies in as much detail as you can. You should provide supporting evidence if you are able to, but we recognise this might not be possible in some cases - please do submit the claim anyway.

Do not delay submitting your claim if you are waiting for your evidence from a third party – such as your workplace or your GP Surgery. Evidence will be accepted up to two working days before the Mitigating Circumstances Panel. Supporting evidence submitted no later than two full working days before the meeting will result in a delay in the consideration of your claim until the next Semester's Panel. You should submit all independent supporting evidence via the same online portal as for the Mitigating Circumstances claim.

The School's policy on valid mitigated circumstances is to give the opportunity to take a missed assessment, or to reattempt a severely impaired assessment at a Repeat First Attempt – this means that

the reassessment will not be capped at 50% - which would usually be the case without a Mitigating Circumstances claim.

You will have two main opportunities to undertake the reassessment, outlined below:

1. The Special Assessment Period in August/September – This carries the benefit of being able to undertake your Assessment outside of term time and not alongside any other Modules or Module Coursework. However, the allocated time to complete your Reassessment is much shorter.
2. At the same time Next Academic Year – This will mean undertaking the Reassessment at the same time after the Module runs in the following Academic Year, unfortunately, this does mean you will have to complete it alongside any other Modules or Module Coursework you have a that time. However, the allocated time to complete your Reassessment is the usual 7 – 8 weeks.

12.3 Extension Requests

Extension requests are subject to university Regulation VII. When exceptional and unforeseeable circumstances beyond your control will prevent you submitting coursework by the submission deadline, but you feel certain that you can complete the work with a little extra time, you can request a Coursework Extension Request.

To request a coursework extension please use the extension request form **here** and submit it to WsSupport@mailbox.lboro.ac.uk. **Do not send extension requests to the module leader.**

Module Leaders CANNOT authorise extensions

Extensions require approval by the Associate Dean Education & Student Experience (ADESE); the request must be explicit about the reason for request and be supported by appropriate evidence.

An extension of up to 48 hours of additional time can be granted.

A longer extension (usually up to 3 weeks) is possible but requires a mitigating circumstances (MC) claim to be submitted as well. If you require a longer extension, please note this in your coursework extension form and please also submit a Mitigating Circumstances (MC) claim (just for that particular coursework assessment).

You can log in to the Self-Service portal to make submit the claim for mitigating circumstances.

Please find below more information about the Coursework Extension Request Process for Apprentices.

Please mention that you are requesting a further extension for your coursework and use the text from the extension form or attach it as evidence.

WS Support will then be able to answer any further questions in relation to your Coursework Extension Request after submission.

12.4 Individual Project Extensions

In general, it is expected that apprentices will move immediately to their EPA gateway once they have received confirmation of passing the Individual project (usually the very last assessed academic work). Thus, an extension to the project impacts the timeline for EPA and, because of the restrictions set out by ESFA regarding the length of the Apprenticeship, only two types of extension are permissible for the individual project. These are:

1. A Two-Week extension allowing you the optimal amount of time to complete your End Point Assessment and attend a Summer Graduation.
2. A Five Month extension with a submission deadline towards the end of January. In this case, the apprentice will need to have their portfolio complete (with all evidence), all reviews and off-the-Job hours completed to target, and associated documentation signed immediately after Dissertation Submission (at risk). The specific timeline for the EPA period should be established with the Apprenticeship Administrative Support staff.

Project extensions should only be sought in exceptional circumstances

Examples of valid reasons for a Project Extension request include:

- Serious or significant medical condition or illness – including any mental health conditions
    - Requests relating to a long-term illness or disability will normally need to be supported with evidence from the University's Counselling and Disabilities Service.
- Exceptional personal circumstances beyond the Apprentice's control
- Exceptional circumstances within the Apprentice's workplace

Examples reasons which are not valid for a Project Extension request include

- Occasional illness or minor ailments
- Everyday problems or events
- Poor time management or personal organization
    - Managing learning, coursework assignments and revision etc
- Circumstances within the Apprentice's control

Please find below more information about the Project Extension Request Process for Apprentices.

To request a Project extension please use the extension request form **here** and submit it to WsSupport@mailbox.lboro.ac.uk. **Do not send extension requests to the Individual Project leader or your Project Supervisor.**

Please ensure that any Extension request is sent with some form of Evidence to substantiate your request. What can be used as evidence can be discussed at the time of your submission – you can talk to the team at WS Apprenticeships and we can provide advice to support your request.

We will then create a new Timeline to EPA for you to review before confirming your acceptance of the Extension and WS Support will then be able to answer any further questions in relation to your Extension Request after this point.

12.5 Break in Learning

If you are experiencing difficult circumstances or anticipate a period in which you feel you will be unable to apply yourself to the Programme, a Break in Learning could allow you time to deal with the situation so you can return to the Apprenticeship later.

A Break in Learning can be provided at any point throughout the Apprenticeship – except after the submission of your MSc Individual Project. Reasons might include, for example:

- Maternity or Paternity Leave
- A period of extended illness or Mental Health and Wellbeing difficulties
- Life events requiring extended attention
- Work events requiring extended attention

You could take a Break in Learning lasting between four weeks and up to one year, we would advise that you return at the start of a Semester in order to rejoin the Modules you have outstanding – this can be discussed in more detail depending upon your situation and the modules you are undertaking. The length of a break in learning is dependent on individual circumstances.

Whilst undertaking a Break in Learning from the Apprenticeship you shall not partake in Off the Job Hours monitoring, Progress Review Meetings or any taught studies. However, we would request at least one or two Keeping in Touch meetings to follow up on your time away and to organise your modules and any reassessments for your return to studies.

12.6 Support Services During your Studies

Although the Wolfson School provides substantial support, If you you require further support during your studies, as a student at Loughborough University you have access to several services and areas for support if you so wish, which we will detail below:

- The **Student Wellbeing and Inclusivity Service** provides a range of support, advice and guidance for students. More information about this service is available through the University intranet. Please visit their website: https://www.lboro.ac.uk/services/student-services/category/mental-health-wellbeing/. If you would like any support or further information, please contact them on:
  - *Student Wellbeing and Inclusivity team – studentwellbeing@lboro.ac.uk - 01509 228338*
  - *Disability office – disability@lboro.ac.uk – 01509 222770*
- **Student Services** can provide support with your wellbeing or mental health:
  - *Student Services can be contacted on 01509 222765 or studentservices@lboro.ac.uk.*
- Our **School Wellbeing Advisor**, Vicky Bailey, can offer advice and support to students on a wide range of wellbeing issues. C*ontact* Vicky *at studentwellbeing@lboro.ac.uk*. Further information can be found on the website (www.lboro.ac.uk/services/cds/wellbeing-advisers).

12.7 Change of Circumstances

During your Apprenticeship, you may also undergo changes in circumstances which may or not may directly affect your Programme.

These circumstances may include:

- Seeking a change to your selected Modules
- Your Workplace Mentor changing
- Maternity or Paternity Leave
- A change of address to an area outside of England[5] i.e Wales, Scotland, Northern Ireland or the EU
- Change of Hours in your contract of employment
- Change in your contract of employment – such as taking a role with another organisation or your contract of employment ending
- Redundancy

In the case that any of the above situations occur we request that you inform us as soon as you become aware of the change so that we can put the relevant arrangements in place. In many cases it is a simple update on forms or records, in other cases it may require further action such as a Break in Learning, a new Training Plan etc..

[5] Apprenticeship legislation varies across the devolved nations. It is a condition of the scheme that levy-funded apprenticeships must work at least 50% of their time in England.

13 End Point Assessment

Each Apprentice will complete their studies by undertaking an End Point Assessment after the release of their MSc results. Please find below the ideal example EPA Timeline starting from after you have submitted your MSc Dissertation:

MSc Dissertation Submission	Latter half of August
Completing any outstanding Off the Job Hours / KSBs and start finalising E-Portfolio	August - December
MSc Outcomes released and Interim Transcript produced	Early November
End Point Assessment Gateway, Portfolio and base documentation Submission*	Mid December
End Point Assessment** ▪ **Creation of 7,500 Project Report** ▪ **Presentation on Project Report** ▪ **Professional Discussion Preparation Period**	Mid December – Mid April
Submission of any outstanding Portfolio items and your Report	April – 8 working days before EPA date
End Point Assessment	Mid April
Registration for Summer Graduation	June
Summer Graduation	July

* You can go to Gateway earlier or later, depending on how quickly you can provide the required documentation and your fully or partially completed Portfolio. However, you must pass your EPA by 27th May—1st of June at the latest to have your EPA alongside your MSc Graduation and to be in line with the tolerable range that ESFA sets.

** You can undertake the creation of your End Point Assessment Project Report in a shorter period if you need more E-Portfolio creation time, if you need more time to complete your Off the Job Hours or if you just want to complete it quickly.

13.1 Important Information

- Before you confirm your EPA Gateway, you must provide up to 3 dates for your Potential End Point Assessment so we can confirm with the EPAO (Pearson) the availability of a suitable Assessor and your Workplace Mentor or other company representative must be available to attend
    - Roles: The Assessor examines the evidence and conducts the whole of the assessment. The company representative, usually the apprentice's mentor, is there to observe and also provides relevant context to the assessor. For instance, the Systems Engineering practices operated by one employer will be distinct from those of another. To ensure that the assessor is able to contextualise the practices used in the evidence, they may seek information from the company representative. The company representative does not have a role in evaluating the quality of the apprentice's work (KS) or behaviour (B).
- You will have up to 4 months to complete your EPA Report, Presentation and Professional Discussion Preparation – as noted above you can take less time to complete this if you prefer.
- All EPA Assessments are held online unless requested otherwise – this is usually by TEAMS, and it is not normally recorded. EPA Assessment can be held in person if security, confidentiality, or inclusivity requires it. The Apprentice or mentor should make the university aware of these needs at the earliest opportunity (Apprenticeship Administration Staff), so that alternative arrangements can be made with the EPAO.
- If you have Confidentiality, Intellectual Data or Security concerns about the content of your Individual Project, Portfolio or Evidence, please do let us know, so that procedures can be implemented to ensure appropriate protection.
- The EPA lasts one half day; it will usually take place in the morning or afternoon with a break between the two assessments.
- Please note – You will need to submit your Project Report eight working days before your End Point Assessment so that the Assessor has time to review the documentation.
- You must have completed any English or Mathematics Functional Skills Assessments prior to EPA (see section 8.2).
- You must have completed all Off the Job Hours prior to EPA (i.e. by the gateway) – you cannot undertake any further Off the Job hours in the period after your EPA Gateway.

13.2 Documentation required for Gateway

There are 7 documents required for you to go to your End Point Assessment:

1. Copies of your English and Maths Certificates – which we will hold from your commencement on the Programme or as part of your Functional Skills Assessment.
2. A Copy of your Interim Transcript which verifies completion of your MSc – which we will upload.
3. A Gateway Declaration Form signed by yourself and, usually, your Workplace Mentor

4. A Portfolio Authentication Declaration Form signed by yourself and, usually, your Workplace Mentor.
5. A Copy of your Portfolio – Please let us know when this is ready, and we will upload it. If you have your Portfolio mostly complete, we can upload this also. It must be completed 8 working days prior to your EPA.
6. It is required that your Knowledge Skills and Behaviours from your Portfolio are mapped to an Evidence Mapping Grid – the EPAO provide a copy you can use, or you can create your own.
7. A Copy of your Project / Dissertation – we will upload this as soon as you send it to us.

Once this documentation is uploaded, we can activate your Gateway, and you can start on your EPA Report, Presentation and Professional Discussion Preparation.

13.3 Helpful Documentation

We have several documents and websites to assist you with the details of the EPA and to guide you through the process listed below:

1. EPA Guidance
2. End Point Assessment Grading Information
3. System Engineering Apprenticeship Assessment Guidance
4. EPA – L7 Systems Engineering STARE Method – Presentation from EPA DAY

14 Celebrating your Apprenticeship

14.1 Graduation

Once the University has received confirmation that you have successfully passed your End Point Assessment, we will invite you to a graduation ceremony where you can celebrate your success. You will attend the ceremony alongside all the other successful students at the University.

More information about Graduation can be found on Loughborough University's website:

https://www.lboro.ac.uk/students/graduation/

Graduation July 2024

15 Complaints

At Loughborough University, we strive to deliver the best possible service for our Apprentices and employer partners, but we recognise that there may be occasions where we fall short.

If you feel this warrants a formal complaint, the below avenues are available.

If your complaint concerns issues with the university in any way, we suggest that in the first instance these should be raised in the following order of escalation:

Wolfson School of Mechanical, Electrical and Manufacturing Engineering

- Programme Director – Michael Henshaw, 01509 635269,
- Associate Dean (Education and Student Experience) – James Flint, 01509 227036

Academic Registry

- Academic Registrar – Dr Jennifer Nutkins, 01509 222227

Complaints to the ESFA

Employers and apprentices can escalate a complaint about any aspect of the apprenticeship to the Education & Skills Funding Agency (ESFA) - see the ESFA dedicated complaints procedure.

Complaints to the OIA

Apprentices can also submit their complaints about the University to the Office of the Independent Adjudicators (OIA) - see the OIA Rules page.

Employer Information

16 New Partners

If your organisation has not engaged with Loughborough University for an Apprenticeship before, then processes will need to be completed prior to your start on the Apprenticeship Programme.

The Systems Engineering Apprenticeship is only open to candidates from companies which have access to the English Apprenticeship Levy.

For your Employer to be Eligible for the Apprenticeship Levy so that you can benefit from this in the form of an Apprenticeship, your employer must:

- Have an annual pay bill of more than £3 million for employees (which are subject to employer class 1 secondary national insurance contributions) or be connected to companies or charities for employment allowance of which the annual pay bill is more than £3 million
- Have employed more than 50 employees over the last 365 days
- Confirm all employees are resident in England
- Have set up a Digital Apprenticeship Service Levy Account and are paying Levy contributions to the English Apprenticeship Fund

In addition, as an Apprentice you would also need to spend at least 50% of your regular, planned working hours (known at the start of the apprenticeship) in England – if this changes at any point please do let us know.

Please speak with your Apprenticeship Manager, Line Manager, Training Manager or other similar authority in your organisation to investigate this and to ask them to review and complete the **Employer Eligibility Checklist** (if they have not done so already) to ascertain if they meet the criteria.

Once this is established and the form completed, we will need to touch base with the contact dealing with the Apprenticeships within your organisation so that you can be formally nominated and so that the contractual requirements for your company - including a Training Needs Analysis and a Training Services Agreement can be established.

Please have them contact wsapprenticeships@lboro.ac.uk to take this forward.

16.1 Nomination of Apprentices

We have found that the best way for Apprentices to engage with the Application process is to be nominated by their organisation as soon as possible so that we are able to provide them with the relevant application and onboarding information, allowing them ample time to collate all required documentation and to complete their application forms.

16.2 Induction, Attendance and Engagement

Apprentices will be expected to attend a Programme Induction on the Loughborough Campus, usually held in the week or two before the Programme Start date. We try and place these Inductions on a Friday or Monday to be least disruptive to your employee's working hours and there are Accommodation options available on campus should they wish to stay overnight instead of travel for the day.

If an Apprentice does not actively engage in their studies we may have to escalate this matter to their organisation directly, but we will make every effort to contact the Apprentice first to check on their wellbeing and to assist them in any way we can.

16.3 Cohort Details for the Digital Apprenticeship Service

If you do not already have details for how to create the required records for your apprentice(s) on the Digital Apprenticeship Service for the Cohort ready for the first round of reporting you will need the following information, the UKPRN for your Cohort records for your apprentice(s) on the Digital Apprenticeship Service is as follows:
Loughborough University Training Provider Reference Number (UKPRN) is 10004113

The apprenticeship to select from the drop down list should be Systems Engineering (degree), Level: 7 (Standard) ST0107

Training start date and end date should be on training Services Agreement or the Training Plan for the Apprentices.

Once the cohort for each set of Apprentices for each Academic Year and each Company has been created, we would be happy to populate information about individual learners and costs and then send this back to your organisation for review and approval.

16.4 Choosing a Workplace Mentor

Apprentices require a Workplace Mentor to support them in their studies. We recommend that it is different to the line manager but also recognise that the line manager may be the most appropriate choice. They should be a professional engineer and, if possible, a Systems Engineer.

If it is not possible for an employer to provide a mentor with Systems Engineering experience, please get in touch with us, as we may be able to support with external Systems Engineering expertise. If you feel you or your organisation will struggle to find a suitable candidate to be your Workplace Mentor, please do let us know as soon as possible so that we can investigate this with your organisation.

In the context of an apprenticeship, the role of the mentor can encompass any or all the following depending on specific needs:

- pass on knowledge, skills and insight as a more experienced member of staff and
- support your personal and career development and encourage independent thinking
- provide a sounding board for elements of your work-based or University-led training and development
- explore challenges and aspirations, talk through choices and options to address these and establish solutions
- be someone to talk to outside the line management structure

Usually, Workplace mentors will be identified by the company. They will be required to:

- develop the apprentice's learning plan with the University Mentor and
- ensure the apprentice completes the minimum off-the-job training
- supports the apprentice whilst working with line manager and University Mentor to ensure they can carry out their day to day role and meet targets and deadlines for the apprenticeship
- participate in reviews and inform the University of any changes

17 Accommodation, Travel and Subsistence on the University Campus

Whilst the Apprenticeship Levy does not cover Accommodation, Travel and Subsistence

Accommodation

There are several places to stay on campus and off campus for attendance for the Induction and the week block-taught modules.

1. **Burleigh Court Hotel 4** «««« (2 min walk)

This large modern hotel is on campus and **very close** to the engineering school buildings. Well-appointed executive double rooms with king size beds, en-suite bathroom, flat screen TV with in-house movie channels, free 1Gbps Wi-Fi, a study desk, hairdryer and tea and coffee making facilities.

https://www.burleigh-court.co.uk/

2. Link Hotel 3 «««« (approx. 5 min drive)

This is across the road from the University but at the right end of campus for the engineering school (West Park). Spacious double rooms furnished with king-size beds, en-suite bathroom, flat screen TV, free 400Mbps Wi-Fi, a study desk, hairdryer and tea and coffee making facilities.

https://www.linkhotelloughborough.co.uk

3. Elite Athlete Hotel 4 ««««« (<10min walk) Only available at specified dates times

This hotel is aimed at elite athletes and provides specialist rooms, proximity to facilities and nutrition required by athletes. However, it is also open to non-athletes. It should be noted, however, that the hotel does not have a bar serving alcohol. Alcohol is available on request, such as at mealtimes.

Standard twin rooms with zip and link beds with athletes in mind, en-suite bathroom, flat screen TV with in-house movie channels, free 400Mbps Wi-Fi, hospitality tray on request and tea and coffee making facilities.

https://www.eliteathletecentre.co.uk/

There are also a few off-campus options available in the Loughborough Area including Premier Inn and Travelodge, Independent Hotels, Bed and Breakfasts and Air BnB Properties.

Travel

Accessing Loughborough University:-

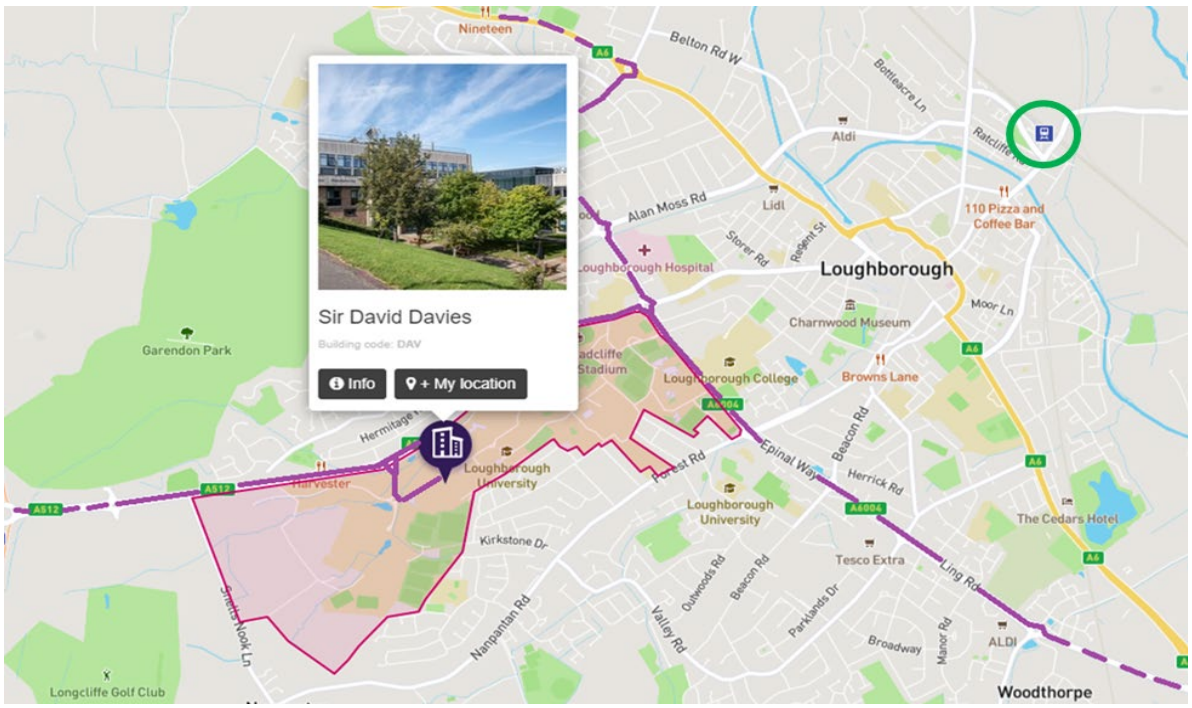
By Train - There are services that arrive at Loughborough Railway Station and upon arrival there are two options to reach the Campus – by Taxi and by Bus.

By Bus – At the stand outside of the Railway station you can catch the Sprint Bus to the Campus. This bus departs at regular intervals and will take roughly 20 minutes with no traffic to get to the Mechanical Engineering Bus Stop after Pilkington Library.

By Taxi or Uber – At the stand outside the railway station there are usually taxis available, Uber is not widely used in Loughborough. You should direct them to Loughborough University via the West Entrance on the A512 / Ashby Road not through the main entrance as this will be more congested – this will take roughly 20 minutes with no traffic, but it can get quite congested.

By Car - We suggest that you enter the Campus via the West Entrance on the A512 / Ashby Road as opposed to the main entrance. Please note navigating across Loughborough town by car can be time consuming and the campus itself spans nearly two miles. Please ensure you allow at least an extra 20 minutes on top of your travel time to accommodate if travelling to campus via Loughborough town.

You can initially use postcode LE11 3UE, but ensure you take the *West Park Entrance* on the roundabout on the A512 / Ashby Road. If you are NOT staying at Burleigh Court, please ensure you have advised us of your Vehicle Registration Number to add to the Parking Whitelist. The University uses ANPR technology and failure to do this may result in a penalty charge notice (PCN) being issued. Sir David Davies Building is the usual building used for teaching the Systems Engineering Modules and most of the Module Leaders and Programme Leads reside in this building or the Wolfson School.



Subsistence

Whilst on campus you can take advantage of Loughborough University's own Café's - https://www.lboro.ac.uk/services/food-drink/cafes-shops/

And if staying at the Burleigh Court Hotel they have their own Restaurant - https://www.burleigh-court.co.uk/food-drink/

In the area around the Loughborough Campus, you can find:

- Hey Chili – Small Oriental Kitchen – Walking Distance Open Tue - Sat - https://www.facebook.com/heychili123/
- Bom Bom Patisserie – two Locations – one next door to Hey Chili and one at the Loughborough Students Union - https://bombompatisserie.com/
- Harvester – Wheatsheaf – Longer Walking Distance - https://www.harvester.co.uk/restaurants/eastandwestmidlands/thewheatsheafloughborough/ourmenus#/
- The Priory – Gastropub – 5 Min Drive - https://www.distinctiveinns.co.uk/the-priory/
- Toby Carvery – 10 Min Drive https://www.tobycarvery.co.uk/restaurants/midlands/loughboroughleicestershire/carvery#/
- John Coopers Bar and Kitchen - Loughborough Student's Union - Campus Shuttle to the Union takes 5 minutes https://lsu.co.uk/jcs
- Subway - Loughborough Student's Union - Campus Shuttle to the Union takes 3 minutes - https://restaurants.subway.com/united-kingdom/en/loughborough/ashby-road

18 FAQs

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Key People/Contacts

	Name and Role	Contact Details
	Professor Michael Henshaw Programme Lead for the Systems Engineering Apprenticeship and Professor of Systems Engineering	m.j.d.Henshaw@lboro.ac.uk +44(0)1509 635 269
	Dr Siyuan Ji Reader in MBSE (Model-based Systems Engineering) and Deputy Director of Doctoral Training Centre in MBSE	s.ji@lboro.ac.uk +44(0)1509 227 124
	Mrs Sarah Parton Postgraduate and Professional Development Programme Manager	wsapprenticeships@lboro.ac.uk +44 (0)1509 227646
	Mrs Dawn Willmor Apprenticeships Compliance Administrator	wsapprenticeships@lboro.ac.uk +44 (0)1509 225827
	Ms Kirsty McKeown / Mrs Kirsty Jennaway (nee McKeown) (Post April) Apprenticeships Programme Administrator	wsapprenticeships@lboro.ac.uk +44 (0)1509 222132

19 Cited References

[1] J. Martin *et al.*, “Towards a common language for systems praxis,” *23rd Annu. Int. Symp. Int. Counc. Syst. Eng. INCOSE 2013*, vol. 2, pp. 961–976, 2013.

[2] N. Cross, “Designerly ways of knowing,” *Des. Stud.*, vol. 3, no. 4, pp. 221–227, 1982.

[3] D. D. Walden, *INCOSE systems engineering handbook*, 5th ed. Hoboken, NJ, USA: John Wiley & Sons, 2023.

Appendix A: Who teaches on the Loughborough Level 7 Apprenticeship in Systems Engineering?

The Loughborough teaching team for the SEMAP comprises a core group of fulltime academic staff in Systems Engineering and others from a variety of specialisms, complemented by Visiting Professors and Fellows from industry that support both curriculum development and delivery of teaching and projects.

The significant levels of senior industrial experience in the teaching team ensures a rich experience of directly applicable knowledge and skills for the apprentices.

Lecturer	**Module(s)**	**Type**
Prof. Michael Henshaw	1. Applied Systems Thinking (WSP062)	C
	1. Enterprise and Capability Engineering (WSP460)	O
	1. Individual (Dissertation) Project (WSP065)	C
	2. Group Systems Project (WSP085)	C
	2. Holistic Engineering (WSP071)	O
	2. Understanding Complexity (WSP462)	C
Dr. Siyuan Ji	1. Systems Architecture (WSP072)	C
	1. Systems Design (WSP066)	C
	1. Validation and Verification (WSP067)	C
	2. Group Systems Project (WSP085)	C
Prof. Paul Davies (Visiting)	1. Group Project (WSP785)	C
Prof. Roy Kalawsky	1. Modelling, Simulation and Visualisation (WSP076)	O
Prof. Andrew Bradley (Visiting)	1. Holistic Engineering (WSP071)	O
Dr. Pedro Ferreira	1. Machine Learning – Principles & Applications for Engineers (WSP774)	O
Dr. Ruichi Wang	2. Mechatronic Systems Design (WSP768)	O

Dr. Diana Segura-Velandia	1. Machine Learning – Principles & Applications for Engineers (WSP774)	O
Dr. Melanie King	1. Digital and Data Engineering (WSP778)	O
	2. Applied Systems Thinking (WSP062)	C
	3. Machine Learning – Principles & Applications for Engineers (WSP774)	O

Table 1: Staff Systems Engineering and Teaching Competency. C=compulsory module, O=optional module. 1=Module Leader, 2=Module tutor.

The considerable industrial Systems Engineering experience of the teaching team strongly supports the balance between theory and practice delivered by the programme. The research activities of members of staff have also contributed significantly to the development of the Systems Engineering discipline and these advances – particularly in the areas of Model-Based Systems Engineering and Systems of Systems Engineering – directly informs the taught programme. Table 2 lists some key Systems Engineering related achievements and recognitions of the expert competence of our team. In some cases, staff listed in Table 1 provide specialist expertise in specific areas (e.g. AI) rather than in Systems Engineering.

Prof. Michael Henshaw	Co-Chair, IEEE Technical Committee in Systems of Systems Engineering; co-editor of Systems Engineering Body of Knowledge; Member at large for UK in Systems Engineering on NATO CSO Systems Concepts and Integration Panel; BSI Committee member IST/15 (Systems and Software) Led construction of the System of Systems Engineering and Cyber Physical Systems research agenda for the European Union.
Dr. Siyuan Ji	Formerly RTF Chair for UPR: UML Profile for ROSETTA. RTF stands for Revision Task Force for OMG; Chair of Safe System Architecting Working Group in INCOSE UK/Safety Critical System Club; Author of 'Architecture and Principles of Systems Engineering' textbook used internationally
Prof. Andrew Bradley	Fellow of the Royal Academy of Engineering; Former Chief Engineer, Hawk Aircraft; Sponsored Royal Academy Professor 2014-18; Former Director of Systems Engineering BAE SYSTEMS UK & Europe. Course Delivery and Development for BAE Systems and adviser to tech start-ups.
Prof. Paul Davies	Formerly head of Systems Research, and Ch. Systems Engineer EW, Thales UK; Royal Academy Visiting Professor at Loughborough from 2007; Formerly Visiting Professor at Southampton University and Visiting Fellow at Bristol University. INCOSE UK President 2001-2003. Former Systems Engineering Discipline Manager for Network Rail.

	Provides training to prepare Systems Engineers for the INCOSE CSEP (Certified Systems Engineering Professional)
Prof. Roy Kalawsky	Royal Academy of Engineering/Airbus Research Chair in Digital and Data Engineering Systems and Airbus Research Chair – Digitalization. Former Technical Head of Systems Engineering Innovation Centre, BAE Systems/Loughborough University. Royal Aeronautical Society Medal for outstanding contribution to cockpit technology.
Prof. Tim Rabbets & Prof. Michael Wilkinson	Joint Chairs of INCOSE UK Architecture Working Group and authors of Architecture guidance for INCOSE.

Table 7: Expert Systems Engineering accomplishments of key members of teaching team

In addition to full-time staff, the visiting professors and fellows in Table 3 provide curriculum guidance and teaching contributions.

Name	**Industry role**	**Loughborough role**	**Contribution**
Prof. Andrew Bradley FREng	Formerly Chief Engineer, Hawk Aircraft, BAE Systems	RAEng Visiting Professor	Leads Holistic Engineering module. Individual project supervisor and examiner. Support to curriculum development
Prof. Paul Davies	Formerly, Head of Systems Research and Technology at Thales. Since 2013, Corporate Systems Engineering training through Project Performance International.	Visiting Professor of Systems Integration	Leads Group Systems Project module. Individual Project supervisor and examiner. Support to curriculum development.
Prof. Kate Gill	Enterprise Data Management lead, BAE Systems. Formerly, Department of Defence F-35 Joint Project Office Digital Transformation Lead	Visiting Professor Digital Systems Eng.	Digital Engineering module development and delivery. Support to curriculum Development.

Dr. Steve Hinsley	Formerly, BAE Systems Advanced Technology Centre, Chief Engineer systems engineering	Visiting Fellow in Systems Engineering	Lectures on Systems Lifecycle. Individual project supervisor and examiner. Apprentice tutor. Support to curriculum development
Prof. Duncan Kemp.	Chief Systems Engineer, DE&S Senior Fellow for Systems Engineering.	Visiting Professor in Systems Thinking	Systems thinking workshops in Capabilty module and Systems Thinking module. Capability module assessor. Support to curriculum development.
Dr. Andrew Kinder	Lockheed Martin, Group Technical Staff member	Visiting Fellow in Systems Modelling	Workshop in Modelling & Simulation. Support to curriculum development
Prof. Tim Rabbets	Chief Systems Engineer and Senior Fellow QinetiQ plc	RAEng Visiting Professor in MBSE	Lectures in Systems Architecture module. Link to Systems Standards community. Support to curriculum development.
Prof. Michael Wilkinson	Chief Technologist and Chief Systems Engineer with BAE Systems Submarines	Visiting Professor in Systems Engineering and Architectures	Lectures in Systems Architectures and Capability modules. Capability module assessor. Support to curriculum development.

Prof Craig Wrigley	Formerly Chief Scientist, Lockheed Martin UK.	Visiting Professor Geospatial system	Delivery of lecture capability module Assessor for capability module. Individual project supervisor and examiner. Support to curriculum development.

Table 8: Visiting Professors and Fellows that provide curriculum guidance and contribute to module teaching, project supervision, and assessment.

The appointment of industry experts as Visiting Professors and Fellows is a strategic approach to ensuring the programme is kept up to date with the latest systems engineering practices and aspirations in industry. Prof. Tim Rabbets participates in an INCOSE working group and also in BSI and ISO working groups on architecting standards that directly contributes to our Architectures module. Together with Prof. Mike Wilkinson, he chairs the INCOSE UK Architecture working group and has authored INCOSE publications on Architecture (both introductory and practitioner).

Prof. Paul Davies, who leads the group project, has recently published an INCOSE guide on managing interfaces and the INCOSE beginners 'don't panic' guide to integration and test. He is also making a presentation about the Group Systems Project of this programme at *the INCOSE International Symposium 2024*, covering the module approach as good practice and the outcomes in terms of student impact.

Prof. Duncan Kemp, co-authored the INCOSE guide on Capability Engineering, and has made significant contributions to Systems Engineering practice, recognised with the award of an INCOSE fellowship. Table 3 summarises the breadth of experience of our visiting staff, that is made up of Systems Engineering thought leaders.

Additionally, in Table 7, It can be seen that Prof. Henshaw is a member of IST/15 (Systems and Software), which is responsible for ISO15288 (the principal standard for Systems Engineering lifecycle). Prof. Dickerson is the founding chair of the Maths Special Interest Group at OMG (Object Management Group – standards body).

Complimentary guest lecturers

In addition to the visiting professors/fellows listed in Table 8, there are eight guest lecturers from industry that deliver a regular contribution to the programme (Table 9).

Guest Lecturer	Position	Topic
Dr. Sofia Ahlberg Pilfold	Global Hd. Systems and Human Factors, Alstom	Lecture on Knowledge Management

Mr. Martin Call	Component Obsolescence Specialist and PDM consultant, BAE Systems	Lecture on Obsolescence Management
Dr. Rachel Craddock	Ch. Tech. Consultant in AI and Machine Learning, Thales UK.	Lecture on industrial application of AI
Dr. Judith Dahmann	Technical Fellow, The MITRE Corporation. Also, INCOSE Fellow	Live online lecture on Mission Engineering and systems of systems lifecycle
Mr. Lee Fitzsimmons	Director, and Logistics Expert, Aspire Consulting, Ltd.	Lecture on logistics
Mr. Chris Garside	Former Chief Engineer, F35 (BAE Systems)	Half-day session on the role of Chief Engineer in delivery
Ms. Isabella Panella	Senior Manager, Advanced Driver-Assistance Systems, JLR	Lecture and workshop on Network Enablement
Prof. John Pearson	Technology Lead - Innovation Team, Rolls-Royce	Lecture in Mechatronic Systems Design
Mr. Bob Smith	Former Chief Engineer Eurofighter Typhoon and Engineering Director (BAE Systems)	Half-day session on role of Chief Engineer in delivery

Table 9: Guest lecturers for the Systems Engineering apprenticeship.

Acknowledgement: Professor Charles Dickerson

We acknowledge the considerable contribution of Prof. Charles Dickerson, formerly Royal Academy Chair in Systems Engineering. Charles retired in from the University in 2024, he held the roles of Chair of Mathematical Formalisms Group for Object Management Group; former chair of INCOSE Architectures Working Group (international); Author of 'Architecture and Principles of Systems Engineering' textbook used internationally. Formerly Director of Architecture for Office of Assistant Secretary of the Navy, US DoD. Charles continues to contribute to the advancement of Systems Engineering through various international fora.

His work in developing key taught material for this MSc. is gratefully acknowledged.

Appendix B: Mentoring – Good Practice

The purpose of the apprenticeship is to develop Professional Systems Engineers with the knowledge, skills, practical experience, and behaviours to manage lifecycle and integration matters for complex systems in industry and public services. They will have developed personal qualities that enable them to lead integration activities for complex systems. They will be well-networked within their own organisation and the wider Systems Engineering community with a vision for how their career will develop in the future.

The mentor has a crucial role to play in the development of the apprenticeship.

We draw a distinction between coaching and mentoring. Whereas coaching is aimed at developing a person's skills and knowledge in a specific area of work leading to achievement of an objective, mentoring is the long-term provision of guidance to someone less experienced in order to support their general development at work. Your role is mentoring.

Mentoring involves:

- A reactive approach, listening, offering advice and making suggestions
- An ongoing broader relationship - the mentor guiding the mentee
- A focus on the overall development of the mentee
- An informal and less structured provision – meetings when the mentee needs guidance

The following acrostic identifies some key mentoring attributes:

- **MANAGE** the Relationship
- **ENCOURAGE** and recognise the mentee's abilities
- **NURTURE** and create an open candid environment
- **TEACH** and create a stimulating environment that challenges the mentee
- **OFFER** mutual respect
- **RESPOND** to mentee's needs

Your role is to be a critical friend that challenges the apprentice, especially in regard to their understanding and practice of Systems Engineering.

Although you will be meeting with the University mentor regularly (at least every 12 weeks), it is expected that the apprentice will interact with their workplace mentor more frequently, and especially to maintain an ongoing conversation about their professional development.

Preparation for Mentoring

Apprentice and Mentor should prepare for their first meeting, because this will set the basis for future meetings and interaction.

Prior to first meeting reflect on

- The relationship itself
- What to cover in each session
- Frequency of contact
- Method of contact
- Levels of confidentiality

Goals for first meeting

- Set your and the mentees objectives
- Logistics and nature of interaction
- Get to know each other
- Who is responsible for what?

Ten ways to be a good mentor

1. Be credible
    - Does not mean that you need to have all the answers. The best answers for your mentee will come from their own thinking, with the help of your wisdom to support them.
2. Be a positive role model
    - Good mentors are respected by their mentees. A mentee can learn a lot from their mentor simply by watching how their mentor behaves in any particular situation
3. Be genuinely interested in your mentee as an individual – the relationship is a personal one
4. Share your experiences and insights - in a neutral way - share failures too
5. Ask open questions to identify the mentee's real needs.
    - Helps the mentee to think through situations themselves and draw out the consequences of the various choices or courses of action they can take.
6. Act as a sounding board - listen
7. Provide a fresh or different perspective with objective feedback
8. Provide helpful feedback on request only which allows the mentee to develop specific qualities or skills.
9. Acknowledge achievements
10. Offer your advice, but only if your mentee asks for it
    - You are there to help them learn to think through issues themselves and trust their own judgment

Sharing Good Practice

We encourage mentors to share good practice with each other. We are aware that in some partner organisations, there are local groups that meet from time to time for this purpose.

We encourage mentors to attend the annual EPA day, held in September and other networking events held from time to time.

Similarly, we strongly recommend that mentors participate in the monthly Portfolio workshops, held online on the first Wednesday of each month.