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Pearson Level 3 Alternative Academic Qualification

BTEC National in

Engineering (Extended Certificate)

L3

Planning and Teaching Guide

First teaching from September 2025

First certification from 2027

Qualification Number: 610/3959/7

About Pearson

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All information in this Guide is correct at time of publication.

Contents

1. Introduction

This Planning and Teaching Guide complements your Pearson Level 3 Alternative Academic Qualification BTEC National in Engineering (Extended Certificate specification, Pearson Set Assignment Briefs (PSABs), Sample Assessment Materials (SAMs) and the Pearson BTEC Level 3 National Alternative Academic Qualification Administrative Support Guide. This Planning and Teaching Guide provides:

- an overview of dates and deadlines for key events and activities relevant to qualification delivery – from registration to assessment and review of marking – throughout the academic year
- suggestions for planning and delivering your course including induction and unit sequencing
- creative and realistic teaching and learning ideas as well as links to resources for each unit to support and inspire you in creating a dynamic learning environment to keep your learners engaged and motivated to learn.
- wider delivery support such as guidance on study programme planning and descriptions and links to qualification resources and materials.

The guide was designed and written in collaboration with current practitioners to ensure that the planning and delivery suggestions and teaching and learning ideas are feasible, pedagogically sound and appropriate for the vocational area and the purpose of the qualification.

We recognise that delivery contexts will vary from one centre to the next and that practitioners are the best decision-makers for what works best for them and their learners. Therefore, teachers can tailor the suggestions and ideas proposed in this guide to meet the specific needs of their learners and the available resources in their centre. There are, however, requirements that have to be met in relation to assessment plans and to teaching and learning preceding assessment, which will be clarified/covered in this guide.

We hope you will find this guidance relevant and useful, and you enjoy teaching this this qualification!!

What's new

When creating these BTEC Nationals, in addition to ensuring the sector technical content was current and up-to date, we have also focused on developing the skills and personal attributes students need to navigate the future. We have worked with many higher education providers, professional bodies, colleges and schools to ensure these qualifications also meet their needs. Employers are looking for future employees with a thorough grounding in the latest industry requirements and work-ready skills such as critical thinking and problem solving. Higher education needs students who have experience of research, extended writing and meeting deadlines to be successful on their undergraduate programmes.

We have addressed these requirements by:

- Facilitating and guiding the development of transferable skills through the design and delivery of the qualifications, using a holistic and practical framework which is based on recent research into the most critical skills needed to navigate the future. A Transferable Skills framework has been used to embed transferable skills in the qualifications where they naturally occur and to signpost opportunities for delivery and development as a part of the wider BTEC learning experience. Please refer to the BTEC Transferable Skills Guide for Teachers for further information on this framework, its relevance and how it has been implemented in the qualifications.
- Supporting the delivery of Sustainability Education and development of Digital Skills naturally through the content design of the qualifications. Mapping is provided in the specification to identify where these opportunities for teaching and learning exist.
- Updating sector-specific content to ensure it is current, relevant and future-facing.
- Implementing a consistent approach to assessment with a balanced combination of internal and external assessments to better engage students, make the qualifications more accessible for them and more manageable for centres to deliver.

We are providing a wealth of support, both resources and people, to help ensure that you and your learners have the best possible experience during their course. Please see the section on Pearson Qualification Support and resources on page 74 for details of the available resources and support with links to access these.

Notes:

The qualification specification provides the content that must be taught and what must be assessed. This planning and teaching guide provides suggestions and ideas for how the content could be delivered. The suggestions given in this guide link with the Pearson Set Assignment Briefs provided by Pearson, which are mandatory for internal assessment and cannot be amended or contextualised by centres.

2. BTEC Calendar of Key Dates

Each academic year there are some key dates and deadlines in the delivery of BTEC qualifications that teachers need to be aware of, and act on appropriately, to ensure:

- the smooth running of learner registration, assessment and the quality assurance process, and
- effective timetable planning to fully prepare students for assessments and ensuring timely completion of administrative tasks.

Here is an overview of the key dates and deadlines for this qualification.

The specific date for each activity or event will vary each academic year and so only the month is provided. For the specific dates for the current academic year, please go to our webpage: Teachers | Pearson qualifications

Month	General related dates	Internal Assessment related dates	External Assessment related dates
September	Student registration		
October		Lead IV registered and completion of team standardisation	Entry deadline for January external assessment
November	Late student registration fee		
December	Late student registration fee Deletion deadline: delete student registrations for any leaner withdrawn from the qualification		
January		Standards Verification Window opens	January External Assessment Series
February			

Month	General related dates	Internal Assessment related dates	External Assessment related dates
March			Restricted release of results to centres Release of results to students Entry deadline for Summer external assessments Review of Marking
April			Review of Marking
May		Standards Verification for first sample closes	Summer External Assessment
June		Standards Verification for second sample closes	
July	Deadline for full qualification claim for summer certification		
August			Restricted release of results to centres Release of results to students Review of marking

3. Planning the Delivery of your Course

Planning your course ensures a coherent and logical approach to teaching that helps learners to connect concepts effectively and build their knowledge progressively.

Effective assessment planning is also essential to allow for timely evaluation of student progress and adjustment of teaching strategies or interventions as needed.

This section offers recommended approaches to support practitioners with planning and implementation of this qualification

Induction

Students

An induction period at the start of the course is recommended to help students understand and prepare for the demands of their chosen course, as well as familiarise them with the BTEC ethos and methodology. This induction aims to not only equip learners with the necessary knowledge and skills but also to create a welcoming environment where they feel safe, supported and gain a sense of belonging as they begin their course in a new setting.

Centres will have their own induction programmes, and to support this, Pearson have provided a range of adaptable resources that can be integrated into this existing programmes. These resources cover areas such as welcome activities and information to include in the induction, with supporting slides. As we believe that every opportunity should be taken to develop transferable skills across the wider BTEC learning experience, we have also provided guidance on which transferable skills could be delivered as a part of the induction process including Managing Own Learning, Continuous Learning, goal setting and personal strength and resilience. The resources are designed to help students develop the relevant transferable skills through learning how to manage their course workload, completing their assessments successfully and meeting deadlines whilst also building their confidence and ability to thrive on their BTEC journey.

Tutors/Teachers

In addition to the annual standardisation training that all BTEC teaching staff are required to complete at the beginning of each academic year using the Pearson provided materials, an induction period for new tutors is also recommended. This will help new tutors familiarise themselves with the specific demands and expectations of the BTEC curriculum, equipping them with the necessary knowledge and skills to effectively plan and support their learners from the outset.

Overview of Assessment Availability

Internal Assessments

Pearson Set Assignments (PSABs) are provided by Pearson for all internally assessed units and must only be used for summative assessment.

These are available for the lifetime of the qualification and are accessible through our website. Teachers with a Pearson online account can log in through the sign-in portal to access them. Any teacher with learners registered for this qualification can create a Pearson online account.

Please note that PSAB's are released each year for units 3 and 4, for example with a new project theme for each series in unit 4. There are elements of the tasks that will need to be completed in supervised sessions in centre, as per the PSAB requirements, such as completing the CAD work.

External Assessments

External assessments are available in two series each academic year as shown below:

Dates	Jan	Mar	May/June	Aug
Assessment	External Assessments Series 1 *Not available in Jan 2026	External assessment Series 1 Results	External assessment Series 2	External Assessment Series 2 Results

Delivery and Assessment Planning

Clear unit planning and understanding is essential for a successful qualification delivery. This helps students to build on prior learning and reinforce concepts to develop a deeper understanding of the unit content and progressively develop their knowledge, understanding and skills throughout the course delivery.

We have produced a sample delivery plan showing how the BTEC National in Engineering (Extended Certificate) **could** be delivered over **two** years, highlighting ordering of units and assessment milestones.

This plan is intended to be used as guidance.

Key

Del = Unit content delivery

PSAB = Pearson Set Assignment Brief

Rev = Revision for External assessment

Ext = External assessment

Resit Ext = Resit External assessment opportunity

Sequence of delivery

Year One

Unit	Unit Title	GLH	Assessment method	Term 1	January exam series	Term 2	Term 3	Summer exam series
1	Engineering Principles	120	Ext	Del Topic A, including Rev of	-	Del (Topics A, B, C)	Del (Topics B,C)	-

				GCSE Maths where needed				
2	Engineering Applications	60	Ext	Del (Learning Aim A)	-	Del (Learning Aim A, B)	Del (Learning Aim B) Rev	Ext
3	Engineering Design	120	Int				Del Topic A	-

Unit 1 Engineering Principles: This unit is an externally assessed examined unit that develops introduces and develops mathematical and scientific techniques essential for onward progression after the course.
There is opportunity to apply the mathematical techniques at a basic level, the design unit 3 such as in calculating measurements and dimensions for a detailed product design specification, or in making justifications of the choice of design made.
In unit 4 they may use the mathematical techniques learned in unit 1 in order to calculate costs, develop detailed specifications for the project, or in using graphical and statistical techniques as part of their project's feasibility study.
Because this is likely to prove the most challenging unit for some learners, and may take a while to deliver, we have suggested delaying the first sitting until the January year 2. This gives plenty of time for teaching including any recap of GCSE concepts required at the start, delivery of topics A, B and C, and co-teaching with topics in unit 2 'Engineering Applications' so that they understand the broader context of mechanical and electrical engineering activities, for which they are solving mathematical problems.

Unit 2 Engineering Applications: This unit is externally assessed by an exam, which is set and marked by Pearson. Learners will explore the different sectors of engineering and modern applications of the industry, common engineering processes. They will gain an understanding of engineering materials and their properties. Understanding processes and material properties is essential to specifying the right materials and a relevant engineering process for their design solution in this unit. It will also be relevant theory for unit 4, Engineering Project, in production planning.

We suggest taking this unit as the first assessment in the summer of year 1, allowing you to finish delivery of the theory that will then be used in year 2 for the internal assessments.

Year Two

Unit	Unit Title	GLH	Assessment method	Term 1	January exam series	Term 2	Term 3	Summer exam series
1	Engineering Principles	120	Ext	Rev	Ext			Resit Ext
2	Engineering Applications	60	Ext		Resit Ext			Resit Ext
3	Engineering Design	120	Int	Del (Topics B,C,D)	-	Del (Topics B,C,D)	PSAB (32 hours)	-
4	Engineering Project	60	Int		-	Del (Topic A, B, C)	Del (Topic B,C) PSAB 30 hours	-

Unit 3 Engineering Design: This unit is internally assessed by a 32-hour internal assignment set by Pearson and marked by the centre. It covers the process of design from understanding product design specifications, developing initial ideas into 3D models and communicating the design solution. Significant time will need to be spent on developing skills with CAD, timetabling access to the IT lab etc, therefore we suggest this is started in term 3 of year 1, scheduling in sufficient time to access IT software. This also ensures that the first year is not completely taken up by knowledge and theory for the examined units.

Unit 4 Engineering Project: This unit is internally assessed through a 30-hour internal assignment, set by Pearson and marked by the centre. Learners will investigate a project in a specialist area, develop project management processes, a design solution, carry out the solution and present it.
Therefore learners first need to have knowledge of modern industry processes and materials covered in unit 2 Engineering Applications, and will use the skills in Design covered in unit 3, to fully undertake the project.
We therefore recommend taking this unit last, and starting delivery in term 2, year 2.

Centres may deliver the qualification over a one-year period if required to provide flexibility to meet student or centre qualification planning needs.

4. Qualification Unit Delivery Guides

This section contains support for delivery of all the units in this qualification. The focus of these guides is on structuring and supporting the teaching and learning process. You will find ideas for activities and guidance on how best to use the activities to develop learners understanding of the topics in each unit. This section also includes activities and information on how to deliver transferable skills which are embedded or signposted in the qualification.

Unit 1: Engineering Principles

Unit overview

Unit 1: Engineering Principles	
Assessment type: External	
Content Area	**Topics**
A: Algebraic, trigonometric and calculus methods	A1 Algebraic methods A2 Trigonometric methods A3 Calculus methods
B: Mechanical Engineering	B1 Static engineering systems B2 Dynamic engineering systems B3 Fluid engineering systems
C: Electronic and Electrical Engineering	C1 Direct current electricity and circuits C2: Magnetism and electromagnetic induction C3: Single-phase alternating current
Assessment overview The unit will be assessed through one examination of 90 marks lasting 2 hours 15 minutes. Students will be assessed through a number of short open response, short- and long calculation questions. Students will need to interpret and analyse information and diagrams related to engineering contexts and use the data presented. The questions will assess knowledge, understanding and application of mathematical, mechanical and electrical/electronic principles within contextualised problems. The assessment availability is twice a year in January and May/June. The first assessment availability is May/June 2026. Sample assessment materials will be available to help centres prepare students for assessment.	

Common student misconceptions

There are no common misconceptions for this unit.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note the activities provided below are suggestions and not mandatory. Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate.

Learning Topic	Activities and guidance for unit content delivery	Resources

A1 Algebraic methods	• **Whole class teaching and learning - Introduction**
	  ○ Introduction of the unit and topic to learners. Discuss prior knowledge of algebra before moving on to discuss laws of indices and logarithms, exemplifying theory with a range of worked examples.
	• **Class activity – Indices and logarithms:**
	  ○ Learners work in pairs to apply the laws of indices to simplify expressions and then work to solve a range of logarithm and/or indices based problems.
	  ○ Introduce learners to natural logarithms (base e) and discuss relationship with common logarithms (base 10). Demonstrate how the laws of logarithms can be applied to solve problems before learners move on to solve problems involving exponential growth/decay which relate to engineering applications.
	• **Teacher led class activity:**
	  ○ Demonstrate how equations can be plotted as straight-line graphs, and how graphs can be interpreted to determine the equation of a line. Learners to solve a range of straight-line graph problems.	

	○ Tutor-led practical demonstration of how simultaneous equations can be solved, both graphically and through calculations before learners attempt to solve problems themselves. ○ Individual activity (20 min): solve a range of problems which apply simultaneous equations to engineering situations. • **Class activity – Factorisation and quadratic equations:** ○ Introduce learners to methods of factorisation of expressions, considering appropriate engineering applications. Learners to work through a series of engineering problems where factorisation of equations is required. ○ Introduce learners to methods of solving quadratic equations, using both factorisation and the quadratic formula. Learners to work through a series of engineering problems where solving quadratic equations is required. Peer assessment of results.	Corbett Maths – factorising quadratics https://youtu.be/X-djBcWVizM?si=PK7EvIxD6-aPHCtU
A2 Trigonometric methods	• **Whole class teaching and learning - Introduction** ○ Introduce learners to circular measurements and then introduce learners to the use of radians for circular measurement. Explain and demonstrate the process of converting between degree measurements and radian measurement. • **Class activity – Angular measurements:** ○ Discuss the concept of angular rotation and the implications for engineers and then ask learners to investigate the application of angular rotation by carrying out appropriate calculations. ○ Introduce learners to the techniques used to determine areas and arc lengths. Learners to work in pairs to solve problems. ○ Tutor presentation to introduce learners to sine, cosine and tangents, and how each is determined before learners solve	The sine rule https://youtu.be/j3VLbjsWdHo?si=PAKVXBwIucVF5fMF

	trigonometric problems and draw the function of each type. Review understanding of Pythagoras' Theorem. • **Whole class teaching – Sine and cosine rules** ○ Introduce learners to the sine and cosine rules, demonstrating the application of each to solve engineering problems before providing learners with tasks to apply the two rules to contextualised problems. • **Whole class teaching – Vectors** ○ Tutor presentation to demonstrate methods of solving engineering problems using vectors, including graphical representation of vectors. ○ Individual task to carry out problem-solving activities using vectors, including the use of vectors for the resolution of forces, velocities and acceleration.	The cosine rule https://youtu.be/9U07GLKicnM?si=Nx9MvXJ77DPXFZJX
A3 Calculus methods	• **Whole class teaching and learning - Introduction** ○ Introduce learners to the use of calculus in engineering, demonstrating types of functions and the principles of differentiation for polynomial functions. ○ Learners to complete a number of tasks to practice differentiating standard formulae. ○ Tutor to demonstrate how to differentiate trigonometric functions before learners practice solving problems with trigonometric functions. • **Class activity – Differentiation:** ○ Discuss with learners, different methods of differentiation, the use of Leibniz notation and common derivatives. ○ Learners to complete a number of tasks to practice differentiating standard engineering formulae.	Introduction to calculus https://youtu.be/q1iSmAh3n-c?si=XyHeSWJzJd0MVIsT

	○ Tutor to discuss numerical values of derivatives and what they signify as well as introducing the concept of rates of change. ○ Learners to carry out a range of activities to determine rates of change for engineering functions. • **Whole class teaching – Integration** ○ Introduce learners to the principles of integration as the reverse of differentiation, demonstrating to learners the routine functions of integrating polynomial and trigonometric functions. Discuss the constant of integration. ○ Introduce learners to common, standard, integrals for polynomial and trigonometric functions. ○ Learners to practice integration of functions before being introduced to definite integrals and how they differ from indefinite integrals. ○ Learners to carry out a range of activities using integration as a summating tool with respect to engineering applications.	
B1 Static engineering systems	• **Whole class teaching and learning** ○ Introduction to learning aim B, followed by tutor-led review of mathematical methods, making reference to vectors. Demonstrate to learners how forces can be represented using space and free body diagrams. ○ Paired activity to construct free body diagrams to represent forces and determine resultants. ○ Introduce moments and resolution of forces into horizontal and vertical components and then provide learners with a range of exercises to find moments and also horizontal and vertical components of resultant forces. • **Tutor presentation – Static equilibrium and simply supported beams**	Calculating reactions for simply supported beams.

	○ Introduce learners to the conditions required for static equilibrium, reviewing vector addition and how this applies to coplanar forces. ○ Individual activity to investigate a range of force systems to determine the resultant, equilibrant and line of action of forces. Teacher to then draw together and review understanding of static equilibrium. ○ Introduce learners to the concepts which surround simply supported beams, including loadings, such as concentrated loads, uniformly distributed loads (UDL) and reaction forces. Learners to then practice solving problems related to simply supported beams with a range of loading conditions. • **Whole class teaching and learning – Loaded components** ○ Tutor presentation to explain to learners what is meant by direct stress and direct strain and how these are calculated. This to be followed by paired activities to calculate direct stresses and strains in structural members. ○ Paired activity to investigate the concepts of shear stress and shear strain. This can be followed by demonstrations of how to calculate the shear stresses and strains present in structural members. ○ Tutor-led discussion to introduce learners to tensile and shear strength, using worked examples. Learners to then work individually to investigate a range of engineered structures to determine tensile and shear strength requirements of the structural members. ○ Class discussion to introduce elastic constants, explaining the impact these have on material selection. Learners to carry out a range of calculations related to Young's Modulus and Modulus of rigidity.	https://youtu.be/ZFl2ZeuQRug?si=voH51ruFrtmtoqYi

B2 Dynamic engineering systems	• **Whole class teaching and learning – Introduction**
	  ○ Discuss with learners their understanding of kinetic parameters, relating to prior learning and experiences. Set learners a task to research kinetic parameters and the links between displacement, velocity and acceleration.
	  ○ Demonstrate how to determine unknowns based on information available using algebraic manipulation. Then introduce equations for linear motion and uniform acceleration.
	  ○ Individual tasks to interpret given information with regards to uniform acceleration to calculate unknown values and quantities for engineering problems.
	• **Tutor-led activity:**
	  ○ Discuss with learners their understanding of dynamic parameters, introducing the concepts of force, inertia and torque along with mechanical work, power and efficiency.
	  ○ Paired activity to investigate dynamic parameters and produce a factsheet that defines each and explains how the parameters relate to each other.
	  ○ Tutor introduction to kinetic and potential energy, including calculations, before learners work in small groups to solve engineering problems which involve energy (kinetic and/or potential).
	• **Tutor presentation** – Conservation of Momentum
	  ○ Introduce the principles of conservation of momentum, including Newton's Laws of Motion.
	  ○ Paired activity to investigate and solve a range of engineering problems which include either the conservation of energy or the
		Conservation of momentum.
		www.youtube.com/watch?v=LrRdKmjhOgw
		Conservation of energy
		www.youtube.com/watch?v=4lYDb6K5UF8
		
		YouTube - Coaster video
		www.youtube.com/watch?v=LrRdKmjhOgw

	conservation of momentum. Use appropriate theories and principles to support findings.
	• **Tutor led discussion:**
	  ○ Investigate the differences between angular and linear motion.
	  ○ Individual learner activity to research angular velocity, centripetal acceleration and uniform circular motion. Produce a short report to explain the principles of each and how they apply in an engineering context.
	  ○ Class discussion to introduce the principle of rotational kinetic energy, including similarities between linear kinetic energy. As a group, work through examples of application.
	• **Small group activity - Lifting machines and mechanical systems**
	  ○ Investigate a range of lifting machines and carry out appropriate calculations to determine factors such as power and force in addition to velocity ratio, mechanical advantage and the effects of friction.
	  ○ Teacher led discussion to consider gear trains and chain drive systems. Learners to investigate and carry out calculations about how they function.	

B3 Fluid engineering system	• **Whole class teaching and learning – Introduction**
	  ○ Introduce learners to the concepts of density and relative density. This can be followed by a discussion about methods of determining relative density. Introduce learners to the flotation method for determining the density of materials.
	  ○ Individual activity to calculate relative densities for a range of materials from given data.
	  ○ Teacher demonstration of methods which should be employed to determine the hydrostatic pressure on surfaces, along with the centre of pressure.
		Youtube
		https://www.youtube.com/watch?v=fq8zqRRBEEY
		
		https://www.youtube.com/watch?v=VIzcER1hEtc

	○ Paired activity to carry out calculations to determine the hydrostatic pressure and hydrostatic thrust on immersed planes. Where appropriate, determine the centre of pressure. • **Whole class teaching and learning – Fluid flow in tapering pipes** ○ Teach led worked examples of how to calculate fluid flow in a gradually tapering pipe. Introduce learners to flow rates and flow velocities, demonstrating how to carry out calculations with factors such as input and output pipe diameters. Explain concepts of incompressible flow and continuity of volumetric and mass flow. ○ Paired activity to analyse and solve a range of problems relating to gradually tapering pipes. • **Whole class teaching and learning – Forces on immersed bodies** ○ Discuss with learners the concepts of buoyant force and upthrust, using demonstrations as appropriate. ○ Discuss how gravitational weight affects immersed bodies.	
C1 Direct current electricity and circuits	• **Whole class teaching and learning – direct current electricity** ○ Tutor-led discussion to introduce learners to concepts of conductance, conventional current flow and voltage. Learners could work in small groups to investigate the concepts covered, producing a definition for each and relating these to engineering applications. ○ Tutor presentation to explain, using examples, charge flow and Coulomb's law, followed by individual tasks to apply processes and procedures to solve problems related to Coulomb's law . • **Group discussion – Resistance and resistors**	

	○ Group discussion to consider factors which influence resistance, introducing temperature coefficient of resistance. Follow this by introducing different types of resistor, their function and values. ○ Teacher demonstration of how to calculate total resistances for resistors in series and in parallel. Paired activity to produce model answers to problems related to various resistor combinations. ○ **Class activity – Electric field strength** ○ Tutor-led discussion to introduce learners to electrical field strength. Demonstrate calculations which are to be performed. This can be followed by paired tasks with learners producing a short fact sheet to explain electrical field strength. Use worked examples to exemplify theory. • **Whole class activity – Capacitors** ○ Group discussion to consider factors which influence capacitance. Also, introduce different types of capacitor, their function and values. Learners to work in pairs to produce a short report to highlight the importance of each. Research different types of capacitor, their functions within circuits and typical values. ○ Teacher demonstration of worked examples to calculate values of capacitors in series and parallel. • **Teacher led activity – Direct current circuit theory** ○ Teacher led discussion to cover Ohm's Law, power and efficiency. Discuss prior knowledge of theories. Tutor demonstration of how to carry out calculations using Ohm's Law, power and efficiency. ○ Tutor-led discussion to introduce Kirchhoff's voltage and current laws using examples. Demonstrate calculations which relate to capacitors.	

	○ Individual activity to perform calculations using Kirchhoff's laws to determine total voltages and currents. Use formulae to determine unknown values with regards to capacitors. ○ Small group activity to investigate RC transients. Produce a short guide as to how to determine and apply theory to DC circuits. This can be followed by individual activities to carry out calculations to determine charge and discharge rates. Plot graphs as appropriate, making reference to exponential growth rates. Use data to determine time constants. ○ Introduce learners to direct power networks, demonstrating how to complete calculations with networks of resistors, two different power sources and capacitors in various combinations. Learners to practice exam style questions.	
C2: Magnetism and electromagnetic induction	• **Whole class teaching and learning – Magnetism** ○ Introduce learners to the concepts of magnetism, including flux density, magnetomotive force and magnetic field strength. Demonstrate how to use calculations correctly. ○ Individual activity to determine flux density and other variables to solve magnetism related problems. ○ Teacher-led practical demonstration showing how to determine permeability and reluctance. Explain to learners the relevance of each in engineering systems, followed by individual activities to determine permeability and reluctance for systems involving magnetism. ○ Tutor presentation of how BH curves are produced and interpreted. • **Whole class teaching and learning – Electromagnetic induction**	Youtube Video - Magnetism www.youtube.com/watch?v=NvJcrGlzGAg

	○ Tutor presentation introducing the meaning of induced electromotive force. Explain and demonstrate the principles which link induced emf and other factors. ○ Paired activity to produce an information sheet which could be used to inform peers (or others) about the how induced emf is influenced by a range of factors. ○ Tutor presentation to introduce the relationship between number of turns, magnetic length, permeability and inductance. Learners to then complete calculations related to electromagnetic induction. • **Teacher led activity – Electromagnetic induction** ○ Teacher led discussion to consider theory of self-inductance and mutual inductance. Demonstrate how to carry out calculations related to inductance of a coil and energy stored in an inductor. ○ Paired task to investigate the operation of transformers, using calculations to exemplify theory. Learners could apply appropriate formulae to determine unknowns when considering step up/down transformers. ○ Discuss efficiency with respect to voltage.	
C3: Single-phase alternating current	• **Teacher led activity – Introduction to single phase AC** ○ Teacher introduction to gauge understanding of single-phase AC theory, followed by a presentation of AC waveforms to learners, noting key features along with instantaneous and average values. This can be followed by the learners drawing and labelling their own. ○ Tutor presentation to explain form factor and how this is calculated followed by learner activities to use given data to determine the form factor for a range of waveforms.	

	○ Discuss the difference between sinusoidal and non-sinusoidal waveforms and what they typically represent. • **Class activity – Single phase AC principles** ○ Discuss why it can be helpful to represent the sums of sinusoidal waveforms graphically. Demonstrate the use of phasor and trigonometric to determine values of alternating currents. ○ Individual activity to determine, both graphically and using phasor addition, the sums of pairs of sinusoidal voltages. ○ Teacher led discussion to review resistance and capacitance for DC circuits before introducing reactance, impedance and capacitance. Demonstrate how to calculate total reactance, impedance and capacitance from given values. ○ Individual activity to use given data to determine total reactance, impedance and capacitance for AC systems.	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
SP – PS Problem solving	Encourage learners to apply a range of approaches when solving problems, for example using analytical and graphical methods in solving problems in electrical or mechanical concepts. Encourage them to attempt activities from a range of starting points and to link together concepts and theories when attempting to solve problems.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

GeeksforGeeks

A comprehensive resource of Engineering Maths Tutorials covering a wide range of principles relevant to Engineering Mathematics.
https://www.geeksforgeeks.org/engineering-mathematics-tutorials/

Learn About Electronics
A website that covers both AC and DC theory, providing educational resources on electronics.
www.learnabout-electronics.org/index.php

Live Science – What is Magnetism?
A detailed article from Live Science that explains the concept of magnetism and its significance.
www.livescience.com/38059-magnetism.html

Textbooks

Bird J – Higher Engineering Mathematics, Seventh Edition, Routledge, 2017 (ISBN 9781138673571).

Bird J – Bird's Electrical Circuit Theory and Technology, Seventh Edition, Routledge, 2021 (ISBN 9781000409345)

Bird J and Ross C Mechanical Engineering Principles, Routledge, 2014 (ISBN 9781138781573).
Greer A et al – BTEC National Mathematics for Technicians, 4th Edition, Nelson Thornes, 2004, (ISBN 978-0748779499)

Pence T and Wichman I, Essential Mathematics for Engineers and Scientists, Cambridge 2020 (ISBN 9781108425445)

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 2: Engineering Applications

Unit overview

Unit title Unit 2: Engineering Applications	
Assessment type: External	
Content Area	**Topics**
A The impact of modern and emerging technologies on functional areas across engineering sectors	A1 Engineering sectors A2 Functional areas A3 Modern and emerging technologies
B: Materials and processes used in engineering	B1 Materials B2 Properties of materials B3 Manufacturing processes
Assessment overview The unit will be assessed through one examination of 70 marks lasting 2 hours. Students will be assessed through a number of multiple-choice, short- and long-answer questions. Students will need to explore and relate to contexts and data presented. The questions will assess understanding of engineering materials, processes and the impact of technological developments on a range of engineering sectors. The assessment availability is twice a year in January and May/June. The first assessment availability is May/June 2026. Sample assessment materials will be available to help centres prepare students for assessment.	

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your learners to avoid and overcome these.

What is the misconception?	How to help learners overcome it
Quality management only relates to quality control checks	Discuss with learners how quality management is applied in engineering, and the differences between approaches across sectors. Consider the types of quality management systems that are used for aerospace applications and why these are important and then compare these with systems used in chemical engineering. Make references to similarities and the overall common goals of quality management systems.
Plastics are a type of material	Encourage learners to use the correct terminology for polymer materials and the groups to which they belong. Make sure that when they are identifying materials, they refer to them as polymers or elastomers.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note the activities provided below are suggestions and not mandatory. Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate.

Learning Topic	Activities and guidance for unit content delivery	Resources

A1 Engineering sectors	• **Whole class teaching and learning - Introduction**
	  ○ Using visual aids and examples of each, present to learners a basic introduction to mechanical and electrical/electronic engineering sectors
	  ○ Discuss the types of activities that are carried out by the two sectors
	  ○ Encourage interactive discussions where students share their understanding of the type of work carried out by mechanical engineering organisations and electrical/electronic engineering organisations.
	• **Small group activity – Engineering sectors:**
	  ○ Ask the learners to carry out research on one of the engineering sectors that are listed in topics A1.1 to A1.6, A1.9 and A1.10. They will investigate the types of products that the sectors manufacture or the services that they provide.
	  ○ Groups will then investigate the activities carried out within their chosen sector including the roles of research and development, design and manufacture/operations.
		Engineering Web – List of different types of engineering sector - 20 Types of Engineering and Their Functions - Engineering Web
		
		Institute of Engineering and Technology - IET - Institution of Engineering and Technology

	○ This activity encourages learners to consider the types of work that are carried out by engineers and the contribution of engineering to community. • **Whole class teaching and learning – Understanding products and services provided by engineering organisations** ○ Explain the concept that although engineering is broken down into a range of different sectors, there is often overlap between the types of products that they produce and subsystems that they manufacture. ○ Encourage students to reflect on and discuss examples they have observed or used such as mobile phones, vehicles or appliances in their home. Discuss how the various engineering disciplines work together to enhance society. • **Whole class and individual activity – Energy generation** ○ Discuss the range of approaches that can be used to generate electricity and the types of locations and environments in which they are used. Discuss the benefits and drawbacks of conventional power stations and also renewable power stations. ○ Assign students to research and present one of the following types of power station (solar panel, wind turbine, hydroelectric, gas fired and nuclear power station) investigating how energy is generated as well as the operation and maintenance of each. • **Whole class activity - Mechatronics**: ○ Provide learners with activities to research mechatronic engineering including the ways in which electro-mechanical systems have been incorporated by other sectors. ○ Allow students to investigate the use of mechatronics in aeronautical, agricultural, biomedical, chemical and marine engineering. Task them with producing presentations which show	How vending machines are designed https://www.youtube.com/watch?v=3KQm8cHmqIw National Geographic Renewable Energy 101 | National Geographic Energy magazine https://energydigital.com/top10/top-10-renewable-energy-sources-2024 MechaMind https://www.youtube.com/watch?v=t_i_0E_zw6U Techlabs

	the connection between the different sectors and how mechatronics is embedded.	https://tech-labs.com/blog/what-mechatronics
A2 Functional areas	• **Whole class teaching and learning - Introduction** ○ Introduce learners to the various different functional areas that are found within engineering organisations. Discuss with learners how the various functions interact with each other and how key decisions are made. ○ Where possible use industry partners through either visits or guest speakers to relate the theory to real life scenarios. Share with learners experiences of how the functions of an engineering organisation cooperate, for example, in the design and manufacture of a new smart phone or drone. • **Small group activity – Engineering functions:** ○ Divide the class into small groups and provide each of them with a different function that is generally found within an engineering organisation. Across the group, all should be investigated; this offers an ideal opportunity for learners to work in pairs to research methodically the activities associated with each of the functions. ○ If it is possible to link this activity to an industry visit, then learners will gain more of an insight into how the functions interact with each other and gain a deeper understanding of an engineering workplace that will help in their preparation for employment. • **Whole class activity** ○ Discuss with learners the need for health and safety management. Provide learners with one of the five areas in topic	FRAME – How BMW design new cars https://www.youtube.com/watch?v=XL9YTPBejUg Organisation and functions within an engineering organisation https://cranstoneng.com/the-engineering-disciplines/

	A2.9 to research and then ask them to present to the group the importance of their given area in an engineering workplace. ○ Lead a class discussion about why training and education are continuous in engineering organisations. • **Individual activity – Information management:** ○ Learners to produce a fact sheet about information management that covers collaborative working, secure document storage, control and distribution. They need to give examples of how these are applied in engineering organisations.	
A3 Modern and emerging technologies	• **Tutor activity to introduce modern and emerging technologies** ○ Introduce the use of modern and emerging technologies in engineering, before discussing their significance and impact on the operation of functional areas in engineering organisations. ○ Develop this into a group discussion on current trends in technology such as robotics, drones, Augmented Reality (AR) and Virtual Reality (VR) and Artificial Intelligence (AI). • **Individual activity – Robotics** ○ Learners to investigate the use of robots in process automation, dangerous environments and autonomous systems. This can be developed into a presentation about the specific use of different types of robots in various industries. ○ Learners can then examine the use of Cooperative Robots (Cobots) and how these are used to assist human workers. Learners to research examples of their use and add these to their presentation. • **Whole class activity**	Wider applications of robots https://www.geeksforgeeks.org/applications-of-robotics/ Simplilearn – what is IoT https://youtu.be/7DZR5UaAM0E Use of AR for aircraft maintenance https://www.youtube.com/watch?v=O7dXn9u2WEc

	○ Discuss with learners the use of drones, VR, AR, cloud computing, the Internet of Things (IoT), AI and 3D printing including the implications of these in modern engineering. ○ Divide the class into smaller groups and provide of them with a different technology to research and then produce a presentation. Groups to share their presentations with the class as a whole. ○ Introduce learners to the concept of digital twins and discuss where and when these are useful in engineering applications.	Mechanical Engineering Magazine – Special Report: Digital Twin Cities https://youtu.be/7DZR5UaAM0E
B1 Materials	• **Whole class teaching and learning – Introduction** ○ Once learners have an understanding of engineering sectors, discuss the understanding of materials that learners may have developed through their previous studies in other qualifications. ○ Introduce learners to the three main groups of materials for this unit - metals, polymers and composites. ○ Use a range of material samples in group work and encourage learners to categorise them into different material groups. This will get learners thinking about the visual, physical and mechanical properties that characterise them and their suitability for use in different applications. ○ Lead a discussion into the reasons why each of these material groups are used for engineered products. • **Small group activity – Metals** ○ Divide the class into groups of three. One member of each group produces a fact sheet for either pure metals, ferrous alloys or non-ferrous alloys. They need to include details of the composition of each and the chemical symbols used. ○ Group members to share their fact sheets with each other.	The efficient engineer – Understanding metals https://youtu.be/PaGJwOPg2kU?si=OpGgJmb_NiQhDs7N

	○ Use a formal presentation to lead learners into thinking about the internal structure of materials (grain structure) and the effect that internal structure has on mechanical properties. Support this teaching with images of microstructures. • **Small group activity - Polymers** ○ Divide learners into small groups to investigate the four groups of polymer listed in B1.2. In their groups they need to produce diagrams of the different structures of each type of polymer. ○ They can then work on producing a short presentation that includes thermoplastics, thermosets, thermoset elastomers and thermoplastic elastomers. For each, gather images of typical uses along with the abbreviations used should be included. • **Individual activity – Composite materials** ○ Learners can then move onto complete an individual set of revision notes that cover Glass fibre reinforced polymer (GFRP), Carbon Fibre Reinforced Polymer (CFRP) and cemented carbide, including details of their structures and how this affects their properties. • **Whole class teaching and learning – Reinforcement matrix of composites** ○ Once learners have researched the different types of composite material, lead a class discussion the reinforcement matrix of composites. Discuss the effects of manipulating fibre alignment and also increasing the matrix to reinforcement ratio. Ask learners to consider why these changes might be needed.	Koenigsegg, composite manufacturing. www.youtube.com/watch?v=Dw6cs7opvzA

B2 Properties of materials	• **Whole class teaching and learning – Introduction**
	  ○ Using a formal presentation, to show an overview of the different materials that learners have been investigating.
	  ○ Show learners engineered components and then have a whole class discussion about what the components are made from – type of material and why they have been chosen, for example mild steel for a shelving system because it is easy to stamp out, form and surface coat.
	  ○ You could then divide them into small groups and ask them to select a product that they are familiar with and think of the reasons why the materials used were chosen.
	
	• **Small group activity – Material properties**
	  ○ Divide the class into seven groups. Give each group one physical property and one mechanical property to investigate. Ask them to find a definition and examples of materials that are selected for their given property.
	  ○ Groups then share their definitions with the wider class.
	  ○ Lead a class discussion about the use of units for different properties and why the use of the correct units of measurement are important.
	
	• **Whole class teaching and learning – Heat treatments**
	  ○ Discuss with learners why heat treatments are used with metals. Ask them to think of examples of where they might have seen heat treatments previously.
	  ○ If possible demonstrate heat treatment processes in the workshop, or use video resources.
	  ○ Explain to learners that heat treatments affect grain size, crystal structure and mechanical properties of metals.
		Brinell hardness test – lasts about three minutes and links on to the Rockwell test.
		www.youtube.com/watch?v=RJXJpeH78iU
		
		Rapid Direct
		Introduction to heat treatments
		https://youtu.be/vc5ValY7agI?si=fLKRnreZDgSJQwax

B3 Manufacturing processes	• **Whole class teaching and learning – Introduction**
	  ○ Lead the group to use some of the common engineering processes listed in B3.4 to B3.6 of the unit content. These should be practical exercises to create awareness of engineering activities such as the set up and use of machinery, hand tools, cutting operations, and additive manufacturing.
	  ○ During every activity the necessary safety considerations should be emphasised and reinforced such as use of PPE, manual handling and controlling hazardous substances.
	• **Group activity – Forming, casting and moulding**
	  ○ Discuss with learners the meaning of the terms forming, casting and moulding. Introduce them to factors such as batch size, dimensional accuracy and surface finish which can be achieved with each.
	  ○ Learners to research forming, casting and moulding processes and produce a presentation. For each they should include details of the benefits of the process, typical products and sustainability factors.
	  ○ Learners to share their presentations and then discuss with the group the types of products that would be used created through these processes.
	• **Class activity – Machining operations**
	  ○ Discuss with learners why drilling, milling and turning are used as common secondary machining processes. Demonstrate, either in the workshop, or through the use of video, the range of machining processes listed in the unit content.
	  ○ In small groups, learners can investigate one of the three machining methods and share their findings with the wider class. They should include different operations for each type of equipment and also the use of work holding devices.
		Introduction to a range of manufacturing processes
		https://www.youtube.com/watch?v=Um_g8sQ_p3Y
		
		Drilling, milling and turning
		https://www.youtube.com/watch?v=SwK5uWrbTEM

	○ Draw the class back together to discuss the use of CNC milling and turning. Consider the benefits of each process over manual methods. ○ Learners to then investigate surface grinding. • **Individual activity – Cutting** ○ Introduce learners to the range of methods that can be used to cut materials for B3.5.1 to B3.5.7 and the types of material that they are used to cut. ○ Learners to investigate the full range of cutting techniques listed in the unit content, making notes about how the process works, the equipment needed, levels of accuracy and the materials they are typically used to cut. • **Whole class activity – additive manufacturing** ○ Discuss with learners what is meant by additive manufacturing. Ask learners to consider why it might be used. ○ Demonstrate, using a video, the use of Fused Deposition Modelling (FDM), Direct Metal Laser Sintering (DMLS) and Metal Fused Filament Fabrication (MFFF) additive manufacturing techniques. ○ Discuss with learners the benefits of each and typical applications.	Berkness Company – FDM additive manufacturing https://www.youtube.com/watch?v=PcNCyHSKK1w Direct Metal Laser Sintering https://youtu.be/FxzFzbi0wF4?si=wxf0VpHYbdt_SFSb MFFF 3D printing https://youtu.be/RecyvmRBg3E?si=CbsJ3yGkXc7YJs2u GE Engine manufacturing, additive manufacture www.youtube.com/watch?v=l0SXlkrmzyw electron-beam-additive manufacturing-technology www.sciaky.com/additive-manufacturing/

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
SP – CT **Creative Thinking**	Encourage learners to investigate engineered products that surround them in their daily life. They can analyse the materials that have been used to make the products, considering the importance of the properties of the material for the products fitness for purpose. To further develop creative thinking learners may consider ways in which these engineered products may evolve and improve for the user, given trends in modern and emerging technology and of the future.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

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Websites

British Metal Forming
The homepage of the Confederation of British Metalforming, a trade body representing the interests of the metal forming industry.
http://britishmetalforming.com

MatWeb
A searchable database of material properties, including data sheets for thermoplastic and thermoset polymers and other engineering materials.
www.matweb.com

Quality Tool - Design Handbook
A useful guide to industrial cutting and forming processes, provided by Quality Tool.
www.qualitytool.com/resources/Design-Handbook-Rev3.pdf

The Library of Manufacturing
An online resource covering a range of manufacturing processes, including sheet metal fabrication.
http://thelibraryofmanufacturing.com/index.html

Industry grade introduction videos and courses in Engineering with CPD for teachers

https://dsle.didacticservices.co.uk

Textbooks

Black BJ – *Workshop Processes, Practices and Materials*, 5th Edition, Routledge, 2015 (ISBN 9781138784727)

Bolton W and Higgins RA – *Materials for Engineers and Technicians*, Routledge, 2014 (ISBN 9781138778757)

Gibson I, Rosen D, Stucker B – *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, Springer, 2014 (ISBN 9781493921133)

Howes P and Laughlin Z – *Material Matters New Materials in Design*, Black Dog Publishing, 2012 (ISBN 9781907317736)

Meyers AR and Slattery TJ – *Basic Machining Reference Handbook, 2nd Edition*, Industrial Press Inc, 2001 (ISBN 9780831102012)

Mitchell B – *An Introduction to Materials Engineering and Science for Chemical and Materials Engineers*, Wiley, 2004 (ISBN 9780471436232)

Walker JR – *Machining Fundamentals: From Basic to Advanced Techniques, 8th Edition*, Goodheart-Willcox Co Inc, 2004 (ISBN 9781590702499)

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 3: Engineering Design

Unit overview

Unit 3: Engineering Design	
Assessment type: Internal	
Learning Aim	**Topics**
A Explore initial design proposals to meet the requirements of an engineering design challenge	A1 Interpreting product technical requirements A2 The characteristics and applications of materials A3 The characteristics and applications of manufacturing processes A4 Generating initial design ideas A5 Modelling design solutions
B Develop initial design ideas into 3-dimensional models in response to an engineering design challenge	B1 Review of initial design ideas B2 CAD and 3D Parametric modelling B3 Developing 3- dimensional components B4 Developing a 3- dimensional assembled model
C Develop 3-dimensional models into 2-dimensional engineering drawings and present the final design solution	C1 Two-dimensional detailed computer-aided drawings of an engineered product C2 Presentation and communication skills
D Review the design process when responding to an engineering design challenge	D1 Review of the final design solution D2 Reflection on personal performance
Assessment overview This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB). Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 32 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification.	

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

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Learning Topic	Activities and guidance for unit content delivery	Resources
Introduction	• **Whole class teaching and learning - Introduction** ○ Issue specification to discuss the unit, the learning outcomes and the method of assessment (Pearson Set Assignment/Portfolio of evidence) ○ Emphasise to the learners that the portfolio will need to be built up during the duration of the project (approximately 32 hrs) ○ Group discussion exploring learners' knowledge of design challenges and the possible skills that learners will need or have developed ○ Encourage interactive discussions where students share their experiences and skills required/developed in order to produce a successful engineering design • **Small group Activity – Introductory context:** ○ Ask the learners to collaborate to use one or more of the objectives from sample PSAB materials to help address an engineering challenge. For example, improving the functionality of a device to protect a mobile phone from being stolen when it is being charged.	

A1 Interpreting product technical requirements	• **Whole class teaching and learning – Customer requirements:**
	  ○ Lead the group on what is meant by product requirements with respect to customer needs. Discuss the importance of meeting customer requirements, considering technical requirements for a product design specifications using the headings listed in the unit specification
	  ○ Encourage learners to explore each of the technical requirements in the unit specification when analysing their design challenge including the internet, journals, databases and libraries
	  ○ There is an opportunity to develop links with an industry partner who could give design briefs which learners will need to interpret in order to develop a product design specification that addresses the client needs.
	• **Small group Activity – Product design specification:**
	  ○ Groups could then be given a product to identify the customer requirements
	  ○ Learners could be given a relatively simple design brief. They could then work through this, in either groups or pairs, to come up with specific criteria needed for the product design specification, bearing in mind the full list of requirements from the unit specification.
	  ○ There is scope for collaborative work in the first instances, with learners developing their skills to be able to work independently prior to beginning their assessments.
	  ○ Learners should pay particular attention to any legal requirements such as intellectual property, health and safety and environmental legislation associated with the design brief. Learners can then investigate the relevant legislation, codes of practice and modify their PDS in light of this.
		Product Design Specification – A useful website giving an insight into the production of a design specification - https://rewisoft.com/blog/how-to-write-the-design-specifications-quick-guide/

A2 The characteristic and applications of materials	• **Whole class teaching and learning – Material Types:**
	  ○ Lead the group with an exploration of range of engineering materials and their applications including pure metals, ferrous and non-ferrous alloys, polymers, elastomers and composites.
	  ○ Encourage learners to explore the differences in these types and their applications such as the use of low carbon steel in products due to its ability to be machined relatively easily.
	• **Small group Activity – Investigating material types:**
	  ○ Groups could then research a range of engineering materials from each of the types listed above. For example, aluminium and titanium from pure metals, polycarbonate and polyester resin from polymers and glass fibre reinforced polymer GFRP from composites. Learners could then be encouraged to look at typical applications in engineering products.
	• **Whole class teaching and learning – Material Properties:**
	  ○ Lead the group on how the properties of materials influence the selection of materials for engineering applications. For example, the high strength to weight ratio of carbon fibre make this an ideal selection for an F1 race car body.
	  ○ Encourage learners to explore relevant resources to help identify material properties including the internet, journals, databases and libraries
	• **Small group Activity – Investigating material properties:**
	  ○ Groups could then research a range of physical and mechanical properties that are evident in engineering materials, considering how these properties affect the use of materials in engineering applications. Properties could include density, corrosion resistance, electrical resistivity, hardness, toughness and tensile strength.
		Material Property Data – A comprehensive website providing a range of properties for a wide variety of materials – www.matweb.com

A3 The characteristic and applications of manufacturing processes	• **Whole class teaching and learning – Manufacturing processes:**
	  ○ Lead the group with an exploration of range of processes used during the manufacture of engineering products. For example, forming, casting, moulding, machining, cutting and additive manufacturing. Introduce learners to the scales of manufacturing associated with engineering such as one off, batch and mass production techniques.
	  ○ Introduce learners to the concept that processing will affect the properties of materials. For example heat treatment of metals.
	
	• **Whole class teaching and learning – Heat treatment of metals:**
	  ○ Lead the group on exploring the range of heat treatment processes used on metals such as quench hardening, tempering, annealing, normalising and case hardening and how they influence the selection of materials for engineering applications. For example, quench hardening materials can make them quite brittle if they are not tempered to reduce the extreme hardness.
	  ○ Encourage learners to explore relevant techniques for these processes including the internet, journals, videos and libraries
	• **Small group Activity – Investigating heat treatment processes:**
	  ○ Groups could then research a range of heat treatment processes from those listed above that are evident in engineering materials, considering how these properties affect the use of materials in engineering applications.
	
	• **Small group Activity – Investigating manufacturing processes:**
	  ○ Investigate a range of products that are produced by engineering organisations and determine their scale at which they are manufactured.
	  ○ Groups could then research a range of engineering processes from each of the types listed in Unit 2. For example, press work
		CNC Programming – A short video demonstrating a machining programme on a milling machine - www.youtube.com/watch?v=WuGKnL0q1ps
		
		Manufacturing on a CNC Machine – Production of a Chess Piece - www.youtube.com/watch?v=Gu0EWKYzXpM
		
		Manufacturing processes – A brief introduction to a range of processes and how they are selected - https://www.youtube.com/watch?v=Um_g8sQ_p3Y

	from forming, injection moulding from moulding, drilling from machining, laser cutting from cutting, sand casting from casting and fused deposition modelling (FDM) from additive manufacturing. Learners could then be encouraged to look at typical engineering products that use these processes. ○ Consider the materials used, their properties and the effects of processes on the materials. For example, forging a product will it give it a tighter uniform grain structure resulting in improved strength and impact resistance.	
A4 Generating initial design ideas	• **Whole class teaching and learning – Presenting Ideas:** ○ Lead the group with a discussion on of the importance of using a range of techniques to present ideas. Consider the different audiences that may need to view your product, engineers or the client. ○ Demonstrate to learners a range of freehand sketching techniques such as isometric, oblique and orthographic projections to include sketching in good proportion and the production of detail drawings. ○ The tutor can offer support to the learners as they develop their design for the project by exploring a range of tools used to design the solution such as engineering drawings, simulations and physical modelling. Include the process of iteration and how the designs can be tested against the technical specification such use of appropriate materials, meeting dimensional tolerances and environmental considerations such as sustainability. • **Individual Activity – Sketching Techniques:** ○ Learners could sketch a range of 2D and 3D objects to develop their skills. These could be physical or paper-based resources.	The iterative design process – Designers use this to simulate methods used in industry to test their ideas - https://www.bbc.co.uk/bitesize/guides/zjjkw6f/revision/4 Sketching Techniques for Beginners – A website showing some basic techniques to help learners communicate ideas - https://shop.zenartsupplies.co/blogs/toolkit/sketching-techniques-for-beginners

	○ Learners could use a range of drawing techniques to generate design ideas for a given product design specification. ○ Develop or enhance the learner's skills base, as necessary, so that they can create a design from the product design specification. • **Whole class teaching and learning – Design proposals:** ○ Lead the group with a discussion focusing on the purpose of communicating design ideas. Demonstrate to learners' possible approaches that could be used to generate initial ideas such as researching existing products, producing freehand sketches, using the information from the product design specification and sustainability considerations including the product life cycle and environmental concerns through production. ○ Encourage learners to explore relevant resources to help generate ideas including the internet, journals, videos and libraries • **Small group Activity – Generating ideas:** ○ Groups could then be given a product design specification that they should address by generating a range of creative design ideas that consider fitness for purpose, constraints, ergonomics, aesthetics, materials, manufacturing, sustainability and refinements.	
A5 Modelling design solutions	• **Whole class teaching and learning – Modelling techniques:** ○ Lead the group with a discussion of the importance of using a range of materials and models to present ideas. Consider the different audiences that may need to view your product, engineers or the client.	The following links allow access to a range of modelling systems: www.lego.com https://www.fischertechnik.de/en https://www.meccano.com/en_gb

	○ Discuss the range of modelling materials available to learners such as sheet materials including different cards, manufactured boards and acrylic, casting and moulding materials including clay, plaster and polymorph. Demonstrate how these materials can be manipulated to create appropriate design ideas. ○ Introduce learners to a range of modelling systems such as Lego, Meccano and Fischertechnik kits ○ Consider commercial processes such as 3D printing, laser cutting and CNC machining as well as more traditional use of hand tools to cut, shape and join modelling materials. ○ The tutor can offer support to the learners as they develop their modelling skills. • **Individual Activity – Use of Modelling Kits:** ○ Learners could experiment with a range of modelling materials and systems to develop a range of 2D and 3D objects to develop their skills. ○ Learners could use a range of hand tools to practise simple techniques for cutting, shaping or joining modelling materials. • **Whole class teaching and learning – Modelling production costs:** ○ Lead the group on the use of Excel spreadsheets and their benefits in recording and maintaining costings for materials, resources and labour. • **Individual Activity – Use of Spreadsheets:** ○ Learners could develop a spreadsheet to record information such as materials, equipment and labour costs relating to their design challenge and any changes made to the design.	Some of the many software companies producing CAD software - many of these provide free educational resources: www.autodesk.co.uk www.solidworks.co.uk http:///www.solidworks.com/sw/products/draftsight-getting-startedguide.htm www.turbocad.co.uk/windows-range/turbocad-deluxe-2d-3d http://caddprimer.com/magazine www.caduser.com www.mycadsite.com/tutorials Excel Basics – An introduction to using Excel spreadsheets - https://www.youtube.com/watch?v=rwbho0CgEAE

B1 Review of initial design ideas	• **Whole class teaching and learning – Design Review:** ○ Lead the group with a discussion focused on the importance of reviewing initial design ideas with particular reference to the product design specification ○ Demonstrate some of the tools they might need such as a weighted matrix which is a decision making tool that can help compare and assess a range of options against the product design specification that is weighted by level of importance. ○ Demonstrate the use of the Example Peer Review Template and discuss how this could be used in a design review meeting where learners will present their ideas to a small group. • **Individual Activity – Reviewing designs:** ○ Learners could be asked to evaluate a sample of design ideas with respect to a product design specification. Learners could complete an example peer review template whilst comparing the designs to the product design specification. ○ Learners could identify those that offer the most scope for being developed. ○ Based on the feedback from peers, designs could be refined, selecting the best idea to be developed based on the PDS, comparisons and peer reviews.	Weighted decision matric – a powerful tool to help you prioritise effectively and make informed decisions - https://www.youtube.com/watch?v=ZYngXGK8yBU Design Review – An insight from a principal engineer and the process of design review – https://www.youtube.com/watch?v=iQglwmFMzmI The design review process – An introduction to requirements for reviewing design ideas - https://dovetail.com/product-development/design-review/s
B2 CAD and 3D Parametric modelling B3 Developing 3-dimensional components	• **Whole class teaching and learning – 3D Modelling:** ○ Topics B2 & B3 would best be taught together as there is clear progression here. ○ Demonstrate how to create simple 3D components. Explain the basic structure of a 3D drawing package and guide learners through the completion of a 3D component.	Software companies producing CAD software - many of these provide free educational resources: www.autodesk.co.uk www.solidworks.co.uk http:///www.solidworks.com/sw/products/draftsight-getting-startedguide.htm

	○ Guide learners through the setup configuration including features such as workplanes, snap, origin and file selection. ○ Start with a simple shape that can easily be extruded and then, perhaps, add a hole, chamfer or radii. ○ Demonstrate how to transfer a 3D component into a 2d or isometric drawing then printing or plotting ○ Demonstrate further commands and skills to allow learners to create components that are more complex, including, for example, revolving, Boolean operations. Ensure learners have an understanding of the advantages of creating models in the correct orientation and the order of creating drilled/threaded holes, pockets and removing surfaces. ○ Demonstrate how to set up and output drawings within a drawing template, to allow learners to create drawings containing orthographic views created from a base view and projected views. These can be fully dimensioned, inclusive of 3D solid model/surface model showing appropriate scale. • **Individual Activity – Using 3D CAD:** ○ Learners could develop their skills by using features such as shells, holes and co-ordinate systems to create simple shapes using commands such as extrusion and circles. Learners could also discover the use of erase and undo as they refine their models. ○ Create 2D orthographic projections of 3D generated components and the use of standard drawing templates within the software ○ Learners could be given further graduated tasks to develop their use of the software commands. These tasks could include more complex shapes and features that include springs and threads.	www.turbocad.co.uk/windows-range/turbocad-deluxe-2d-3d http://caddprimer.com/magazine www.caduser.com www.mycadsite.com/tutorials

B4 Developing a 3-dimensional assembled model	• **Whole class teaching and learning – 3D Assemblies:**
	  ○ Demonstrate how to create an assembly drawing, including a parts list and bill of materials. Ensure that the 3D components are placed within the correct orientation and that the appropriate constraints are applied such as using the 'mate or 'align' commands to attach components correctly.
	  ○ Demonstrate further commands and skills to allow learners to create complex assemblies where 'edge' constraints provide hinged movements.
	  ○ Demonstrate commands that will allow learners to apply materials or surface textures and to interrogate components to determine volume, density and mass.
	• **Individual Activity – Developing 3D assemblies:**
	  ○ Learners could develop their skills by using constraints such as mate and/or align to assembled 3D components to meet the brief.
	  ○ Create 2D orthographic projections of 3D assemblies and the use of standard drawing templates within the software
	  ○ Learners could be given further graduated tasks to develop their use of the software commands. These tasks could include more complex shapes and features such as animation of movement or hinging of components.
		AutoDesk Cad Tutorials – A website containing online video tutorials for those wanting to develop CAD skills - https://www.autodesk.com/in/campaigns/autocad-tutorials

C1 Two-dimensional detailed computer aided drawings of an engineered product	• **Whole class teaching and learning – Principles of Engineering Drawing:**
	  ○ This builds on the sketching techniques introduced in Topic A4. Demonstrate how to create simple 2D engineering drawings and basic principles that must be followed (views, dimensions, layout etc.)
	  ○ Explain the basic structure of a 2D drawing package and guide learners through the completion of setting up a 2D computer aided drawing system that makes use of layers.
		Videos:
		
		Using 2D Design – A series of tutorials to help learners use this powerful software to create all types of engineering drawings - https://www.youtube.com/watch?v=4_BQIU5fIJU
		
		Understanding Engineering Drawings – A basic introduction to understanding this complex task -

	○ Support the learners individually and as a group to enhance their skills at 2D CAD by demonstrating a wide range of commands such as chamfers, radii, springs and threads as well as modify commands such as trim, array and mirror. • **Individual Activity – Using 2D CAD:** ○ Learners could develop their skills by using features such as grid, snap and co-ordinate systems to create simple shapes using commands such as line, arc, circle and text. Learners could also discover the use of erase and undo. ○ The basic commands will also allow learners to create a drawing template on which all drawings can then be produced within. ○ Learners could be given further graduated tasks to develop their use of the software commands. These tasks could include more complex shapes and features that include threads, chamfers and holes. ○ Learners could then use their component drawings to produce orthogonal views to an appropriate scale, sectional views and general arrangement drawings.	https://www.youtube.com/watch?v=ht9GwXQMgpo Understanding Engineering Drawings – An insight into the basic of understanding engineering drawings - https://www.youtube.com/watch?v=ht9GwXQMgpo
C2 Presentation and communication skills	• **Whole class teaching and learning – Presenting outcomes:** ○ Lead a group discussion on the importance of good communication skills when presenting your design challenge. Stress the importance of knowing your audience, making eye contact with them and knowing your body language. Ensure presentations are kept simple and that learners plan their presentation. ○ Demonstrate verbal communication skills such as the use of voice and tone. The way in which a learner speaks is a crucial element to a good presentation, for example, finding a balance	Communication Skills – A breakdown of the different types and their importance when presenting information - https://www.skillsyouneed.com/ips/communication-skills.html

	in volume as often too loud will sound aggressive and too quiet may lead audiences to feel the speaker lacks confidence. ○ Stress the importance of including all the activities carried out throughout the design process from the initial brief, through the research to the design and modelling of the solution leading to the presentation. • **Individual Activity – Presenting outcomes :** ○ Learners could be given a familiar product to them and try to present a five-minute pitch about why it is is so important to them. This could be with a small audience and feedback discussion on how they actually did.	
D1 Review of the final solution	• **Whole class teaching and learning – Reviewing the final design proposal:** ○ Lead a group discussion on the importance of reviewing their final design solution with respect to the product design specification in order to meet the design challenge. Emphasise the importance of justifying the decisions made and communicate these clearly and effectively. • **Individual Activity – Review the final solution:** ○ Learners could be given examples of products along with their related product design specification. They could then analyse the products with respect to the PDS to confirm the success of the design. This could be done through partnership with a local company who could give learners examples of products and related documents. ○ Learners could be given the same products to assess against the weighted matrix, comparing the results to determine if there are any differences.	Communication Skills – A breakdown of the different types and their importance when presenting information - https://www.skillsyouneed.com/ips/communication-skills.html The design review process – An introduction to requirements for reviewing design ideas - https://dovetail.com/product-development/design-review/s

D2 Reflection on personal performance	• **Whole class teaching and learning – Presenting the solution:** ○ Lead a group discussion of the importance of reflecting on your own performance. Emphasise the importance of identifying your personal strengths and weaknesses whilst completing the various tasks for the design challenge. ○ Discuss with learners the concept that improving a product for one reason will often have other benefits. For example, modifying a product by reducing material usage will also have a cost and sustainability benefit. ○ Discuss with a range of theories and frameworks for reflective practise such Experience, Reflection, Action (ERA Cycle) or Driscoll's What Model. ○ Demonstrate the use of performance review tools such as Strengths, Weaknesses, Opportunities and Threats (SWOT Analysis) • **Individual Activity – Project presentation:** ○ Learners could reflect on their own performances over the course of the unit. For example, when using drawing and modelling techniques to generate 2D and 3D models, learners could identify strengths and weaknesses and think of ways to improve performance if they were to repeat a similar activity later in the course or during the external assessment. ○ Learners could carry out SWOT analysis on the previous products supplied for other tasks or on their own performance throughout the unit.	Self-Reflection – An Open University webpage looking at the importance of self-reflection – https://www5.open.ac.uk/choose/unison/develop/my-skills/self-reflection#:~:text=Reflecting%20helps%20you%20to%20develop,doing%20it%20in%20the%20future
Preparing for Internal assessment	○ Learners could be given a final design challenge that could be based around the sample assessment materials. ○ They could follow the design process through from the beginning by interpreting a given brief into Product Design Specification and user requirements.	

	○ An iterative design approach should then be taken to produce a developed design proposal that can be peer reviewed and confirmed with regards to the PDS and the weighted matrix. ○ Learners could then have an opportunity to suggest further refinements to their solution whilst considering material and manufacturing choices to meet the design challenge. ○ Learners should also have the opportunity to use the assessment documentation such as the Starting Point Ideas, Project Proposal, Record Log and Peer Review Template.	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
EL – CL Effective Learning – Continuous Learning	Group Activity To practice reviewing initial design ideas for an engineering solution, students could work in small groups to share their ideas in response to a design brief given to the group by the teacher. Students can review each other's ideas, helping to refine and improve their own using peer feedback which will also serve as useful practice for the assignment.
IS – V&NC Interpersonal Skills – Verbal and Non-Verbal Communication	Individual Activity Students could be tasked with reviewing design solutions for engineered products that they are familiar with, for example a device they use and completing technical review of the design, presenting it to the class in an appropriate format. This will help practice and develop both verbal presentation skills and

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

Pearson has partnered with Didactic Training Services https://dsle.didacticservices.co.uk (login/ account required) to provide centres with guidance on how to introduce units 3 and 4 to learners

Project development:

www.jamesdysonfoundation.co.uk

www.matweb.com

www.teachengineering.org

www.engineering.com

There are links below to some of the support systems available, including software houses producing CAD software. Many of these provide free educational software.

www.autodesk.co.uk/

www.solidworks.co.uk/

www.solidworks.com/sw/products/draftsight-getting-started-guide.htm

www.turbocad.co.uk/windows-range/turbocad-deluxe-2d-3d

http://website.denford.ltd.uk/

www.techsoft.co.uk/

Industry grade introduction videos and courses in Engineering and CPD for teachers

https://dsle.didacticservices.co.uk

Textbooks

There are textbooks that reference various technical stages, including graphics packages software command structure. Learning materials are available for the different companies that supply CAD/CAM software and the different versions of the software packages that they produce. Books and magazines are

available on electronics, maintenance, CNC, 3D printing and many more subject areas to support technical detail.

Bolton W and Higgins RA – Materials for Engineers and Technicians (Routledge, 2014) ISBN 9781138778757.

Darbyshire A – Mechanical Engineering (Newnes, 2008) ISBN 9780750686570. Useful general resource for tutors.

Gibson I, Rosen D, Stucker B – Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (Springer, 2014) ISBN 9781493921133. Wide range of additive manufacturing methods are covered in detail.

Johnson A & Gibson A – Sustainability in Engineering Design (Academic Press, 2014) ISBN 9780124045910. Features a range of techniques to use in engineering design including an iterative approach.

Mitchell B – An Introduction to Materials Engineering and Science for Chemical and Materials Engineers (Wiley, 2004) ISBN 9780471436232.

Timings RL – Engineering Materials, Volume 1 (Longman, 1998) ISBN 9780582319288. Comprehensive range of engineering materials are covered.

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

Unit 4: Engineering Project

Unit overview

Unit 4: Engineering Project	
Assessment type: Internal	
Learning Aim	**Topics**
A Investigate an engineering project in a relevant specialist area	A1 Project life cycle A2 Project idea generation and solution development A3 Feasibility study of solutions
B Develop project management processes and a design solution for the engineering project	B1 Planning and monitoring project management processes B2 Risk and issue project management processes B3 Technical specification B4 Design information
C Undertake the solution for an engineering project and develop skills to present the solution	C1 Undertake and test the solution to the problem C2 Demonstrate relevant behaviours C3 Present a solution to the problem
Assessment overview This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB). Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 30 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification.	

Common student misconceptions

Below are some common misconceptions related to the content of this unit by students and ideas for how you can help your learners to avoid and overcome these.

What is the misconception?	How to help learners overcome it
Learners assume that this can be a group project.	All learners must independently generate individual evidence that can be authenticated. The main sources of evidence are likely to be portfolios containing reports, learner logbooks, planning documentation and testing documentation, printed or plotted portfolios of drawings and the annotated photographs of the process of solving a problem through a project-management approach. Learners should also produce screenshots to show processes and editing. BTEC assessors should complete observation records and learners' colleagues in placements or part-time work could complete witness statements. Note that observation records alone are not sufficient sources of learner evidence; the original learner-generated evidence must also support them.
Assumption that the assignment for the project must involve production of a physical product, requiring specific tools/ equipment in a workshop	The focus of the task is on application of project management processes to plan, undertake, monitor and refine a solution. This could be a virtual output or a model, as long as it is sufficient to generate data for testing and observation, can solve the problem to be addressed, and can be presented in sufficient detail to meet the task criteria.

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note the activities provided below are suggestions and not mandatory. Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate.

Learning Topic	Activities and guidance for unit content delivery	Resources

Introduction	• **Whole class teaching and learning - Introduction**
	  ○ Issue specification to discuss the unit, the learning outcomes and the method of assessment (Pearson Set Assignment Brief/Portfolio of evidence)
	  ○ Emphasise to the learners that the portfolio will need to be built up during the duration of the project (30 hrs)
	  ○ Group discussion exploring learners' knowledge of the use of project-management processes and the possible skills that learners will need or have developed
	  ○ Encourage interactive discussions where learners share their experiences and skills required/developed in order to manage a project successfully
	• **Small group Activity – Project identification:**
	  ○ Ask the learners to collaborate to come up with examples of different projects they could investigate, manufacture or design along with their motivations for doing so.
	  ○ Videos could be shown of project ideas.
		Mechanical Engineering Projects – a selection of low cost engineering projects developed by students - www.youtube.com/watch?v=ibE626hR0sk
		Mechanical Engineering Mini Projects – a selection of low cost mini engineering projects developed by students - www.youtube.com/watch?v=jMwrkB4JQ4M

A1 Project life cycle	• **Whole class teaching and learning – Problem identification:**
	  ○ Lead the group on project development and provide a presentation on identifying a problem
	  ○ Groups will then consider how major manufacturers develop projects at component, assembly and product level, Consider the project development of systems and maintenance activities. A series of case studies could be used to highlight either failures or successes in project development. For example, learners could consider the development of the Airbus A380 and the use of titanium within additive manufacturing for aerospace parts.
	  ○ Encourage learners to explore the rationale for success or failure **[IPS - CS& I]**
	
	• **Small group Activity – Using information sources:**
	  ○ Ask the learners to identify projects that have succeeded and those that have failed that are different from the case studies shown above. Learners could present their findings to the class.
	  ○ Learners should discuss their findings on successful and failed projects and look at the features that are similar and those that are different between these projects
	
	• **Whole class teaching and learning – Choosing a Project:**
	  ○ Ask the learners to choose a possible engineering project from a tutor-led or employer-led theme. Possible project ideas or themes could include energy creation, safety systems for aircraft or vehicles, developing a maintenance schedule or manufacturing a model vehicle. The input of employers at this point with possible ideas would be highly advantageous
	  ○ Lead the group on project development and consider the different stages:
	  ○ Initiation
		A database of Engineering Organisations – A website offering learners an opportunity to find the websites of different engineering organisations and the services they supply. - www.realworldengineering.org/library_search.html
		
		Mechanical Engineering Science Projects – Learners are able to access this website to explore simple ideas to assist with their chosen project - www.sciencebuddies.org/science-fair-projects/Intro-Mechanical-Engineering.shtml
		
		The Electronic Hub – this will allow learners access to over 150+ electronics project ideas - www.electronicshub.org/electronics-projects-ideas/
		
		Maintenance projects:
		Machinery Lubrication – A website allowing learners to explore the basics of project planning in terms of maintenance and reliability - www.machinerylubrication.com/read/1330/planning-maintenance
		Project life cycle:4 Stages of a Project Life Cycle – A video providing details of a typical project life cycle - https://www.youtube.com/watch?v=N3N9-RLSbvo

	○ Planning and design ○ Implementation ○ Evaluation	
A2 Project idea generation and solution development	• **Whole class teaching and learning – Thinking skills:** ○ Lead the group on the use of thinking skills to analyse a problem such as brainstorming, challenging assumptions, mind mapping, sketching and thinking in reverse ○ Encourage learners to explore relevant resources to help identify their problem including the internet, journals, databases and libraries. They could also look at publicly available information from engineering companies. • **Small group Activity – Using information sources:** ○ Groups could then identify the problems that could become projects. Employers could be utilised here to support with ideas ○ Learners could be asked to focus individually or in small groups on possible projects and carry out research to explore the physical resources, associated materials and different types of inputs and outputs required for their project • **Whole class teaching and learning – Outline specification:** ○ Lead the group on developing an outline specification by considering graphical solutions such as sketching, photographs, storyboarding and the creation of flow charts or diagrams ○ Further knowledge of outline specification development could also consider the processing requirements for the project such as machine tools, machining processes, systems and assemblies ○ Lead the group to develop their initial technical information. This will clearly be determined by the project itself but examples could be approximate mass, volume, dimension, suggested materials and outline performance parameters	Problem-Solving Techniques – A website that looks at a wide range of powerful creative problem-solving techniques - https://scottjeffrey.com/creative-problem-solving-techniques/ Six Thinking Hats – This is a simple, effective parallel thinking process that helps people be more productive - https://www.debonogroup.com/services/core-programs/six-thinking-hats/ Sketching Techniques for Beginners – A website showing some basic techniques to help learners communicate ideas - https://shop.zenartsupplies.co/blogs/toolkit/sketching-techniques-for-beginners Product Design Specification – A useful website giving an insight into the production of a design specification - https://rewisoft.com/blog/how-to-write-the-design-specifications-quick-guide/

	• **Small group Activity – Developing an outline specification:**
	  ○ Groups could then generate sketches/drawings or develop storyboards and examine flow charts
	  ○ Learners could suggest possible engineering process requirements and discuss their impact on the project
	  ○ Learners could suggest a range of initial technical information for their project such as function, user requirements, materials, product dimensions, costs, aesthetics, safety processes and time and legal constraints	

A3 Feasibility study of solutions	• **Whole class teaching and learning – Feasibility criteria:**
	  ○ Lead the group on the selection of criteria for a feasibility study which could include the size/complexity of the problem, how well the solution solves the problem, the cost and time required to develop solutions, the expertise and risks involved with the solutions, sustainability and any legal constraints
	• **Small group Activity – Feasibility study:**
	  ○ Groups could then identify the criteria for their feasibility study and discuss the pros and cons in relation to their project. Again, employers could be utilised here to support with ideas
	  ○ Learners could be asked to focus individually or in small groups on each of the chosen criterion to help develop a solution to the problem
	• **Whole class teaching and learning – Proposing a solution:**
	  ○ Lead the group on the selection of the proposed solution by considering objective testing, design analysis and comparison methods
	  ○ Present information to support their understanding of statistical/graphical methods including frequency tables, histograms, frequency distribution, bar and pie charts
		Feasibility Studies – A video giving an sight into how to conduct a feasibility study - https://www.youtube.com/watch?v=WI6_snOjlm0
		
		Bond WT – *Design Project Planning: A Practical Guide for Beginners, 1st Edition* (Prentice Hall, 1995) ISBN 9780133492750
		
		Plummer F – *Project Engineering: The Essential Toolbox for Young Engineers, 1st Edition* (Butterworth–Heinemann, 2007) ISBN 9780750682794
		
		Smith NJ – *Engineering Project Management, 3rd Edition* (Wiley-Blackwell, 2007) ISBN 9781405168021

	○ Present information to support their understanding of quality and resource requirements and limitations along with process capability and fitness for purpose • **Small group Activity – Objective testing:** ○ Groups could then identify appropriate forms of objective testing on their solutions such as gathering project requirements, defining the scope of the testing, setting measurable goals to prevent or identify defects. ○ Learners could be asked to carry out some design analysis using different methods such as iterative steps, feasibility assessment and cost benefits of the solution	
B1 Planning and monitoring project management processes	• **Whole class teaching and learning – Planning:** ○ Lead the group on project development, as they will need to begin the planning stage. Discuss the key points for successful project management. ○ Demonstrate some of the tools they might need such as Gantt Charts and critical path analysis to explore time and resource requirements. ○ Explain advantages and disadvantages of critical path analysis and Gantt charts as forms of planning tools • **Individual Activity – Developing planning skills:** ○ Learners could be asked to develop planning methods for their chosen project using some of the tools discussed in the group activity. For example, they could use Gantt charts to consider the time constraints to carry out each part of their project or critical path analysis to identify 'bottle-necks' in the project.	Successful Project Management – a video exploring the successes and failures of projects - www.youtube.com/watch?v=XjA3EhqCw3U Cost Estimation – A video exploring how to estimate project costs - https://www.youtube.com/watch?v=YQ2Wi3Jh3X0 Excel Basics – An introduction to using Excel spreadsheets - https://www.youtube.com/watch?v=rwbho0CgEAE Project cost estimation – a website exploring the basic types of costs and estimation - https://www.projectmanager.com/blog/cost-estimation-for-projects

	• **Whole class teaching and learning – Costs and Resources:**
	  ○ Lead the group on what they think are the key points for successful project budgeting and resource management.
	  ○ Consider how the learner and the tutor will monitor budget and resource considerations. Explain to learners that they cannot all use, for example, the additive machining equipment or laser cutter simultaneously and that planning is needed to utilise the resources effectively.
	  ○ Lead the group on the use of Excel spreadsheets and their benefits in recording and maintaining project costings for materials, resources and time.
	• **Individual Activity – Use of Spreadsheets:**
	  ○ Learners could develop a spreadsheet to record information such as costings and timings relating to the project
		Basic tasks in Excel – Useful starting tips for those new to spreadsheets - https://support.microsoft.com/en-gb/office/basic-tasks-in-excel-dc775dd1-fa52-430f-9c3c-d998d1735fca

B2 Risk and issue project management processes	• **Whole class teaching and learning – Risk management:**
	  ○ Lead the group with a discussion on the issues and problems that are likely to arise during the development of the project such as availability of resources, materials and time constraints that could affect project deadlines. Explain what the potential risks are and how they can be controlled such as ensuring that you have adequate resources within the centre or factoring in extra time in case there are delays. Explain how managing these risks can determine the success of the project.
	  ○ Introduce methods that can be used to mitigate against risks, such as prevention, reduction and acceptance.
	• **Individual Activity – Risk identification:**
	  ○ Learners could be asked to identify possible risk factors in their projects and consider appropriate solutions.
		Understanding Risks v Issues in Project Management – a video exploring the differences between the two and how they affect your project - https://www.youtube.com/watch?v=UX26R2s2hk0
		Risk Management – a website exploring the risk management process in project management - https://www.projectmanager.com/blog/risk-management-process-steps
		
		HSE Risk Assessment – a guide to safer working practices - https://www.hse.gov.uk/simple-health-safety/risk/

B3 Technical Specification	• **Whole class teaching and learning – Technical solution:**
	  ○ Lead the group with a discussion on the development of the final solution and consider how to create a detailed technical specification.
	  ○ Demonstrate to learners how to develop a technical specification. This should enhance and provide much greater technical detail than the outline specification created for learning aim A. For example, actual voltages or bought in components sizes should be stated and the correct battery size and type or mechanical fastener should be specified.
	• **Individual Activity – Final Technical Solution:**
	  ○ Learners could develop their technical specification in conjunction with their tutor. Ensure that these are presented in their final portfolios, complete with their planning documentation, outline specification and the development work for three possible solutions.
		A Practical guide to writing technical specifications – Writing a technical specification increases the chances of having a successful project - https://stackoverflow.blog/2020/04/06/a-practical-guide-to-writing-technical-specs/

B4 Design information	• **Whole class teaching and learning – Iteration and Final solution:**
	  ○ Lead the group with a discussion on the development of the final design solution with the learners and consider how to create detailed workable designs.
	  ○ Develop or enhance the learner's skills base, as necessary, so that they can create a design from the technical documentation that supports their project.
	  ○ The tutor can offer support to the learners as they develop their design for the project by exploring a range of tools used to design the solution such as engineering drawings, simulations and physical modelling. Include the process of iteration and how the designs can be tested against the technical specification such use of appropriate materials, meeting dimensional tolerances and environmental considerations such as sustainability.
		The iterative design process – Designers use this to simulate methods used in industry to test their ideas - https://www.bbc.co.uk/bitesize/guides/zjjkw6f/revision/4
		
		AutoDesk Cad Tutorials – A website containing online video tutorials for those wanting to develop CAD skills - https://www.autodesk.com/in/campaigns/autocad-tutorials
		
		Understanding Engineering Drawings – An insight into the basic of understanding engineering drawings -

	○ The tutor can also offer support with how to address cost, demand and cultural requirements. • **Individual Activity – Developing the final solution:** ○ Learners could develop their final design solution to include drawings, models, simulations and safety factors. The final design solutions must be agreed with the tutor. Ensure that these are presented in their final portfolios, complete with their planning documentation, outline specification and the development work for three possible solutions.	https://www.youtube.com/watch?v=ht9GwXQMgpo
C1 Undertake and test the solution to the problem	• **Whole class teaching and learning – Practical support:** ○ Support the learners through small-group practical activities as they develop their processes and modify their designs as a result of trial and error. For example, demonstrate the use of the additive machine or the laser cutter for prototyping or demonstrate the use of secondary machining techniques such as drilling or milling. This will depend on the type of projects being undertaken by the learners but the tutor should look for common activities. ○ Support the learners as they further develop their solutions and refer back to the initial proposal and technical specification, to ensure their work is focused and stays on task, identifying corrective actions to overcome issues and problems such as alternate modelling or manufacturing techniques as equipment may not be available. ○ Ensure learners are aware of the essential safety considerations for practical activities and the use of machinery such as the wearing of appropriate PPE and safe use of machines and equipment.	Laser Cutter for Beginners – An introductory video exploring the basics of laser cutting for beginners - https://www.youtube.com/watch?v=SV_9ZyZlorw 3D Printing – A basic introduction to additive manufacturing - https://www.youtube.com/watch?v=1Q7YO5svZtY Design Iteration – A website that explores this simple concept to bring powerful results https://www.interaction-design.org/literature/article/design-iteration-brings-powerful-results-so-do-it-again-designer?srsltid=AfmBOopX7LQ3DpXUZ-SRuQX7ZyrBM0GVFo5Ol_NFYREVqgxo3JND1Rzk

	• **Individual Activity – Product realisation:**
	  ○ Learners could develop their design solutions and create prototypes to test their ideas. Learners should use iteration and modify their design against their prototypes whilst staying within the parameters of their technical specification.
	  ○ Learners can then create their final design solution safely.
	  ○ Once created learners can then test the fitness for purpose of their solution, using appropriate testing methods, and the analysis of test data.	

C2
Demonstrate relevant behaviours
	• **Whole class teaching and learning – Report Writing:**
	  ○ Stress the importance of including their relevant behaviours and safe operation of the project. Consider general engineering skills and be critical in their own abilities noting skills that went well and what did not go well and any rationale for this. They should particularly focus on any issues relating to time planning and resource management.
	
	• **Individual Activity – Portfolio development:**
	  ○ Learners could further develop their project portfolios, to the point of the final conclusion, comparing the success of the project against the initial brief and final technical specification,
	  ○ Learners could also consider the safety aspects of the project and consider the support they may have received from various sources during the project, such as technicians, guests or local employers.
		Report Writing – An introductory video exploring the basics of report writing - https://www.youtube.com/watch?v=2qFTKBOtUSk

C3 Present a solution to the problem	• **Whole class teaching and learning – Presenting the solution:**
	  ○ Lead a group discussion about the portfolio presentation. Emphasise the importance that the portfolio should be a document that they would be proud to present to a future employer.
	  ○ Stress the importance of including all the activities carried out throughout the whole project from the initial brief, through the research and feasibility study to the design and modelling of the solution leading to the presentation of the project.	

	• **Individual Activity – Project presentation:** ○ Learners could collate their portfolio to include all the main features of the activities carried out across all learning aims. Tutors could offer learners their support in compiling their final project portfolios, ensuring they evaluate the success of the project against the initial brief and final technical specification. .	

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

Transferable skills	Ideas for delivery
MY-TPR Taking Personal Responsibility	**Group Activity:** Students can be set a mini project on an area of their choosing, to research a solution to an engineering problem and present their findings back to the class in a short time frame. This will help develop time planning and management skills, developing organisational skills to allocate roles within a group within the group to ensure that each team member plays a part and contributes towards overall success. It will also help practice skills later covered in assessment including independent research and investigation into a problem and presenting a solution.

Resources

This section has been created to provide a range of links and resources that are publicly available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We'd also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

Websites

Pearson has partnered with Didactic Training Services https://dsle.didacticservices.co.uk (login/ account required) to provide centres with guidance on how to introduce units 3 and 4 to learners

Project ideas and development:
www.realworldengineering.org/library_search.html
www.sciencebuddies.org/science-fair-projects/Intro-Mechanical-Engineering.shtml
www.electronicshub.org/electronics-projects-ideas/
http://nevonprojects.com/project-ideas/
https://projecthub.arduino.cc/
https://www.inspiritai.com/blogs/ai-blog/engineering-ideas
https://www.instructables.com/Project-Based-Engineering-for-Kids/
https://www.selfcad.com/blog/best-3d-printing-projects-for-engineering-students

Maintenance projects:
www.machinerylubrication.com/read/1330/planning-maintenance.

There are links below to some of the support systems available, including software houses producing CAD software. Many of these provide free educational software.
www.autodesk.co.uk/
www.solidworks.co.uk/
www.solidworks.com/sw/products/draftsight-getting-started-guide.htm
www.turbocad.co.uk/windows-range/turbocad-deluxe-2d-3d.

There are many links available on the web to some of the many software houses producing CAD/CAM and CNC programming software and machine tools, which may be useful, dependent upon the choice of project.
www.haas.co.uk/
http://website.denford.ltd.uk/
www.techsoft.co.uk/
www.fanuc.eu/uk/en
www.heidenhain.co.uk/

Textbooks

Various textbooks are available for project development. These often cover project development at graduate level and above and may not always be suitable for a Level 3 project. There are textbooks that reference various technical stages, including graphics packages software command structure. Learning materials are available for the different companies that supply CAD/CAM software and the different versions of the software packages that they produce. Books and magazines are available on electronics, maintenance, CNC, 3D printing and many more subject areas to support technical detail.

Bond WT – *Design Project Planning: A Practical Guide for Beginners, 1st Edition* (Prentice Hall, 1995) ISBN 9780133492750. This book explores basic project management, linking it to the design process. It enhances basic design concepts and introduces the design process and its relationship to modelling.

Plummer F – *Project Engineering: The Essential Toolbox for Young Engineers, 1st Edition* (Butterworth-Heinemann, 2007) ISBN 9780750682794. This is a book aimed at the young engineer who wants to enter project management or who has just started in project management. It is written with a work-based approach.

Smith NJ – *Engineering Project Management, 3rd Edition* (Wiley-Blackwell, 2007) ISBN 9781405168021. This book describes engineering project management and aims to have a multi-disciplinary approach to projects. It is useful because it explores the management of small and large projects.

Pearson paid resources also available

- Pearson Student book
- ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
- Digital Teacher Pack (via ActiveLearn Digital Service)

5. Pearson Qualification Support and Resources

This section provides information on support and resources that are available on the Pearson website for this qualification.

Exam Wizard

A free online resource containing a huge bank of past paper questions and support materials to help you create your own mock exams and tests

Pearson Set Assignment Briefs (PSABs)

These assignments are set by Pearson and marked internally by the centre. They should be used for all internal assessments on the course. There are specific PSABs for each internally assessed unit on the course.

Results plus

A free online results analysis tool for teachers giving a detailed breakdown of students' performance in BTEC external assessments.

Sample Assessment Material (SAMs)

These resources illustrate the format and style of questions for the external assessment for this qualification. A mark scheme is also provided which shows how credit is awarded for these questions. The resources can be used to help prepare learners for their external assessment.

SAMS Unit 1 Engineering Principles

SAMS Unit 2 Engineering Applications

Specification

This document contains an overview of the qualification, qualification purpose and structure, units including content and assessment, planning and implementing the qualification, qualification grade, glossary of terms used for internally assessed units, Transferable skills framework, digital skills framework, sustainability framework.

The teachers are expected to use these at the start of the year to standardise the team by answering questions posed in the standardisation materials. A commentary is provided to confirm the correct responses with reasoning and justification provided.

Statement of Purpose

This provides an overview of the qualification's key details. It outlines what students will study, the knowledge and skills they will develop, and any related subjects that complement the qualification. It also highlights potential progression routes for further learning and lists the Higher Education Institutes that have formally expressed their support and recognition for the qualification.

Subject Adviser

A dedicated subject adviser available throughout the year for email, phone and one to one appointment help so please do get in touch if you would like any support or guidance with:

- Planning your courses
- Overview of BTEC quality assurance processes
- Suggested resources
- Teaching and Assessment of internal units and components
- Teaching external units and components
- The training and support materials we have available.

Training

Available training sessions can be booked here. On the left-hand side of the screen, select the qualification 'BTEC National' and subject. Where current training is available a list of titles, an overview of the training and dates will be provided giving teachers the option to select and book onto relevant sessions.

Transferable Skills Guide for Teachers

This guide provides and overview of the BTEC Transferable Skills Framework and how it has been used to integrate the delivery of these skills in the new suite of BTEC Level 3 and Level 2 qualifications starting in 2025.

Transition Guide

This guide provides an overview of what's new in the qualification, a comparison of the previous qualification to this new qualification, an overview of the assessment approach, a mapping guide to show where content is the same, updated or new.

Annexe

Curriculum Planning

The models in this section are intended to support your delivery planning and provide suggestions for the types and subjects of qualifications that might be delivered with this qualification.

Suggested combinations with other qualifications

This qualification can be combined in the following ways depending on the destination of students.

For students intending to progress to higher education to study Engineering (whether general or the various specialist routes)

Option 1	Option 2	Option 3
Maths Physics	Maths AAQ Construction & the Built Environment	Maths Design and Technology

For students intending to progress to higher education to study Product Design

Option 1	Option 2	Option 3
Design & Technology Maths	Design & Technology Physics	BTEC Art & Design Physics

BTEC Key Terms

GLH – Guided Learning Hours, time the students have supervised teaching and learning

IV – Internal Verification, for internal quality assurance

Lead IV – the person responsible for the internal quality assurance across a qualification or programme subject area.

PSAB – Pearson Set Assignment Brief, used for summative internal assessments

SV – Standards Verification, for external quality assurance

Transferable Skills

Managing Yourself

Acronym	
MY-TPR	Taking Personal Responsibility
MY-PS&R	Personal Strengths and Resilience
MY-COP	Career Orientation Planning
MY-PGS	Personal Goal Setting

Effective Learning

Acronym	
EL-MOL	Managing Own Learning
EL-CL	Continuous Learning
EL-SRS	Secondary Research Skills
EL-PRS	Primary Research Skills

Interpersonal Skills

Acronym	
IS-WC	Written Communications
IS-V&NC	Verbal and Non-verbal Communications
IS-T	Teamwork
IS-C&SI	Cultural and Social Intelligence

Solving Problems

Acronym	
SP-CT	Critical Thinking
SP-PS	Problem Solving
SP-C&I	Creativity and Innovation

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For information about Pearson Qualifications, including Pearson Edexcel and BTEC qualifications visit qualifications.pearson.com

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