Institute for Apprenticeships & Technical Education

Engineering and Manufacturing: Manufacturing, Processing and Control

T Level outline content

November 2019

Contents

Introduction

Outline content

This outline content has been produced by T Level panels of employers, professional bodies and providers, and is based on the same standards as those used for apprenticeships. The outline content will form the basis of the specifications for T Level Technical Qualifications, which will be developed by awarding organisations for approval by the Institute for Apprenticeships and Technical Education. One awarding organisation will be appointed to develop and deliver each Technical Qualification following a procurement process.

Colleges and other education and training providers will decide how to structure the T Level courses they offer, based on the qualification specifications. This will enable them to deliver the study programme's mandatory components in the most effective way for students.

A T Level programme consists of a Technical Qualification, substantial industry placement, English and maths, and other occupation-specific requirements where essential for entry to skilled employment. This outline content relates solely to the Technical Qualification part of a T Level programme.

To support progression to skilled employment and further study, the outline content for Engineering and Manufacturing includes a significant level of maths content. However, the admissions requirements of individual Higher Education institutions vary and may also require students to undertake an A level in maths or equivalent alongside their T Level. Additional funding is available to ensure providers are able to offer maths A level, or further maths alongside the T Level should they deem it appropriate to support student progression, and the T Level panel have recommended this is made available to students where appropriate.

A reference document has also been prepared by the T Level panel to provide further detail on the knowledge and skills that they would expect a student to develop as part of the T Level. This will be shared with the awarding organisation selected to deliver this T Level ahead of their direct engagement with the panels prior to milestone 1 of the contract.

Further information about T Levels is available on the website of the Institute for Apprenticeships and Technical Education here: www.instituteforapprenticeships.org, and at www.education.gov.uk.

Engineering and Manufacturing route: Manufacturing, Processing and Control pathway

Awarding organisations will need to ensure that students have an up-to-date knowledge of the legal and regulatory obligations relating to employment in the occupations relevant to the T Level, and understand the practical implication of these on their work.

Maths, English and digital skills are set out in a separate annex. Awarding organisations should integrate these within the qualification so that they are applied in occupationally relevant contexts.

Core content

The core content relates to the whole route 'route core', and the pathway that the Technical Qualification covers 'pathway core'. The core knowledge and understanding is assessed through an examination and core skills through a practical employer-set project.

The core knowledge and understanding focuses on the students' knowledge and understanding of contexts, concepts, theories and principles relevant to the T Level. This could include, where appropriate, assessment of knowledge and understanding relevant to the route and the pathway.

The employer-set project provides the opportunity to develop and apply a minimum range of core skills important for employability. The allocation of content to each type of assessment will need to be approved by the Institute for Apprenticeships and Technical Education.

Engineering and Manufacturing: core skills and workplace practices

The outline content for the T Level "Engineering and Manufacturing: Manufacturing, Processing and Control" confirms the knowledge, skills and behaviours which form the basis of its syllabus and its assessment requirements. The outline content will be designed and developed into a high-quality technical qualification by the awarding organisation that is awarded the licence for this T Level.

The outline content presents knowledge and skills statements across the different components based upon the intended assessment method (e.g. examinations; employer set project; occupational specialism assignments). It is important to recognise that the structure of the document does not illustrate intended course design, indicate recommended teaching and learning strategies, or imply that these components should be delivered discretely or even sequentially.

T Levels are intended to support flexible delivery models, and to increase the opportunities for centres and practitioners to work with their awarding organisation to determine how best to develop and deliver the knowledge and skills outlined, and to tailor programmes to meet the diverse needs of their students.

Engineering and Manufacturing T Level students must start to develop technical and practical skills from the beginning of their programmes, while becoming familiar with the

workplace practices that are essential to safe and effective engineering and manufacturing activities. The content specified is to be developed and secured through experience-led learning where possible, and students should begin to develop and apply fundamental knowledge and skills – using relevant tools and equipment – from the outset. These skills proficiencies, which will lead to defined “levels of competence” in the relevant occupational specialisms, must be developed in ways that reflect genuine workplace demands and world-class industry practices.

While the outline content defines the occupational specialist skills which will be acquired and developed by T Level students, it is important to recognise that these more advanced, specialist skills are underpinned by basic engineering and manufacturing skills and workplace practices, which form the foundation of operating safely and effectively in all engineering and manufacturing environments.

Core knowledge and understanding across Engineering and Manufacturing Route

Element		Content
Working within the Engineering and Manufacturing Sectors	**1.1**	**Engineering and manufacturing design practices** An understanding of: • key principles, tools and methodologies in engineering and manufacturing design practice and processes; • how materials, conditions and context influence engineering and manufacturing design processes and products; • how user requirements are translated into engineering and manufacturing designs; • how research and testing, and different research and testing methodologies, support effective design practices and outcomes.
	1.2	**Maintenance, installation and repair practices** An understanding of: • the roles, functions and operations in this area of engineering and manufacturing practice, and how they relate to the sectors generally; • the key principles, techniques and methodologies relevant to engineering and manufacturing maintenance, installation and repair; • the tools and equipment used in maintenance, installation and repair; • key innovations, changing practices, and trends relevant to maintenance, installation and repair.
	1.3	**Manufacturing, processing and control practices** An understanding of: • key principles and practices that apply in manufacturing, processing and control; • key manufacturing, processing and control tools, equipment, infrastructure, systems and operations; • an understanding of the relationship between manufacturing, processing and control, and engineering design, and engineering maintenance, servicing, installation and repair.
Engineering and manufacturing past, present, and future	**2.1**	An understanding of: • engineering and manufacturing from an historical perspective, including awareness of important technological advances across different sectors, and significant periods of change;

		• significant areas of innovation and emerging trends, and their implications for the sector, including artificial intelligence (AI), robotics, autonomous systems, distributed energy, new and smart materials, hybrid technologies; • the influence, effects, and consequences of significant technological advances, and changing practices, in engineering and manufacturing, to include: ○ principles of sustainability, including product lifecycle, circular economy, exploring alternatives, waste and disposal.
Engineering representations	**3.1**	**Engineering drawings and graphical language** An understanding of: • how to accurately produce, interpret, and amend engineering representations, drawings, and graphical information (e.g. sketches, schematics, diagrams) in different contexts, using various techniques and relevant communications media; • how best to calculate and apply the rules and principles of dimensioning, tolerancing and sizing within engineering and manufacturing contexts.

Essential mathematics for engineering and manufacturing	**4.1**	**Mathematical theory and applications**
		
		A Level 3 knowledge and understanding of mathematics for engineering and manufacturing, including:
		• standard arithmetic:
		  ○ Ordering, intergers, fractions, decimals, percentages, ratios
		  ○ algebra – transposing, factorising and quadratics, Indices and standard forms
		  ▪ including sequences and series,
		  ▪ Problem solving involving growth and decay
		• Geometry including:
		  ○ Calculation of areas and volumes of regular solids e.g. cylinders and spheres,
		• Graphs and charts, relevant to straightforward engineering and manufacturing contexts;
		• standard trigonometry including:
		  ○ Pythagoras' theorem; circular measure; functions, sine and cosine rules; triangular measurement; graphs of trigonometric functions, logs (base 10 and natural)
		  ○ Common ergonomic identities; common ergonomic values.
		  ○ Applications of vectors including dot and cross product (in forces and motions, and alternating current).
		  ○ An understanding of moments (in mathematics and physics).

		• standard calculus including:
		  ○ An understanding of the use of basic calculus to solve defined engineering-based problems using differential and integral calculus.
		• Standard matrices and determinants including:
		  matrices and determinants for routine and non-routine operations;
		• Statistical analysis and probability relevant to fundamental engineering and manufacturing practices.

	4.2	**Number systems used in engineering and manufacturing** An understanding of: • numbering systems and their applications e.g. decimal, binary, octal and hexadecimal
Essential science for engineering and manufacturing	**5.1**	**Scientific methods** An understanding of standard international systems and units of measurement including: • the system of SI base quantities; • the relationship between metric and imperial measures and methods for converting between these two systems; • the nature (and differences) between scalars and vectors. An understanding of scientific method and effective approaches to scientific inquiry and research including: • the concept of the “scientific method”; • different methods, techniques, and models for scientific enquiry and research; • how to analyse, evaluate, synthesise and apply information, data, research findings, deliberation, and the processes, results and outcomes of testing, modelling, and experimenting; • the difference between accuracy, reliability and precision.
	5.2	**Measurement** An understanding of: • techniques for making appropriate and accurate measurements along with use of a range of measurement instruments, technologies, tools and equipment.

	5.3	**Chemical composition and behaviours**
		
		An understanding of:
		• atomic and chemical structures of matter including:
		  ○ the structure, composition, interaction and taxonomy of matter i.e. elements, atoms, molecules and compounds; mixtures, solutions, suspensions and solubility; density; crystals; metals;
		  ○ simple to complex chemical structures.
		• the principle behaviours and effects of chemical interactions in straightforward engineering and manufacturing contexts, including:
		  ○ atomic structure, including the three types, and how this relates to material property
		  ○ how chemicals are used in electricity, including electrochemical cells, the simple cell, internal resistance of a cell, primary and secondary cells, cell capacity, electrolysis and electroplating;
		  ○ common behaviours and effects of chemical reactions in engineering and manufacturing contexts, such as acidity and alkalinity, corrosion and corrosion resistance, material degradation, and potentially dangerous chemical reactions in high-risk operational and manufacturing contexts, and appropriate management and control of these substances;
		  ○ the nature and purpose of chemical interactions and reactions commonly used within engineering and manufacturing contexts, such as chemical etching, surface finishing, bonding, and applications for oils and lubricants
		  ○ the relationship between chemical composition and material qualities (e.g. strength, ductility, weldability)

	5.4	**Physical forces and behaviours**
		
		An understanding of:
		• work, efficiency, energy, and power including:
		  ○ the basic terminology and concepts;
		  ○ force, displacement and cause in “work”;
		  ○ mathematical equations for representing work and how the amount of work done by forces is calculated, negative work, and units of work;
		  ○ potential, kinetic and mechanical energy including the interrelationship;
		  ○ embodied energy.
		• the principal behaviours and effects of physical forces (static and dynamic) in straightforward engineering and manufacturing contexts including:
		  ○ speed, velocity, acceleration, force, and mass;
		  ○ forces acting at a point, linear and angular motion, linear momentum and impulse (and impulsive forces), the principles of conservation of energy and energy conversion, friction, effects of forces on materials, torque, forces acting within supported beams and structures.
		
		A basic understanding of:
		• fluid dynamics and general applications including flow, conditions of flow, viscosity, key differences between liquid and aerodynamics, gas flow, Bernoulli’s principle;
		• thermodynamics and applications including heating and cooling, thermal expansion, heat transfers mechanisms, the four laws of thermodynamics, steam cycles, heat engines, gas cycles, ideal gas laws.
		
		An understanding of:
		• Effects of forces on materials including:
		  ○ Tensile force
		  ○ Compressive force
		  ○ Sheer force
		  ○ Stress and strain
		  ○ Elasticity and elastic limit
		  ○ Hooke’s law

Materials and their properties	**6.1**	An understanding of: • the properties, structures, and classification of materials including: ○ material structures, composition, and bonding in relation to (i.e.): metals (ferrous and non-ferrous), plastics, polymers, natural materials, and composites, and comparative evaluation of materials. • the selection (including rationale), applications and disposal requirements of materials, including:

		○ mechanical, electrical, thermal, magnetic, optical, and deteriorative contexts, and applications; ○ the nature, applications, and advantages of contemporary and smart materials. • material processing techniques and their effects on materials, including: ○ common methods of materials processing and their appropriateness to particular materials and contexts e.g. welding, joining, shaping, brazing, soldering, tempering, hardening, annealing, casting, moulding, sintering, forging, machining, ceramics, composites, wood, foam, smart materials, additive manufacturing; measuring and marking out; • how different materials respond to processing; • heat treatments and surface treatments; • material quality, the condition of materials, how these are managed, and materials testing methods and techniques (destructive and non-destructive), including: ○ how materials degrade and fail, mitigation and prevention; ○ how the condition of materials is identified, monitored, and maintained; ○ the range of standard materials testing methods and techniques, their purposes, applications, and relative advantages and disadvantages (e.g. tensile, hardness, ultrasonic, magnetic particle, disposal).
Mechanical principles	**7.1**	An understanding of: • the fundamentals of motion and mechanics (static and dynamic) underpinning engineering and manufacturing systems, including: ○ (Newtonian) 'laws of motion'; principles and laws relating to inertia, friction, momentum, and gravity; different types of forces (e.g. concurrent forces, non-concurrent co-planar force systems, and non-contact forces); ○ simply supported beams, including static equilibrium (and associated conditions), loading, load distribution, supported reactions; loaded components; ○ relevant laws and theories of motion and mechanics, and how they relate to forces and force systems. • storage and transfer of forces and energy in operation, including: ○ kinetic energy, principles and parameters, to include displacement, velocity and uniform linear acceleration; ○ dynamic parameters and principles; tractive effort, braking force, gravitational force, frictional resistance, momentum, mechanical work power, Newton's laws of motion, D'Alembert's principle,

		principle of conservation of momentum, principle of conservation of energy; ○ practical examples of storage, potential and transfer of energy (e.g. fly wheels, springs, height, pressurised fluids); ○ the range of power sources available across physical, mechanical, electrical, and renewable, including examples of solar, hydro, wind, electric motors, internal combustion, and steam; ○ the operation of mechanical principles and systems.
Electrical and electronic principles	**8.1**	**Electrical and electronic principles** An understanding of: • the basic principles of electricity and electronics, including: ○ the physical principles underpinning electrical and electronic systems and devices (e.g. basic atomic theory, structure and composition, energy, power, networks, charges, flow, force, current, capacitance, waves, conduction, magnetism, inductance, and standard units of measure). • the fundamentals of electric circuit theory and its applications including the coverage of: ○ electricity, electronics, voltage, current, AC/DC, power, resistance, potential difference and dividers, basic electrical elements, Ohm and Kirchhoff's current and voltage laws; ○ use of Ohm's law to calculate parameters in series circuits, parallel circuits and mixed circuits; ○ calculation of current, voltage, and resistance, using circuit theory. • the basic principles of analogue and digital electronics and their applications, including: ○ the differences in signals used in transmission of information, usually electronic signals; ○ characteristics of analogue and digital signals, their definitions, waveforms, voltage and current values, fan in and fan out, signal conditioning, and relevant control systems; ○ examples and relevant technologies, waves, representations (e.g. block diagrams and hierarchical design), flexibilities, uses, memory, power and cost; ○ mathematical methods applied to signal processing. • how to apply knowledge of theories, laws and relevant representations to investigate and solve straightforward problems relating to voltage, current, and resistance in engineering contexts (e.g.): ○ analysis of voltage and current in DC circuit networks comprising resistors, capacitors and

		inductors in series, parallel, and combined series parallel circuits; ○ the relationship between voltage, current and power in AC circuits and represent them in graphs and phasor diagrams; ○ the key electrical properties of semiconductor devices such as diodes operating in forward and reverse mode; ○ High power electrical equipment and electronic devices, their specific issues and applications. • basic properties and principles of magnetism and their common applications in relevant engineering and manufacturing contexts, for example, the relationship between flux density and field strength.
Mechatronics	**9.1**	An understanding of the key components of integrated mechanical and electrical systems; their design, operation, and applications, including: • the operation of electronic devices and circuits in mechatronic contexts; • the operation, use and applications of programmable logic controllers, and the integration and application of mechatronic systems; • the basic principles and applications of hydraulics and pneumatics in relevant contexts.
Engineering and manufacturing control systems	**10.1**	**Control systems** An understanding of: ○ control system theory, including: ○ open and closed loop systems, including their functions and operation, applications, advantages and disadvantages; ○ how control systems are represented in diagrams and their key features (e.g. input/output; transfer function; feedback; summing points) in different applications (e.g. electrical, pneumatic); ○ the relationship between input and output (e.g. steady rate error); ○ feedback and performance in closed loop systems, including under or over-damped, and time dependency; ○ a basic understanding of pulse width and amplitude modulation for control; ○ the advantages and disadvantages of analogue and digital control systems; ○ An understanding of measured parameters (e.g. pressure flow, temperature, speed, position) An understanding of: • how sensors and actuators are used in automation control systems, including:

		○ the purpose and functions of sensors and actuators in control systems (e.g. position and volume of objects being processed; mechanised lifting and moving of objects); ○ types of sensors (e.g. analogue; digital; active; passive), their applications (e.g. switches; proximity sensors; laser; vision systems) and their measurement applications, including electrical, mechanical, thermal, chemical, biological, optical, acoustic and radiation; ○ types of actuators and applications, and different power sources.
Recognised standards in engineering and manufacturing	**11.1**	**Recognised engineering and manufacturing standards** An understanding of: • the framework of relevant established engineering and engineering standards, for example: ○ British Standards (BS) and International Organisation for Standardisation standards (ISO), in terms of range, purposes, and applications in engineering contexts; some awareness of other standards, in terms of types, jurisdictions (e.g. CE), content differences and purposes standards, symbols, conventions and annotations. • the authorities (e.g. Engineering Council), agencies and professional bodies (e.g. IET, IMechE, SOE,) responsible for established engineering and manufacturing standards, their roles and responsibilities; • the purposes, value and applications of established engineering and manufacturing standards in engineering contexts including: ○ the intended effects of these standards on the quality and safety of goods, products, processes, people, and the environment.
Standard operating procedures (SOPs)	**12.1**	An understanding of: • standard operating procedures, in terms of types, purposes, functions, value, and applications; • how and why standard operating procedures are produced, implemented and evaluated in different contexts and for different purposes; • how to access, interpret and comply with standard operating procedures.
Health and safety principles and coverage	**13.1**	**Health and safety principles, coverage, and legislation** An understanding of: ○ essential Health and Safety principles, practices, and procedures which apply in engineering and manufacturing contexts, including:

		○ the importance of Health and Safety practices within the workplace; ○ potential risks and hazards in engineering and manufacturing contexts e.g. equipment, tools; electricity, harmful substances including gases, environments; common industrial injuries that can occur without appropriate precautions ○ the importance of health and safety requirements and practices within high power electrical contexts, across generation, distribution, isolation and storage ○ how health and safety practices, legal requirements and duties apply to different spheres and at different levels e.g. personal/individual, employee and employer obligations, local, national, and global requirements; ○ the health and safety issues, risks and practices that apply generally to engineering and manufacturing workplaces (e.g. safe systems of work; fire safety, oxygen use in the workplace, fire and explosion hazards, manual handling), and an awareness that specific requirements and regulations apply in specialist areas (e.g. Chemicals, Electrical testing, Guarding, Asphyxiation hazards); ○ effective risk and hazard management in different workplace and engineering and manufacturing specific contexts, for example: ○ an understanding of risk and hazard identification, and grading methods and procedures; ○ control measures (e.g. ERICPD, HAZOPs, HAZIDs) ○ key health and safety legislation, relevant regulations, duties, and authorities, including how to access them, for example: ○ Health and Safety Executive (HSE); ○ Reporting of Injuries, Diseases, and Dangerous Occurrences 2013 (RIDDOR); Health and Safety at Work etc. Act 1974 (HASAWA); Control of Substances Hazardous to Health regulations 2002 (COSHH); ○ sector specific examples of relevant legislation, regulations, duties and obligations; • the principles and practices relating to environmental standards, legislation, regulations, compliance and wider sustainability issues, including waste disposal requirements and regulations.
Business, commercial and financial awareness	**14.1**	An understanding of: • basic commercial principles, contexts and operations, including: ○ commercial priorities, principles relating to efficiency and “added value”; ○ markets, customers/clients/partners and resource allocation.

		• Standard and emerging business and commercial practices, including: ○ tendering and contracts and legal issues; ○ management practices, business models, staffing, training, development, research and innovation. An understanding of: • financial and economic concepts and terms relating to the management of money, sources of finance, transactions, revenue, cash flow, profit, costs, payments, assets, liabilities, solvency, financial responsibility, performance; • basic financial literacy e.g. budgets and recording financial transactions, business taxes and rates.
Professional responsibilities, attitudes, and behaviours	**15.1**	An understanding of: • professional conduct and responsibilities in the workplace (and in different engineering and manufacturing contexts), including those relating to: ○ an understanding of own role and responsibilities, relationship to others, organisational structure, accountabilities and inter-dependencies; ○ equality, access and inclusion. • "human factors" within engineering and manufacturing contexts, including: ○ human characteristics, capabilities and limitations; ○ how design, performance and evaluation consider safety, comfort and productivity; ○ human performance, error, and error reduction tools and methodologies. • reputation, ethics, personal, professional, and wider, responsibilities which apply in the workplace, in commercial settings, and in different engineering and manufacturing contexts; • Continuous professional development (CPD) and professional recognition.
Stock and asset management	**16.1**	**Stock and inventory management and control** A general understanding of: • stock and inventory management principles and practices including: ○ the purpose of effective stock inventory management and control; ○ common models and their purposes. • key issues, risks, advantages and disadvantages associated with different stock inventory management and control practices, including: ○ product life cycles, write down, redundant stock, obsolescence, and minimum stock levels; supply chain issues; packaging/storage (e.g. electro-static discharge).

		Asset management and control
		
		An understanding of:
		• asset management principles and practices including:
		  ○ asset lifecycle management processes.
		• key issues, risks, advantages and disadvantages associated with different asset management and budgetary control practices including:
		  ○ understand the asset “life cycle” and the “whole life” approach;
		  ○ issues and requirements associated with the operation and maintenance of assets;
		  ○ the importance of asset management and budgetary control practices.

Quality assurance, control and improvement	**17.1**	An understanding of:
		  ○ quality in engineering and manufacturing developments, processes and activities, including:
		  ○ the main principles, purposes and outcomes of quality assurance; quality control, inspection and testing; quality improvement systems, processes and practices;
		  ○ Workplace practices e.g. 6S methodology – “sort”, “set in order”, “shine”, “standardise”, “sustain” and “safety”.

Continuous improvement	**18.1**	An understanding of:
		• the principles and practices of continuous improvement;
		• specific stages and methods for planning, implementing, monitoring and evidencing continuous improvement, including:
		  ○ reflection and evaluation of processes and practices, continual, incremental changes, improvements and refinements;
		  ○ different methods for gathering feedback and evidence about performance;
		• different approaches to continuous improvement including:
		  ○ different methods and objectives appropriate to specific roles;
		  ○ lean principles and practices;
		  ○ management philosophies focused on continuous improvement (e.g. Six Sigma, Kaizen)

Project and programme management	**19.1**	An awareness of: • how projects are defined, structured, reported on, and measured, according to standardised project management practices, protocols, processes and documentation; • the roles, responsibilities, structure and management of relevant personnel in project management practices

		including external stakeholders and communication channels. An understanding of: • project planning, control methodologies and practices; • risk management ○ budget, quality, cost and time.

Core knowledge and understanding across Manufacturing, Processing and Control pathway

Element		Content
Mechanical principles and systems in practice	**P1**	Demonstrate understanding of fundamental mechanical principles, components, and systems in practical and specialist manufacturing and processing contexts, including: • Understand the operation of different mechanical principles and systems (e.g. how they manage forces, power and motion) • Understand the fundamentals of common mechanisms and lifting machines, including how controllers maintain and control performance (e.g. governors, brakes, levers, gear boxes or torque converters). • Understand key principles relating to the storage and transfer of energy in practical contexts • Understand key principles relating to static, dynamic, structural, and fluid loads in practical contexts; the effects of mechanical loadings on structures and components (e.g. weight, torque, fatigue, aerodynamics)
Electrical and electronic principles and systems in practice	**P2**	Demonstrate understanding of fundamental electrical and electronic principles, components, and systems in practical and specialist manufacturing and processing contexts, including: • Understand the nature, behaviour and measurement of electricity in systems, the key characteristics of power flow analysis and its applications. • Understand the construction and operation of standard power conversion systems. • Know the components of electrical installations and their uses, including common failure modes and protection methods. • Understand common drive devices, their purposes, parameters and applications. • Understand the properties and applications of different electrical circuits and their applications. • Understand the main characteristics of standard electronic systems, components and their uses. • Understand the purposes and applications of electronic sensing and measurement techniques and technologies.

Planning, preparing and implementing manufacturing and processing activities	**P3**	Demonstrate understanding of how to plan, prepare and implement manufacturing and processing activities, including: • an understanding of how to analyse and interpret manufacturing and processing requirements, proposals and technical information to achieve specific outcomes; • an understanding of how to plan and prepare manufacturing and processing activities by determining and specifying technical and resource requirements to achieve objectives; • an understanding of how to produce manufacturing and processing plans.
Manufacturing, processing and control tools, techniques and practices	**P4**	Demonstrate understanding of different manufacturing and processing tools, techniques and practices used in manufacturing and processing, including: • An understanding of advanced tools and techniques used; • an understanding of common materials processing techniques; • a general understanding of the important techniques and processes used, including: assembly and fitting of components; common production techniques; joining techniques; casting and dyes; primary forming processes; common fabrication processes, welding techniques and practices; bonding techniques and practices; jigs and fixtures; and maching tools, systems and processes. • an understanding of computer aided manufacturing (CAM) (e.g. use of industrial robots and flexible manufacturing systems, CAD/CAM interfaces, using modelling to simulate manufacturing process, interpreting component specifications and producing plans for CNC manufacture).
Complex systems in manufacturing, processing and control	**P5**	Demonstrate understanding of how complex engineering systems function in manufacturing and processing operations, including: • an understanding of the operation and use of electronic devices and circuits; • an understanding of electronic circuit design and manufacture; an understanding of the operation of control systems and programmable devices; • an understanding of programmable logic controllers and automation in manufacturing and processing; • an understanding of the operation of different engineering systems in manufacturing and processing

		operations (e.g. system diagrams, system control, system response); • an understanding of the operation of electrical machines; an understanding of motors and drives (e.g. three-phase motors and drives, their load characteristics, rating and calculations, commissioning).
Quality control, quality assurance and quality improvement	**P6**	Demonstrate understanding of quality control, quality assurance and quality improvement principles and practices in manufacturing and processing operations, including: • an understanding of measuring, metrology and testing in manufacturing and processing operations; • an understanding of project management, monitoring and control in manufacturing and processing operations; • an understanding of data analysis and processing (e.g. sourcing, interpreting, validating and recording data to monitor, review, record, validate and evaluate manufacturing and processing operations and performance); • an understanding of evaluation and reporting processes; • an understanding of quality assurance practices in manufacturing and processing operations; • an understanding of continuous improvement techniques and practices in manufacturing and processing operations; • an understanding of organisational efficiency; • an understanding of business improvement techniques

Employer-set project

The employer-set project ensures students have the opportunity to combine core knowledge and skills to develop a substantial piece of work in response to an employer-set brief. The employer-set project forms part of the Technical Qualification and is a separate part of the T Level programme to the Industry Placement.

To ensure consistency in project scope and demand, awarding organisations will develop assessment objectives, which require students to:

- plan their approach to meeting the brief
- apply core knowledge and skills as appropriate
- select relevant techniques and resources to meet the brief
- use maths, English and digital skills as appropriate
- realise a project outcome and review how well the outcome meets the brief

The awarding organisation will work with a relevant employer or employers, to devise a set brief that:

- ensures a motivating starting point for students' projects, for example, a real-world problem to solve
- ensures students can generate evidence that covers the assessment objectives
- is manageable for providers to deliver
- is officially approved by the awarding organisation and employer

By completing the project brief, learners will develop an appreciation of the breadth and diversity of Engineering and Manufacturing and have an opportunity to demonstrate high-quality workplace practices, which allow them to work safely and effectively across different workplace contexts and contemporary workshop environments.

By achieving the assessment objectives and meeting the employer-set brief, students will demonstrate the following core skills to produce quality outcomes, using relevant technology, tools, equipment, systems and components:

Analyse and interpret an employer-set brief

- Evaluate and confirm the brief with reference to context, objectives and constraints (e.g. requirements, resources, precedents, technical issues, costs, health and safety, regulations, possibilities)

Plan and prepare suitable responses to the brief

- Propose, plan and prepare key activities, stages, methods, processes, techniques, documentation, tools, equipment and work areas, including risk assessments.

Develop response/s using key skills and processes

- Apply engineering and manufacturing processes and workshop practices to achieve specific objectives and to produce quality outcomes, using relevant techniques, tools, equipment and technology, within limits of own authority (i.e. a multiple-component operational model, working artefact, or manufactured solution)

Evaluate and quality assure processes and outcomes

- Carry out investigations and tests on proposals, options, components and systems at relevant stages to gather and evaluate relevant evidence and data, and to confirm the suitability of plans, processes, actions and outcomes (including quality control and quality assurance activities)

Communicate and present outcomes and evidence

- Record, report, communicate and present plans, proposals, processes, issues, risks and outcomes to both technical and non-technical audiences, across a range of suitable formats and media (e.g. diagrams; physical and digital records; presentations).

Occupational Specialist Content

Specialist content is structured into different occupational specialisms, which correspond to the apprenticeship standards listed on the relevant occupational map. Occupational specialisms ensure students develop the knowledge and skills necessary to achieve a level of competence needed to enter employment in the occupational specialism, and are organised around ‘performance outcomes’ that indicate what the student will be able to do, as a result of learning and applying the specified knowledge and skills.

Programme: **Engineering and Manufacturing T Level**

Occuational Specialism: **Manufacturing, processing and control (production technologies)**

Performance outcome 1: Analyse projects and specifications, considering the specific requirements, context, resources, tools and equipment, and the suitability of different production technologies, processes, and methods.

Knowledge specific to performance outcome	Skills specific to performance outcome
Scientific knowledge Understand fundamental mechanical principles and systems, and the fundamentals of common mechanisms and lifting machines, in practical and specialist production contexts. Understand fundamental electrical and electronic principles and systems in practical and specialist production contexts. Understand the practical and theoretical uses of the most common production machines and their applications. Understand the application of work-holding devices, cutting tools, and setting up procedures, including how to analyse and conduct production requirements to ensure that work outputs meet required specifications. **Mathematical knowledge** Understand how to use number systems, measurement techniques, and estimation in practical production contexts. Know how to carry out standard calculations in production contexts, using relevant aspects of arithmetic, algebra, geometry and statistics.	**Identify** technical information and resources required for specific production projects, tasks and activities **Interpret and analyse** relevant technical information, data, representations and documentation: - Accurately interpret drawings, specifications, charts (e.g. electrical loading; torque specification charts), scales, and technical terms related to production methods (e.g. cutting, bending, moulding, laminating, and assembly) **Confirm nature and scope** of projects, tasks and activities, based upon specific requirements detailed, context, resources, tools and equipment - Agree and confirm necessary resources, raw materials, costs, outcomes, and timescales. **Identify any potential issues, risks, and areas for further analysis** or investigation: - Evaluate production requirements in terms of time, costs, resources, risks, management processes, and outcomes. **Analyse issues and problems** with machinery, equipment, tools and material, proposing/implementing solutions, where appropriate:

Understand how to apply trigonometry and standard calculus, matrices and determinants in context. Understand standard component classification, numbering and referencing systems and how they apply to production contexts.	- Identify simple machine faults, their cause, and options for resolution (e.g. fast running; blunt tooling; burn marks; incorrect tool compensation)

Performance outcome 2: Plan and prepare relevant materials, resources, tools, and equipment needed to produce the relevant products and outcomes

Knowledge specific to performance outcome	Skills specific to performance outcome
Materials Understand the structure, composition, properties and classification of common materials used in production contexts. Understand the uses, applications and disposal requirements of materials. Understand characteristics relating to material quality and condition, how materials degrade and fail, and how these properties are monitored and maintained (e.g. identification; preventative techniques). Know the range of standard materials testing methods and techniques, their purposes, applications, and relative advantages and disadvantages. Understand materials processing techniques and their effects on materials **Technical information** Understand the purposes and types of standard technical documentation,	**Safely prepare** for relevant production tasks, projects or activities, identifying, anticipating, and addressing actual and potential issues and problems: - Select appropriate materials, products and components to meet customer's needs - Prepare materials, resources, tools, equipment and other technologies, carrying out any risk assessments required, and other necessary checks (e.g. compliance, quality and function) - Carry out routine and specialist maintenance of tools and equipment, in line with organisational guidelines. - Outline, review and verify suitable plans and designs for production **Check and evaluate requirements** (e.g. time, cost, resources, management, processes and outcomes) to help plan, organise and manage projects through relevant stages and to completion. **Review materials and evidence** to inform planning and preparations, making appropriate decisions and changes where necessary:

including how to produce, interpret and amend them. Understand the representations, symbols, annotations and conventions used in engineering and manufacturing technical information. Understand technical drawings, diagrams and representations (e.g. produce 3D model from 2D diagrams).	- Suitable methods and work sequence - Use precedents and estimation to support planning - Check materials conform to grades and dimensions, as specified or detailed in relevant representations **Use relevant documentation,** records (e.g. health and safety), and schedules, to confirm accuracy and feasibility with colleagues/stakeholders **Effectively set up and accurately use** tools, equipment, machinery and other technologies, following relevant instructions and safety requirements: - Set up, adjust, and accurately use relevant measuring, testing, diagnostic tools, rigs and equipment, confirming correct operating parameters. - Correct set up equipment and technology for machining operations, including CNC machines (e.g. to cut, sand, bore, drill, create joints, mould and plane components) to meet production specifications - Measure and mark out components according to specifications and requirements, recognising, selecting and using most appropriate tools and equipment - Apply correct locking and securing methods and techniques **Use correct methods for receiving, moving, handling** and preparing materials (e.g. consumables), resources, tools and equipment **Plan** appropriately **for wastage, disposal, recyclability and sustainability** in planned tasks, projects and activities (including consideration of costs)

Performance outcome 3: Produce relevant products and outcomes, considering the specified requirements, context and materials, using the relevant production technologies, methods, and processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Tools and equipment Know the types and purposes of standard hand and power tools and equipment. Understand the specific applications of different types of tools and equipment used in production contexts, including measurement tools (e.g CMM systems). Know how to select, prepare, use and maintain tools and equipment in production environments, to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary. Understand the range and purposes of standard CAD and CAM systems and software Understand how to use CAD and CAM systems and software in production contexts, across multiple dimensions and collaboratively (e.g. standard features, functions, formats, program tools, techniques, operations and outputs) **Machinery and technology** Understand how to use machinery and technology used in the production environments (e.g. CNC machinery), to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary. **Workplace practices** Understand roles, responsibilities, functions and tasks in production workplace contexts.	**Apply suitable production methods** and techniques to projects, tasks and activities, using appropriate technologies, methods and processes **Apply standard operating procedures** and work towards best practice **Disassemble and assemble** components, sub-assemblies and whole systems (e.g. mechanical, electrical, and electronic), using appropriate techniques and following correct procedures: - Identify, mark, store and organise dismantled parts for reassembly. - Make adjustments and carry out checks for orientation - Correctly secure components using mechanical fasteners (e.g. solid and hollow rivets; anchor units; pins) **Accurately mill and turn** materials and products, using appropriate machines, tools and equipment - Apply these processes across a range of materials, profiles and features - Combine operations within each of these production techniques to produce key components to meet specifications and quality requirements **Carry out cutting, sawing and fitting accurately** to produce shapes and profiles to meet specifications (including with CNC machines). - Use a range of methods and materials, to be used for various assemblies.

Know how to carry out functions in accordance with standard workplace practices, with a particular focus on health and safety, standard engineering processes, hand and power tools and equipment, machinery and technology. Know the limits of own authority and expertise, and how to seek advice, guidance, and relevant expertise and support, as necessary. **Fault finding, diagnosis and resolution methods** Understanding and use a range of basic, or first line, fault diagnosis and resolution methods (both quantitative and qualitative) in production contexts. Understand basic fault detection and isolation methods in production contexts.	**Carry out drilling accurately** and consistently, with given tolerances - Carry out drilling, tapping, reaming and counter-sinking to meet production specifications **Produce one-off components** to meet specifications, including using additive manufacture techniques - Fabricate a range of shapes, profiles and items, including by soldering and brazing. **Install and connect pipework** systems and assemblies to meet specifications, using pipe cutting, bending, forming and assembly techniques appropriate to operations and specific materials and components: - cutting and bending pipes, including angular bends, offsets, bridge sets, and expansion loops - assemble pipes using straight connectors, elbows, tee pieces, reducers, tank connectors and valves. **Produce quality welds** to meet specific requirements, using more than one type of welding technology (e.g. gas welding; MMA; TiG; MiG; and MaG), using single and multi-run welds (to a minimum of 150mm). **Effectively operate programmable processes and computer-controlled systems and technologies** to produce products, using appropriate safety measures - Prepare programs to machine a range of complex features and profiles.

	Apply basic surface treatments to products effectively **Re-instate work areas** and equipment effectively, storing and maintaining tools and equipment appropriately.

Performance outcome 4: Support the delivery (and the management) by helping to **evaluate and review** the outcomes to improve the final product, production methods, and work place practices and processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Standards Know and understand relevant engineering standards to ensure quality, compliance, performance and function. Know and understand standard operating procedures in production and organisational contexts. **Legal and regulatory context** Know and understand relevant legal and regulatory frameworks and documentation, including how to access sources of authoritative information. Understand relevant statutory, quality, environmental quality and compliance procedures and systems. **Health and safety** Understand organisational health and safety regulations and procedures in production contexts. Understand relevant site and process safety, environment and risk management systems and practices.	**Apply safe systems of work** in the delivery of all activities, taking responsibility for safe practices and legal compliance **Monitor production processes**, being alert to potential risks, and anticipating, diagnosing, and identifying potential and actual issues and problems - Follow and maintain work procedures, method statements and production records **Deal promptly and effectively with issues and problems** within the limits of own authority, using appropriate techniques and processes to address or resolve them: - Select suitable methods for fault finding and analysis - Select suitable methods of fault, risk and issue resolution, maintaining operating procedures, outputs, quality, and cost (e.g. help address production problems, breakdowns) - Make first line basic repairs whilst safeguarding the integrity of components and the surrounding area - Check components for robustness, fit and tolerances.

Understand how to confirm, interpret, follow and comply with health and safety requirements at all times. **Quality control, assurance and improvement** Understand the purposes and application of quality control, quality assurance and quality improvement in production contexts. Understand standard quality inspection and testing methods and techniques in production contexts, including non-destructive testing (e.g. ultrasonic or thermographic). Know how to complete and record relevant quality processes in production contexts. **Programme and project management** Know how projects (and programmes) are defined, structured, reported on, and measured in standardised management practices, including project planning and control methodologies. Understand how relevant roles, responsibilities, accountability and management operates in relevant production contexts. Understand how to support and improve projects through research, evidence and evaluation. **Business and commercial awareness** Know how to evaluate production activities in terms of quality, cost and time. Understand commercial and financial objectives and constraints, considering project objectives, resources, efficiency, cost, reputation and risk.	**Report** issues and problems, where appropriate, not exceeding own authority or heightening unacceptable risks **Carry out or assist with** appropriate **quality monitoring and assurance** checks, and tests (including NDT), as part of production processes, including any necessary initial, progressive and confirmatory checks **Check outcomes (e.g. materials) conform** to grades and dimensions, as specified or detail in relevant representations **Monitor and report stock**, materials, resources, and usage (e.g. quantities; volumes) in production processes, identifying potential or emerging issues, problems or risks **Complete effective handover** procedures, confirming quality standards, any specific requirements, and other issues **Evaluate and review** production processes, practices and outcomes, providing relevant technical information and suggestions about quality, performance and potential improvements: - Make effective and efficient use of resources, materials and time. - Make informed recommendations (based upon experience and evidence) on materials, tolerances, plans, specifications, quality, operational performance and outcomes - Evaluate and improve production in line with Continuous Improvement (CI) techniques and take responsibility for CI activity - Support internal audits and participate in external audits, in line with organisational procedures. - Introduce new processes, products and machinery effectively (e.g. confirming

	changed requirements; minimising disruption) - Engage constructively in individual and team performance review activities. **Make positive contributions** to relevant production contexts, identifying opportunities for improvement and using problem-solving techniques (e.g. identifying and eliminating root cause of issues)

Performance outcome 5: **Communicate** production information, proposals and solutions, **producing, recording and explaining** relevant technical information, representations, processes and outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Communication Understand how to communicate technical information and data in production contexts. **Information technology and digital** Know how to use relevant digital and information and communication technology (ICT) to record, manage, store, and amend information, data and records (including using collaborative technologies) in production contexts.	**Demonstrate effective communication**, inter-personal skills and relationship management methods with different technical and non-technical audiences: - Use effective communication techniques at all levels (including oral and written communication) - Demonstrate effective listening, questioning, recording and presentation techniques - Prepare adequately for meetings and formal discussions **Accurately record** relevant technical information, data, risks and issues to support production projects, tasks and activities, at relevant stages **Produce basic** engineering and manufacturing **representations and**

	drawings, and annotations, to support production processes **Monitor, amend and correct information**, data, and communications at relevant stages, within limits of authority **Support high-quality communications** in production activities by confirming information, requirements, expectations, plans, performance, and outcomes in ways that are suitable for purpose and context.

Programme: **Engineering and Manufacturing T Level**

Specialism: **Manufacturing, processing and control (Manufacturing technologies)**

Performance outcome 1: Analyse projects and specifications, considering the specific requirements, context, resources, tools and equipment, and the suitability of different manufacturing technologies, processes, and methods.

Knowledge specific to performance outcome	Skills specific to performance outcome
Scientific knowledge Understand fundamental mechanical principles and systems, and the fundamentals of common mechanisms and lifting machines in practical and specialist manufacturing contexts. Understand fundamental electrical and electronic principles and systems in practical and specialist manufacturing contexts. Know methods for visualising how final manufactured products will look and can be realised from design drawings, and understand the manufacturing stages that will be required. Understand professional planning techniques – resources, tools, equipment, people; and time management. Understand the planning and preparation needed to carry out the manufacturing operations (e.g. obtaining the correct component drawings, material specification and data sheets including COSHH) to determine the manufacturing processes required and the sequence of operations. **Mathematical knowledge**	**Identify** technical information and resources required for specific manufacturing projects, tasks and activities **Interpret and analyse** relevant technical information, data, representations and documentation - Accurately interpret drawings, specifications, scales, and technical terms related to manufacturing methods (e.g. cutting, bending, moulding, laminating and assembly) **Confirm nature and scope** of projects, tasks and activities, based upon specific requirements detailed, context, resources, tools and equipment - Agree and confirm necessary resources, raw materials, costs, outcomes, and timescales. - Outline, review and verify concepts, plans and designs for manufacture **Identify any potential issues, risks,** and areas for further analysis or investigation, to inform processes and agreed outcomes and timeframes: - Evaluate manufacturing requirements in terms of time, costs, resources, risks, management processes, and outcomes. **Analyse issues and problems** with manufacturing machinery, equipment, tools and materials, proposing and implementing solutions, where appropriate

Understand how to use number systems, measurement techniques, and estimation in practical manufacturing contexts. Know how to carry out standard calculations in manufacturing contexts, using relevant aspects of arithmetic, algebra, geometry and statistics. Understand how to apply trigonometry and standard calculus, matrices and determinants in context. Understand standard component classification, numbering and referencing systems and how they apply to manufacturing contexts.	- identifying simple machine faults, their cause and options for resolution (e.g. fast running, blunt tooling, burn marks, incorrect tool compensation)

Performance outcome 2: Plan and prepare the relevant processes, tools, equipment, and resources, needed to manufacture relevant products and produce appropriate outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Materials Understand the structure, composition, properties and classification of common materials used in manufacturing contexts. Understand the uses and limitations of materials in practical, manufacturing contexts, including wood and timber, man-made composite materials (including glass, plastics, electrical components and fittings), fabrics, springs, and fillings and adhesives (man-made and natural). Understand the characteristics of composites and their various applications in practical manufacturing contexts.	**Safely prepare** for relevant manufacturing tasks, projects or activities, identifying, anticipating and addressing actual and potential issues and problems: - Select appropriate materials, resources, products and components to meet customer's needs. **Check and evaluate requirements** (e.g. time, cost, resources, management, processes, and outcomes) to help plan, organise and manage projects through relevant stages, and to completion. - Agree suitable constituent parts, consumables, methods, and work sequence.

Understand the uses, applications and disposal requirements of materials in practical and specialist manufacturing contexts. Understand characteristics relating to material quality and condition, how materials degrade and fail, and how these properties are monitored and maintained (e.g. identification; preventative techniques) Know the range of standard materials testing methods and techniques, their purposes, applications, and relative advantages and disadvantages in manufacturing contexts. Understand materials processing techniques and their effects on materials in manufacturing contexts. Understand the “end-to-end” process required to manufacture products, including fabrics (e.g. pattern development, sampling, drafting, measuring, cutting, sewing, finishing and quality checks). **Technical information** Understand the purposes and types of standard technical documentation, including how to produce, interpret and amend them. Know the representations, symbols, annotations and conventions used in engineering and manufacturing technical information. Understand technical drawings, diagrams and representations (e.g. produce 3D model from 2D diagrams). Understand how to interpret, apply and use technical information in practical and manufacturing contexts, including bills of materials (BOM), component/assembly	- Use precedents and estimation to support planning **Review materials and evidence** to inform planning and preparations, making appropriate decisions and changes where necessary: - Appraise given production plans, proposals and records, challenging and confirming assumptions, estimations, requirements, processes and methodologies. **Produce relevant documentation,** records (e.g. health and safety), and schedules, confirming appropriateness and feasibility with colleagues/stakeholders **Prepare** materials, tools, equipment and other technology, **carrying out any risk assessments** required or other necessary checks (e.g. compliance, quality or function): - Set up equipment and technology for machining operations (e.g. to cut, sand, bore, drill, create joints, mould and plane components) to meet manufacturing specifications - Carry out routine and specialist maintenance of tools and equipment, in line with organisational guidelines. **Effectively set up and accurately use** relevant measuring-aids and equipment **Apply correct locking and securing** methods and techniques **Use correct methods for receiving, moving, handling** and preparing

documentation, inspection records, assembly instructions, electrical/pneumatic/hydraulic circuit diagrams.	materials (e.g. consumables), resources, tools and equipment **Accurately set and adjust** machine, equipment and tool operating parameters (e.g. for CNC machines), following relevant instructions and safety requirements **Measure and mark out** components according to specifications and requirements, correctly selecting and using the most appropriate tools and equipment **Plan** appropriately **for wastage, disposal, recyclability and sustainability** in planned tasks, projects and activities (including consideration of costs)

Performance outcome 3: Produce relevant products and outcomes, considering the specified requirements, context and materials, using the relevant manufacturing technologies, methods and processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Tools and equipment Understand the specific applications of different types of tools and equipment used to manufacture products, including measurement tools (e.g CMM systems). Understand the requirements for the calibration and testing of equipment used in manufacturing contexts. Know the types and purposes of standard hand and power tools and equipment used in manufacturing contexts. Know how to select, prepare, use and maintain tools and equipment in manufacturing environments, to follow relevant guidelines and instructions, and to	**Apply suitable manufacturing methods** and techniques to projects, tasks and activities, confirming appropriate technologies, methods and processes **Apply standard operating procedures** and work towards best practice **Disassemble and assemble** components, sub-assemblies and whole systems, according to appropriate instructions and procedures: - identify, mark, store and organise dismantled parts for reassembly. - Safeguard materials and components during assembly.

seek advice and guidance, where necessary. Understand specific and specialist construction methods for manufactured products (e.g. doweling, jointing, gluing, bonding) in practical contexts. Understand the different methods of laying-up composite materials (e.g. hand lay-up, spray lay-up, and automated lay-up) in practical, manufacturing contexts. Understand the different finishes available for manufactured products, their uses and their limitations in practical, manufacturing contexts. Know the specific options for holding and clamping components prior to manufacturing/assembly in practical contexts. Understand the range and purposes of standard CAD and CAM systems and software in practical contexts. Understand how to use CAD and CAM systems and software in manufacturing contexts, across multiple dimensions and collaboratively (e.g. standard features, functions, formats, program tools, techniques, operations and outputs). **Machinery and technology** Understand the specific applications of different types of machines and technology used to manufacture products. Understand the requirements for the calibration and testing of machinery and technology used in manufacturing. Understand how to use machinery and technology used in the manufacturing environments (e.g. CNC machinery), to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary.	**Accurately shape and manipulate** components and products by material removal, using appropriate machines, tools and equipment - Move, shape and manipulate components to achieve best fit **Accurately mill, turn, and cut** materials and products, using appropriate machines, tools and equipment - Apply these processes across a range of materials, profiles and features - Combine operations within each of these production techniques to produce key components to meet specifications and quality requirements **Carry out drilling accurately** and consistently, with given tolerances, to meet specifications **Ensure that joins are suitably made and treated**, checking that joins are sealed and fit for purpose. **Carry out relevant moulding and laying up** activities to support production **Fix and install** components, using the most appropriate method and material. **Manufacture new or replacement components** to the required specification. **Effectively operate CNC machinery**, using appropriate safety measures and guards.

Workplace practices Understand roles, responsibilities, functions and tasks in manufacturing workplace contexts, including limits of own authority and expertise. Know how to carry out functions in accordance with standard workplace practices, with a particular focus on health and safety, standard engineering processes, hand and power tools and equipment, machinery and technology. Understand the requirements and process for creating complex jigs and templates to meet manufacturing specifications and requirements. Understand the properties, uses and limitations of a range of fixtures and fittings used in practical manufacturing contexts. Understand relevant technical processes that support manufacturing activities, including capability, awareness of manufacturing procedures, defining operating procedures, the need for production scheduling and rescheduling, and how to resolve manufacturing production problems and breakdowns. **Fault finding, diagnosis and resolution methods** Understand and use a range of basic, or first line, fault diagnosis and resolution methods (both quantitative and qualitative) in manufacturing contexts. Understand basic fault detection and isolation methods in manufacturing contexts. Know the limits of own authority and expertise, and how to seek advice,	**Prepare surfaces and apply suitable treatments**, ensure they are free from defects and protect them. **Re-instate work areas** and equipment effectively, storing and maintaining tools and equipment appropriately

guidance, and relevant expertise and support, as necessary.	

Performance outcome 4: Support the delivery (and management) of relevant projects and activities, helping to **evaluate and review** processes and outcomes, and to improve practices.

Knowledge specific to performance outcome	Skills specific to performance outcome
Standards Know and understand relevant engineering standards to ensure quality, compliance, performance and function. Know and understand standard operating procedures in manufacturing and organisational contexts. **Legal and regulatory context** Know and understand relevant legal and regulatory frameworks and documentation, including how to access sources of authoritative information. Understand relevant statutory, quality, environmental quality and compliance procedures and systems. **Health and safety** Understand organisational health and safety regulations and procedures in manufacturing contexts. Understand relevant site and process safety, environment and risk management systems and practices. Understand how to confirm, interpret, follow and comply with health and safety requirements at all times. **Programme and project management** Know how projects (and programmes) are defined, structured, reported on and measured in standardised management	**Apply safe systems of work** in the delivery of all activities, taking responsibility for safe practices and legal compliance **Monitor manufacturing processes**, being alert to potential risks, and anticipating, diagnosing, and identifying potential and actual issues and problems - Follow and maintain work procedures, method statements and production records **Deal promptly and effectively with issues and problems** within the limits of own authority, using appropriate techniques and processes to address or resolve them: - Select suitable methods for fault finding and analysis - Select suitable methods of fault and issue resolution, maintaining operating procedures, outputs, quality, and cost (e.g. help address production problems, breakdowns) - Make first line basic repairs whilst safeguarding the integrity of components and the surrounding area - Check components for robustness, fit and tolerances. **Report** issues and problems, where appropriate, not exceeding own authority and expertise, or heightening risks **Carry out** appropriate **quality monitoring and assurance** checks as part of

practices, including project planning and control methodologies. Understand relevant roles, responsibilities, accountability and management operates in relevant manufacturing contexts. Understand how to support and improve projects through research, evidence and evaluation. **Business and commercial awareness** Know how to evaluate manufacturing activities in terms of quality, cost and time. Understand commercial and financial objectives and constraints, considering project objectives, resources, efficiency, cost, reputation and risk. **Quality control, assurance and improvement** Understand the purposes and application of quality control, quality assurance and quality improvement in manufacturing contexts. Understand quality standards and the application of Quality Management Standards in the workplace (e.g. ISO9001). Understand standard quality inspection and testing methods and techniques in manufacturing contexts Know how to complete and record relevant quality processes in manufacturing contexts.	manufacturing processes, including initial, progressive and confirmatory checks as appropriate - Assess fixtures and fittings for quality and stability. **Check materials conform** to grades and dimensions, as specified or detailed in relevant representations **Monitor and report** stock, materials, resources and usage (e.g. quantities; volumes) in manufacturing processes, identifying potential or emerging issues, problems or risks **Complete effective handover** procedures, confirming quality standards, any specific requirements, and other issues **Evaluate and review** manufacturing processes, practices and outcomes, providing relevant technical information and suggestions about quality, performance and potential improvements - Make efficient and effective use of resources, materials and time. - Make informed recommendations (based upon experience and evidence) on materials, tolerances, plans, specifications, quality, operational performance and outcomes - Evaluate and improve production in line with Continuous Improvement (CI) techniques and take responsibility for CI activity - Support internal audits and participate in external audits, in line with organisational procedures. - Help to introduce new processes, products and machinery effectively (e.g. confirming changed requirements; minimising disruption). - Engage constructively in individual and team performance, as required.

	Make positive contributions to relevant manufacturing contexts, identifying opportunities for improvement and using problem-solving techniques (e.g. identifying and eliminating root cause of issues)

Performance outcome 5: **Communicate** production information, proposals and solutions, **producing, recording and explaining** relevant technical information, representations, processes and outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Communication Understand how to communicate technical information and data in manufacturing contexts. **Information technology and digital** Know how to use relevant digital and information and communication technology (ICT) to record, manage, store, and amend information, data and records (including using collaborative technologies) in manufacturing contexts.	**Demonstrate effective communication**, inter-personal skills and relationship management methods with different technical and non-technical audiences: - Apply effective communication techniques at all levels (including written and oral communication) - Effective listening, questioning, recording and presentation techniques - Prepare for meetings and discussions **Accurately record** relevant technical information, data, risks and issues to support manufacturing projects, tasks and activities, at relevant stages **Produce basic** engineering and manufacturing **representations and drawings** to support manufacturing processes **Monitor, amend and correct information**, data, and communications at relevant stages, within limits of authority **Support high-quality communications**, by confirming information, requirements, expectations, plans, performance, and outcomes in ways appropriate to purpose and context.

Programme: **Engineering and Manufacturing T Level**

Specialism: **Manufacturing, processing and control (processing technologies)**

Performance outcome 1: Analyse tasks, projects and specifications, considering the specific requirements, context, resources, tools and equipment, and the suitability of different technologies, methods and processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Scientific knowledge Understand the operation of different mechanical principles and systems (e.g. how they manage forces, power and motion) Understand the fundamentals of common mechanisms, lifting machines, and drive devices, and how controllers maintain and control performance (e.g. governors, brakes, levers, gear boxes or torque converters) for processing plant. Understand the application of pneumatics and hydraulics as applied to various processing plant and machinery. Understand fundamental electrical and electronic principles and systems in practical and processing contexts. Understand the properties and applications of different electrical and electronic circuits and their application in processing plants. Understand the purposes and applications of electronic sensing and measurement techniques and technologies, and specifically their function within contemporary continuous processing plants. **Mathematical knowledge**	**Identify** technical information and resources required for specific processing projects, tasks and activities **Interpret and analyse** relevant technical information, data, representations and documentation **Confirm nature and scope** of process tasks and activities, based upon specific requirements, detailed, context, resources, tools and equipment **Identify any potential issues, risks,** and areas for further analysis or investigation. - Evaluate processing requirements in terms of time, costs, resources, risks, management processes, and outcomes. **Analyse issues and problems** with process plant, machinery, equipment, instrumentation, and materials, proposing and implementing solutions, where appropriate: - Identify simple machine faults, their cause, and options for resolution (e.g. fast running; blunt tooling; burn marks; incorrect tool compensation)

Understand how to use number systems, measurement techniques, and estimation in practical processing contexts. Know how to carry out standard calculations in processing contexts, using relevant aspects of arithmetic, algebra, geometry and statistics. Understand how to apply trigonometry and standard calculus, matrices and determinants in context. Understand standard component classification, numbering and referencing systems and how they apply to production contexts.	

Performance outcome 2: Plan and prepare the relevant tools, equipment and resources needed to process relevant materials and produce appropriate outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Materials Understand the structure, composition, properties and classification of common materials used in processing contexts. Understand the uses, applications and disposal requirements of materials in processing contexts. Understand characteristics relating to material quality and condition, how materials degrade and fail, and how these properties are monitored and maintained (e.g. identification; preventative techniques).	**Safely prepare** for relevant processing tasks, identifying, anticipating and addressing potential issues and problems. **Check and evaluate requirements** (e.g. time, cost, resources, management, processes, and outcomes) to help plan, organise and manage processing activities through relevant stages and to completion. **Produce relevant documentation**, records (e.g. health and safety), schedules, confirming appropriateness and feasibility with colleagues/stakeholders **Prepare** materials, tools and equipment, **carrying out any risk assessments**

Know the range of standard materials testing methods and techniques, their purposes, applications, and relative advantages and disadvantages. Understand materials processing techniques and their effects on materials. **Technical information** Understand the purposes and types of standard technical documentation, including how to produce, interpret and amend them. Know the representations, symbols, annotations and conventions used in engineering and manufacturing technical information. Understand technical drawings, diagrams and representations (e.g. produce 3D model from 2D diagrams).	required and other preparatory checks (e.g. compliance, quality and function, pre-use safety): - Correctly prepare raw materials, processing equipment, and other technologies - Carry out routine and specialist maintenance of tools and equipment, in line with organisational guidelines. **Effectively set up and accurately use** relevant measuring, testing and diagnostic tools and equipment **Accurately set and adjust** plant and machinery **operating parameters**, following relevant instructions and safety requirements **Check and measure materials** according to specifications and requirements using appropriate equipment (e.g. weighing food; measuring packaging; confirming proportions and composition). **Use correct methods for receiving, moving, handling** and preparing materials, resources, tools and equipment (e.g. raw materials; processing equipment). **Plan** appropriately **for wastage, disposal, recyclability and sustainability** in planned tasks, projects and activities (including consideration of costs)

Performance outcome 3: Produce the relevant product, process or outcome, considering the specified requirements, context, resources and materials, using suitable methods or processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Tools and equipment	**Apply suitable processing methods** and techniques to projects, tasks and

Know the types and purposes of standard hand and power tools and equipment. Understand the specific applications of different types of tools and equipment used in processing contexts, including measurement tools (e.g CMM systems). Know how to select, prepare, use and maintain tools and equipment in processing environments, to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary. Understand the principles of plant maintenance of equipment and processes and how they apply in practice. Understand the range and purposes of standard CAD and CAM systems and software Understand how to use CAD and CAM systems and software in processing contexts, across multiple dimensions and collaboratively (e.g. standard features, functions, formats, program tools, techniques, operations and outputs) **Machinery and technology** Understand how to use machinery and technology used in the processing environment, to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary. Understand the application of processing techniques, including rolling, moulding, injection, pressing, and associated processes, and how these are applied in batch and continuous processing operations. Understand how to control and monitor a process, or plant and equipment, effectively, efficiently and securely, and to resolve common problems or correct abnormal conditions.	activities, using appropriate technologies, methods and processes - Start-up, operate, shutdown or complete a manufacturing batch or continuous process. - Carry out multi-stage operations, including start-up, shutdown and changeovers. **Apply standard operating procedures** and work towards best practice **Carry out necessary tests, experiments and other controlled activities** to investigate and support processing activities (e.g. quality control), analysing and accurately recording results and data. **Disassemble and assemble** components and sub-assemblies in accordance with appropriate instructions and procedures (e.g. for setting up, re-setting, or undertaking first line maintenance of process equipment). **Use basic hand tools and equipment for first line maintenance purposes.** **Apply sealing, bonding and joining** techniques effectively, using seals, gaskets and appropriate jointing materials (e.g. to ensure mechanical integrity after maintenance activities). **Effectively operate programmable processes and computer-controlled systems** and technologies to process materials and products, using appropriate safety measures. **Re-instate work areas** effectively, maintaining and storing tools and equipment appropriately.

Workplace practices Understand roles, responsibilities, functions and tasks in processing workplace contexts, including the limits of own authority and expertise. Know how to carry out functions in accordance with standard workplace practices, with a particular focus on health and safety, standard engineering processes, hand and power tools and equipment, machinery and technology. Understand multi-stage processing operations, including start-up, shutdown and changeovers, and how standard operating procedures (SOPs) are deployed to ensure standardised working practices are maintained in practice. Understand your roles (both independently and within a team) to maintain safe systems of working and the operations required to: - start-up a manufacturing batch or continuous process in line with appropriate standard operating procedures - operate a manufacturing batch or continuous process in line with appropriate standard operating procedures, understanding the principles of operation - shut down/complete a run of the manufacturing batch or continuous process in line with appropriate standard operating procedures, understanding the principles of operation. Understand the potential impact on the processing function of introducing new processes, products and machinery and how to manage and mitigate these issues. **Fault finding, diagnosis and resolution methods**	

Understand and use a range of basic, or first line, fault diagnosis and resolution methods (both quantitative and qualitative) across products, equipment and safety, in line with organisational processes. Understand basic fault detection and isolation methods in processing contexts Know the limits of own authority and expertise, and how to seek advice, guidance, and relevant expertise and support, as necessary.	

Performance outcome 4: Support the delivery (and the management) of relevant projects and activities, helping to **evaluate and review** processes and outcomes, and to improve practices.

Knowledge specific to performance outcome	Skills specific to performance outcome
Standards Know and understand relevant engineering and manufacturing standards to ensure quality, compliance, performance and function. Understand the internal and external regulatory environment for the sector and the employer, and how to comply with regulations in practice. Know and understand standard operating procedures in processing and organisational contexts. **Legal and regulatory context** Know and understand relevant legal and regulatory frameworks and documentation, including how to access sources of authoritative information. Understand relevant statutory, quality, environmental quality and compliance procedures and systems. **Health and safety**	**Apply safe systems of work** in the delivery of all activities, taking responsibility for safe practices and legal compliance **Monitor processes**, being alert to potential risks, and anticipating, diagnosing, and identifying potential and actual issues and problems **Deal promptly and effectively with issues and problems** within the limits of own authority, using appropriate techniques and processes to address or resolve them: - execute incident management protocols **Report** issues and problems, where appropriate, not exceeding own authority and expertise, or heightening risks **Carry out** appropriate **quality monitoring and assurance** checks as part of

Understand organisational health and safety regulations and procedures in processing contexts. Understand relevant site and process safety, environment and risk management systems and practices. Understand how to confirm, interpret, follow and comply with health and safety requirements at all times. **Programme and project management** Know how projects (and programmes) are defined, structured, reported on and measured in standardised management practices, including project planning and control methodologies. Understand relevant roles, responsibilities, accountability and management operates in relevant processing contexts. Understand how to support and improve projects through research, evidence and evaluation. **Business and commercial awareness** Know how to evaluate processing activities in terms of quality, cost and time. Understand commercial and financial objectives and constraints, considering project objectives, resources, efficiency, cost, reputation and risk. **Quality control, assurance and improvement** Understand the purposes and application of quality control, quality assurance and quality improvement in processing contexts. Understand standard quality inspection and testing methods and techniques in processing contexts.	production processes, including initial, progressive and confirmatory checks, as appropriate **Check that materials required for the process conform** to the specification. **Monitor and report** stock, materials, resources, and usage (e.g. quantities; volumes) in processing activities, identifying potential or emerging issues, problems or risks, and taking steps to minimise waste. **Complete effective handover** procedures, confirming quality standards, any specific requirements, and other issues **Evaluate and review** production processes, practices and outcomes, providing relevant technical information and suggestions about quality, performance and potential improvements: - Evaluate and improve production in line with Continuous Improvement (CI) techniques and take responsibility for CI activity - Support internal audits and participate in external audits, in line with organisational procedures. - Introduce new processes, products and machinery effectively (e.g. confirming changed requirements; minimising disruption). - Engage constructive in individual and team performance reviews, as required. **Make positive contributions** to relevant processing contexts, identifying opportunities for improvement and using problem-solving techniques (e.g. identifying and eliminating root cause of issues)

Know how to complete and record relevant quality processes in processing contexts.	

Performance outcome 5: **Communicate** production information, proposals and solutions, **producing, recording and explaining** relevant technical information, representations, processes and outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Communication Understand how to communicate technical information and data in processing contexts. **Information technology and digital** Know how to use relevant digital and information and communication technology (ICT) to record, manage, store, and amend information, data and records (including using collaborative technologies) in processing contexts.	**Demonstrate effective communication**, inter-personal skills and relationship management methods with different technical and non-technical audiences **Accurately record** relevant technical information, data, risks and issues to support production projects, tasks and activities, at relevant stages **Produce basic** engineering and manufacturing **representations and drawings** to support production processes **Monitor, amend and correct information**, data, and communications at relevant stages, within limits of authority **Support high-quality communications**, by confirming information, requirements, expectations, plans, performance, and outcomes in ways appropriate to purpose and context.

Programme: **Engineering and Manufacturing T Level**

Specialism: **Manufacturing, processing and control (Materials technologies)**

Performance outcome 1: Analyse the tasks, projects and specifications, considering the specific processing requirements, context, resources, materials, tools and equipment, and the suitability of different technologies, methods and processes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Scientific knowledge Understand fundamental mechanical principles and systems, and the fundamentals of common mechanisms and lifting machines, in practical and materials manufacture and processing contexts. Understand fundamental electrical and electronic principles and systems in practical and materials manufacture and processing contexts. **Mathematical knowledge** Understand how to use number systems, measurement techniques, and estimation in practical materials manufacture and processing contexts. Know how to carry out standard calculations in materials manufacture and processing contexts, using relevant aspects of arithmetic, algebra, geometry and statistics. Understand how to apply trigonometry and standard calculus, matrices and determinants in practical contexts. Understand contraction allowances in the calculations for specific materials manufacturing and production processes.	**Identify** technical information and resources required for specific materials technology projects, tasks and activities **Interpret and analyse** relevant technical information, data, representations and documentation: - Accurately interpret drawings, specifications, scales, and technical terms related to materials manufacturing and processing (e.g. cutting, bending, moulding, laminating and assembly) - Analyse and report information and data accurately. **Confirm nature and scope** of projects, tasks and activities, based upon specific requirements detailed, context, resources, tools and equipment: - Agree and confirm necessary resources, materials, costs, outcomes, and timescales. **Identify any potential issues, risks,** and areas for further analysis or investigation, to inform processes and agreed outcomes and timeframes. **Analyse issues and problems** with machinery, equipment, tools and material, proposing/implementing solutions, where appropriate: - Identify simple machine faults, their cause and options fo resolution (e.g.

Understand standard component classification, numbering and referencing systems and how they apply to materials manufacture and processing contexts.	fast running, blunt tooling, burn marks, incorrect tool compensation).

Performance outcome 2: Plan and prepare the relevant processes, tools, equipment, and resources, needed to manufacture relevant materials and products

Knowledge specific to performance outcome	Skills specific to performance outcome
Materials Understand the structure, composition, properties and classification of a wide range of materials used in manufacturing and processing contexts, including pattern making materials such as different wood, metal and plastic types; foundry sand; binders; coatings, feeding and filtration systems, refractory materials; metals and alloys; additives; waxes and lubricants; pulps and fibres; and chemicals, such as bleach and brightening agents. Understand the uses, applications and disposal requirements of materials in practice. Understand characteristics relating to material quality and condition, how materials degrade and fail, and how these properties are monitored and maintained (e.g. identification; preventative techniques) in practice. Know the range of standard materials testing methods and techniques, their purposes, applications, and relative advantages and disadvantages in practice.	**Safely prepare** for relevant materials technology tasks, projects or activities, identifying, anticipating and addressing potential and actual issues and problems: - Select appropriate materials, components and resources to meet needs - Outline, review and verify suitable concepts, plans and proposals for materials manufacture and processing **Check and evaluate requirements** (e.g. time, cost, resources, management, processes, and outcomes) to help plan, organise and manage projects through relevant stages and to completion. **Review materials and evidence** to inform planning and preparations, making appropriate decisions and changes where necessary. **Check materials conform** to grades and dimensions, as specified. **Produce and maintain relevant documentation,** records (e.g. health and safety), and schedules, confirming appropriateness and feasibility with colleagues/stakeholders

Understand materials processing techniques and their effects on materials in practice. Understand the processes and practices relating to the production and use of castings (e.g. metal casting) in materials manufacturing and processing contexts. **Technical information** Understand the purposes and types of standard technical documentation, including how to produce, interpret and amend them. Know the representations, symbols, annotations and conventions used in engineering and manufacturing technical information. Understand technical drawings, diagrams and representations (e.g. produce 3D model from 2D diagrams) in practice.	- Store, maintain, manage, retrieve and transfer information and knowledge - Use data sheets effectively for different materials **Prepare** materials, tools, equipment and other technology, **carrying out any risk assessments** required and other necessary checks (e.g. compliance, quality and function): - Carry out routine and specialist maintenance of tools and equipment, in line with organisational guidelines. **Effectively set up and accurately use** relevant measuring, testing, diagnostic tools, rigs and equipment **Use correct methods for receiving, moving**, **handling** and preparing materials (e.g. consumables), resources, tools and equipment - Manage and use materials according to their specified shelf-life. **Accurately set and adjust** machine, equipment and tool **operating parameters**, following relevant instructions and safety requirements - Provide information to support the setting and adjustment of machine, equipment and tool operating parameters. **Measure and mark out** components according to specifications and requirements, correctly selecting and using the most appropriate tools and equipment **Plan** appropriately **for wastage, disposal, recyclability and sustainability** in planned

	tasks, projects and activities (including consideration of costs).

Performance outcome 3: Produce the relevant product considering the specified requirements and raw materials using the relevant production process and method.

Knowledge specific to performance outcome	Skills specific to performance outcome
Tools and equipment Know the types and purposes of standard hand and power tools and equipment. Understand the specific applications of different types of tools and equipment used in materials manufacture and processing environments, including measurement tools (e.g CMM systems). Know how to select, prepare, use and maintain tools and equipment in materials manufacture and processing environments, to follow relevant guidelines and instructions, and to seek advice and guidance, where necessary, including a range of specialist tools and equipment, such as complex moulds, dies and assemblies used in foundry production; and hand and mechanical tools used for manufacturing patterns. Understand the range and purposes of standard CAD and CAM systems and software Understand how to use CAD and CAM systems and software in materials manufacture and processing contexts, across multiple dimensions and collaboratively (e.g. standard features, functions, formats, program tools, techniques, operations and outputs) **Machinery and technology** Understand how to use machinery and technology used in the materials manufacture and processing environment, to follow relevant guidelines and	**Apply suitable materials production methods** and techniques to projects, tasks and activities, confirming appropriate technologies, methods and processes **Apply standard operating procedures** and work towards best practice **Disassemble and assemble** components, sub-assemblies and whole systems, according to appropriate instructions and procedures - Identify, mark, store and organise dismantled parts for reassembly. - Identify re-usable components **Use effective joining and bonding** techniques: - Use appropriate adhesives for a range of materials **Accurately shape** products by material removal, using appropriate machines, tools and equipment **Carry out relevant moulding and laying up** activities to support materials manufacture and processing **Produce and use casts** as part of materials manufacture and processing activities.

instructions, and to seek advice and guidance, where necessary, including specialist machinery, such as vertical milling centres used for manufacturing patterns, and mechanical pulpers, refiners, de-inkers, and other equipment used in paper making. **Workplace practices** Understand roles, responsibilities, functions and tasks in materials manufacture and processing workplace contexts, including the limits of own authority and expertise. Know how to carry out functions in accordance with standard workplace practices, with a particular focus on health and safety, standard engineering processes, hand and power tools and equipment, machinery and technology. **Fault finding, diagnosis and resolution methods** Understand and use a range of basic, or first line, fault diagnosis and resolution methods (both quantitative and qualitative) in materials manufacture and production contexts. Understand basic fault detection and isolation methods in materials manufacture and processing contexts. Know the limits of own authority and expertise, and how to seek advice, guidance, and relevant expertise and support, as necessary.	**Apply sealing and jointing** techniques effectively, using suitable methods for different materials manufacture **Fix components**, using the most appropriate methods and materials **Produce one-off components** to meet specifications, including through additive manufacture **Produce quality welds** to meet specific requirements **Prepare surfaces and apply suitable treatments** ensuring they are free from defects and protected (e.g. hardening, chemical, ceramic). **Effectively operate programmable processes and computer-controlled systems and technologies** to support materials manufacture and processing. **Re-instate work areas** and equipment effectively, storing and maintaining tools and equipment appropriately.

Performance outcome 4: Support the delivery (and the management) of relevant projects and activities, helping to **evaluate and review** processes and outcomes, and to improve practices.

Knowledge specific to performance outcome	Skills specific to performance outcome

Standards Know and understand relevant engineering standards to ensure quality, compliance, performance and function Know and understand standard operating procedures in organisational and materials manufacture and processing contexts. **Legal and regulatory context** Know and understand relevant legal and regulatory frameworks and documentation, including how to access sources of authoritative information. Understand relevant statutory, quality, environmental quality and compliance procedures and systems. Understand current legislation and approved codes of practice related to tools, machinery and equipment used in a range of materials manufacture and processing contexts. **Health and safety** Understand organisational health and safety regulations and procedures in materials manufacture and processing contexts. Understand relevant site and process safety, environment and risk management systems and practices. Understand how to confirm, interpret, follow and comply with health and safety requirements at all times. **Programme and project management** Know how projects (and programmes) are defined, structured, reported on and measured in standardised management practices, including project planning and control methodologies.	**Apply safe systems of work** in the delivery of all activities, taking responsibility for safe practices and legal compliance **Monitor materials technology processes**, being alert to potential risks, and anticipating, diagnosing, and identifying potential and actual issues and problems **Deal promptly and effectively with issues and problems** within the limits of own authority, using appropriate techniques and processes to address or resolve them **Report** issues and problems, where appropriate, not exceeding own authority and expertise, or heightening risks **Carry out** appropriate **quality monitoring and assurance** checks as part of production processes, including initial, progressive and confirmatory checks as appropriate **Monitor and report** stock, materials, and resources, and usage (e.g. quantities; volumes) in materials technology processes, identifying potential or emerging issues, problems or risks **Complete effective handover** procedures, confirming quality standards, any specific requirements, and other issues **Evaluate and review** production processes, practices and outcomes, providing relevant technical information, feedback and suggestions about quality, performance and potential improvements: - Make effective and efficient use of resources, materials and time. - Make informed recommendations (based upon experience and evidence) on materials, tolerances, plans,

Understand relevant roles, responsibilities, accountability and management operates in relevant materials manufacture and processing contexts. Understand how to support and improve projects through research, evidence and evaluation. **Business and commercial awareness** Know how to evaluate materials manufacture and processing activities in terms of quality, cost and time. Understand commercial and financial objectives and constraints, considering project objectives, resources, efficiency, cost, reputation and risk. **Quality control, assurance and improvement** Understand how quality control operates in materials manufacture and processing contexts. Understand the importance of quality assurance processes and management, and how they operate in materials manufacture and processing contexts. Understanding standard destructive and non-destructive testing methods, including the capabilities and limitations of different techniques across different materials manufacture and processing contexts. Understand quality improvement practices and how they apply to materials manufacture and processing contexts, including specific workplace organisation and problem-solving techniques (e.g. 5 S workplace management; visual management systems; single minute exchange of die). Know about lean tools, techniques and methodologies relevant to materials	specifications, quality, operational performance and outcomes - Evaluate and improve production in line with Continuous Improvement (CI) techniques and take responsibility for CI activity - Support internal audits and participate in external audits, in line with organisational procedures. - Help to introduce new processes, products and machinery effectively (e.g. confirming changed requirements; minimising disruption). - Engage constructively in individual and team-based performance reviews, as required. **Make positive contributions** to relevant materials manufacture and processing contexts, identifying opportunities for improvement and using problem-solving techniques (e.g. identifying and eliminating root cause of issues)

manufacture and processing (e.g. process flow analysis; 8 wastes).	

Performance outcome 5: **Communicate** production information, proposals and solutions, **producing, recording and explaining** relevant technical information, representations, processes and outcomes.

Knowledge specific to performance outcome	Skills specific to performance outcome
Communication Understand how to communicate technical information and data in materials manufacture and processing contexts, including formal reports and analysis. **Information technology and digital** Know how to use relevant digital and information and communication technology (ICT) to record, manage, store, and amend information, data and records (including using collaborative technologies) in materials manufacture and processing contexts.	**Demonstrate effective communication**, inter-personal skills and relationship management methods with different technical and non-technical audiences **Accurately record** relevant technical information, data, risks and issues to support production projects, tasks and activities, at relevant stages **Produce basic** engineering and manufacturing **representations and drawings** to support materials manufacture and processing activities - Provide detailed engineering and manufacturing representations where necessary. **Monitor, amend, correct and report information**, data, and communications at relevant stages, within limits of authority **Support high-quality communications**, by confirming information, requirements, expectations, plans, performance, and outcomes in ways appropriate to purpose and context.