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Qualification

Specification

EAL Level 3 Technical Occupational Entry in

Machining (Diploma)

Qualification Number: 610/3910/X

Version 1

Table of Contents

[1.0 About EAL 2](#_Toc129958676)

[2.0 Introduction to the Qualification 3](#_Toc129958677)

[3.0 Qualification Structure 5](#_Toc129958678)

[4.0 Centre and Qualification Approval 6](#_Toc129958679)

[5.0 Profiles and Requirements 7](#_Toc129958680)

[6.0 Assessment 10](#_Toc129958681)

[7.0 Quality Control of Assessments 16](#_Toc129958682)

[8.0 Unit Content 17](#_Toc129958683)

[Appendix 1: Centre Exam Specifications 81](#_Toc129958684)

[Appendix 2: Learner Registration and Certification 82](#_Toc129958685)

# About EAL

For over fifty years, EAL has been the specialist awarding organisation for engineering, manufacturing, building services and related sectors. Developed to the highest technical standards, our qualifications reflect ever-changing industry and regulatory needs. We support the providers of our qualifications with an unparalleled level of service to ensure that learners are well prepared to take the next step in their journeys, whether study, an apprenticeship or work.

Through industry partnerships with EAL Centres and training providers, decades of experience supporting our core sectors, and our role as part of the Enginuity Group, we have built unrivalled knowledge and understanding of employer skills needs. As a result, EAL’s skills solutions, including apprenticeship End-Point Assessment, External Quality Assurance and qualifications are respected and chosen by employers to deliver real lifelong career benefits for all our learners. That’s why in the last ten years, 1.2 million people across the UK have taken EAL qualifications.

## 1.1 Equal Opportunities and Diversity

EAL expects its Centres to enable learners to have equal access to training and assessment for qualifications in line with equalities legislation. Further details can be located in the EAL Equal Opportunities and Diversity Policy.

## 1.2 Customer Experience and Feedback

Customer Experience is a fundamental part of EAL’s commitment to you. EAL aims to ensure that all customers receive a high-quality efficient service. We are always interested in feedback and if you have any comments or feedback on our qualifications, products or services, please contact the Customer Experience team:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

# Introduction to the Qualification

What is this qualification?

This qualification is for adults only (19+) and aligns to the knowledge, skills, and behaviours (KSBs) in the Machining Technician Apprenticeship Standard in England.

It **will not** make the learner industry competent in metal fabrication work but facilitates progression into the occupation by providing potential employers with reliable evidence of the learner’s attainment against the Machining Technician Apprenticeship Standard.

It is intended to form part of an engaging course of learning for adult learners and provides occupational entry, so that learners can progress with further learning and training, into employment and completion of the Apprenticeship Standard.

Who is this qualification for?

Adults (19+) who wish to pursue a career in the advanced manufacturing engineering and engineering construction sectors but have not yet secured employment or an apprenticeship.

What does this qualification cover?

This qualification comprises of units, which reflect specific KSBs in the Machining Technician Apprenticeship Standard.

Please refer to Section 3: Qualification Structure for the units included in this qualification.

## 2.1 Support for this Qualification

This qualification:

* Is regulated at Level 3
* Is supported by employers from the engineering sector
* Forms part of recognised route to help adults into employment in the industry

## 2.2 Progression Opportunities

Learners who complete this qualification will be able to demonstrate to potential employers their commitment and achievement against the KSBs in the Machining Technician Apprenticeship Standard, thus enhancing employability prospects. This will also enable learners to progress to the recognised sector apprenticeship, and work toward becoming an industry recognised machining technician. Learners can further progress to undertake qualifications such as:

* EAL Level 3 Extended Diploma in Machining (Development Knowledge)
* EAL Level 3 Diploma in Advanced Manufacturing Engineering (Development Knowledge)

Further information can be obtained from the EAL Website or alternatively contact:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

## 2.3 Qualification Support Materials

The following materials are available for these qualifications:

* **Assessor Pack**: which contains all relevant assessor guidance relating to the delivery and assessment and marking schemes for the holistically assessed practical assessment
* **Learner Assessment Pack:** which contains the holistically assessed practical assessment, assessment checklists and all associated guidance for learners
* **\*Practice Exam:** for the externally set and marked on-screen exam

**\***The practice exams is available to schedule online as per externally set and marked exams.

All other materials can be accessed by EAL registered Centres from the EAL Website [www.eal.org.uk](http://www.eal.org.uk)

2.4 Achievement of the Qualification

This qualification is gained when all the necessary units have been achieved. The Centre will then be able to apply for the learner’s certificate.

# Qualification Structure

## 3.1 Rule of Combination

This qualification will be obtained by the learner once they have successfully completed the **FOUR** mandatory core units and **FOUR** mandatory occupational specialism units.

This qualification has **600** guided learning hours (GLH) and a Total Qualification Time (TQT) of **630** hours.

**Mandatory core units: ALL must** be achieved.

|  |  |  |  |
| --- | --- | --- | --- |
|  EAL Code | Unit Title | GLH | Ofqual Code |
| TOEC3/001 | Engineering and environmental health and safety in the workplace | 75 | M/651/0911 |
| TOEC3/002 | Engineering organisational efficiency and improvement | 75 | R/651/0912 |
| TOEC3/003 | Essential mathematics and science for engineering and manufacturing | 60 | T/651/0913 |
| TOEC3/004 | The structure, properties and characteristics of common materials | 60 | Y/651/0914 |

**Mandatory occupational specialism units: ALL must** be achieved.

|  |  |  |  |
| --- | --- | --- | --- |
| TOEMA3/001 | Computer-aided draughting, engineering data and documentation required to produce machined engineering components | 90 | T/651/0940 |
| TOEMA3/002 | Machining engineering components using secondary processing machines | 90 | Y/651/0941 |
| TOEMA3/003 | Measuring and inspecting machined engineering components | 60 | D/651/0943 |
| TOEMA3/004 | Producing machined engineering components using computer-aided engineering systems (CNC, CAD/CAM) | 90 | H/651/0945 |

# Centre and Qualification Approval

Centres wishing to run the qualifications will need to comply with the Qualification Specification and EAL’s Centre recognition criteria for these qualifications upon accreditation and launch. Centres must also put in place the appropriate physical and human resources and administration systems to effectively run the qualifications. Please refer to Section 5 for the requirements of Centre staff involved in the delivery of the qualifications.

**For existing EAL Centres to put the qualification on your Centre remit:**

* To add these qualifications to your Centre qualification remit, create and complete a qualification approval application form in Smarter Touch and submit to EAL

**For non EAL Centres to gain Centre approval to run the qualification:**

* Please contact the EAL Customer Experience Department, who will be delighted to hear from you:

EAL Customer Experience

Tel: +44 (0)1923 652 400

Email: Customer.Experience@eal.org.uk

# Profiles and Requirements

## 5.1 Staff Responsible for Registering and Certification of Learners

Centres are required to appoint a suitable member of staff who can take responsibility for registering learners onto qualifications, submitting entries for assessments to EAL and taking receipt of external assessment procedures (if appropriate). They may also be responsible for applying to EAL for learner certificates. The role may be undertaken by the same person who undertakes quality assurance.

## 5.2 Teaching Staff

Tutors / instructors involved with the delivery of the units must demonstrate an understanding of the topics/technical content in this qualification. As a minimum they must have achieved a relevant technical qualification to at least Level 3 which covers the key topics in this qualification.

Teaching staff **must** have knowledge and understanding of:

* The qualification structure and content
* The learning outcomes and assessment criteria they are delivering

It is a **recommendation** that teaching staff will:

* Have a minimum of two years’ experience in teaching / training

  **or**

* Be working towards an appropriate teaching / training qualification

 **or**

* Hold an appropriate teaching/training qualification (e.g., Cert Ed or Learning and Development trainer units)

## 5.3 Learners

There are no formal academic entry requirements for the qualification; however, Centres should ensure that learners have the potential to achieve the qualification. Learners must have the minimum levels of literacy and numeracy to complete the learning outcomes and assessments.

Centres should make learners with particular requirements aware of the content of the qualification and they should be given every opportunity to successfully complete the qualification. EAL will consider any reasonable suggestions for, and from, those with disabilities that would help them to achieve the learning outcomes without compromising the standards required.

Age Restrictions

Learners **must** be at least 19 years old.

##

## 5.4 Assessors

The Centre MUST provide EAL with the names of any tutors, trainers or other individuals who will undertake internal assessment, so that these can be approved prior to them carrying out an assessment role.

Internal assessors **must:**

* Have knowledge and understanding of the assessment criteria they are assessing
* Have knowledge and understanding of the qualification structure, content and assessment components
* Understand the assessment process

It is a **recommendation** that assessor’s will**:**

* Have a minimum of two years’ experience in assessment (e.g. within an N/SVQ or teaching / training environment)

  **or**

* Be working towards an appropriate assessment qualification, such as the ‘Level 3 Award in Assessing Vocationally Related Achievement’

 **or**

* Hold an appropriate assessment qualification (as above)

Assessor continuing professional development

It is the responsibility of each assessor to identify and make use of opportunities for Continuing Professional Development (CPD), such as industry conferences, access to trade journals, and Professional Body / Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge.

It is imperative that records are kept of all such CPD opportunities / occasions and that they provide evidence of cascading such technical knowledge and industry intelligence to all relevant colleagues.

## 5.5 Markers: Technically Competent

Where Centre-based assessments are marked by a person who does not come into the assessor category, the marker must have auditable technical competence in the subject. As an example, for a scientific based assessment the person may have auditable competency in that subject area.

## 5.6 Internal Quality Assurers

This relates to staff undertaking internal verification/moderation of assessment. The Centre MUST provide EAL with the names of any tutors, trainers or other individuals who will undertake internal quality assurance, so that these can be approved prior to them carrying out this role.

The main focus of internal quality assurance for these qualifications are:

* The quality assurance of assessment procedures, including standardisation of assessment practice across different assessors within the Centre
* Internal standardisation of marking and moderation of learner grade awarded

Internal quality assurance staff **must**:

* Be familiar with the occupation(s) covered by the qualification
* Have knowledge and understanding of the qualification structure and content
* Understand the assessment process and the role of quality assurance

It is a **recommendation** that the quality assurance staff will:

* Have experience in quality management / internal verification

 **or**

* Hold an appropriate qualification, such as the ‘Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practice, or the ‘Level 4 Certificate in Leading the Internal Quality Assurance of Assessment Processes and Practice’

Continuing professional development of internal quality assurance staff

It is the responsibility of each internal quality assurance staff member to identify and make use of opportunities for CPD, such as industry conferences, access to trade journals, and SSC and Professional Body / Trade Association events, at least on an annual basis to enhance and upgrade their professional development and technical knowledge. It is imperative that records are kept of all such CPD opportunities/occasions and that they provide evidence of cascading such technical knowledge and industry intelligence to all relevant colleagues.

## 5.7 Staff Invigilating On-Screen Exams

Members of staff with responsibility for invigilating on-screen exams must know, understand, and comply with the Procedures for Conducting the Exam Component within EAL Qualifications’ (EAF 1), which are published by EAL. These members of staff must also:

* Have experience in conducting and controlling exam sessions

 **or**

* Be supervised by an individual experienced in conducting and controlling exam sessions

Note: A tutor / trainer who has prepared the learners for the subject of the exam must not be the sole supervisor at any time during an exam for that subject(s).

# Assessment

The following table indicates the assessment components that are included in the qualification and for each component:

* Who is responsible for setting and marking the component
* How the component is quality assured

|  |  |  |  |
| --- | --- | --- | --- |
| **Assessment component** | **Set by** | **Marked by** | **Method of quality assurance** |
| **Internal** | **External** |
| On-screen exam1 | EAL | EAL | Exam invigilation | Verification and continuous monitoring via EQA visits |
| Centre marked holistic assessments2 | EAL | Centre | On-going standardisation within the Centre(Including moderation) | Verification and continuous monitoring via EQA visits |

1 Refer to Section 6.1 External Assessments (On-Screen Exams).

2 Refer to Section 6.2 Internal Holistic Assessments (EAL Set and Centre Marked).

The learner must pass ALL assessments to achieve the qualification.

A breakdown showing the assessment requirements for each unit is shown below:

|  |  |  |  |
| --- | --- | --- | --- |
| **EAL Code** | **Unit Title** | **On-Screen Exam** | **Centre Marked Holistic Assessment** |
| TOEC3/001 | Engineering and environmental health and safety in the workplace | Core Knowledge Exam 1 | No |
| TOEC3/002 | Engineering organisational efficiency and improvement |
| TOEC3/003 | Essential mathematics and science for engineering and manufacturing | Core Knowledge Exam 2 | No |
| TOEC3/004 | The structure, properties and characteristics of common materials |
| TOEMA3/001 | Computer-aided draughting, engineering data and documentation required to produce machined engineering components | No | Holistic practical assessmentQuestioning component |
| TOEMA3/002 | Machining engineering components using secondary processing machines |
| TOEMA3/003 | Measuring and inspecting machined engineering components  |
| TOEMA3/004 | Producing machined engineering components using computer-aided engineering systems (CNC, CAD/CAM) |

## 6.1 External Assessments (On-Screen Exams)

A specification for the exam, indicating the number of questions to be set for each learning outcome is provided in Appendix 1.

Key Points

* Arrangements must be made for learners to complete the external assessment between the 01st and the 30th of April
* The exam must be undertaken by the learner under controlled exam conditions, in accordance with EAL’s Procedures for Conducting the Exam Component within EAL Qualifications’ (EAF 1)
* The EAL co-ordinator within the Centre will assume responsibility for liaison and correspondence regarding the external assessment component
* Centres will be sampled, and spot checks will be carried out by EAL to ensure exams are delivered in accordance with EAL published procedures
* EAL will release exam results at the end of the third week in May

Assessment objectives are used to set the level of thinking skills being assessed within the level 3 context, including knowledge, understanding and application of knowledge and understanding. Our approach to assessment objectives is designed to complement the purpose of the qualification and align with the occupational levels’ guidance provided by the regulator.

Each unit within the setting specification (Appendix 1) has a set number of questions. Across the questions, there is a question writing requirement to meet a defined coverage of each assessment objective so that the following assessment objective profile is met across the full range of assessment questions, as shown in the table below:

|  |  |
| --- | --- |
| **Assessment Objective** | **MCQ Coverage** |
| **AO1** Knowledge of the principles, processes and procedures | 25% |
| **AO 2** Understanding of the principles, processes and procedures | 50% |
| **AO3** Application of understanding of the principles, processes and procedures | 25% |

Resitting external assessments (on-screen exams)

Learners who fail to achieve a pass will be permitted to resit this exam after feedback and appropriate tuition has taken place.

The learner will be allowed a maximum of two resit opportunities (three attempts in total). Learners who fail to achieve after three attempts will be required to re-register on the qualification.

The resits for externally set and marked exams will be subject to the current published charges.

Resit scheduling

Learners will be permitted to resit within the following arrangements:

Resit 1:

* EAL will open the window for the first resit scheduling opportunity during the last week of May
* Arrangements must be made for learners to complete the external assessment between 1st and the 14th of June.

Resit 2:

* EAL will open the window for the second resit scheduling opportunity during the last week of June
* Arrangements must be made for learners to complete the external assessment between 1st and the 14th of July.

Practice exams

In January of academic year 1 (following the launch of the qualification), EAL will make available an onscreen practice exam. This can be accessed via EAL’s Surpass Exam System. The practice exam is not part of the formal assessment arrangements and will therefore NOT count towards the qualification.

6.2 Internal Holistic Assessments (EAL Set and Centre Marked)

Internal holistic assessment both knowledge and practical are a form of controlled internal assessment marked by the Centre. General information regarding conducting controlled internal assessment can be found in the document ‘EAL Guidance for Controlled Internal Assessment marked by the Centre’ with specific guidance referenced from or contained within this qualification specification.

Internal holistic assessment includes practical and /or knowledge assessments. These assessments are set by EAL and marked by members of the delivery team at the Centre (see profiles of markers in Section 5). All assessment decisions are then subject to internal standardisation and external quality assurance.

Holistic assessments involve collecting and evaluating evidence that demonstrates achievement of the learning outcome / criteria. They are accompanied by marking criteria and other materials to ensure that the markers are consistent in their approach to assessment across learners.

Centres are responsible for ensuring that Centre marked assessments are suitably controlled to ensure that assessment decisions are valid and reliable, and that work submitted for assessment by learners is prepared and produced by them independently, without assistance from others, and free of plagiarism.

Specific Guidance - Controlled internal assessment marked by the Centre

Assessor packs

Assessor packs contain relevant information for Centre staff to use as reference/guidance. These documents must not be shared with the learner as they may contain confidential information for Centre staff only.

Learner assessment packs

Learner assessment packs contain instructions relating to the practical and knowledge assessment. Learners will require access to these documents when they are ready to be assessed. Assessors should issue the learner assessment packs to the learner, together with any Centre devised practical assessment task or tasks which have been developed based on the assessment specification provided by EAL. These documents must be controlled by the assessor and provided to the learner as and when required but not retained by the learner. All assessment documentation must be retained by the assessor and/ or internal quality assurer within the controlled environment, unless where otherwise specified.

Centres must ensure that the assessment criteria information is only made available to a learner during the active part of the assessment.

Learners must be appropriately supervised when undertaking the practical and knowledge assessments. The level of supervision must be sufficient to safeguard the learners’ health and safety, and ensure the evidence generated is attributable to the learner.

Electronic systems and records

Interactive word-based versions of the learner assessment pack and knowledge assessments are available through on-line publications. Where an electronic system is used to administer the electronic versions of the learner assessment pack and /or knowledge assessment, the system used **must** operate with the necessary controls in the same manner as that described under ‘Learner assessment packs and knowledge assessment’ i.e., no assessment documentation should be left with the learners to have uncontrolled access etc. Any electronic system that is used **must** prevent the unauthorised sharing of assessment documentation by learners i.e., via email etc. Where electronic systems with the necessary controls are used, evidence such as learner reports and completed knowledge assessment answers may be uploaded or embedded within the system.

E-portfolio systems are generally NOT considered appropriate for delivering / administering internal assessments electronically. E-portfolio systems may be used to track learner attainment, record assessment outcomes and feedback. The following elements from the assessor and learner assessment packs may be replicated/uploaded to an e-portfolio system:

* Assessor pack: learning outcomes, assessment criteria, assessment specification to include the assessment criteria.
* Learner assessment pack: record of achievement for the knowledge assessment, assessment specification to include the assessment criteria, assessment checklist for the practical assessment and assessment feedback.

It is the responsibility of the internal quality assurer (IQA) for the qualification in advance to verifier the electronic system’s functionality and to agree the systems capabilities with regards to the control of qualification documentation before first use and to quality assure what has been uploaded/embedded is accurate and fit for purpose.

In relation to this qualification, evidence should generally not be uploaded to an e-portfolio system without the necessary controls but may reference to what the evidence is, and where this is located. Where electronic or e-portfolio systems are used, the system must be capable of capturing auditable electronic declarations of authenticity, learner and assessor sign off or the electronic equivalent.

About the holistic assessment

Learners are required to complete a holistic assessment for this qualification between the 01st of April and the 30th of June.

The holistic assessment will be set by EAL and comprises of a work-related scenario.

The holistic assessment will be designed to cover a range of assessment criteria from several units that are relevant to the scenario and related tasks.

The holistic assessment will ensure that all relevant learning outcomes within the qualification have been appropriately covered.

The instructions provided with the holistic assessment will specify the time allowed to complete the tasks, the type of evidence that is expected, and other requirements, as appropriate.

Delivery of the holistic assessment will be subject to rigorous internal standardisation (including moderation).

Planning and conducting the Holistic Assessment

Scheduling the holistic assessment

Arrangements must be made for learners to complete the holistic assessment between the 01st of April and the 30th of June. Centres may determine the precise timing of the holistic assessment to suit local needs.

Time allowed

The time (number of hours) in which the holistic assessment must be completed will be specified in the instructions that accompany it from EAL. The ‘actual’ number of hours spent on the holistic assessment, and the period over which it is completed, must be logged by the learner and verified by Centre staff.

Setting a deadline for completing the holistic assessment

The Centre must specify a due date when learners must complete the holistic assessment. The due date must fall within the designated period (see above) and be communicated clearly to learners. In setting the due date, consideration should be given to ensuring that:

* Learners have a realistic period of time in which to complete the holistic assessment, taking into consideration the specified number of hours and any possible limitations on access to equipment, materials, etc
* Sufficient time will be available for grading, moderation and external verification after the due date has passed
* Contingency arrangements need to be made in the event of learner absence and in extreme cases centres are advised to make a request for special consideration and/or reasonable adjustment.

Resources

Access to resources should be limited to those that are appropriate to the tasks to be completed as part of the holistic assessment, taking account of any requirement for learners to select appropriate tools and materials, if this is specified in the assessment criteria.

The nature of the holistic practical assessment is “open book”. This dictates that access to the internet may be a requirement but will be appropriately restricted in order for learners to access (e.g.) programming manuals, maintenance manuals, relevant formulas, etc. Centres will need to ensure access to unauthorised electronic or wi-fi enabled devices, such as laptops, mobile phones, mobile watches, etc. is restricted. This is to ensure confidentiality of all assessments. EAL recommends that all learner’s unauthorised electronic devices and wi-fi enabled devices, such as mobile phones/watches, are collected by the supervisor at the start of each session.

Learners should be provided with the flexibility to be able to move in the allocated workshop space from one station to another.

Supervision

Learners are not required to be directly supervised under high control conditions with invigilators and high-profile codes of conduct rules on display for learners to adhere to. However, there needs to be sufficient levels of supervision to enable the learner's work to be authenticated (e.g. by delivery staff). This measure will ensure that the progress of the response, at each stage of the development, to the assessment task the learner submits is their own.

The assessor will ensure that interactions between learners are kept to a minimum and are solely for the purpose of accessing the required facilities. At no time should learners be discussing information directly or indirectly related to the assessment.

Learner collaboration

Learners must complete and evidence their work individually. Collaboration between learners undertaking any aspect of the holistic assessment should only be allowed where tasks explicitly state that this is acceptable.

Advice and Feedback from Assessors

Assessors may review learners’ work and provide oral and/or written advice at a general level and, subsequently, allow learners to progress with their task. General advice of this nature does not need to be recorded or considered when the work is being assessed.

Assessors should not give any assistance which goes beyond general advice, for example:

* provide detailed specific advice on how to deliver any aspect of what is being assessed in the assessment criteria
* give detailed feedback on production mistakes which limits learners’ opportunities to show initiative themselves
* intervene personally to improve the product outcome

Assessors must not provisionally assess work (e.g. conduct a formative assessment) and then allow the learner to revise it. Failure of centre staff to adhere to this may constitute malpractice.

Completion and submission

Any material evidence and other supporting information submitted by learners for the holistic assessment will be detailed in the Learner Assessment Pack.

Late submission

Learners must complete their holistic assessment and hand in all relevant materials to the Centre by the due date. Any request to extend the submission date must be considered in accordance with EAL’s policy for Special Consideration.

Assessment decisions and annotation

Assessors are responsible for making assessment decisions of work, in accordance with the assessment criteria detailed in the relevant specification and guidance documents. Assessor annotation should be used to provide evidence to indicate how and why assessment decisions have been awarded. This will facilitate the standardisation of assessment decisions within the centre and enable the moderator to check that assessment decisions are in line with the assessment criteria.

Grading the holistic assessment

Centre assessors should allocate a grade for the holistic assessment for each learner using the Assessment Checklist provided. No other sources of information should be used to make judgements about the quality and sufficiency of the evidence.

All materials should be retained securely and confidentially by the Centre, in accordance with EAL policy.

Retaking Internal Holistic Assessments

Learners who fail to achieve a pass in any specific area of the holistic assessment/s will be permitted a retake opportunity after feedback and appropriate tuition have taken place.

The learner will be allowed a maximum of two retake opportunities (three attempts in total) for each section within the Assessment Checklist. Learners who fail to achieve after three attempts, will be required to re-register on the qualification.

All assessment documents that pass or refer must be recorded and retained by the Centre and made available on request.

Standardisation of Holistic Assessment

Members of the internal quality assurance team at the Centre should work with tutors / assessors to ensure that the correct procedures relating to the delivery of the holistic assessment are followed and ensure assessment decisions taken by different assessors are consistent, fair and reliable. Key activities will include:

* Meeting with tutor / assessors (individually and collectively) throughout the course to discuss quality assurance and standardisation issues and provide support and guidance where needed
* Observing tutor / assessors and giving them feedback to help improve their assessment technique
* Sampling learner evidence across different learner cohorts to ensure that appropriate standards have been met
* Arranging cross-marking of learner work to compare results and agree benchmarks

In addition, once all learners have undertaken and completed the holistic assessment and grading has been carried out, internal moderation should be undertaken by a nominated member of the quality assurance team. This will involve checking and / or re-marking a sample of learner’s work to:

* Ensure that assessors have been consistent in their use of the Assessment Checklist
* Ensure that grades have been allocated fairly and consistently for all learners
* Check the authenticity of learner evidence
* If appropriate, agree changes to grades where anomalies have been detected

Centres/Organisations must have a moderation process in place to ensure that the assessing of internal assessments is both valid and reliable, through which adjustments to results are made and recorded accordingly. This ensures that the assessment process remains current and standards are consistently applied.

Internal moderation should be based on a sample of at least 25% of learners who have completed the holistic assessment and cover all assessors who have been involved in grading decisions. The sample should include any borderline cases that have been identified for review by assessors. If there are fewer than five learners who have completed the holistic assessment, then all learners’ work should be moderated.

Where inconsistencies or other discrepancies are identified, or where there is a disagreement on the grades allocated for particular learners, the level of sampling should be increased. All supporting records should include the comparison of assessment decisions from a representative sample of assessments including purposely highlighting where adjustments were necessary.

The outcomes from internal moderation of holistic assessment, including any proposed changes to allocated grades, should be recorded and made available to the External Quality Assurer.

Centres must maintain an assessment and feedback record for each learner, which details the evidence evaluated against the outcomes and the feedback given to the learner. The record will form part of the Learner Assessment Pack. These records must be available to the External Quality Assurer.

Centres/Organisations can utilise EAL’s IQA documents to support their moderation activities, which can be obtained through Smarter Touch.

Further guidance on holistic assessment is provided within the Assessor Pack.

Questioning component

At appropriate opportunities throughout the duration of the practical holistic assessment, the assessor will ask 10 open questions to assess any underpinning technical knowledge that did not naturally occur during the observation. The assessor may ask open questions to enable to learner to underpin the skills demonstrated too. The assessor may also ask follow-up questions where clarification is required. Examples of open question types have been provided in Section 3 of the Assessor Pack. Questioning must be completed within the total time allowed for the practical holistic assessment. All questions, together with the learner’s responses must be recorded and attached to the assessment recording document in the Learner Assessment Pack. The questioning component must be conducted on a one-to-one basis, under controlled conditions free from influence. A quiet room free from distraction should be made available to the learner if they wish to use it. However, due to the nature of the questions, the learner may choose to demonstrate part, or all, of their understanding whilst within the working area (e.g., by providing a narrative response during a walk through if appropriate).

The assessor should:

* Use open questions to provide opportunities for all learners to demonstrate attainment
* Use follow-up questions, giving the learner the opportunity to explore the discussion point fully. The questions should be thoughtful, relevant and pitched at the appropriate level
* Discuss the learner’s activities with them, looking for evidence of specific knowledge, procedures and processes, and decision making, together with their skills. Questioning should provide a gradual ‘handing over’ to the learner. You would expect the learner to be taking the lead in the discussion after the initial opening questions / brief.

What to avoid:

* Using one question type throughout
* Answering the question yourself instead of expanding on it to get a response
* Overloading the learner with too many questions, allowing them no time to think or to answer fully
* Disregarding answers
* Spending too long on one area of discussion, reducing the time available for other areas
* Asking complex questions too early in the discussion
* Asking closed questions unless a ‘yes’ or ‘no’ answer is specifically required

# Quality Control of Assessments

There are two major activities in which EAL interacts with the Centre in relation to the External Quality Control of Assessment for this qualification. These are:

* Recognition: When a Centre decides to offer the qualification, the EAL External Quality Assurer (EQA) ensures that the Centre is suitably equipped and prepared for delivery and assessment
* Engagement: Throughout the ongoing delivery of the qualification EAL, through monitoring and other mechanisms will review the quality and consistency of assessment and internal quality assurance and recommend actions to address issues of concern

Recognition

In granting approval, EAL, normally through its EQAs, will ensure that the prospective Centre:

* Meets any procedural requirements specified by EAL
* Has sufficient and appropriate physical and staff resources
* Meets relevant health and safety and / or equality and access requirements
* Has a robust plan for the delivery, assessment, and QA for the qualifications (including, where appropriate, scope for involving employers)

EAL may decide to visit the Centre to view the evidence provided.

Engagement

EAL, through EQA Engagement and other mechanisms will ensure that:

* A strategy is developed and deployed for the ongoing monitoring of the Centre – this will be based on an active risk assessment of the Centre, and will include details of the learner, assessor and internal quality assurer’s sampling strategy and the rationale behind this
* The Centre’s internal quality assurance processes are effective in learner assessment
* Outcomes of internal assessment are verified, through sampling, to ensure standards are being maintained
* Sanctions are applied to a Centre where necessary and that corrective actions are taken by the Centre and monitored by the EQA
* Reviews of EAL’s external auditing arrangements are undertaken

8.0 Unit Content

## Unit: TOEC3-001 Engineering and environmental health and safety in the workplace

### GLH: 75

### Unit description

### This unit focuses on the essential knowledge required to ensure a comprehensive understanding of key aspects of both health and safety practices and environmental management.

### Summary of learning outcomes

1. Understand health and safety roles and responsibilities
2. Understand the application of health and safety in the engineering environment
3. Understand environmental management

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand health and safety roles and responsibilities
 | 1.1 | Recognise the roles of key people involved in workplace health and safety | Cover:* HSE inspectors
* Safety officers
* Safety representatives
* Environmental health officers

Look at the powers and roles of these key people in ensuring a safe working environment for all. |
| 1.2 | Recognise the roles of organisations involved in workplace health and safety | Cover:* Health and Safety Executive (HSE)
* Local authorities
* Trading standards
* Environmental health

Look at the powers and penalties at the disposal of these organisations and how they work with engineering companies. |
| 1.3 | State the key duties of the employee in conforming with health and safety requirements | Cover: Duties of employees under sections 7and 8 of the HASAWA; to include the implications of not complying with regulations and procedures.The correct procedures and responsibilities for reporting accidents and injuries in the workplace as given in The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR):* Recording and reporting: accidents, near misses or reportable occurrences
* Principles: incidents, accidents, minor or serious
 |
| 1.4 | State the key duties of the employer in the management of health and safety | Cover: Duties of employers under both the HASAWA section 2 and the Management of Health and safety at Work (MHSW) Regulations. |
| 1.5 | Recognise the content and application of key health and safety legislation | Cover: The content of a typical Health and Safety Policy Statement, to include:* Responsibilities
* Risks
* Consultation with employees
* Safe plant and equipment
* Safe handling and use of substances
* Information, instruction and supervision
* Induction training
* Accident, first aid monitoring
* Emergency, fire procedures
* Key areas of risk
* Lone working

The content, application and responsibilities within Key Health and Safety Legislation to include current issue of:* The Health and Safety at Work etc. Act 1974
* Control of Substances Hazardous to Health (COSHH) Regulations
* The Health and Safety (Safety Signs and Signals) Regulations
* The Provision and Use of Work Equipment Regulations
* The Health and Safety (Display Screen Equipment) Regulations
* The Personal Protective Equipment at Work (PPE) Regulations
* The Management of Health and Safety at Work Regulations
* The Workplace (Health, Safety and Welfare) Regulations
* The Manual Handling Operations Regulations
* First Aid at Work Regulations
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the application of health and safety in the engineering environment
 | 2.1 | Recognise the procedures in performing a risk assessment activity | Cover: How the procedures apply to the learner:* What is risk assessment?
* What are risks / hazards?
* What are the 5 steps to risk assessment?
* Recording risk assessments
* When to perform a risk assessment
* Relationship with other safety regulations
 |
| 2.2 | State how to safely perform manual handling tasks | Cover:* Correct manual handling procedures and risk assessment
* The content of The Manual Handling Operations Regulations:
	+ Duties of employer
	+ Duties of employee
	+ Assessing loads and risk
* The use of mechanical aids to assist manual handling
* The correct handling / lifting technique
* The maximum recommended manual handling load weights at specified heights
* Distance from the body
 |
| 2.3 | State how to safely move loads |
| 2.4 | Recognise how to correctly store gases, oil, acids, adhesives and engineering materials | Cover:* The requirements of COSHH regulations
* The structure of storage buildings, stillages and shelving
* Control of ventilation, extraction and temperature
* Good housekeeping and stock management
* The storage of flammable liquids / compressed gases
* The storage of oil, acids and adhesives
 |
| 2.5 | Recognise the procedures for working in dangerous circumstances | Cover:* Confined spaces
* Trenches
* At height
* With chemicals / toxic substances
* Dust enriched atmospheres
* Damp/wet atmospheres
 |
| 2.6 | Recognise fire and emergency evacuation procedures | Cover:* The causes of fire and the fire triangle
* Types of extinguishers and the classes of fire
* Evacuation and fire procedures notices
* Escape route identification
* The role of fire marshals
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand environmental management
 | 3.1 | Recognise the relevant legislation and EU directives with regard to environmental management | Cover: The basic content and application of current environmental legislation and EU directives, to include:* ISO 14001
* Environmental Protection Act
* Pollution Prevention and Control Act
* Clean Air Act
* Radioactive Substances Act
* Controlled Waste Regulations
* Dangerous Substances and Preparations and Chemical Regulations
* Hazardous waste regulations
* Waste Electric and Electronic Equipment (WEEE) Regulations
 |
| 3.2 | Identify what other sources of energy are available other than fossil fuels | Cover: How are they harnessed and converted into usable energy, to include:* Solar
* Heat pump
* Hydroelectric (reservoirs)
* Tidal
* Wind power (wind farms)
* Waste end energy-producing incineration
 |
| 3.3 | Identify the types and likely causes of industrial emissions | Cover:* Air / pollution
* Noise
* Water
* Vibration
* Light
 |
| 3.4 | Recognise the requirements for the safe disposal of waste | Cover:* Labelling of waste materials
* Oils; cutting oil, sump oil, etc
* Contaminated PPE
* Radioactive waste
* Chemicals, dangerous substances, acids and adhesives
* Refrigeration gases
* Workshop waste; oily rags, swarf, etc
* The action required in the event of accidental spillage / release of substances
 |
| 3.5 | Identify ways in which industry may manage, reduce or control their emissions and meet carbon reduction targets  | Cover:* Designing products to be more sustainable
	+ Using less energy to manufacture products
	+ Using less material and packaging within products
	+ Increasing the services life of products; making products easier to repair and spare parts available
	+ Manufacture products from recyclable material and / or manufacture products from materials that can be recycled at the end of their life
* Recycling waste materials from the manufacturing process and / or services to recycle products at the end of their life
* Climate change agreements and impact on industry
* Mandatory carbon emissions reduction scheme for energy-intensive organisations in the public and private sectors; Carbon Reduction Commitments (CRC)
* Energy monitoring: Data logging to optimise energy performance
 |

Unit: TOEC3-002 Engineering organisational efficiency and improvement

GLH: 75

Unit description

This unit focuses on the essential knowledge required to ensure a comprehensive understanding of key aspects of modern production methods, quality control, business improvement and the rights and responsibilities of those employed within an engineering organisation.

Summary of learning outcomes

1. Understand production activities
2. Understand the application of quality control and quality assurance
3. Understand organisational improvement techniques and competitiveness
4. Understand personal rights and responsibilities within an organisation

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 4.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand production activities
 | 1.1 | Explain the different types and methods of production | Cover:* Mass
* Flow
* Automated
* Batch
* One-off
 |
| 1.2 | Recognise the considerations that need to be made when selecting a production type or method | Cover:* Market requirements
* Design of product
* Plant and equipment availability
* Plant and equipment layout
* Personnel
* Production control
* Quality control
* Cost
* Reverse engineering

The methods and application of Cellular and Just in Time (JIT) production techniques to modern production needs. Explain and give examples of how Push and Pull types of production are applied to meeting company and customer needs and expectations.The cost factors to be considered with the different production methods, to include both direct and indirect costs. |
| 1.3 | Identify the different stages of production planning | Cover:* Scheduling
* Loading
* Dispatching (co-ordination of pre-production activities)

Describe the requirements necessary to produce a work schedule, to include:* Engineering drawings
* Technical data
* Personnel
* Machinery / tools
* Components
* Materials
* Consumables
* Time management
 |
| 1.4 | Explain how to apply typical process charts | Cover:* Flow charts / diagrams, to include Gantt charts
* The symbols used in flow charts
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand the application of quality control and quality assurance
 | 2.1 | Explain the meaning of the terms ‘Quality Control’ and ‘Quality Assurance’ | Cover:The meaning of the term ‘quality’ as fitness for purpose or meeting customer expectations.The meaning of the terms ‘quality control’ and ‘quality assurance’:* Quality control as carrying out the procedures identified in quality assurance
* Quality assurance as the writing and implementing the procedures that ensure
* Quality control takes place

When to apply quality control:* Design
* Purchasing
* Production planning
* Manufacture (process control)
* Final inspection and dispatch
 |
| 2.2 | Describe the role and stages of inspection activities | Cover:Inspection as the tool by which quality control is applied and the role of the Inspector as checking compliance with the quality standard and procedures.Statistical process control (SPC) as a means of measuring quality/performance is within agreed limits.Document control as an integral part of quality assurance that provides:* Evidence about the existence of a system
* A record of the correct operation

Quarantine as a clearly marked area that is controlled by the quality department that is used to store any defective work, whilst a decision is made if the work will be:* Scrapped
* Reworked
* Adjusted

Types and the purpose of sampling, to include:* Spot check and random sampling
* Process sampling and batch sampling

What is meant by mean time between failures (MTBF), in the context of sample size and frequency. |
| 2.3 | Explain the application and content of the BS EN ISO 9000 series of standards | Cover:BS EN ISO 9001, as an internationally recognised quality assurance standard, which is designed to bring together all the activities that may already exist in a company that support quality advantages including:* Involvement of all levels within a company
* Rationalised systems and procedures
* Improved costs
* Improved efficiency
* Consistent quality of product or service
* Customer confidence

The role of the Quality Manual, the Process / Procedures Manual and internal / external audits in compliance with BS EN ISO 9001. |
| 2.4 | Explain the role and responsibilities of the Quality Manager | Cover:The role of the quality manager / team as a functional role in terms of relationship with other managers/departments within the company. |
| 2.5 | List the elements of quality planning | Cover:The considerations to be made when developing a quality plan, to include:* Establishing quality requirements (customer expectations)
* Allocation of responsibilities (at all levels)
* Agree production times to ensure quality can be met
* Agree budgets to support quality activities
* The setting up of systems to measure quality and report progress
* Identification and calibration of quality equipment
* Ability to take corrective actions if nonconformity is found
 |
| 2.6 | Describe the principles of Total Quality Management (TQM) | Cover:The principles of Total Quality Management (TQM), as a way of thinking about goals, organisations, processes and people to ensure that the right things are done right first time. This thought process can change attitudes, behaviour and hence results for the better.The advantages of adopting TQM, to include:* Making an organisation more competitive
* Establishing a new culture which will enable growth and longevity
* Providing a working environment in which everyone can succeed
* Reducing stress, waste and friction
* Building teams, partnerships and co-operation
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand organisational improvement techniques and competitiveness
 | 3.1 | Explain the meaning of the terms Lean Manufacture, Kaizen, Just in Time and Kanban and their overall advantages | Cover:Examples for the terms meanings:* Lean manufacture e.g., removal of waste of all kinds (time, motion, inventory, poor cost of quality etc.), stimulate productivity and quality and use value-added processes. (Low Quality = High Waste; High Quality = Low waste and Higher Values)
* Kaizen e.g., a philosophy that encompasses continuous improvement, ‘can we make it faster with less waste and fewer mistakes and also make it easier’
* Just in time (stockless production or lean production) e.g., manufacturing to order not to stock
* Kanban is an aspect of manufacturing that manages the overall supply chain efficiently and effectively

Examples of overall advantages:* Better quality products
* Making quality a responsibility of every worker, not just for quality control inspectors
* Reduced scrap and rework
* Reduced cycle times
* Lower setup times
* Smoother production flow
* Less inventory of raw materials, work-in-progress and finished goods
* Cost savings
* Higher productivity
* Higher worker participation
* More skilled workforce, able and willing to switch roles e.g., multi skilling and flexible workforce
* Reduced space requirements
* Improved relationships with supplier
* Improved safety
 |
| 3.2 | Recognise the importance of improving productivity | Cover:The meaning of the term ‘production’, using historical and present day examples of practice to compare how it has developed in recent years.How improved productivity benefits the company, the region, the GDP of a country and also the individual employee in terms of:* Earnings
* Pension security
* Safety
* Working hours / conditions

How improved productivity means by definition less waste (show how this has an effect on the environment).How the national and global marketplaces are driven by competitiveness, therefore the importance for companies to improve productivity:* Multinationals, nationals and regional
* SMEs and sole traders
 |
| 3.3 | Recognise the need for continuous improvement to ensure organisational competitiveness | Cover:* What is ‘continuous improvement’?
* What benefits are gained as a result of continuous improvement?
* Who within an organisation is involved with continuous improvement and in which roles?
* What are the basic four stages of a continuous improvement cycle (plan, do, check, and action)?
* What are the underlying principles that support continuous improvement?
* How ‘flexible working’ and ‘multi-skilling’ apply to continuous improvement?

Why continuous improvement is important in the national and global marketplaces, to allow a company to keep its competitive edge:* Multinationals, nationals and regional
* SMEs and sole traders
 |
| 3.4 | Recognise how to manage the production process | Cover:* What is the importance of the layout of the production area?
* What are: batch production, synchronisation and lead-time?
* How can lead time be improved?
 |
| 3.5 | Recognise the importance of teamwork and the individual’s contribution to effective teamwork | Cover:Teamwork and individuals’ contribution; the meaning of the term ‘team’:T - together E - everyone A - achieves M – more.What are the stages of the development of a team?* What are the roles within a team (e.g., leaders, doers, thinkers and carers)?
* Why is it important to have balance in a team?
* What can individuals bring to a team?
* How can team building be used to bring a team together into and effective group?
* How effective communication within the team is important

What skills are important for effective teamworking? * Good communication, influencing, listening, problem-solving, planning and organising, decision making, conflict resolution, reliability.
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand personal rights

and responsibilities within anorganisation | 4.1 | Identify the relevant organisational documentation and employment legislation in relation to personal rights and responsibilities | Cover:What is contained in each of the relevant organisational documentation and employment legislation listed below:* Contracts of Employment
* Employment Rights Act
* Staff Handbook
* Working Time Regulations
* Health and Safety at Work etc Act
* Data Protection Act
* Personnel Records
* Equal Opportunities Policies
* Human Rights Act
* Equalities Act
* Grievance Procedures
* Appraisals
* Discipline Procedures
 |
| 4.2 | Identify the personal opportunities for development and progression | Cover:The various development and progression opportunities listed below and what is required to achieve them (e.g., the necessary career path):* Company training programme
* Apprenticeships
* Organisational training opportunities
* Promotion
* Transfer
* Higher education
* Professional qualifications
 |

Unit: TOEC3-003 Essential mathematics and science for engineering and manufacturing

GLH: 60

Unit description

This unit enables the learner to develop knowledge and understanding of fundamental numeracy and science applied to engineering and manufacturing practice.

Summary of learning outcomes

1. Understand fundamental numeracy applied to engineering and manufacturing
2. Understand fundamental science applied engineering and manufacturing

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 2.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**Calculations should, wherever possible, be related to the engineering activities the learners are involved in. |
| --- | --- | --- |
| 1. Understand fundamental numeracy applied to engineering and manufacturing
 | 1.1 | Identify the metric and imperial systems and the preferred standard form | Cover:* Converting metres to centimetres and millimetres
* Converting feet to metres and centimetres
* Expressing large, small, and decimal numbers in preferred standard form
* Converting square millimetre (mm²) to square metres (m²)

  |
| 1.2 | Identify the techniques used for calculating approximation | Cover:* Calculating approximate material requirements
* Calculating approximate cost
* Calculating approximation to complete a task
 |
| 1.3 | Add, subtract, multiply and divide: whole numbers, fractions and decimals | Cover:* Add, subtract, multiply and divide: whole numbers
* Add, subtract, multiply and divide: fractions
* Add, subtract, multiply and divide: decimals (to 2 decimal places)
 |
| 1.4 | Convert fractions to decimals and decimals to fractions | Cover:* Converting fractions to decimals (to 2 decimal places)
* Converting decimals (to 2 decimal places) to fractions
 |
| 1.5 | Calculate average, mean, median and mode | Cover:* Calculating the mean of specific engineering data
* Calculating the median of specific engineering data
* Calculating the mode of specific engineering data
 |
| 1.6 | Calculate ratio, proportion and percentages | Cover:* Calculating ratio in an engineering context
* Calculating proportion in an engineering context
* Calculating percentages in an engineering context
 |
| 1.7 | Calculate area, surface area, mass, volume, capacity | Cover:* Calculating area (rectangles, squares, circles, triangles)
* Calculating surface area (cylinders and spheres)
* Calculating mass (solid objects and liquid substances)
* Calculating volume (rectangular prisms and cubes, cylinders and pyramids)
* Calculating capacity (spherical objects and cone-shaped objects)
 |
| 1.8 | Calculate probability | Cover:* Calculating single event probability
* Calculating two independent events probability
* Calculating dependant events probability
 |
| 1.9 | Calculate the square and square root of a number | Cover:* Square of whole numbers
* Square root of a number
* Definition and formula for obtaining the square of a number
* Definition and formula for obtaining the square root of a number
 |
| 1.10 | Transpose simple formulae | Cover:* Transposing formula, such as:
	+ Ohms law (V = IR)
	+ Area of a circle (A= πr²)
	+ Newton’s second law of motion (F = m x a)
* Methods of transposition such as: adding, subtracting, dividing or multiplying the same quantity both sides
* Methods of transposition by using the opposite sign method
 |
| 1.11 | Calculate spindle speeds  | Cover: * Calculating spindle speeds for twist drills of various diameters

Formula (Metric)Spindle Speed [Revolutions Per Minute (RPM)] = S x 1000 / π x DS (m/min) = Surface speed or cutting speed constant provided by the manufacturer for a given material D = Diameter of the twist drill |
| 1.12 | Solve problems using Pythagoras’ theorem for right-angle triangles  | Cover:* Finding the length of c of a right-angle triangle:

c2 = a2 + b2* Finding the length of b of a right-angle triangle:

b2 = c2 - a2* Finding the length of a of a right-angle triangle:

a2 = c2 - b2Using practical engineering examples, where appropriate. |
| 1.13 | Solve problems using trigonometry for right-angle triangles  | Cover:* Finding the length of the hypotenuse in a right-angle triangle: sin x = opposite / hypotenuse
* Finding the length of the adjacent side of the hypotenuse in a right-angle triangle: cos x = adjacent / hypotenuse
* Finding the length of the opposite side in a right-angle triangle: tan x = opposite / adjacent
* Calculating the size of an angle in a right-angle triangle using three primary trigonometric ratios for a right-angled triangle: sine (sin), cosine (cos), and tangent (tan)
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Understand fundamental science applied to engineering and manufacturing
 | 2.1 | Recognise common SI units | Cover:* Length
* Area
* Volume
* Time
* Heat
* Temperature
* Mass
* Force
 |
| 2.2 | Identify the types of forces used in engineering | Cover:* Tension
* Compression
* Bending
* Torsion
* Shear
 |
| 2.3 | Identify the modes of heat transfer | Cover:* Conduction
* Convection
* Radiation
 |
| 2.4 | Identify how and why materials are selected with low frictional values | Cover:* Inhibit mechanical damage
* Reduce noise
* Reduce heat
 |
| 2.5 | Identify structures and states of matter | Cover:* Atoms
* Molecules
* Elements
* Mixtures
* Compounds
 |
| 2.6 | Identify lines of flux within magnetic fields | Cover:* Lines of flux for like poles
* Lines of flux for unlike poles
* Current passing along a straight wire
* Solenoids
* Transformer induction
 |
| 2.7 | Identify the causes of friction | Cover:* Surface roughness
* Surface contamination
* Inter-surface adhesion
 |
| 2.8 | Recognise the main principles of the basic theory of electricity | Cover:* Electron flow
* Structure of an atom
* Charged particles
* Coulomb
* Ampere
 |
| 2.9 | Recognise the relationship between conductors, current, magnetic fields and relative movement | Cover:* Production of alternating current
* Production of direct current
* Generator principle (Fleming’s Right Hand Rule)
* Motor principle (Fleming’s Left Hand Rule)
 |
| 2.10 | Calculate moments and levers | Cover:* Calculating moments (m = force x perpendicular distance)
* Classes of levers
* Mechanical advantage (MA = Fo )

 Fi |
| 2.11 | Calculate heat input and change in length | Cover:* Calculating heat input (Amps x Volts) / Travel speed
* Calculating thermal expansion (ΔL = αLΔT)
 |
| 2.12 | Calculate resistors in series and parallel circuits | Cover:* Calculate resistors in series circuits
* Calculate resistors in parallel circuits
* Calculate resistors in equivalent circuits
 |
| 2.13 | Perform simple calculations using thebasics of electricity | Cover:* Simple circuits
* Power (W) = Voltage (V) x Current (A)
* Resistance
* Ohms law
 |

Unit: TOEC3-004 The structure, properties and characteristics of common materials

GLH: 60

Unit description

This unit enables the learner to develop knowledge and understanding of the structure, properties and characteristics of common materials.

Summary of learning outcomes

1. Understand how to select engineering materials
2. Understand material properties and heat treatment processes

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice exam, which assesses the knowledge requirements of learning outcomes 1 – 2.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the on-screen multiple-choice exam.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**To support the learning from this learning outcome, learners should be encouraged to consider how materials are applied to engineering applications and why. |
| --- | --- | --- |
| 1. Understand how to select engineering materials
 | 1.1 | Identify the factors that make materials suitable for engineering applications | Cover:* Available forms of supply
* Cost
* Properties of material
* Application of product
* Manufacturing capability
* How a material reacts in different environments
 |
| 1.2 | Identify the classification, range and application of materials used in engineering | Cover:Material classification:* Metallic (pure metals and alloys)
* Non-metallic materials
* Composites
* Natural materials
* Thermoplastics
* Thermosetting plastics
* Ceramics

Range of materials:* Cast iron
* Carbon and alloy steels
* Stainless steel
* Aluminium
* Aluminium alloys
* Copper
* Brass
* Bronze
* Lead
* Nylon
* PVC
* Perspex
* Rubber
* Wood
* Glass
* Glass fibre
* Epoxy resins
* Carbon fibre
 |
| 1.3 | Identify the forms of supply of engineering materials | Cover:* Sheet
* Plate
* Bar
* Wire
* Section
* Extrusions
* Castings
* Wrought
* Forgings
* Pipe and tube
* Hot and cold rolled
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth** If possible, learners should be shown materials at different stages/states of heat treatment (e.g., before and after annealing work hardened) showing how properties can be altered to suit further reworking. |
| --- | --- | --- |
| 1. Understand material properties and heat treatment processes
 | 2.1 | Identify the properties associated with basic engineering materials | Cover:* Ductility
* Malleability
* Hardness
* Toughness
* Strength
* Brittleness
* Plasticity
* Elasticity
* Conductivity
* Dielectric strength
 |
| 2.2 | Identify the basic heat treatment process as applied to changing the properties of materials | Cover:* Hardening
* Tempering
* Annealing
* Normalising
 |
| 2.3 | Identify how the properties are affected by the application of heat | Cover:* Thermal expansion
* Structural alterations
* Magnetism
* Electrical resistance
 |
| 2.4 | Identify why the different properties make materials suitable for different applications | Cover:* Heat resistance
* Thermal and electrical conductivity
* Thermal and electrical insulation
* Wear resistance
* Corrosion resistance
* Load bearing capacity
* Shear strength
* Weight
* Cost
* Tensile strength
* Ability to withstand low temperatures
* Factors why engineering materials can fail
 |

Unit: TOEMA3-001 Computer-aided draughting, engineering data and documentation required to produce machined engineering components

GLH: 90

Unit description

This unit enables the learner to acquire knowledge and skills to interpret and use engineering data and documentation required to produce machined engineering components.

Summary of learning outcomes

1. Be able to use verbal and written communication skills in engineering settings
2. Be able to obtain and use engineering information
3. Be able to interpret engineering CAD drawings that comply with drawing standards
4. Be able to produce engineering drawings using a computer-aided design (CAD) system that comply with drawing standards
5. Be able to develop and use a product specification to produce a production plan for machining

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 5.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to use verbal and written communication skills in engineering settings
 | 1.1 | Communicate information effectively in written work | Cover:* Note taking, e.g., lists, mind mapping / flow diagrams; writing style, e.g., business letter, memo writing, report styles and format, email; proofreading and amending text; use of diary / logbook for planning and prioritising work schedules; graphical presentation techniques, e.g., use of graphs, charts and diagrams
 |
| 1.2 | Communicate information effectively using verbal methods | Cover:* Speaking, e.g., with peers, supervisors, use of appropriate technical language, tone and manner; listening, e.g., use of paraphrasing and note taking to clarify meaning; impact and use of body language in verbal communication
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to obtain and use engineering information
 | 2.1 | Use appropriate information sources to solve an engineering task | Cover:* Information sources:
	+ non-computer-based sources, e.g., books, technical reports, institute and trade journals, data sheets and test / experimental results data, manufacturers’ catalogues
	+ computer-based sources, e.g., inter / intranet, electronic / cloud based, DVD-based information (manuals, data, analytical software, manufacturers’ catalogues), spreadsheets, databases
* Use of information: e.g., for the solution of engineering problems, for product / service / topic research, gathering data or material to support own work, checking validity of own work / findings
 |
| 2.2 | Use appropriate ICT software packages and hardware devices to present information | Cover:* Safety considerations e.g., housekeeping (slips trips and falls), display screen equipment regulations, recycling bins and safe disposal of waste
* Software packages: word processing; drawing, e.g., 2D CAD, graphics package; data handling and processing, e.g., database, spreadsheet, presentation package, simulation package such as electrical / electronic circuits, plant / process systems; communication, e.g., email, inter / intranet, video conferencing, optical and speech recognition system
* Hardware devices: computer system, e.g., personal computer, network, plant / process control system; input / output devices, e.g., keyboard, scanner, optical / speech recognition device, printer, plotter
* Present information: report that includes written and technical data, e.g., letters, memos, technical product / service specification, emails, tabulated test data, graphical data; visual presentation, e.g., charts, computer-based presentations (PowerPoint)
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to interpret engineering CAD drawings that comply with drawing standards
 | 3.1 | Identify relevant national and international standards and conventions relating to engineering drawing practice | Cover:* Requirements of current national and international standards and conventions e.g., engineering drawing practice BS 8888:2020, BS 5070-3:1988, BS 499-1:2009, ISO standards
 |
| 3.2 | Interpret the main features of a given engineering CAD drawing which complies with drawing standards | Cover:* Obtaining information from engineering drawings, e.g., component features, dimensions and tolerances, surface finish, manufacturing detail, assembly instructions and parts list; company standardised layouts, e.g., drawing number, title and issue number, projection symbols (first angle, third angle), scale, units, general tolerances, name of person responsible for producing drawing
* Line types, e.g., Centre, construction, outline, hidden, leader, dimension; lettering, e.g., titles, notes
* Projection e.g., isometric, orthographic projection: first and third angle; views, e.g. elevation, plan, end, section, auxiliary
* Representation of common features, e.g. screw threads, springs, splines, repeated items
* Section views, e.g. hatching style, webs, nuts, bolts and pins, solid shafts
* Symbols and abbreviations, e.g. A/F, CHAM, Ф, R, PCD, M
* Standard representation / symbols, e.g., mechanical, welding, electrical, electronic, hydraulic / pneumatic.
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to produce engineering drawings using a computer-aided design (CAD) system that comply with drawing standards
 | 4.1 | Prepare a template drawing using a CAD system and save to file that comply within drawing standards using appropriate commands | Cover:* Prepare a template: standardised drawing sheet, e.g., border, title block, company logo; save to file
 |
| 4.2 | Produce, store and present detailed CAD drawings of a minimum of three single-piece engineering components that comply with drawing standards using appropriate commands | Cover:* CAD systems: computer systems, e.g., personal computer, networks; output devices, e.g., printer, plotter; storage, e.g., server, hard disc, CD, pen drive; 2D CAD
* Software packages, e.g., AutoCAD, Microstation, Cattia, Pro/Engineer, Pro / Desktop
* Produce engineering drawings: set-up commands, e.g., absolute / relative / polar coordinates, limits / extents, grid, snap, layers / levels, colours
* Drawing commands, e.g., coordinate entry, line, arc, circle, snap, polygon, hatch, text, dimensioning
* Editing commands e.g., copy, move, erase, rotate, mirror, trim, extend, chamfer, fillet
* Viewing commands e.g., zoom, pan, rotate
* Inserting other drawings / objects e.g., symbols, blocks
* Modifying commands e.g., copy, rotate, move, erase, scale, chamfer, fillet
* Store and present engineering drawings: save work as an electronic file, e.g., hard drive, server, pen drive, DVD; produce paper copies, e.g., print, plot, scale to fit
 |
| 4.3 | Produce a CAD assembly drawing of a product containing three parts that complies with drawing standards using appropriate commands |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to develop and use a product specification to produce a production plan for machining
 | 5.1 | Develop a product specification for use in production planning for machining | Cover:* Product specification: aspects relative to manufacturing and not the customer; type of information required for manufacture, e.g., engineering drawings, process description, make and assembly techniques and requirements, materials required, measurements, tolerances and other quality specifications
 |
| 5.2 | Use a product specification to produce a production plan for machining | Cover:* Production plan: consideration of a product specification and types of production; requirements (processes, materials required, quantities required, tools and equipment, labour required, estimated process times, quality checks
 |

Unit: TOEMA3-002 Machining engineering components using secondary processing machines

GLH: 90

Unit description

This unit enables the learner to acquire knowledge and skills to machine engineering components using secondary processing machines.

Summary of learning outcomes

1. Know how traditional and specialist secondary processing machines function
2. Know how work-holding devices and tools are set up to produce a range of engineering component feature
3. Be able to safely set-up and operate secondary processing machines to accurately produce engineering components with a range of features

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Know how traditional and specialist secondary processing machines function
 | 1.1 | Explain how traditional secondary processing machines function | Cover:* Kinematics: machine tool design; generation and forming of shapes; six degrees of freedom
* Traditional secondary processing machines: basic principles of operation; machine’s suitability to manufacture relevant components (process selection); relevant safe working practices for each machine; machine terminology, e.g. cross slide, spindle, head stock, generation of shapes, forming of shapes; traditional secondary machining techniques, e.g. turning (Centre lathe, capstan, turret, single-spindle automatic, multi-spindle automatic), milling (horizontal, vertical, universal), grinding (surface, cylindrical, Centreless, universal, thread grinding, tool and cutter grinding, universal or purpose-built machines), drilling (single spindle, multi-spindle), boring (horizontal, vertical)
	+ turning: machine, e.g., Centre lathe, turret; features of the workpiece, e.g., flat faces, diameters (such as parallel, stepped, tapered), holes (such as drilled, bored, reamed), profile forms, threads (such as internal, external), eccentric features, parting off, chamfers, knurls or special finishes, grooves, undercuts
	+ milling: machine, e.g., horizontal, vertical, universal, planer / gantry; up-cut; down-cut; features of the workpiece, e.g., faces (such as flat, square, parallel, angular), steps / shoulders, slots (such as open ended, enclosed/recesses, tee), holes (such as drilled, bored), profile forms (such as vee, concave, convex, gear), serrations, indexed or rotated forms (such as gear cutting), special forms
	+ boring: machine, e.g., jig boring, horizontal, vertical; features of the workpiece, e.g., bored holes (such as through workpiece, to a depth, tapered), holes (such as drilled to depth, drilled through workpiece, reamed, threaded), external diameters, grooves / recesses, chamfers / radii, faces (such as flat, square, parallel, angular, milled), slots, forms (such as indexed, rotated), external tapers
	+ grinding: machine, e.g. surface (such as horizontal, vertical), cylindrical (such as external, internal), Centreless, universal, thread, profile; features of the workpiece, e.g. faces (such as flat, vertical, parallel, square to each other, shoulders and faces), slots, diameters (such as parallel, tapered), bores (such as counterbores, tapered, parallel), profiles forms, thread forms (such as vee, right hand, single start, multi-start, internal, external), angular faces
 |
| 1.2 | Explain how specialist secondary processing machines function | Cover:* Specialist secondary processing machines: basic principles of operation; machine’s suitability to manufacture relevant components (process selection); relevant safe working practices for each machine; machine terminology, e.g., e.g., dielectric tank, pump, filter, machine bed, head, electrode holder, machine slides/axis of movement, wire guide, wire pulley; broach, pulling head; honing tool, reciprocating shaft, lapping disc, loading disc, abrasive material, slurry, hob spindle, hob, hob frame, machine slides / axis of movement; generation of shapes, forming of shapes; specialist secondary machining techniques e.g., electro-discharge (spark erosion, wire erosion), honing and lapping (horizontal and vertical honing, rotary disc lapping, reciprocating machines), gear cutting/hobbing
	+ electro discharge: machines, e.g., spark erosion, wire erosion; features of the workpiece e.g. holes, faces (such as flat, square, parallel, angular), forms (such as concave, convex, profile, square / rectangular), other features (such as threads, engraving, cavities, radii/ arcs, slots)
	+ broaching: machines, e.g., horizontal, vertical; features of the workpiece e.g., keyways, holes (such as flat sided, square, hexagonal, octagonal), splines, serrations, other special forms
	+ honing and lapping: machines, e.g., honing (such as horizontal, vertical), lapping (such as rotary disc, reciprocating); features of the workpiece, e.g., holes (such as through, blind, tapered), faces (such as flat, parallel, angular)
	+ gear tooth production, e.g. forming (milling), generation (such as gear planing, gear shaping, gear hobbing) and gear finishing (grinding)
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Know how workholding devices and tools are set up to produce a range of engineering component features
 | 2.1 | Explain how workholding devices and tools are used on traditional secondary processing machines, the operations that can be performed and the features that can be produced | Cover:* Workholding devices for traditional secondary machining techniques (selection) e.g., chucks (hard or soft jaws, three or four jaw, collet, power, magnetic), fixtures and other machine specific devices for:
	+ turning (drive plate and Centres, faceplates, magnetic or pneumatic devices, fixed steadies or travelling steadies)
	+ milling (clamping direct to machine table, pneumatic or magnetic table, machine vice, angle plate, vee block and clamps, indexing head / device, rotary table)
	+ grinding (Centres, faceplate, machine vices, clamps, angle plates, vee blocks, works rests, control stops, injector mechanisms, magnetic blocks, pots, arbors)
	+ drilling (clamping direct to machine table, machine vice, angle bracket, vee block and clamps, drill jigs, indexing device).
	+ boring (clamping direct to machine table, machine vice, pneumatic or magnetic table, indexing / rotary device, chucks, faceplates)
* Tools: materials and form (selection), e.g., solid high-speed steel, brazed tungsten carbide, indexable tips, electrode material, abrasive stone, composite wheels; tools for traditional secondary machining techniques, e.g., for:
	+ turning (turning tools, facing tools, form tools, parting-off tools, thread chaser, single-point threading, boring bars, recessing tools, Centre drills, twist / core drills, solid reamers, expanding reamers, taps, dies, knurling tool)
	+ milling (face mills, slab mills / cylindrical cutters, side and face cutters, slotting cutters, slitting saws, profile cutters, twist drills, boring tools, end mills, slot drills)
	+ grinding (soft wheel, hard wheel, cup, flaring cup, straight sided wheel, recessed wheel, double recessed wheel, dish, saucer, disc, segmented)
	+ drilling (drill bit, flat-bottomed drill, counterboring tool, countersinking tool, Centre drill, spot facing tool, reamer, tap)
	+ boring (boring bars, facing, recessing, chamfering or radii, forming, milling / jig boring heads)
* Machine parameters: position of workpiece; position of tools in relationship to workpiece; cutting fluid flow rate; position and operation of machine guards / safety mechanisms; parameters for different traditional secondary processing techniques, e.g., for:
	+ turning (threading / profile / taper mechanisms, workpiece revolutions per minute, linear feed rate, depth of cut for roughing and finishing)
	+ milling (linear / table feed rate, milling cutter revolutions per minute, depth of cut for roughing and finishing)
	+ grinding (linear / table feed rate, depth of cut for roughing and finishing, cross feed, dressing of wheels)
	+ drilling (tooling revolutions per minute, linear feed rate, swarf clearance)
	+ boring (set up and tooling relative to datum, feed rate, cutter / tool revolutions per minute, depth of cut for roughing and finishing)
* Features of the component: materials, e.g., ferrous, non-ferrous, non-metallic; holes, e.g., drilled, bored (parallel or tapered), reamed, threaded, blind, through, counterbored, flat bottomed; relevant component features produced using traditional secondary processing techniques, e.g., for:
	+ turning operations (flat faces, parallel diameters, stepped diameters, tapered diameters, profile forms, external threads, eccentric features, parting off, chamfers, knurls or special finishes, grooves, undercuts)
	+ milling operations (flat faces, square faces, parallel faces, angular faces, steps / shoulders, open ended slots, enclosed slots, recesses, tee slots, profile forms, serrations, indexed or rotated forms, special forms)
	+ grinding operations (flat faces, vertical faces, parallel faces, faces square to each other, shoulders and faces, slots, parallel diameters, tapered diameters, profiles forms, other thread forms, vee-form threads, right-hand threads, single start threads, multi-start threads, external threads, angular faces)
	+ drilling operations (countersinking, spot facing, holes)
	+ boring operations (internal profiles; external profiles, e.g., external diameters, grooves / recesses, chamfers / radii, flat faces, square faces, parallel faces, angular faces, slots, index or rotated forms)
 |
| 2.2 | Explain how workholding devices and tools are used on specialist secondary processing machines, the operations that can be performed and the features that can be produced | Cover:* Workholding devices for specialist secondary machining techniques (selection) e.g., angle plate, vee block and clamps, other machine specific devices for:
	+ electrical discharge machining (clamping direct to machine table, machine vice, pneumatic or magnetic table, ancillary indexing device)
	+ broaching (vice, chuck, clamping, fixtures)
	+ honing and lapping (pots, magnetic blocks, faceplate)
* Tools for specialist secondary machining techniques (selection) e.g., for:
	+ electrical discharge machining (plain electrode, profile electrode, hollow electrode, wire)
	+ broaching (keyway push broach, keyway pull broach, square push broach, hexagon push broach, Izod and Charpy notch broaches, rotary broach)
	+ honing and lapping (mandrel, wedge, honing stone, lapping disc/ pad)
* Parameters for different specialist secondary processing techniques, e.g., for:
	+ electrical discharge machining; dielectric flow rate, electrical conditions, wire tension, wire speed, alignment of electrodes and wire, ventilation and fume extraction, filtration.
	+ broaching (stationary, rotary, push, pulled, guides, speed, alignment)
	+ honing and lapping (revolutions per minute or reciprocating speed, stroke length, stroke overrun length, stroke speed, stone or disc pressure)
* Relevant component features produced using specialist secondary processing techniques, e.g., for:
	+ electrical discharge machining operations (holes; faces – flat, square, parallel, angular; forms – concave, convex, profile, square / rectangular; other features – threads, engraving, cavities, radii/arcs, slots)
	+ broaching (keyway, splines, serrations, hexagon, square)
	+ honing and lapping operations (honing holes; lapping faces, e.g., flat, parallel, angular)
	+ with consideration to relevant material being machined e.g., ferrous, non-ferrous
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to safely set-up and operate secondary processing machines to accurately produce engineering components with a range of features
 | 3.1 | Set-up secondary processing machines in readiness to safely produce engineering components with a range of features  | Cover:* Risk assessment and hazard identification processes and procedures in the work area
* Set up: machine guards in place; select and set tooling; checking tool / wheel condition; holding components securely without distortion; selection and use of suitable work-holding device(s); set machine parameters to manufacture given component
* Housekeeping and maintenance practices and techniques e.g., work area clean and tidy (slips trips and falls), planned, preventative and predictive methods, frequency, and reactive activates
* Safe working: safe set-up of moving parts, e.g., setting stops, preventing tooling clashes; use of machine guards to protect operator and others; choice and handling of cutting fluids/dielectric flow rate; checks for insecure components; facilities for emergency stop and machine isolation; identification of appropriate protective clothing and equipment; following work area policies and procedures to include ethical responsibilities, environmental and sustainability regulations, safe disposal of waste, recycling or re-use of materials and efficient use of resources
* Standard operating procedures and safe working practices relevant to specific secondary processing technique, e.g., for:
	+ turning (handling turning tools, airborne particles, tool breakage, swarf disposal)
	+ milling (handling milling cutters, cutter breakage, swarf disposal, backlash in machine slides)
	+ boring (handling tools and cutters, airborne particles, tool breakage)
	+ electrical discharge machining (electrical components, handling dielectrics, fumes, handling and storing electrodes and wires)
	+ grinding (handling grinding wheels, sparks / airborne particles, bursting wheels)
	+ drilling (handling drills, taps and reamers, tool breakage, swarf disposal)
	+ honing and lapping (handling and storing stones, airborne particles)
* Checks for accuracy: components to be free from burrs and sharp edges; use of appropriate tools and instruments; checks for dimensional accuracy and surface finish; checks relevant to specific secondary machining technique e.g., for:
	+ General dimensional tolerances within plus or minus 0.25mm or 0.010inch, specific fundamental tolerances within plus or minus 0.05mm or plus or minus 0.002inch or BS EN ISO 286 where applicable, geometric tolerance where specified to BS EN ISO 1101, reamed and bored holes within H8, screw threads BS medium fit, angles and tapers within plus or minus 0.5 degree
	+ turning; components to be free from false tool cuts, surface finish 1.6 µm or 63 µin, checks, e.g., for thread form, parallelism, squareness, angle / taper, profile, ovality / lobing, concentricity
	+ milling; components to be free from false tool cuts, surface finish 1.6 µm or 63 µin, flatness and squareness within 0.025mm per 25mm or 0.001inch per inch
	+ boring; components to be free from false tool cuts, surface finish 1.6 µm or 63 µin, flatness and squareness within 0.025mm per 25mm or 0.001inch per inch
	+ electrical discharge machining; components to be free from false starts and sharp edges, surface finish 0.8 µm 32 µin or 18 VDI; checks, e.g., for parallelism, angle / taper, squareness, profile
	+ grinding; components from false grinding cuts, surface finish 0.2 µm or 8 µin; checks, e.g., for thread form, parallelism, squareness, angle / taper, profile, ovality/lobing, concentricity
	+ drilling; components to be free from false tool cuts, surface finish 1.6 µm or 63 µin; check for e.g., position, squareness, ovality / lobing, concentricity
	+ honing and lapping; components to be free from stone / disc marks, surface finish 0.2 µm or 8 µin; honed components checked for parallelism and ovality / lobbing; lapped components checked for parallelism and flatness

Note: when working to BS EN ISO 286 the following relationship between the capability of the specific secondary machining process and the international tolerance (IT) grade is the minimum acceptable practice within this unit: * International Tolerance (IT) Grade:
	+ IT11 - drilling
	+ IT10 - planing, shaping, slotting
	+ IT8 - high quality milling, boring, reaming, capstan and automatic lathe work
	+ IT7 - high quality turning, electro-discharge machining, broaching
	+ IT6 - grinding, fine honing
	+ IT5 - machine lapping
* Relevant fault finding e.g., diagnostic methods and techniques for identifying engineering and manufacturing problems and escalation techniques
* Select and check the condition of tools and equipment, identify issues and take action to resolve as required
* Stock and services considerations e.g., availability, stock lead times, correct handling, stock value, faulty stock and returns process
 |
| 3.2 | Operate secondary processing machines safely to accurately produce engineering components with a range of features | Cover:* Pre-production e.g., plan and organise own work and resources; select the relevant machining process
* Use of machine: correct use of workholding devices; tools; machine parameters and safety, fault-finding, how to diagnose and resolve issues / escalate e.g. check the condition of workholding devices or fixtures for signs of wear, damage or looseness in the clamps, screws, bolts, pin etc, check for improper alignment or positioning of the workpiece relative to the machine spindle, tool or datum, check for insufficient or excessive clamping force or pressure applied (use of torque wrench as applicable), check for inadequate support or rigidity of the workpiece of fixture to prevent deflection, vibration or chatter, respond to self-diagnostic codes/alarms, use of senses to identify issues (when safe to do so); look, listen, smell, feel, operator limits of responsibility and competence, escalate to supervisor/maintenance personnel
* Apply ethical principles e.g. report mistakes/scrap, damaged, missing or broken tools
* Apply team working principles e.g. help others with manual handling, show flexibility accessing resources
* Produce components: to meet the features and accuracy required by the specification e.g., measure and check, make adjustments as required.
* Carry out inspection and quality checks following quality assurance processes and procedures
* Identify issues in the manufacturing process and take action to resolve as required e.g. vibration, loss of swarf control i.e. jamming, re-cutting of swarf, long/unbroken snarls, unsatisfactory surface finish, burr formation, loss of efficiency (power curve), insert wear
* Communicate verbally with colleagues and supervisors as necessary within the work area using correct terminology
* Follow machine shut down, safe isolation, handover or escalate issues as appropriate
* Reinstate: follow defined procedures to safely dispose of waste, clean the work area, tooling, tools, machinery and equipment and return all items to the correct location e.g., stores, tool cabinets, shadow boards, recycling bins etc
 |

Unit: TOEMA3-003 Measuring and inspecting machined engineering components

GLH: 60

Unit description

This unit enables the learner to acquire knowledge and skills to measure and inspect machined engineering components.

Summary of learning outcomes

1. Know the principles and applications of mechanical measurement
2. Be able to safely use measurement equipment and techniques
3. Be able to use comparators and gauges to measure dimensions and angle

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Know the principles and applications of mechanical measurement
 | 1.1 | Explain the principles of measurement  | Cover:* Physical standard of measurement e.g. length, National Physical Laboratory (NPL), National Primary Standards, calibration of secondary standards and measuring equipment, traceability, gauge blocks (slip gauges) kinematics of equipment
* United Kingdom Accreditation Service (UKAS), International System of Units (SI)
* Standard specifications e.g., British Standards Institute (BSI), European Standardisation Organisation (CEN, CENELEC, ETSI) International Organisation for Standardisation (ISO)
	+ prefixes British Standard (BS), European Standard (EN) and International Standard (ISO).
	+ relevant standards e.g., BS 969, BS 1134, BS 2634
 |
| 1.2 | Explain linear and geometric tolerancing of dimensions | Cover:* Linear tolerancing
	+ limits and fits
		- nominal size, basic size, actual size, limits, tolerance, deviation
		- classes of fit and terminology e.g., accuracy required by design / function, clearance, transition, interference, minimum metal condition, maximum metal condition, tolerance zone, upper and lower limits of size, minimum clearance (allowance)
* Geometric tolerancing
	+ principles of geometric tolerancing
		- standard tolerancing symbols and characteristics e.g. straightness, flatness, circularity, cylindricity, profile of a line, profile of a surface, parallelism, perpendicularity, angularity, position concentricity and coaxiality, symmetry, circular run-out, total run-out
		- relevant standards e.g., BS EN ISO 1101
 |
| 1.3 | Use relevant tolerancing principles to calculate hole and shaft tolerances for a required engineering component fit | Cover:* Standard systems of limits and fits e.g., BS EN ISO 286
	+ selection of tolerance grades
	+ application of tables of limits and fits
		- primary selection of fits
		- standard tolerance grades
	+ hole and shaft based systems
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to safely use measurement equipment and techniques
 | 2.1 | Use linear measurement equipment safely to carry out practical measurements on a machined engineering component | Cover:* Linear measurement equipment: range (Verniers, callipers / height gauge, micrometers); principles involved; scales; types; use in dimensional measurement; specific calibration issues
 |
| 2.2 | Use further measurement techniques safely on a machined engineering component to establish surface texture, alignment and angular measurement | Cover:* Further measurement techniques: determining surface texture, e.g. significance to component function, surface texture symbols, roughness average, waviness, finish, amplitude parameters, spacing parameters, instrumentation used for surface texture measurement; determining alignment, e.g. principles of straight edges, measurement of straightness, squareness, flatness and parallelism; determining angular measurements, e.g. concepts of geometry, divided circles, principles of angular measurement, angular scales, methods for angular measurement, taper measurement
 |

|  |  |  |
| --- | --- | --- |
| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth** |
| 1. Be able to use comparators and gauges to measure dimensions and angles
 | 3.1 | Use comparators and gauges to measure dimensions and angles on machined engineering components | Cover:* Gauge blocks (slip gauges) e.g., material, finish, grades, design (flat / parallel), principles of use (minimum number of blocks, clean, wringing together, separation / sliding apart), maintenance (cleaning, returning to case, storage)
* Comparator e.g., gauge blocks (slip gauges), dial test indicator (DTI), gauge block accessories, sine bar / table, cosine error
* Gauges e.g., gauge tolerances, types of gauges (plug gauge, caliper gauge, ring gauge, adjustable gauge, gauge material), Taylor’s principle of gauging, not-go element, go element
 |

Unit: TOEMF3-004 Producing machined engineering components using computer-aided engineering systems (CNC, CAD/CAM)

GLH: 75

Unit description

This unit enables the learner to acquire knowledge and skills to produce machined engineering components using computer-aided engineering systems CNC and CAD/CAM.

Summary of learning outcomes

1. Know the principles of Computer Numerical Control (CNC) and machine structures
2. Be able to develop and use a product specification to produce a production plan for CNC machining
3. Be able to manufacture machined engineering components safely using computer-aided engineering systems

Assessment

This unit is assessed by an externally set and Centre marked holistic assessment, which assesses the knowledge and skills requirements of learning outcomes 1 – 3.

Guidance

The learner should be briefed on what is involved and expected of them and be fully prepared for the practical holistic assessment.

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Know the principles of Computer Numerical Control (CNC) and machine structures
 | 1.1 | Explain relevant principles on which a machine tool operates when controlled by a CNC system | Cover:* System, e.g., machine control unit, drive mechanisms, tool/ workpiece interface, transducers, feedback, correction
* Datum points, e.g., machine, component
* Definition of parameters using numerical coding, e.g., position, movement, spindle speeds, cutting tools, clamping, application of coolant
* CNC process, e.g., select machine, select tooling, select workholding, identify machining sequence, calculate positional coordinates, calculate spindle speeds, programming, post- processing, set-up sheet, verify and edit, store for future use
* Integration of CNC with other engineering systems e.g.,
	+ technological developments and innovation in the machining sector:
		- industry 4.0 e.g., flexible manufacturing cells / robotics
		- digitisation e.g., 2D/3D CAD, CAD / CAM, additive manufacturing / 3D printing, simulation / digital twining
		- innovation e.g. metal additive manufacturing, automated set-up and inspection with the use of machine tool probes, laser measurement systems for machine tools, application of machine learner and artificial Intelligence (AI) in CNC machining.
 |
| 1.2 | Explain, with the aid of suitable diagrams, the structure of a relevant CNC machine type | Cover:* Machine structures:
	+ types, e.g., milling, drilling, turning Centre, machining Centre
	+ designation of axes, e.g., two-axis, three-axis, x, y, z
	+ motor and drive units, e.g., spindles, stepless drives, ball screw, stepper motors
	+ transducers, e.g., positional, linear, rotary, analogue, digital, optical encoders, inductive, capacitive, magnetic
	+ tooling, e.g., modular, quick change, turret
	+ tool transfer, e.g., automatic, chain magazine, circular magazine
	+ workholding, e.g., pallets, sub tables, rotary work changer, grid plate
	+ swarf removal, e.g., chutes, chip controllers, conveyors cooling, e.g., cutting fluid, cooling systems
	+ computer hardware, e.g. keypad, display, central processing unit (CPU), storage, cabling links, machine control unit (MCU)
	+ computer software, e.g., programming language, CAD / CAM DXF files
	+ safety, e.g., overloading the cutting tool, guards, light barriers, interlocks, operator safety
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to develop and use a product specification to produce a production plan for CNC machining
 | 2.1 | Develop a product specification for use in production planning for CNC machining | Cover:* Component specification:
	+ detailed drawing
	+ material, e.g., steel, aluminium, polymer, other stable material reference points, e.g., edge datum, Centre line datum
	+ dimensional, e.g., external, internal, Centres distances, bore diameters, tolerances
	+ surface finish, e.g., Ra, Rz values
 |
| 2.2 | Use a product specification to produce a production plan for CNC machining  | Cover:* Operational plan:
	+ zero datums
	+ workholding, e.g., clamps, fixtures, chucks, vices, setting points
	+ changing components, e.g., pallets, sub tables, rotary work changer, grid plate
	+ sequence of operations, e.g., loading, machining, roughing and finishing operations, measurement, unloading
	+ calculations, e.g., cutter path coordinates for intersections, polar Centres, arc Centres, cutter compensation, cutting speeds, feed rates; use of trigonometric ratios, e.g., sine, cosine, tangent; RPM = (surface speed or cutting speed x 1000 / (π × cutter diameter); feed rate = (feed per tooth × number of teeth × spindle speed)
	+ grouping of similar operations
	+ canned cycles, e.g., irregular pockets, geometric, hole patterns
	+ tooling, e.g., cutters, drills, reamers
	+ other reference data, e.g., cutting fluids, flow rates, equipment sizing, special requirements relating to specific materials
* Inspection, e.g., first off proving against specification, on machine measurement; set up sheet and tool list
 |

| **Learning Outcome****The learner will:** | **Assessment Criteria****The learner can:** | **Coverage and Depth**  |
| --- | --- | --- |
| 1. Be able to manufacture machined engineering components safely using computer-aided engineering systems
 | 3.1 | Write a part program for the manufacture of a machined engineering component using computer numerical control (CNC) | Cover:* Part program:
	+ user interface, e.g., menu bar, identification line, tool display window, system status
	+ work/ tool relationships, e.g., position, direction, amount of movement
	+ rates of change, e.g., feed rates, spindle speeds; auxiliary functions, e.g. metric / imperial units, tool selection, cutting fluids, workpiece loading and holding, tool changing
	+ CNC codes, e.g., block number, preparatory functions (G codes)
	+ miscellaneous functions (M codes)other letter addresses (arc Centres, spindle speed, feed rate)
	+ dimensional information, e.g., axis coordinates (x, y, z), absolute, incremental
	+ words, e.g., modal, non-modal
	+ block format, e.g., block number, G code, coordinates
	+ special function G codes, e.g., movement system, measuring system, tool compensation, canned cycles, sub-routine
	+ M codes, e.g., coolant, tool change, workholding, spindle speed, spindle direction
 |
| 3.2 | Manufacture a machined engineering component safely using a two- or three-axis CNC machine | Cover:* Manufacture:
	+ post-processing, e.g., transfer of files / data between systems, download program to machine tool
	+ pre-manufacture, e.g., risk assessment and hazard identification processes and procedures in the work area, run through using graphics display on machine tool, prove program, dry run, load workpiece, stepping, adjust feed rates run program
	+ select and check the condition of tools and equipment, identify issues in the manufacturing process and take action to resolve as required
	+ relevant fault finding e.g., diagnostic methods and techniques for identifying engineering and manufacturing problems and escalation techniques
	+ apply ethical and teamworking principles
	+ manufacturing, e.g., load and clamp workpiece, set tooling, initiate program cycle, machine workpiece, first off inspect and check against specification e.g., measure and check, make adjustments as required, store verified program for future use, quality monitor, shutdown, isolation, handover or escalate issues
	+ carry out inspection and quality checks following quality assurance processes and procedures
	+ communicate verbally with colleagues and supervisors as necessary within the work area using correct terminology
	+ housekeeping (slips trips and falls), safe disposal of waste, clean the work area, tooling, tools, machinery and equipment and return all items to the correct location e.g., stores, tool cabinets, shadow boards, recycling bins etc
 |
| 3.3 | Use a CAD / CAM package to produce a part program for the manufacture of a machined engineering component using computer numerical control (CNC) | Cover:* CAD / CAM package:
	+ hardware, e.g., CAD workstation, data storage, hard copy equipment, network system to download data to machine tools
	+ software, e.g., Autodesk Inventor, Esprit, Solid Works, Edge CAM, Denford VR milling / turning; universal formats, e.g., extensions (such as DXF, IGS, AI, EPS, PLT, NC), proprietary formats (such as DWG, CDR, CDL, GE3, NC1, BMP, MSP,PCX, TIF)
* Part program: e.g., 3D geometric model using CAD software, select machining operations, select tooling, generate CNC program using CAM software, simulation of tool changing and tool paths in the machining process, correction and editing
 |
| 3.4 | Manufacture a machined engineering component safely on a CNC machine using a post-processed program generated using CAM software | Cover:* Manufacture
	+ post-processing, e.g., transfer of files / data between systems, download program to machine tool
	+ pre-manufacture, e.g., risk assessment and hazard identification processes and procedures in the work area, run through using graphics display on machine tool, prove program, dry run, load workpiece, stepping, adjust feed rates, run program
	+ select and check the condition of tools and equipment, identify issues in the manufacturing process and take action to resolve as required
	+ relevant fault finding e.g., diagnostic methods and techniques for identifying engineering and manufacturing problems and escalation techniques
	+ apply ethical and teamworking principles
	+ manufacturing, e.g., load and clamp workpiece, set tooling, initiate program cycle, machine workpiece, first off inspect and check against specification e.g., measure and check, make adjustments as required, store verified program for future use, quality monitor, shutdown, isolation, handover or escalate issues
	+ carry out inspection and quality checks following quality assurance processes and procedures
	+ communicate verbally with colleagues and supervisors as necessary within the work area using correct terminology
	+ housekeeping (slips trips and falls), safe disposal of waste, clean the work area, tooling, tools, machinery and equipment and return all items to the correct location e.g., stores, tool cabinets, shadow boards, recycling bins etc
 |

# Appendix 1: Centre Exam Specifications

**Core knowledge exam 1**

|  |
| --- |
| **Units:** TOEC3/001 - Engineering and Environmental Health and Safety in the Workplace TOEC3/002 - Engineering Organisational Efficiency and Improvement  |
| Assessment type: Multiple ChoiceNumber of questions: 35Time allowed: 70 minutesClosed bookThe exam will cover the knowledge learning outcomes of the units, as follows: |
| **No** | **Learning outcome title** | **No of questions** |
| 1.1 | Understand health and safety roles and responsibilities | 7 |
| 1.2 | Understand the application of health and safety in the engineering environment | 6 |
| 1.3 | Understand environmental management | 5 |
| 2.1 | Understand production activities | 4 |
| 2.2 | Understand application of quality control and quality assurance | 6 |
| 2.3 | Understand organisational improvement techniques and competitiveness | 5 |
| 2.4 | Understand personal rights and responsibilities within an organisation | 2 |
| **Total:** | **35** |
| **NOTE:** The pass mark for the exam is 60%.  |

**Core knowledge exam 2**

|  |
| --- |
| **Units:** TOEC3/003 -Essential Mathematics and Science for Engineering and Manufacturing TOEC3/004 - The Structure, Properties and Characteristics of Common Materials |
| Assessment type: Multiple ChoiceNumber of questions: 35Time allowed: 70 minutesClosed book, non-programmable calculator permittedThe exam will cover the knowledge learning outcomes of the units, as follows: |
| **No** | **Learning outcome title** | **No of questions** |
| 3.1 | Understand fundamental numeracy applied to engineering and manufacturing | 13 |
| 3.2 | Understand fundamental science applied engineering and manufacturing | 13 |
| 4.1 | Understand how to select engineering materials | 4 |
| 4.2 | Understand material properties and heat treatment processes | 5 |
| **Total:** | **35** |
| **NOTE:** The pass mark for the exam is 60%.  |

# Appendix 2: Learner Registration and Certification

Learners must be registered with EAL on a code which relates to the qualification - this must be completed prior to assessment. Both learner registration and certification can be completed online at the EAL Website www.eal.org.uk. For paper-based registration and certification use the appropriate forms. These are located on the EAL Website, for guidance on registration and certification please refer to the Registration and Certification User Guide.

To register the learner on the chosen qualification / pathway code:

|  |  |
| --- | --- |
| **Qualification Title:** | **Code:** |
| EAL Level 3 Technical Occupation Entry in Machining (Diploma) | 610/3910/X |

For further information, please contact EAL Customer Experience:

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