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Qualification

Specification

EAL Level 3 Technical Occupational Entry in

Mechatronics (Diploma)

Qualification Number: 610-3911-1

Version 1

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# 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](mailto:EAL%20Customer%20Experience%20%3cCustomer.Experience@eal.org.uk%3e)

# 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 Engineering Technician (Mechatronics Maintenance) Apprenticeship Standard in England.

It **will not** make the learner industry competent in mechatronics maintenance work but facilitates progression into the occupation by providing potential employers with reliable evidence of the learner’s attainment against the Engineering Technician (Mechatronics Maintenance) 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 Engineering Technician (Mechatronics Maintenance) 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 a 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 Engineering Technician (Mechatronics Maintenance) 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 mechatronics maintenance technician. Learners can further progress to undertake qualifications such as:

* 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](mailto:EAL%20Customer%20Experience%20%3cCustomer.Experience@eal.org.uk%3e)

## 2.3 Qualification Support Materials

The following materials are available for these qualifications:

* **Assessor pack**: which contain all relevant assessor guidance relating to the delivery and assessment and marking schemes for the holistically assessed practical and knowledge assessments
* **Learner assessment pack:** which contain the holistically assessed practical and knowledge assessments, assessment checklists and all associated guidance for learners
* **Controlled knowledge assessments:** which contain knowledge assessments that must be completed by the learner under appropriately controlled conditions
* **\*Practice examination:** for the externally set and marked on-screen examination

**\***The practice examinations are available to schedule online as per externally set and marked examinations.

All 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 a minimum 545 GL(H) and 605 Total Qualification Time.

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

|  |  |  |  |
| --- | --- | --- | --- |
| EAL Code | Unit Title | GL(Hrs) | 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.

|  |  |  |  |
| --- | --- | --- | --- |
| EAL Code | Unit Title | GL(Hrs) | Ofqual Code |
| TOEME3/001 | Engineering Maintenance Procedures and Techniques | 75 | A/651/0942 |
| TOEME3/002 | Maintenance of Mechanical Systems | 65 | F/651/0944 |
| TOEME3/003 | Maintenance of Electrical Equipment | 65 | J/651/0946 |
| TOEME3/004 | Condition monitoring and Fault Diagnosis of Engineering Systems | 70 | K/651/0947 |

# 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](mailto:EAL%20Customer%20Experience%20%3cCustomer.Experience@eal.org.uk%3e)

# 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 / trainers 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 2 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 2 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 Examinations

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

* Have experience in conducting and controlling examination sessions

**or**

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

Note: A tutor / trainer who has prepared the learners for the subject of the examination must not be the sole supervisor at any time during an examination 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 examination1 | EAL | EAL | Examination invigilation | Verification and continuous monitoring via EQA visits |
| Centre marked  holistic practical / knowledge 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 Examinations).

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 Examination** | **Centre Marked Holistic Assessment** |
| TOEC3/001 | Engineering and environmental health and safety in the workplace | Core Knowledge  Examination 1 | No |
| TOEC3/002 | Engineering organisational efficiency and improvement |
| TOEC3/003 | Essential mathematics and science for engineering and manufacturing | Core Knowledge Examination 2 | No |
| TOEC3/004 | The structure, properties and characteristics of common materials |
| TOEME3/001 | Engineering Maintenance Procedures and Techniques | No | Holistic knowledge assessment  Holistic practical assessment  Questioning component |
| TOEME3/002 | Maintenance of Mechanical Systems |
| TOEME3/003 | Maintenance of Electrical Equipment |
| TOEME3/004 | Condition monitoring and Fault Diagnosis of Engineering Systems |

## 6.1 External Assessments (On-Screen Examinations)

A specification for the examination, 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 1st of April and the 30th April
* The examination must be undertaken by the learner under controlled examination conditions, in accordance with EAL’s Procedures for Conducting the Examination 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 audits will be carried out by EAL to ensure examinations are delivered in accordance with EAL published procedures
* EAL will release examination 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 examinations)

Learners who fail to achieve a pass will be permitted to resit this examination after feedback and appropriate tuition have taken place in the specific areas they failed to achieve.

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 examinations 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 examination

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 assessment involves collecting and evaluating evidence that demonstrates achievement of the learning outcomes / criteria. They are accompanied by marking criteria / assessment checklists 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 holistic 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.

A detailed Assessment Checklist will be provided by EAL, which must be held securely in accordance with EAL procedures, and adhered to by all assessors who are involved in assessing the holistic assessment.

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.

Retake Internal Holistic Assessments

Learners who fail to achieve a pass in the holistic assessment/s in the specific areas they failed to achieve, will be permitted a retake opportunity after feedback and appropriate tuition has taken place.

The learner will be allowed a maximum of two retake opportunities (three attempts in total). 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 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 holistic practical 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 holistic practical 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

1. 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 the principles and practices relating to environmental legislation and considerations

Assessment

This unit is assessed by an externally set and marked on-screen multiple-choice examination, 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 examination.

| **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 7 and 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 |
| 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 examination, 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 examination.

| **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)   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 non-conformity 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 environmental management | 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 an  organisation | 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 examination, 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 examination.

| **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 D  S (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 - b2  Using 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 * Conventional current 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 the  basics 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 examination, 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 examination.

| **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 | Describe the basic heat treatment process as applied to changing the properties of materials | Cover:   * Hardening * Tempering * Annealing * Normalising |
| 2.3 | Describe 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: TOEME3-001 Engineering Maintenance Procedures and Techniques

GLH: 75

Unit description

This module enables the learner to acquire both the knowledge and skills necessary to use the techniques and equipment required in the general maintenance of mechatronic systems. They will develop the knowledge of tools, equipment and techniques and apply this knowledge in a practical task.

Summary of learning outcomes

1. Understand the selection and use of tools and equipment used in maintenance engineering
2. Understand the sources and use of formal information systems used in maintenance engineering
3. Understand the organisation and techniques used in maintenance engineering
4. Understand mechanical and electrical principles in a mechatronics maintenance environment
5. Understand how equipment being maintained functions and operating parameters in individual components and how they interact
6. Understand condition monitoring methods and equipment used and understand how the information gained supports the planning of maintenance activities
7. Understand fault diagnostic methods, techniques and equipment used when maintaining equipment and systems

Assessment

This unit is assessed by an externally set and Centre marked holistic knowledge assessment and questioning components, which assesses the knowledge and skills requirements of learning outcomes 1 – 7.

Guidance

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

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand the selection and use of tools and equipment used in maintenance engineering | 1.1 | Identify and use the **tools** and **equipment** applicable to a maintenance engineering environment | Cover:  **Tools**  **Hand** – spanners, sockets (ratchet, universal joints, extension bars), screwdrivers, torx, pry bars, punches, chisels, hacksaw, pliers wire strippers, soldering iron, de-soldering tool, mole grips, stilsons, side cutters, bolt cutters, files, hammers, mallets, crimpers, drills, jig saws, riveter, rivet nut gun, torque tools, pipe cutters.  **Power** jigsaw, angle grinder, multitool, reciprocating saw, cutters, grinders, drills, electrical, pneumatic, hydraulic.  **Equipment** – monitoring & test equipment (multimeters, electronic control unit (ECU) diagnostic testers),  measuring tools (micrometers, Vernier callipers, flow meter, pressure gauges, infra-red cameras, ultrasonic detectors), oscilloscopes, signal generators, logic probes, data logger, oil testing kit, lifts, jacks, hoist pulleys, overhead crane, forging, isolation kit, digital technologies (laptops, tablets, mobile applications, handheld PC (H / PC), personal digital assistant (PDA)).  Operation of equipment process controllers to place the equipment into a suitable condition for maintenance activities.  How to check the physical condition of tools prior to use.  The suitable applications and limitations of the identified equipment. |
| 1.2 | Explain how to maintain tools and equipment and use them in a safe manner, following all safety regulations relating to use |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand the sources and use of formal information systems used in maintenance engineering | 2.1 | Interpret technical engineering drawings and graphics | Cover:  Installation plans, plant and equipment schematics, services (power, air, water) manufacturer-specific drawings (assembly drawings, exploded drawings, component-level drawings), electrical circuit schematics and components, connectors, pneumatic and hydraulic circuit diagrams. |
| 2.2 | Demonstrate an understanding of and use information technology devices, sources and software, used in maintenance engineering | Cover:  PC-based hardware and software, manufacturer software and hardware, physical connection and cabling, software connection to equipment, testing routines, extracting of diagnostic information, error codes and messages, upgrading of process equipment software, user levels, and software version control. |
| 2.3 | Interpret relevant engineering/manufacturing data and documentation in order to complete their job role | Cover:  Statistical Process Control, Failure Modes and Effect Analysis (FMEA), Root Cause Analysis, Condition Based Maintenance, Predictive Analysis, manufacturer specifications and service guidelines, industry best practice, ISO / EN standards, and in-house procedures. |
| 2.4 | Describe the importance of only using current approved processes, procedures, documentation and the potential implications for the organisation if this is not adhered to | Cover:  Continuous improvement, standard work. Implications for safety, quality control, legal issues, reduced productivity, loss of business |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand the organisation and techniques used in maintenance engineering | 3.1 | Demonstrate an understanding of what is involved in maintenance management | Cover:  Maintenance scheduling, staffing & training, management of spare parts (local stock vs JIT delivery), identification of fault trends, prioritisation of maintenance activities, preventative vs reactive maintenance, contact with equipment manufacturers for updates / technical support, risk assessment / management, permits to work, method statements, budgeting, project management, installation, commissioning and hand-over to production. Documentation / record-keeping. |
| 3.2 | Demonstrate an understanding of the various different maintenance systems and techniques used | Cover:  Preventive maintenance – includes regular and periodic (time-based) schedules.  Corrective maintenance – occurs when an issue is noticed.  Predetermined maintenance – follows a factory schedule.  Condition-based maintenance – occurs when a situation or condition indicates maintenance is needed.  Predictive maintenance – is data-driven and impacted by pre-set parameters.  Reactive maintenance – occurs when a total breakdown or failure appears. |
| 3.3 | Demonstrate an understanding of the reliability of the information and data | Cover:  Information (manufacturer information, updates), company updates, equipment updates, data (measurement error, operator error, calibration error) random errors, systematic errors, data recording errors |
| 3.4 | Explain the different roles and functions in the organisation and how they interact. | Cover:  Leadership, operations, R&D, quality control, finance, purchasing, HR, sales & marketing |
| 3.5 | Explain approved diagnostic methods and techniques used to help solve engineering/manufacturing problems | Cover:  Interpretation of controller error messages and codes using manufacturer fault-finding guides. Use of logical fault-finding methods to isolate hardware problems (half-split, 5 whys, 8D, unit component exchange, removal of components for out-of-circuit testing), visual indication, audible fault identification, temperature measurement, vibration measurement. |
| 3.6 | State the typical problems that may arise within their normal work activities/environment | Cover:  Time pressures, lack of tools / equipment, lack of parts, breakdowns, raw material issues, IT problems, incorrect or outdated equipment, poor communication, process and system issues |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand mechanical and electrical principles in a mechatronics maintenance environment | 4.1 | State how the mechanical systems manage forces, power, and motionand the associated loads on structures and components | Cover:  **Mechanical systems** – gearbox, cams and followers, pulleys, levers, actuation, cooling, lubrication, integrated systems (hydraulic, pneumatic, electronic).  **Mechanical principles** – motions and forces (static and dynamic loading, stress, strain, tensile shear, compressive shear, moments, torque), thermal, friction, system principles (input, process and output), hydraulic, pneumatic, work done and efficiency, mechanical advantage. |
| 4.2 | State the principles and applications of mechatronics and the mechanical systems that use them |
| 4.3 | State the nature and behaviour of electricity and its application in mechatronic systems | Cover:  Potential difference, current flow, charge storage, induction, resistance heating, high voltage arcing, electromagnetism, interference.  Ohm’s law, P=VI, I2R, charge, capacitance, impedance, Kirchoff’s law. |
| 4.4 | Explain the properties, characteristics and application of electrical and electronic systems, circuits and components within mechatronic engineering | Cover:  **Properties** – voltage, current, resistance, impedance, power.  **Systems** – mechatronic, mechanical, electromechanical, electrical, power electronics, microelectronics, digital electronics, integrated circuits, Wheatstone bridge, amplifiers, power  supplies, sequential, asynchronous/synchronous logic, programmable systems, data logging and  measurement systems, automation, AI.  **Circuits** – series, parallel, series-parallel, open and closed circuits, control, latching, power, timer, auxiliary, printed circuit board (PCB), surface mount technology (SMT).  **Components** – switches, sensors (temperature, flow, level, pressure, light, proximity, position),  diodes, transistors, rectifiers, capacitors, RCD’s, resistors, inductors, relays, actuators, motors  (electric, stepper, control, flow control), visual display units (VDU), human machine interface (HMI), transformers, operational amplifiers, potentiometers. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand how equipment being maintained functions and operating parameters in individual components and how they interact | 5.1 | State the functions of common mechanisms used in mechatronics | Cover:  **Mechanisms** – levers, rams, valve blocks, gears (characteristics of gears including teeth, root, pitch, meshing, backlash), gear trains, gearbox, governors, pulleys, cylinders, cams and followers, friction devices/clutches (mechanical, hydraulic, electromagnetic), structural components (frames, bearings, springs, bushes), overhead cranes, hoists.  **Controllers** – microprocessors, microcontrollers, sensors (displacement, position, proximity, velocity and motion, force, pressure, flow, viscosity, level, temperature, light sensors and switches), actuators, motors (electric, stepper, control, flow control), automation, artificial intelligence (AI).  Speeds, reliability, accuracy, power consumption, ease of maintenance, ease of programming, ease of diagnosis, safety implications. |
| 5.2 | Describe the use of **PLCs** and their use in controlling mechatronic systems | Cover:  **PLCs**  Concepts of input (digital/analogue) outputs (digital – relay, transistor, triac / analogue) 4-20mA, 0-10V, digital data, communication protocols and hardware, scan cycle, programming languages, sink/source inputs and outputs, hardware specifications. |
| 5.3 | Describe the purpose and outcomes of system testing | Cover:  **System testing**  Quality control, risk management, performance optimisation, legal or regulatory compliance (e.g. emissions, waste). |
| 5.4 | Explain how sensing and measurement technologies are used to measure parameters and signals | Cover:  **Sensing –** temperature, acceleration, position, pressure, displacement, vibration, proximity,  velocity/motion, force, flow (gas, liquid), viscosity, level, photoelectric, switches  **Sensing technologies –** inductive, capacitive, hall effect, operational amplifiers, Wheatstone bridge, filtering, transformers, and piezoelectric transducers.  **Measurement techniques and technologies –** multimeters, oscilloscopes, signal generators, thermocouples, residual temperature devices (RTDs), data logging, analysers (logic, dewpoint, hygrometers, hydrometers, thermometer), test routines in controller software. |
| 5.5 | State the relative benefits and limitations of sensing and measurement techniques and technologies |
| 5.6 | Describe the purposes and applications of standardised component classification, numbering and referencing**,** and how to interpret current standards | Cover:  **Component classification** – passive, active, electromechanics, manufacturers specifications.  **Numbering –** part numbers, manufacturers specifications, bill of materials (BOM), labelling, specifications.  **Referencing systems –** wiring identification, identification codes and technical data, standard reference designations for electrical and electronic parts and equipment (IEEE standards), colour codes, component numbering, QR codes, barcodes, CE marking, IET wiring regulations (British Standard 7671), BS3939, EMC Directive, BS, IEC, EN and ISO Standards. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand condition monitoring methods and equipment used and understand how the information gained supports the planning of maintenance activities | 6.1 | Describe the basic principles of condition monitoring, and how it helps prevent equipment failure | Cover:  Deterioration of a machine can be detected through the monitoring and the assessment of trends of various operating parameters – noise, vibration, speed, temperature, abnormal pressures, increased power usage, poor positioning accuracy / repeatability. |
| 6.2 | Describe the different types of monitoring component or sensor (such as temperature, force, pressure, vibration, rotational, voltage, current), their fittings, and their applicationin machinery protection / preventative maintenance | Cover:  **Types of equipment**  Thermocouples, thermistors, piezoelectric sensors, pressure transducers, load cells, strain gauges, axial/linear encoders, resolvers, current clamps/transformers, shunt resistors, Hall-effect sensors, optical sensors.  **Applications**   * Calibration * Vibration analysis * Ultrasonic analysis * Infrared analysis * Oil analysis * Laser-shaft alignment * Motor circuit analysis |
| 6.3 | Describe the importance of correctly selecting, setting up, operation and maintenance of condition monitoring equipment. | Cover:  **Methods of connecting equipment**  Permanent, temporary, direct measurement (flow, temperature, pressure), indirect measurement (vibration, noise), data logging of equipment parameters by interfacing to the equipment controller or independent measurement of process conditions by separate measurement.  **Selecting appropriate equipment**  Use of manufacturer instructions / specifications, industry standards or company procedures to ensure valid data is recorded.  **Operation**  Condition monitoring equipment needs to be able to repeatedly and accurately measure specific process conditions and use upper and lower tolerance limits that, if met, ensure the process is within specification.  **Maintenance**  Consult information sources to determine the calibration status of the equipment.  If it is not calibrated, determine the process that would need to be followed to re-calibrate the equipment (manufacturer calibration, independent calibration service or by in-house methods). |
| 6.4 | Describe the problems that can occur during the monitoring activity, and how they can be overcome | Cover:  Incorrect process, incorrect equipment, operator error, incorrect installation, incorrect operating conditions, equipment damage, corrupted or missing data. |
| 6.5 | Explain how to record and report the results from conditioning monitoring, and the documentation to be used | Cover:  Use of specific data reporting methods (paper-based, electronic records, backups) and communication methods and processes to ensure data is distributed to relevant departments (maintenance, quality, production, manufacturers) in a timely manner. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Understand fault diagnostic methods, techniques and equipment used when maintaining equipment and systems | 7.1 | State the function and operational characteristics of electrical components, cabling and wiring | Cover:  **Components** – passive components (resistors, capacitors, inductors, transformers, circuit board, wire harness, connectors), active components (voltage and current sources), generators, transistors, operational amplifiers, diodes (Zener, photodiodes, light emitting diodes (LED`s)), residual current devices (RCD), wiring (standards, earth leakage).  **Failure modes** – equipment failure (human error, environmental conditions), circuit faults (symmetrical and unsymmetrical faults, short circuit and open circuit connections, high resistance connections, connections to earth), power supply faults (components out of specification, intermittent faults, fault and tolerance testing), digital faults (input, output, logic).  **Protection methods** – relays, earthing and bonding, fuses, circuit breakers, solenoids, diodes.  The advantages and limitations of protection methods. |
| 7.2 | Identify common failure modes and protection methods |

Unit: TOEME3-002 Maintenance of mechanical equipment

GLH: 65

Unit description

This module enables the learner to acquire both the knowledge and skills necessary to perform mechanical maintenance on a range of mechatronic equipment

Summary of learning outcomes

1. Be able to apply safe working practices to planned maintenance activities on mechanical equipment
2. Be able to plan and prepare the maintenance activities on mechanical equipment
3. Be able to carry out planned maintenance activities on mechanical equipment
4. Be able to restore the work area on completion of the maintenance activity

Assessment

This unit is assessed by an externally set and Centre marked holistic practical assessments, which assesses the knowledge and skills requirements of learning outcomes 3 and 4 and a holistic knowledge assessment which assesses the knowledge requirements of learning outcomes 1 and 4.

Guidance

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

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to apply safe working practices to planned maintenance activities on mechanical equipment | 1.1 | Comply with health and safety legislation and regulations relevant to maintenance activities | The learner will need to comply with the health and safety requirements of the area in which the maintenance activity is to take place, and the responsibility these requirements place on them.  The learner will need to know the isolation and lock-off procedures or permit-to-work procedure that applies.  The learner will need to comply with the specific health and safety precautions to be applied during the maintenance procedure and their effects on others:   * Health & Safety at Work Act 1974 * Manual Handling Regulations * Provision & Use of Work Equipment Regulations (PUWER) * Control of Substances Hazardous to Health (COSHH) * Equipment Regulations * ISO 10218-1:2011 Robots and Robotic Devices * ISO/TS 15066:2016 Collaborative Robots * Management of Health & Safety at Work * Lifting Operation and Lifting Equipment Regulations * Personal Protective Equipment Regulations |
| 1.2 | Comply with environmental legislation and regulations relevant to maintenance activities | The learner will need to comply with   * Environment Act 2021 * ISO 14001 |
| 1.3 | Assess risks and hazards associated with maintenance activities | The learner will need to know the hazards associated with carrying out mechanical maintenance activities (such as handling oils, greases, stored pressure / force, misuse of tools, using damaged or badly maintained tools and equipment, and not following laid-down maintenance procedures), and how to minimise these and reduce any risks.  ISO 31000 Risk Management. |
| 1.4 | Apply the correct methods for moving and handling materials | The learner will need to use lifting and handling equipment in the maintenance activity.  The learner will need to safely perform manual handling activities – safe lifting technique, the load being lifted, any twisting or bending movements, distances, height from floor, environmental factors (weather, temperature, lighting), the physical ability of the person. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to plan and prepare the maintenance activities on mechanical equipment | 2.1 | Plan and communicate the maintenance activities to cause minimal disruption to normal working | The learner will need to estimate the total period of downtime by using equipment / manufacturer guides, best practice, previous experience.  The learner will need to ensure all resources are correct and available before the maintenance activity commences.  The learner will need to know suitable gaps in production where the equipment is available (evening/night shifts, weekends, shutdown periods).  The learner will need to communicate planned maintenance activities and timescales to production management.  The learner will need to complete a method statement.  The learner will need to complete the maintenance activity, clean the area, test, and hand over to production.  The learner will need to maintain a record of maintenance activities and parts used to assist in identifying trends, plan preventative maintenance activities, and maintain required levels of spares/consumables.  The learner will need to know the importance of applying the appropriate occupational behaviours in the workplace and the implications for both the apprentice and the business if these are not adhered to. |
| 2.2 | Obtain and use the correct issue of company and/or manufacturer's drawings and maintenance documentation | The learner will need to know how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process |
| 2.3 | Obtain all the applicable resources required to undertake the work activity | The learner will need to obtain drawings, manuals, documentation, tooling, jigs, spare parts, consumables, cleaning materials. |
| 2.4 | Ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids) | The learner will need to know suitable safe isolation methods to minimise disruption to other work areas.  The learner will need to communicate isolation plan to relevant work areas.  The learner will need to use a lock-out system to prevent unauthorised reconnection of services or equipment before the work has been completed. |
| 2.5 | Provide and maintain safe access and working arrangements for the maintenance area | The learner will need to obtain risk assessment of activity, reassess if changes have been made to equipment since the last assessment.  The learner will need to know the use of visible guarding or warning signs, close off a work area, use of tables / workbenches, good lighting, protected from elements.  The learner will need to provide and wear suitable PPE. |
| 2.6 | Maintain mechanical equipment in compliance with relevant standards | The learner will need to comply with   * ISO 55000 Asset Management Standards * ISO 13372:2012(EN) Condition monitoring and diagnostics of machines * ISO 9000 Quality management standards * BS 7671 18th Edition * BS 6423:2014 Code of practice for maintenance of low-voltage switchgear and control gear * ISO 10218-1:2011 Robots and Robotic Devices * ISO/TS 15066:2016 Collaborative Robots * Manufacturer information * Organisational standards   The learner will need to ensure process parameters are maintained (temperature, pressure, speed, flow rate, wear rates and limits, vibration limits, power supplies, cooling systems, noise levels, lubrication specifications, replacement part sourcing and quality, speeds, leaks / leakage rates, pollution levels, production quality). |
| 1. Be able to carry out planned maintenance activities on mechanical equipment 2. Be able to carry out planned maintenance activities on mechanical equipment 3. Be able to carry out planned maintenance activities on mechanical equipment 4. Be able to carry out planned maintenance activities on mechanical equipment | 3.1 | Check equipment is functioning within normal limits using manufacturer information, internal specifications or best practice | The learner will need to **Check / Identification activities:**  Planned maintenance checks, shift logs, identification of noise, odours, vibration, abnormal function (jamming, restricted/slow movement), temperature, fluid / gas leakage, abnormal pressure readings, evidence of dust / dirt / metal particles, discolouration, equipment indicators (error messages/logs or indicator lamps), manufacturer-specific equipment. |
| 3.2 | Identify and plan maintenance schedules | The learner will need to carry out m**aintenance scheduling including:**   * Plan activities before undertaking maintenance. Consult manufacturer instructions or company procedures / best practice. Estimate time required. Obtain tools, parts, consumables and PPE. Organise the work area, inform relevant personnel of work to be carried out and timescales. * Manufacturer guidelines / documentation specifying maintenance time intervals, part inspection / replacement, fluid changes, tooling required, spare part lists, consumables. |
| 3.3 | Carry out the maintenance activities using appropriate techniques, equipment, processes and procedures in the specified sequence and in an agreed timescale | The learner will need to carry out m**aintenance activities**:   * Sensing devices (buttons, limit switches, optical sensors, linear / rotary encoders, resolvers, proximity sensors, inductive sensors, Hall-effect sensors) * Control cabling * Connectors * Status indicators, indicating panels or HMI screens * Single-phase power supplies * Control systems and components * Three-phase power supplies * Electrical plant * Direct current power supplies * Wiring enclosures * Motors and starters * Switchgear and distribution panels * Other specific electrical equipment   **Appropriate techniques**:   * Selection of appropriate PPE and safety equipment * Isolating and locking-off equipment * Removing and replacing damaged wires, cables and connectors * Use of grounding straps to minimise the risk of static electricity damage to electronic devices * Use of noise, vibration, abnormal performance, temperatures, pressures to identify early signs of component failure * Use of electrical/electronic test equipment (multimeters, signal generators, oscilloscopes, PC-based software and hardware and use of controller error logs or alerts) to isolate defective components * Disconnecting and reconnecting wires, cables and connectors * Attaching suitable cable identification markers * Removing and replacing wiring enclosures * Removing electrical units/components * Setting and adjusting replaced components * Checking components for serviceability * Making `off-load' checks before powering up * Replacing damaged/defective components * Functionally testing the completed system |
| 3.4 | Carry out the maintenance activities within the limits of their personal authority | The learner will need to know the extent of their own authority and to whom they should report if they have a problem that they cannot resolve. |
| 3.5 | Replace/refit a range of mechanical components | The learner will need to include ten of the following:   * Robot end effectors / tooling * Motors * Shafts * Brakes * Cams and followers * Wire ropes / cables * Couplings * Bearings * Chains & sprockets * Housings * Gears / gearboxes * Seals * Pulleys and belts * Actual mechanisms * Clutches * Fitting keys * Levers and links * Structural components * Valves and seats * Springs * Slides * Locking and retaining devices (such as circlips, pins, lift nuts) * Pneumatic / hydraulic pipework & fittings * Pistons * Diaphragms * Rollers * Splined components |
| 3.6 | Report any instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule | The learner will need to deal~~ing~~ promptly and effectively with engineering / manufacturing problems within the limits of their responsibility using approved diagnostic methods and techniques and report those which cannot be resolved to the appropriate personnel. |
| 3.7 | Complete relevant maintenance records accurately and pass them on to the appropriate person | The learner will need to include:   * Asset numbering * Dates and times * Maintenance performed * Parts added * Manufacturer recommendations * Use (time or number of operations) * Equipment condition / Risk assessment * Name and date (traceability) * Storage of maintenance information records * Copies to staff (maintenance management/production / quality) |
| 1. Be able to restore the work area on completion of the maintenance activity | 4.1 | Re-connect and return the system to service on completion of activities | The learner will need to connect services (compressed air, fluid power, gases, water, liquid fuels, electricity).  The learner will need to prime pumps, ensure raw material feeds are working, check process parameters are within specification, and final test before hand-over to production. |
| 4.2 | Restore the work area on completion of the maintenance activity | The learner will need to include:   * Dispose of old parts * Clean work area * Return tools and equipment * Return any unused parts to stores * Remove lock-out methods * Remove barriers * Hand equipment back to production |
| 4.3 | Dispose of waste items in a safe and environmentally acceptable manner and leave the work area in a safe condition | The learner will need to know the environmental effects of different waste types  Flammability, corrosivity, reactivity, toxicity.  Disposal methods (landfill, incineration, waste treatment, recycling) to minimise environmental impact.  Refurbishment / reconditioning of old parts vs disposal. |
| 4.4 | Return any resources and consumables to the appropriate location | The learner will need to include:   * Return documentation (manuals, drawings) * Return tools , use of visual checks (shadow boards) * Return unused parts to stores (complete paperwork) |

Unit: TOEME3-003 Maintenance of Electrical equipment

GLH: 65

Unit description

This module enables the learner to acquire both the knowledge and skills necessary to use the techniques and equipment required to perform electrical maintenance of mechatronic equipment. They will develop the knowledge of tools, equipment and techniques and apply this knowledge in a practical task.

Summary of learning outcomes

1. Be able to apply safe working practices to planned maintenance activities on electrical equipment
2. Be able to plan and prepare the maintenance activities on electrical equipment
3. Be able to carry out planned maintenance activities on electrical equipment
4. Be able to restore the work area on completion of the maintenance activity

Assessment

This unit is assessed by an externally set and Centre marked holistic practical assessment and questioning components, which assesses the knowledge and skills 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 holistic practical assessment.

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to apply safe working practices to planned maintenance activities on electrical equipment | 1.1 | Comply with health and safety legislation and regulations relevant to maintenance activities | The learner will need to comply with the health and safety requirements of the area in which the maintenance activity is to take place, and the responsibility these requirements place on them.  The learner will need to know the isolation and lock-off procedures or permit-to-work procedure that applies.  The learner will need to comply with the specific health and safety precautions to be applied during the maintenance procedure and their effects on others:   * Health & Safety at Work Act 1974 * Manual Handling Regulations * Provision & Use of Work Equipment Regulations (PUWER) * Control of Substances Hazardous to Health (COSHH) * Equipment Regulations * ISO 10218-1:2011 Robots and Robotic Devices * ISO/TS 15066:2016 Collaborative Robots * Management of Health & Safety at Work * Lifting Operation and Lifting Equipment Regulations * Personal Protective Equipment Regulations |
| 1.2 | Comply with environmental legislation and regulations relevant to maintenance activities | The learner will need to comply with   * Environment Act 2021 * ISO 14001 |
| 1.3 | Assess risk and hazards associated with maintenance activities | The learner will need to know the hazards associated with carrying out electrical maintenance activities (such as electrical shock, greases / lubricants, stored pressure / force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise these and reduce any risks.  ISO 31000 Risk Management. |
| 1.4 | Apply the correct methods for moving and handling materials | The learner will need how to use lifting and handling equipment in the maintenance activity.  The learner will need how to safely perform manual handling activities – safe lifting technique, the load being lifted, any twisting or bending movements, distances, height from floor, environmental factors (weather, temperature, lighting), the physical ability of the person. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to plan and prepare the maintenance activities on electrical equipment | 2.1 | Plan and communicate the maintenance activities to cause minimal disruption to normal working | The learner will need to estimate the total period of downtime by using equipment / manufacturer guides, best practices, previous experience.  The learner will need to ensure all resources are correct and available before the maintenance activity commences.  The learner will need to know suitable gaps in production where the equipment is available (evening / night shifts, weekends, shutdown periods).  The learner will need to communicate planned maintenance activities and timescales to production management.  The learner will need to complete a method statement.  The learner will need to complete the maintenance activity, clean the area, test, and hand over to production.  The learner will need to maintain a record of maintenance activities and parts used to assist in identifying trends, plan preventative maintenance activities and maintain required levels of spares / consumables. |
| 2.2 | Obtain and use the correct issue of company and/or manufacturer's drawings and maintenance documentation | The learner will need to know the importance of applying the appropriate occupational behaviours in the workplace and the implications for both the apprentice and the business if these are not adhered to.  The learner will need to know how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process. |
| 2.3 | Obtain all the applicable resources required to undertake the work activity | The learner will need to obtain Drawings, manuals, documentation, tooling, jigs, spare parts  consumables, cleaning materials. |
| 2.4 | Ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids) | The learner will need to know suitable safe isolation methods to minimise disruption to other work areas.  The learner will need to communicate isolation plan to relevant work areas.  The learner will need to use a lock-out system to prevent unauthorised reconnection of services or equipment before the work has been completed. |
| 2.5 | Provide and maintain safe access and working arrangements for the maintenance area | The learner will need to obtain risk assessment of activity, reassess if changes have been made to equipment since last assessment.  The learner will need to know the of visible guarding or warning signs, close off a work area, use of tables / workbenches, good lighting, protected from elements.  The learner will need to provide and wear suitable PPE. |
| 2.6 | Maintain electrical equipment in compliance with specifications | The learner will need to comply with   * ISO 55000 Asset Management Standards * ISO 13372:2012(en) Condition monitoring and diagnostics of machines * ISO 9000 Quality management standards * BS 7671 18th Edition * BS 6423:2014 Code of practice for maintenance of low-voltage switchgear and control gear * ISO 10218-1:2011 Robots and Robotic Devices * ISO / TS 15066:2016 Collaborative Robots * Other organisational guidelines * Equipment manufacturers guidelines   The learner will need to ensure process parameters are maintained (temperature, pressure, speed, flow rate, wear rates and limits, vibration limits, power supplies, cooling systems, noise levels, lubrication specifications, replacement part sourcing and quality, speeds, leaks / leakage rates, pollution levels, production quality). |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to carry out planned maintenance activities on electrical equipment | 3.1 | Check equipment is functioning within normal limits using manufacturer information, internal specifications or best practice | The learner will need to **Check / Identification activities:**  Planned maintenance checks, shift logs, identification of noise, odours, vibration, abnormal function (jamming, restricted/slow movement), temperature, fluid / gas leakage, abnormal pressure readings, evidence of dust / dirt / metal particles, discolouration, equipment indicators (error messages / logs or indicator lamps), manufacturer-specific equipment. |
| 3.2 | Identify and plan maintenance schedules | The learner will need to consult manufacturer guidelines / documentation specifying maintenance time intervals, part inspection / replacement, fluid changes, tooling required, spare part lists, consumables.  The learner will need to plan activities before undertaking maintenance. Consult manufacturer instructions or company procedures / best practice. Estimate time required. Obtain tools, parts, consumables and PPE. Organise the work area, inform relevant personnel of work to be carried out and timescales. |
| 3.3 | Carry out the maintenance activities using appropriate techniques, equipment, processes and procedures in the specified sequence and in an agreed timescale | The learner will need to carry out m**aintenance activities**:   * Sensing devices (buttons, limit switches, optical sensors, linear / rotary encoders, resolvers, proximity sensors, inductive sensors, Hall-effect sensors) * Control cabling * Connectors * Status indicators, indicating panels or HMI screens * Single-phase power supplies * Control systems and components * Three-phase power supplies * Electrical plant * Direct current power supplies * Wiring enclosures * Motors and starters * Switchgear and distribution panels * Other specific electrical equipment   **Appropriate techniques**:   * Isolating and locking-off equipment * Removing and replacing damaged wires, cables and connectors * Use of grounding straps to minimise the risk of static electricity damage to electronic devices * Use of noise, vibration, abnormal performance, temperatures, pressures to identify early signs of component failure * Use of electrical / electronic test equipment (multimeters, signal generators, oscilloscopes, pc-based software and hardware and use of controller error logs or alerts) to isolate defective components * Disconnecting and reconnecting wires, cables and connectors * Attaching suitable cable identification markers * Removing and replacing wiring enclosures * Removing electrical units / components * Setting and adjusting replaced components * Checking components for serviceability * Making `off-load' checks before powering up * Replacing damaged/defective components * Functionally testing the completed system |
| 3.4 | Carry out the maintenance activities within the limits of their personal authority | The learner will need to know the extent of their own authority and to whom they should report if they have a problem that they cannot resolve. |
| 3.5 | Replace / refit a range of electrical components | The learner will need to include ten of the following:   * Wires, cables and connectors * Status indicators, indicator panels or hmi screens * Motors * Capacitors * Contactors * Rectifiers * Batteries * Relay components * Encoders or resolvers * Switches, electrical controls and sensors * Overload protection devices * Inverter and servo controllers * Solenoids * Locking and retaining devices (cable ties, clips, proprietary fasteners) * Circuit boards, microcontrollers, plc units, single-board computers, data loggers, pc-based control or other monitoring equipment * Transformers * Thermistors or thermocouples |
| 3.6 | Report any instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule | The learner will need to deal promptly and effectively with engineering / manufacturing problems within the limits of their responsibility using approved diagnostic methods and techniques and reporting those which cannot be resolved to the appropriate personnel. |
| 3.7 | Complete relevant maintenance records accurately and pass them on to the appropriate person | The learner will need to include:   * Asset numbering * Dates and times * Maintenance performed * Parts added * Manufacturer recommendations * Use (time or number of operations) * Equipment condition / Risk assessment * Name and date (traceability) * Storage of maintenance information records * Copies to staff (maintenance management / production / quality) |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to restore the work area on completion of the maintenance activity | 4.1 | Re-connect and return the system to service on completion of activities | The learner will need to connect services (compressed air, fluid power, gases, water, liquid fuels, electricity).  The learner will need to prime pumps, ensure raw material feeds are working, check process parameters are within specification, final test before hand-over to production. |
| 4.2 | Restore the work area on completion of the maintenance activity | The learner will need to include:   * Dispose of old parts * Clean work area * Return tools and equipment * Return any unused parts to stores * Remove lock-out methods * Remove barriers * Hand equipment back to production |
| 4.3 | Dispose of waste items in a safe and environmentally acceptable manner and leave the work area in a safe condition | The learner will need to know the the environmental effects of different waste types  Flammability, corrosivity, reactivity, toxicity.  Disposal methods (landfill, incineration, waste treatment, recycling) to minimise environmental impact.  Refurbishment / reconditioning of old parts vs disposal. |
| 4.4 | Return any resources and consumables to the appropriate location | The learner will need to include:   * Return documentation (manuals, drawings) * Return tools, use of visual checks (shadow boards) * Return unused parts to stores, and complete paperwork to ensure stock levels are correct |

Unit: TOEME3-004 Condition Monitoring and Fault Diagnosis of Engineering Systems

GLH: 75

Unit description

This module enables the learner to acquire both the knowledge and skills necessary to use the techniques and equipment required in condition monitoring of mechatronic equipment. They will develop the knowledge of tools, equipment and techniques and apply this knowledge in a practical task.

Summary of learning outcomes

1. Be able to apply safe working practices to maintenance activities
2. Be able to plan and prepare the monitoring activity
3. Be able to carry out the required checks during condition monitoring
4. Be able to carry out the fault diagnosis and rectification of mechatronic systems
5. Be able to restore the work area on completion of the maintenance activity

Assessment

This unit is assessed by an externally set and Centre marked holistic practical assessment and questioning components, 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 holistic practical assessment.

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to apply safe working practices to maintenance activities | 1.1 | Comply with health and safety legislation and regulations relevant to condition monitoring activities | The learner will need to comply with the health and safety requirements of the area in which the condition monitoring activity is to take place, and the responsibility these requirements place on them.  The learner will need to know the isolation and lock-off procedures or permit-to-work procedure that applies.  The learner will need to comply with the specific health and safety precautions to be applied during the maintenance procedure and their effects on others:   * Health & Safety at Work Act 1974 * Manual Handling Regulations * Provision & Use of Work Equipment Regulations (PUWER) * Control of Substances Hazardous to Health (COSHH) * Equipment Regulations * ISO 10218-1:2011 Robots and Robotic Devices * ISO / TS 15066:2016 Collaborative Robots * Management of Health & Safety at Work * Lifting Operation and Lifting Equipment Regulations * Personal Protective Equipment Regulations |
| 1.2 | Comply with environmental legislation and regulations relevant to maintenance activities | The learner will need to comply with   * Environment Act 2021 * ISO 14001 |
| 1.3 | Assess risk and hazards associated with condition monitoring activities | The learner will need to know hazards associated with carrying out condition monitoring activities (such as handling oils, greases, stored pressure / force, misuse of tools, using damaged or badly maintained tools and equipment, and not following laid-down maintenance procedures), and how to minimise these and reduce any risks.  ISO 31000 Risk Management. |
| 1.4 | Apply the correct methods for moving and handling materials | The learner will need to use lifting and handling equipment in the maintenance activity.  The learner will need to safely perform manual handling activities – safe lifting technique, the load being lifted, any twisting or bending movements, distances, height from floor, environmental factors (weather, temperature, lighting), the physical ability of the person. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to plan and prepare the monitoring activity | 2.1 | Plan and communicate the condition monitoring activities to minimise disruption to normal working | The learner will need to estimate the total period of downtime by using equipment / manufacturer guides, best practice, previous experience.  The learner will need to ensure all resources are correct and available before the monitoring activity commences.  The learner will need to know suitable gaps in production where the equipment is available (evening / night shifts, weekends, shutdown periods).  The learner will need to communicate planned monitoring activities and timescales to production management.  The learner will need to complete a method statement.  The learner will need to complete the maintenance activity, clean the area, test, and hand-over to production.  The learner will need to maintain a record of monitoring activities and any parts used to assist in identifying trends, plan preventative maintenance activities, maintain required levels of spares / consumables. |
| 2.2 | Adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work | The learner will need to consult risk assessments when preparing for monitoring activities, check that risk assessments are relevant to the task and equipment and regularly updated to reflect equipment or process changes. |
| 2.3 | Select the appropriate condition monitoring equipment for the intended purpose | The learner will need to use suitable sources of information (manufacturer documentation, in-house technical information, industry best practice).  The learner will need to identify the correct equipment for the task. |
| 2.4 | Check the calibration of the monitoring equipment before use | The learner will need to consult information sources to determine the calibration status of the equipment, if it is not calibrated, determine the process that would need to be followed to re-calibrate the equipment (manufacturer calibration, independent calibration service or by in-house methods). |
| 2.5 | Set up the monitoring equipment in accordance with the appropriate procedures and verify it is functioning within specification | The learner will need to consult relevant sources of information (manufacturer documentation, in-house technical information, industry best practice) to correctly configure the monitoring equipment (connection order, power source, cabling, connection to test points on the equipment to be monitored and use the correct test mode).  The learner will need to perform any pre-calibration tests to ensure the test equipment is correctly set-up and functioning.  The learner will need to place the equipment to be monitored in the correct mode(s) or state. |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to carry out the required checks during condition monitoring | 3.1 | How to use monitoring systems | The learner will know how for the following monitoring conditions:   * Equipment operating under the effects of weather, natural hazards, temperature or pressure * Equipment operating in environments with potential flammable or explosive conditions (such as dust, vapours, liquids or gases) * Equipment working in wet, dirty, dusty or corrosive conditions * Equipment operating in a benign or clean room environment |
| 3.2 | Carry out the monitoring activities, using appropriate **techniques** and **methods** | The learner will need to carryout t**echniques**   * Vibration analysis * Positional analysis (e.g. Robot mastering / calibration) * Linear / rotational speed analysis * Gas composition * Pressure analysis * Temperature analysis * Voltage / current / resistance analysis * Flow analysis * Radio telemetry analysis * Particle analysis * Thickness analysis * Crack detection analysis * Oil analysis * Leak detection analysis * Corrosion detection * Humidity analysis * Environmental pollutant analysis * Photo/optical equipment * Specific monitoring equipment   **Methods**   * Off-line / portable monitoring * Protection monitoring * Sampled monitoring * Human sensory monitoring (sight, sound, touch, smell) * Continuous monitoring |
| 3.3 | Use appropriate monitoring techniques to set up, check and calibrate equipment protection systems, or predictive maintenance system monitoring techniques, | The learner will need to use techniques on **two** of the following types of equipment:   * Engines (such as piston or turbine) * Rotating or reciprocating machinery (such as pumps, and compressors) * Mechanical equipment (such as cyclic and rotational devices, gearboxes, drives and linkages) * Production machinery (such as robots, machine tools, presses, and transfer mechanisms) * Process equipment (such as furnaces, and chemical baths) * Rotating electrical machinery (such as generators, and motors) * Stationary electrical equipment (such as transformers, and switchgear) * Stationary plant and equipment (such as air receivers, accumulators, tanks, and piping) * Emergency standby or alarm/warning systems and equipment * Fluid power equipment (such as pipework, cylinders and actuators and pumps) * Process controller (such as program controller, input/output interfacing, wiring/cabling, and monitoring sensors) * Electrical components (such as power supplies, switchgear and distribution panels, and control systems) * Environmental systems (such as air conditioning, and fume extraction) |
| 3.4 | Record and review the outcomes on completion of the condition monitoring activities, and take appropriate actions | The learner will need to   * Validation and evaluation of the condition monitoring systems and procedures used * Suggested improvements to the process of condition monitoring * Draw valid conclusions, based on the information gained from the condition monitoring activities   The learner will need to recommend actions to be taken in respect of the engineering plant and equipment being monitored. |
| 3.5 | Complete and store all relevant monitoring documentation in accordance with organisational requirements | The learner will need to use one of the following:   * Job cards * Predictive maintenance log or report * Permit to work / formal risk assessment and / or sign on / off procedures * Organisational-specific documentation * Electronic reports |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to carry out the fault diagnosis and rectification of mechatronic systems | 4.1 | Check that the diagnostic tools and equipment are functioning correctly | The learner will need to check diagnostic tools and equipment   * Test equipment (multimeters, diagnostic testers, CMM) * Measuring tools (micrometers, Vernier callipers, rule) * Oscilloscopes * Signal generators * Logic probes * Data logger * Flow meter * Pressure gauges * Pressure sources * Calibration equipment |
| 4.2 | Carry out fault detection **techniques** and diagnostic **methods** | The learner will need to carryout t**echniques**   * Self-diagnostic * Unit substitution * Input output * Half split technique * 6 point technique * Component isolation * Operational experience * End to end * Top-down techniques * Timed test run * Sensory checks * Hmi * Reported faults * Fault history * Tools and equipment   Methods   * Sensory checks * Collection of fault data (mean time between failures (mtbf) * Mean time to repair (mttr) * Self-diagnosis * Inspection * Digital systems * Material testing * Tools and equipment |
| 4.3 | Carry out isolation **methods** and fault **resolution** | The learner will need to carryout i**solation methods**   * Electrical isolation * Supply * Testing for dead * Keys * Lock out * Electrical * Temperature * Pressure * Residual current device (rcd) * Tools and equipment   **Resolution**   * Replace * Repair * Adjust * Modification * Preventative measures * Reporting * Recording * Informing * Amendments |
| 4.4 | Carry out confirmation testing to support maintenance activities, installation and commissioning | The learner will need to carryout   * After mechanical or electrical maintenance has been carried out, perform confirmation testing to demonstrate that the equipment is operating within manufacturer or company specifications. * During the installation of new plant or equipment or during the commissioning phase, perform confirmation testing to demonstrate that the equipment is operating within manufacturer or company specifications. * Carry out smooth handover of equipment and plant by ensuring all test equipment is removed, plant or equipment is returned to normal operating condition, area is left tidy, production are informed of completion of activities and any documentation is completed. |
| 4.5 | Complete and store all relevant inspection, testing and recording documentation in accordance with organisational requirements | The learner will need to use one of the following:   * Maintenance logs * Defect logs * Reports * Statements * Checklists * Equipment * Digital technologies * Amending documentation |

| **Learning Outcome**  **The learner will:** | **Assessment Criteria**  **The learner can:** | | **Coverage and Depth** |
| --- | --- | --- | --- |
| 1. Be able to restore the work area on completion of the maintenance activity | 5.1 | Restore the work area on completion of the maintenance activity | The learner will need to   * Return tools and monitoring equipment * Remove lock-out methods * Remove barriers * Complete documentation/records relating to calibration, testing or condition monitoring activities * Hand equipment back to production |
| 5.2 | Return any resources and consumables to the appropriate location | The learner will need to   * Return documentation (manuals, drawings) * Return tools, use of visual checks (shadow boards) * Return unused parts to stores (complete paperwork) |

# Appendix 1: Centre Examination Specifications

**Core knowledge examination 1**

|  |  |  |
| --- | --- | --- |
| **Units:** TOEC3/001 - Engineering and Environmental Health and Safety in the Workplace  TOEC3/002 - Engineering Organisational Efficiency and Improvement | | |
| Assessment type: Multiple-choice Question (MCQ) Examination  Number of questions: 35  Time allowed: 70 minutes  Closed book  The examination 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 examination is 60%. | | |

**Core knowledge examination 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-choice Question (MCQ) Examination  Number of questions: 35  Time allowed: 70 minutes  Closed book, non-programmable calculator permitted  The examination 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 examination 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 Mechatronics (Diploma) | 610-3911-1 |

For further information, please contact EAL Customer Experience:

Tel: +44 (0)1923 652 400

Email: [Customer.Experience@eal.org.uk](mailto:EAL%20Customer%20Experience%20%3cCustomer.Experience@eal.org.uk%3e)

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