LICQual

LICQual Level 6 Diploma in Mechanical Quality Control and Quality Assurance (QC/QA)

Qualification Specification

Address:

27 Old Gloucester Street, London, United Kingdom, WC1N 3AX

LICQual

Contents

Qualification Specification

About LICQual

LICQual is a globally recognized awarding body based in the United Kingdom. Renowned for its commitment to excellence in education, LICQual specializes in delivering high-quality qualifications designed to meet the evolving needs of international learners, professionals, and industries. LICQual is dedicated to fostering innovative and flexible learning pathways, providing learners with the tools and knowledge needed to excel in today's dynamic professional landscape. The organization emphasizes adherence to international qualification frameworks and standards, ensuring global recognition and applicability of its certifications.

The vision of LICQual is to establish itself as a global benchmark in quality education and skills development. Its mission is to equip individuals and organizations with internationally recognized qualifications that enhance employability, professional productivity, and academic progression.

Underpinned by a team of experienced professionals, including examiners, moderators, and assessors, LICQual ensures the highest standards of quality assurance and continuous improvement. Its qualifications are designed to empower individuals with the expertise and competencies necessary to thrive in today's competitive and ever-changing global environment.

Course Overview

The LICQual Level 6 Diploma in Mechanical Quality Control and Quality Assurance (QC/QA) is an advanced certification specifically designed for professionals seeking to deepen and formalize their expertise in the mechanical engineering domain. This comprehensive qualification moves beyond basic principles to focus on industry standards, best practices, and the development of robust quality management systems. It provides learners with the essential skills and in-depth theoretical and practical knowledge required to effectively manage, oversee, and enhance quality processes within the mechanical industry. By emphasizing both applied quality control measures and strategic assurance protocols, the diploma prepares individuals to maintain high standards and drive continuous improvement across mechanical operations.

Objectives and Aims

The primary goal of the Level 6 Diploma is to develop competent and confident leaders in the field of Mechanical Quality Control and Quality Assurance.

Core Objectives

Develop Quality Management Systems: Equip learners with the ability to design, implement, and audit comprehensive quality management systems relevant to the mechanical engineering sector.

- **Master Inspection and Testing:** Provide in-depth knowledge and practical skills in applying advanced inspection techniques, testing methodologies, and quality control measures to ensure product and process compliance.
- **Ensure Regulatory Compliance:** Train professionals to understand and adhere to national and international compliance standards and regulatory requirements specific to mechanical operations.
- **Cultivate Leadership Skills:** Prepare individuals to take on managerial and supervisory roles by developing their ability to oversee quality operations and lead QC/QA teams effectively.

Long-Term Aims

- **Career Advancement:** Serve as a valuable stepping stone for professional growth, enabling graduates to secure leadership and managerial positions in mechanical QC/QA.
- **Industry Competitiveness:** Meet the demands of today's competitive job market by producing highly skilled professionals capable of driving high product quality and efficiency.
- **Practical Application:** Bridge the gap between theoretical knowledge and practical application, ensuring graduates can immediately implement effective quality control and assurance protocols in a real-world setting.

Targeted Audience

This qualification is ideal for ambitious professionals who are already working in or aspiring to a leadership role within the mechanical quality sector.

- **Aspiring Managers and Leaders:** Professionals aiming to take on managerial positions in Quality Assurance, Quality Control, or Quality Management within the mechanical industry.
- **Experienced QC/QA Professionals:** Individuals currently working in Quality Control, Inspection, or Assurance roles who wish to upskill and gain an advanced, formal certification to enhance their career trajectory.
- **Mechanical Engineers and Technicians:** Those with a background in mechanical engineering or related technical fields looking to specialize in the crucial area of quality and compliance.
- **Auditors and Compliance Officers:** Professionals involved in mechanical testing, regulatory compliance, and auditing who need a deeper understanding of quality management system development and implementation.

Certification Framework

Qualification title	**LICQual Level 6 Diploma in Mechanical Quality Control and Quality Assurance (QC/QA)**
Course ID	LICQ2200174
Qualification Credits	120 Credits
Course Duration	3 - 6 Months
Grading Type	Pass / Fail
Competency Evaluation	Coursework / Assignments / Verifiable Experience
Assessment	The assessment and verification process for LICQual qualifications ensures that learners achieve the required standards and maintain consistency across all Approved Training Centres (ATCs). This process is divided into two key stages: **Internal Assessment and Verification:** ✓ This stage is conducted by the staff at the ATC, ensuring that learners meet the qualification standards through ongoing assessments. ✓ Internal Quality Assurance (IQA) is performed by the centre's designated IQA staff to validate and maintain the integrity of the assessment processes. **External Quality Assurance:** ✓ This stage is overseen by LICQual AB verifiers, who periodically review the centre's assessment and IQA procedures. ✓ The external verification ensures that assessments adhere to the required standards and that consistent practices are maintained across all centres.

Entry Requirements

To enroll in the LICQual Level 6 Diploma in Mechanical Quality Control and Quality Assurance (QC/QA), applicants must meet the following criteria:

- ✓ **Age Requirement:** Applicants must be at least 16 years old.
- ✓ **Educational Requirements:** A minimum of a Level 4 or Level 5 qualification in mechanical engineering, quality management, or a related field is required. Alternatively, candidates with a bachelor’s degree in mechanical engineering or a similar discipline will also be considered.
- ✓ **Experience:** While no prior work experience is mandatory, individuals with at least 2 years of relevant experience in mechanical engineering, quality control, or quality assurance will have an advantage.
- ✓ **English Language Proficiency:** As the course is delivered in English, applicants must demonstrate proficiency in the English language through a recognized qualification, such as IELTS with a minimum score of 6.0, or an equivalent test.

Qualification Structure

This qualification comprises 6 mandatory units, totalling 120 credits. Candidates must successfully complete all mandatory units to achieve the qualification.

Mandatory Units		
Unit Ref#	**Unit Title**	**Credits**
LICQ2200174-1	Quality Management Systems (QMS) in Mechanical Engineering	20
LICQ2200174-2	Mechanical Testing and Evaluation Methods	20
LICQ2200174-3	Failure Analysis and Root Cause Investigation	20
LICQ2200174-4	Risk Management and Quality Control Strategies	20
LICQ2200174-5	Advanced Quality Assurance and Process Improvement	20
LICQ2200174-6	International Standards and Regulatory Compliance in Mechanical Engineering	20

Centre Requirements

To deliver the LICQual Level 6 Diploma in Mechanical Quality Control and Quality Assurance (QC/QA), training centres must meet the following key requirements:

1. ***Approval from LICQual:***
    - Centres must be formally approved by LICQual to deliver this specific qualification, ensuring alignment with quality standards.
2. ***Qualified Staff:***
    - Tutors and assessors must possess a minimum Level 6 qualification in Mechanical Engineering or Quality Management and extensive, current professional experience in mechanical quality control, quality assurance leadership, or compliance.
3. ***Learning Facilities:***
    - Centres must provide suitable classrooms, access to environmental legislation and monitoring tools (e.g., sensors, lab kits), and digital learning resources.
4. ***Health and Safety Compliance:***
    - All learning and practical environments must comply with current health and safety regulations.
5. ***Assessment Resources:***
    - Centres should maintain appropriate tools, templates, and systems to support consistent and fair assessment.
6. ***Learner Support:***
    - Support must be available for all learners, including academic guidance, disability accommodations, and career development support.
7. ***Policies and Procedures:***
    - Centres must implement core policies (e.g., Equality, Safeguarding, Complaints, Data Protection) to maintain educational quality and integrity.
8. ***Reporting to LICQual:***

- Centres are required to regularly report learner progress, maintain records of assessments, and support LICQual in external verification.

Support for Candidates

Centres must ensure that materials developed to support candidates:

- Enable the tracking of learners' progress as they achieve the specified learning outcomes and assessment criteria.
- Provide clear guidance on accessing LICQual's policies and procedures.
- Establish robust mechanisms to allow Internal and External Quality Assurance personnel to verify and authenticate evidence efficiently.

This structured approach promotes transparency, enhances the learning experience for candidates, and ensures adherence to high-quality assurance standards.

Assessment

Part 1: Knowledge and Understanding

- **Written Assignments and Research Projects:** Learners are required to complete structured written tasks and independent research projects that demonstrate advanced knowledge of health and social care management theories, policies, and practices. These assignments allow learners to critically analyse concepts and apply them to real-world contexts.
- **Oral and Written Questioning:** Learners will participate in structured oral or written questioning sessions, where they will be assessed on their comprehension of complex issues such as leadership, ethics, policy frameworks, and quality management in health and social care.

Part 2: Practical Application

- **Assessor Observation and Professional Discussions:** Learners will be observed in real or simulated workplace environments to evaluate their practical application of management and leadership skills. Professional discussions with assessors will further assess decision-making, problem-solving, and reflective thinking abilities.
- **Case Studies and Problem-Solving Exercises:** Learners will engage with detailed case studies and simulated scenarios, where they must identify problems, propose strategies, and justify their decisions using evidence-based practices and relevant care standards.

Part 3: Evidence and Verification

- **Portfolio of Evidence:** Learners will compile a portfolio containing reports, audits, presentations, reflective journals, and other forms of evidence produced during their training or workplace practice. This portfolio provides a comprehensive record of competence and progression.
- **Witness Testimonies and Recognition of Prior Learning (RPL):** Verified statements from supervisors or managers may be used to confirm learner competence, while credit for prior experience and previously achieved qualifications can also be recognised to support progression.

Unit Descriptors

LICQ2200174-1 Quality Management Systems (QMS) in Mechanical Engineering

This unit covers the design, implementation, and evaluation of advanced Quality Management Systems (QMS) tailored for mechanical engineering projects. Learners will analyse QMS frameworks, including ISO 9001, to ensure product quality, system reliability, and meet customer/regulatory requirements. The focus is on quality planning, documentation, and the strategic application of QMS principles in manufacturing environments.

Learning Outcome:	1. Understand the core principles, frameworks, and objectives of Quality Management Systems (QMS) in mechanical engineering.
Assessment Criteria:	1.1. Critically analyse the strategic objectives of a QMS (e.g., competitive advantage, risk mitigation, and continuous improvement) and justify their priority within a mechanical engineering enterprise. 1.2. Differentiate the seven Quality Management Principles (QMP) and evaluate how they translate into documented processes within a complex mechanical design and manufacturing environment. 1.3. Evaluate the role of the Plan-Do-Check-Act (PDCA) cycle as the core framework for sustained QMS performance and systematic problem resolution in mechanical operations. 1.4. Analyze the interdependence between the QMS documentation hierarchy (e.g., Quality Manual, Procedures, Work Instructions) and the overall system integrity of a multi-site mechanical firm.
Learning Outcome:	2. Evaluate the application of QMS standards (e.g., ISO 9001) to ensure product quality and system reliability.
Assessment Criteria:	2.1. Systematically evaluate the mandatory requirements of ISO 9001:2015 and determine their direct impact on the reliability and performance specification of mechanical components. 2.2. Critically interpret the requirement for "context of the organization" in ISO 9001 and propose a mechanism for its continuous review in response to unpredictable market changes in the mechanical sector. 2.3. Appraise an existing mechanical company's quality manual against the requirements of a chosen QMS standard, formulating an expert opinion on gaps in compliance. 2.4. Justify the necessary cultural and organizational changes required for a mechanical engineering firm to transition from basic inspection to a fully compliant, process-based QMS. 2.5. Formulate an expert opinion on the benefits and limitations of standardizing QMS across a mechanical product portfolio that utilizes diverse technologies (e.g., casting, additive manufacturing).
Learning Outcome:	3. Analyze the integration of QMS practices in mechanical engineering projects to meet customer and regulatory requirements.

Assessment Criteria:	3.1. Analyze a mechanical engineering project lifecycle and determine the optimal points for embedding integrated QMS checks, gates, and formal sign-offs to prevent downstream quality failures. 3.2. Dissect the requirements elicitation process to ensure QMS documentation comprehensively captures both explicit customer specifications and implicit regulatory standards for a new mechanical product. 3.3. Critically examine the role of advanced methodologies (e.g., Design for Six Sigma) as an integrated QMS approach during the conceptual design phase of complex mechanical assemblies. 3.4. Evaluate a scenario involving conflicting customer performance requirements and mandatory regulatory standards, proposing a justifiable QMS pathway to resolution and compliance. 3.5. Investigate and report on how QMS documentation acts as the critical evidence trail for regulatory audits and compliance verification in the high-stakes mechanical engineering sector. 3.6. Analyze the critical success factors for seamlessly integrating quality planning documentation with overall mechanical project management schedules, budgets, and resource allocation.
Learning Outcome:	4. Design quality management strategies tailored to mechanical engineering processes and manufacturing workflows.
Assessment Criteria:	4.1. Develop a comprehensive quality strategy (including defined metrics and governance) for a complex mechanical manufacturing workflow that involves multiple critical subcontractors and specialized processes. 4.2. Design a robust inspection and testing regime (In-Process, Final, Acceptance) that is specifically tailored to mitigate the highest-risk elements in a chosen mechanical assembly process. 4.3. Formulate criteria for supplier qualification and management that align directly with the specific quality and technological demands of advanced mechanical components. 4.4. Create a framework for managing non-conforming mechanical products, detailing the systematic decision-making criteria for release, rework, repair, or scrap based on cost and criticality. 4.5. Propose a structured methodology for identifying, documenting, and controlling critical-to-quality (CTQ) characteristics for a mechanical product with many interacting components. 4.6. Justify the selection of appropriate quality tools (e.g., Statistical Process Control) to be strategically deployed at various stages of a mechanical casting or machining process. 4.7. Architect a quality documentation hierarchy suitable for ensuring traceability and control within a high-volume mechanical production line, detailing the flow of information between levels.
Learning Outcome:	5. Implement continuous monitoring and feedback mechanisms to enhance QMS performance in mechanical operations.

Assessment Criteria:	5.1. Implement a system for capturing and classifying all quality costs (prevention, appraisal, failure) within a mechanical operation and use the resulting profile to prioritize improvement investment. 5.2. Determine and apply a set of key performance indicators (KPIs) and quality metrics (e.g., First Pass Yield, Defect Rate) suitable for the real-time monitoring of a mechanical manufacturing process. 5.3. Develop a systematic internal audit program, including audit schedules, checklists, and reporting protocols, for a medium-sized mechanical engineering department to ensure compliance. 5.4. Design and execute a closed-loop feedback mechanism that ensures customer complaint data directly drives revisions to mechanical design and manufacturing processes. 5.5. Critically review an existing QMS monitoring dashboard, proposing advanced visualisations and data sources necessary for executive-level, strategic decision-making. 5.6. Demonstrate the effective communication of QMS performance data to various internal and external stakeholders (e.g., operators, management) to drive a cohesive culture of continuous improvement. 5.7. Formulate a formal management review agenda and structure that systematically addresses QMS performance, adequacy, and opportunities for mechanical process enhancement. 5.8. Propose and justify a plan for utilizing advanced data analytics (e.g., machine learning) to predict future quality risks based on historical mechanical performance data.

LICQ2200174-2 Mechanical Testing and Evaluation Methods

This unit focuses on advanced mechanical testing and evaluation techniques. Students will gain expertise in both destructive and non-destructive testing (NDT) methods, such as ultrasonic, radiographic, and magnetic particle testing. It covers the ability to conduct tests, interpret complex data, assess material properties, and ensure mechanical components comply with performance and safety standards.

Learning Outcome:	1. Understand the principles and objectives of mechanical testing methods, including destructive and non-destructive testing techniques.
Assessment Criteria:	1.1. Critically analyze the fundamental stress-strain principles underpinning destructive tests (e.g., tensile, compression) and evaluate their limitations in predicting the long-term life of a component. 1.2. Explain the physical principles (e.g., wave propagation, magnetism, radiation) that enable the detection of discontinuities using common Non-Destructive Testing (NDT) methods. 1.3. Differentiate the strategic objectives of material characterisation testing versus component proof testing and relate each to different mechanical design verification requirements. 1.4. Evaluate the strategic reasons for selecting a destructive versus a non-destructive testing methodology based on cost, component criticality, and the accessibility of the inspection area. 1.5. Justify the required sample preparation and environmental controls necessary to ensure the validity and reproducibility of mechanical test results according to international standards. 1.6. Analyze the concept of material anisotropy and its specific implications for mechanical testing procedures and the interpretation of resulting data.
Learning Outcome:	2. Demonstrate the ability to conduct mechanical tests (e.g., tensile, hardness, fatigue) and interpret their results.
Assessment Criteria:	2.1. Accurately calibrate and set up the testing apparatus (e.g., universal testing machine) to execute a standard mechanical test, ensuring compliance with relevant safety and technical protocols. 2.2. Perform a chosen destructive or non-destructive test on a sample mechanical component, rigorously documenting all procedural steps and raw data collected. 2.3. Interpret the primary data outputs from the test (e.g., load-displacement curves, ultrasonic signals) to determine the component's immediate mechanical response. 2.4. Demonstrate a high standard of laboratory practice, including correct waste disposal and post-test equipment maintenance, in a mechanical testing environment.
Learning Outcome:	3. Analyze test data to assess material properties, performance characteristics, and suitability for specific applications.
Assessment Criteria:	3.1. Process raw test data to derive key mechanical properties (e.g., modulus of elasticity, fracture toughness, endurance limit) and quantify the associated measurement uncertainty. 3.2. Compare the experimentally derived material properties against specified design requirements (e.g., material datasheet values) and critically comment on any observed discrepancies.

	3.3. Analyze the microstructure of a tested sample (e.g., via microscopy) and correlate the observations with the macroscopic mechanical test results. 3.4. Utilize statistical methods (e.g., t-tests, regression analysis) to analyze a batch of test data and determine the statistical suitability of the material for a critical application. 3.5. Generate a comprehensive technical report that translates complex mechanical test data into clear, actionable conclusions regarding material quality and performance characteristics.
Learning Outcome:	4. Evaluate the effectiveness of various mechanical testing techniques in identifying defects and ensuring product quality.
Assessment Criteria:	4.1. Systematically evaluate the detection capabilities, limitations (e.g., depth penetration, surface preparation needs), and cost-effectiveness of three distinct NDT methods for locating subsurface flaws in welds. 4.2. Critically assess the concept of Probability of Detection (POD) for a chosen NDT method and justify its significance in ensuring the overall quality of a high-reliability mechanical product. 4.3. Justify the selection of a specific accelerated life-testing protocol (e.g., Highly Accelerated Life Test - HALT) over traditional fatigue testing for evaluating a mechanical product's longevity, based on time-to-market constraints. 4.4. Appraise the trade-offs between performing 100% in-process inspection versus a statistically defined sampling plan for quality assurance in a mechanical assembly line. 4.5. Evaluate how the combined application of both destructive and non-destructive tests provides a more holistic and cost-effective assessment of mechanical product quality. 4.6. Formulate a risk-based matrix that maps specific types of material defects (e.g., porosity, inclusion, crack) to the most effective mechanical testing technique for reliable identification.
Learning Outcome:	5. Apply advanced testing technologies to optimize mechanical system design and functionality.
Assessment Criteria:	5.1. Design a methodology for integrating sensor data (e.g., strain gauges) from mechanical testing directly into a Finite Element Analysis (FEA) model for validation and design refinement. 5.2. Apply Digital Image Correlation (DIC) or similar advanced non-contact methods to measure full-field strain and displacement on a mechanical prototype under load. 5.3. Propose a Structural Health Monitoring (SHM) system based on advanced NDT (e.g., phased array ultrasonic testing) for a critical, inaccessible mechanical asset. 5.4. Develop a testing protocol for validating the functionality of an Additive Manufactured (3D printed) mechanical component, addressing the unique challenges of layer-by-layer fabrication. 5.5. Utilize advanced data from acoustic emission testing or vibration analysis to predict imminent failure in a rotating mechanical system before physical damage is evident. 5.6. Justify the use of computed tomography (CT) scanning as a quality control tool for complex internal geometries in a mechanical part, evaluating its cost vs. benefit.

LICQ2200174-3 Failure Analysis and Root Cause Investigation

This unit provides the skills to systematically investigate mechanical failures and determine their root causes. Learners will study common failure modes (e.g., fatigue, corrosion, wear) and apply advanced techniques like Fishbone Diagrams and Fault Tree Analysis (FTA). The goal is to recommend effective corrective and preventive actions (CAPA) to improve product reliability and process integrity.

Learning Outcome:	1. Understand the principles and methodologies of failure analysis in mechanical systems and components.
Assessment Criteria:	1.1. Critically discuss the importance of systematic, unbiased evidence collection and preservation immediately following a mechanical failure event. 1.2. Explain the key stages of a forensic engineering failure investigation, including documentation, non-destructive examination, destructive testing, and final reporting. 1.3. Analyze the role of fractography (macroscopic and microscopic) in interpreting the fracture surface characteristics and determining the mechanical mechanism of failure initiation. 1.4. Differentiate between primary, secondary, and tertiary factors contributing to a mechanical component failure and explain the necessity of addressing all factors in the analysis. 1.5. Evaluate the ethical and legal implications of mechanical failure analysis, particularly in relation to product liability and intellectual property. 1.6. Define and illustrate the difference between failure mode, failure mechanism, and root cause in the context of mechanical equipment breakdown. 1.7. Justify the necessity of cross-referencing field operational data (e.g., loading history, environment) with laboratory analysis results during a failure investigation. 1.8. Critically examine two established failure analysis standards or guidelines (e.g., from ASTM or ASM) and assess their applicability to a modern complex mechanical system.
Learning Outcome:	2. Identify common failure modes in mechanical engineering, such as fatigue, corrosion, and wear.
Assessment Criteria:	2.1 Identify the distinct visual and microscopic characteristics (e.g., beach marks, striations) associated with fatigue failure in rotating mechanical parts. 2.2 Classify and differentiate between the major forms of corrosion (e.g., pitting, galvanic, stress corrosion cracking) based on their underlying electrochemical mechanisms and mechanical context. 2.3 Recognise the macroscopic evidence of various wear modes (e.g., abrasive, adhesive, erosive) on mechanical contact surfaces and relate them to lubrication and operational conditions. 2.4 Differentiate between brittle fracture, creep failure, and high-temperature stress rupture based on the operating temperature, strain rate, and microstructure observed. 2.5 Analyze a case study involving component overload and determine if the failure was due to gross yielding, brittle fracture, or a combination of factors.

Learning Outcome:	3. Apply root cause analysis (RCA) techniques to diagnose and address failures in mechanical systems (e.g., Fishbone Diagram, Fault Tree Analysis).
Assessment Criteria:	3.1 Apply Fault Tree Analysis (FTA) to a given mechanical system failure, systematically developing the logic gates and base events to trace the potential paths to the undesired top event. 3.2 Construct a Fishbone (Ishikawa) Diagram to structure the investigation of a complex, multi-factor mechanical failure, ensuring all 5Ms (Man, Machine, Material, Method, Measurement) are critically addressed. 3.3 Execute the "5 Whys" technique rigorously to drill down from a manifest mechanical failure to the underlying system or management deficiencies that allowed it to occur. 3.4 Systematically evaluate the effectiveness and limitations of two different RCA techniques (e.g., Failure Mode and Effects Analysis vs. Fault Tree Analysis) when applied to the same complex mechanical system failure case study.
Learning Outcome:	4. Evaluate the impact of identified failure causes on system performance, safety, and operational continuity.
Assessment Criteria:	4.1. Quantify the direct and indirect financial costs associated with a diagnosed mechanical failure, including downtime, repair, and lost production/revenue. 4.2. Critically evaluate the safety implications of a component failure, determining the risk level and potential cascading effects on human safety and environmental impact. 4.3. Analyze the reliability metrics (e.g., Mean Time Between Failures - MTBF) of a mechanical system before and after a diagnosed failure to measure the impact on operational continuity. 4.4. Assess the long-term integrity and remaining service life of non-failed, sibling components that shared the same operational history as the failed part, based on the identified root cause. 4.5. Formulate a concise executive summary report that translates the technical findings of a failure analysis into clear recommendations regarding business risk and required strategic decisions.
Learning Outcome:	5. Develop and implement corrective actions and preventive measures to minimize recurrence and enhance system reliability.
Assessment Criteria:	5.1. Develop a set of stratified corrective actions (immediate, medium-term, long-term) that directly address the root causes identified through a formal RCA process. 5.2. Design a revised inspection or maintenance schedule (e.g., Predictive Maintenance strategy) specifically to prevent the identified failure mechanism from recurring. 5.3. Implement a change management procedure to formally introduce a modified mechanical design or operational parameter, ensuring controlled and documented application. 5.4. Determine and justify the cost-benefit analysis for implementing a proposed preventative measure (e.g., material upgrade, new NDT technique) versus accepting the risk of recurrence.

LICQ2200174-4 Risk Management and Quality Control Strategies

This unit addresses risk assessment and mitigation within mechanical engineering contexts. Students learn to identify potential operational, safety, and quality risks associated with mechanical systems. It focuses on using tools like Failure Mode and Effects Analysis (FMEA) to prioritize risks, design effective quality control measures, and implement risk mitigation plans to ensure project compliance.

Learning Outcome:	1. Understand the principles of risk assessment and quality control in mechanical engineering contexts.
Assessment Criteria:	1.1. Critically explain the relationship and differences between Quality Assurance (QA), Quality Control (QC), and Risk Management (RM) in the mechanical design and manufacturing environment. 1.2. Analyze the structure of a typical risk management framework (e.g., ISO 31000) and justify its application for mechanical engineering projects that involve limited definition. 1.3. Define and differentiate between the key components of risk: likelihood, severity/consequence, and detectability, in the context of mechanical component failure. 1.4. Explain the concept of 'acceptable risk' and how it is determined in the mechanical sector, considering relevant industry standards and corporate risk appetite. 1.5. Differentiate between product-based risk (e.g., material failure) and process-based risk (e.g., inadequate calibration) in a high-precision machining operation. 1.6. Critically review the ethical dimensions of risk management decisions in mechanical engineering, particularly those affecting public safety or environmental impact.
Learning Outcome:	2. Identify potential risks associated with mechanical systems and processes, including operational, safety, and environmental risks.
Assessment Criteria:	2.1 Systematically identify and categorize potential operational risks (e.g., excessive vibration, thermal shock, control system error) during the commissioning of a complex mechanical system. 2.2 Identify all plausible failure modes that could lead to catastrophic safety risks (e.g., pressure vessel rupture, loss of containment) within a designated mechanical plant. 2.3 Determine and document the environmental risks (e.g., pollutant release, energy waste) associated with the entire lifecycle of a mechanical manufacturing process. 2.4 Analyze the risks introduced by reliance on a single, highly specialized supplier for a critical mechanical component and propose risk mitigation through diversification. 2.5 Identify the specific risks related to human factors (e.g., operator error, inadequate training, fatigue) that can compromise the quality of mechanical assembly or maintenance. 2.6 Categorize the financial and reputational risks associated with a significant mechanical product recall due to an undetected systemic defect.

Learning Outcome:	3. Analyze and prioritize risks using tools such as FMEA (Failure Mode and Effects Analysis) and risk matrices.
Assessment Criteria:	3.1 Execute a structured Design FMEA (DFMEA) for a new mechanical component, systematically identifying failure modes, effects, and classifying them by severity, occurrence, and detection. 3.2 Calculate the Risk Priority Number (RPN) for a set of identified mechanical failure modes and use this metric to generate a prioritized list of concerns. 3.3 Critically analyse the inherent limitations and subjectivity of the RPN calculation and propose methods for enhancing the objectivity of the FMEA process. 3.4 Construct and justify the axes and thresholds of a customized 5x5 risk matrix suitable for prioritizing operational and safety risks in a mechanical workshop environment.
Learning Outcome:	4. Design and implement effective quality control measures to mitigate risks and ensure product compliance.
Assessment Criteria:	4.1. Design a comprehensive quality control plan that details the required inspection points, acceptance criteria, and measurement techniques necessary to mitigate the top five mechanical risks identified in an FMEA. 4.2. Implement a robust calibration and measurement system to ensure the accuracy of all inspection equipment used in QC, thereby reducing the risk of 'false acceptance'. 4.3. Develop and implement detailed Standard Operating Procedures (SOPs) for critical mechanical processes, incorporating specific control checks and sign-offs to prevent known failure modes.
Learning Outcome:	5. Evaluate the effectiveness of risk management and quality control strategies in improving mechanical system performance.
Assessment Criteria:	5.1. Evaluate the change in RPN (Risk Priority Number) for high-risk mechanical failure modes following the implementation of corrective quality control measures. 5.2. Analyze historical incident and non-conformance data to determine the measurable reduction in operational risk and associated quality costs post-strategy implementation. 5.3. Critically assess the cultural impact of the risk management strategy on employee behaviour, accountability, and proactive hazard reporting within the mechanical team. 5.4. Design a framework for conducting periodic reviews and stress-testing of the implemented risk strategies to ensure their continued relevance in a dynamic mechanical environment. 5.5. Formulate a set of recommendations for the strategic reallocation of quality control resources based on the demonstrated effectiveness of current risk mitigation efforts.

LICQ2200174-5 Advanced Quality Assurance and Process Improvement

This unit focuses on driving continuous improvement using advanced quality assurance methodologies. It covers the application of statistical tools, including Statistical Process Control (SPC) and Six Sigma, to monitor process performance. Learners will develop and implement strategies such as Lean Manufacturing and Agile practices to optimize efficiency and enhance overall product quality.

Learning Outcome:	1. Understand the role of advanced quality assurance (QA) techniques in mechanical engineering projects.
Assessment Criteria:	1.1. Critically analyze the strategic shift from reactive Quality Control to proactive Quality Assurance and its benefits in reducing the Cost of Poor Quality (COPQ) in mechanical manufacturing. 1.2. Explain the conceptual framework of Total Quality Management (TQM) and justify its applicability to foster a continuous improvement culture in a mechanical engineering firm. 1.3. Differentiate between the quality assurance roles during the design phase (e.g., Design Review, DFMEA) versus the manufacturing phase (e.g., Process Audit, SPC). 1.4. Analyze the role of concurrent engineering and integrated product teams (IPTs) as advanced QA techniques in accelerating the mechanical product development cycle. 1.5. Evaluate the strategic necessity of conducting comprehensive supplier QA audits, particularly for suppliers providing critical, high-precision mechanical sub-components. 1.6. Explain the concept of a 'Quality Gate' within a mechanical product development process and justify its use as a mandatory assurance checkpoint for high-risk systems.
Learning Outcome:	2. Apply statistical tools (e.g., Six Sigma, SPC) to monitor and improve process efficiency and product quality.
Assessment Criteria:	2.1 Apply the DMAIC (Define, Measure, Analyze, Improve, Control) methodology to a significant quality issue identified in a mechanical manufacturing process (e.g., high scrap rate in CNC machining). 2.2 Construct and interpret variable and attribute control charts (e.g., X-bar and R charts, p-charts) for a critical mechanical process parameter and determine if the process is in a state of statistical control. 2.3 Calculate and interpret Process Capability Indices (Cp and Cpk) for a mechanical feature to assess its ability to meet specified tolerance requirements. 2.4 Utilize a hypothesis test (e.g., ANOVA) on mechanical process data to determine if a change in raw material or machine setting has a statistically significant effect on product quality. 2.5 Apply Taguchi Methods (e.g., Orthogonal Arrays) to design robust mechanical experiments that minimise the effects of uncontrollable noise factors on product performance.
Learning Outcome:	3. Analyze process performance data to identify areas for improvement in mechanical manufacturing and design workflows.

Assessment Criteria:	3.1 Analyze the distribution of mechanical defect types using a Pareto Chart to identify the 'vital few' failure causes responsible for the majority of non-conformance. 3.2 Critically examine a Value Stream Map (VSM) of a mechanical assembly line to identify non-value-added activities, bottlenecks, and excessive cycle times contributing to poor quality. 3.3 Analyze Scatter Plots and Regression Analysis on mechanical process data to identify and quantify the correlation between two interacting variables. 3.4 Dissect the causes of process variation using a sophisticated Run Chart or Western Electric rules to distinguish between common-cause and special-cause variation. 3.5 Evaluate the efficiency of a mechanical design review process by analyzing the correlation between the number of design errors found in the review stage and those found during field testing.
Learning Outcome:	4. Develop and implement strategies for continuous process improvement, including lean manufacturing and agile practices.
Assessment Criteria:	4.1. Develop a comprehensive plan to implement a single-piece flow system (cellular manufacturing) and Kanban inventory control to reduce inventory and lead time in a mechanical component line. 4.2. Design a 5S (Sort, Set in order, Shine, Standardise, Sustain) implementation strategy specifically tailored for enhancing safety and quality control in a heavy mechanical maintenance bay. 4.3. Formulate a Kaizen event charter for a specific mechanical quality bottleneck, detailing the scope, objectives, team structure, and anticipated measurable results. 4.4. Propose and justify the application of an Agile quality management framework for the rapid, iterative development and testing of a new mechanical prototype. 4.5. Develop a Poka-Yoke (mistake-proofing) device or procedure to physically eliminate the possibility of a common assembly error in a mechanical final assembly process. 4.6. Implement a Total Productive Maintenance (TPM) schedule focused on preventing mechanical equipment breakdowns that directly compromise quality specifications.
Learning Outcome:	5. Evaluate the impact of quality assurance initiatives on overall system productivity, cost-effectiveness, and customer satisfaction.
Assessment Criteria:	5.1. Quantify the return on investment (ROI) of a major quality initiative (e.g., Six Sigma project) by calculating the reduction in quality costs and the increase in process throughput. 5.2. Evaluate the correlation between the improvement in internal quality metrics (e.g., process capability) and external measures of customer satisfaction (e.g., warranty claims). 5.3. Critically assess the change in mechanical system reliability (e.g., MTBF) and availability (e.g., Overall Equipment Effectiveness - OEE) as a direct result of implemented QA improvements.

LICQ2200174-6 International Standards and Regulatory Compliance in Mechanical Engineering

This unit ensures professionals are competent in navigating and applying global regulatory frameworks and standards. It covers key international standards (e.g., ASME, API, various ISO certifications) relevant to mechanical products and processes. The unit emphasizes the legal and ethical implications of compliance and the evaluation of certification processes to guarantee global market relevance.

Learning Outcome:	1. Understand the international standards governing mechanical engineering practices (e.g., ISO 14001, ASME codes).
Assessment Criteria:	1.1. Explain the scope and primary objectives of the International Organization for Standardization (ISO) standards (e.g., 14001, 45001) in relation to mechanical engineering operational and management practices. 1.2. Differentiate between mandatory regulatory requirements (e.g., government safety laws) and voluntary consensus standards (e.g., ASME, API codes) and their legal implications for mechanical firms. 1.3. Critically analyse the structure of a major mechanical design code (e.g., ASME Pressure Vessel Code) and explain how it influences the specification of materials and manufacturing processes. 1.4. Discuss the significance of the CE mark or similar conformity assessment markings for mechanical products accessing specific global markets. 1.5. Evaluate the strategic advantages for a mechanical firm operating globally to adopt integrated management systems that encompass quality, environment, and occupational health/safety standards.
Learning Outcome:	2. Analyze the regulatory requirements for mechanical systems and their implications for global compliance.
Assessment Criteria:	2.1 Analyze the conflicting or overlapping regulatory requirements for a specific mechanical product across three different major geopolitical markets (e.g., EU, USA, Asia). 2.2 Dissect a complex regulatory document (e.g., a national safety law) and translate its clauses into specific, actionable design and manufacturing requirements for a mechanical system. 2.3 Investigate a case study of a major mechanical product recall due to non-compliance, analysing the regulatory breach and the subsequent financial and legal repercussions. 2.4 Analyze the process of Declaration of Conformity (DoC) or Type Approval for a mechanical product, identifying the critical technical documentation required for submission. 2.5 Evaluate the role of an Authorised Representative or Notified Body in verifying compliance for mechanical products entering regulated international markets. 2.6 Determine the specific environmental compliance obligations (e.g., WEEE, RoHS, REACH) that apply to the materials selection and end-of-life disposal of a heavy mechanical machine.
Learning Outcome:	3. Demonstrate knowledge of the certification processes for mechanical products and systems according to international standards.

Assessment Criteria:	3.1. Systematically describe the full certification lifecycle for a new mechanical product seeking a recognized international mark, from design verification to final approval. 3.2. Demonstrate the process of preparing a comprehensive technical file or design dossier that provides auditable evidence of compliance with the essential requirements of a standard. 3.3. Explain the difference between product certification (e.g., a valve) and management system certification (e.g., ISO 9001) and the appropriate auditing bodies for each in the mechanical sector. 3.4. Outline the internal quality control procedures and documentation required to successfully pass an initial third-party certification audit for a mechanical process. 3.5. Analyze the renewal and surveillance audit processes for maintaining a mechanical quality system certification (e.g., ISO 9001) and the consequences of non-conformance during these audits.
Learning Outcome:	4. Evaluate the risks and consequences of non-compliance in mechanical engineering practices.
Assessment Criteria:	4.1. Evaluate the direct financial costs associated with regulatory fines, penalties, and mandatory recalls resulting from a significant mechanical non-compliance event. 4.2. Critically assess the long-term damage to corporate brand reputation and loss of market access following a publicized failure to adhere to mechanical safety standards. 4.3. Analyze the liability exposure (civil and criminal) faced by individual engineers and the mechanical firm for non-compliance that results in injury, fatality, or significant property damage. 4.4. Determine the potential for forced cessation of operations or withdrawal of business licenses due to repeated or severe non-compliance with environmental or safety regulations. 4.5. Evaluate the risk of major customers terminating supply contracts due to a supplier's failure to maintain required QMS or product compliance certifications.
Learning Outcome:	5. Apply compliance frameworks to ensure adherence to safety, environmental, and operational standards in mechanical engineering projects.
Assessment Criteria:	5.1. Develop a comprehensive compliance checklist and verification plan based on a chosen international standard (e.g., ISO 14001 for environment) for a mechanical fabrication project. 5.2. Design and implement a formal legal register that tracks all applicable national, regional, and international compliance obligations for a mechanical firm's operations. 5.3. Apply a structured compliance audit methodology (e.g., checklist-based, evidence-based) to assess the adherence of a mechanical production line to a specific operational safety standard. 5.4. Formulate a strategy for translating abstract regulatory requirements into concrete, measurable process control parameters and Key Performance Indicators (KPIs) for mechanical teams.

	5.5. Implement a system for the controlled distribution and management of current versions of all relevant standards and regulatory documents throughout the mechanical design office and shop floor. 5.6. Design a compliance review process that ensures all new mechanical designs are systematically assessed against global regulatory requirements before final release.

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