Certified Quality Engineer

Quality excellence to enhance your career
and boost your organization's bottom line

Mastrolee Certification is considered mark of quality excellence in many industries. It helps you advance your career, and boosts your organization's bottom line through your mastery of quality skills. Becoming certified as a Quality Engineer confirms your commitment to quality and the positive impact it will have on your organization.

Certified Quality Engineer

The Certified Quality Engineer is a professional who understands the principles of product and service quality evaluation and control. This body of knowledge and applied technologies include, but are not limited to, development and operation of quality control systems, application and analysis of testing and inspection procedures, the ability to use metrology and statistical methods to diagnose and correct improper quality control practices, an understanding of human factors and motivation, facility with quality cost concepts and techniques, and the knowledge and ability to develop and administer management information systems and to audit quality systems for deficiency identification and correction.

Examination

Each certification candidate is required to pass a written examination that consists of multiple-choice questions that measure comprehension of the Body of Knowledge. The Quality Engineer examination is a one - part, 60-question, two-hour exam. It is offered in English.

Minimum Expectations for a Certified Quality Engineer

- Will have a fundamental understanding of quality philosophies, principles, systems, methods, tools, standards, organizational and team dynamics, customer expectations and satisfaction, supplier relations and performance, leadership, training, interpersonal relationships, improvement systems, and professional ethics.

- Will have a fundamental understanding of a quality system and its development, documentation, and implementation to domestic and international standards or requirements.

- Will have a basic understanding of the audit process including types of audits, planning, preparation, execution, reporting results, and follow-up.

- Will be able to develop and imple-ment quality programs, including tracking, analyzing, reporting, and problem solving.

- Will be able to plan, control, and assure product and process quality in accordance with quality principles, which include planning processes, material control, acceptance sampling, and measurement systems.

- Will have basic knowledge of reliability, maintainability, and risk management, including key terms and definitions, modeling, systems design, assessment tools, and reporting.

- Will have a thorough understanding of problem-solving and quality improvement tools and techniques. This includes knowledge of management and planning tools, quality tools, preventive and corrective actions, and how to overcome barriers to quality improvements.

- Will be able to acquire and analyze data using appropriate standard quantitative methods across a spectrum of business environments to facilitate process analysis and improvements.

For comprehensive exam information on the Quality Engineer certification, visit **www.mastrolee.com**

Body of Knowledge
Certified Quality Engineer

The topics in this Body of Knowledge (BOK) include subtext explanations and the cognitive level at which the questions will be written. This information will provide useful guidance for both the Exam Development Committee and the candidate preparing to take the exam. The subtext is not intended to limit the subject matter or be all-inclusive of that material that will be covered in the exam. It is meant to clarify the type of content that will be included on the exam. The descriptor in parentheses at the end of each entry refers to the maximum cognitive level at which the topic will be tested. A complete description of cognitive levels is provided at the end of this document.

I Management and Leadership

A. **Quality Philosophies and Foundations**
    Explain how modern quality has evolved from quality control through statistical process control (SPC) to total quality management and leadership principles (including Deming's 14 Points), and how quality has helped form various continuous improvement tools including lean, six sigma, theory of constraints, etc. (Remember)

B. **The Quality Management System (QMS)**
    1. **Strategic planning**
        Identify and define top management's responsibility for the QMS, including establishing policies and objectives, setting organization-wide goals, supporting quality initiatives, etc. (Apply)
    2. **Deployment techniques**
        Define, describe, and use various deployment tools in support of the QMS: benchmarking, stakeholder identification and analysis, performance measurement tools, and project management tools such as PERT charts, Gantt charts, critical path method (CPM), resource allocation, etc. (Apply)
    3. **Quality information system (QIS)**
        Identify and define the basic elements of a QIS, including who will contribute data, the kind of data to be managed, who will have access to the data, the level of flexibility for future information needs, data analysis, etc. (Remember)

C. **ASQ Code of Ethics for Professional Conduct**
    Determine appropriate behavior in situations requiring ethical decisions. (Evaluate)

D. **Leadership Principles and Techniques**
    Describe and apply various principles and techniques for developing and organizing teams and leading quality initiatives. (Analyze)

E. Facilitation Principles and Techniques
Define and describe the facilitator's role and responsibilities on a team. Define and apply various tools used with teams, including brainstorming, nominal group technique, conflict resolution, force-field analysis, etc. (Analyze)

F. Communication Skills
Describe and distinguish between various communication methods for delivering information and messages in a variety of situations across all levels of the organization. (Analyze)

G. Customer Relations
Define, apply, and analyze the results of customer relation measures such as quality function deployment (QFD), customer satisfaction surveys, etc. (Analyze)

H. Supplier Management
Define, select, and apply various techniques including supplier qualification, certification, evaluation, ratings, performance improvement, etc. (Analyze)

I. Barriers to Quality Improvement
Identify barriers to quality improvement, their causes and impact, and describe methods for overcoming them. (Analyze)

🔵 The Quality System

A. Elements of the Quality System
Define, describe, and interpret the basic elements of a quality system, including planning, control, and improvement, from product and process design through quality cost systems, audit programs, etc. (Evaluate)

B. Documentation of the Quality System
Identify and apply quality system documentation components, including quality policies, procedures to support the system, configuration management and document control to manage work instructions, quality records, etc. (Apply)

C. Quality Standards and Other Guidelines
Define and distinguish between national and international standards and other requirements and guidelines, including the Malcolm Baldrige National Quality Award (MBNQA), and describe key points of the ISO 9000 series of standards and how they are used. [Note: Industry-specific standards will not be tested.] (Apply)

D. Quality Audits

1. **Types of audits**
Describe and distinguish between various types of quality audits such as product, process, management (system), registration (certification), compliance (regulatory), first, second, and third party, etc. (Apply)

2. **Roles and responsibilities in audits**
Identify and define roles and responsibilities for audit participants such as audit team (leader and members), client, auditee, etc. (Understand)

3. **Audit planning and implementation**
Describe and apply the steps of a quality audit, from the audit planning stage through conducting the audit, from the perspective of an audit team member. (Apply)

4. **Audit reporting and follow-up**
Identify, describe, and apply the steps of audit reporting and follow-up, including the need to verify corrective action. (Apply)

E. Cost of Quality (COQ)
Identify and apply COQ concepts, including cost categories, data collection methods and classification, and reporting and interpreting results. (Analyze)

F. Quality Training
Identify and define key elements of a training program, including conducting a needs analysis, developing curricula and materials, and determining the program's effectiveness. (Apply)

III Product and Process Design

A. Classification of Quality Characteristics
Define, interpret, and classify quality characteristics for new products and processes. [Note: The classification of product defects is covered in IV.B.3.] (Evaluate)

B. Design Inputs and Review
Identify sources of design inputs such as customer needs, regulatory requirements, etc., and how they translate into design concepts such as robust design, QFD, and Design for X (DFX, where X can mean six sigma (DFSS), manufacturability (DFM), cost (DFC), etc.). Identify and apply common elements of the design review process, including roles and responsibilities of participants. (Analyze)

C. Technical Drawings and Specifications
Interpret technical drawings including characteristics such as views, title blocks, dimensioning, tolerancing, GD&T symbols, etc. Interpret specification requirements in relation to product and process characteristics. (Evaluate)

D. Design Verification
Identify and apply various evaluations and tests to qualify and validate the design of new products and processes to ensure their fitness for use. (Evaluate)

E. Reliability and Maintainability

1. **Predictive and preventive maintenance tools**
Describe and apply these tools and techniques to maintain and improve process and product reliability. (Analyze)

2. **Reliability and maintainability indices**
Review and analyze indices such as, MTTF, MTBF, MTTR, availability, failure rate, etc. (Analyze)

3. **Bathtub curve**
Identify, define, and distinguish between the basic elements of the bathtub curve. (Analyze)

4. **Reliability/safety/hazard assessment tools**
Define, construct, and interpret the results of failure mode and effects analysis (FMEA), failure mode, effects, and criticality analysis (FMECA), and fault tree analysis (FTA). (Analyze)

IV Project Management

A. Tools
Define, identify, and apply product and process control methods such as developing control plans, identifying critical control points, developing and validating work instructions, etc. (Analyze)

B. Material Control

1. **Material identification, status, and traceability**
Define and distinguish these concepts, and describe methods for applying them in various situations. [Note: Product recall procedures will not be tested.] (Analyze)

2. **Material segregation**
Describe material segregation and its importance, and evaluate appropriate methods for applying it in various situations. (Evaluate)

3. **Classification of defects**
Define, describe, and classify the seriousness of product and process defects. (Evaluate)

4. **Material review board (MRB)**
Identify the purpose and function of an MRB, and make appropriate disposition decisions in various situations. (Analyze)

C. Acceptance Sampling

1. **Sampling concepts**
Define, describe, and apply the concepts of producer and consumer risk and related terms, including operating characteristic (OC) curves, acceptable quality limit (AQL), lot tolerance percent defective (LTPD), average outgoing quality (AOQ), average outgoing quality limit (AOQL), etc. (Analyze)

2. **Sampling standards and plans**
   Interpret and apply ANSI/ ASQ Z1.4 and Z1.9 standards for attributes and variables sampling. Identify and distinguish between single, double, multiple, sequential, and continuous sampling methods. Identify the characteristics of Dodge-Romig sampling tables and when they should be used. (Analyze)

3. **Sample integrity**
   Identify the techniques for establishing and maintaining sample integrity. (Analyze)

D. Measurement and Test

1. **Measurement tools**
   Select and describe appropriate uses of inspection tools such as gage blocks, calipers, micrometers, optical comparators, etc. (Analyze)

2. **Destructive and nondestructive tests**
   Distinguish between destructive and nondestructive measurement test methods and apply them appropriately. (Analyze)

E. Metrology
Identify, describe, and apply metrology techniques such as calibration systems, traceability to calibration standards, measurement error and its sources, and control and maintenance of measurement standards and devices. (Analyze)

F. Measurement System Analysis (MSA)
Calculate, analyze, and interpret repeatability and reproducibility (Gage R&R) studies, measurement correlation, capability, bias, linearity, etc., including both conventional and control chart methods. (Evaluate)

V Continuous Improvement

A. Quality Control Tools
Select, construct, apply, and interpret tools such as 1) flowcharts, 2) Pareto charts, 3) cause and effect diagrams, 4) control charts, 5) check sheets, 6) scatter diagrams, and 7) histograms. (Analyze)

B. Quality Management and Planning Tools
Select, construct, apply, and interpret tools such as 1) affinity diagrams, 2) tree diagrams, 3) process decision program charts (PDPC), 4) matrix diagrams, 5) interrelationship digraphs, 6) prioritization matrices, and 7) activity network diagrams. (Analyze)

C. Continuous Improvement Techniques
Define, describe, and distinguish between various continuous improvement models: total quality management (TQM), kaizen, Plan-Do-Check-Act (PDCA), six sigma, theory of constraints (TOC), lean, etc. (Analyze)

D. Corrective Action
Identify, describe, and apply elements of the corrective action process including problem identification, failure analysis, root cause analysis, problem correction, recurrence control, verification of effectiveness, etc. (Evaluate)

E. Preventive Action
Identify, describe, and apply various preventive action tools such as error-proofing/poka-yoke, robust design, etc., and analyze their effectiveness. (Evaluate)

VI Quantitative Methods and Tools

A. Collecting and Summarizing Data

1. **Types of data**
   Define, classify, and compare discrete (attributes) and continuous (variables) data. (Apply)

2. **Measurement scales**
   Define, describe, and use nominal, ordinal, interval, and ratio scales. (Apply)

3. **Data collection methods**
   Describe various methods for collecting data, including tally or check sheets, data coding, automatic gaging, etc., and identify their strengths and weaknesses. (Apply)

4. **Data accuracy**
Describe the characteristics or properties of data (e.g., source/ resource issues, flexibility, versatility, etc.) and various types of data errors or poor quality such as low accuracy, inconsistency, interpretation of data values, and redundancy. Identify factors that can influence data accuracy, and apply techniques for error detection and correction. (Apply)

5. **Descriptive statistics**
Describe, calculate, and interpret measures of central tendency and dispersion (central limit theorem), and construct and interpret frequency distributions including simple, categorical, grouped, ungrouped, and cumulative. (Evaluate)

6. **Graphical methods for depicting relationships**
Construct, apply, and interpret diagrams and charts such as stem-and-leaf plots, box-and-whisker plots, etc. [Note: Run charts and scatter diagrams are covered in V.A.] (Analyze)

7. **Graphical methods for depicting distributions**
Construct, apply, and interpret diagrams such as normal probability plots, Weibull plots, etc. [Note: Histograms are covered in V.A.] (Analyze)

B. **Quantitative Concepts**

1. **Terminology**
Define and apply quantitative terms, including population, parameter, sample, statistic, random sampling, expected value, etc. (Analyze)

2. **Drawing statistical conclusions**
Distinguish between numeric and analytical studies. Assess the validity of statistical conclusions by analyzing the assumptions used and the robustness of the technique used. (Evaluate)

3. **Probability terms and concepts**
Describe and apply concepts such as independence, mutually exclusive, multiplication rules, complementary probability, joint occurrence of events, etc. (Apply)

C. **Probability Distributions**

1. **Continuous distributions**
Define and distinguish between these distributions: normal, uniform, bivariate normal, exponential, lognormal, Weibull, chi square, Student's t, F, etc. (Analyze)

2. **Discrete distributions**
Define and distinguish between these distributions: binomial, Poisson, hypergeometric, multinomial, etc. (Analyze)

D. **Statistical Decision-making**

1. **Point estimates and confidence intervals**
Define, describe, and assess the efficiency and bias of estimators. Calculate and interpret standard error, tolerance intervals, and confidence intervals. (Evaluate)

2. **Hypothesis testing**
Define, interpret, and apply hypothesis tests for means, variances, and proportions. Apply and interpret the concepts of significance level, power, type I and type II errors. Define and distinguish between statistical and practical significance. (Evaluate)

3. **Paired-comparison tests**
Define and use paired-comparison (parametric) hypothesis tests, and interpret the results. (Apply)

4. **Goodness-of-fit tests**
Define and use chi square and other goodness-of-fit tests, and interpret the results. (Apply)

5. **Analysis of variance (ANOVA)**
Define and use ANOVAs and interpret the results. (Analyze)

6. **Contingency tables**
Define, construct, and use contingency tables to evaluate statistical significance. (Analyze)

E. **Relationships Between Variables**

1. **Linear regression**
Calculate the regression equation for simple regressions and least squares estimates. Construct and interpret hypothesis tests for regression statistics. Use regression models for estimation and prediction, and analyze

the uncertainty in the estimate. [Note: Nonlinear models and parameters will not be tested.] (Analyze)

2. **Simple linear correlation**
Calculate the correlation coefficient and its confidence interval, and construct and interpret a hypothesis test for correlation statistics. [Note: Serial correlation will not be tested.] (Analyze)

3. **Time-series analysis**
Define, describe, and use time-series analysis including moving average, and interpret time-series graphs to identify trends and seasonal or cyclical variation. (Analyze)

F. **Statistical Process Control (SPC)**

1. **Objectives and benefits**
Identify and explain objectives and benefits of SPC such as assessing process performance. (Understand)

2. **Common and special causes**
Describe, identify, and distinguish between these types of causes. (Analyze)

3. **Selection of variable**
Identify and select characteristics for monitoring by control chart. (Analyze)

4. **Rational subgrouping**
Define and apply the principles of rational subgrouping. (Apply)

5. **Control charts**
Identify, select, construct, and use various control charts, including $\bar{X}$-R, $\bar{X}$- s, individuals and moving range (ImR or XmR), moving average and moving range (MamR), p, np, c, u, and CUSUM charts. (Analyze)

6. **Control chart analysis**
Read and interpret control charts, use rules for determining statistical control. (Evaluate)

7. **PRE-control charts**
Define and describe how these charts differ from other control charts and how they should be used. (Apply)

8. **Short-run SPC**
Identify, define, and use short-run SPC rules. (Apply)

G. **Process and Performance Capability**

1. **Process capability studies**
Define, describe, calculate, and use process capability studies, including identifying characteristics, specifications, and tolerances, developing sampling plans for such studies, establishing statistical control, etc. (Analyze)

2. **Process performance vs. specifications**
Distinguish between natural process limits and specification limits, and calculate percent defective. (Analyze)

3. **Process capability indices**
Define, select, and calculate Cp, Cpk, Cpm, and Cr, and evaluate process capability. (Evaluate)

4. **Process performance indices**
Define, select, and calculate Pp and Ppk and evaluate process performance. (Evaluate)

H. **Design and Analysis of Experiments**

1. **Terminology**
Define terms such as dependent and independent variables, factors, levels, response, treatment, error, and replication. (Understand)

2. **Planning and organizing experiments**
Define, describe, and apply the basic elements of designed experiments, including determining the experiment objective, selecting factors, responses, and measurement methods, choosing the appropriate design, etc. (Analyze)

3. **Design principles**
Define and apply the principles of power and sample size, balance, replication, order, efficiency, randomization, blocking, interaction, and confounding. (Apply)

4. **One-factor experiments**
Construct one-factor experiments such as completely randomized, randomized block, and Latin square designs, and use computational and graphical methods to analyze the significance of results. (Analyze)

5. **Full-factorial experiments**
Construct full-factorial designs and use computational and graphical methods to analyze the significance of results. (Analyze)

6. **Two-level fractional factorial experiments**
Construct two-level fractional factorial designs (including Taguchi designs) and apply computational and graphical methods to analyze the significance of results. (Analyze)

Levels of Cognition
Based on Bloom's Taxonomy—Revised (2001)
In addition to **content** specifics, the subtext for each topic in this BOK also indicates the intended **complexity level** of the test questions for that topic. These levels are based on "Levels of Cognition" (from Bloom's Taxonomy—Revised, 2001) and are presented below in rank order, from least complex to most complex.

Remember
Recall or recognize terms, definitions, facts, ideas, materials, patterns, sequences, methods, principles, etc.

Understand
Read and understand descriptions, communications, reports, tables, diagrams, directions, regulations, etc.

Apply
Know when and how to use ideas, procedures, methods, formulas, principles, theories, etc.

Analyze
Break down information into its constituent parts and recognize their relationship to one another and how they are organized; identify sublevel factors or salient data from a complex scenario.

Evaluate
Make judgments about the value of proposed ideas, solutions, etc., by comparing the proposal to specific criteria or standards.

Create
Put parts or elements together in such a way as to reveal a pattern or structure not clearly there before; identify which data or information from a complex set is appropriate to examine further or from which supported conclusions can be drawn.

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