

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - 5 SEMESTER – MID TERM – W26 – ANSWER BANK

Subject Name & Code:

QUALITY AND RELIABILITY ENGINEERING - BE05000331

1) Define Quality and explain its significance in manufacturing industries.

Quality: Degree to which a product meets customer requirements and specifications.

Significance:

- Increases customer satisfaction and loyalty
 - Reduces rework, waste, and manufacturing costs
 - Enhances market competitiveness and brand reputation
 - Ensures product reliability and safety
-

2) Explain the various dimensions of quality with suitable examples.

- **Performance:** Primary operating characteristics (e.g., car speed)
 - **Reliability:** Consistency of performance over time (e.g., appliance lifespan)
 - **Durability:** Product life expectancy (e.g., tire tread life)
 - **Serviceability:** Ease of repair and maintenance (e.g., modular electronics)
 - **Aesthetics:** Appearance and feel (e.g., smartphone design)
 - **Features:** Secondary characteristics (e.g., camera quality in phone)
 - **Conformance:** Meeting specifications (e.g., dimensional accuracy)
 - **Perceived Quality:** Brand image (e.g., Rolex watches)
-

3) What is inspection? Explain the need for inspection in manufacturing.

Inspection: Process of examining products to verify conformity to specifications.

Need:

- Ensures products meet quality standards before delivery
 - Detects defects early, reducing waste and rework
 - Prevents defective products from reaching customers
 - Verifies manufacturing process effectiveness
-

4) Explain different types of inspection used in manufacturing industries.

- **Incoming Inspection:** Checks raw materials before production
 - **In-Process Inspection:** Monitors quality during manufacturing stages
 - **Final Inspection:** Verifies finished products before dispatch
 - **Source Inspection:** Performed at supplier's facility
 - **Patrol Inspection:** Random checks during ongoing production
 - **Functional Inspection:** Tests product performance and operation
-

5) How would you decide where and how much inspection is required in a production process?

Decision factors:

- **Criticality of part:** Critical components require 100% inspection
 - **Cost of inspection vs. cost of defect:** Balance economic factors
 - **Process capability:** Stable processes need less inspection
 - **Historical defect rates:** High-defect areas need more inspection
 - **Customer requirements:** Specifications dictate inspection level
 - **Stage selection:** Inspect at points where defects originate or are costly
-

6) Explain the relationship between product design and product quality.

- **Design defines quality standards:** Specifications, tolerances, and materials determine achievable quality
 - **Design determines manufacturability:** Poor design leads to production difficulties and defects
 - **Design affects reliability:** Component selection and layout impact product life
 - **Design influences cost:** Over-design increases cost; under-design reduces quality
 - **Early design decisions:** 70-80% of quality issues are determined at design stage
-

7) How does the manufacturing process affect product quality? Explain with an example.

- **Process capability:** Determines ability to meet tolerances consistently
- **Process variation:** Higher variation leads to more defects
- **Machine condition:** Worn equipment produces poor quality
- **Operator skill:** Affects precision and consistency
- **Environmental factors:** Temperature, humidity affect product quality

Example: In CNC machining, tool wear causes dimensional drift; without compensation, parts exceed tolerance limits, resulting in rejection.

8) Discuss the role of the quality control department in an organizational structure.

- **Policy formulation:** Establishes quality standards and objectives
 - **Inspection and testing:** Verifies conformance at all stages
 - **Quality planning:** Develops control plans and procedures
 - **Data analysis:** Tracks quality metrics and identifies trends
 - **Corrective action:** Investigates and resolves quality problems
 - **Supplier quality:** Evaluates and monitors vendor performance
 - **Training:** Educates employees on quality requirements
-

9) Develop a suitable quality control and inspection framework for a small manufacturing organization.

- **Incoming inspection:** Check raw materials against specifications
 - **In-process inspection:** Operator self-checks and patrol inspection at critical stages
 - **Final inspection:** 100% or sampling inspection before dispatch
 - **Documentation:** Maintain inspection records and rejection logs
 - **Control charts:** Monitor key process parameters
 - **Corrective action system:** Address non-conformities promptly
 - **Training:** Basic QC training for operators and inspectors
-

10) Explain: Quality Control

Quality Control: Operational techniques and activities used to fulfill quality requirements.

- Focuses on detection and correction of defects
 - Involves inspection, testing, and measurement
 - Maintains products within specified limits
 - Reactive approach—identifies problems after they occur
-

11) Define and explain process capability and explain its significance.

Process Capability: Ability of a process to produce output within specification limits consistently.

Significance:

- Indicates whether process meets customer requirements
 - Measured by Cp and Cpk indices
 - $Cp \geq 1.33$ considered capable
 - Helps decide if process needs improvement
 - Predicts defect rates and quality levels
-

12) Analyze the effect of process variation on product quality and manufacturing cost.

- **Increased defects:** Higher variation causes more parts outside tolerance
- **Higher inspection cost:** More checking required to catch defects

- **Increased scrap and rework:** Defective parts must be discarded or reworked
 - **Customer dissatisfaction:** Inconsistent products reduce loyalty
 - **Warranty claims:** Variable quality leads to field failures
 - **Reduced profit margin:** All above factors increase total cost
-

13) Explain the procedure for establishing and interpreting control charts.

Establishing:

- Select quality characteristic to monitor
- Choose appropriate chart type (X-bar-R, p, c, etc.)
- Collect 20-25 subgroups of data
- Calculate control limits (UCL, LCL)
- Plot data and limits

Interpreting:

- Points within limits: Process in control
 - Points outside limits: Assignable cause present
 - Non-random patterns: Trends, shifts, cycles indicate problems
 - Investigate and correct before continuing
-

14) Develop suitable criteria for evaluating and rating suppliers/vendors based on quality performance.

- **Quality of incoming materials:** Defect rate, rejection percentage
 - **Delivery performance:** On-time delivery, lead time consistency
 - **Price competitiveness:** Cost relative to quality
 - **Technical capability:** Ability to meet specifications
 - **Responsiveness:** Handling of complaints and corrective actions
 - **Certifications:** ISO, quality system compliance
 - **Financial stability:** Long-term reliability
-

15) Explain the steps involved in implementing Six Sigma in an organization.

- **Define:** Identify problem, project scope, and customer requirements
 - **Measure:** Collect data on current process performance
 - **Analyze:** Identify root causes of defects and variation
 - **Improve:** Develop and implement solutions
 - **Control:** Monitor and sustain improvements
 - **Training:** Belt system (Green, Black, Master Black Belt)
 - **Project selection:** Focus on high-impact problems
-

16) Explain the scope and industrial applications of Six Sigma.

Scope:

- Reduces defects to 3.4 per million opportunities
- Data-driven methodology for process improvement
- Applicable to manufacturing and service sectors

Applications:

- **Automotive:** Reduce assembly defects
 - **Electronics:** Improve soldering quality
 - **Pharmaceuticals:** Ensure dosage accuracy
 - **Healthcare:** Reduce medical errors
 - **Banking:** Streamline transaction processes
-

17) Analyze the relationship between process capability, control charts and Six Sigma.

- **Process capability:** Measures potential to meet specifications
- **Control charts:** Monitor process stability over time
- **Six Sigma:** Methodology to achieve 3.4 DPMO capability
- **Relationship:** Control charts maintain stability; capability indices quantify performance; Six Sigma drives improvement to reach world-class capability

- **Integration:** All three focus on reducing variation and defects

18) Analyze how vendor rating can improve incoming material quality and overall production performance.

- **Supplier accountability:** Ratings motivate vendors to maintain quality
- **Selection of best suppliers:** Data-driven decisions for sourcing
- **Reduced incoming defects:** Better vendor quality reduces inspection burden
- **Fewer production disruptions:** Reliable materials ensure smooth flow
- **Lower total cost:** Reduced rework, scrap, and warranty claims
- **Continuous improvement:** Feedback helps vendors improve

19) Define Total Quality Management (TQM) and explain its basic principles.

TQM: Organization-wide approach to continuously improve quality of products and processes.

Principles:

- **Customer focus:** Meet and exceed customer expectations
- **Continuous improvement:** Never-ending effort to improve
- **Employee involvement:** Everyone participates in quality
- **Process approach:** Manage activities as processes
- **Factual approach:** Decisions based on data
- **Leadership:** Management commitment and direction

20) Explain the role of quality circles in continuous quality improvement.

- **Definition:** Small group of employees voluntarily meeting to solve work-related problems
- **Problem identification:** Identify quality issues in their work area
- **Root cause analysis:** Investigate causes using QC tools
- **Solution development:** Propose and implement improvements
- **Employee empowerment:** Builds ownership and motivation
- **Continuous improvement:** Regular small improvements accumulate

21) Describe the 5S practice and explain its benefits in a manufacturing organization.

5S:

- **Seiri (Sort):** Remove unnecessary items
- **Seiton (Set in order):** Organize needed items
- **Seiso (Shine):** Clean workplace regularly
- **Seiketsu (Standardize):** Establish standards for above
- **Shitsuke (Sustain):** Maintain discipline

Benefits:

- Improved safety and reduced accidents
- Increased productivity and efficiency
- Better quality through organized workplace
- Reduced waste and search time
- Higher employee morale

22) What is Total Quality Control (TQC)? Explain its importance.

TQC: Company-wide system integrating quality control efforts across all departments and functions.

Importance:

- Involves all employees in quality
- Covers all stages from design to after-sales
- Focuses on prevention rather than detection
- Reduces cost and improves customer satisfaction
- Requires top management commitment

23) Define Failure Mode and Effects Analysis (FMEA) and explain its purpose.

FMEA: Systematic method to identify potential failures, their causes, and effects.

Purpose:

- Identify failure modes before they occur
- Assess severity, occurrence, and detection
- Prioritize risks using RPN (Risk Priority Number)
- Implement preventive actions
- Improve product/process reliability

24) Explain the concept and procedure of Fault Tree Analysis (FTA).

FTA: Deductive, top-down method to identify causes of a specific failure.

Procedure:

- Define top event (undesired failure)
- Identify immediate causes using logic gates (AND, OR)
- Continue down to basic events
- Construct fault tree diagram
- Analyze to find critical paths
- Recommend corrective actions

25) Explain the role of Kaizen approach with a suitable industrial example.

Kaizen: Continuous, incremental improvement involving everyone.

Role:

- Small, daily improvements
- Employee-driven suggestions
- Eliminates waste in processes
- Standardizes improvements

Example: Toyota production line—workers suggest small changes to reduce cycle time or eliminate motion waste, accumulating significant productivity gains over time.

26) Select an appropriate 7 QC tool for analyzing a given quality problem and justify your selection.

Note: Specific problem not provided. General approach:

- **Pareto Diagram:** For prioritizing problems (80/20 rule)
- **Cause-Effect Diagram:** For identifying root causes
- **Check Sheet:** For data collection
- **Histogram:** For understanding distribution
- **Scatter Diagram:** For correlation analysis
- **Control Chart:** For monitoring stability
- **Flow Chart:** For understanding process steps

Justification: Select based on objective—prioritization, root cause, monitoring, etc.

27) Compare the traditional 7 QC tools with the 7 new quality improvement tools.

Traditional 7 QC Tools	7 New Quality Tools
For data analysis	For planning and management
Numerical data focus	Verbal/idea focus
Pareto, Cause-Effect, Check Sheet, Histogram, Scatter, Control Chart, Flow Chart	Affinity, Tree, Matrix, Matrix Data Analysis, Arrow, PDPC, Relations Diagram
Used by operators	Used by managers

28) Define Lean Manufacturing and explain its major principles.

Lean Manufacturing: Production philosophy focused on eliminating waste while maximizing value.

Principles:

- **Value:** Define from customer perspective
- **Value Stream:** Map all steps and eliminate non-value-added
- **Flow:** Make value-creating steps flow smoothly
- **Pull:** Produce only what customer demands
- **Perfection:** Continuously improve toward zero waste

29) Define Agile Manufacturing and explain its importance in a changing market.

Agile Manufacturing: Ability to respond quickly to customer needs and market changes.

Importance:

- Rapid response to demand fluctuations
- Customization capability
- Reduced time-to-market
- Competitive advantage in dynamic markets
- Flexibility in product variety and volume

30) Explain the major principles of JIT production.

- **Zero inventory:** Materials arrive just when needed
- **Pull system:** Production triggered by customer demand
- **Continuous improvement:** Eliminate waste constantly
- **Small lot sizes:** Reduce batch quantities
- **Setup time reduction:** Enable quick changeovers
- **Supplier partnership:** Reliable, frequent deliveries
- **Quality at source:** No defects passed forward

31) What is a KANBAN system? Explain its working with a suitable example.

KANBAN: Visual signal system that triggers production or material movement based on consumption.

Working:

- Downstream process withdraws from upstream
- Card/signal indicates need for replenishment
- Upstream produces only what is signaled
- Limits work-in-progress inventory

Example: In automotive assembly, when a bin of parts is emptied, a Kanban card is sent to the feeding process to produce exactly one bin more.

32) Evaluate the benefits of implementing an ISO-based quality management system in a manufacturing organization.

- **International recognition:** Demonstrates commitment to quality
- **Consistent processes:** Documented procedures ensure uniformity
- **Customer confidence:** Certification builds trust
- **Continuous improvement:** Regular audits drive enhancement
- **Market access:** Often required for global customers
- **Reduced waste:** Systematic approach minimizes errors
- **Legal compliance:** Meets regulatory requirements
