GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Mechanical, Manufacturing, Production and Mechatronics
Subject Code: BE05000331
Subject Name: Quality and Reliability Engineering

w. e. f. Academic Year:	2025-26
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Nil
Rationale:	The course on Quality and Reliability Engineering provides essential knowledge of quality concepts, statistical quality control, total quality management, and reliability engineering for modern industrial applications. In a competitive environment, industries require consistent quality, reduced variability, and cost-effective processes. This course helps students understand inspection systems, process control, and quality assurance techniques. Statistical Quality Control (SQC) enables data-driven decision-making using tools such as control charts, process capability analysis, and acceptance sampling. The course also introduces TQM, Six Sigma, Lean, Agile Manufacturing, and Just-In-Time (JIT), which are vital for continuous improvement and waste reduction. Additionally, it covers service quality and cost of quality to balance performance and economic efficiency, along with ISO standards for global quality practices. Reliability engineering concepts help analyse product life and failure behaviour. Overall, the course prepares students to enhance product quality, improve processes, and achieve customer satisfaction in manufacturing and service industries.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Apply principles of quality management to analyze inspection methods, quality control systems, and their role in improving product design, manufacturing, and performance.	18
CO-2	Analyze process variation and evaluate process capability using statistical quality control tools such as control charts and acceptance sampling techniques.	22
CO-3	Evaluate service quality and cost of quality models to improve organizational performance and customer satisfaction.	16
CO-4	Apply Total Quality Management (TQM) tools and techniques, along with modern manufacturing approaches like Lean, Agile, and JIT, to enhance productivity and continuous improvement.	22
CO-5	Analyze reliability concepts, failure mechanisms, and life characteristics to assess and improve system reliability over the product life cycle.	22

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

**** Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Quality:** Concept, Different Definitions and Dimensions, Inspection: Need for inspection, types of inspections, inspection stages-where and how much to inspect, organizing for inspection, Quality Control: Basic objectives, Product effectiveness & quality of design, manufacture and performance, total systems cost, quality assurance, benefits from quality assurance on reliability and quality control, quality control and production relationship in organization structure.	8
2	**Statistical Quality Control** Quality control-its introduction and benefits, Variation in processes: factors, process capability & Its analysis, control charts for variables and attributes, Establishing & interpreting control charts, Concept of Acceptance Sampling, sampling by attributes, single and double sampling plans, inspections by samples, AQL, LTPD, consumers and producer's risk, construction and use of operating characteristic curves, use of standard sampling tables and related IS, sampling by variables, Continuous sampling plan, vendor ratings. Concept of six sigma: Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation of all as applicable	10
3	**Service Quality management and Cost of Quality** Products and services, Classification of services, Service Quality, Measuring Service Quality, Prevention costs, Appraisal Costs, Internal and External failure costs, Cost of quality models, India's Quality Journey so far, Quality management in India, Quality related priorities of Indian companies, Case studies	7
4	**Total Quality Management (TQM):** Introduction, Definitions and Principles of Operation, Tools and Techniques, such as, Quality Circles, 5 S Practice, Total Quality Control (TQC), Total Employee Involvement (TEI), Problem Solving Process, Quality Function Deployment (QFD), Failure Mode and Effect analysis (FMEA), Fault Tree Analysis (FTA), Kaizen, Poka-Yoke, 7QC Tools, PDCA Cycle, 7 New Quality Improvement Tools, TQM	10

	Implementation and Limitations. Basic concept of Concurrent Engineering, Lean Manufacturing, Agile Manufacturing, and World Class Manufacturing. Introduction to JIT production system, KANBAN system, JIT and Quality Production. ISO 9000, ISO 14000 and QS 9000: Basic Concepts, Scope, Implementation, Benefits, Implantation Barriers.	
5	**Reliability Engineering:** Introduction, Concepts of Reliability and failure: Reliability, Failure, Failure mechanism, failure severity and consequences. Reliability basic functions: Probability density function, cumulative function and reliability function, conditional distribution and residual life, failure rate and cumulative hazard functions, relation between reliability basic functions. Life characteristics: Measure of life time, Dispersion of lifetime, Skewness and kurtosis of life dispersion. Reliability of repairable system: Failure repair process, Reliability measure, Reliability point process. Evolution of reliability over Product life cycle: Design reliability, Inherent reliability, Reliability at sale, field reliability.	**10**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**25**	**25**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Quality and Reliability Engineering* directly contributes to

SDG 3	**Good health and well being**
SDG 6	**Clean water and Sanitation**
SDG 7	**Affordable and clean energy**
SDG 8	**Decent work and Economic growth**
SDG 9	**Industry Innovation and Infrastructure**
SDG 11	**Sustainable cities**
SDG 12	**Responsible consumption**
SDG 13	**Climate action**

Reference Books:

1. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India
2. Introduction to Quality and Reliability Engineering, Jiang R, Springer Publication, 2015.
3. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers
4. Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Educaiton
5. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
6. Reliability Engineering by Srinath L. S., Affiliated East West Press.
7. Total Quality Management by K C Arora, S K Kataria & Sons
8. Total Quality Management: Poornima M. Charantimath, Pearson education(Singapore) Pte. Ltd.
9. Managing for Total Quality: N. Logothetis, Prentice Hall of India Pvt. Ltd.
10. Managing Quality : Barrie G. Dole, Blackwell publishing
11. TQM – an integrated approach – Samunel K Ho, Crest pubslishing House.

Standards and Act:

1. **IS 2500 (Part 1–5)** – Sampling inspection tables (by attributes & variables)
2. **IS 397 (Part 1 & 2)** – Methods for statistical quality control
3. **IS 7873** – Guide for control charts
4. **IS 10675** – Guide on quality control systems
5. **IS 10201** – Methods of inspection and sampling
6. I**S 2500 (Part 1 &2)** – Sampling plans indexed by AQL, Sampling plans indexed by LTPD
7. **IS/ISO 9001:2015** – Quality Management Systems (QMS requirements)
8. **IS/ISO 9000:2015** – Fundamentals and vocabulary
9. **IS/ISO 14001:2015** – Environmental management systems
10. **IS 11810** – Reliability testing and estimation methods
11. **IS 13369 (Part series)** – Reliability terminology and concepts
12. **IS 13567** – Reliability program management
13. **IS/IEC 61703** – Mathematical expressions for reliability, availability

List of Experiments:

1. Experiments/Exercise on Basic Quality Data Analysis
2. Experiments/Exercise on Control Charts for Variables ($\bar{X}$ & R Chart)
3. Experiments/Exercise on Control Charts for Attributes (p, np, c, u Charts)
4. Experiments/Exercise on Process Capability Analysis (Cp, Cpk)
5. Experiments/Exercise on Acceptance Sampling Plan & OC Curve
6. Experiments/Exercise on Pareto Analysis and Cause-Effect Diagram
7. Experiments/Exercise on Failure Mode and Effect Analysis (FMEA)
8. Experiments/Exercise on Quality Function Deployment (QFD)
9. Experiments/Exercise on Process Simulation using Lean/JIT Concepts
10. Experiments/Exercise on Service Quality Measurement
11. Experiments/Exercise on Cost of Quality Analysis
12. Experiments/Exercise on Reliability Analysis using Weibull Distribution
13. Experiments/Exercise on Failure Data Analysis and Reliability Estimation of Repairable Systems

Major Equipment:

Nil

List of Open Source Software

1. Python: NumPy, Pandas, SciPy, Statsmodels: Six Sigma projects
2. LibreOffice
3. JASP (Jeffreys's Amazing Statistics Program) is an open-source software application for statistical analysis
4. R is a free, open-source programming language and environment designed for statistical computing, data analysis, and visualization

List of learning website:

http://nptel.ac.in/courses/

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment

7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group	Group Discussion	Duration = 1h – 3h per	Based on performance in group

	Discussion / Quiz / Simulation	on emerging/trending technical topics based on subject	topic	discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Quality and Reliability Engineering compulsorily incorporates Micro Project and 5 marks as PBL activities for PEC and Seminar and Mini Project for PCC.**

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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